Application Note

Programming in Production with TPLD

Nikki Dengel

ABSTRACT

This document provides a comprehensive guide for designers and manufacturers who wish to perform in-house programming of TI Programmable Logic Devices (TPLDs) that support in-line programming. Although TPLD can be ordered pre-programmed with no additional cost, users can increase flexibility in their design and manufacturing process by utilizing the in-line programming options that TPLD provides. This guide outlines how to program TPLD at the end of your own factory line and how to utilize TPLD's Always Configure mode.

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Trademarks

1 Introduction

This document provides the programming procedure for TI Programmable Logic Devices (TPLDs) with one-time programmable (OTP) memory that support in-line programming. When utilizing TPLD, there are three options for programming:

1. TPLD can be ordered pre-programmed directly from TI with no additional cost. See TPLD Ordering Process for more information.
2. TPLD can be programmed at the end of the factory line (in-line) by following the Configuration and Permanent Programming procedures outlined in this document.
3. TPLD can be operated in an *Always Configure* mode in which the device boots up without a configuration (blank) and is configured after start-up without locking the OTP. This procedure is also outlined in this document.

2 Programming Flow Chart

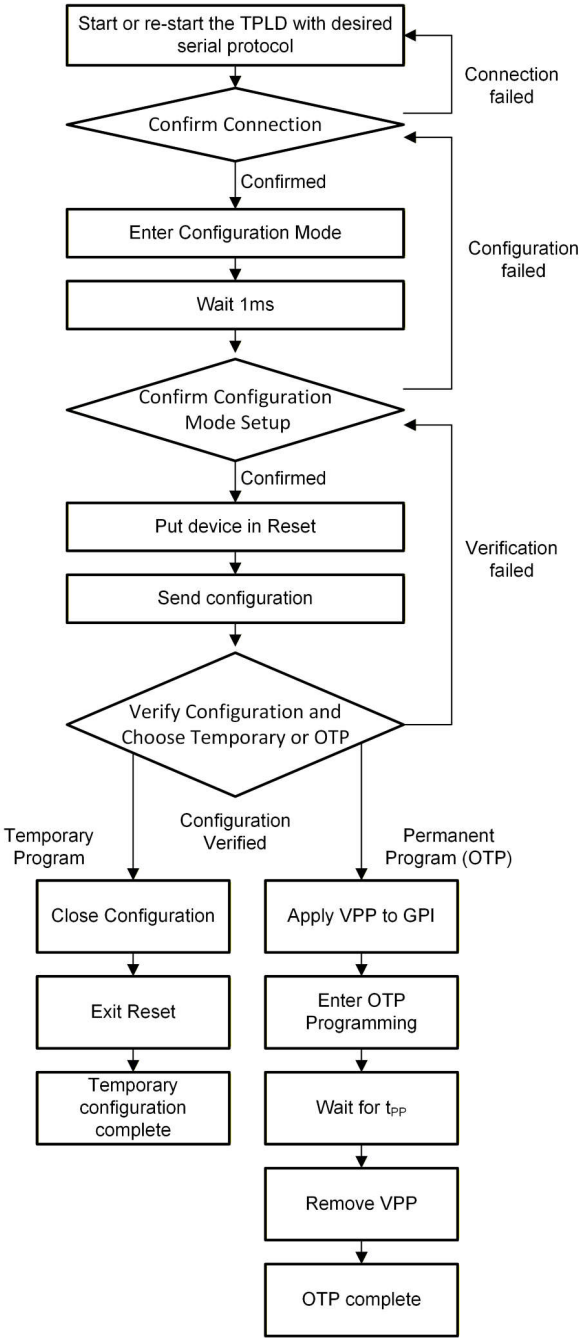

Figure 2-1. TPLD Programming Flow Chart

3 Hardware Requirements and Selectable I2C/SPI Interface

Certain hardware requirements vary by TPLD. Check the datasheet for the specific device to determine the supported serial communication modes, speeds, and I/O and pin number associations for the following:

- Specifications for programming: programming voltage (VPP), programming time (t_{PP}), and startup time (t_{SU}).
- Pin Configuration and Functions for I2C: VPP, Interface Select (optional), SCL, SDA, Address 6 (A6), A5, A4, and A3.
- Pin Configuration and Functions for SPI: VPP, Interface Select, nCS, SCLK, SDI (COPI), and SDO (CIPO).

