MCP6S22 PGA PICtail™ Demo Board User's Guide

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

Printed on recycled paper.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

Table of Contents

NOTES:

MCP6S22 PGA PICTAIL™ DEMO 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 MCP6S22 PGA PICtail™ Demo Board. Items discussed in this chapter include:

- About This Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support

ABOUT THIS GUIDE

Document Layout

This document describes how to use MCP6S22 PGA PICtail™ Demo 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 MCP6S22 PGA PICtail™ Demo Board.
- **Chapter 2: MCP6S22 PGA PICtail™ Demo Board** – This chapter includes instructions on how to get started with this demo board and a detailed description of each function of the demo board.
- **Appendix A: Schematic and Layouts** – Shows the schematic and layout diagrams for the MCP6S22 PGA PICtail™ Demo Board.
- **Appendix B: Bill-of-Materials** – Lists the parts used to build the MCP6S22 PGA PICtail™ Demo Board.

Conventions Used in this Guide

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

<table>
<tr><th>Description</th><th>Represents</th><th>Examples</th></tr>
<tr><td colspan="3">Arial font:</td></tr>
<tr><td rowspan="2">Italic characters</td><td>Referenced books</td><td>MPLAB® IDE User’s Guide</td></tr>
<tr><td>Emphasized text</td><td>...is the only compiler...</td></tr>
<tr><td rowspan="3">Initial caps</td><td>A window</td><td>the Output window</td></tr>
<tr><td>A dialog</td><td>the Settings dialog</td></tr>
<tr><td>A menu selection</td><td>select Enable Programmer</td></tr>
<tr><td>Quotes</td><td>A field name in a window or dialog</td><td>“Save project before build”</td></tr>
<tr><td>Underlined, italic text with right angle bracket</td><td>A menu path</td><td><u>File>Save</u></td></tr>
<tr><td rowspan="2">Bold characters</td><td>A dialog button</td><td>Click OK</td></tr>
<tr><td>A tab</td><td>Click the Power tab</td></tr>
<tr><td>‘bnnnn</td><td>A binary number where n is a digit</td><td>‘b00100, ‘b10</td></tr>
<tr><td>Text in angle brackets < ></td><td>A key on the keyboard</td><td>Press <Enter>, <F1></td></tr>
<tr><td colspan="3">Courier font:</td></tr>
<tr><td rowspan="6">Plain Courier</td><td>Sample source code</td><td><code>#define START</code></td></tr>
<tr><td>Filenames</td><td><code>autoexec.bat</code></td></tr>
<tr><td>File paths</td><td><code>c:\mcc18\h</code></td></tr>
<tr><td>Keywords</td><td><code>_asm, _endasm, static</code></td></tr>
<tr><td>Command-line options</td><td><code>-Opa+, -Opa-</code></td></tr>
<tr><td>Bit values</td><td><code>0, 1</code></td></tr>
<tr><td>Italic Courier</td><td>A variable argument</td><td><code>file.o</code>, where <code>file</code> can be any valid filename</td></tr>
<tr><td><code>0xnnnn</code></td><td>A hexadecimal number where n is a hexadecimal digit</td><td><code>0xFFFF</code>, <code>0x007A</code></td></tr>
<tr><td>Square brackets [ ]</td><td>Optional arguments</td><td><code>mcc18 [options] file [options]</code></td></tr>
<tr><td>Curly brackets and pipe character: { | }</td><td>Choice of mutually exclusive arguments; an OR selection</td><td><code>errorlevel {0|1}</code></td></tr>
<tr><td rowspan="2">Ellipses...</td><td>Replaces repeated text</td><td><code>var_name [, var_name...]</code></td></tr>
<tr><td>Represents code supplied by user</td><td><code>void main (void)
{ ...
}</code></td></tr>
</table>

RECOMMENDED READING

This user's guide describes how to use MCP6S22 PGA PICtail™ Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP6S2X Data Sheet (DS21117)

This data sheet provides detailed information about the MCP6S2X product family.s

AN248, “Interfacing MCP6S2X PGAs to PICmicro® Microcontroller” (DS00248)

This application note shows how to program the six-channel MCP6S26 PGA gains, channels and shutdown registers using the PIC16C505 microcontroller.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

- **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
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- 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:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP6S22 PGA PICtail Demo Board and covers the following topics:

- What is MCP6S22 PGA PICtail Demo Board?
- What the MCP6S22 PGA PICtail Demo Board kit includes

1.2 WHAT IS MCP6S22 PGA PICTAIL DEMO BOARD?

The MCP6S22 PGA PICtail Demo Board is used to evaluate and demonstrate Microchip Technology's Programmable Gain Amplifier (PGA) family, MCP6S21/2/6/8. This board has a user interface to program the MCP6S22 two-channel PGA. It can also be interfaced with Microchip's PICkit™ 1 Flash Starter Kit Development Board. This platform allows the user to develop firmware that selects the PGA gains and channels using the SPI™ interface.

The MCP6S22 PGA PICtail Demo Board can be used as a stand-alone, with a user interface that allows the PGA gains and channels to be selected without a firmware development. The board uses a USB interface to communicate with a Personal Computer (PC), while the Pickit software can be used as a Graphical User Interface (GUI) to display the PGA output voltage.

1.3 WHAT THE MCP6S22 PGA PICTAIL DEMO BOARD KIT INCLUDES

This MCP6S22 PGA PICtail Demo Board Kit includes:

- The MCP6S22 PGA PICtail Demo Board
- MCP6S22 Demo Firmware
- USB cable
- MCP6S22 PGA PICtail Demo Board User's Guide (DS51481)
- MCP6S2X Data Sheet (DS21117)

NOTES:

Chapter 2. MCP6S22 PGA PICtail Demo Board

2.1 INTRODUCTION

The MCP6S22 PGA PICtail Demo Board is designed to demonstrate Microchip's family of Programmable Gain Amplifiers (PGAs) and uses the two-channel MCP6S22 PGA device. An optical sensor circuit and potentiometer are used as voltage sources to the PGA input channels. This demo board can be used to demonstrate firmware development to program the PGA gains and channels using the PICkit 1 Flash Starter Kit.

In addition, the PGA gains and channels can be selected using the user interface DIP switch. A PICmicro® microcontroller unit (MCU) is used to program the PGA according to user configuration. This microcontroller also measures the PGA output voltage using a 12-bit Analog-to-Digital Converter (ADC), with the measured data being transferred to a Personal Computer (PC) using a Universal Serial Bus (USB) interface. The Pickit 1 Flash Starter Kit software is used as a Graphical User Interface (GUI) is used to display the data on the PC.

This board is designed to evaluate the PGA with minimum PCB trace-induced noise or crosstalk. It uses a four-layer board with solid ground and power layers. The placement of each trace has been carefully considered so that the user can evaluate the PGA over a wide frequency range.

