MCP3424 Evaluation Board User's Guide

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MCP3424 EVALUATION BOARD USER'S GUIDE

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MCP3424 EVALUATION BOARD USER'S GUIDE

Preface

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) 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 MCP3424 Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the MCP3424 Evaluation Board as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. "Quick Start Instructions"** – this chapter provides an overview of the MCP3424 Evaluation Board and instructions on how to use the MCP3424 Evaluation Board with the PICkit Serial Analyzer.
- **Appendix A. "Schematic and Layouts"** – shows the schematic and layout diagrams for the MCP3424 Evaluation Board.
- **Appendix B. "Bill Of Materials (BOM)"** – lists the parts used to build the MCP3424 Evaluation Board.

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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use MCP3424 Evaluation Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

PICkit™ Serial Analyzer User's Guide (DS51647)

Consult this document for instructions on how to use the PICkit Serial Analyzer hardware and software.

MCP3424 Data Sheet, "18-Bit Analog-to-Digital Converter with 4 Input Channels, I^2C Interface and On-Board Reference" (DS22088)

This data sheet provides detailed information regarding the MCP3424 product family.

THE MICROCHIP WEB SITE

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Technical Support

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

DOCUMENT REVISION HISTORY

Revision A (July 2008)

- Initial Release of this Document.

NOTES:

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Chapter 1. Quick Start Instructions

1.1 INTRODUCTION

The following sections provide an overview of the MCP3424 Evaluation Board and demonstrate how to use it with using the PICkit™ Serial Analyzer (P/N: DV164122).

The following topics are covered:

- Description of the MCP3424 Evaluation Board
- How to use MCP3424 Evaluation Board with the PICkit Serial Analyzer

1.2 DESCRIPTION OF THE MCP3424 EVALUATION BOARD

The MCP3424 Evaluation Board (P/N MCP3424EV) contains an MCP3424 18-bit Delta-Sigma Analog-to-Digital Converter (ADC). The MCP3424 is a 4-channel ADC device with various configuration options. The board has analog input connection pads and various test pads. The user can connect inputs and test the conversion results using the PICkit Serial Analyzer and its PC graphic user interface (GUI). The MCP3424 Evaluation Board has the following interfaces:

- PICkit Serial Analyzer (P/N: DV164122) for writing configuration register bits and reading the conversion data.

Note:	The user can use this board without the PICkit Serial Analyzer as long as the V_{DD}, SCL, and SDA are provided through J1 connector. This Evaluation Board does not include MCU.

The board has test points for SDL, SDA, and analog inputs. By connecting an oscilloscope to these test points, the user can examine the data communications through the $I^2C^{™}$ bus line and observe the resulting conversion output. Refer to **Appendix A. "Schematic and Layouts"**

1.2.1 I^2C Address Bits and A0 Address Bit Selection

The I^2C device code and address bits of the MCP3424 device are:

- Device Code: '1101'
- A2, A1, A0 Address Bits: determined by the JP2 (Adr1 pin) and JP3 (Adr0 pin).
- See Table 1-1 for the I^2C Device Address bits and JP2 and JP3 connections.

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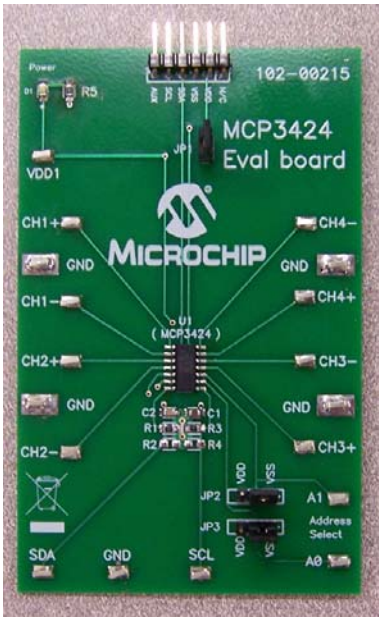

FIGURE 1-1: *Front View of the MCP3424 Evaluation Board.*

1.3 GETTING STARTED WITH PICKIT SERIAL ANALYZER

Figure 1-1 shows the MCP3424 Evaluation Board, and Figure 1-2 shows the MCP3424 and PICkit Serial Analyzer.

The following describes how to use them together:

1. Connect the MCP3424 Evaluation Board's 6-pin socket to the PICkit Serial Analyzer as shown in Figure 1-2.
2. Connect the oscilloscope probes to the SCL and SDA test pins (optional).
3. V_{DD} Selection: You can use the V_{DD} from the PICkit Serial Analyzer or use your own external V_{DD}. The JP1 connector selects the V_{DD} path.

   (a) Connect JP1, if using V_{DD} from PICkit Serial Analyzer,

   (b) Disconnect JP1 and apply V_{DD} at V_{DD}1 pin, if you are using an external V_{DD}.
4. Address bit selection using JP2 and JP3 connectors.

The I^2C device code and address bits of the MCP3424 device are:

- MCP3424 I^2C device code: '1101'
- A2, A1, A0 Address Bits: determined by the JP2 (Adr1 pin) and JP3 (Adr0 pin)
- The JP2 and JP3 connectors are external address bit selections. Connect these pins to V_{SS}, V_{DD}, float, or connect any arbitrary voltage
- See Table 1-1 for the I^2C Device Address bits and JP2 and JP3 connections

5. **Connecting V_{DD}:** LED D1 turns on when V_{DD} is applied. The PICkit Serial Analyzer will provide V_{DD} automatically, if it is connected to the PC. Make sure LED D1 turns on, when you execute the command using the PICkit Serial Analyzer.
6. **Connecting the analog inputs:** If you need to measure a single-ended input, connect the unused pin (example, CHX-) to V_{SS}.

- **Connecting the inputs:** The MCP3424 Evaluation Board has input pads for analog inputs for each input channel. You can connect all inputs at the same time and multiplex the input channel using configuration register settings. You can also leave the unused channel inputs floating

7. Use the PICkit Serial Analyzer PC GUI to send I^2C write and read commands.

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CAUTION

Each analog input pin has an ESD diode. Certain input conditions can damage the device. Please use the following conditions:

(a) Do not apply an input greater than the input range specified by the MCP3424 Data Sheet.

(b) Apply the input signal after V_{DD} is powered-up.

TABLE 1-1: I^2C ADDRESS BITS VS. JP2 AND JP3 CONNECTORS

I^2C Device Address Bits	JP2 (Adr1 Pin)	JP3 (Adr0 Pin)
1101 **000** $\overline{\mathbf{W}}$**/R**	Connected to V_{SS}	Connected to V_{SS}
1101 **001** $\overline{\mathbf{W}}$**/R**	Connected to V_{SS}	Float
1101 **010** $\overline{\mathbf{W}}$**/R**	Connected to V_{SS}	Connected to V_{DD}
1101 **100** $\overline{\mathbf{W}}$**/R**	Connected to V_{DD}	Connected to V_{SS}
1101 **101** $\overline{\mathbf{W}}$**/R**	Connected to V_{DD}	Float
1101 **110** $\overline{\mathbf{W}}$**/R**	Connected to V_{DD}	Connected to V_{DD}
1101 **011** $\overline{\mathbf{W}}$**/R**	Float	Connected to V_{SS}
1101 **111** $\overline{\mathbf{W}}$**/R**	Float	Connected to V_{DD}
1101 **000** $\overline{\mathbf{W}}$**/R**	Float	Float

Note 1: $\overline{W}$/R bit = “0” for writing, “1” for reading.

2: Float: (a) Leave pin without connecting to anything, or (b) apply Addr_Float voltage. See MCP3424 Data Sheet for more details.

