

MCP6S2X Evaluation Board (Rev. 4)
User's Guide

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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 MCP6S2X Evaluation Board (Rev. 4). Items discussed in this chapter include:

- About This Guide
- Warranty Registration
- Recommended Reading
- Troubleshooting
- The Microchip Web Site
- Development Systems Customer Change Notification Service
- Customer Support

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ABOUT THIS GUIDE

Document Layout

This document describes how to use MCP6S2X Evaluation Board (Rev. 4) as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1: MCP6S2X Evaluation Board (Rev. 4) -** this section describes how to use the various features of the MCP6S2X Evaluation Board (Rev. 4).
- **Appendix A: Schematic** – shows the schematic and printed circuit board (PCB) layout diagrams for the MCP6S2X Evaluation Board (Rev. 4).
- **Appendix B: Bill of Materials (BOM)** – shows the parts used to build the MCP6S2X Evaluation Board (Rev. 4).
- **Appendix C: Evaluation Board Firmware** – shows the firmware for the PIC16C505 source code used on the MCP6S2X Evaluation Board (Rev. 4).
- **Appendix D: Setup Conditions** – shows configuration tables for the DIP switch settings and connections used for the MCP6S2X Evaluation Board (Rev. 4).

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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
'b*nnnn*	A binary number where *n* is a digit	'b00100, 'b10
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier font:		
Plain Courier	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`
Italic Courier	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
`0x`*`nnnn`*	A hexadecimal number where *n* is a hexadecimal digit	`0xFFFF`, `0x007A`
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) { ... }`

RECOMMENDED READING

This user's guide describes how to use MCP6S2X Evaluation Board (Rev. 4). Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP6S2X PGA Data Sheet (DS21117)

This data sheet provides detailed information regarding the MCP6S21/2/6/8 family of PGAs.

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 (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
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- **Emulators** – The latest information on Microchip in-circuit emulators.This includes the MPLAB ICE 2000 and MPLAB ICE 4000.
- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debugger, MPLAB ICD 2.
- **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 SIM and MPLAB SIM30 simulators, MPLAB IDE Project Manager and general editing and debugging features.
- **Programmers** – The latest information on Microchip programmers. These include the MPLAB PM3 and PRO MATE® II device programmers and the PICSTART® Plus development programmer.

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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

NOTES:

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MCP6S2X Evaluation Board (Rev. 4) User's Guide

Chapter 1. MCP6S2X Evaluation Board (Rev. 4)

1.1 INTRODUCTION

The MCP6S21/2/6/8 family of Programmable Gain Amplifiers (PGA) is available with one, two, six or eight signal input channels, respectively. The user can digitally select a specific input channel and set the gain. This family of PGAs can be evaluated using the MCP6S2X Evaluation Board (Rev. 4). The evaluation board schematic is shown in Figure 1-1. This board uses the MCP6S21 and MCP6S26 to allow the user to connect two signal sources to evaluate the PGAs. The 10 kΩ pull-up resistors provide noise immunity for the PGA digital input pins.

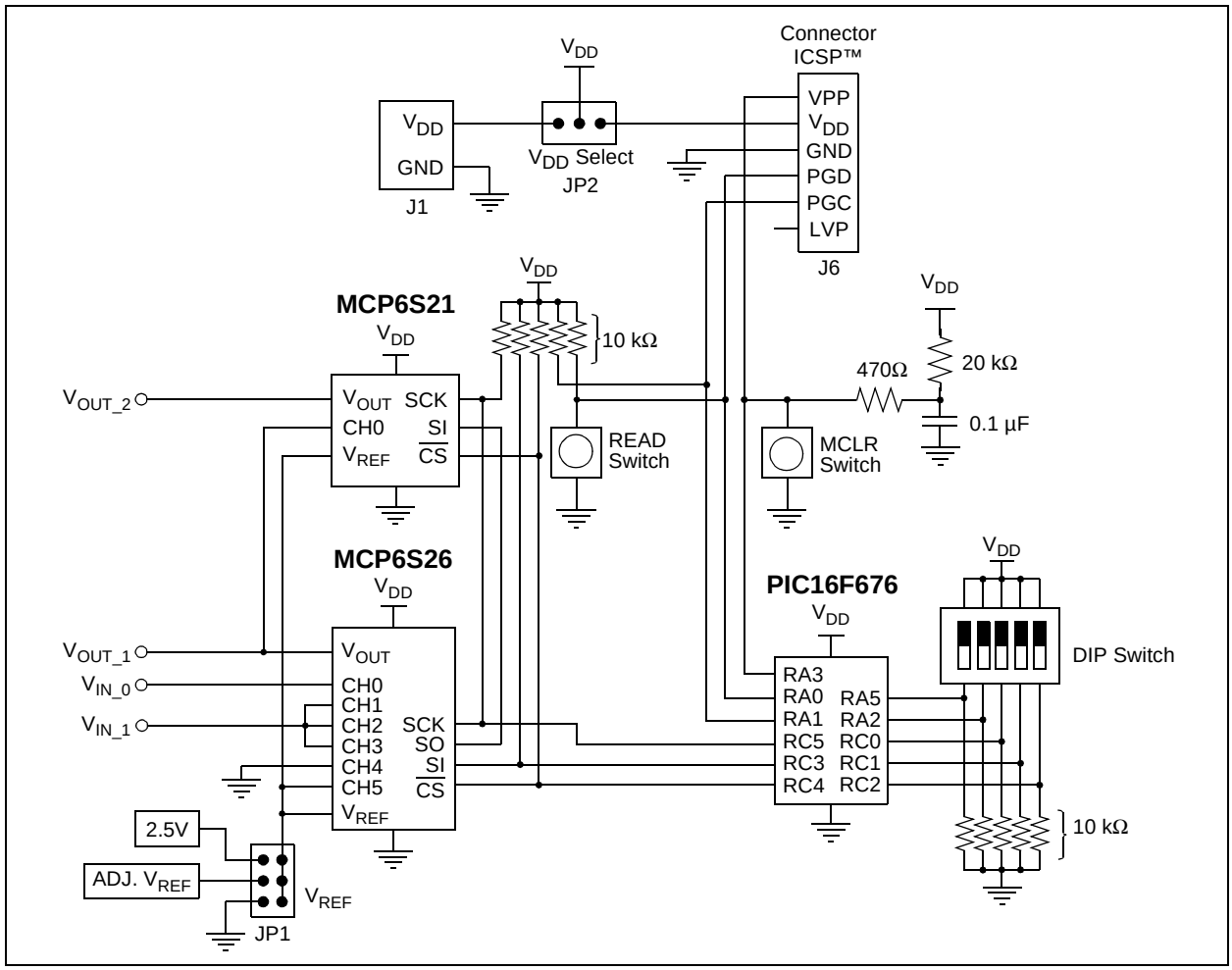


FIGURE 1-1: *MCP6S2X Evaluation Board (Rev. 4) simplified schematic.*

1.2 EVALUATION BOARD DESCRIPTION

The single-channel MCP6S21 and six-channel MCP6S26 have been selected for this evaluation board. The PIC16F676 microcontroller is used to program the PGAs according to the user inputs. User inputs are selected using the on-board DIP switch settings that are configured according to the table printed on the evaluation board. This allows the user to program the channel, gain and shutdown of each PGA. Either PGA or both PGAs can be shut down. The six channels of the MCP6S26 and the PGA gains of 1, 2, 4, 5, 8, 10, 16 and 32 V/V can be configured. Refer to **Appendix D."Setup Conditions"**, for additional information.

When the momentary **READ** push button switch is pressed, the microcontroller reads the DIP switch configuration through the I/O ports. The controller determines the proper command and data bytes to be transmitted to the PGAs and the transmits a 16 or 32-bit word through the Serial Peripheral Interface (SPI™) port.

When the momentary **MCLR** push button switch is pressed, the microcontroller Master Clear is activated. This resets the microcontroller to a known initial state.

The ICSP connector provides the capability of programming the PIC16F676 from a PC. This requires additional hardware, such as MPLAB® ICD 2.

The two PGAs are cascaded, while the signal output of the MCP6S26 is directly connected to the analog input of the MCP6S21. This configuration outputs a maximum signal gain of 1024 V/V.

The digital lines of the PGA are daisy chained. The MCP6S26 has a Serial-Out (SO) line that can be used to serially program another device. Therefore, the SO line is connected to the Serial-In (SI) line of the MCP6S21. If the MCP6S26 is removed from the socket, the MCP6S21 cannot be programmed.

The MCP6S2X family of PGAs has a reference voltage input pin to offset the output signal. There are three reference voltage options on the board: 2.5V, adjustable reference voltage (0V to 5V) and ground. These options can be selected using the on-board jumper (JP1).