2.2 FEATURES

The MCP6S22 PGA PICtail Demo Board has the following features:

- Demonstration of the MCP6S22 PGA
- 13-Bit Analog-to-Digital Converter (ADC) with SPI™ interface
- USB PIC16C745 microcontroller
- An optical sensor circuit connected to the PGA
- An adjustable voltage source using a thumb-wheel potentiometer connected to the PGA
- Four-layer PCB with separate ground and power supply planes for noise immunity

2.3 GETTING STARTED

The MCP6S22 PGA PICtail Demo Board is used for evaluation and demonstration of the PGA's features. A block diagram of the demo board layout is shown in Figure 2-1. The following procedure describes how to operate this demo board.

1. Install and run the GUI from the PC.
2. Connect the demo board to a PC using a USB cable.
3. Plug the jumpers for JP_1 and JP_2 to connect the optical sensor and the potentiometer voltage to the PGA input channels (CH0 and CH1).
4. The PGA output voltage will be graphically displayed on the PC.
5. Select the PGA gain and channel using the on-board DIP switch according to the configuration table printed on the demo board silk-screen.
6. Press the **READ** push button switch to program the PGA.

> **Note:** This demo board can be powered with an external voltage source, +5V, using the V_{DD} and GND test points. In this case, the user interface switches used to program the PGA gains and channels would still be functional, but the user has to use an oscilloscope to measure the output voltage. The demo can also be powered by connecting the 14-pin header to the PICkit 1 Flash Starter Kit. However, the user interface switches can not be used to program the PGA. The user must use the supplied firmware (`MCP6S22 PICtail.hex`), or develop custom firmware using the PICkit 1 Flash Starter Kit, to configure the PGA (refer to **Section 2.4.6 "PGA Interface to PICkit 1 Flash Starter Kit"**).

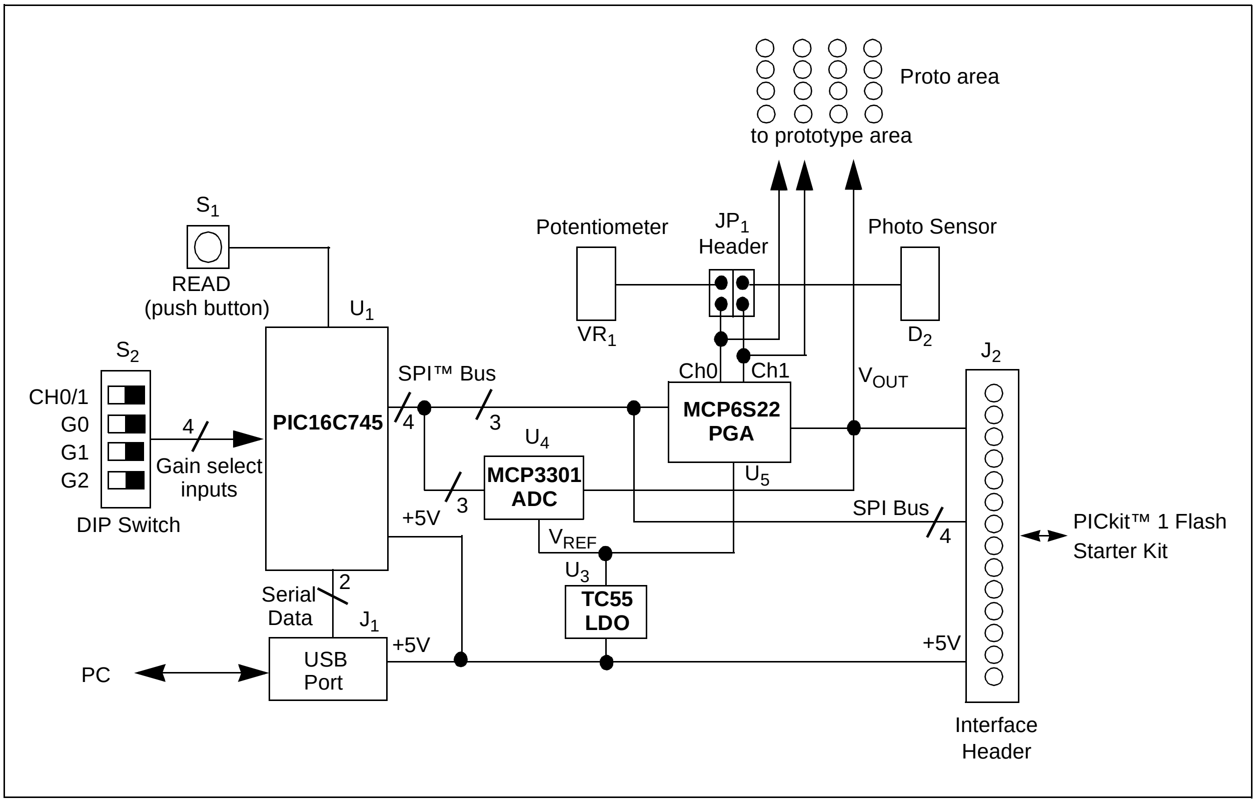


FIGURE 2-1: *MCP6S22 PICtail™ Demo Board Functional Block Diagram.*

2.4 DEMO BOARD DESCRIPTION

The following sections describe each element of this demo board in further detail.

2.4.1 Power

This demo board can be powered using the USB interface, an external voltage source or the PICkit 1 Flash Starter Kit. Power to the digital and analog components is separated in order to avoid digital crosstalk to the analog components; particularly noise from the fast transient edges of serial data signals that are riding on the USB power line. In order to minimize high-frequency noise, a two-pole Resistor-Capacitor (RC) filter network is used to attenuate the noise. This filtered source is regulated using Microchip's TC55 voltage regulator (U3). The TC55 regulates the +5V supply from the USB source to +4.1V. This regulated voltage (V_{REG}) powers the analog devices which includes the MCP6S22 PGA (U5), MCP3301 ADC (U_4), photodiode circuit (D_2) and the potentiometer (VR_1). The unregulated +5V supply (V_{DD}) powers the PICmicro MCU and the pull-up resistors that are connected to the PICmicro microcontroller I/O lines.

To minimize ground noise on the analog components, the Printed Circuit Board (PCB) has four layers. The top layer is for analog circuits and the bottom layer is for digital circuits. The two layers in the middle are the power and ground planes.

The I/O lines connected to the PGA have a resistor voltage-divider network. Since the PICmicro microcontroller is powered by a +5V supply and the PGA is powered with +4.1V supply, there is an approximate 1V difference in the serial communication level. This could trigger the PGA's Electrostatic Discharge (ESD) protection diodes or damage the device. Therefore, a voltage divider network is used to lower the serial communication voltage level to 4V.