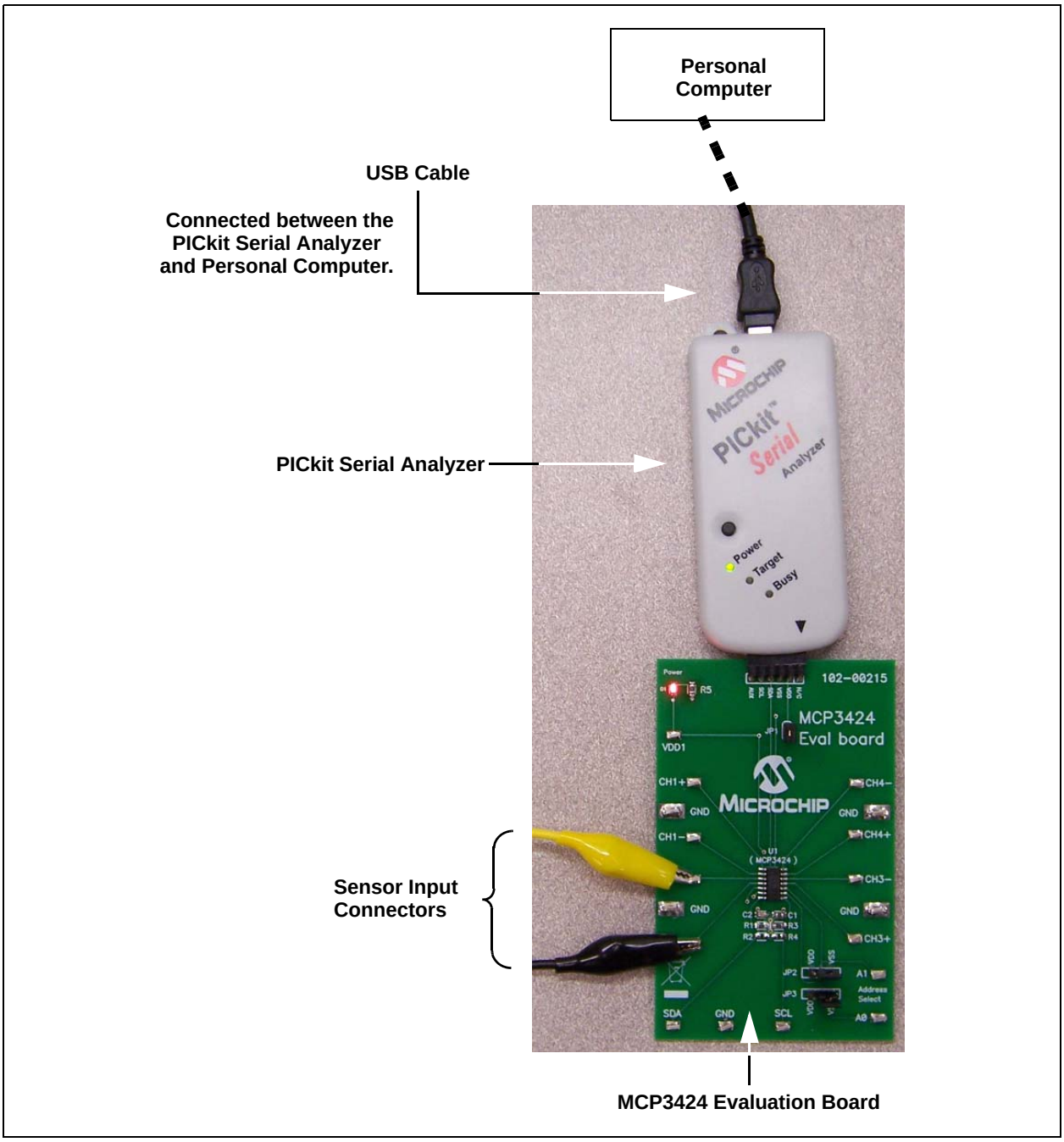

FIGURE 1-2: *MCP3424 Evaluation Board with the PICkit Serial Analyzer.*

1.3.1 PICkit Serial Analyzer PC Software Setup for the MCP3424 Evaluation Board

The following steps describe how to set up and use the PICkit Serial Analyzer PC Graphic User Interface (GUI).

1. Install the PICkit Serial Analyzer software onto your personal computer (PC).
2. Connect the USB cable between the PICkit Serial Analyzer and the PC.
3. Run the PICkit Serial PC Software: It will open to the following GUI. Click the **Next** button and follow the instructions.

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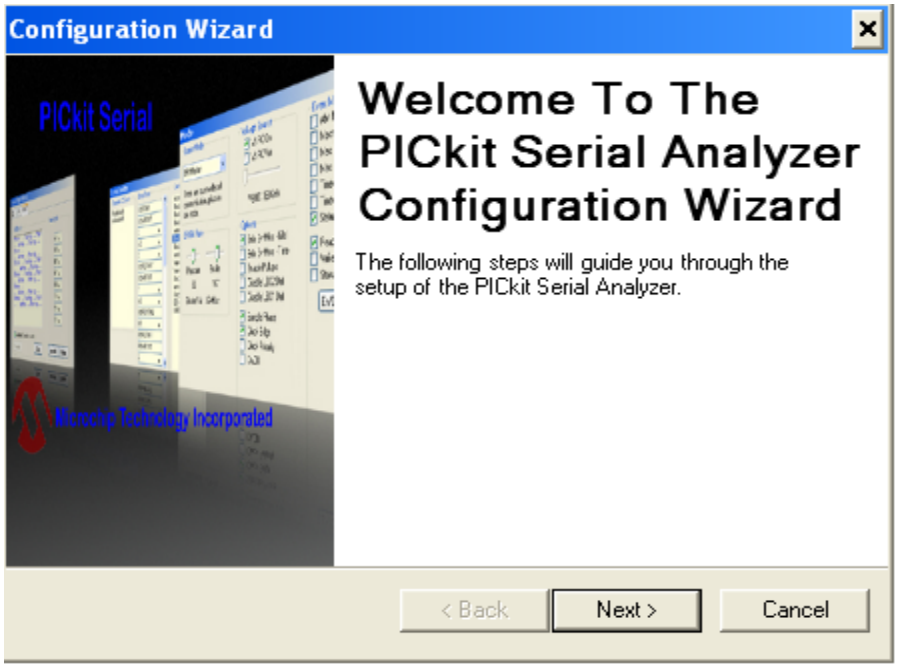
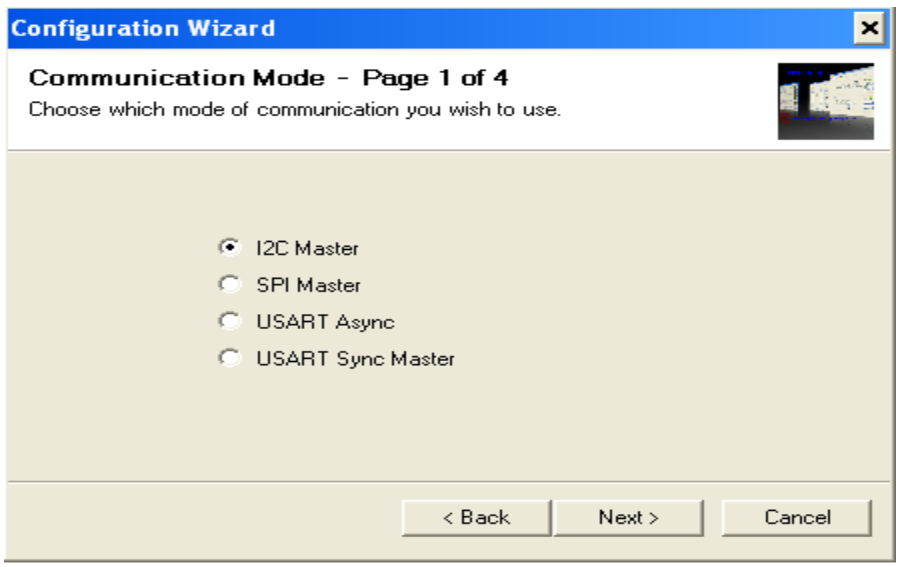
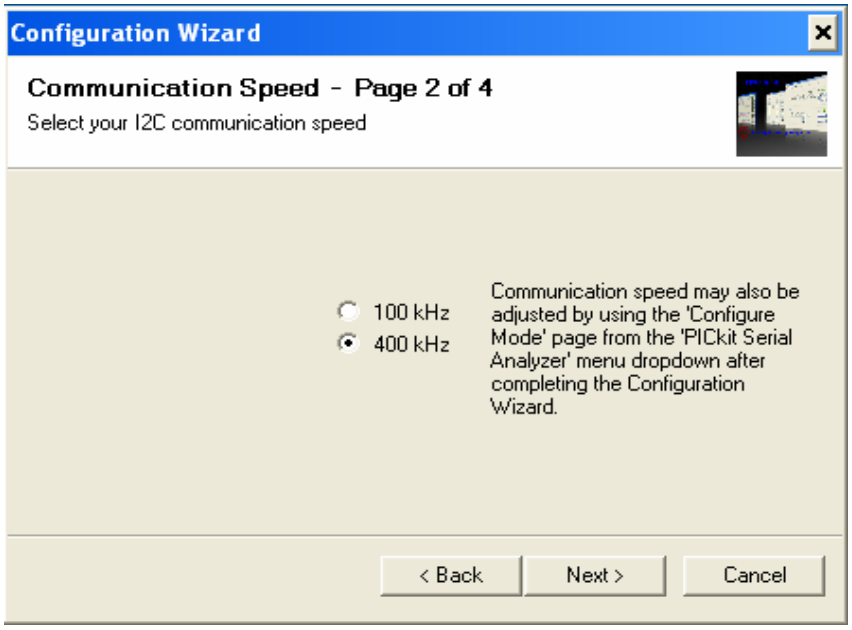


4. Select the Communication Mode type: **I²C Master**, and click the **Next** button.



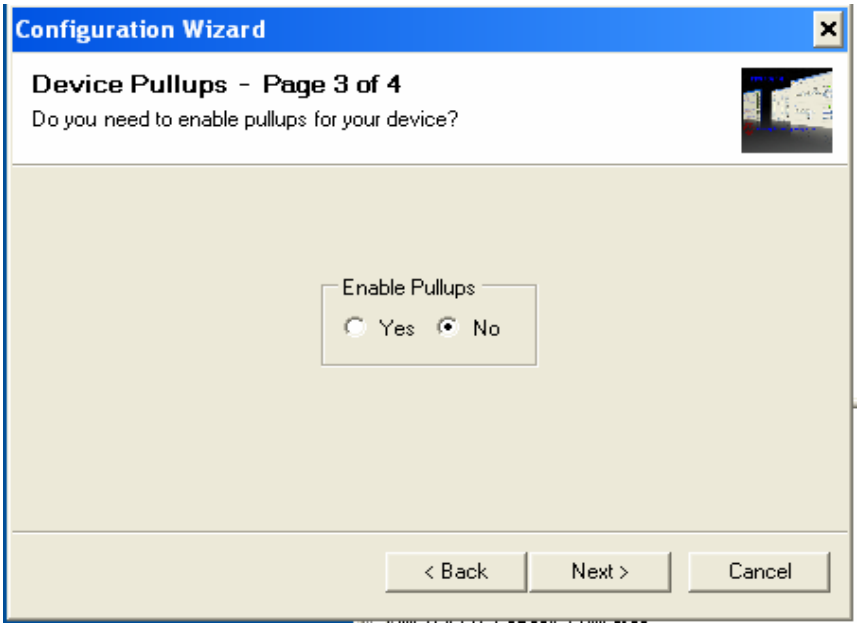
5. Select 100 kHz or 400 kHz. Either one will be fine. Click the **Next** button.