A prototype area is available for user circuit interface. The inputs, outputs and reference voltage traces of the PGAs conveniently pass near the prototype area for ease of connection. Test point connectors are available to interface with external circuits. The signals V_{IN_0}, V_{IN_1}, V_{OUT_1} and V_{OUT_2} can use SMA connectors that slide horizontally onto the board. 50Ω termination resistors can be added to V_{IN_O} and V_{IN_1}. Refer to **Appendix A."Schematic and Board Layouts"** and **Appendix D."Setup Conditions"**, for additional information.

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1.3 HOW IT IS USED

1.3.1 Application Procedure - Stand-Alone Mode

1. Apply a 2.5V to 5.5V supply voltage to the V_{DD} and ground (GND) terminals of J1. Place the V_{DD} SELECT jumper (JP2) at the bottom (nearest J1).

> **Note:** If jumper JP2 is incorrectly placed, there may be a conflict between power supplies.

   For additional information on powering-up the MCP6S2X Evaluation Board (Rev. 4), refer to **Section 1.4.2 "Applying Power"**. During power-up, the MCP6S2X PGA's default settings are Channel 0 (CH0) and gain = 1 V/V.

> **Note:** Do **NOT** use the ICSP connector while in this mode (disconnect the cable). The results may be unpredictable and damage might occur due to conflicting voltage sources.

2. Connect a voltage-measuring device (such as an oscilloscope) to V_{OUT_1} for the MCP6S26 and/or V_{OUT_2} for the MCP6S21.
3. Select the desired reference voltage using JP1. If the adjustable reference voltage is selected, adjust this voltage using the potentiometer (ADJ_V_{REF}). A test point is available to measure the reference voltage.
   Refer to **Section 1.4.5 "Reference Voltage"** for additional information.

> **Note:** There are soldering pads available across each input terminal for termination resistors (R_4 and R_5). If these resistors (e.g., 50Ω) are needed for your application, solder them across the pads.

4. Apply the input signal source at V_{IN_0} and/or V_{IN_1}. V_{IN_0} is connected to Channel 0 and V_{IN_1} is connected to Channel 1 of the MCP6S26 (refer to **Section 1.4.4 "Analog Interface"**). Make sure that the input signal range is at the proper level to avoid railing the amplifier output when the signal is gained. Refer to **Section 1.4.5 "Reference Voltage"** for additional information.
5. Refer to the Table 1-1 and select the desired gain, channel or shutdown using the on-board DIP switch. Press and release the **READ** push button switch to program the PGA and notice the change in the output voltage. Refer to **Section 1.4.6 "Programming The PGA"** for further explanation.

TABLE 1-1: DIP SWITCH CONFIGURATION TABLE

Register	MCP6S26 MSB → LSB	MCP6S21 MSB → LSB
Gain 1	00000	01000
Gain 2	00001	01001
Gain 4	00010	01010
Gain 5	00011	01011
Gain 8	00100	01100
Gain 10	00101	01101
Gain 16	00110	01110
Gain 32	00111	01111
Channel 0	10000	—
Channel 1	10001	—
Channel 2	10010	—
Channel 3	10011	—
Channel 4	10100	—
Channel 5	10101	—
SHDN	11000	—
SHDN	—	11001
SHDN	11010	11010

1.3.2 Application Procedure - Program Mode

1. Place the V_{DD} SELECT jumper (JP2) at the top (away from J1). The MPLAB ICD 2 will provide 5V to the PGAs and to the microcontroller. Disconnect any external power supply from J1.

> **Note:** The ICSP™ connector can only be used to program the PIC16F676. In order to debug the firmware, use the MPLAB ICD 2 header. Refer to the MPLAB ICD 2 Header Installation Information (DS51292) for more information.

2. Configure the MPLAB ICD 2 to provide power to the evaluation board through the ICSP connector. This is accomplished by changing the MPLAB ICD 2 configuration in MPLAB IDE. The MPLAB ICD 2 needs to be powered by an external power source.
3. Connect the MPLAB ICD 2 to the ICSP connector and update the PIC16F676 firmware from a PC using MPLAB ICD 2.

> **Note:** Do not change either of the manual push button switches (**MCLR** and **READ**) while debugging the firmware. The results of this action would be unpredictable, and may cause damage due to conflicting voltage sources.

4. Follow steps 3 thru 5 in **1.3.1 "Application Procedure - Stand-Alone Mode"**.

1.4 HOW IT WORKS

1.4.1 PGA Functions

The PGA has an internal precision operational amplifier in a non-inverting configuration. The gain of this operational amplifier is set using resistive ladders in the feedback loop. The resistor ratio is set using analog switches that are configured according to the instructions stored in the memory registers.

The MCP6S21/2/6/8 family of PGAs provide various input channel options: one, two, six or eight channel inputs, respectively. The non-inverting input of the internal precision operational amplifier is directly connected to the input channels through a multiplexer. The multiplexer is also configured according to the command stored in the memory registers. Figure 1-2 shows a block diagram of the MCP6S26 with six input channels. For the single-channel MCP6S21, the non-inverting input is directly connected to the input pin without a multiplexer.

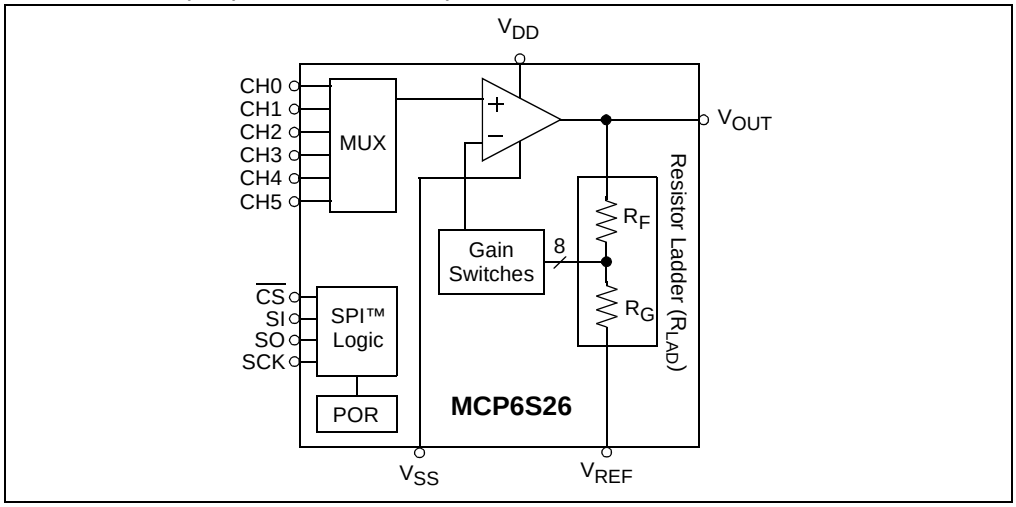


FIGURE 1-2: *The six-channel MCP6S26 PGA Block Diagram. The single-channel MCP6S21 does not have an input multiplexer.*

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1.4.2 Applying Power

The V_{DD} SELECT jumper (JP2) connects the power plane (V_{DD}) to either an external power supply (through J1) or to MPLAB ICD 2 (via the ICSP connector (J6)). It selects between two modes of operation:

1. **Stand-Alone Mode** - The MCP6S2X Evaluation Board (Rev. 4) is configured using the on-board switches. Power is brought in to connector J1 from an external supply and the V_{DD} SELECT jumper selects J1. The external supply can be between 2.5V and 5.5V. When the PIC16F676 is in a valid operating voltage, the device will run the program stored in the device's program memory (the firmware).
2. **Program Mode** - The MCP6S2X Evaluation Board (Rev. 4) is connected to the MPLAB ICD 2, which is connected to a PC. Power is brought in via the ICSP connector and the V_{DD} SELECT jumper selects the ICSP source. V_{DD} is 5.0V. The PIC16F676 firmware is reprogrammed by MPLAB IDE (application on PC).

1.4.3 Digital Interface

The memory registers are programmed using the SPI™ interface from a PIC16F676 microcontroller. The digital interface uses a standard 3-wire SPI protocol with Chip Select ($\overline{CS}$), Serial Clock (SCK) and Serial In (SI) lines. These lines are directly connected to the MCP6S26 and have pull-up resistors. These pull-up resistors provide noise immunity for the PGA from the PICmicro® microcontroller's I/O pins. The two PGAs are daisy chained with the SO pin from the MCP6S26 and connected to the SI pin of the MCP6S21. The SCK and $\overline{CS}$ lines are also connected to the MCP6S21.

In order to program the MCP6S21 through the daisy chain, the microcontroller pulls $\overline{CS}$ low and sends the 32-bit word through the SPI line. The first 16-bit word contains the command and data bytes for the MCP6S21, while the next 16-bit word contains the command and data bytes for the MCP6S26. The second 16-bit word can be zeros or a NOP command. At the end of the 32nd clock cycle, the first 16-bit word is pushed out of the MCP6S26 (through the SO line) and into the MCP6S21 (through the SI line). When $\overline{CS}$ toggles high, the bytes are latched in the registers. Instructions in the registers are then executed.