2.4.2 PGA Input Channels and On-Board Circuits

This demo board uses the dual-channel MCP6S22 PGA (U5) to demonstrate the PGA functions. There are two on-board circuits that can be used to demonstrate the PGA functions. These circuits are an optical sensor (D_2) and a thumb-wheeled potentiometer (VR_1). The two input channels are connected to the jumpers JP_1 and JP_2. Pins 1 and 2 of JP_2 connect the optical sensor to Channel 0, while pins 1 and 2 of JP_1 connect the potentiometer to Channel 1 of the PGA.

Caution:	The jumpers need to be removed when connecting circuits using the prototype area or the SMA (SPC 10611) connectors.

The user can change the voltage to the input channels of the PGA and observe the PGA output voltage on the GUI or an oscilloscope. The thumb-wheeled potentiometer can be used to quickly demonstrate the PGA's gain function by adjusting the input voltage and changing the gain. However, the optical sensor circuit requires a change in the ambient light. The change in ambient light results in a change in voltage. Therefore, the photodiode on the PCB needs to be pointed towards higher light intensity. The PGA can be used to gain up the voltage change from either sensor circuit, thereby utilizing the full input range of the ADC.

The user can also develop a circuit on the prototype development area and connect the circuit to the PGA input channels (refer to **Section 2.4.7 "Using the Prototype Area"** for soldering guidance). In this case, the jumpers on JP_1 and JP_2 need to be disconnected.

2.4.3 PGA Gain and Channel Selection

The PGA gains and channels can be configured using the DIP switch (S_2) and the momentary push button switch (S_1). The user can slide the G2, G1, G0 switches and Ch0/1 to the '0' or '1' position according to the configuration table provided on the demo board silk-screen and momentarily pressing the **READ** push button switch to configure the PGA. The configuration table is also shown in Table 2-1 and Table 2-2.

TABLE 2-1: DIP SWITCH CONFIGURATION TO PROGRAM PGA GAIN

Gain	G2	G1	G0
1	0	0	0
2	0	0	1
4	0	1	0
5	0	1	1
8	1	0	0
10	1	0	1
16	1	1	0
32	1	1	1

TABLE 2-2: DIP SWITCH CONFIGURATION TO PROGRAM PGA CHANNEL

Channel	Ch 0/1
0	0
1	1

These configuration switches **cannot** be used to program the PGA if this demo board is connected to the PICkit 1 Flash Starter Kit (Refer to **Section 2.4.6 "PGA Interface to PICkit 1 Flash Starter Kit"** for further explanation).

2.4.4 Measuring the PGA Output

The MCP6S22 PGA output is connected to a MCP3301 13-bit ADC with RC anti-aliasing filter. The ADC continuously measures the PGA output voltage and transmits the data to the PIC16C745 using an SPI bus interface. The measured data is transmitted to the PC via the USB port for display. The PGA output pin is also connected to a test point, allowing the user to connect an oscilloscope probe and measure the PGA output.

When the scope probe is connected, the effect of the probe on the PGA output needs to be considered. The probe capacitance introduces a capacitive load to the PGA, so the effects of capacitive load needs to be considered (refer to the MCP6S22 data sheet (DS21117) for further details). In addition to the probe capacitance, a long ground lead from the scope probe to the demo board creates a ground loop and compromises the PGA performance. Therefore, the probe ground lead needs to be as short as possible.

It is recommended that the user solder SMA connectors in the space provided (Figure 2-2) and use shielded cables to connect the input and output signals from an external voltage source, and to an oscilloscope. This ensures proper demonstration of the MCP6S22 PGA performance.

2.4.5 PICmicro Microcontroller Functions

When the MCP6S22 PGA PICtail Demo Board is operating in "stand-alone" mode (not connected to the PICkit 1 Flash Starter Kit), the PIC16C745 microcontroller (U_1) performs three major functions: (1) It communicates to the host PC via the USB port (J_1); (2) programs the PGA according to the user-configured DIP switch settings (S_1 and S_2); and (3) communicates with the MCP3301 ADC (U_4) via the SPI interface in order to read the ADC's digitized output voltage.

Initially, the microcontroller establishes communication with the host PC via the USB port. It then commands the ADC to perform a conversion and reads the data. This data is then transferred to the host PC. This routine continues until the user momentarily pushes the **READ** push button switch. When the user requests the read, the PICmicro microcontroller reads the DIP switch configuration and programs the PGA's gain and channel settings accordingly using the SPI interface. The routine then continues to transmit data from the ADC to the host PC.

Note that it is not necessary to connect the USB interface to a PC to program the PGA. The demo board can be powered using an external +5V source and the user can program the PGA using the **READ** push button switch. In this case, an oscilloscope needs to be used to measure the output voltage.

2.4.6 PGA Interface to PICkit 1 Flash Starter Kit

This MCP6S22 PGA PICtail Demo Board can be connected to a PICkit 1 Flash Starter Kit using the 14-pin header. In this configuration, the MCP6S22 PGA PICtail Demo Board can be used as an evaluation tool for most of the 14-pin Flash PICmicro microcontrollers. The user can develop firmware to change the PGA gains and channels using this demo board.

A demo firmware has been provided that can be programmed in a 14-pin PICmicro microcontroller (PIC16F676) using the PICkit 1 Flash Starter Kit. The user can change the PGA gains and channels using the available push button switch (SW1) and potentiometer (VR_1). The push button allows the user to step through the gains, while turning the potentiometer to the left or right changes the channel. The gain setting is displayed on the on-board LEDs in binary format. In addition, this firmware uses the internal 10-bit ADC to measure the PGA output voltage. The data is transmitted to the PC for display in strip-chart format using the PICkit 1 Flash Starter Kit software.

Only 5 pins of the 14-pin header are connected for I/O. Four of the five lines (RC3, RC4, RC5 and RC2) are connected to the SPI pins of the PGA and ADC (SCK, SData and $\overline{CS}$) pins. The fifth line (RC0) is connected to the PGA output voltage pin. This line is selected specifically for 14-pin PICmicro microcontrollers with an internal ADC. Note that if the PICkit 1 Flash Starter Kit is being used, the PICmicro microcontroller RC0 I/O pin is configured as an output. This will load down the PGA's output and the performance will be degraded. Therefore, be sure to configure the PICmicro microcontroller RC0 I/O pin as a high-impedance A/D input pin.

Since the PICkit 1 Flash Starter Kit is powered via the USB port, the voltage level of the SPI line is +5V, which is higher than the PGA supply voltage. Therefore, a voltage divider network (R_{11}-R_{16}, R_{24}, R_{25}) is implemented between the PIC16C745 and MCP6S22 to lower the communication voltage level. Refer to Section **2.4.1 "Power"** for further explanation.