In an unprogrammed TPLD, the Interface Select pin is sampled at device power up to determine which interface the TPLD boots up with after t_{su}(max).

As an example, when the Interface Select pin of TPLD2001 is tied to GND (logic low) or floating, the TPLD2001 is configured with an I2C interface with the first four bits of the target address determined by the respective HW Addr IO and the next three bits default to 001b, or ADDR = [A6][A5][A4][A3][0][0][1], hereafter referred to as ADDR.

When the Interface Select pin of TPLD2001 is tied to VCC (logic high), the TPLD2001 starts up with an SPI interface.

4 Temporary Configuration Procedure

This section will outline the configuration procedure. The following examples uses TI USB2ANY and the TPLD2001. This procedure can be replicated using any I^{2}C or SPI host/controller and any TPLD that supports in-line programming.

Step 1: Start or re-start the device with the desired serial communications protocol, then read the DEVICE_ID from registers 0x000 and 0x001 to confirm that the communication with the device has been established.

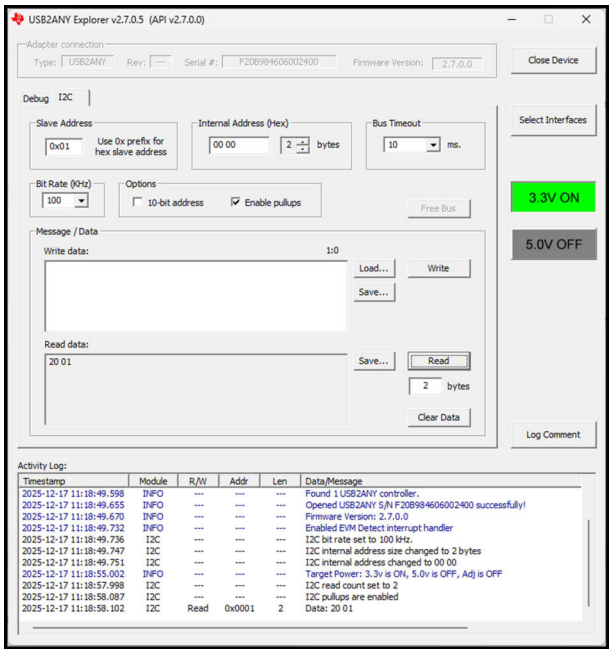

Figure 4-1. Step 1: I^{2}C

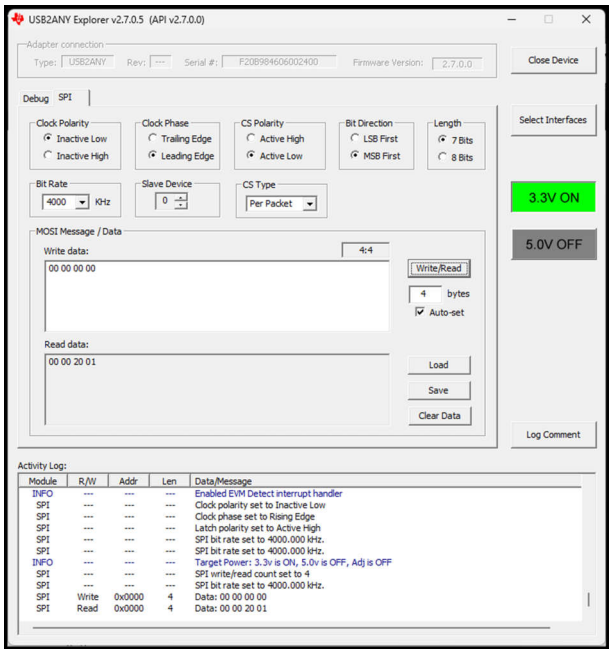

Figure 4-2. Step 1: SPI

Step 2: Enter configuration mode.