1.4.4 Analog Interface

The input channel 0 of the MCP6S26 is connected to V_{IN_0}. The input channels 1, 2 and 3 are connected to V_{IN_1}. Input channel 4 is connected to ground and input channel 5 is connected to the reference voltage. The user can connect two signal sources to channel 0 and channel 1 at V_{IN_0} and V_{IN_1}. .

Note: There are soldering pads available across each input terminal for termination resistors (R_4 and R_5). If these resistors (e.g., 50Ω) are needed for your application, solder them across the pads.

The output pin of the MCP6S26 is connected to V_{OUT_1}. This pin is also connected to Channel 0 of the MCP6S21. The MCP6S21 can be used to gain the signal from the MCP6S26 by gains of 1, 2, 4, 5, 8, 10, 16 and 32 V/V. If both PGAs are configured for a gain of 32 V/V, the total signal gain is 1024 V/V. This illustrates the fact that the user can cascade several PGAs to get higher gains. The output pin of the MCP6S21 is connected to V_{OUT_2}. The outputs of both PGAs are loaded with 10 kΩ resistors and 56 pF capacitors in parallel. These loads can be changed by the user.

Note: The signals V_{IN_0}, V_{IN_1}, V_{OUT_1} and V_{OUT_2} can be setup for test points (surface-mount on top) or for SMA connectors (slide onto board horizontally). Refer to **Appendix D, D.3 "SMA Connectors"** for more information.

1.4.5 Reference Voltage

The MCP6S2X Evaluation Board (Rev. 4) has three reference-voltage settings, as shown in Figure 1-3. The MCP1525, a precision reference voltage device, is used to provide a 2.5V reference. The minimum supply voltage for this device is 2.7V. Therefore, this device will not operate when the evaluation board supply voltage (V_{DD}) is below 2.7V. An adjustable reference voltage (0V to 5V) is also available using a mechanical potentiometer. Since the reference voltage input of the PGA requires a low-impedance source, these reference voltages are buffered using the MCP6022, a 10 MHz operational amplifier. The PGA reference voltage input can also be connected to ground. All of these options can be selected using the on-board jumper connector JP1 (refer to **Appendix D."Setup Conditions"** and **D.5 "Reference Voltage Jumper Positions"** for more information).

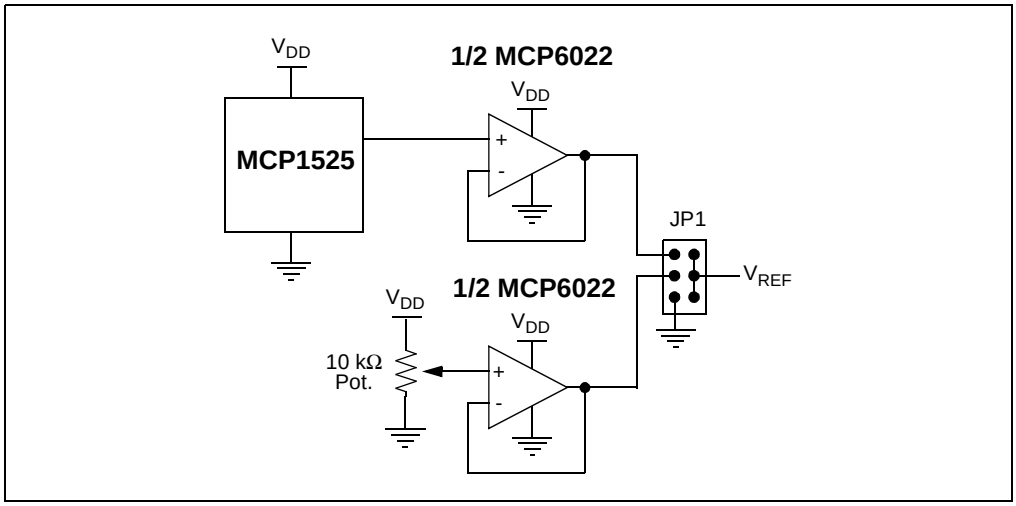


FIGURE 1-3: *Simplified Reference Voltage Schematic.*

The input and output of this PGA can swing rail-to-rail (V_{DD} and GND supply voltages). However, in order to keep linearity, the output voltage should not exceed the Maximum Output Voltage Swing, referred to in the electrical specifications of the MCP6S21/2/6/8 Data Sheet (DS21117). The reference voltage must be adjusted so that the maximum output would not exceed the specified limit.

The PGA output voltage, with respect to the input and reference voltages, can be determined using the following equation:

EQUATION 1-1:

$$V_{OUT_1} = G_{MCP6S26}(V_{IN_X} - V_{REF}) + V_{REF}$$

$$V_{OUT_2} = G_{MCP6S26} \times G_{MCP6S21}(V_{IN_X} - V_{REF}) + V_{REF}$$

Where:
$G_{MCP6S26}$ = gain of 1, 2, 4, 5, 8, 10, 16 or 32 V/V
$G_{MCP6S21}$ = gain of 1, 2, 4, 5, 8, 10, 16 or 32 V/V
V_{IN_X} = signal at the MCP6S26's selected channel
V_{REF} = Reference Voltage at V_{REF} pin.

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1.4.6 Programming The PGA

The DIP switch lines are connected to the five microcontroller I/O lines (RA5, RA2, RC0, RC1 and RC2) with pull-down resistors (Refer to Figure 1-1 and **Appendix A. "Schematic and Board Layouts"**). The extreme top switch is the Most Significant Bit (MSB) and the extreme bottom switch is the Least Significant Bit (LSB). Pushing the switches right corresponds to the '1', as shown on Table 1-1. Once the DIP switch is configured to the desired setting, the **READ** push-button switch must be pressed and released. When the button is released, the microcontroller reads the DIP switch settings and transmits the corresponding command and data bytes to the PGAs. The microcontroller remains in a loop to continuously monitor the **READ** push button switch. Refer to Table 1-1 for the settings.

NOTES:

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Appendix A. Schematic and Board Layouts

A.1 INTRODUCTION

This appendix contains the schematic and printed circuit board (PCB) layout diagrams for the MCP6S2X Evaluation Board (Rev. 4).

A.1.1 Highlights

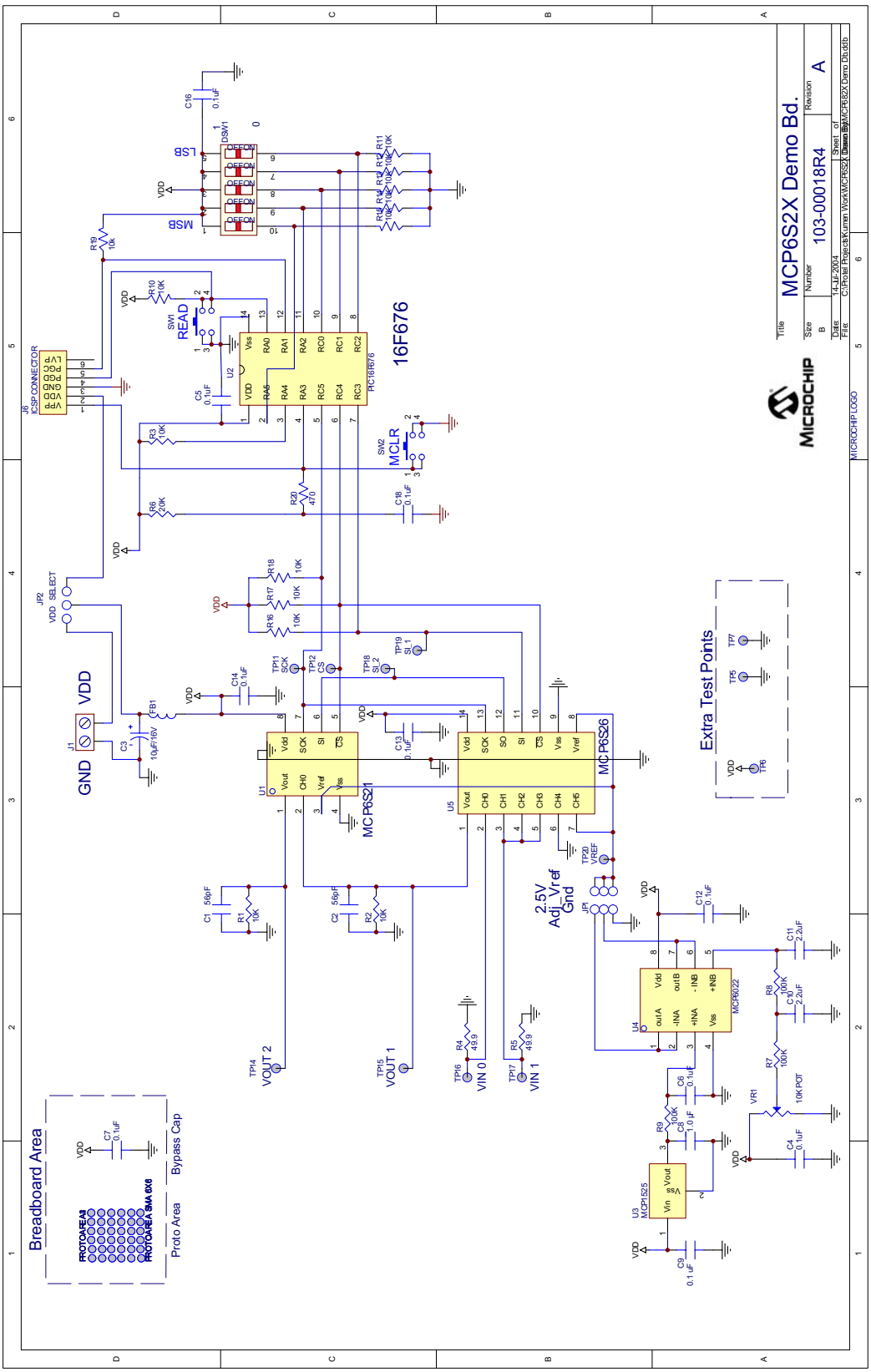
The MCP6S2X Evaluation Board (Rev. 4) is constructed using a four-layer PCB. The top and bottom layers are for components and traces. The second layer is the ground plane and the third layer is (V_{DD}) the power plane.