When the MCP6S22 PGA PICtail Demo Board is connected to the PICkit 1 Flash Starter Kit, the gain and channel configuration DIP switch (S_2) and the **READ** push button switch (S_1) cannot be used to configure the PGA. The serial I/O lines from the on-board USB PICmicro microcontroller (PIC16C745) are configured as high-impedance inputs. This prevents a potential serial bus conflict if the user-developed firmware for the MCP6S22 PGA PICtail Demo Board and the PICmicro microcontroller on the PGA demo board try to access the PGA at the same time.

2.4.7 Using the Prototype Area

Soldering pads are provided on this MCP6S22 Demo Board for SMA connectors and prototype circuit development. These pads are different from the traditional through-hole prototype area. In order to measure optimum PGA performance, it is essential that the analog circuit have a solid ground plane. Therefore, this demo board is developed on a four-layer board with a minimum number of through-holes through the analog ground plane. Because of this, the pins may need to be bent accordingly for soldering purposes.

Regulated 4.1V supply voltage (V_{REG}), ground (GND), PGA channel inputs (CH0, CH1) and PGA output (V_{OUT_PGA}) signals are also available on the prototype area. If V_{REG} is heavily loaded, the 4.1V may be reduced.

The illustration below shows how the SMA connectors are slid onto the board at test points CH0, CH1 and V_{OUT}. 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.

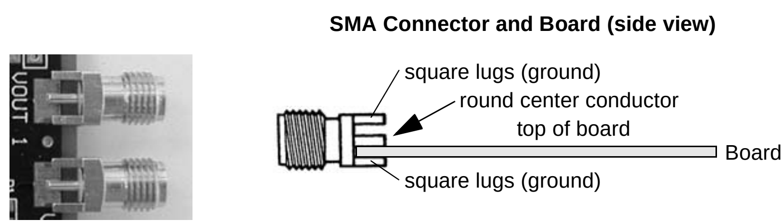


FIGURE 2-2: *SMA Connectors.*

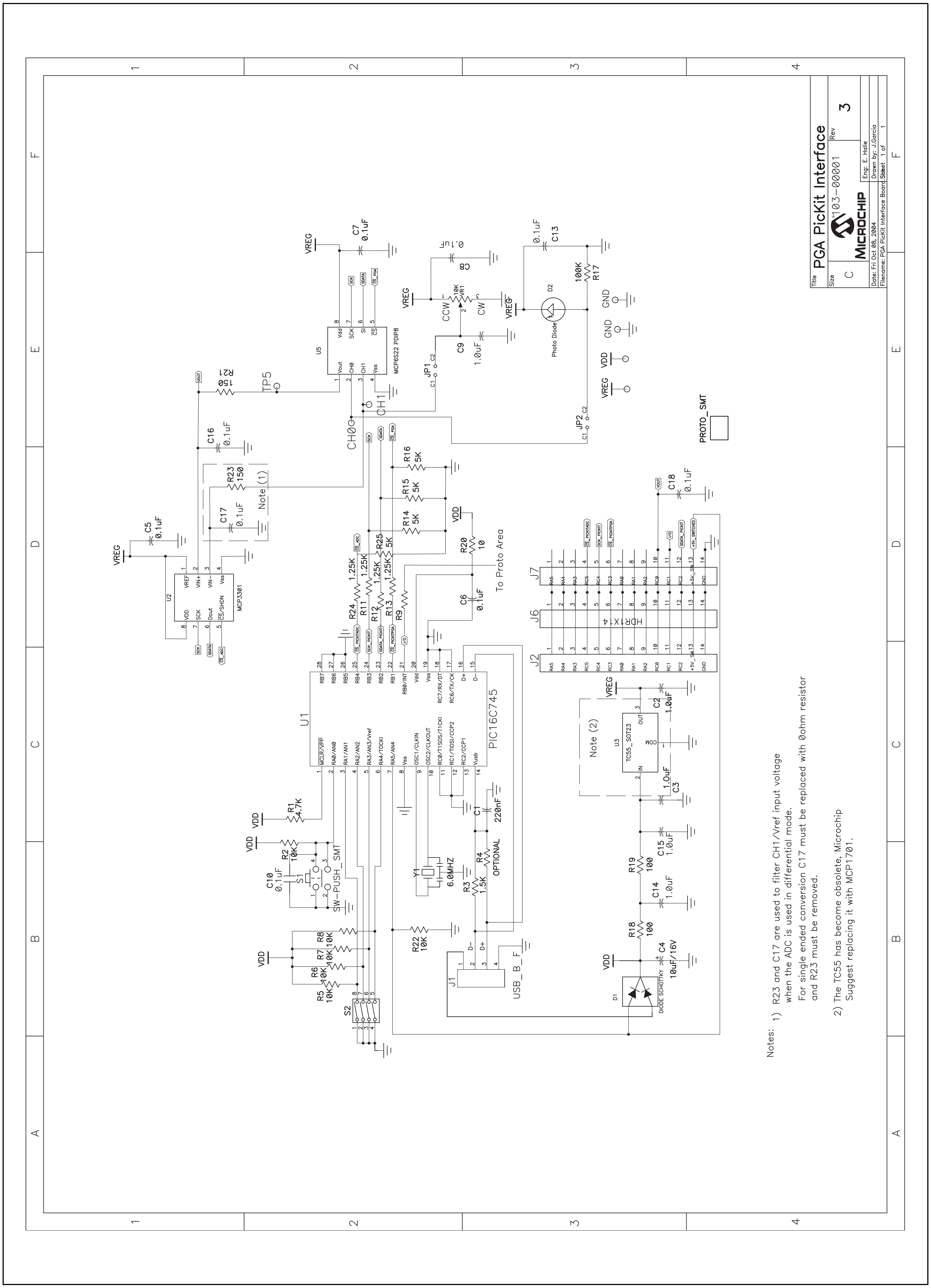
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

