



# **MCP46XXEV**

## **Evaluation Board**

### **User's Guide**

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# MCP46XXEV EVALUATION BOARD USER'S GUIDE

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NOTES:

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## Preface

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### NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site ([www.microchip.com](http://www.microchip.com)) to obtain the latest documentation available.

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 on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

## INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP46XXEV Evaluation Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- The Microchip Web Site
- Customer Support
- Document Revision History

## DOCUMENT LAYOUT

This document describes how to use the MCP46XXEV Evaluation Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the MCP46XXEV Evaluation Board.
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with this evaluation board.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the MCP46XXEV Evaluation Board.
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MCP46XXEV Evaluation Board.

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

Description	Represents	Examples
<b>Arial font:</b>		
Italic characters	Referenced books	<i>MPLAB<sup>®</sup> IDE User's Guide</i>
	Emphasized text	...is the <i>only</i> 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	<u><i>File&gt;Save</i></u>
Bold characters	A dialog button	Click <b>OK</b>
	A tab	Click the <b>Power</b> 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>

## RECOMMENDED READING

This user's guide describes how to use the MCP46XXEV Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

**AN1080 Application Note, “*Understanding Digital Potentiometer Resistor Variations*”, DS01080**

**AN1316 Application Note, “*Using Digital Potentiometers for Programmable Amplifier Gain*”, DS01316A**

These data sheets provide detailed information regarding the MCP46XX product family:

**MCP463X/5X Data Sheet, “*7/8-Bit Quad I<sup>2</sup>C Digital POT with Volatile Memory*”, DS22096**

**MCP464X/6X Data Sheet, “*7/8-Bit Quad I<sup>2</sup>C Digital POT with Non-Volatile Memory*”, DS22107**

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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

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://support.microchip.com>

In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 – United States and most of Canada

1-480-792-7302 – Other International Locations

## DOCUMENT REVISION HISTORY

### Revision A (March 2010)

- Initial Release of this Document.



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## Chapter 1. Product Overview

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### 1.1 INTRODUCTION

This chapter provides an overview of the MCP46XXEV Evaluation Board and covers the following topics:

- What is the MCP46XXEV Evaluation Board?
- What the MCP46XXEV Evaluation Board kit includes

### 1.2 WHAT IS THE MCP46XXEV EVALUATION BOARD?

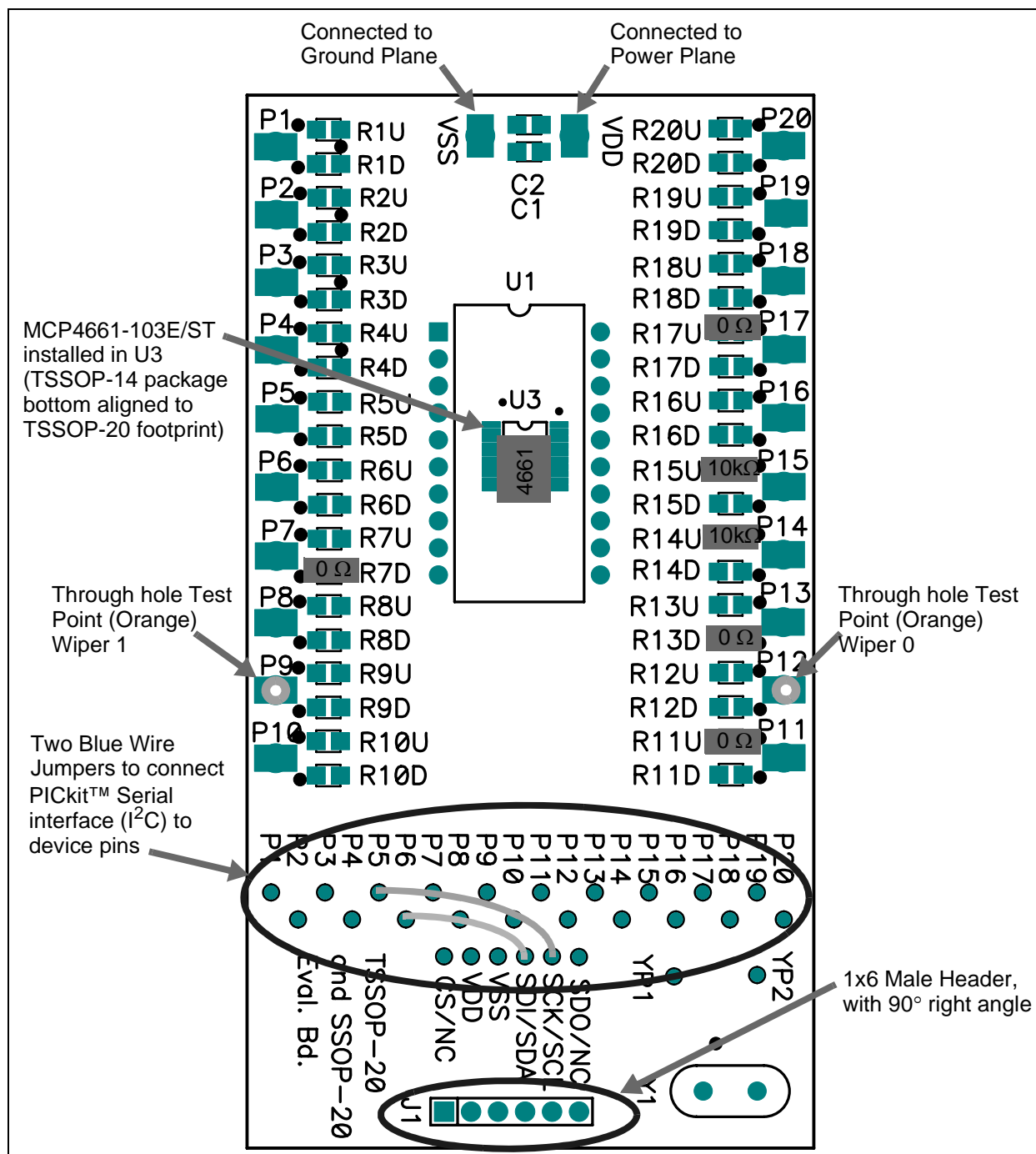
The MCP46XXEV Evaluation Board allows the system designer to quickly evaluate the operation of Microchip Technology's MCP4661 Digital Potentiometer device. This device is similar to the following devices:

- MCP4531
- MCP4532
- MCP4541
- MCP4542
- MCP4551
- MCP4552
- MCP4562
- MCP4631
- MCP4632
- MCP4641
- MCP4642
- MCP4651
- MCP4652
- MCP4661
- MCP4662

The board uses the TSSOP20EV generic PCB and has been populated for the MCP4661. The 6-pin header (PICKit™ serial) has been jumpered to the MCP4661's appropriate pins. This allows the PICKit serial to communicate with the device.

Additional blank PCBs may be ordered by using the order number: TSSOP20EV. Each TSSOP20EV kit contains 5 PCBs.

Figure 1-1 shows the top view of the populated TSSOP20EV PCB which creates the MCP46XXEV Evaluation Board.



**FIGURE 1-1:** MCP46XXEV Evaluation Board Using the TSSOP20EV Evaluation Board (MCP4661 installed in U3).

## 1.3 WHAT THE MCP46XXEV EVALUATION BOARD KIT INCLUDES

This MCP46XXEV Evaluation Board kit includes:

- MCP46XXEV Evaluation Board
- One TSSOP-20 and SSOP-20 Evaluation Board blank PCB, 102-00272. Extra blank PCBs can be ordered (order #: TSSOP20EV).
- Important Information Sheet

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## Chapter 2. Installation and Operation

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### 2.1 INTRODUCTION

The MCP46XXEV Evaluation Board allows the system designer to quickly evaluate the operation of the MCP4661 10 k $\Omega$  (-103) digital potentiometer device using the PICkit Serial Analyzer. The PICkit Serial Analyzer is available separately (order number: DV164122).

This board is a minimum configuration for the device. As well as the device, other desired passive components (resistors and capacitors) and connection posts may be installed.

The board can also be very easily jumpered into a customer's existing circuit. This gives an indication of the MCP4661 device performance, but is affected by the jumper lead length and the EM noise that the jumpers pick up.

The MCP4661 has two resistor networks. The device's Resistor Network 0 has been configured in a Potentiometer mode with the A terminal connected to  $V_{DD}$  through a 0 $\Omega$  resistor and the B terminal connected to  $V_{SS}$  with a 0 $\Omega$  resistor. Resistor Network 1 can be evaluated for rheostat operation.

The MCP46XXEV Evaluation Board uses the generic TSSOP20EV Evaluation Board PCB. The kit includes a second PCB which is blank for the user to populate as desired. Additional PCBs may be ordered (order number: TSSOP20EV). The TSSOP20EV kit includes 5 blank PCBs.

Other boards can easily be built up using the TSSOP20EV PCB to allow evaluation of other resistance options (5 k $\Omega$ , 50 k $\Omega$ , or 100 k $\Omega$ ) or any of the other digital potentiometer devices in the following packages:

- TSSOP-20 package
  - MCP4331, MCP4341, MCP4351, or MCP4361
- TSSOP-14 package
  - MCP4332, MCP4342, MCP4352, MCP4362, MCP4231, MCP4241, MCP4251, MCP4261, MCP4631, MCP4641, MCP4651, MCP4661, MCP42010, MCP42050, or MCP42100

The board also has a 6-pin interface (PICkit serial, ICSP™, etc.) whose signals can easily be jumpered to any of the device's pins.

Additional information on using the TSSOP20EV Evaluation Board PCB or for modifying the MCP46XXEV Evaluation Board is available in the TSSOP20EV User's Guide (DS51875). **Appendix A. "Schematic and Layouts"** has information on the PCB schematic and layout while Figure 2-2 shows components that are installed on the PCB.

## 2.2 FEATURES

The MCP46XXEV Evaluation Board has the following features:

- MCP4661-103E/ST is installed
- $0\Omega$  resistors connect MCP4661  $V_{DD}$  and  $V_{SS}$  signals to the appropriate power or ground plane (see Figure 2-2)
- $0\Omega$  resistors connect MCP4661's Resistor Network 0 A terminal signal to power plane, resistor network is in a voltage divider configuration (see Figure 2-2)
- $0\Omega$  resistors connect MCP4661's Resistor Network 0 B terminal signal to ground plane, resistor network is in a voltage divider configuration (see Figure 2-2)
- Through-hole connection terminal (orange) for all wiper pins
- Connection terminal points for all device pins (either through-hole or surface-mount)
- Footprints for optional passive components (SMT 805 footprint) for:
  - Power supply filtering ( $C_1$  and  $C_2$  footprints)
  - Device bypass capacitor (RxD footprint for device pin connected to  $V_{DD}$ )
- Silk-screen area to write specifics of implemented circuit (on back of PCB), such as MCP4661 10 k $\Omega$
- PICKit Serial Analyzer Header

The included TSSOP20EV Board has the following features:

- Connection terminals may be either through-hole or surface-mount
- Three package type footprints supported:
  - TSSOP-20
  - TSSOP-14
  - TSSOP-8
  - SSOP-20
  - DIP-20 (600 mil body)
- Footprints for optional passive components (SMT 805 footprint) for:
  - Power supply filtering ( $C_1$  and  $C_2$  footprints)
  - Device bypass capacitor (RxD footprint for device pin connected to  $V_{DD}$ )
  - Output filtering (RxD footprint)
  - Output pull-up resistor (RxU footprint)
  - Output pull-down resistor (RxD footprint)
  - Output loading resistor (RxD footprint)
- Silk-screen area to write specifics of implemented circuit (on back of PCB), such as MCP4661 10 k $\Omega$
- PICKit Serial Analyzer / PICKit 2 Programming (ICSP™) Header

## 2.3 GETTING STARTED

The MCP46XXEV Evaluation Board allows quick evaluation of the MCP4661-103E/ST device. The understanding of the device characteristics (such as the resistor network) is applicable to any of the devices in the MCP46XX family. The MCP4661-103 device has a typically  $R_{AB}$  resistance of 10 k $\Omega$ . Evaluation can be done by:

- Using the PICkit Serial Analyzer for interface communication
- Jumpering the MCP46XXEV Evaluation Board into your application circuit to control the MCP4661-103 device

This user guide will discuss the steps needed to evaluate the MCP4661-103E/ST device using the PICkit Serial Analyzer (order number: DV164122).

**Section 2.5 “Configuring The PICkit™ Serial Analyzer”** shows the steps to configure the PICkit Serial Analyzer as well as create User Script files which are used to communicate with the MCP4661, based on the device's SPI communication protocol format.

## 2.4 MCP46XXEV EVALUATION BOARD DESCRIPTION

The MCP46XXEV Evaluation Board uses the flexible TSSOP20EV Evaluation Board PCB. This simple evaluation board allows the system designer to quickly evaluate the operation of the MCP4661-103 device ( $R_{AB(TYP)} = 10 \text{ k}\Omega$ ) using the PICkit Serial Analyzer or by jumpering the board into their application system. The PICkit Serial Analyzer is available separately (order number: DV164122).

### 2.4.1 The Hardware

Figure 2-2 shows the component layout of the MCP46XXEV Evaluation Board. This is a small four-layer board (3.9" x 2.1" (99.06 mm x 53.34 mm)). There are twenty-two connection points/pads that can use either through-hole or surface-mount connector posts.