- For SPI, send the following four frames with at least 200µs between frames: 0x9000B9, 0x90003E, 0x9000AF, 0x900058.
- For I^{2}C, use four write transactions to send the following with at least 500µs between transactions:
  - Transaction 1: BYTE0 = ADDR, BYTE1 = 0x01, BYTE2 = 0xB9
  - Transaction 2: BYTE0 = ADDR, BYTE1 = 0x01, BYTE2 = 0x3E
  - Transaction 3: BYTE0 = ADDR, BYTE1 = 0x01, BYTE2 = 0xAF
  - Transaction 4: BYTE0 = ADDR, BYTE1 = 0x01, BYTE2 = 0x58

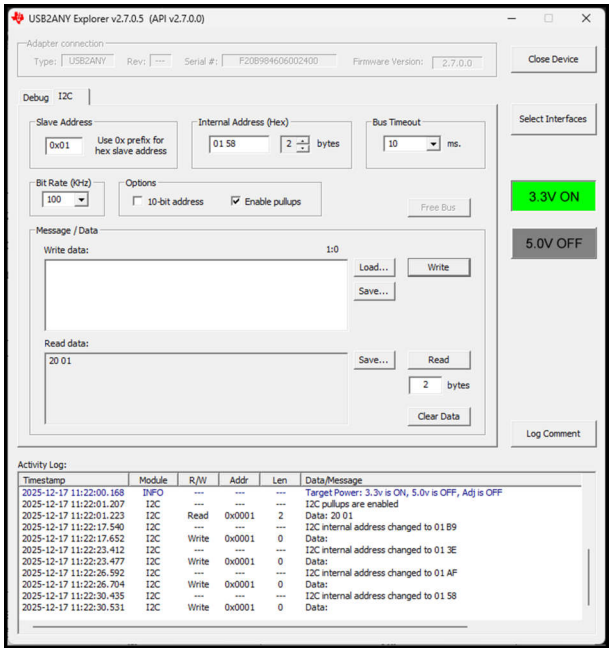

Figure 4-3. Step 2: I²C

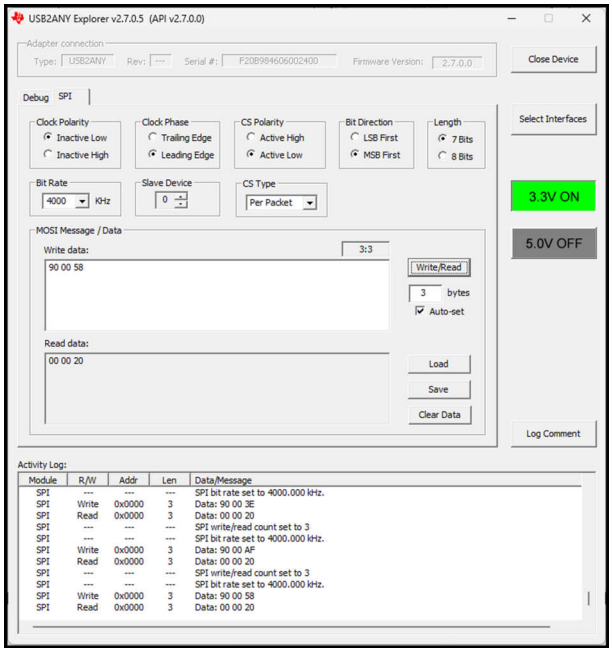

Figure 4-4. Step 2: SPI

Step 3: After the final frame is sent, wait 1ms.

Step 4: Make sure the configuration mode has been entered correctly by reading 0x10 from register 0x400.