Diagrams included in this appendix include:

- Schematic
- Top Silk Screen Layer
- Top Metal Layer
- Ground Plane Layer
- Power Plane Layer
- Bottom Metal Layer
- Bottom Silk Screen Layer

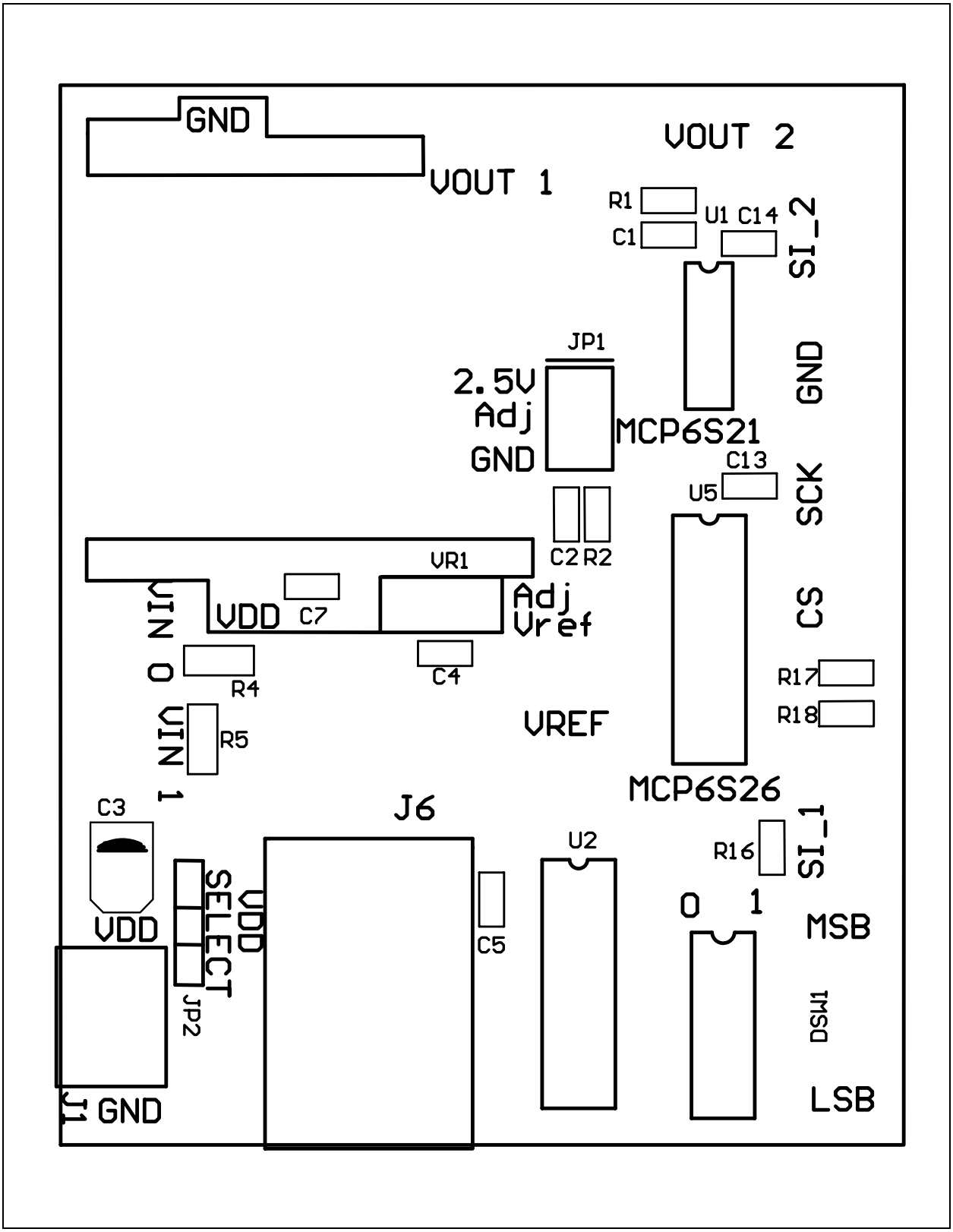
Note: The bottom metal layer (A.7) is missing a connection between pin 8 of the PIC16F676 (U2 in A.2) and pin 6 of the DIP switch (DSW1 in A.2) and with the pull-down resistor (R11). These traces have been corrected prior to shipping by making a solder bridge between these pins.