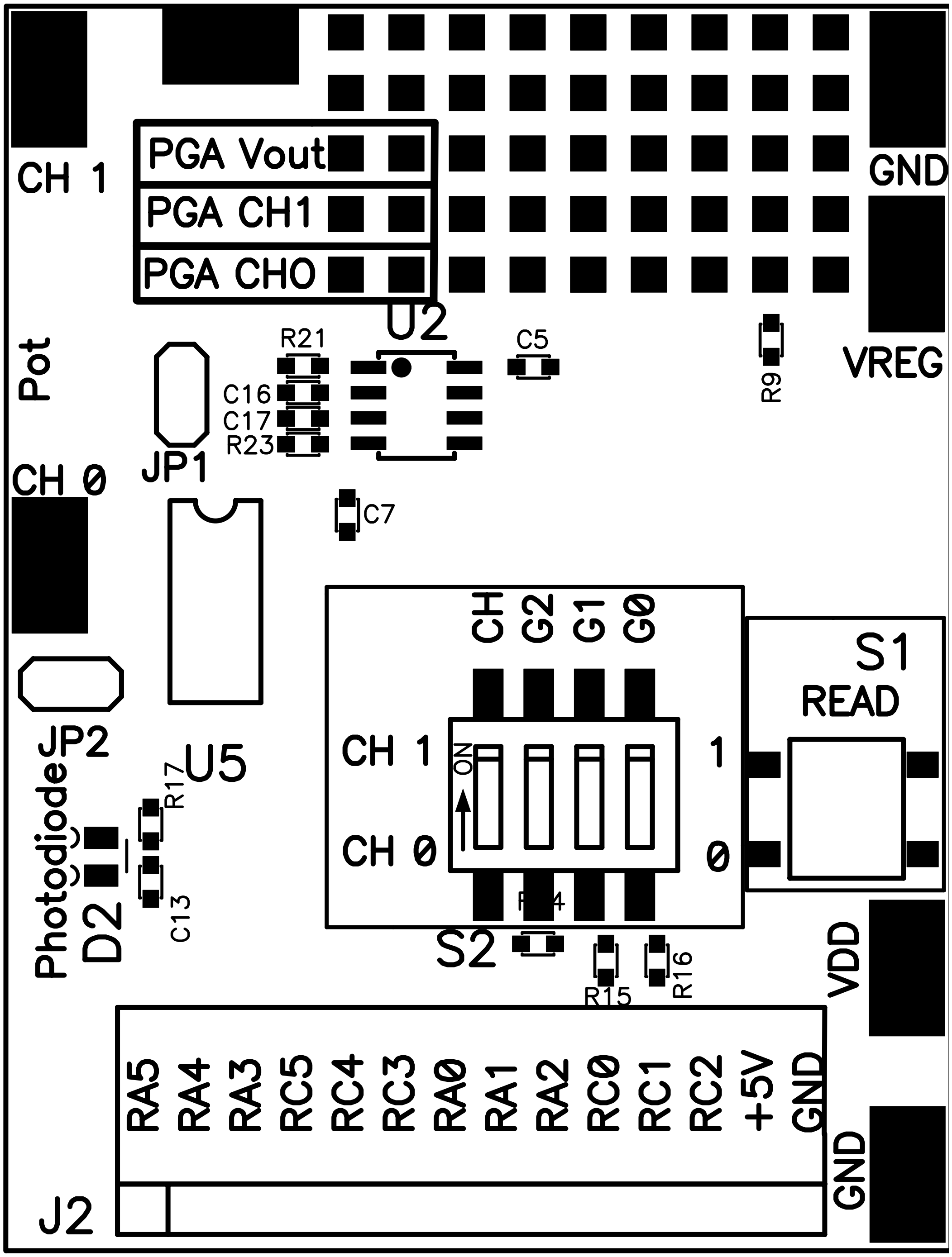
This appendix contains the following schematics and layouts for the MCP6S22 PGA PICtail Demo Board:

- Board Schematic
- Board - Top Assembly and Silk-Screen
- Board - Top Layer
- Board - Bottom Assembly and Silk-Screen
- Board - Bottom Layer
- Board - Ground Layer
- Board - Power Layer