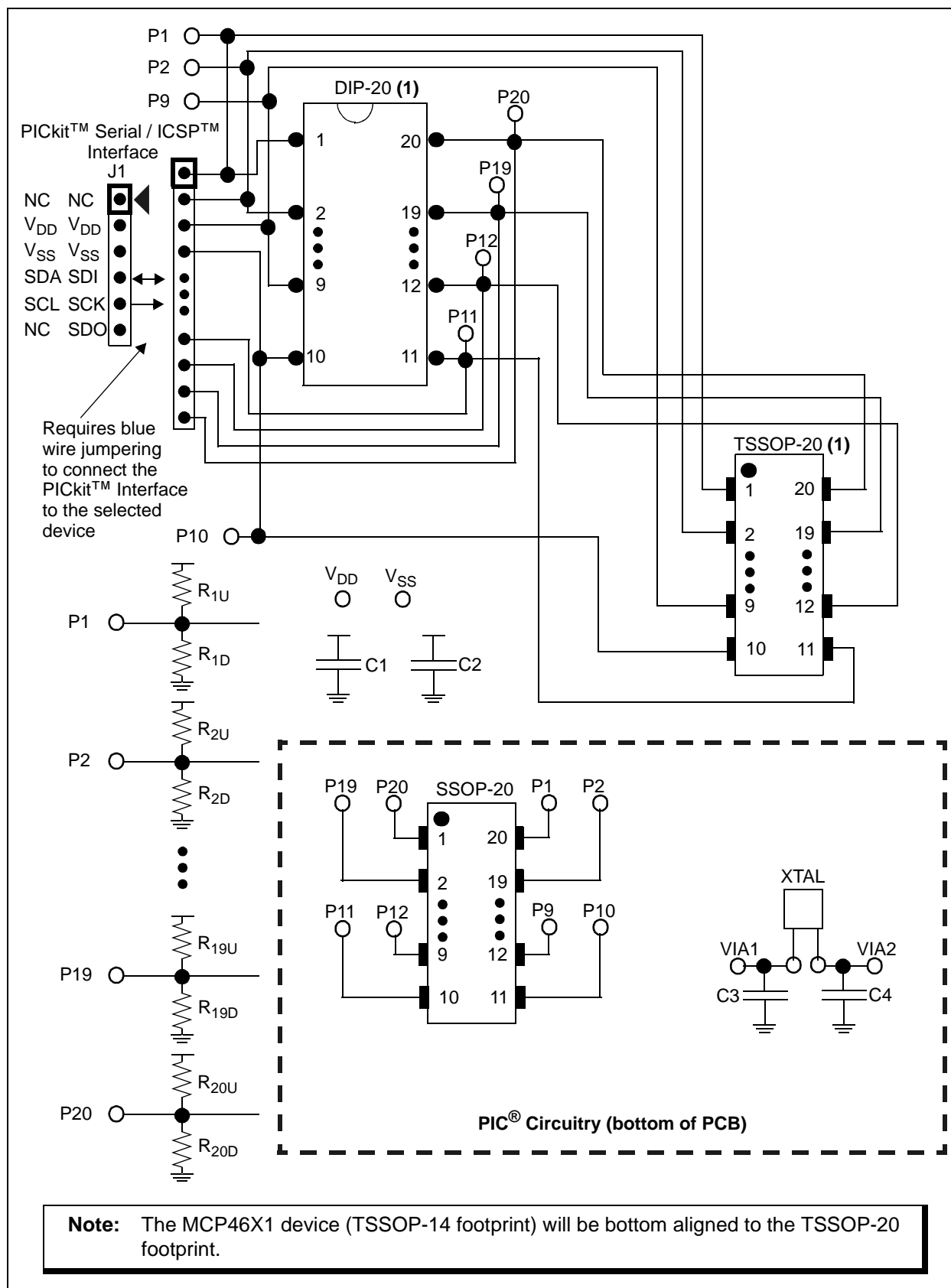
The pad labeled  $V_{DD}$  is connected to the PCB power plane, while the pad labeled  $V_{SS}$  is connected to the PCB ground plane. All the passive components that are connected to  $V_{DD}$  or  $V_{SS}$  are connected to either the power plane or ground plane.

The twenty remaining PCB pads correspond to the device pins (i.e.; pad 1 connects to pin 1).

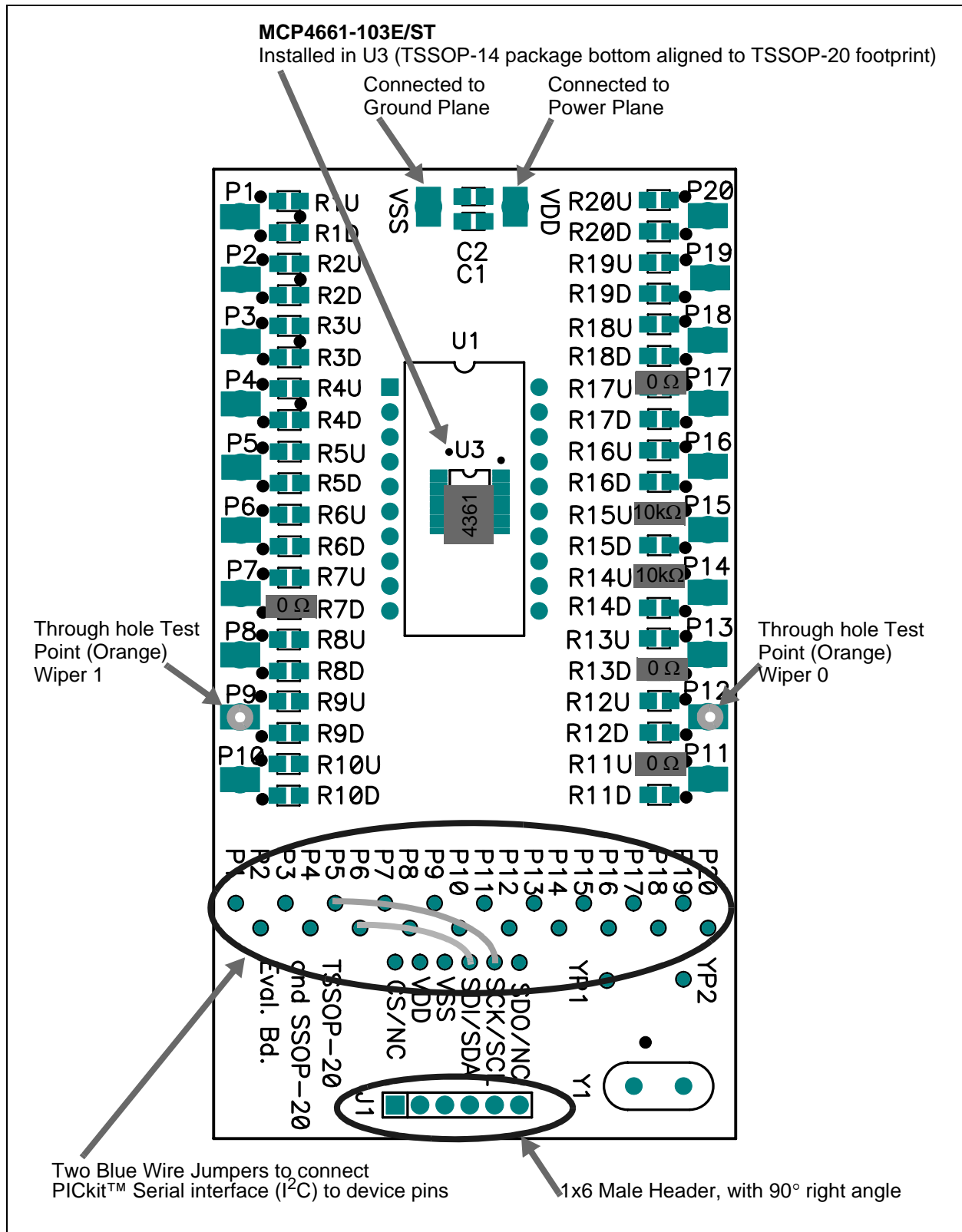
Each pad has two passive components associated with them: a pull-up resistor and a pull-down resistor. The pull-up resistor is always RXU and the pull-down resistor is RXD. The “X” is a numeric value that corresponds to a particular pad (1 to 8). As an example, Pad 5's pull-up resistor is R5U. Capacitor C1 and C2 are the power supply filtering capacitors. For whichever pin is the device's  $V_{DD}$ , the RxD component footprint can be used for the device's bypass capacitor. Table 2-2 describes the components.

A 6-pin header interface is available to support the PICkit Serial or the PIC® MCU In-Circuit Serial Programming™ (ICSP™) interface.

The MCP4661 is bottom aligned in the U3 footprint so that the interface signals are on the same U3 package pins as future device. This is planned to be similar to the footprint compatibility between the MCP42X1 and MCP43X1 devices.



**FIGURE 2-1:** TSSOP20EV Evaluation Board Circuit.



**FIGURE 2-2:** MCP46XXEV Evaluation Board Component Placement Using the TSSOP20EV Evaluation Board (Top).

# MCP46XXEV Evaluation Board User's Guide

**TABLE 2-1: INSTALLED PASSIVE COMPONENTS <sup>(2)</sup>**

Component	Description	Comment
R11U, R17U	0 $\Omega$ SMT 805	Pull-up resistor
R14U, R15U	10 k $\Omega$ SMT 805	Pull-up resistor
R7D, R13D	0 $\Omega$ SMT 805	Pull-down resistor <sup>(1)</sup>
U3	MCP4661-103E/ST	R <sub>AB(TYP)</sub> = 10 k $\Omega$
P9, P12	Test Point - through hole connector (Orange)	
J1	1x6 Male Header, 100 mil spacing 90° angle.	PICkit™ Serial / ICSP™ header
—	Blue Wire: J1 SDI/SDA via to P6 via J1 SCK/SCL via to P5 via	See Figure 2-2

**Note 1:** Whichever pin is the device's V<sub>DD</sub> pin, that corresponding RXD footprint can be used for the device's bypass capacitor. So if Pin 8 is the device's V<sub>DD</sub> pin, then install the bypass capacitor in the R8D footprint.

**2:** All passive components use the surface mount 805 footprint.



**TABLE 2-2: OPTIONAL PASSIVE COMPONENTS - NOT INSTALLED <sup>(2)</sup>**

Component	Comment
C1, C2	Power supply bypass capacitors <sup>(3)</sup>
C3, C4	PIC <sup>®</sup> MCU Crystal capacitors
R1U, R2U, R3U, R4U, R5U, R6U, R7U, R8U, R9U, R12U, R13U, R16U, R18U, R19U, R20U	Pull-up resistor
R1D, R2D, R3D, R4D, R5D, R6D, R8D, R9D, R10D, R11D, R12D, R14D, R15D, R16D, R17D, R18D, R19D, R20D	Pull-down resistor <sup>(1)</sup>
U1, U2	Alternate package footprints
VDD, GND	Power and Ground plane connection points
Y1	Can connect to either PIC <sup>®</sup> MCU's main oscillator or to the Timer oscillator circuit.
P1, P2, P3, P4, P5, P6, P8, P10, P11, P13, P14, P15, P16, P17, P18, P19, P20	Test Point connectors

**Note 1:** Whichever pin is the device's  $V_{DD}$  pin, that corresponding RXD footprint can be used for the device's bypass capacitor. So if Pin 8 is the device's  $V_{DD}$  pin, then install the bypass capacitor in the R8D footprint.

**2:** All passive components use the surface mount 805 footprint.

**3:** If the board is powered via the  $V_{DD}$  and GND connection points, the use of bypass capacitors on C1 and C2 may improve performance. The benefit is reduced if the board is powered via the PICKIT<sup>™</sup> serial interface.

## 2.4.2 The MCP4661 Device

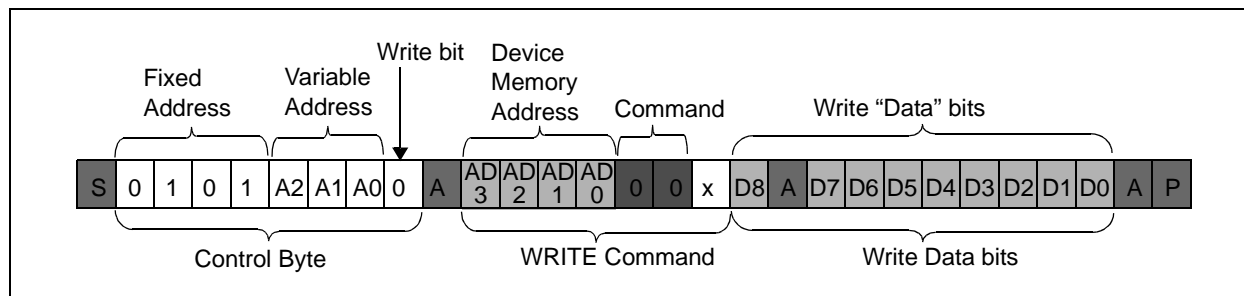
To make variations to the commands sent to the MCP4661 device (from the commands shown in the demo section), one must know the device memory map (see Table 2-3) and the command formats (see Figure 2-3 through Figure 2-5). For additional device operational information, refer to the MCP4661 device data sheet (DS22107).