A.2 SCHEMATIC

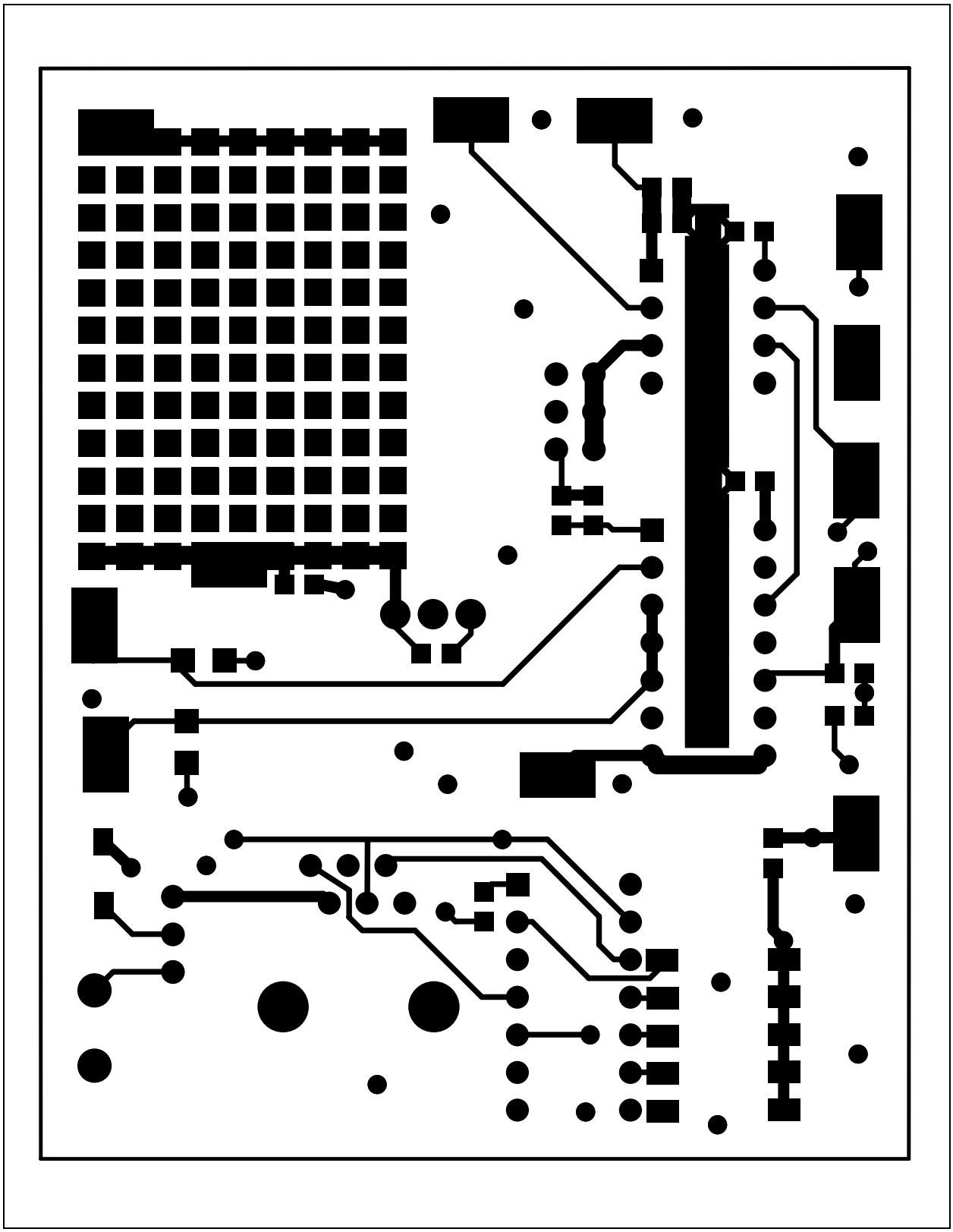


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A.3 TOP SILK SCREEN

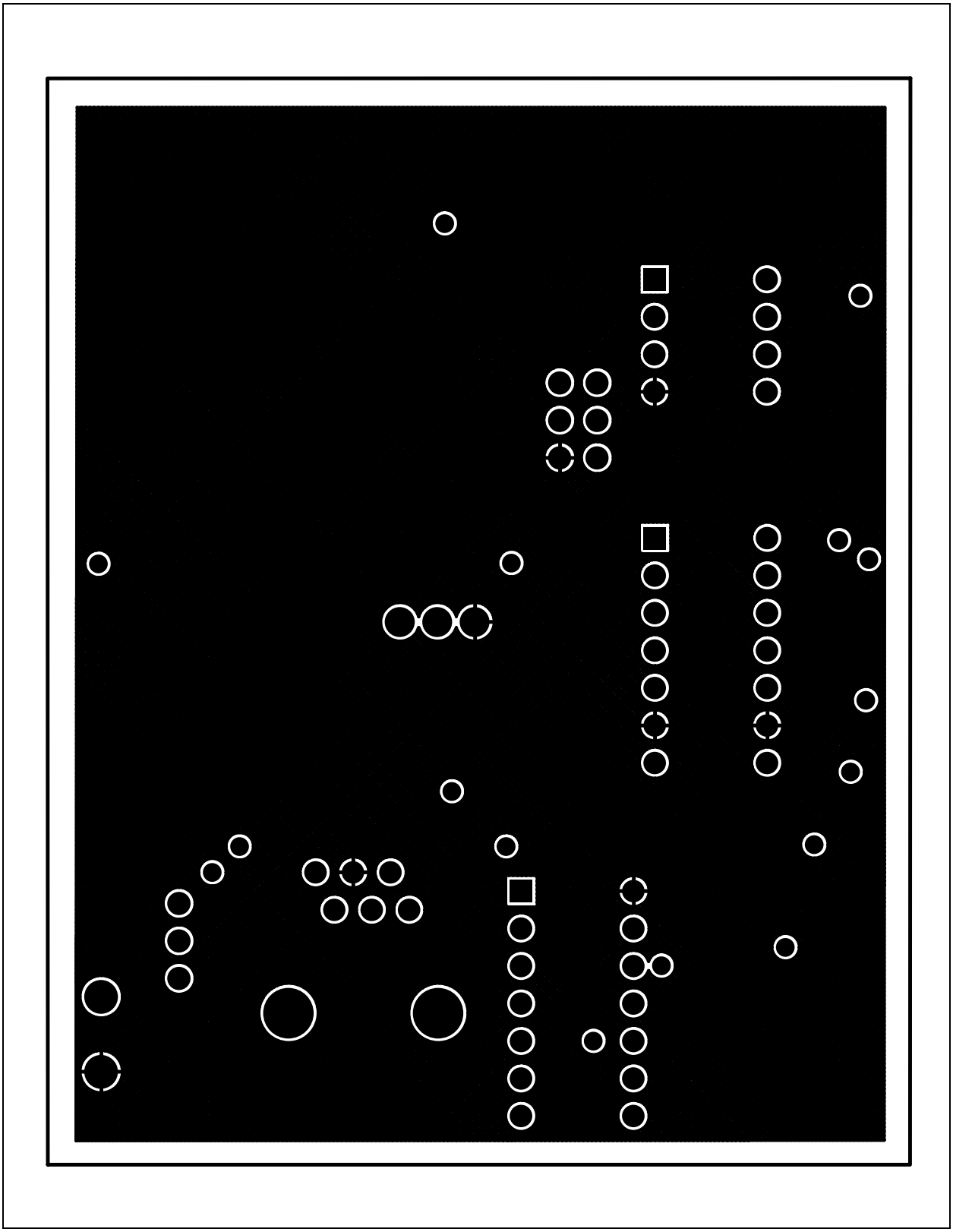


A.4 TOP METAL LAYER

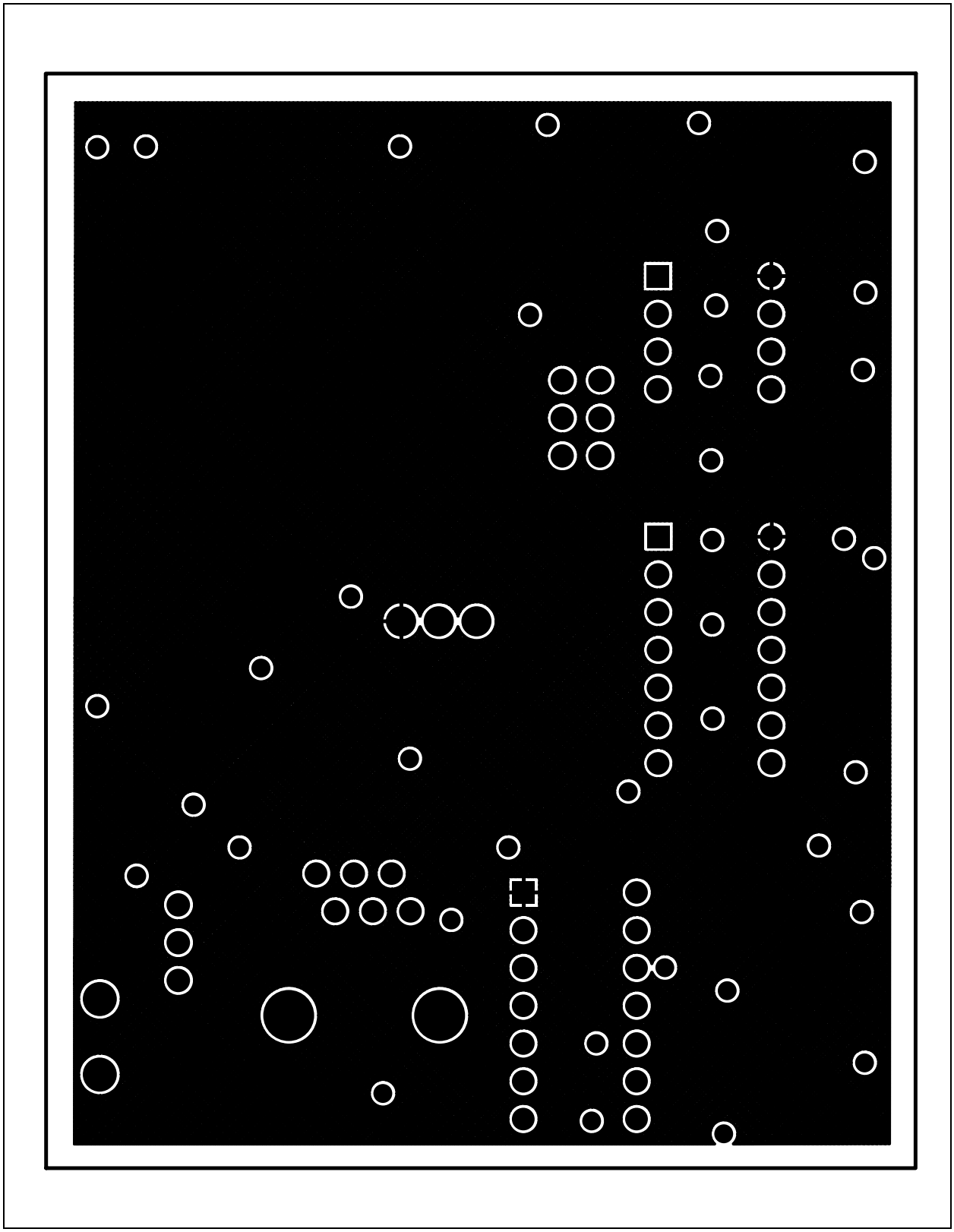


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A.5 GROUND PLANE LAYER