Note: The MCP3424 device supports the I^2C bus data rate up to 3.4 MHz, but the current version of the PICkit Serial Analyzer supports the I^2C bus data rate up to 400 kHz only.

6. Select **No** on Enable Pull-ups and click the **Next** button.

Note: The MCP3424 Evaluation Board has its own pull-up resistors.



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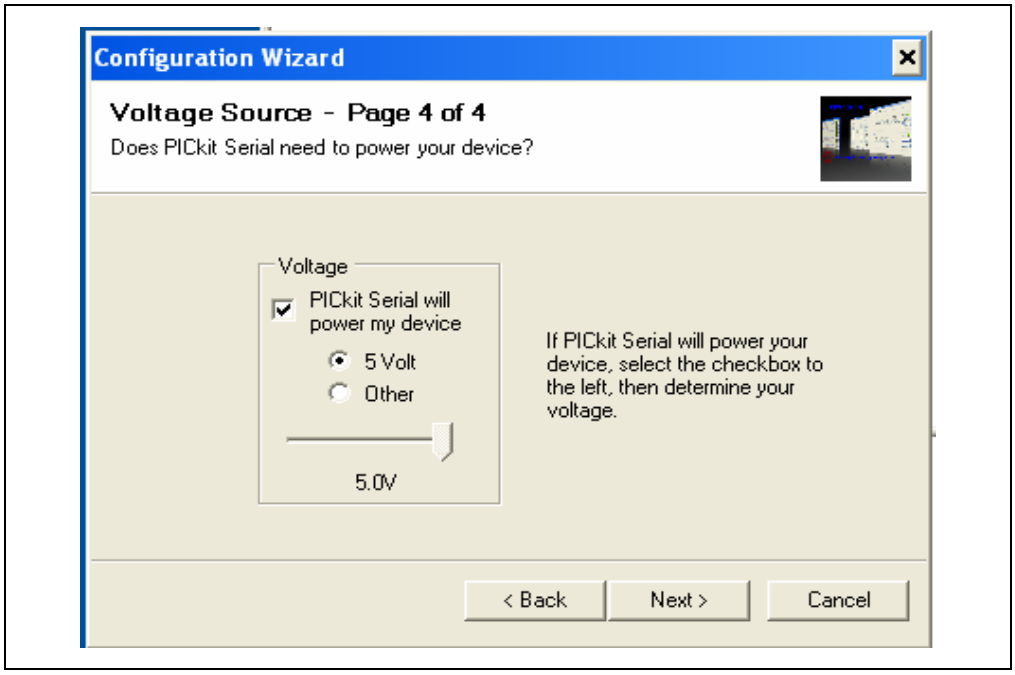
7. Select the V_{DD} voltage of the MCP3424 Evaluation Board and click the **Next** button.

Case 1: When you use V_{DD} from the PICkit Serial Analyzer:

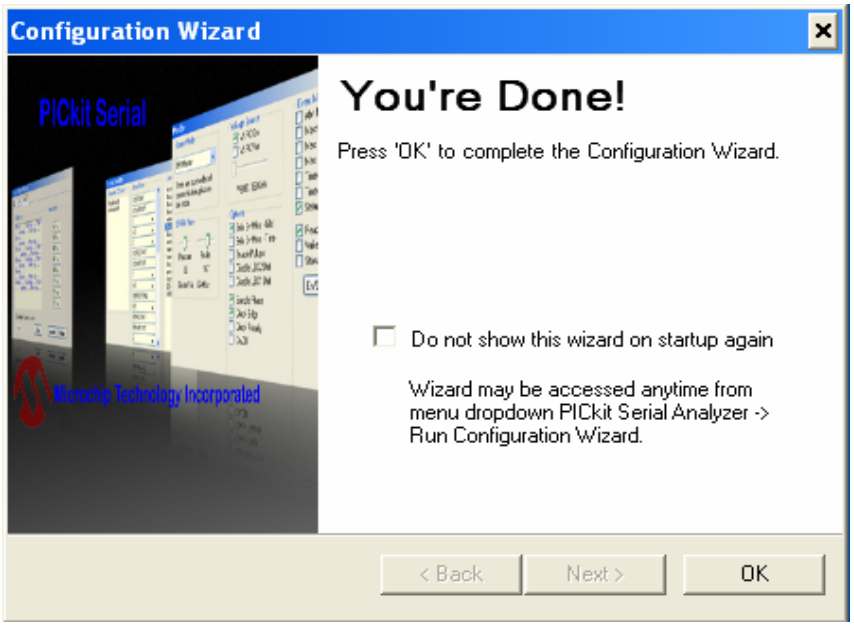
If you choose **PICkit Serial will power your device** and **5 Volts** as shown below, the MCP3424 Evaluation Board is powered by the 5V DC from the PICkit Serial Analyzer through the JP1 jumper. In this case, make sure that the JP1 jumper on the MCP3424 Evaluation Board is connected.

Case 2: When you use your own V_{DD}:

You can also provide your own V_{DD} voltage by applying a V_{DD} voltage at VD1 test point. In this case, make sure that the JP1 jumper is disconnected.



8. Click the **OK** button. You have made all of the PICkit Serial Analyzer Configuration Setups. You are now ready to program the MCP3424 Evaluation Board using the PICkit Serial Analyzer.



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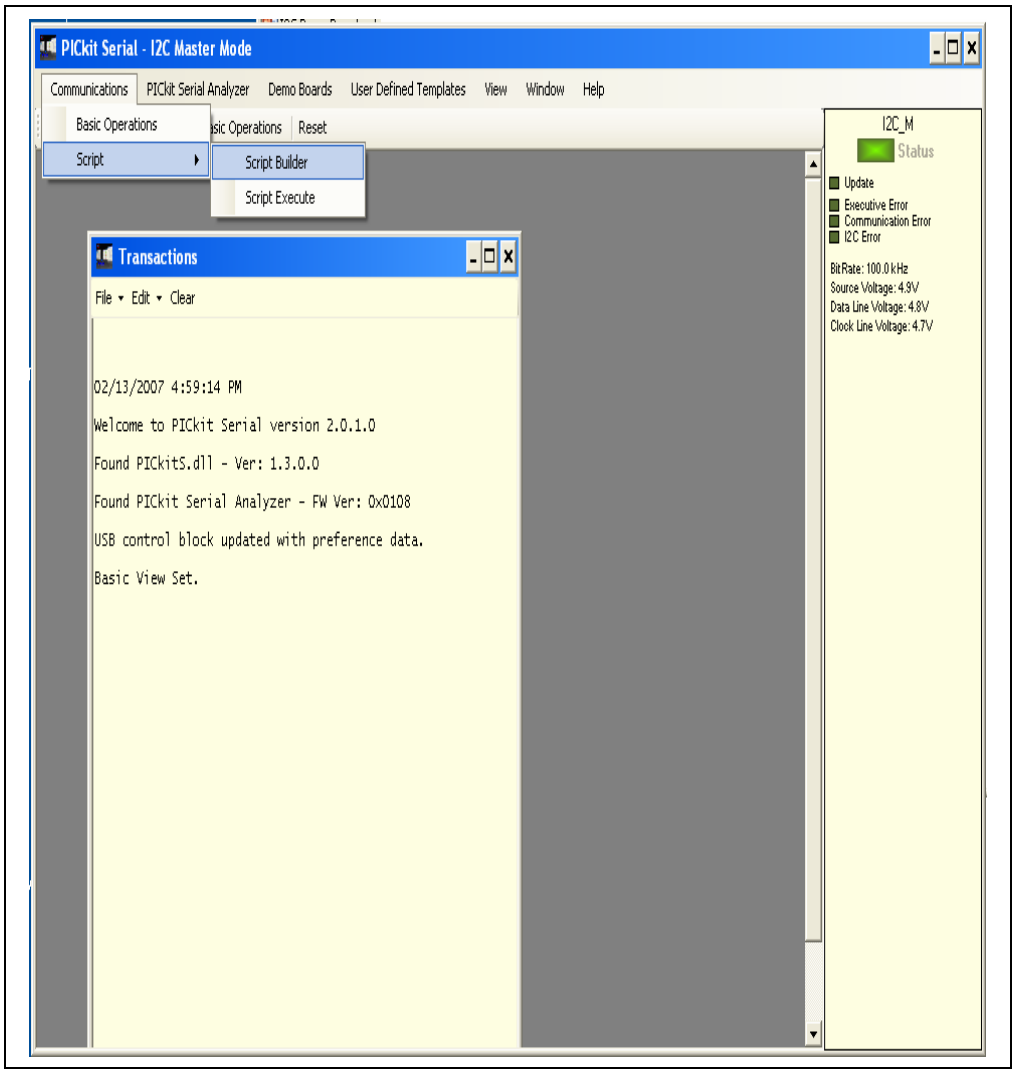
1.3.2 Creating Script Files:

In order to make a communication connection between the PICkit Serial Analyzer and the MCP3424 Evaluation Board, a script file is needed. The following shows how to create script files and how to use them.