**TABLE 2-3: MEMORY MAP AND THE SUPPORTED COMMANDS**

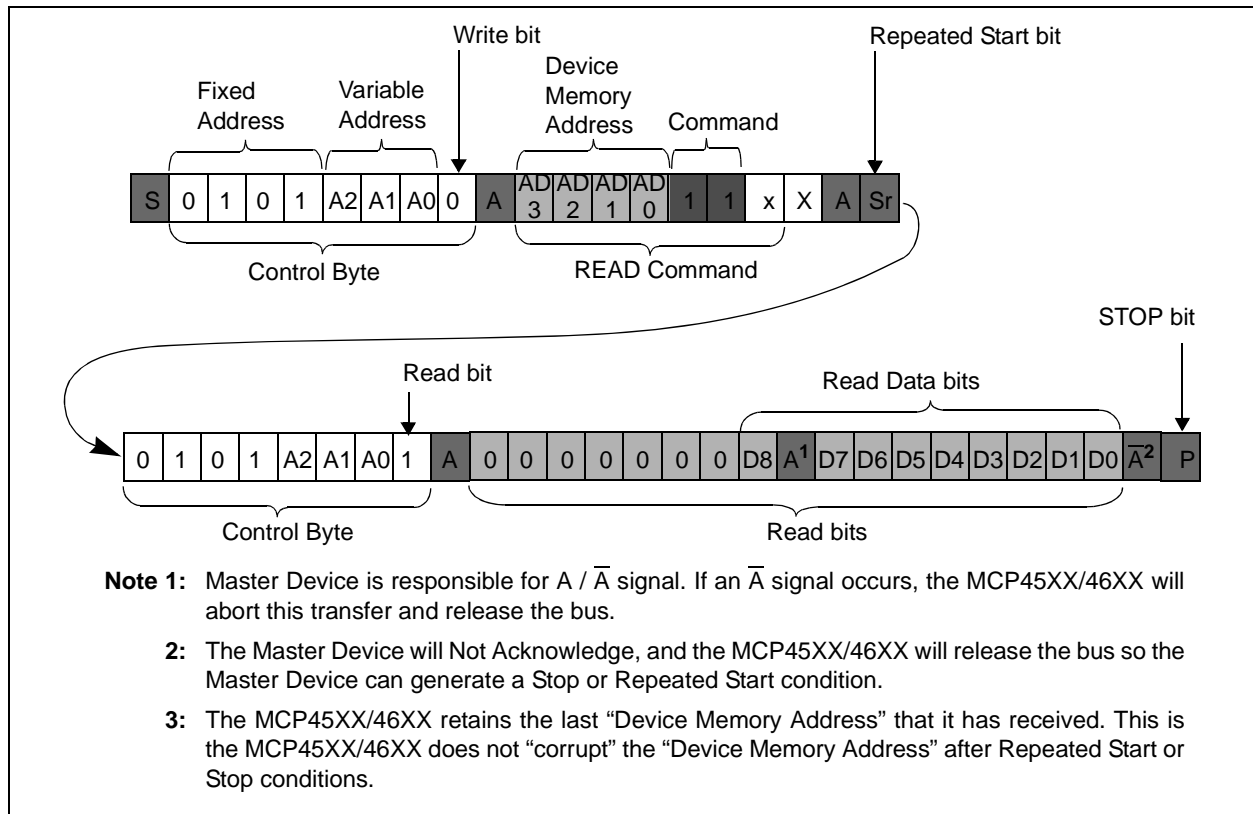
Address	Function	Memory Type	Allowed Commands	Disallowed Commands <sup>(2)</sup>
00h	Volatile Wiper 0	RAM	Read, Write, Increment, Decrement	—
01h	Volatile Wiper 1	RAM	Read, Write, Increment, Decrement	—
02h	Non-Volatile Wiper 0	EEPROM	Read, Write <sup>(1)</sup>	Increment, Decrement
03h	Non-Volatile Wiper 1	EEPROM	Read, Write <sup>(1)</sup>	Increment, Decrement
04h	Volatile TCON Register	RAM	Read, Write	Increment, Decrement
05h	Status Register	RAM	Read	Write, Increment, Decrement
06h - 0Fh	Data EEPROM	EEPROM	Read, Write <sup>(1)</sup>	Increment, Decrement

**Note 1:** When an EEPROM write is active, these are invalid commands and will generate an error condition. The user should use a read of the STATUS register to determine when the write cycle has completed. To exit the error condition, the user must take the  $\overline{CS}$  pin to the  $V_{IH}$  level and then back to the active state ( $V_{IL}$  or  $V_{IHH}$ ).

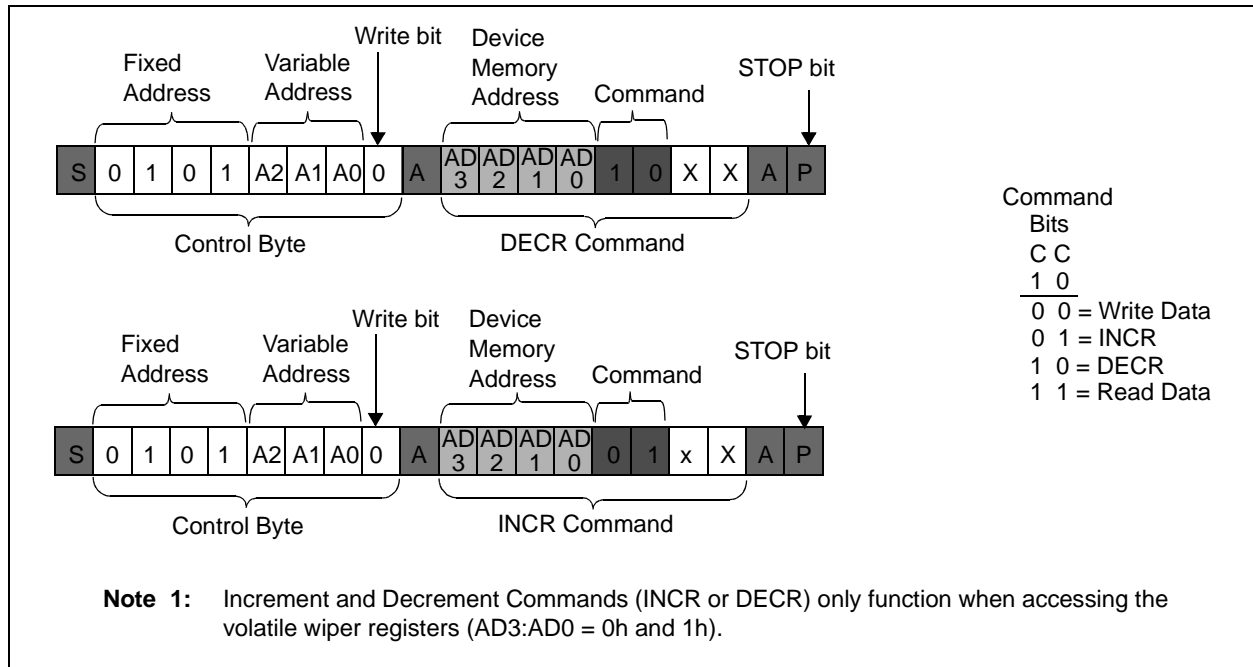
**2:** This command on this address will generate an error condition. To exit the error condition, the user must take the  $\overline{CS}$  pin to the  $V_{IH}$  level and then back to the active state ( $V_{IL}$  or  $V_{IHH}$ ).



**FIGURE 2-3:** MCP46XX I<sup>2</sup>C Single Write Command Format.



**FIGURE 2-4:** MCP46XX I<sup>2</sup>C Single Read Command Format.



**FIGURE 2-5:** MCP46XX I<sup>2</sup>C Single Increment / Decrement Command Format.

## 2.5 CONFIGURING THE PICKIT™ SERIAL ANALYZER

### 2.5.1 Modifying the “CommScripts.txt” file

Example 2-1 shows the User Scripts that need to be added to the PICKit serial's CommScripts.txt file. The default install location of this file is:

C:\Program Files\Microchip\PICKit Serial Analyzer

Once these are saved in the CommScripts.txt file and the Master SPI mode is selected as the communication mode, these User Scripts will be available to select from.

#### NOTICE

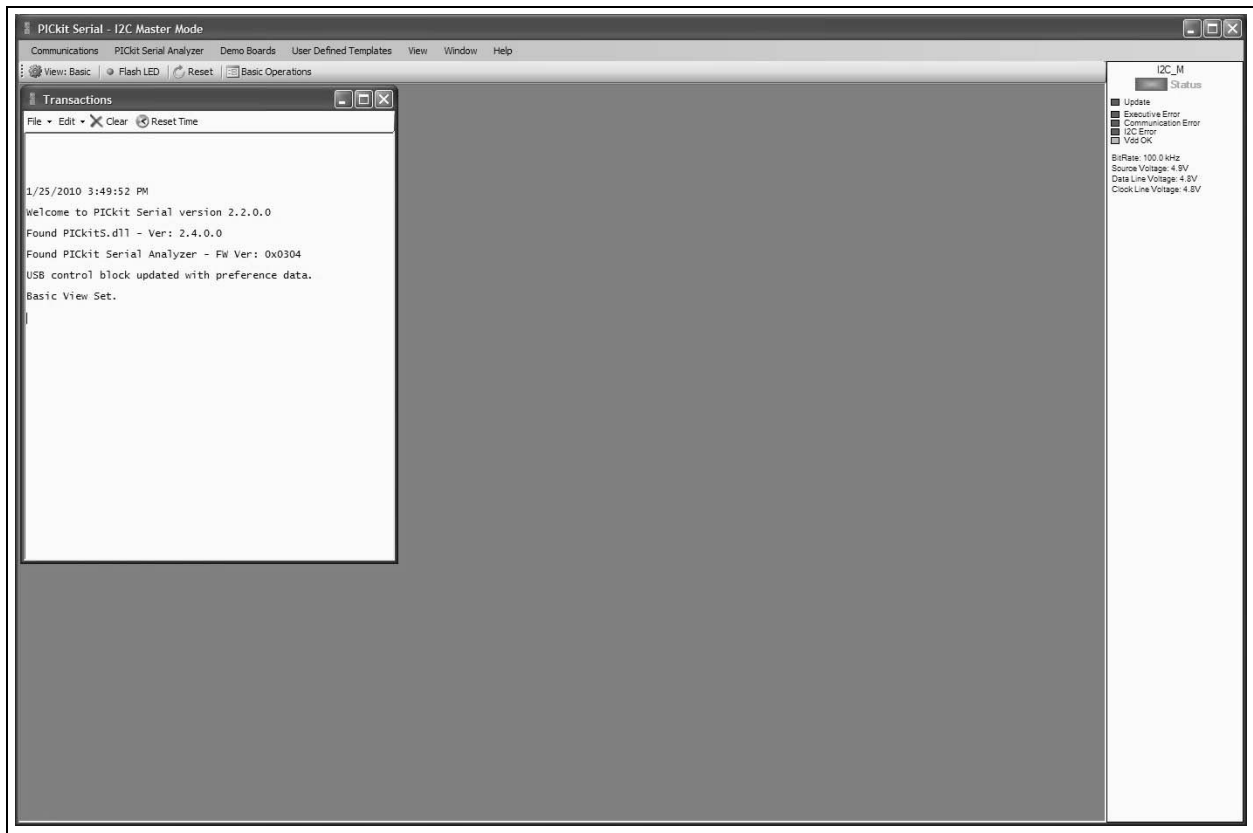
- Note 1:** It is recommended that you make a backup of your CommScripts.txt file before making any edits with a text editor.
- 2:** It has been observed that copying the text from this PDF and pasting into the PICKit serial's CommScripts.txt file will cause errors due to the blank spacing used in the PDF file. Please copy from the MCP46XX CommScript.txt file available from the Microchip web site (MCP46XXEV Evaluation Board Product Page).

#### EXAMPLE 2-1: MCP46XX SCRIPT FILE (COMMSSCRIPTS.TXT)

MCP4661W0WR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x00	0x7F	I2CSTOP
MCP4661W1WR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x10	0x7F	I2CSTOP
MCP4661NVW0WR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x20	0x7F	I2CSTOP
MCP4661NVW1WR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x30	0x7F	I2CSTOP
MCP4661TCON0WR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x40	0x7F	I2CSTOP
MCP4661BEWR	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x60	0x7F	I2CSTOP
MCP4661W0RD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x0C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661W1RD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x1C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661NVW0RD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x2C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661NVW1RD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x3C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661TCON0RD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x4C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661STATUSRD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x5C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661EERD	I2C	I2CSTART	I2CWRTBYT	0x02	0x5E	0x6C	I2CRESTART	I2CWRTBYT
				0x01	0x5F	I2CRDBYTNLB	0x02	I2CSTOP
MCP4661W0INC	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x04	0x7F	I2CSTOP
MCP4661W0DEC	I2C	I2CSTART	I2CWRTBYT	0x03	0x5E	0x08	0x7F	I2CSTOP

## 2.5.2 Working With the PICkit™ Serial Analyzer

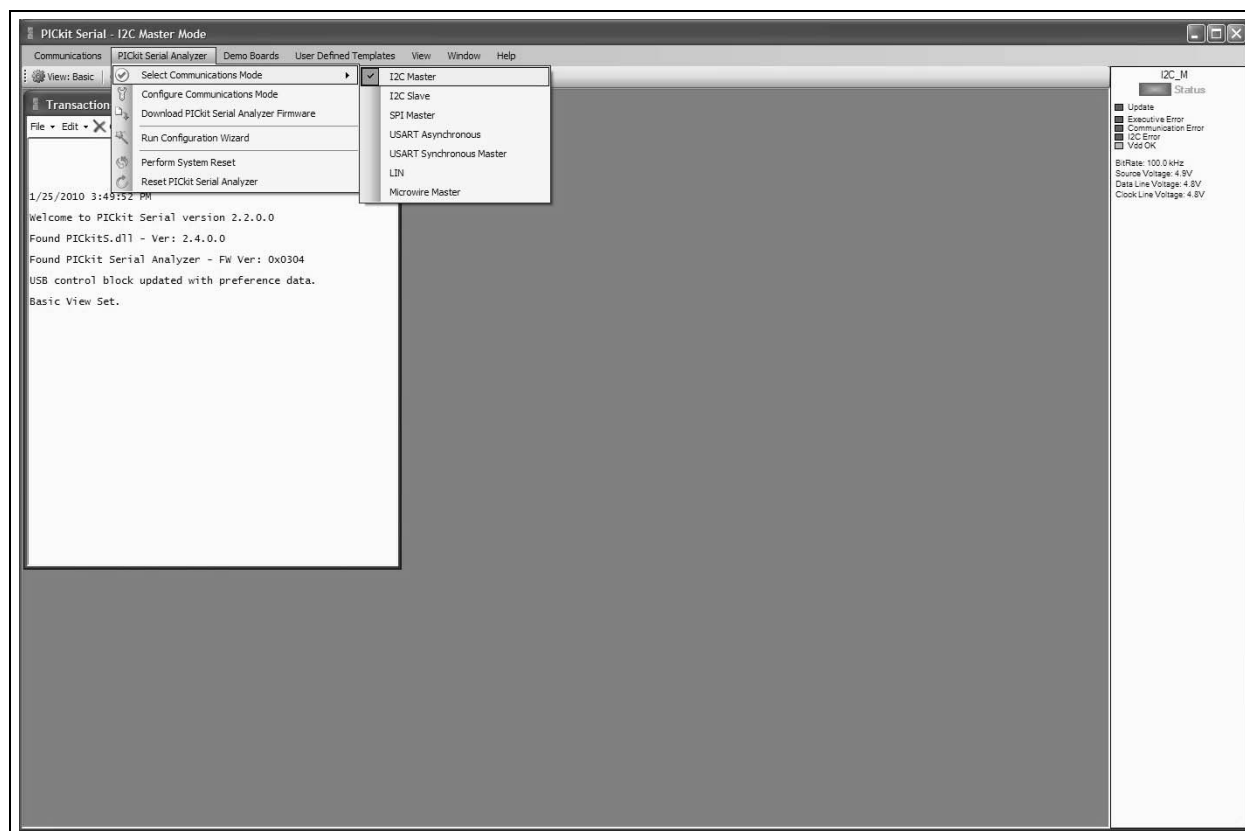
Figure 2-6 shows the PICkit Serial Window after the program has started. The Transaction window indicates if the PICkit Serial GUI located the PICkit Serial Analyzer hardware. When starting the PICkit Serial Analyzer for the first time, some setup questions may be asked. If you have any questions, please refer to the PICkit Serial Analyzer documentation, available at [www.Microchip.com/PICkitSerial](http://www.Microchip.com/PICkitSerial).