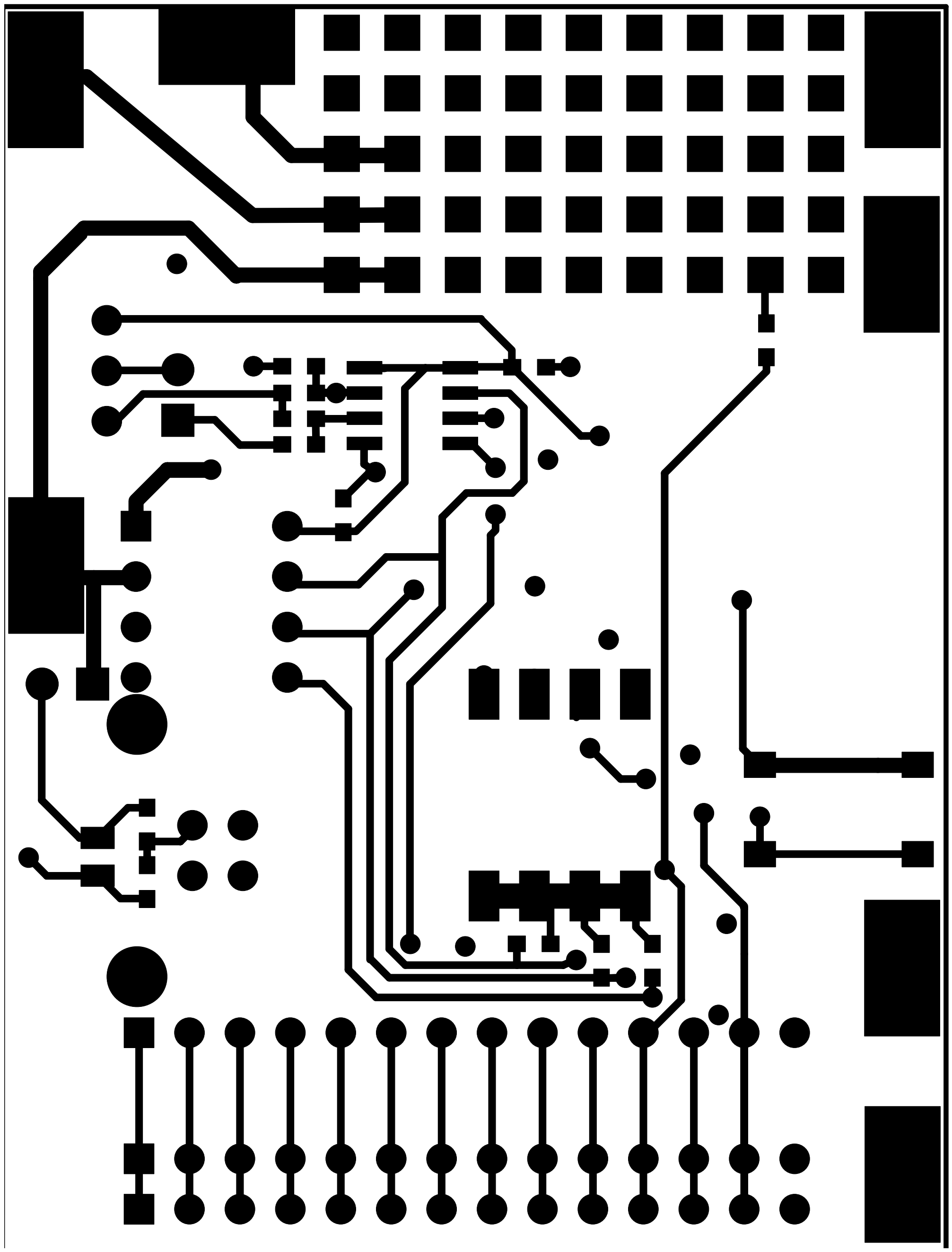
A.2 BOARD SCHEMATIC



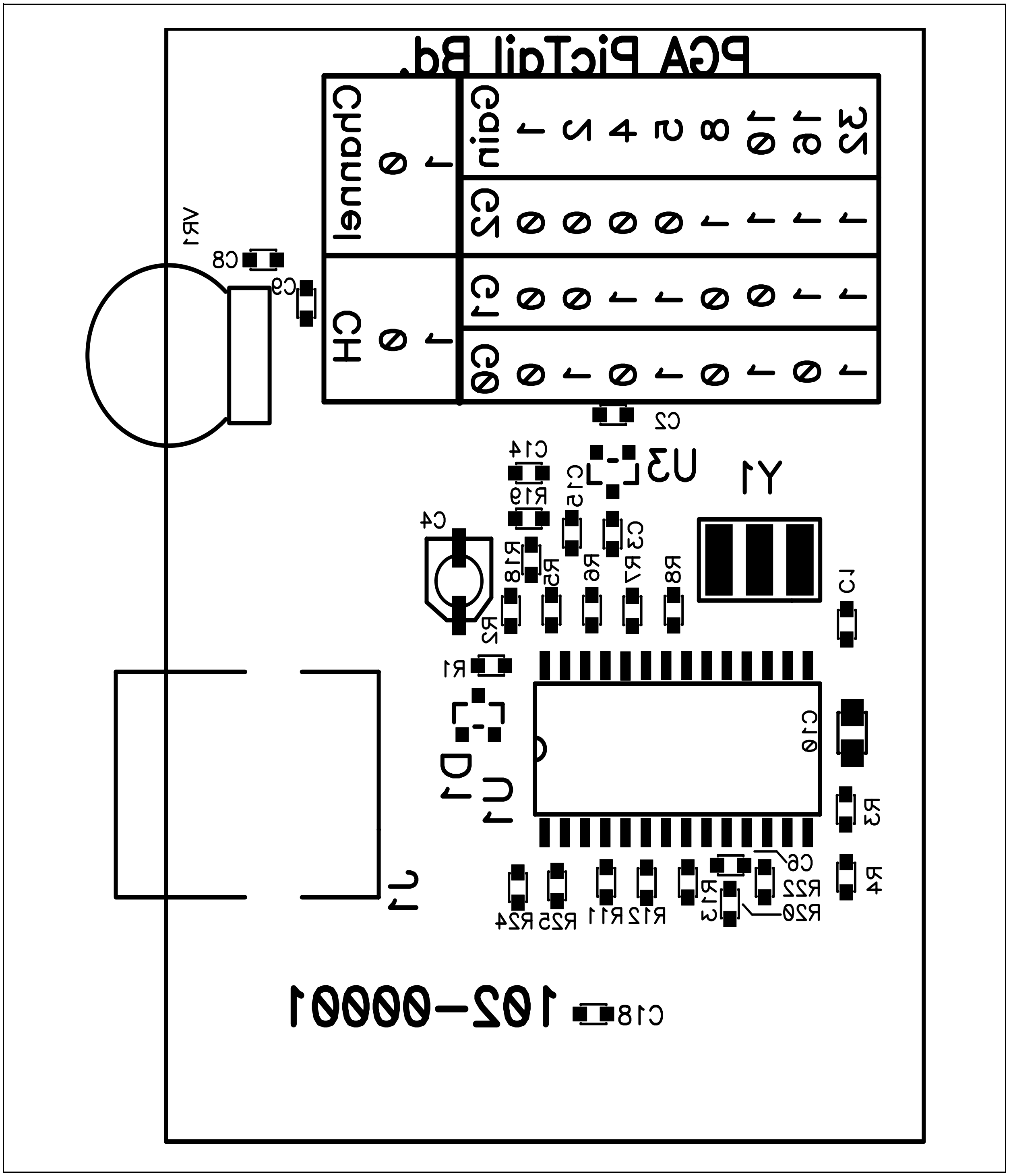
A.3 BOARD - TOP ASSEMBLY AND SILK-SCREEN



