Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

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Mixed Signal 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.
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- 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."

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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.

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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 Mixed Signal PICtail™ Demo Board. Items discussed in this chapter include:

- About This Guide
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support

ABOUT THIS GUIDE

Document Layout

This document describes how to use the Mixed Signal PICtail™ Demo Board. The manual layout is as follows:

- **Chapter 1. Product Overview** – Important information about the Mixed Signal PICtail™ Demo Board.
- **Chapter 2. Installation and Operation** – Includes instructions on how to get started with this demo board and a detailed description of each function of the demo board.
- **Appendix A. Schematics and Layouts** – Shows the schematic and layout diagrams for the Mixed Signal PICtail™ Demo Board.
- **Appendix B. Bill-Of-Materials (BOM)** – Lists the parts used to build the Mixed Signal PICtail™ Demo Board.
- **Appendix C. MixedSignal_V100.asm Description** – Example "Main" assembly firmware for the PIC16F767-I/SS microcontroller used to demonstrate the various features of the supported analog products.
- **Appendix D. DAC_dtmf.asm Source Code** – Example assembly source firmware used to generate Dual Tone Multiple Frequency (DTMF) signals. This firmware is utilized by the "Main" firmware, `MixedSignal_v100.ASM`.
- **Appendix E. MixedSignal_16f767i.lkr Source Code** – Linker script file used to build the example PIC16F767 firmware.
- **Appendix F. DTMF Scope Captures** – Oscilloscope screen captures of the various DTMF tones displaying their FFT to illustrate the quality of the DTMF tones.
- **Appendix G. Scope Probe Noise Captures** – Isolating scope probe noise is challenging. These scope captures illustrate the difference between using a standard scope probe and using coaxial cable directly from the board into the scope.
- **Appendix H. Sine Wave and Filtered DTMF Scope Captures** – Oscilloscope screen capture of the 32-step sine wave routine and the DTMF waveform. The DTMF waveform illustrates the non-filtered DAC output and a simple RC-filtered output.
- **Appendix I. MPLAB® IDE Screen Capture** – MPLAB IDE 6.3x was used to generate the example source firmware. This screen capture illustrates the tool, the project files and the included Watch windows.

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 the Mixed Signal PICtail™ Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP4921/22, "12-Bit DAC with SPI™ Interface" Data Sheet (DS21897)

Provides detailed information regarding the MCP492X devices.

TC1320, "8-Bit Digital-to-Analog Converter with Two-Wire Interface" Data Sheet (DS21386)

Provides detailed information regarding the TC1320 device.

TC1321, "10-Bit Digital-to-Analog Converter with Two-Wire Interface" Data Sheet (DS21387)

Provides detailed information regarding the TC1321 device.

MCP3302/3304, "13-Bit Plus Sign Differential Input 2.7V Low-Power A/D Converter with SPI™ Serial Interface" Data Sheet (DS21697)

Provides detailed information regarding the MCP3302 and MCP3304 devices.

MCP3204/3208, "2.7V 12-Bit A/D Converters with SPI™ Serial Interface" Data Sheet (DS21298)

Provides detailed information regarding the MCP3204 and MCP3208 devices.

MCP1525/1541, "2.5V and 4.096V Voltage Reference" Data Sheet (DS21653)

Provides detailed information regarding the MCP1525 and MCP1541 devices.

TC55, "1 µA Low-Dropout Positive Voltage Regulator" Data Sheet (DS21653)

Provides detailed information regarding the TC55 device.

MCP1700, "Low-Quiescent Current LDO" Data Sheet (DS21826)

Provides detailed information regarding the MCP1700 device.

MCP616/617/618/619, "2.3V to 5.5V Micropower Bi-CMOS Op Amps" Data Sheet (DS21613)

Provides detailed information regarding the MCP616, MCP617, MCP618 and MCP619 devices.

PIC16F737, PIC16F747, PIC16F767, PIC16F777, "PIC16F7X7 Data Sheet" (DS30498)

Provides detailed information regarding the PIC16F737, PIC16F747, PIC16F767 and PIC16F777 devices.

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 and 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 Mixed Signal PICtail™ Demo Board and covers the following topics:.