**FIGURE 2-6:** PICkit™ Serial Main Window at Startup.

# MCP46XXEV Evaluation Board User's Guide

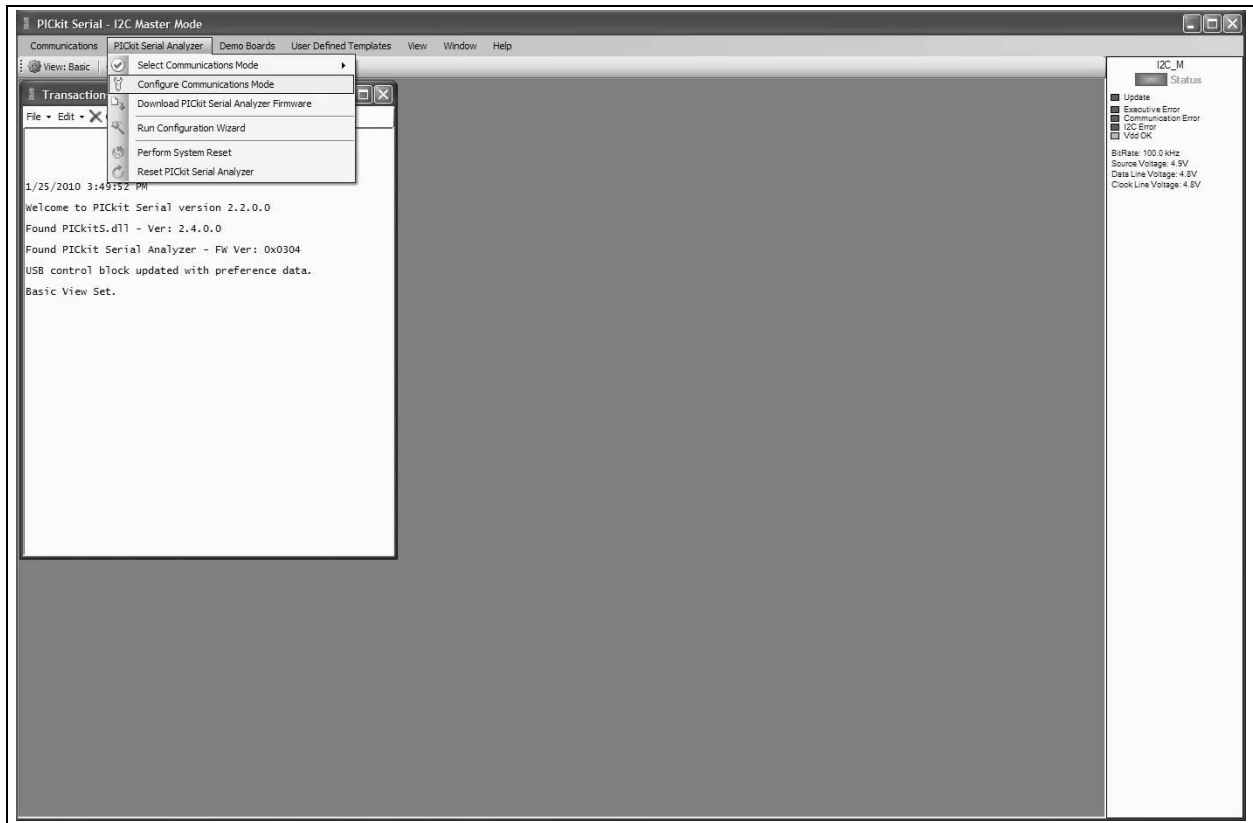
We need to select the PICkit Serial Analyzer GUI to be in I2C Master mode. Figure 2-7 shows how to select the proper mode. Select PICkit Serial Analyzer -> Select Communications Mode -> I2C Master menu item (make sure the I2C Master item is checked).



**FIGURE 2-7:** PICkit™ Serial Selecting Communications Mode.

# Installation and Operation

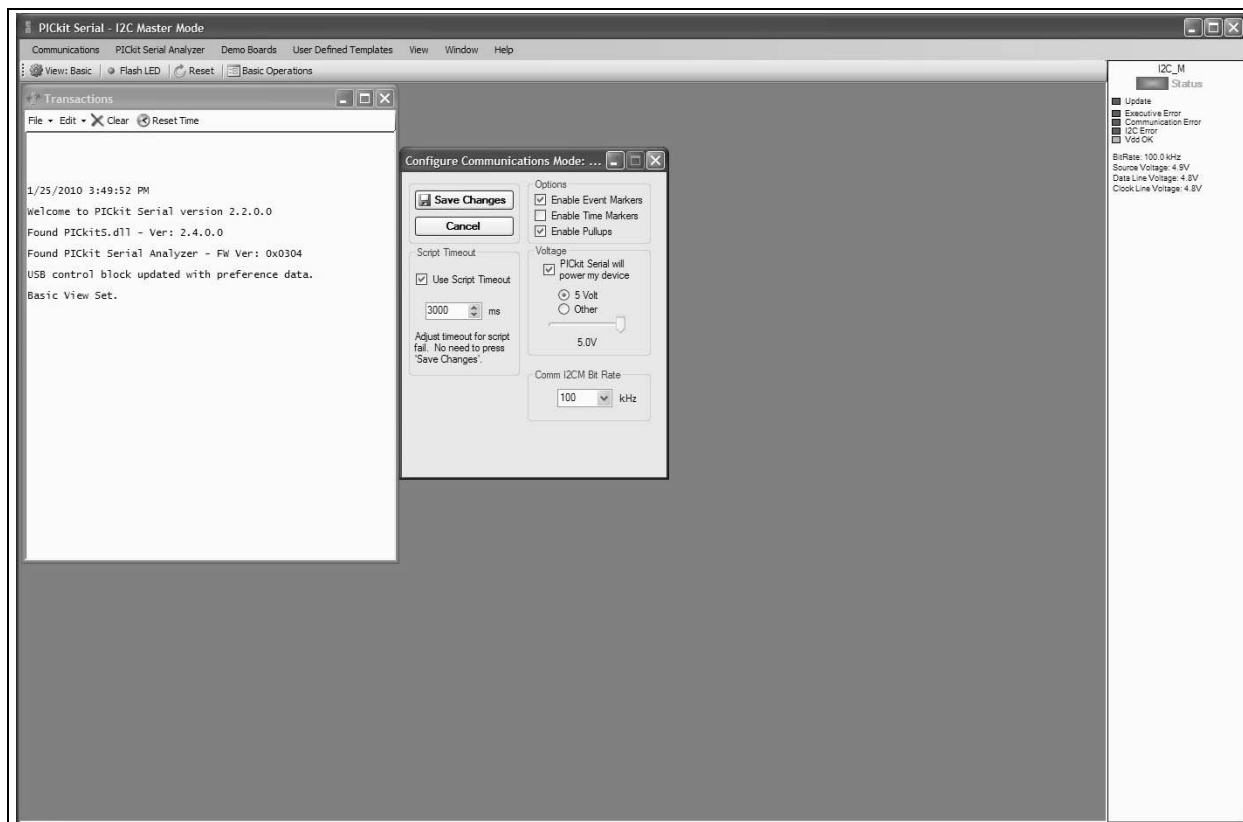
Now we need to configure the mode that we selected. Figure 2-8 shows how to open the Communications Mode window. Select PICkit Serial Analyzer -> Configure Communications Mode menu item. This will open a new window:



**FIGURE 2-8:** PICkit™ Serial - Opening the Communications Mode Window.

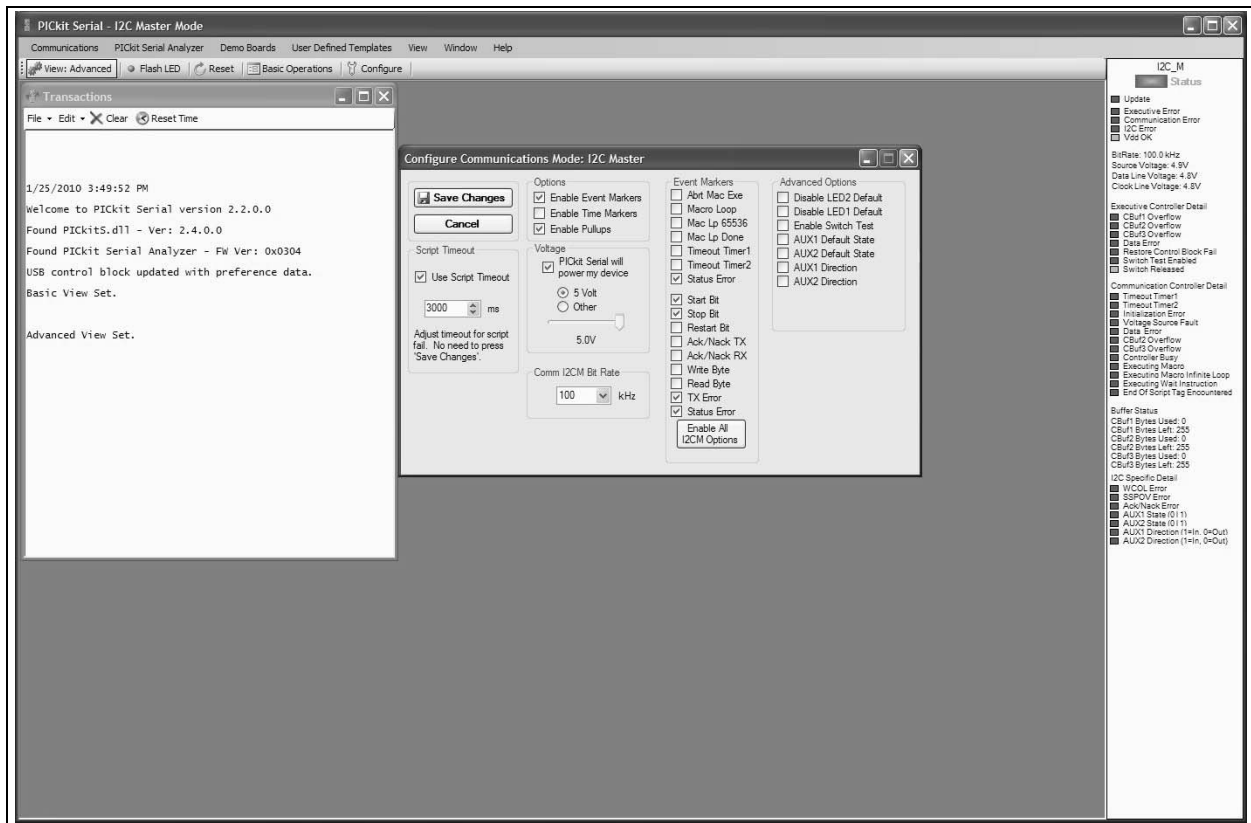
# MCP46XXEV Evaluation Board User's Guide

Figure 2-9 shows the Configure Communications Mode window in Basic view while Figure 2-10 shows the Configure Communications Mode window in Advanced view. Ensure that your window options and settings are the same as this window, and then select the **Save Changes** button. The Configure Communications Mode window may now be closed. Ensure that the pull-ups are enabled, the board is powered if necessary, and the desired I2CM bit rate has been selected.