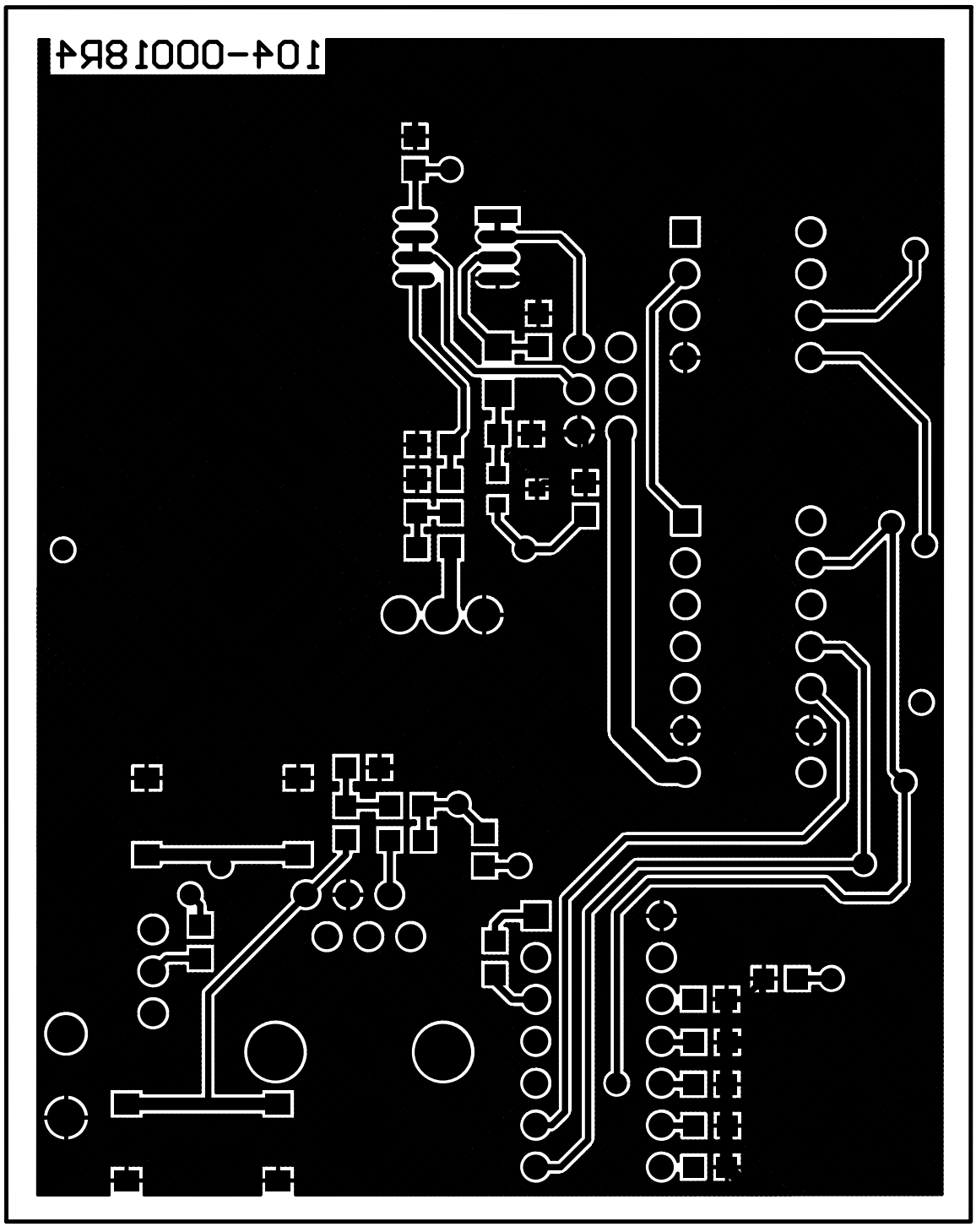


A.6 POWER PLANE LAYER

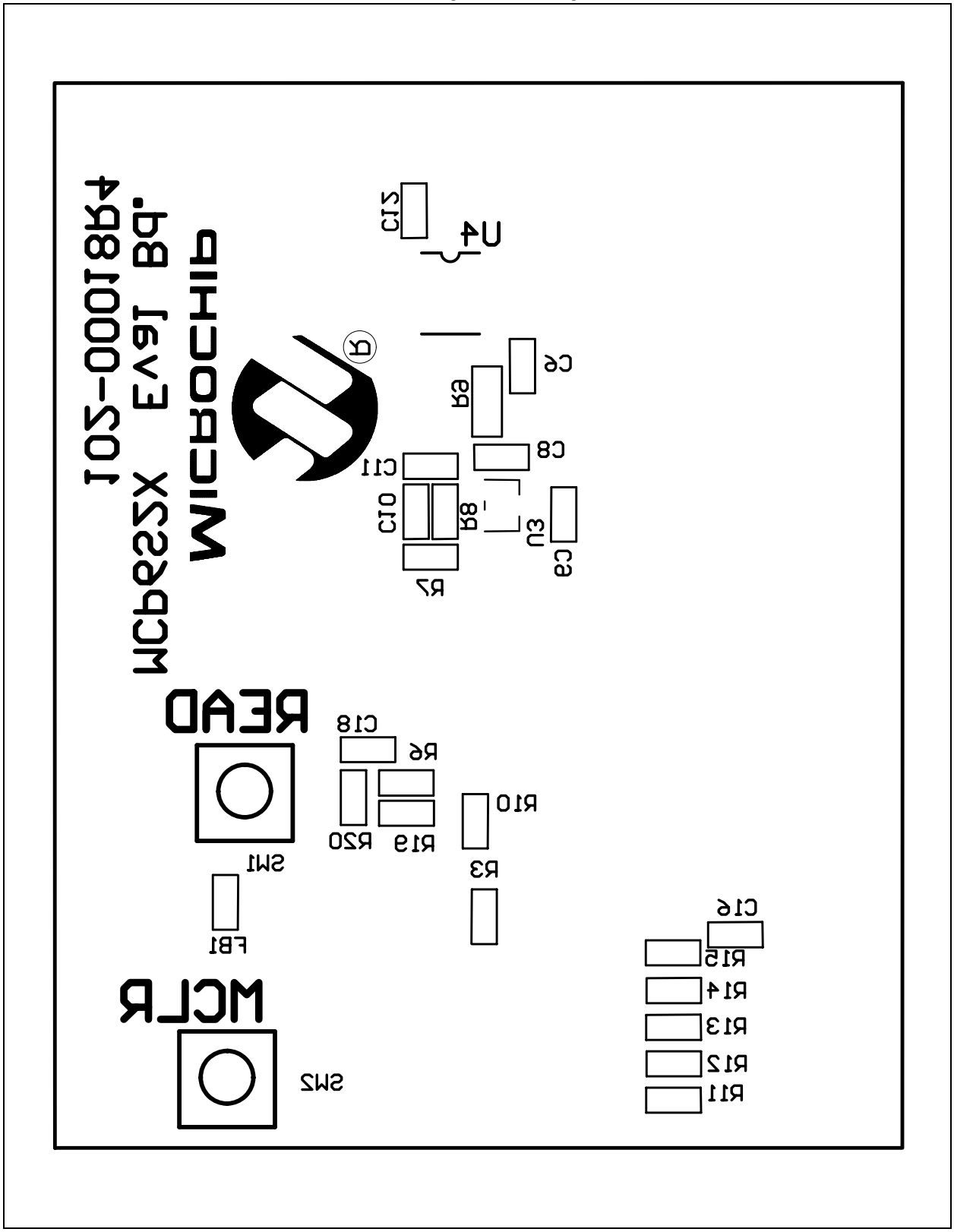


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A.7 BOTTOM METAL LAYER



A.8 BOTTOM SILK SCREEN LAYER (TOP VIEW)



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Appendix B. Bill of Materials (BOM)