- Select **Communication -----> Script ---> Script Builder**



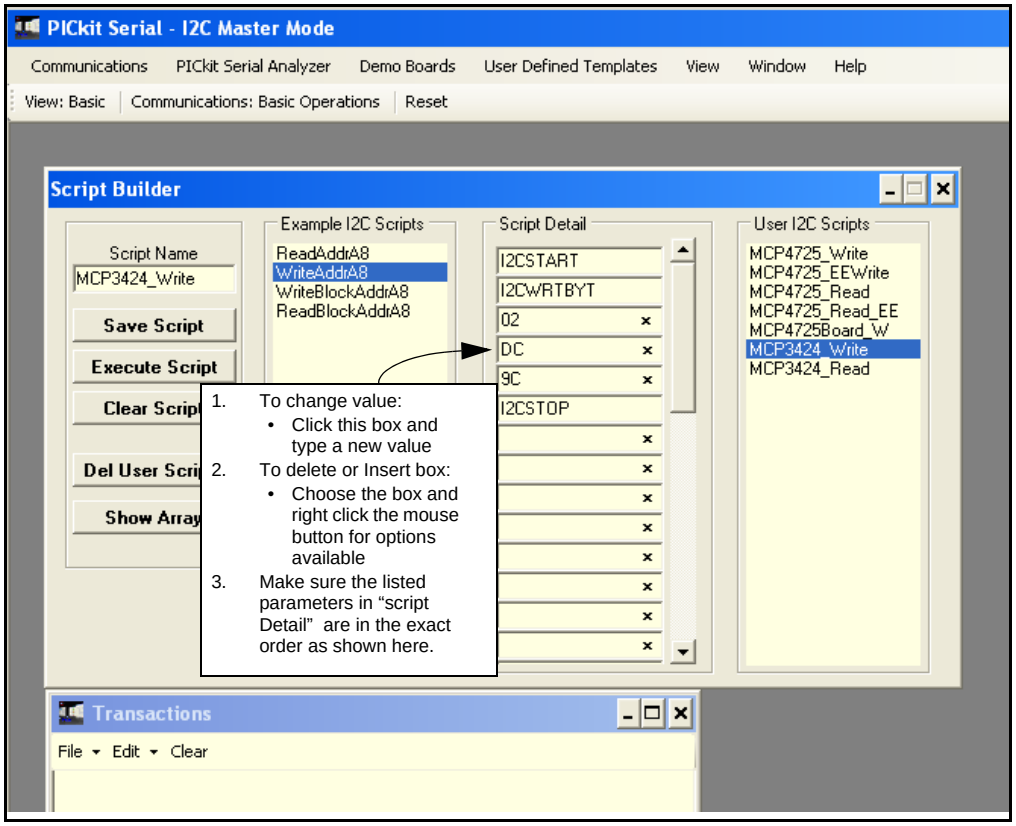
1.3.2.1 CREATING SCRIPT FILE FOR CONFIGURATION BYTE WRITING

1. Click on **WriteBlockAddrA8** in "Example I^2C Scripts" column.

   This will result in filling in the spaces under the **Script Detail** column. You can now modify the **Script Detail** column parameters by clicking with the right mouse button.

How to modify the parameters box in Script Details:

1. Under the **Script Detail** box, select the item in the parameter box.
2. Right click the mouse button and an option box appears to the right of your selection. These are the options available for the parameter selected.
3. Select the desired option and delete or insert the parameter box.
4. Keep the parameters in order as shown below.



4. Change the parameter value.

Script Detail	
I2CSTART	*
I2CWRTBYT	*
02	------> This means there are two bytes to send
DC	------> 1st Write Byte: Address byte with W/R bit = 1101-1100
9C	------> 2nd Write Byte: 1001-1100
I2CSTOP	*

Note: All 6 parameters above must be listed in order. The parameter above with * are not modifiable. Address bits (A2, A1, A0) = (1,1,0) if both JP2 and JP3 are tied to V_{DD}. You can use different address bits by rearranging the connectors. See MCP3424 Data Sheet for more information on address bit sections.

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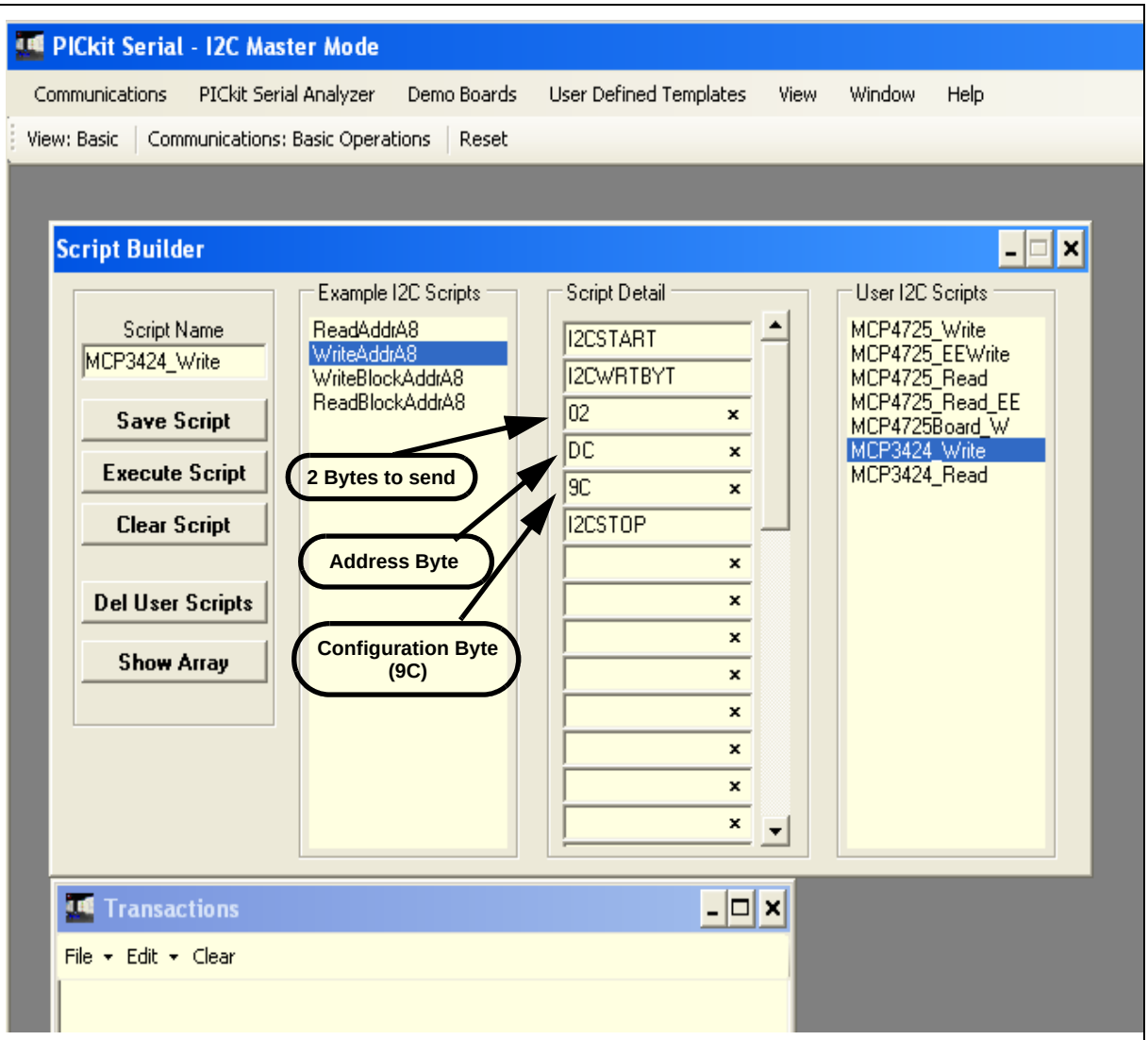

Note: The "9C" in the configuration byte selects the following options:
- Conversion Mode: Continuous Conversion
- Channel Selection: Channel 1
- Bit Resolution: 18 bits
- Gain Selection: 1x

FIGURE 1-3: *Script file example for I^2C Write Command.*

1.3.2.2 SAVE THE SCRIPT FILE AND PROGRAMMING THE MCP3424 CONFIGURATION REGISTER

1. Change the 2nd and 3rd data bytes you want in the Script Detail.
2. Type in any script name (i.e., MCP3424_Write) in the space below the **Script**

Name menu.

3. Click **Save Script** button.
4. Click **Execute Script** button.

> **Note:** At this point, the PICkit Serial transmits the I^2C Write Command to the MCP3424 device. The saved file name will appear in **Users I2C Scripts** column, and can be re-used any time by selecting the file name.

5. You can also see the SCL and SDA waveforms using the Oscilloscope.

> **Note:** When you click on the "Execute Script" menu, the "Busy" LED on the PICkit Serial Analyzer will momentarily turn on and then turn off. If the LED remains ON, a communications problem has occurred. Remove the PICkit Serial Analyzer from your computer and recheck the parameter values including the order of parameters under the "Script Detail" column, and try again until the "Busy" LED turns OFF immediately after sending the I^2C command.