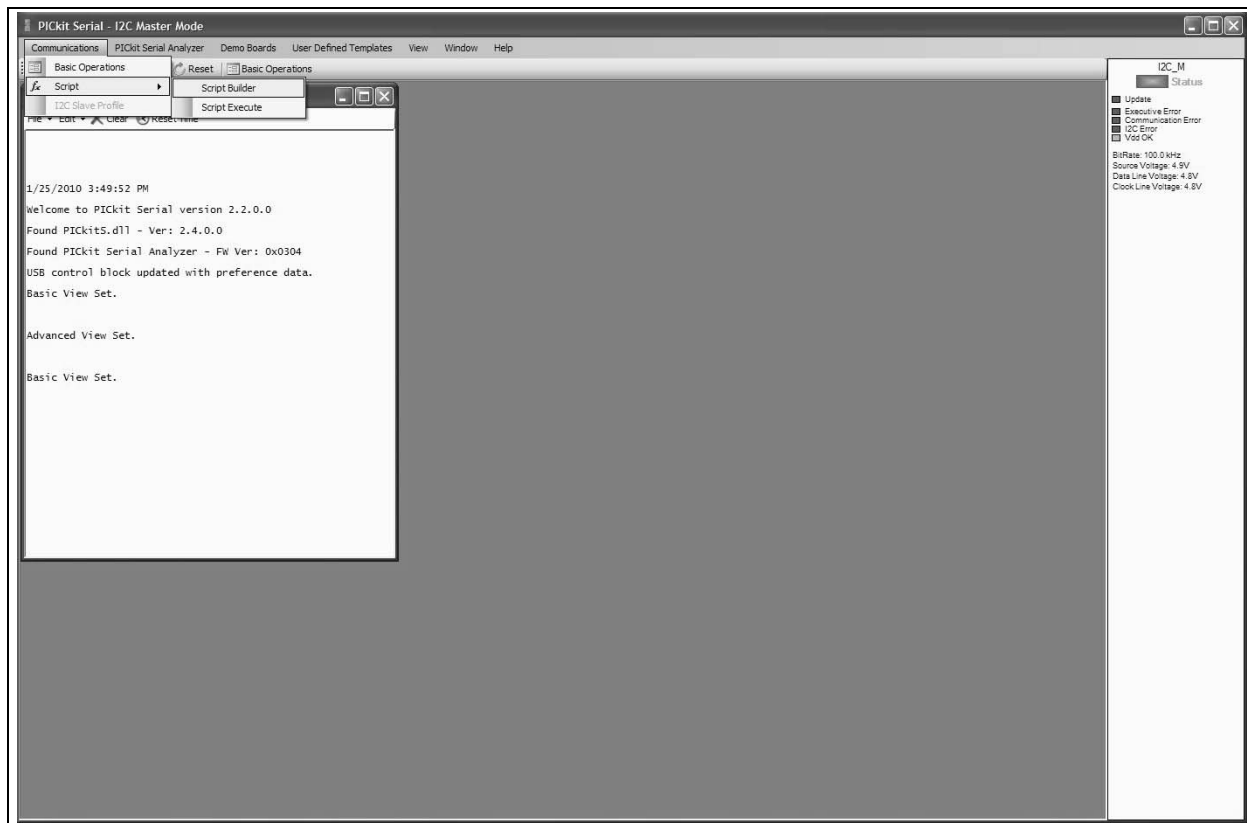
**FIGURE 2-9:** PICkit™ Serial Configure Communications Mode window - Basic View.





**FIGURE 2-10:** PICkit™ Serial Configure Communications Mode window - Advanced View.

Now we are going to open the Script Builder window, select the Communications -> Script -> Script Builder menu item (see Figure 2-11).



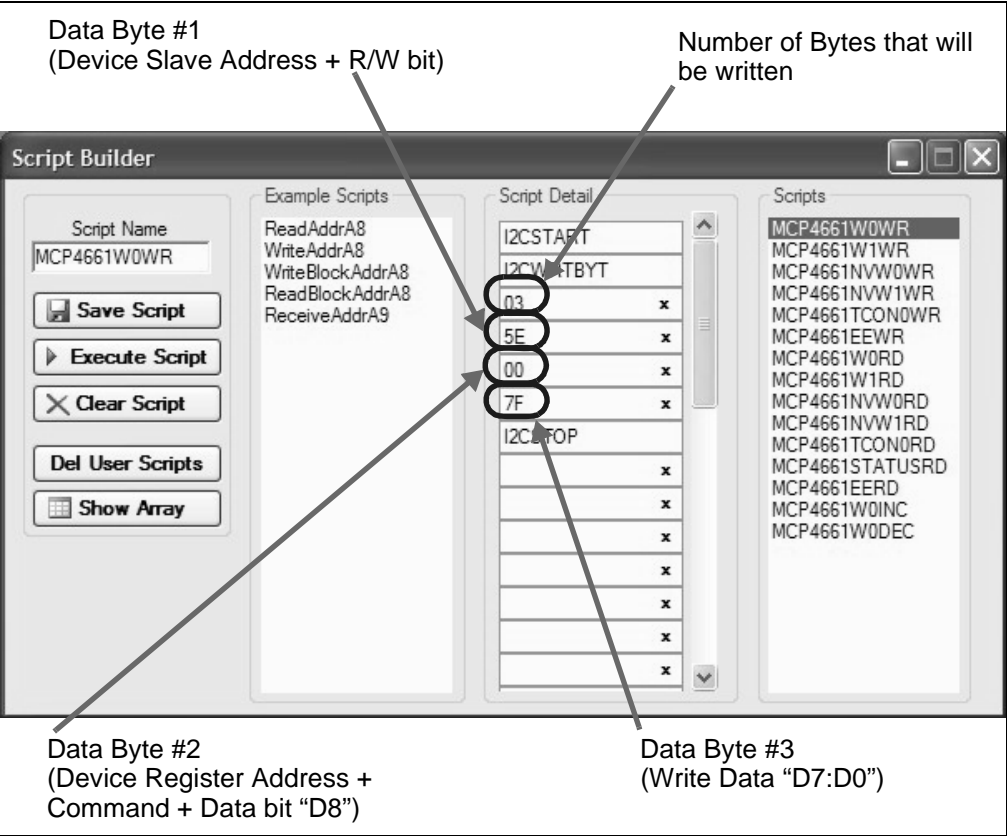
**FIGURE 2-11:** PICkit™ Serial - Script Builder Menu Selection.



# MCP46XXEV Evaluation Board User's Guide

Double clicking on the MCP4661W0WR User I2CM Script will load the script details. Figure 2-13 shows what the values mean in the Script Details. These values are hex numbers.

The first value (03h), is the number of bytes that will be written. The second byte (5Eh) is the MCP4661 I2C Slave Address with the R/W bit indicating a write ('0'). The third byte (00h) is a data byte and contains the Device Register Address, the Device Command, and the two Most Significant bits (MSb) of the write data. The fourth byte (7Fh) is the 2nd data byte and contains the remaining 8 bits of the write data.



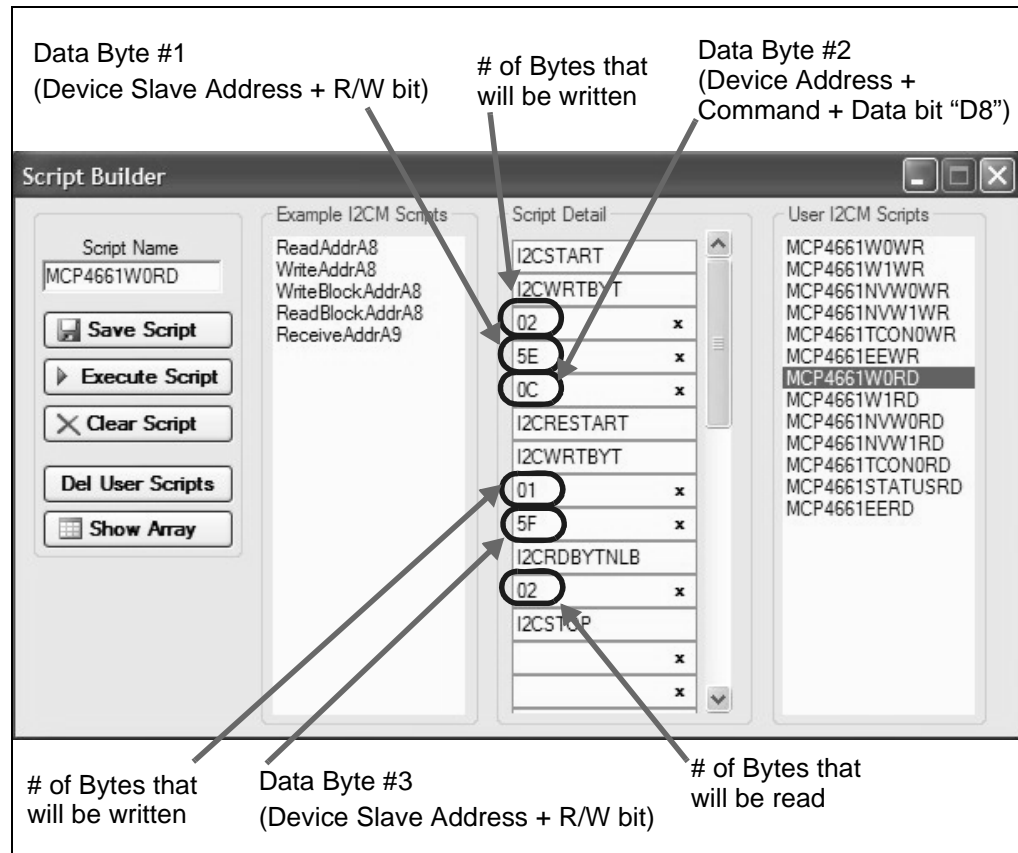
**FIGURE 2-13:** Example Write Script.

# Installation and Operation

Double clicking on the MCP4661WORD User I2CM Script will load the script details. Figure 2-14 shows what the values mean in the Script Details. These values are hex numbers.

The first value (02h), is the number of bytes that will be written. The second byte (5Eh) is the MCP4661 I2C Slave Address with the R/W bit indicating a write (0). The third byte (0Ch) a data byte and contains the Device Register Address, the Device Command, and the two Most Significant bits (MSb) of the write data.

The I<sup>2</sup>C protocol now has a restart bit. So the first value (01h) is the number of bytes that will be written. The second byte (5Fh) is the MCP4661 I2C Slave Address with the R/W bit indicating a read (1). The last byte (02h) is the number of bytes that will be read.



**FIGURE 2-14:** Example Read Script.

## 2.6 MCP4661 DEMO STEPS

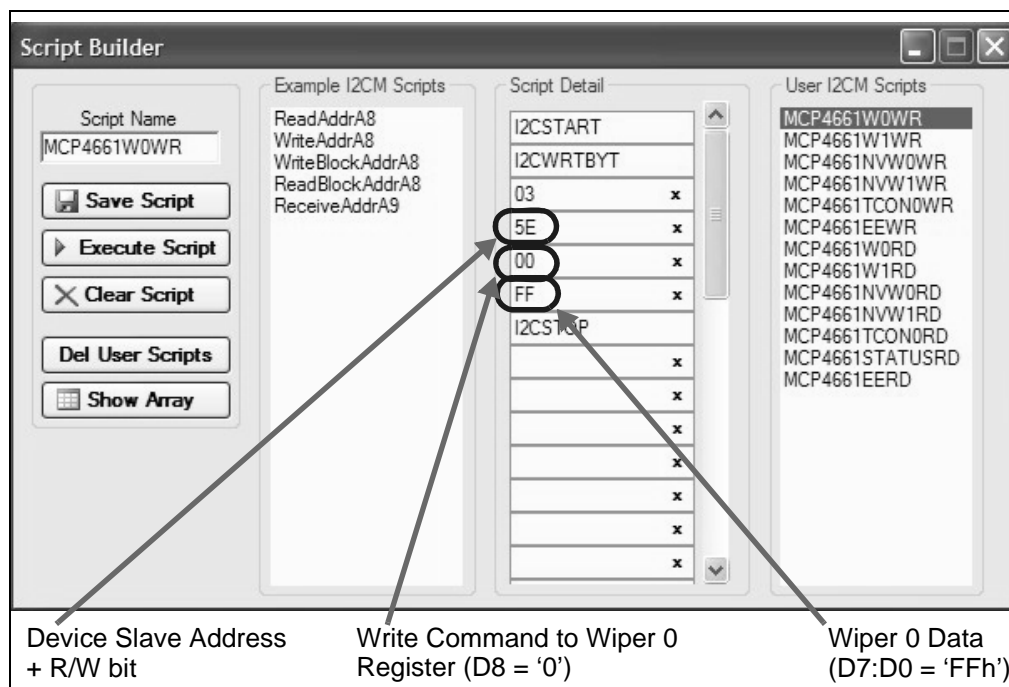
This demo assumes that you know how to configure the PICKit Serial Analyzer for Master I<sup>2</sup>C operation. See **Section 2.5 “Configuring The PICKit™ Serial Analyzer”** or the *“PICKit Serial Analyzer User's Guide”* (DS51647) for additional information.

1. Plug the PICKit serial device into the PC's USB port.
2. Plug the MCP46XXEV Evaluation Board into the PICKit serial.
3. Add the User Scripts (see Example 2-1) to the `CommScripts.TXT` file.
4. Start the PICKit serial GUI.
5. Ensure the GUI is in Master I<sup>2</sup>C communication mode (see Figure 2-7).
6. Ensure that the Master I<sup>2</sup>C configuration is appropriately configured (see Figure 2-9).
7. Measure the Wiper 0 voltage on the MCP46XXEV Evaluation Board (see Figure 2-2) using an oscilloscope or digital multimeter. Measure voltage from the ground plane (GND) to the wiper (P12). The voltage on the wiper should be  $\sim V_{DD}/2$  ( $\sim 2.5V$ ).
8. Open the Script Builder window (see Figure 2-11).
9. Double click on the “MCP4661W0WR” script in the “Example I2CM Scripts” column. This loads the Script Detail column (see Figure 2-13).
10. Click on the **Execute Script** button. This executes the script shown in the Script Detail column, which will update the wiper value to 7Fh. The wiper voltage will now be  $\sim V_{DD}/2$  ( $\sim 2.5V$ ).
11. Select the “MCP4661W0RD” script in the User I2CM Scripts column. It should look like Figure 2-14.
12. Click on the **Execute Script** button. This executes the script shown in the Script Detail column. The Transaction window (see Figure 2-17) will be updated to indicate the execution of the script.
13. Double click on the “MCP4661W0WR” script in the Example I2CM Scripts column. This loads the Script Detail column (see Figure 2-13). Modify the fourth byte to FF (see Figure 2-15).
14. Click on the **Execute Script** button. This executes the script shown in the Script Detail column, which will update the wiper value to FFh. The wiper voltage will now be  $\sim V_{DD}$  ( $\sim 5.0V$ ).
15. Select the “MCP4661W0RD” script in the User I2CM Scripts column. It should look like Figure 2-14.
16. Click on the **Execute Script** button. This executes the script shown in the Script Detail column. The Transaction window (see Figure 2-17) will be updated to indicate the execution of the script.
17. Double click on the “MCP4661W0WR” script in the Example I2CM Scripts column. This loads the Script Detail column (see Figure 2-13). Modify the fourth byte to 3F (see Figure 2-15).
18. Click on the **Execute Script** button. This executes the script shown in the Script Detail column, which will update the wiper value to 3Fh. The wiper voltage will now be  $\sim V_{DD}/4$  ( $\sim 1.25V$ ).
19. Select the “MCP4661W0RD” script in the User I2CM Scripts column. It should look like Figure 2-14.
20. Click on the **Execute Script** button. This executes the script shown in the Script Detail column. The Transaction window (see Figure 2-17) will be updated to indicate the execution of the script.
21. In the Transaction window, click the **Clear** button.