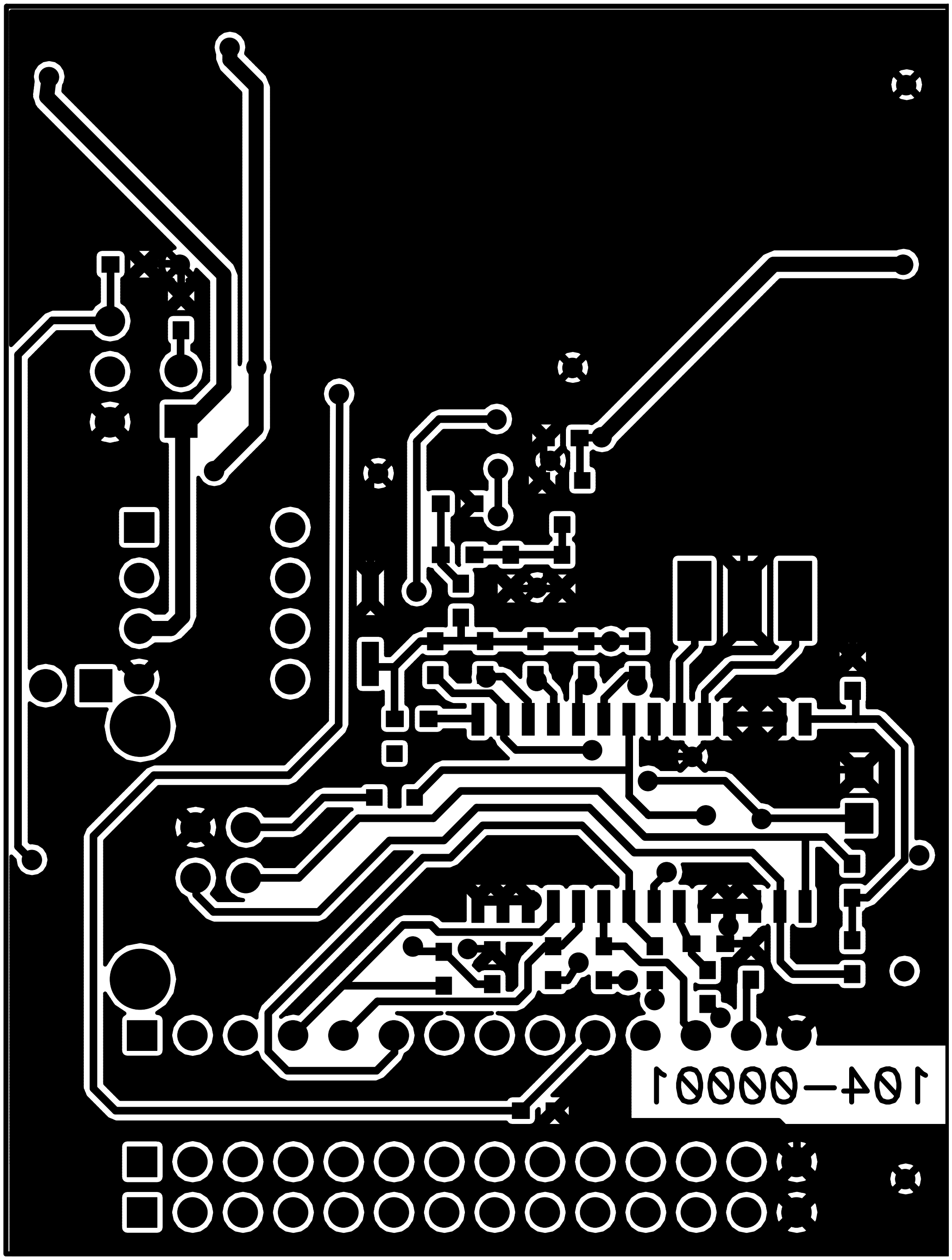
A.4 BOARD - TOP LAYER



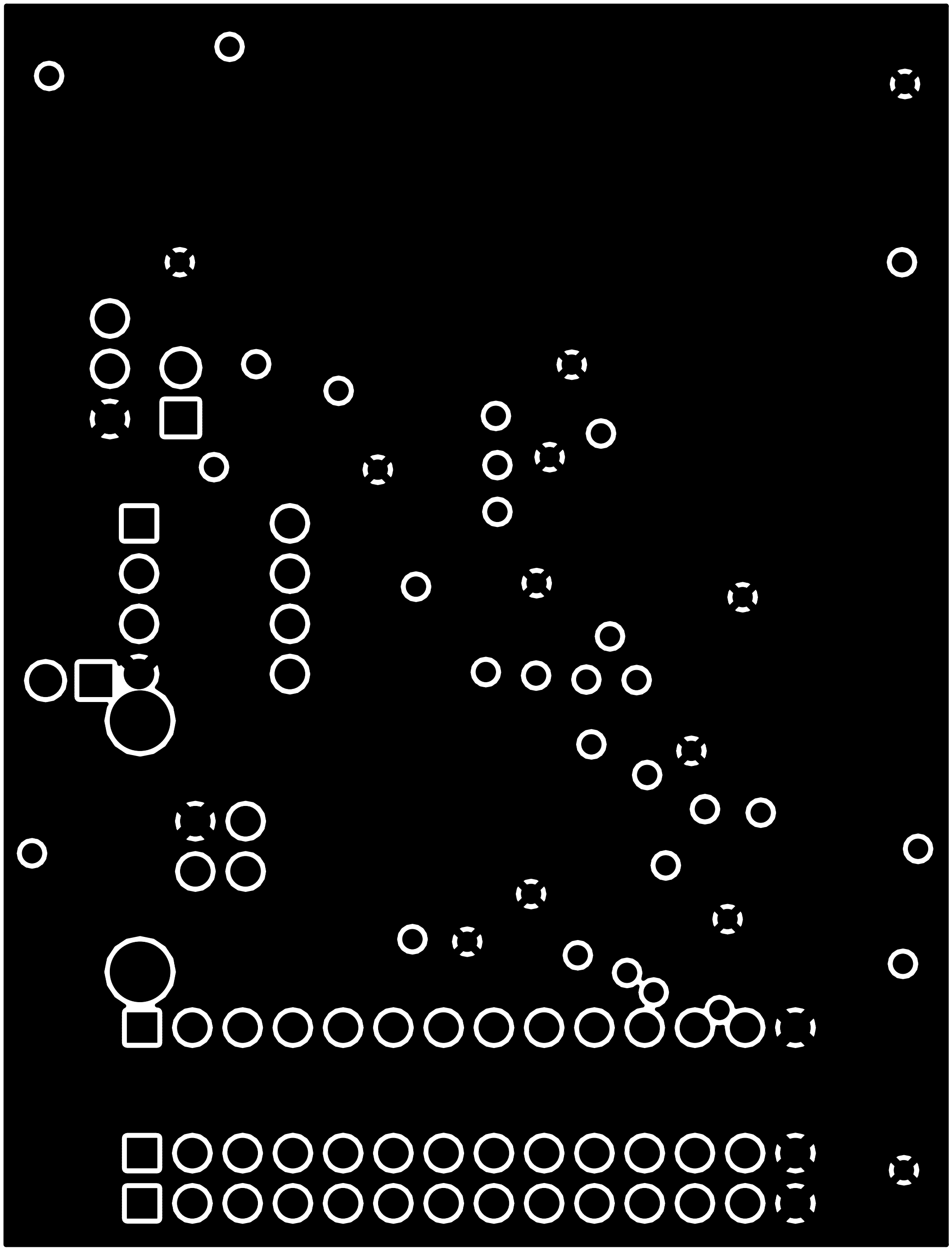
A.5 BOARD - BOTTOM ASSEMBLY AND SILK-SCREEN