B.1 INTRODUCTION

TABLE B-1: BILL OF MATERIALS

Reference Designator	Qty	Description	Manufacturer	Manufacturer Part Number
C1,C2	2	Capacitor, 56 pF, 0805	Digi-Key	PCC560CGCT
C3	1	Capacitor, 10 µF/16V, SMT	Jameco	192997
C4-C7,C9,C12-C14,C16, C18	10	Capacitor, 0.1 µF, 0805	Digi-Key	PCC1828CT-ND
C8	1	Capacitor, 1.0 µF, 0805	Digi-Key	PCC1849CT-ND
C10,C11	2	Capacitor, 2.2 µF, 0805	Digi-Key	PCC1851CT-ND
C15, C17		**Note 4**	—	—
DSW1	1	DIP Switch, DIP10	Digi-Key	CKN1289-ND
FB1	1	Ferrite Chip, 0805	Digi-Key	240-1018-1-ND
J1	1	2-pin Terminal Block, Connector	Digi-Key	ED1623-ND
J2-J5 **(Note 1)**	0	SMA Board Connectors, Female	Newark	SPC10611
J6	1	ICSP™ Connector, 6x6 Jack, R/A	Digi-Key	A9049-ND
JP1	1	Jumper, 3x2	Jameco	115035
JP2	1	Jumper, 1x3	Jameco	109575
	2	Shorting block for JP1, JP2	Jameco	152670
R1-R3,R10-R19	13	Resistor, 10 kΩ, 0805	Digi-Key	P10.0KCCT-ND
R4,R5 **(Note 2)**	2	Resistor, 49.9 Ω, 0805	Digi-Key	P49.9CCT-ND
R6	1	Resistor, 20 kΩ, 0805	Digi-Key	P20.0KCCT-ND
R7-R9	3	Resistor, 100 kΩ, 0805	Digi-Key	P100KCCT-ND
R20	1	Resistor, 470 Ω, 0805	Digi-Key	P475CCT-ND
SW1,SW2	2	Momentary push button switch	Digi-Key	SW400-ND
TP5-TP7, TP11, TP12, TP18-TP20	8	Testpoint, SMT	Digi-Key	5016K-ND
TP14-TP17 **(Note 3)**	4	Testpoint, SMT	Digi-Key	5016K-ND
TP1-TP4, TP8-TP10, TP13		**Note 4**	—	—
U1	1	MCP6S21, PDIP-8	Microchip Technology Inc.	MCP6S21
U2	1	PIC16F676, PDIP-14	Microchip Technology Inc.	PIC16F676
U3	1	MCP1525, SOT23-3	Microchip Technology Inc.	MCP1525
U4	1	MCP6022, SOIC-8	Microchip Technology Inc.	MC6022
U5	1	MCP6S26, PDIP-14	Microchip Technology Inc.	MCP6S26
VR1	1	10 kΩ Potentiometer	Digi-Key	3296W-103-ND
	1	8-pin DIP socket (for U1)	Jameco	51625
	2	14-pin DIP socket (for U2, U5)	Jameco	37196

Note 1: Optional; supplied by customer (use J2-J5 or TP14-TP17).

2: Optional; in kit of parts.

3: Optional; in kit of parts (use J2-J5 or TP14-TP17).

4: These capacitors and test points do not exist on the board; they are gaps in the numbering sequence.

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NOTES:

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Appendix C. Evaluation Board Firmware

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```
;------------------------------------------------------------------------
;       This firmware is developed for the MCP6S2X PGA demo board.
;
;       The firmware reads the user interface dip and push-button switch
;       settings and programs the PGA accordingly.
;
;
;       File name:      pga_demo.asm
;       Date:           08/09/04
;       File Version:   1.00
;
;       Programmer:     MPLAB ICE 2
;       File Required:  PIC16F676.inc
;
;       Demo Board:
;               Name:   MCP6S2X Eval. Bd.
;               Number: 102-00018R4
;               Rev.:   R4
;               PGAs:   MCP6S21 (or MCP6S91), MCP6S26
;
;       Author:         Ezana Haile
;       Company:        Microchip Technology, Inc.
;
;------------------------------------------------------------------------

        ERRORLEVEL -302
        ERRORLEVEL -305

#INCLUDE <P16F676.INC>

    __CONFIG        _MCLRE_ON & _WDT_OFF & _INTRC_OSC_NOCLKOUT & _PWRTE_OFF & _BODEN_OFF &
_CPD_OFF

; definitions

      #DEFINE     CS            PORTC, 4      ; CHIP SELECT
      #DEFINE     SCK           PORTC, 5      ; CLOCK
      #DEFINE     DO            PORTC, 3      ; DATA OUT
      #DEFINE     PUSH          PORTA, 0      ; READ PUSH BUTTON
      #DEFINE     SW1           PORTC, 2      ; SWITCH 1
      #DEFINE     SW2           PORTC, 1      ; SWITCH 2
      #DEFINE     SW3           PORTC, 0      ; SWITCH 3
      #DEFINE     SW4           PORTA, 2      ; SWITCH 4
      #DEFINE     SW5           PORTA, 5      ; SWITCH 5
      #DEFINE     PRG_GAIN      B'01000000'   ; PROGRAM GAIN
      #DEFINE     PRG_CHANNEL   B'01000001'   ; PROGRAM CHANNEL
      #DEFINE     PGA_SHDN      B'00100000'   ; SHUTDOWN PGA
```

```
; reserve memory byte

      CBLOCK  0X20
            COUNTER, BUFFER
      ENDC

;=============================================================
;==========     PROGRAM         ============================
;=============================================================

PGA_DEMO                    ; CODE NAME
      ORG     0X00
      GOTO    START

START ORG     0X05

      BCF     STATUS, RP0   ; BANK 0
      MOVLW   H'07'
      MOVWF   CMCON         ; DIGITAL I/O
      BSF     STATUS, RP0   ; BANK 1
      CLRF    ANSEL         ; DIGITAL I/O
      CLRF    WPUA
      MOVLW   H'3F'
      MOVWF   TRISA         ; SET PORT A AS INPUT
      MOVLW   H'07'         ; SET RC<5,4,3> OUTPUT AND RC<2,1,0> INPUT
      MOVWF   TRISC         ; SET PORT C AS INPUT
      BCF     STATUS, RP0   ; BANK 0

READ  BTFSC   PUSH          ; CHECK TO SEE IF THE READ BUTTON IS PRESSED
      GOTO    READ
RDING BTFSS   PUSH          ; WAIT UNTIL THE BUTTON IS RELEASED
      GOTO    RDING         ; LOOP

      BSF     CS            ; UNSELECT THE DEVICES
      BCF     DO            ; KEEP THE DATAOUT (DO) LOW
      BCF     SCK           ; SET CLOCK
      CLRF    BUFFER        ; CLEAR BUFFER

      BTFSC   SW5
      GOTO    CHANNEL_SHDN  ; DETERMINE IF IT'S FOR CHANNEL OR
                            ; SHUTDOWN OTHERWISE PROGRAM GAIN

; PROGRAM THE GAIN OF PGA 1 (MCP6S26) OR PGA 2 (MCP6S21)

      BTFSC   SW4
      GOTO    PGA_2_GAIN    ; DETERMINE THE DEVICE

PGA_1_GAIN
      BCF     CS            ; SELECT PGA
      MOVLW   PRG_GAIN      ; PROGRAM GAIN CONFIGURATION
      MOVWF   BUFFER
      CALL    BITBANG       ; SEND IT THROUGH SPI
      CALL    READ_SWITCH   ; READ SWITCH SETTINGS
      CALL    BITBANG       ; SEND IT THROUGH SPI AND PROGRAM PGA
      BSF     CS            ; UNSELECT THE DEVICES
      GOTO    READ

PGA_2_GAIN
       BCF    CS            ; SELECT PGA
       MOVLW  PRG_GAIN      ; PROGRAM GAIN CONFIGURATION
       MOVWF  BUFFER
       CALL   BITBANG       ; SEND IT THROUGH SPI AND PROGRAM PGA
       CALL   READ_SWITCH   ; READ SWITCH SETTINGS
       CALL   BITBANG       ; SEND IT THROUGH SPI
       CLRF   BUFFER        ; SEND ZEROS TO PUSH OUT THE DATA TO PGA 2
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       BSF    CS            ; UNSELECT THE DEVICES
       GOTO   READ

; PROGRAM THE CHANNEL OR SHUTDOWN PGA 1 (MCP6S26) OR PGA 2 (MCP6S21)