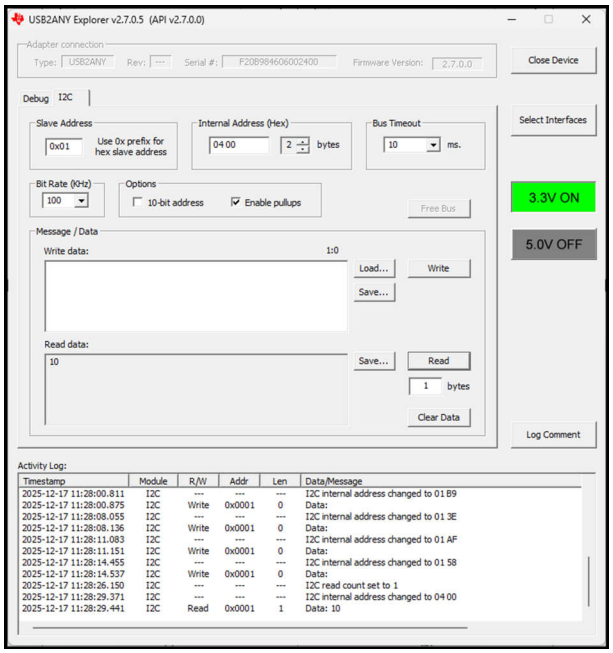

Figure 4-5. Step 4: I²C

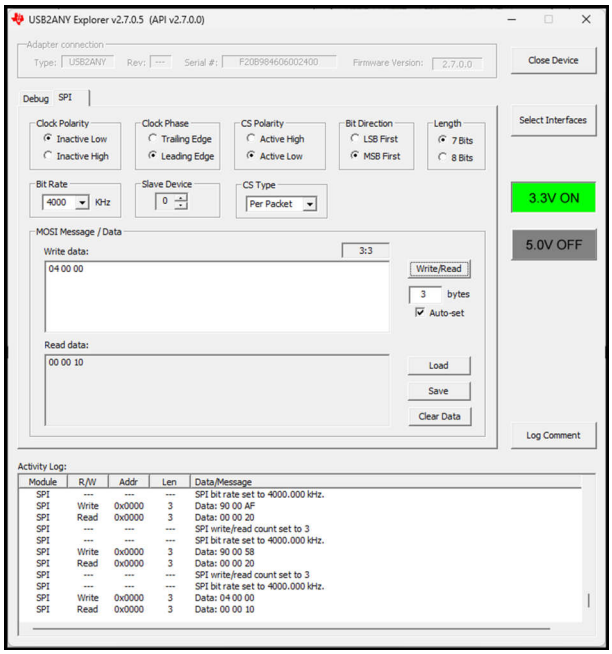

Figure 4-6. Step 4: SPI

Step 5: Put the device is reset mode by writing 0x02 to register 0x400.