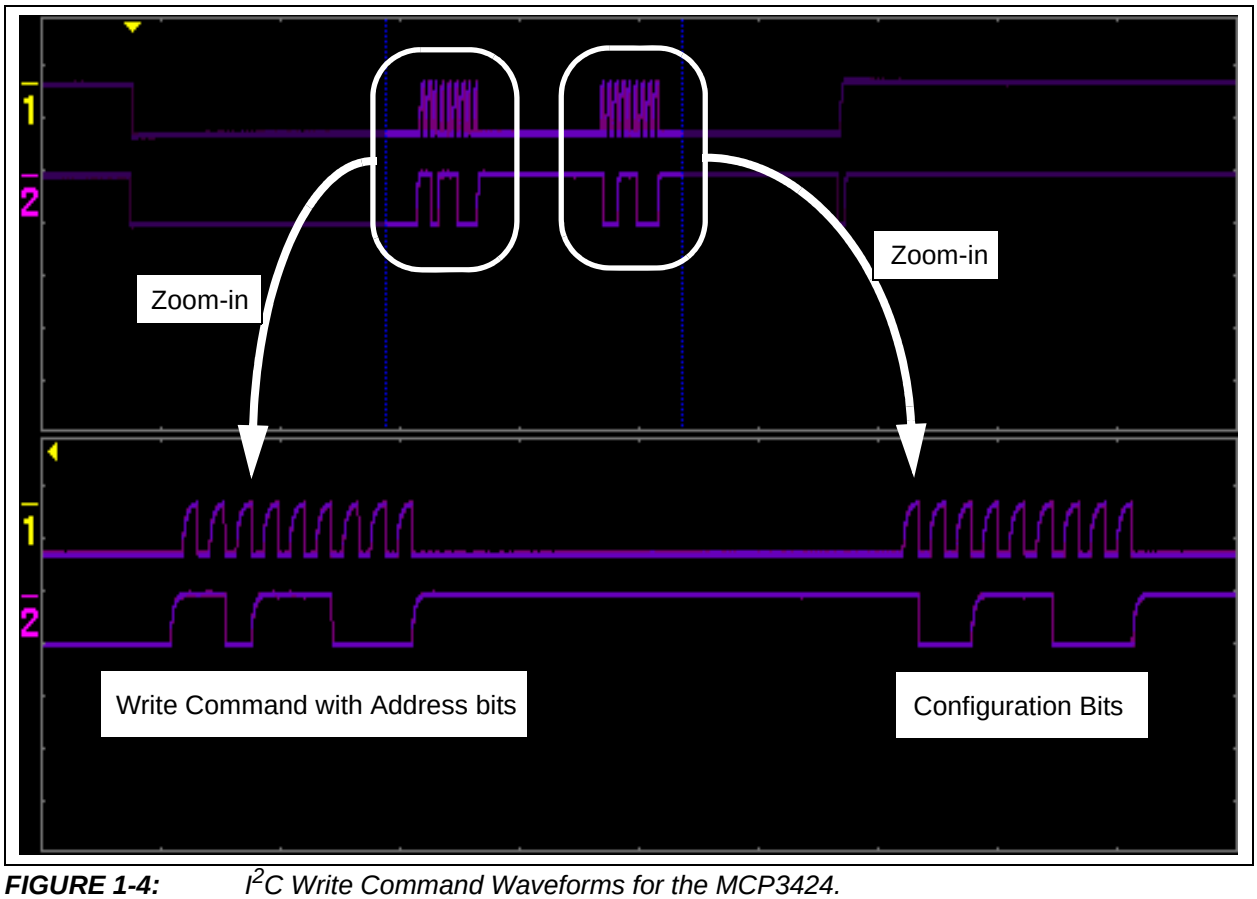

FIGURE 1-4: *I^2C Write Command Waveforms for the MCP3424.*

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1.3.3 Reading the Conversion Data using the PICkit Serial Analyzer

You can read back the conversion data with the following steps.

1.3.3.1 CREATING SCRIPT FILE TO READ CONVERSION DATA

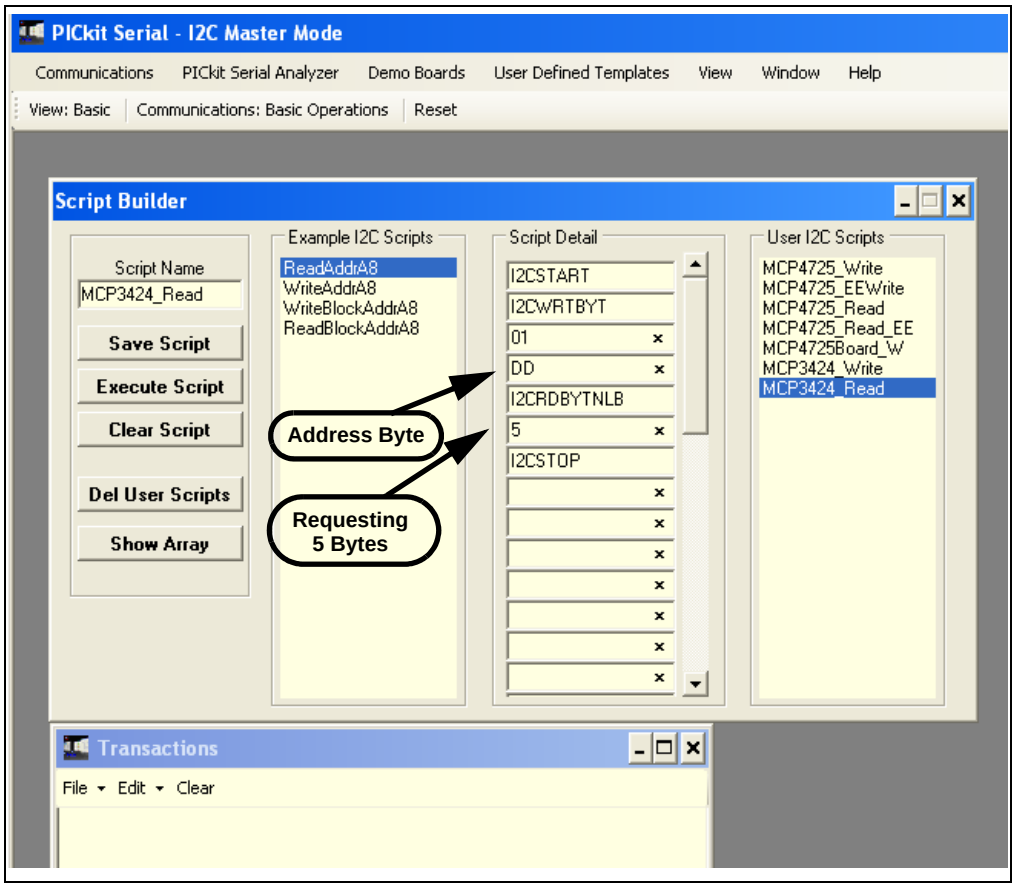
1. Click on **ReadAddrA8** in “Example I2C Scripts” column.

   This will result in filling in the spaces under **Script Detail** column.
   Now you can modify the parameter boxes (delete or insert) in the **Script Detail** column with options. The list of options will appear if you click the right mouse button at the parameter box. You can delete the parameter box or add a new one.

2. Make sure you have the “Script Detail” parameters are listed in order as follows:

Script Detail	
I2CSTART	*
I2CWRTBYT	*
01	------> This means there is one byte for address
DD	------> Address byte with W/R bit = 1101-1101
I2CRDBYTNLB	*
5	------> 5 bytes to read
I2CSTOP	*

Note: All 7 parameters above must be listed in order. The permeates above with * are not modifiable. Address bits (A2, A1, A0) = (1,1,0) if both JP2 and JP3 are tied to V_{DD}. You can use different address bits by rearranging the JP1 and JP2 connectors. See MCP3424 Data Sheet for more information on address bit selections.



3. Type in any script name (i.e., MCP3424_Read) in the space below the **Script Name** menu.
4. Click **Save Script** button.
5. Click **Execute Script** button.

Note: At this point, the PICkit Serial transmits the I^2C Read Command to the MCP3424 device. The saved file name will appear in **Users I2C Scripts** column, and can be re-used any time by selecting the file name.

6. You can also see the SCL and SDA waveforms using the Oscilloscope.

Note: When you click on the **"Execute Script"** menu, the "Busy" LED on the PICkit Serial Analyzer will momentarily turn on and then turn off. If the LED remains ON, a communications problem has occurred. Remove the PICkit Serial Analyzer from your computer and recheck the parameter values including the order of parameters under the "Script Detail" column, and try again until the "Busy" LED turns OFF immediately after sending the I^2C command.