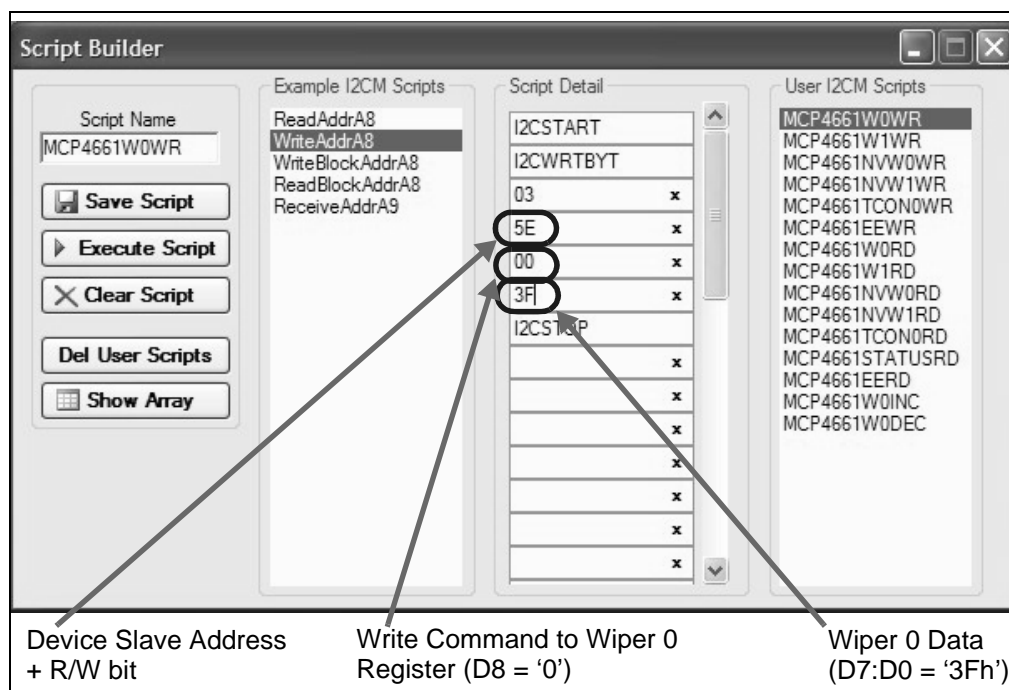
22. On the PICKit Serial Analyzer command bar, click the **Reset** button.
23. Select the “MCP4661W0WR” script in the User I2CM Scripts column and then click on the **Execute Script** button.
24. Select the “MCP4661W0RD” script in the User I2CM Scripts column and then click on the **Execute Script** button.
25. Select the “MCP4661W0DEC” script in the User I2CM Scripts column and then click on the **Execute Script** button three times.
26. Select the “MCP4661W0RD” script in the User I2CM Scripts column and then click on the **Execute Script** button. The Transaction window shows the scripts that were executed and the current value of the Wiper 0 (see Figure 2-18).
27. In the Transaction window, click the **Clear** button.
28. On the PICKit Serial Analyzer command bar, click the **Reset** button.
29. Select the “MCP4661W0WR” script in the User I2CM Scripts column and then click on the **Execute Script** button.
30. Select the “MCP4661W0RD” script in the User I2CM Scripts column and then click on the **Execute Script** button.
31. Select the “MCP4661W0INC” script in the User I2CM Scripts column and then click on the **Execute Script** button three times.
32. Select the “MCP4661W0RD” script in the User I2CM Scripts column and then click on the **Execute Script** button. The Transaction window shows the scripts that were executed and the current value of the Wiper 0 (see Figure 2-19).
33. You can repeat the sequence of writing values to the wiper register or writing then reading the values back.

## NOTICE

If at any time during script execution, an error message is generated in the transaction window, it is good practice to reset the PICKit™ Serial Analyzer (PKSA). The PKSA can be reset using the “Reset” toolbar icon. Verify that subsequent script operations do not generate errors.



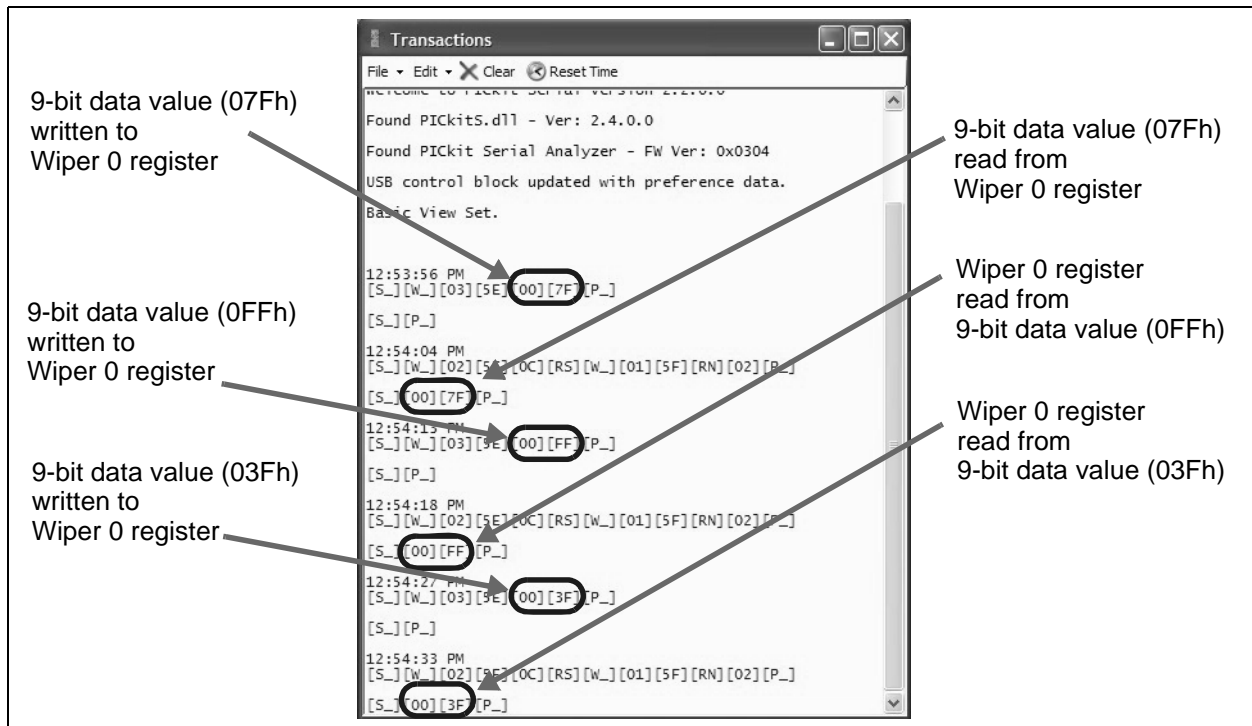
**FIGURE 2-15:** MCP46XX Write Wiper 0 Script File - Wiper Value = 0FFh.



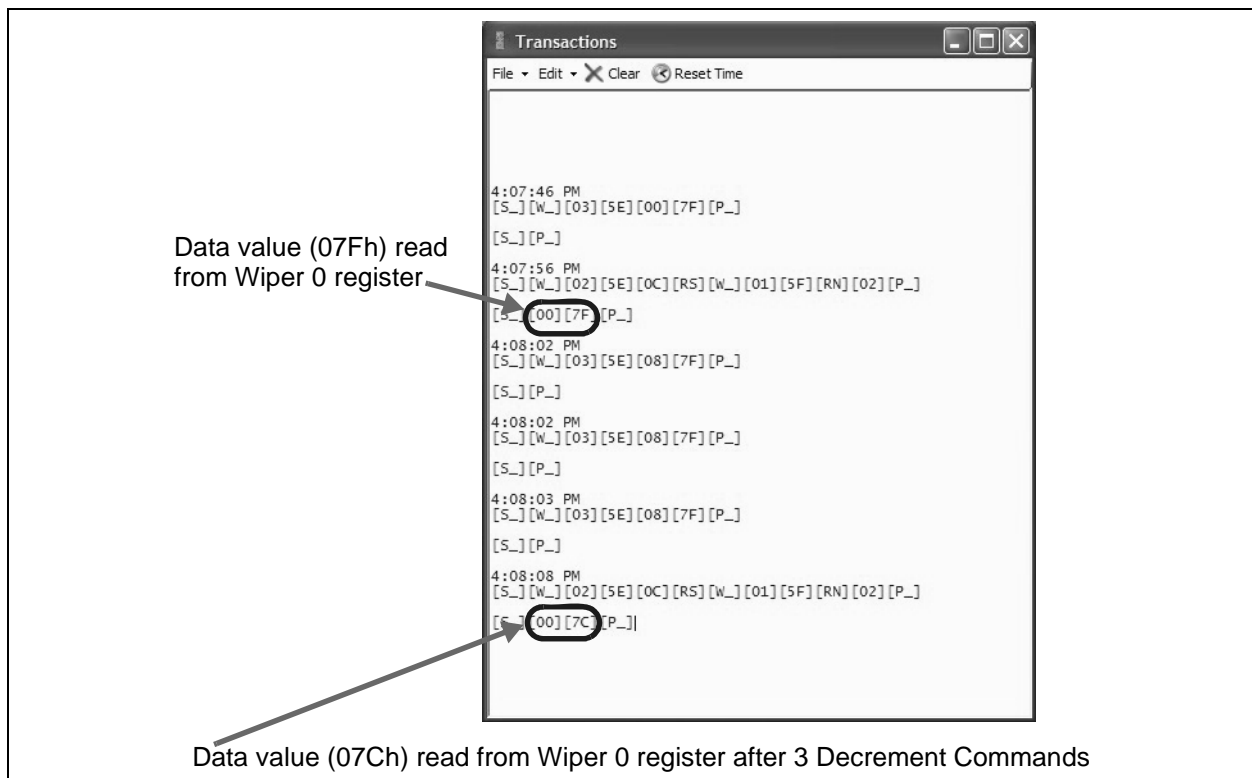
**FIGURE 2-16:** MCP46XX Write Wiper 0 Script File - Wiper Value = 03Fh.



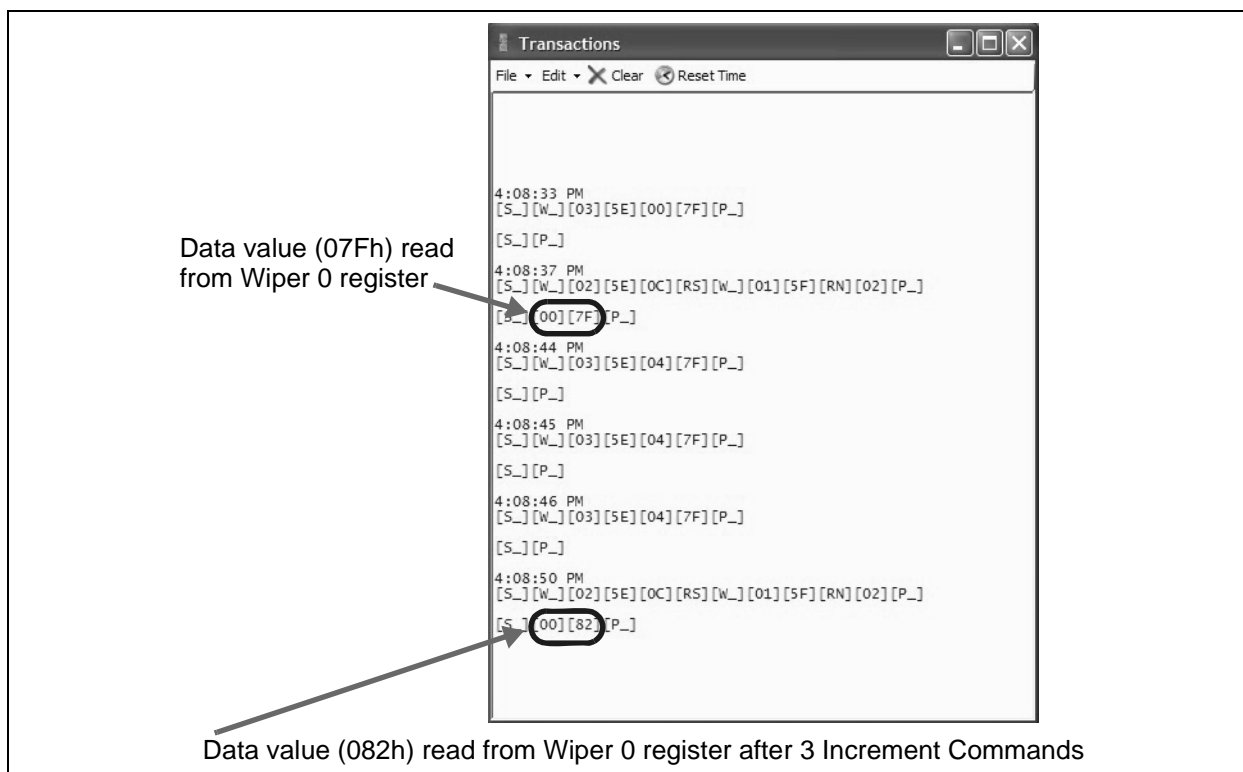
# Installation and Operation



**FIGURE 2-17:** MCP4661 Transaction Window - Wiper 0 Writes and Reads.



**FIGURE 2-18:** MCP4661 Transaction Window - Wiper 0 Decrements.



**FIGURE 2-19:** MCP4661 Transaction Window - Wiper 0 Increments.

## 2.6.1 The TSSOP20EV PCB and Supported Digital Potentiometers

Table 2-4 shows the current digital potentiometers that are supported by the TSSOP20EV PCB.