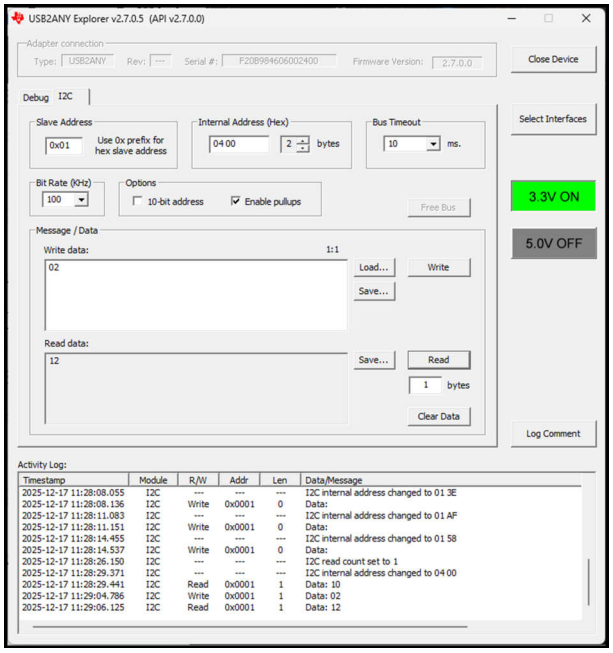

Figure 4-7. Step 5: I²C

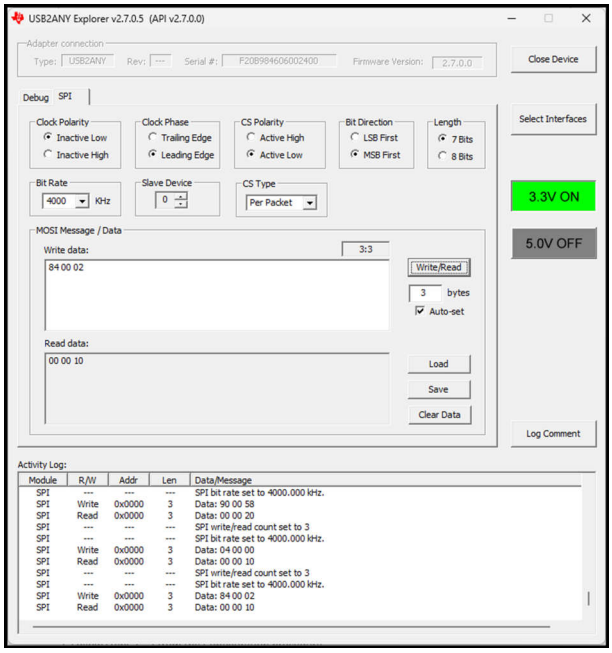

Figure 4-8. Step 5: SPI

Step 6: Send configuration bits to 0x200 - 0x3FF.

Step 7: If desired, use read commands to verify the correct data was written to the device.

Step 8: Then close the configuration by sending the following:

- For SPI, send the following frame: 0x90004B.
- For I²C, send the following write transaction: BYTE0 = ADDR, BYTE1 = 0x01, BYTE2 = 0x4B.

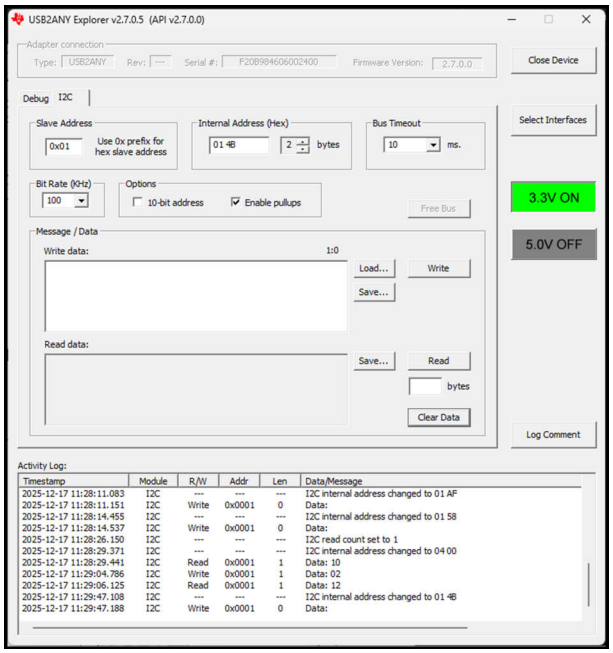

Figure 4-9. Step 8: I²C

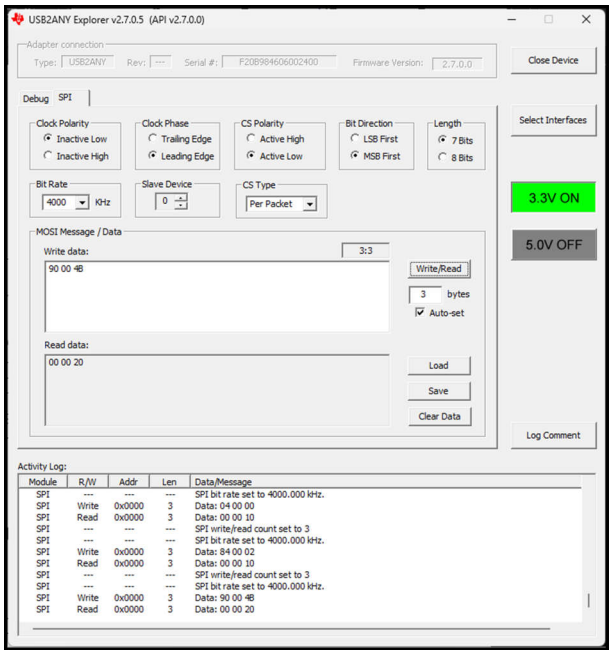

Figure 4-10. Step 8: SPI

Step 9: Write 0x00 to register 0x400 for the configuration to take effect and exit reset mode.