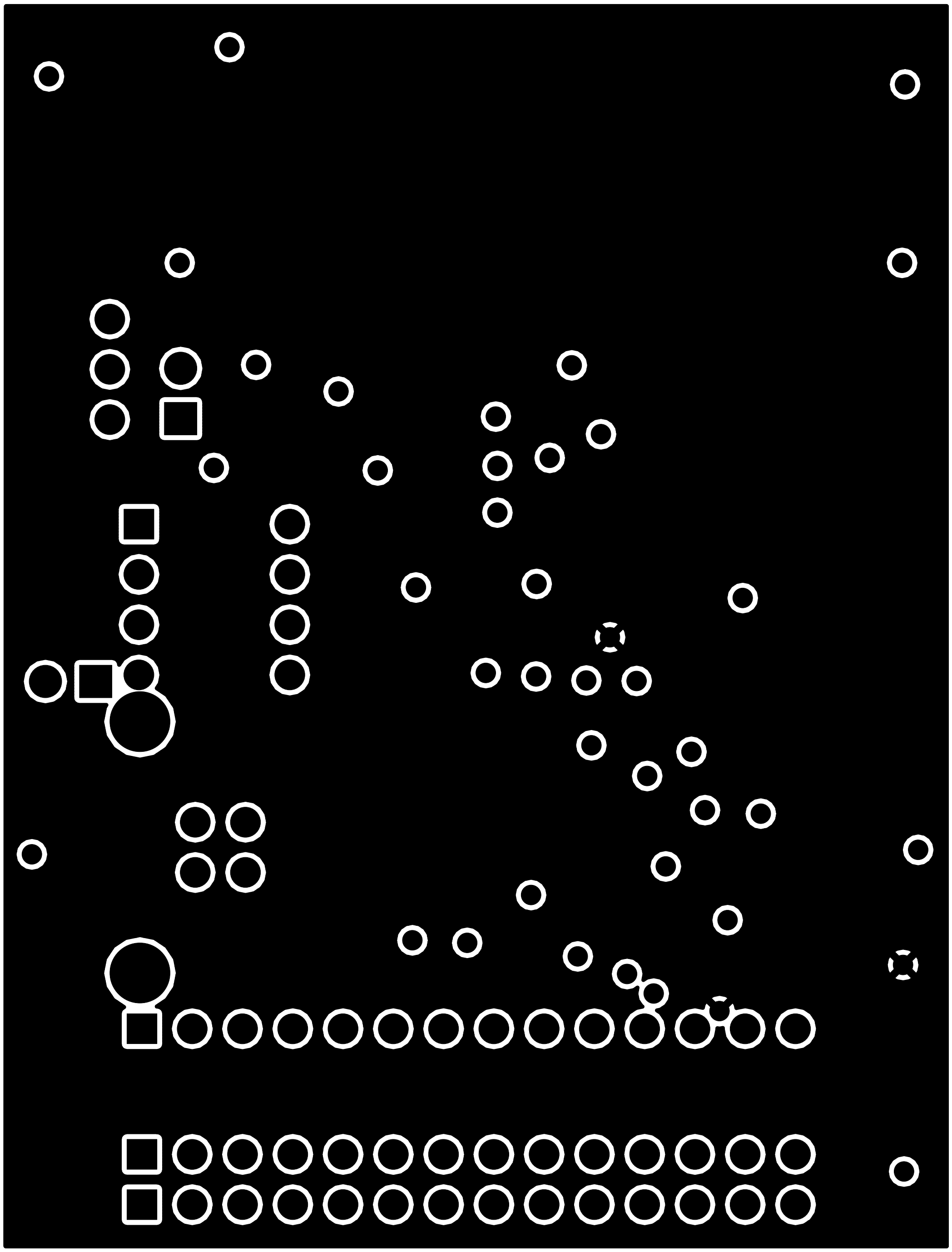
A.6 BOARD - BOTTOM LAYER



A.7 BOARD - GROUND PLANE



A.8 BOARD - POWER PLANE



Appendix B. Bill-Of-Materials (BOM)

TABLE B-1: BILL-OF-MATERIALS

Qty	Reference	Description	Manufacturer	Part Number
8	C5-C8,C13, C16,C17,C18	Capacitor, .1 µF 16V Ceramic, X7R 0603	Panasonic®	ECJ-1VB1C104K
3	C2,C3,C9	Capacitor, 1.0 µF 16V, Ceramic, X5R 0603	Panasonic	ECJ-1VB1C105K
1	C1	Capacitor, 0.22 µF 10V, Ceramic, X5R 0603	Panasonic	ECJ-2YB1E224K
1	C4	Capacitor, 10 µF, 16V, SMT,Electrolytic	Panasonic	SE10/16
1	R3	Resistor, 1.50 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF1501V
1	R1	Resistor, 4.75 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF4751V
8	R2,R5-R8, R10,R22,R26	Resistor, 10.0 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF1002V
3	R9,R11,R24	Resistor, 1.24 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF1241V
3	R14,R15, R16,R25	Resistor, 4.99 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF4991V
1	R17	Resistor, 100 kΩ, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF1003V
2	R18,R19	Resistor, 10.0Ω, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF10R0V
1	R20	Resistor, 10.2Ω, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF10R2V
1	R21	Resistor, 150Ω, 1/16W 1% 0603 SMD	Panasonic	ERJ-3EKF1500V
1	C17	Resistor, 0.0 Ω 1/10W 5% 0603 SMD)	Yageo America	9C06031A0R00JLHFT
1	R23	Not populated	N/A	N/A
1	R4	Optional Resistor	N/A	N/A
1	Y1	Resonator, Ceramic, 6.00 MHZ, SMD	ECS™ Inc.	ECS-SR1-6.00-B
1	D1	Diode, Schottky, 30V, 20 mA, MINI 3P	Panasonic SSG	MA3X786E0L
1	D2	Photodiode, IR 820NM SIDE LOOK	Sharp™ Microelectronics	PD100MC0MP
1	VR1	Potentiometer, 10 kΩ,, Thumbwheel, Cerm ST	Bourns® Inc.	3352W-1-103
1	U1	PIC16C745/765 Microcontroller	Microchip Technology Inc.	PIC16C745-SO
1	U3	TC55 Low-Dropout Voltage Regulator	Microchip Technology Inc.	TC55RP4101
1	U4	MCP3301,A/D Converter, SO8	Microchip Technology Inc.	MCP3301
1	U5	Single-Ended, Rail-to-Rail I/O, Low Gain PGA	Microchip Technology Inc.	MCP6S22-I/P
1	U5	8 PIN Socket	Mill-Max®	110-93-308-41-001
1	J1	Connector, USB RTANG Male Type B PCB	Assmann Electronics, Inc	AU-Y1007
1	J2,J6,J7	Connector, Header, 14-Pos .100 VERT TIN	Molex®/Waldom® Electronics Corporation	22-28-4140
1	S1	Switch, TACT, 6 MM, SMD MOM 160GF	Omron® Electronics, Inc - ECB Div	B3S-1000
1	S2	Switch, Dip, 4-Pos Top Slide SMT	CTS Corporation Resistor/Electrocomponents	204-4ST
7	CH0,CH1,V_{OUT}, GND,V_{REG},V_{DD}	PC Test Point Compact, SMT	Keystone Electronics®	5016

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200
Fax: 480-792-7277
Technical Support:
http:\\support.microchip.com
Web Address:
www.microchip.com

Atlanta
Alpharetta, GA
Tel: 770-640-0034
Fax: 770-640-0307

Boston
Westford, MA
Tel: 978-692-3848
Fax: 978-692-3821

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

San Jose
Mountain View, CA
Tel: 650-215-1444
Fax: 650-961-0286

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8676-6200
Fax: 86-28-8676-6599

China - Fuzhou
Tel: 86-591-750-3506
Fax: 86-591-750-3521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Qingdao
Tel: 86-532-502-7355
Fax: 86-532-502-7205

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-2229-0061
Fax: 91-80-2229-0062

India - New Delhi
Tel: 91-11-5160-8632
Fax: 91-11-5160-8632

Japan - Kanagawa
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Taiwan - Hsinchu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

EUROPE

Austria - Weis
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark - Ballerup
Tel: 45-4420-9895
Fax: 45-4420-9910

France - Massy
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Ismaning
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

England - Berkshire
Tel: 44-118-921-5869
Fax: 44-118-921-5820

09/27/04