CHANNEL_SHDN
       BTFSC  SW4
       GOTO   SHDN          ; GOTO SHUTDOWN

CHANNEL
       BCF    CS            ; SELECT PGA
       MOVLW  PRG_CHANNEL   ; PROGRAM CHANNEL CONFIGURATION
       MOVWF  BUFFER
       CALL   BITBANG       ; SEND IT THROUGH SPI
       CALL   READ_SWITCH   ; READ SWITCH SETTINGS
       CALL   BITBANG       ; SEND IT THROUGH SPI AND PROGRAM PGA
```


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```
       BSF    CS            ; UNSELECT THE DEVICES
       GOTO   READ

SHDN
       BTFSC  SW3           ; IF THE 3RD SWITCH IS HIGH THEN DON'T SHUTDOWN
       GOTO   READ

       BTFSC  SW2           ; DETERMINE WHICH DEVICE
       GOTO   SHDN_BOTH     ; SHUTDOWN BOTH PGAS
       BTFSC  SW1
       GOTO   SHDN_PGA_2    ; IF THE 1RD SWITCH IS HIGH THEN DON'T SHUTDOWN

SHDN_PGA_1                  ; SHUTDOWN THE FIRST PGA
       BCF    CS            ; SELECT PGA
       MOVLW  PGA_SHDN      ; PROGRAM SHUTDOWN CONFIGURATION
       MOVWF  BUFFER
       CALL   BITBANG       ; SEND IT THROUGH SPI AND PROGRAM PGA
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       BSF    CS            ; UNSELECT THE DEVICES
       GOTO   READ

SHDN_PGA_2                  ; SHUTDOWN THE SECOND PGA
       BCF    CS            ; SELECT PGA
       MOVLW  PGA_SHDN      ; PROGRAM SHUTDOWN CONFIGURATION
       MOVWF  BUFFER
       CALL   BITBANG       ; SEND IT THROUGH SPI AND PROGRAM PGA
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       CLRF   BUFFER
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       BSF    CS            ; UNSELECT THE DEVICES
       GOTO   READ

SHDN_BOTH                   ; SHUTDOWN BOTH PGAs
       BCF    CS            ; SELECT PGA
       MOVLW  PGA_SHDN      ; PROGRAM SHUTDOWN CONFIGURATION
       MOVWF  BUFFER
       CALL   BITBANG       ; SEND IT THRU SPI AND SHUTDOWN PGA
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       CALL   BITBANG       ; SEND IT THRU SPI AND SHUTDOWN PGA
       CALL   BITBANG       ; SEND 8 DUMMY BITS
       BSF    CS            ; UNSELECT THE DEVICES
       GOTO   READ

;-------------------------------------------------------------------------
;--- READ THE SWITCH SETTINGS
;-------------------------------------------------------------------------

READ_SWITCH
       CLRF    BUFFER        ; PROGRAM BUFFER FROM SWITCHES
       BTFSC   SW3           ; CHECK THE 3RD SWITCH
       BSF     BUFFER, 2
       BTFSC   SW2           ; CHECK THE 2RD SWITCH
       BSF     BUFFER, 1
       BTFSC   SW1           ; CHECK THE 1RD SWITCH
       BSF     BUFFER, 0
       RETURN

;-------------------------------------------------------------------------
;---- BIT BANG SPI COMMUNICATION
;-------------------------------------------------------------------------

BITBANG
       CLRC
       MOVLW   H'08'
       MOVWF   COUNTER       ; SET THE BIT BANG COUNTER
SEND   BTFSC   BUFFER, 7     ; SEE THE LAST BIT OF THE BUFFER
       BSF     DO            ; THE SWITCH IS SET, THEN SET THE BUFFER HIGH
       BSF     SCK           ; SET CLOCK
       BCF     SCK           ; CLEAR CLOCK
       BCF     DO            ; CLEAR THE DATA
       RLF     BUFFER,F      ; ROLL THE BITS
       DECFSZ  COUNTER, F    ; CHECK END OF COUNTER
       GOTO    SEND          ; LOOP
       RETURN
;-------------------------------------------------------------------------

       END
```

NOTES:

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Appendix D. Setup Conditions

D.1 DIP SWITCH CONFIGURATIONS (STAND-ALONE MODE)

TABLE D-1: DIP SWITCH CONFIGURATION FOR MCP6S21 ONLY

Register	MCP6S21 MSB → LSB
Gain 1	01000
Gain 2	01001
Gain 4	01010
Gain 5	01011
Gain 8	01100
Gain 10	01101
Gain 16	01110
Gain 32	01111
SHDN (Shutdown)	11001

TABLE D-2: DIP SWITCH CONFIGURATION FOR MCP6S26 ONLY

Register	MCP6S26 MSB → LSB
Gain 1	00000
Gain 2	00001
Gain 4	00010
Gain 5	00011
Gain 8	00100
Gain 10	00101
Gain 16	00110
Gain 32	00111
Channel 0	10000
Channel 1	10001
Channel 2	10010
Channel 3	10011
Channel 4	10100
Channel 5	10101
SHDN (Shutdown)	11000

TABLE D-3: DIP SWITCH CONFIGURATION FOR MCP6S21 AND MCP6S26

Register	MCP6S21/MCP6S26 MSB → LSB
SHDN (Shutdown)	11010

D.2 MOMENTARY PUSH BUTTON SWITCH

D.2.1 Read Function

To change the PGA settings:

1. **Stand-alone Mode** - Configure the DIP Switch according to the tables in **Appendix D.1**. Press and release the **READ** switch; the microcontroller immediately updates the PGA's configuration.
2. **Program Mode** - The change in PGA configuration needs to be provided in customer-supplied firmware.

D.2.2 Master Clear Function

To re-initialize the microcontroller:

1. **Stand-alone Mode** - Press and release the **MCLR** switch.
2. **Program Mode** - Do not use the **MCLR** switch. Disconnect from MPLAB ICD 2 and reconnect.

D.3 SMA CONNECTORS

The illustration below shows how the SMA connectors are slid onto the board at test points V_{IN_0}, V_{IN_1}, V_{OUT_1}, and V_{OUT_2}. The round center conductor goes over the test pad and two of the square lugs go underneath the board on the unmasked ground fill (bottom metal). Solder the lugs and center conductor to the board.

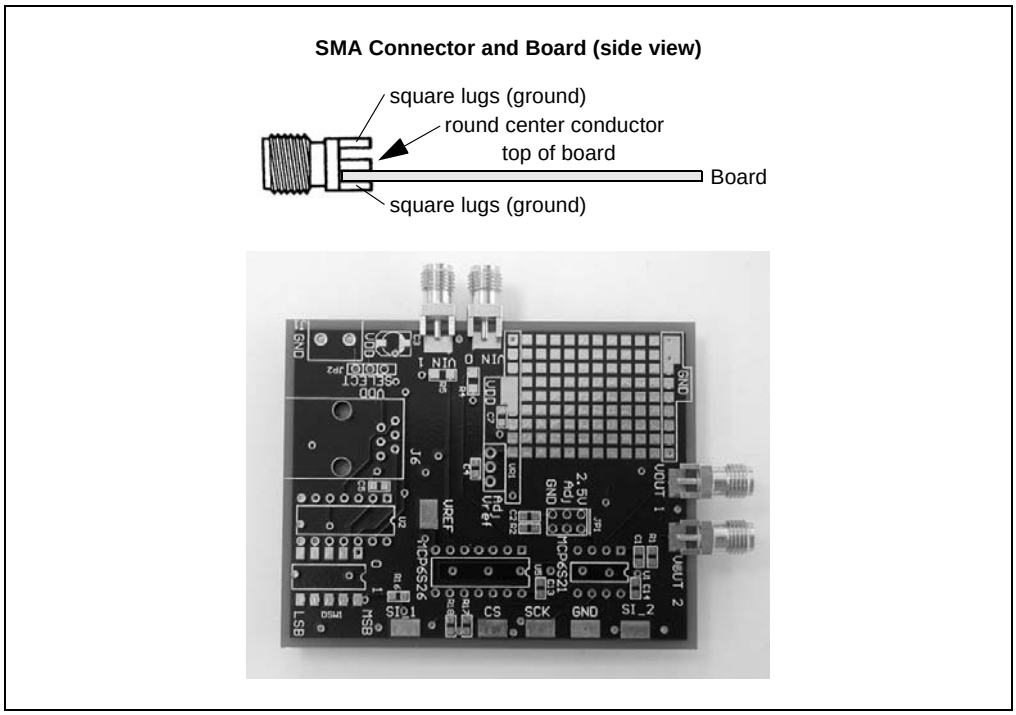


FIGURE D-1: *SMA Connectors.*

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D.4 TEST POINTS

TABLE D-4: TEST POINT CONNECTORS

Name	Reference Designator	Description
V_{IN_0}	TP16	Input Voltage to Channel 0 (**MCP6S26**)
V_{IN_1}	TP17	Input Voltage to Channel 1 (**MCP6S26**)
V_{OUT_1}	TP15	Output Voltage from **MCP6S26** (Input Voltage to **MCP6S21**)
V_{OUT_2}	TP14	Output Voltage from **MCP6S21**
V_{REF}	TP20	Reference Voltage (for **MCP6S26** and **MCP6S21**)
V_{DD}	TP6	Positive Supply Voltage
GND	TP5, TP7	Ground (Negative Supply Voltage)
$\overline{CS}$	TP12	SPI™ Chip Select
SCK	TP11	SPI Serial Clock
SI_1	TP19	SPI Serial Data In (**MCP6S26**)
SI_2	TP18	SPI Serial Data In (**MCP6S21**); SPI Serial Data Out (**MCP6S26**)

D.5 REFERENCE VOLTAGE JUMPER POSITIONS

TABLE D-5: JUMPER POSITIONS

Jumper	Position	Function
JP1	Top	2.5V
	Middle	Adjustable Reference Voltage
	Bottom	Ground
JP2	Top	V_{DD} supplied by ICSP™ Connector J6
	Bottom	V_{DD} supplied by Terminal Block J1

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