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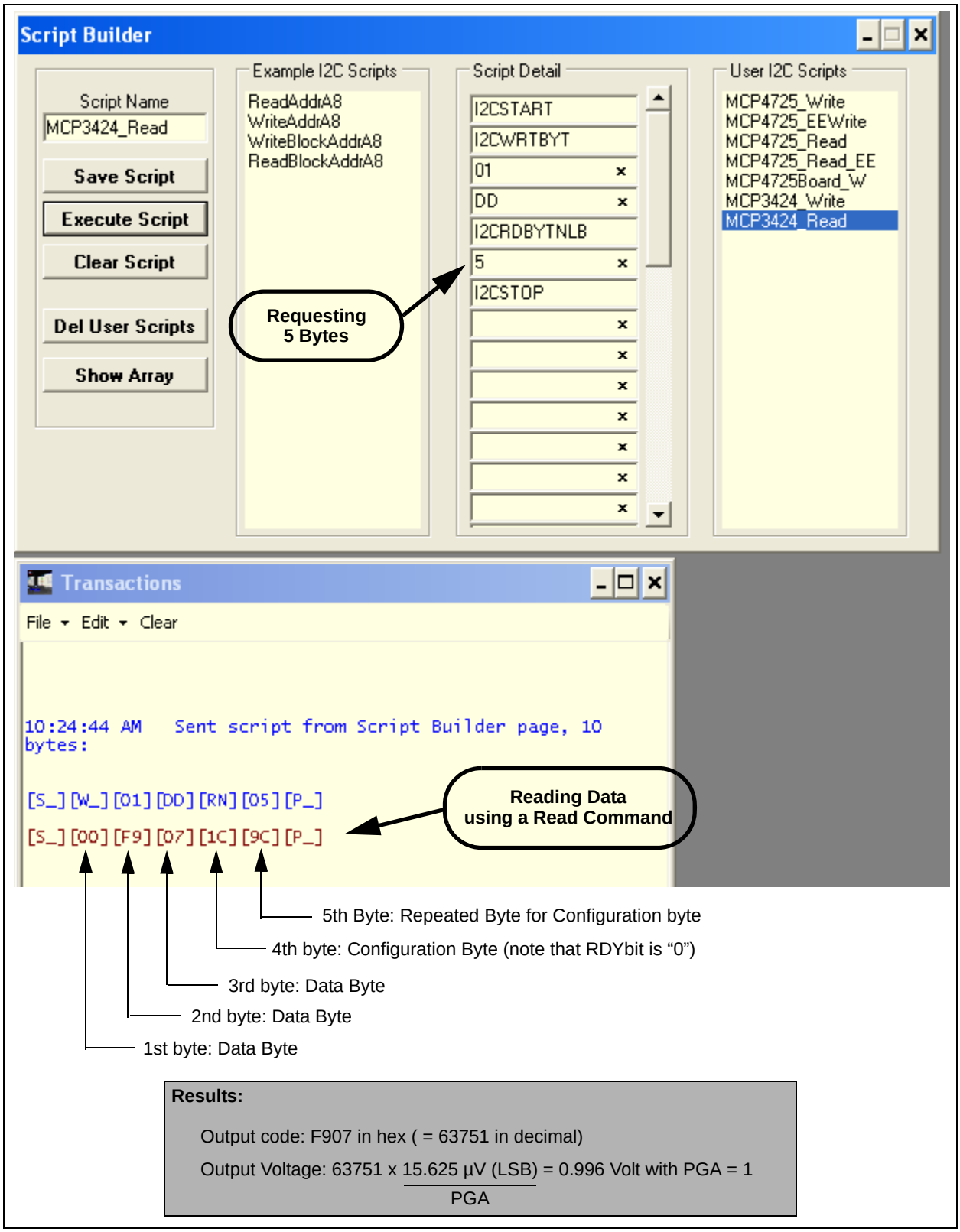
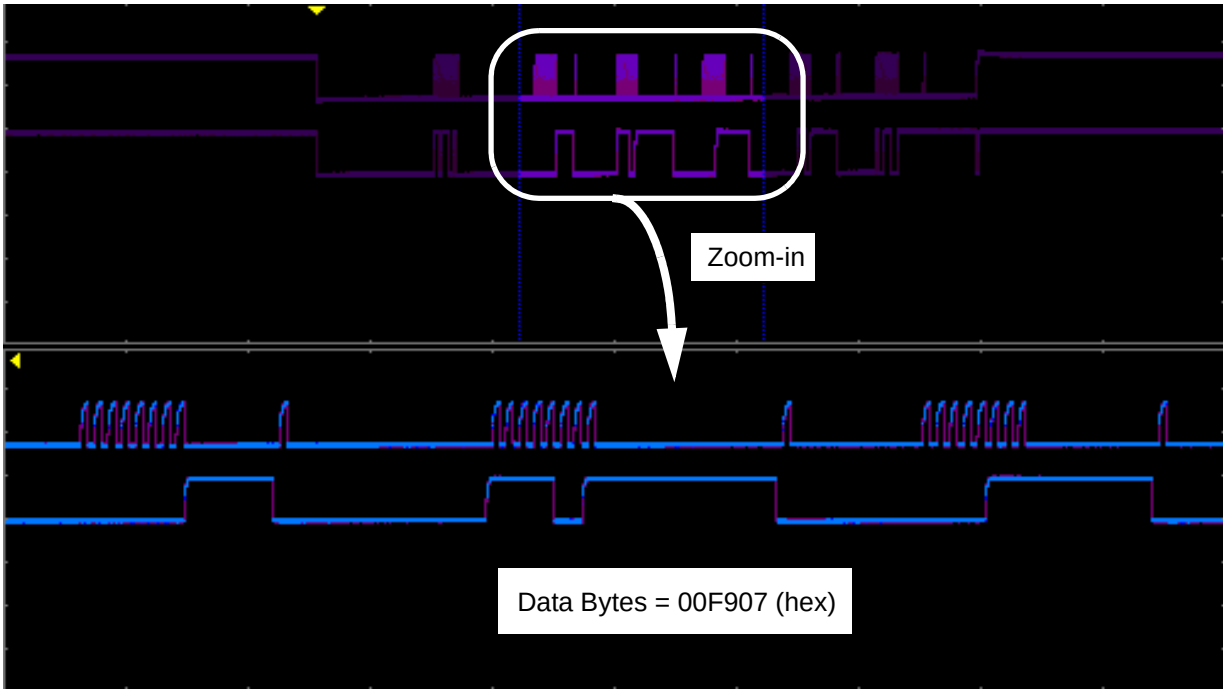
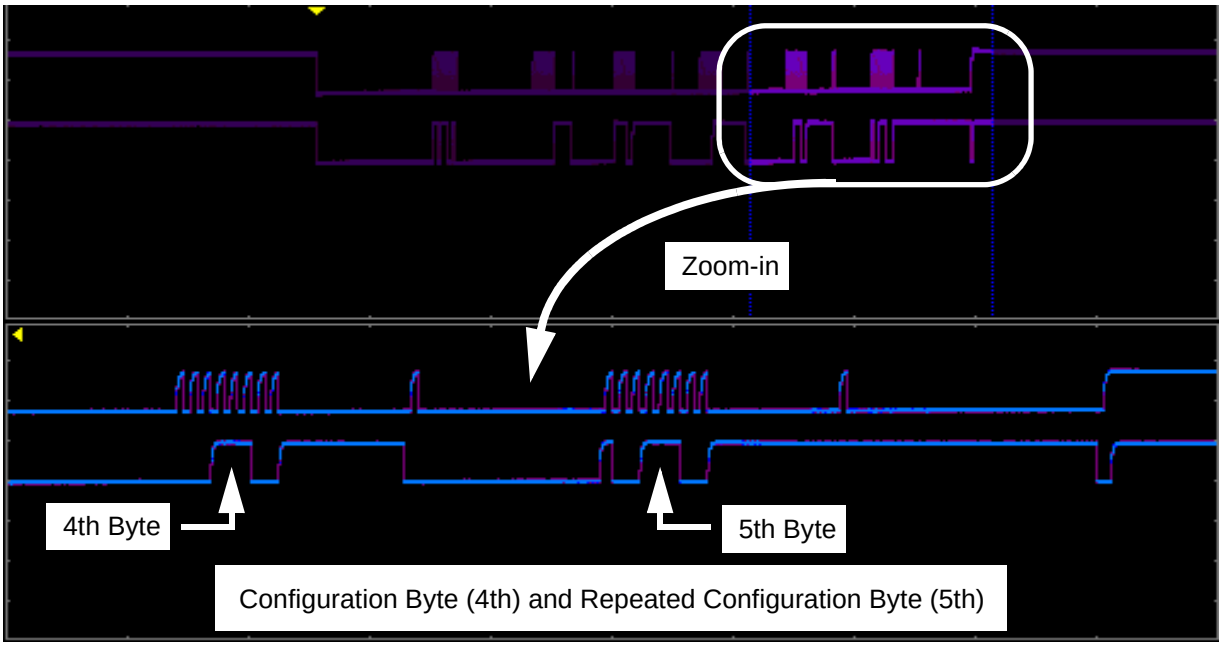


FIGURE 1-5: *Reading Conversion Results: Note that the Input = 0.996V is applied at CH1. The reading indicates the measured value is 0.996 Volts.*



(a) Read command and outputs. The 3 data bytes are zoomed in for better clarity.



(b) Read command and outputs. The last two data bytes are zoomed in for better clarity.

FIGURE 1-6: *Read Command and Data on I^2C bus. Note the $\overline{RDY}$ bit in 4th byte is "0". This means the conversion data just read is the latest conversion data. The $\overline{RDY}$ bit becomes "1" in the 5th byte (repeated byte). This means the device is now in the process of new conversion and the new result is not ready yet.*

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1.4 EXPERIMENT WITH INPUTS OTHER THAN CH1

Repeat **Section 1.3.2 “Creating Script Files:”** to **Section 1.3.3 “Reading the Conversion Data using the PICkit Serial Analyzer”** for the input channels 2, 3, and 4.

NOTES:

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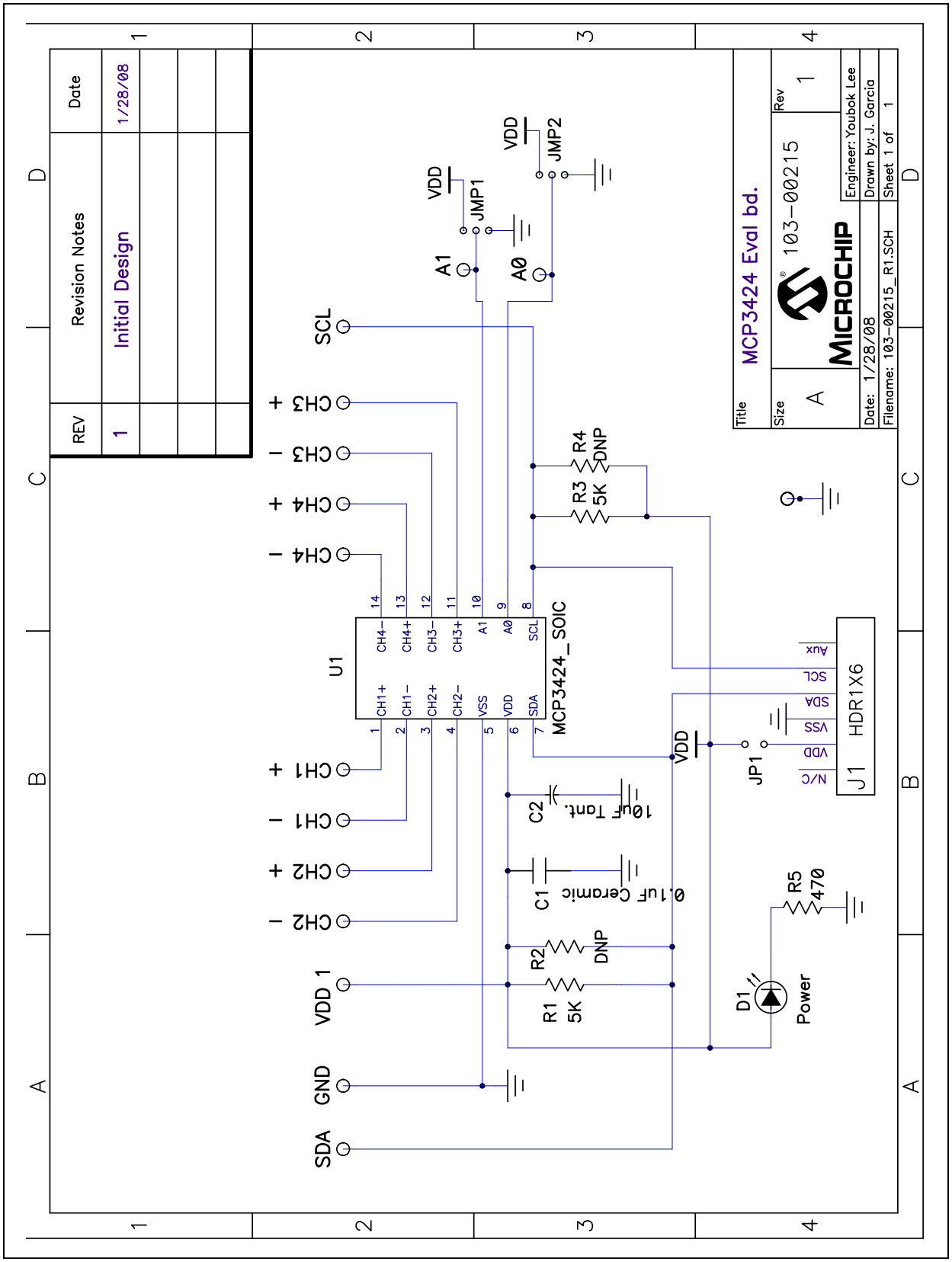
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP3424 Evaluation Board:

- Board – Schematic
- Board – Top Layer
- Board – Top Metal Layer
- Board – Bottom Layer

A.2 BOARD – SCHEMATIC



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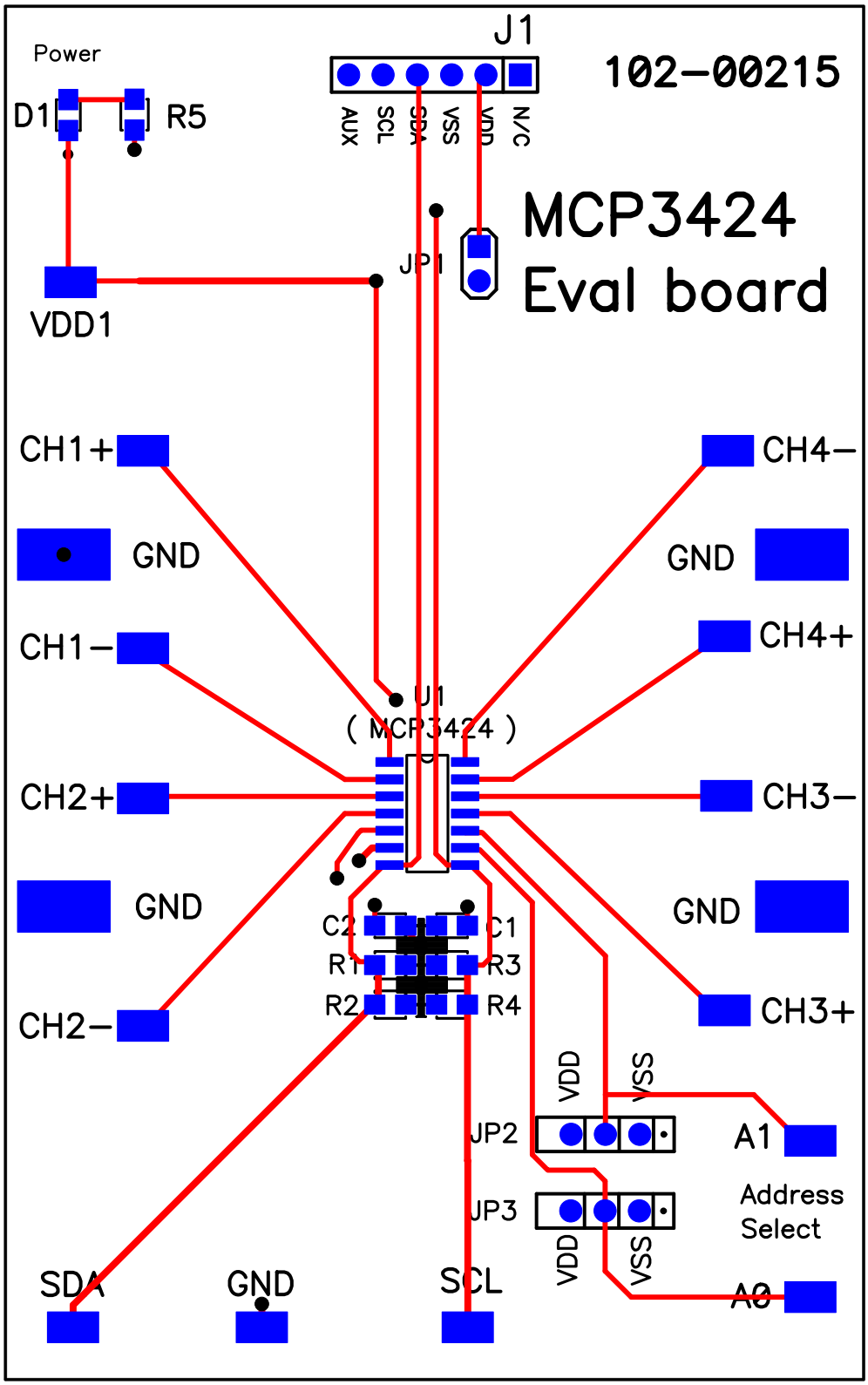
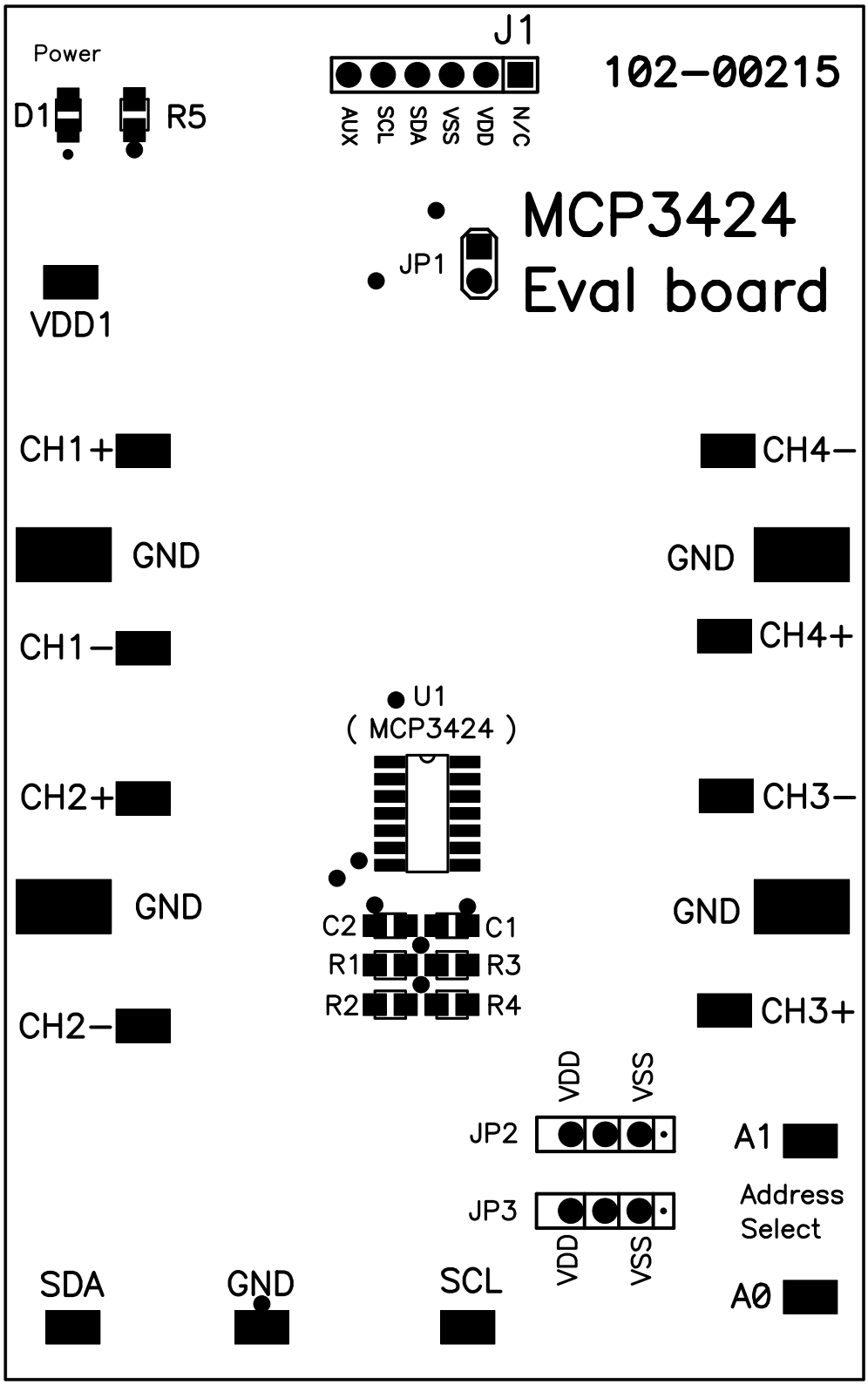
A.3 BOARD – TOP LAYER