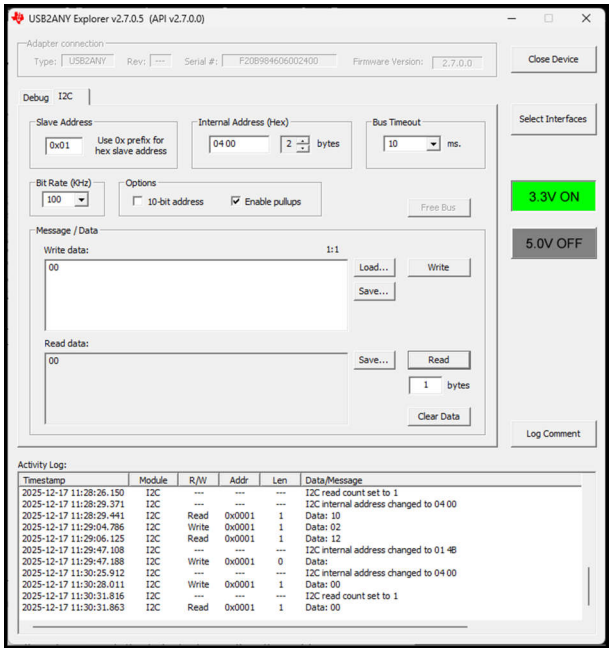

Figure 4-11. Step 9: I²C

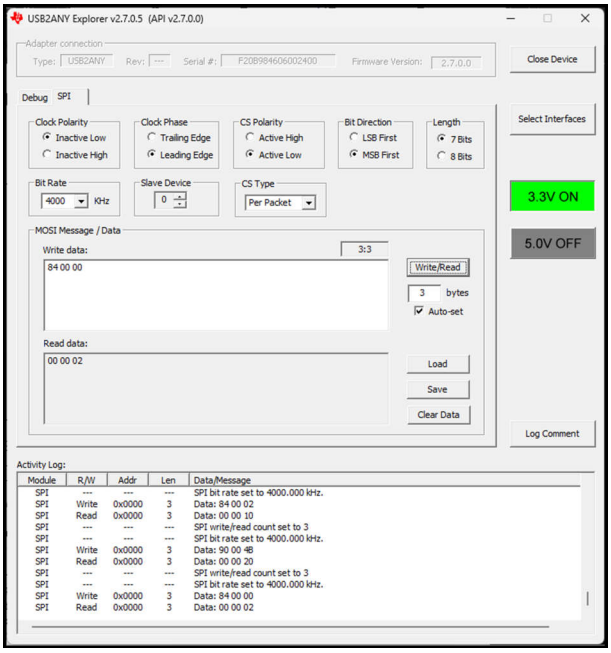

Figure 4-12. Step 9: SPI

Step 10: The device is now temporarily configured. This configuration can be cleared by power cycling the device.

5 Permanent Programming Procedure

1. If the device has been temporarily configured, power cycle the device to clear configuration registers.
2. Follow steps one to seven from Section 4.
3. Apply VPP to the GPI pin.
4. Write 0x01 to register 0x401 to start the OTP programming.
5. Wait t_{PP} for the programming to be complete.
6. Remove VPP from the GPI pin.
7. Device OTP is now burned. Permanent programming is complete.

6 Summary

This document provides a step-by-step guide to temporarily configuring and permanent programming of TPLDs that have the in-line programming feature that allows the user to program the device on a factory line. In-line programming allows greater programming flexibility and control over the TPLD internal configuration over the option of ordering pre-programmed TPLDs. The devices can be configured using I^2C or SPI interfaces, and a series of frames or transactions must be sent to complete the configurations.

When getting started with in-line programming, check the datasheet of the specific device being programmed to ensure correct programming procedures. Although this document uses TPLD2001 and TI's USB2ANY as examples, the procedure defined in this document can be applied to any of the TPLD that allow in-line programming and any I^2C or SPI controller.

TPLD allows engineers to design-in and integrate logic and level translators into a single device, simplifying the BOM and reducing design size. For more information on TPLD, visit the product page of a specific device or ask our engineers a question on the TI E2E™ Support Forum.

7 References

- Texas Instruments, TI Programmable Logic Devices, webpage.
- Texas Instruments, *TPLD In-System Developing*, application brief.
- Texas Instruments, *TPLD Ordering Process*, application note.

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Last updated 10/2025