**TABLE 2-4: TSSOP20EV PCB SUPPORTED DIGITAL POTENTIOMETERS**

Device	TSSOP-20	TSSOP-14	Comment
MCP4231	—	Yes	Dual Pot, SPI Interface
MCP4241	—	Yes	Dual Pot, SPI Interface
MCP4251	—	Yes	Dual Pot, SPI Interface
MCP4261	—	Yes	Dual Pot, SPI Interface
MCP4331	Yes	—	Quad Pot, SPI Interface
MCP4341	Yes	—	Quad Pot, SPI Interface
MCP4351	Yes	—	Quad Pot, SPI Interface
MCP4361	Yes	—	Quad Pot, SPI Interface
MCP4631	—	Yes	Dual Pot, I <sup>2</sup> C™ Interface
MCP4641	—	Yes	Dual Pot, I <sup>2</sup> C™ Interface
MCP4651	—	Yes	Dual Pot, I <sup>2</sup> C™ Interface
MCP4661	—	Yes	Dual Pot, I <sup>2</sup> C™ Interface
MCP42010	—	Yes	Dual Pot, SPI Interface
MCP42050	—	Yes	Dual Pot, SPI Interface
MCP42100	—	Yes	Dual Pot, SPI Interface

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## Appendix A. Schematic and Layouts

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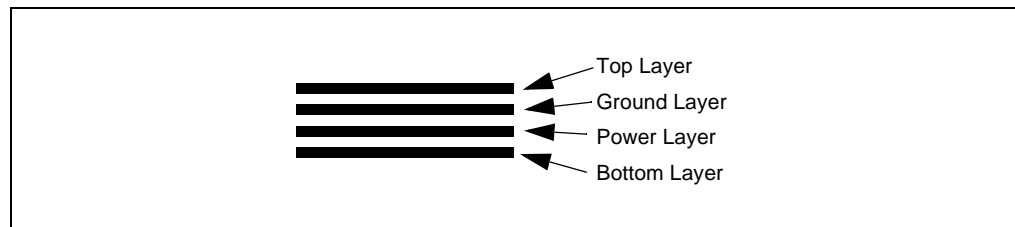
### A.1 INTRODUCTION

This appendix contains the schematics and layouts for the MCP46XXEV Evaluation Board. Diagrams included in this appendix:

- Board – Schematic
- Board – Top Trace, Silk and Pads
- Board – Bottom Trace and Pads
- Board – Layer 2 Ground Plane
- Board – Layer 3 Power Plane
- Board Layout – Top Components
- Board – Bottom Silk, Trace and Pads

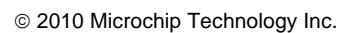
### A.2 SCHEMATICS AND PCB LAYOUT

Board – Schematic shows the schematic of the MCP46XXEV Evaluation Board. The layer order is shown in Figure A-1.