A.4 BOARD – TOP METAL LAYER



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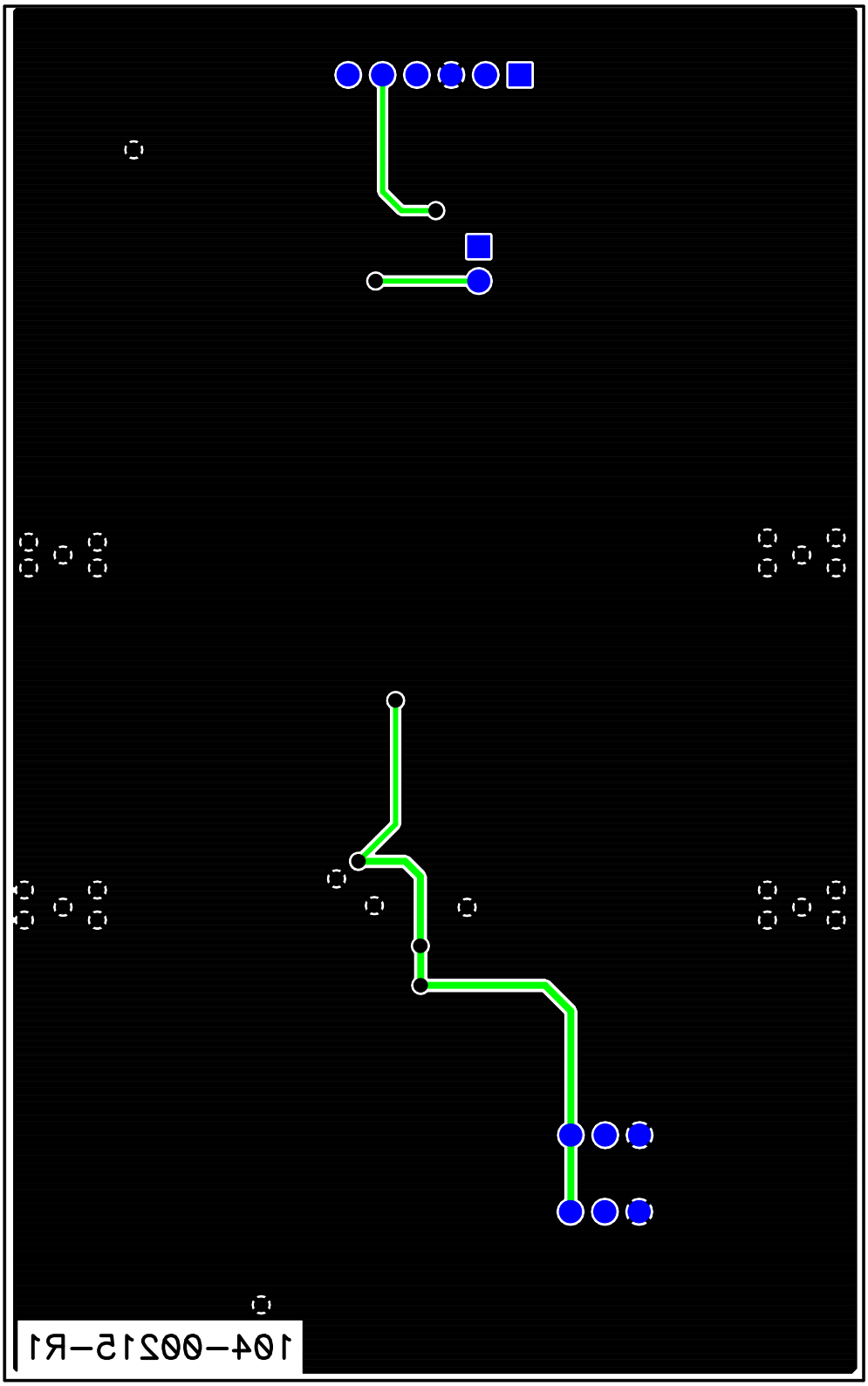
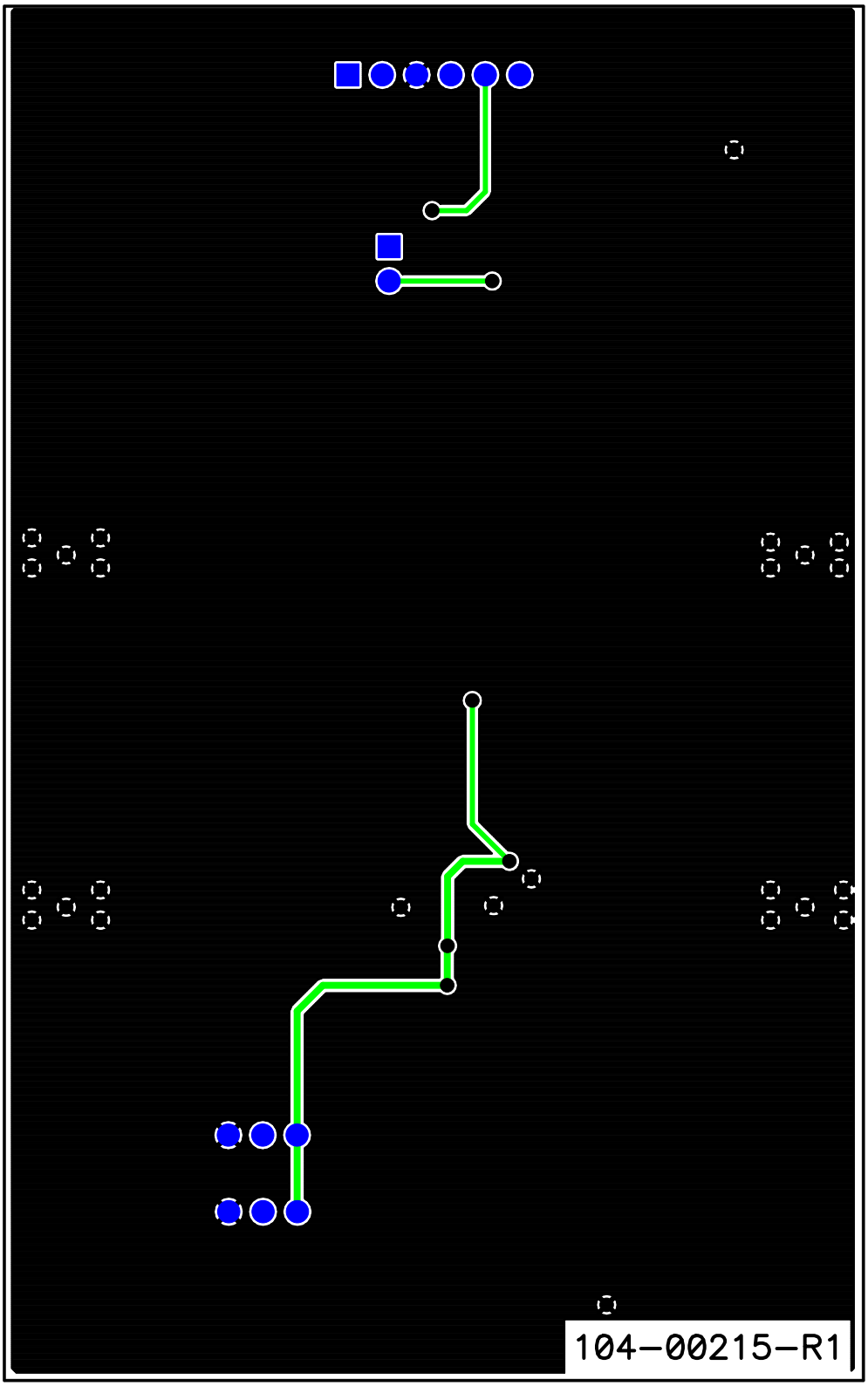
A.5 BOARD – BOTTOM LAYER



A.6 BOARD – BOTTOM METAL LAYER



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Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
1	C1	CAP .1UF 25V CERAMIC X7R 0805	Panasonic® - ECG	ECJ-2VB1E104K
1	C2	CAP CERAMIC 10UF 6.3V X5R 0805	Panasonic - ECG	ECJ-2FB0J106K
1	D1	LED RED ORANGE CLEAR 0805 SMD	LITE-ON INC	LTST-C170EKT
1	PCB	RoHS Compliant Bare PCB, MCP3424 Evaluation Board	—	104-00215
2	R1, R3	RES 4.99K OHM 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4991V
1	R5	RES 470 OHM 1/8W 5% 0805 SMD	Panasonic - ECG	ERJ-6GEYJ471V
1	J1	CONN HEADER 6POS .100 R/A TIN	Molex®/Waldom® Electronics Corp	22-05-2061
1	JP1	CONN HEADER 2POS .100 VERT TIN	Molex/Waldom Electronics Corp	22-03-2021
2	JP2, JP3	CONN HEADER 3POS .100" STR TIN	Molex/Waldom Electronics Corp	90120-0123
1	U1	4 Channel 18 Bit Data Sigma ADC	Microchip Technology Inc.	MCP3424-E/ST
14	VDD1, CH1+, CH1-, CH2+, CH2-, CH3+, CH3-, CH4+, CH4-, A1, A0, SDA, SCL, GND	TEST POINT PC COMPACT SMT	Keystone Electronics®	5016
2	R2, R4	DO NOT POPULATE	—	—

Note 1: 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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