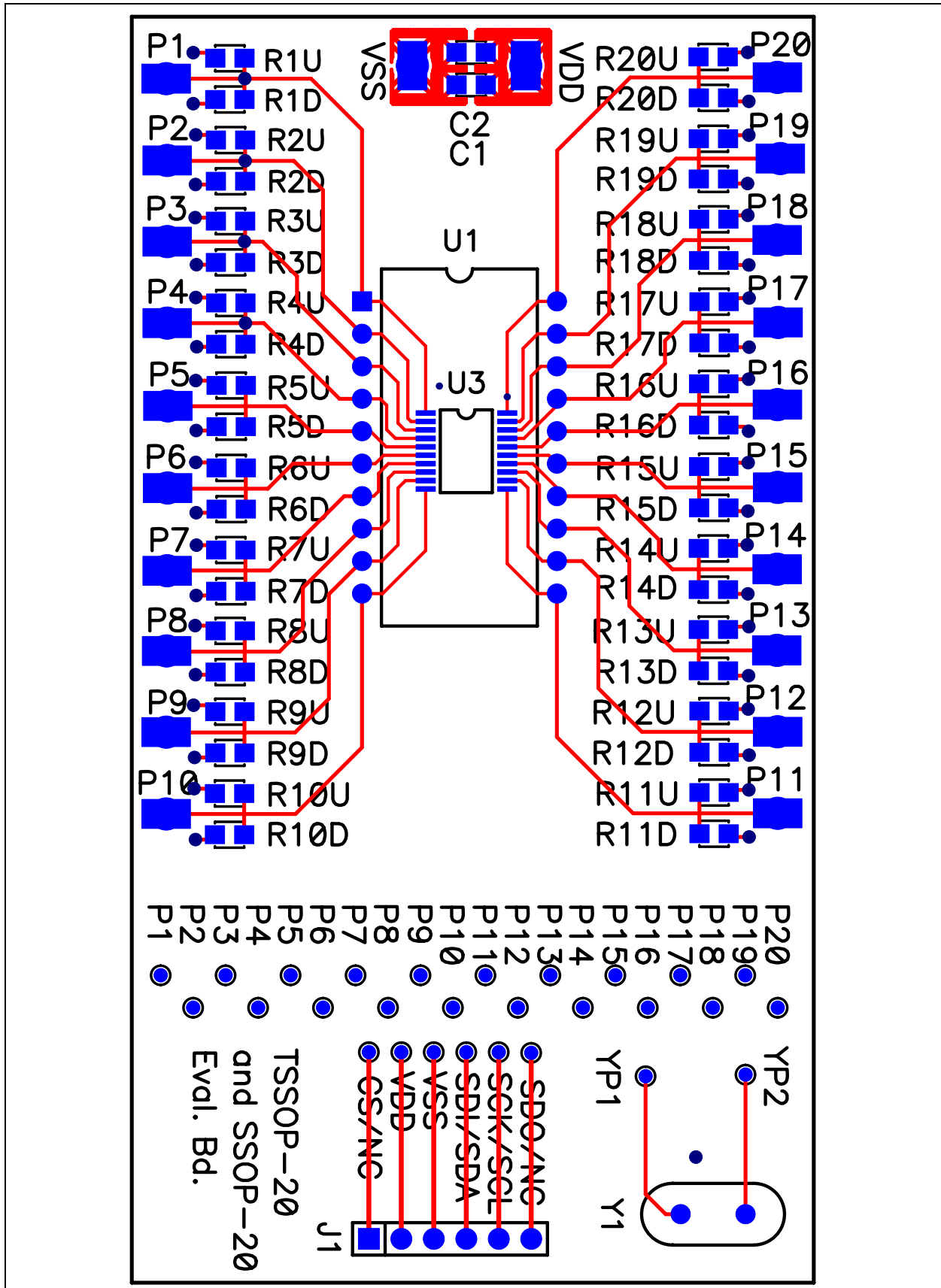


**FIGURE A-1:**      *Layer Order.*

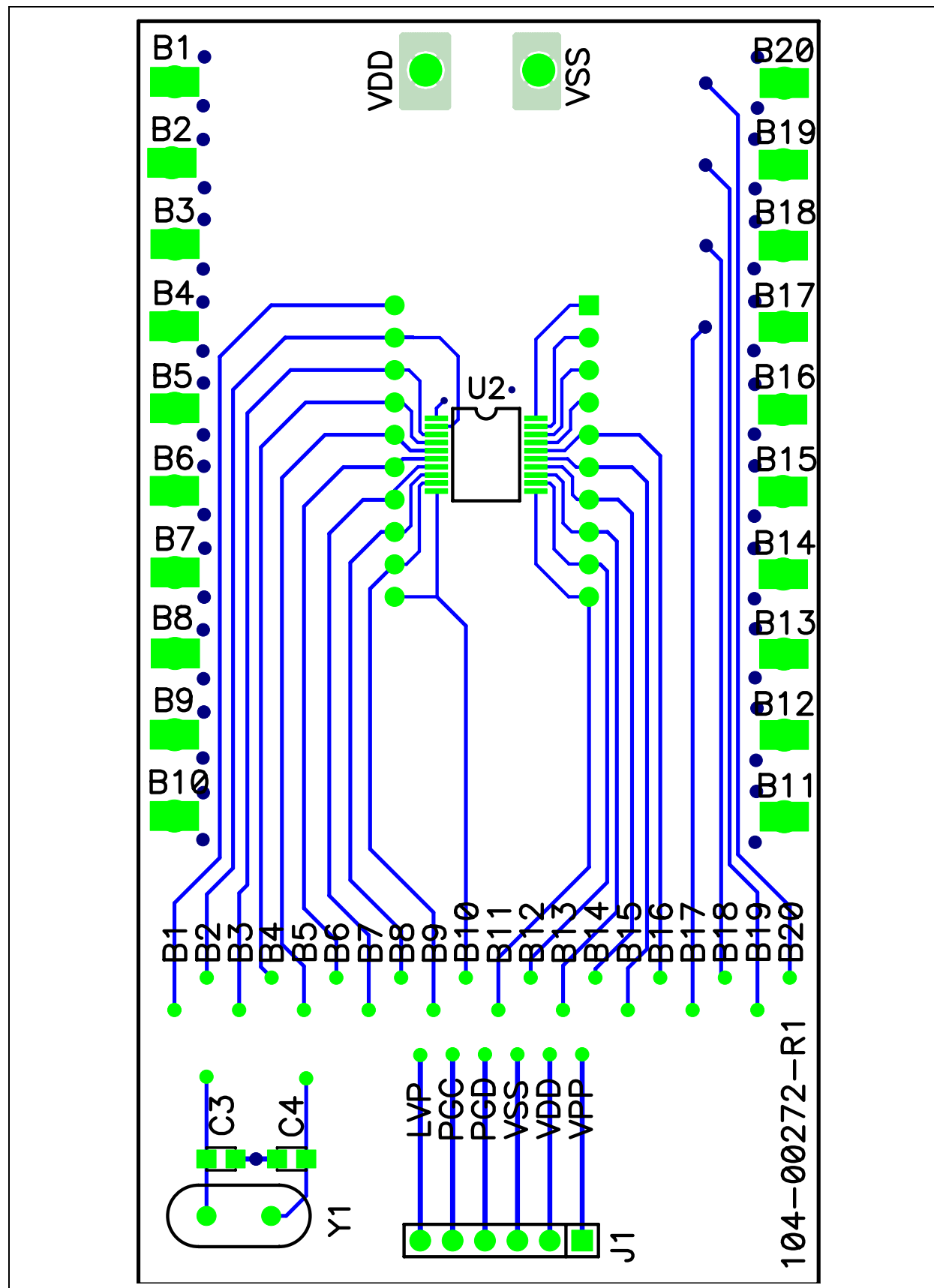
### A.3 BOARD – SCHEMATIC



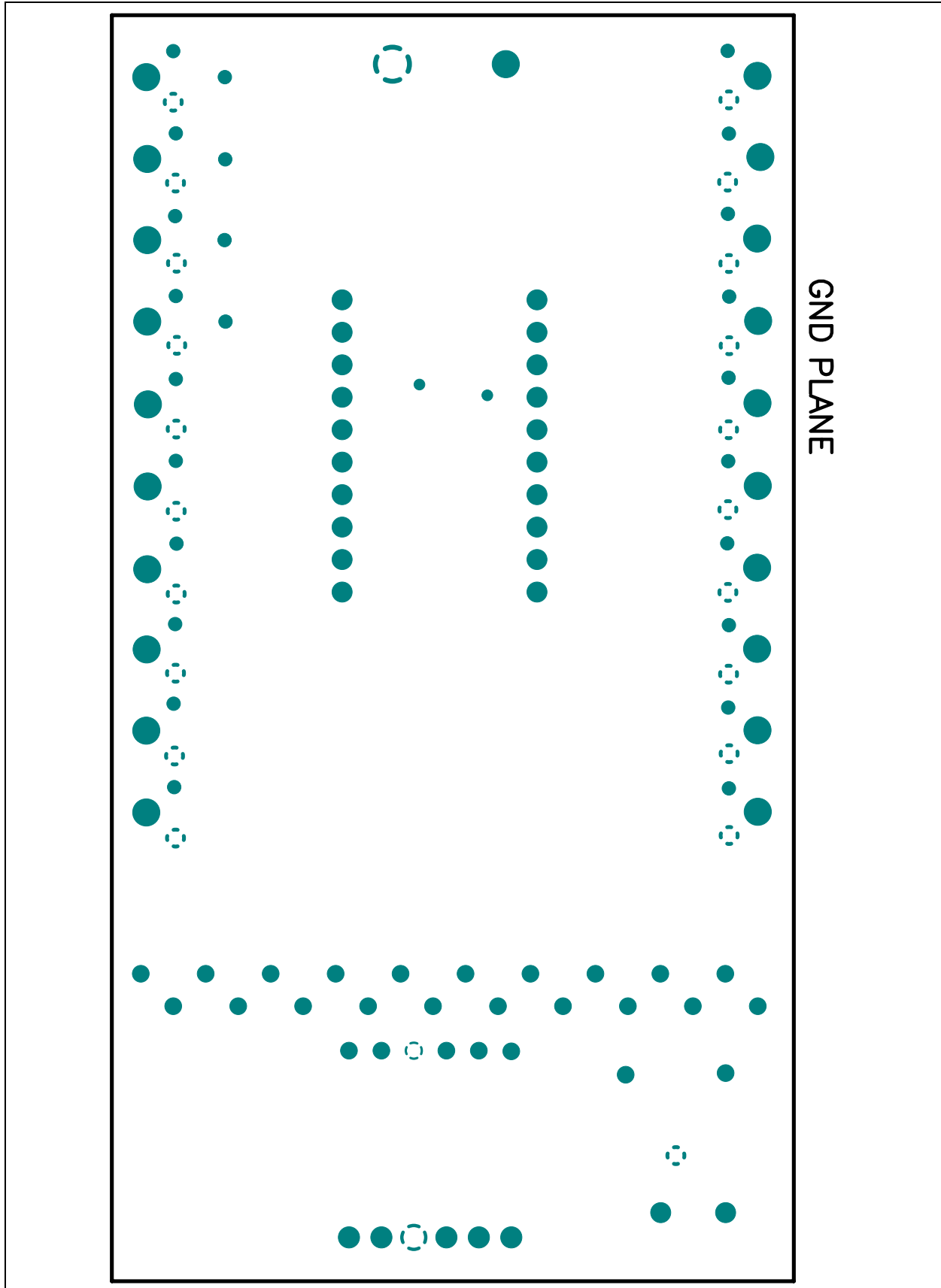
## A.4 BOARD – TOP TRACE, SILK AND PADS



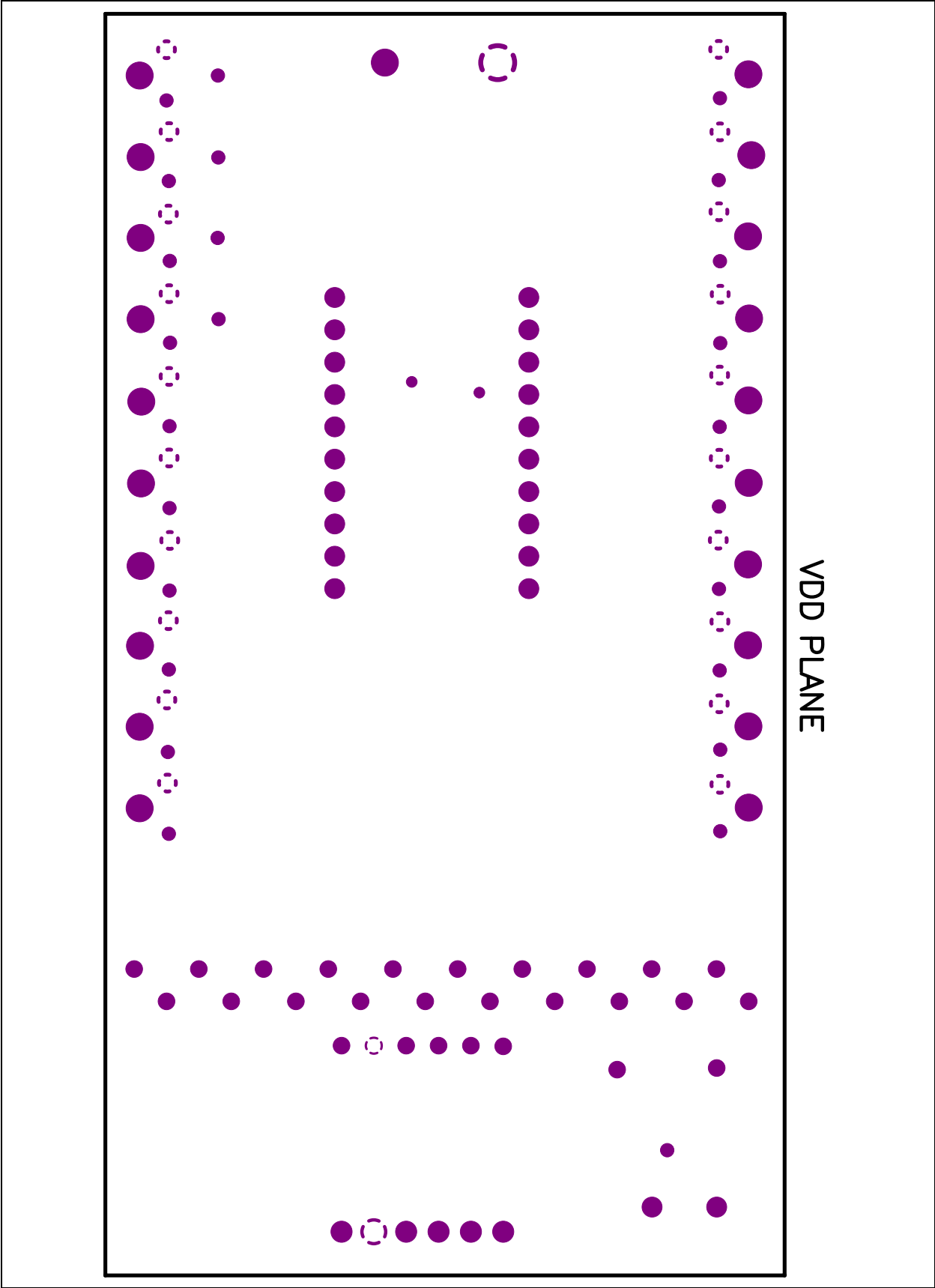
## A.5 BOARD – BOTTOM TRACE AND PADS



## A.6 BOARD – LAYER 2 GROUND PLANE

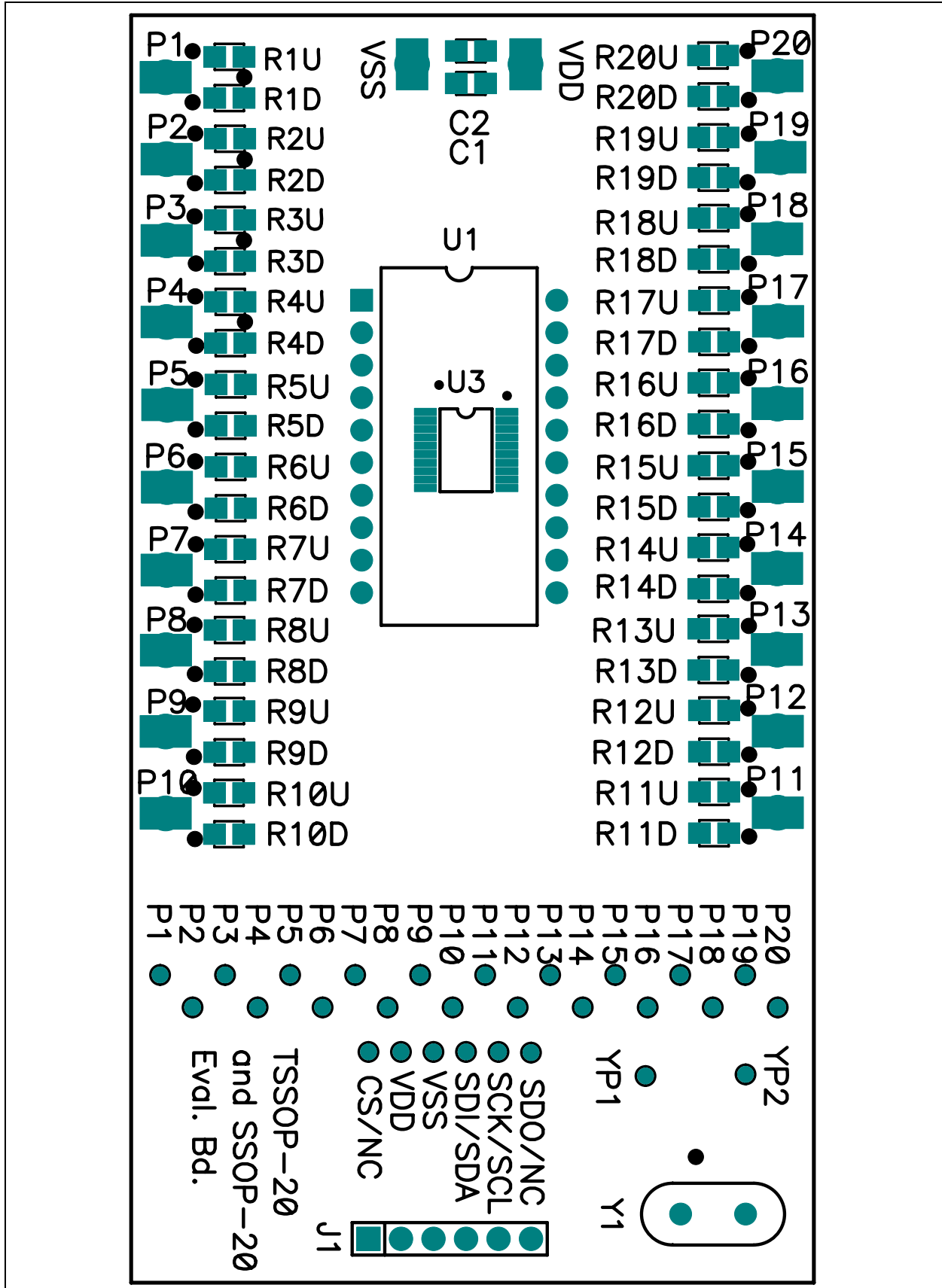


A.7 BOARD – LAYER 3 POWER PLANE

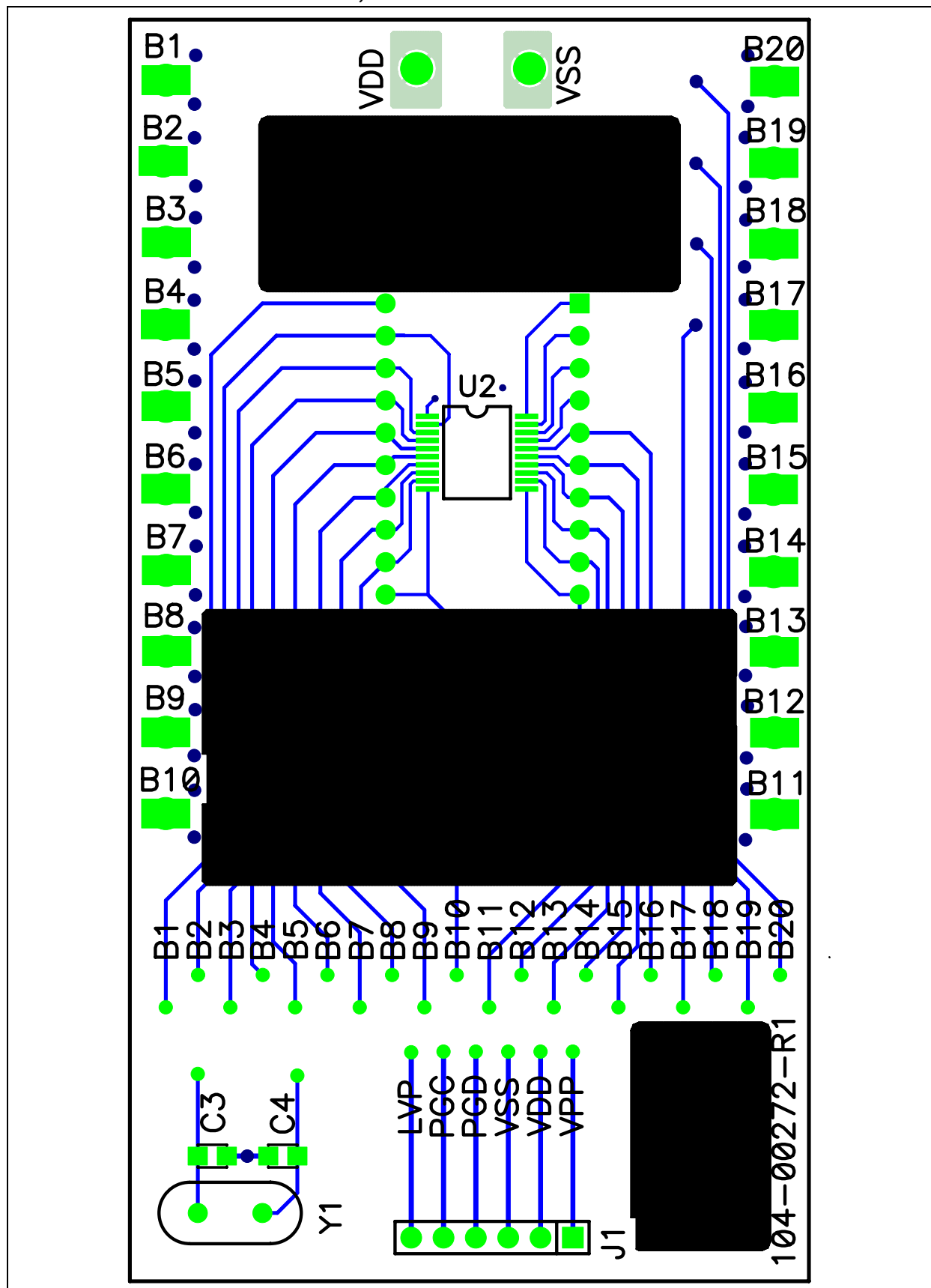




## A.8 BOARD LAYOUT – TOP COMPONENTS



## A.9 BOARD – BOTTOM SILK, TRACE AND PADS



## Appendix B. Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS**

Qty	Reference	Description	Manufacturer	Part Number
1	J1	CONN HEADER 6POS .100 R/A TIN	Molex/Waldom Electronics Corp	22-05-2061
2	P9, P12	TEST POINT PC MULTI PURPOSE THROUGH HOLE (Orange)	Keystone Electronics®	5013
1	PCB	<b>Note 1</b>	Microchip Technology Inc.	104-00272
2	R14U, R15U	RES 10K OHM 1/8W 5% 0805 SMD	Panasonic - ECG	ERJ-6GEYJ103V
4	R7D, R11U, R13D, R17U	RES 0.0 OHM 1/8W 5% 0805 SMD	Panasonic® - ECG	ERJ-6GEY0R00V
1	U3	MCP4661 10 kOhm Digital Potentiometer device. Device bottom aligned in U3 footprint (See Assembly Drawing).	Microchip Technology Inc.	MCP4261-103E/ST

**Note 1:** This assembly uses RoHS Compliant TSSOP-20 to DIP-20 Evaluation Board.

**2:** The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.



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