- Purpose and utility of the Mixed Signal PICtail™ Demo Board
- Contents of the Mixed Signal PICtail™ Demo Board Kit

1.2 PURPOSE AND UTILITY OF THE MIXED SIGNAL PICtail™ DEMO BOARD

The Mixed Signal PICtail™ Demo Board allows the system designer to quickly evaluate the suitability of several Microchip analog products for their product's design. Microchip's Digital-to-Analog Converters (DACs), Analog-to-Digital Converters (ADCs), V_{REF}s, Low Dropout Output (LDO) regulators and the PIC16F7X7 devices are supported. Evaluating precision analog products for specific applications can be challenging for practical reasons. First, many products are only available in surface-mount packages. Secondly, analog circuits tend to be affected adversely by system noise. Common breadboarding techniques are not practical for these reasons. The Mixed Signal PICtail™ Demo Board utilizes a 4-layer Printed Circuit Board (PCB), with attention paid to reducing system noise.

The Mixed Signal PICtail™ Demo Board can isolate a specific device's performance to establish baseline performance. The board can be customized quickly for specific system requirements.

1.3 CONTENTS OF THE MIXED SIGNAL PICtail DEMO BOARD KIT

This Mixed Signal PICtail™ Demo Board includes:

- The Mixed Signal PICtail™ Demo Board PCB
- PIC16F767 firmware that demonstrates how to configure and write to the MCP492X, MCP482X and TC132X DAC products
- PIC16F767 firmware demonstrating DTMF generation using a DAC
- PIC16F767 firmware demonstrating sine-wave generation using a DAC
- PIC16F767 firmware to configure and read the MCP330X/320X SAR ADCs
- PIC16F767 firmware that configures and reads the MCP3551 Sigma-Delta ADC
- MCP617 dual op amp (standard 8-pin dual layout) that can be configured as an input signal filter (ADC) or an output signal conditioning stage for the DACs
- Four DIP switches allow simple firmware mode selection
- Two indicator LEDs (red and green) for visual feedback
- PICkit™ 1 Flash Starter Kit's 14-pin header provides an interface to Microchip's 8- and 14-pin PICmicro® microcontroller devices

NOTES:

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The Mixed Signal PICtail™ Demo Board demonstrates several Microchip analog products in a signal chain configuration. The product families demonstrated include DACs, ADCs, V_{REF}s, LDOs and PICmicro® microcontroller devices. Evaluating precision analog products for specific applications can be challenging due to noise sources related to the PCB layout and not the silicon under evaluation. The Mixed Signal PICtail™ Demo Board provides the necessary hardware and firmware to exercise each of these devices in real-world applications. Users can quickly modify the existing hardware and firmware to validate functionality for their specific system needs.

2.2 FEATURES

The Mixed Signal PICtail™ Demo Board has the following features:

- Printed Circuit Board (PCB) is a 4-layer board designed to minimize external noise
- A 28-pin PICmicro (PIC16F767) microcontroller footprint is provided to permit code development. In-Circuit Debugger is supported via the RJ11 connector
- The 14-pin header is designed to seamlessly interface to the PICkit™ 1 Flash Starter Kit
- Firmware demonstrating DTMF generation on the MCP492X/482X DAC is included
- Firmware demonstrating a precision sine-wave generation on the TC132X DAC is included
- Firmware to configure and read the MCP330X/320X SAR ADCs is included
- Two precision voltage references (V_{REF}s) are supported (can compare noise)
- Flexible amplifier circuit layout supports a dual op amp in multiple configurations for either an input signal filter (ADC) or an output signal-conditioning stage for the DACs
- Four DIP switches allow simple firmware mode selection are supported
- Two indicator LEDs (red and green) are supported
- Can be powered by either the PICkit™ 1 Flash Starter Kit or by an external 9V supply

2.3 GETTING STARTED

The Mixed Signal PICtail™ Demo Board is assembled and tested for evaluation and demonstration of the MCP492X, MCP482X, TC132X, MCP3551, MCP3302, MCP3204, MCP1541, MCP1701, PIC16F767 and MCP617 features. Additional product samples with footprints supported by this board are included. A block diagram of the demo board is shown in Figure 2-1. Refer to **Appendix A. "Schematics and Layouts"** and **Appendix B. "Bill-Of-Materials (BOM)"** for more detailed circuit information.

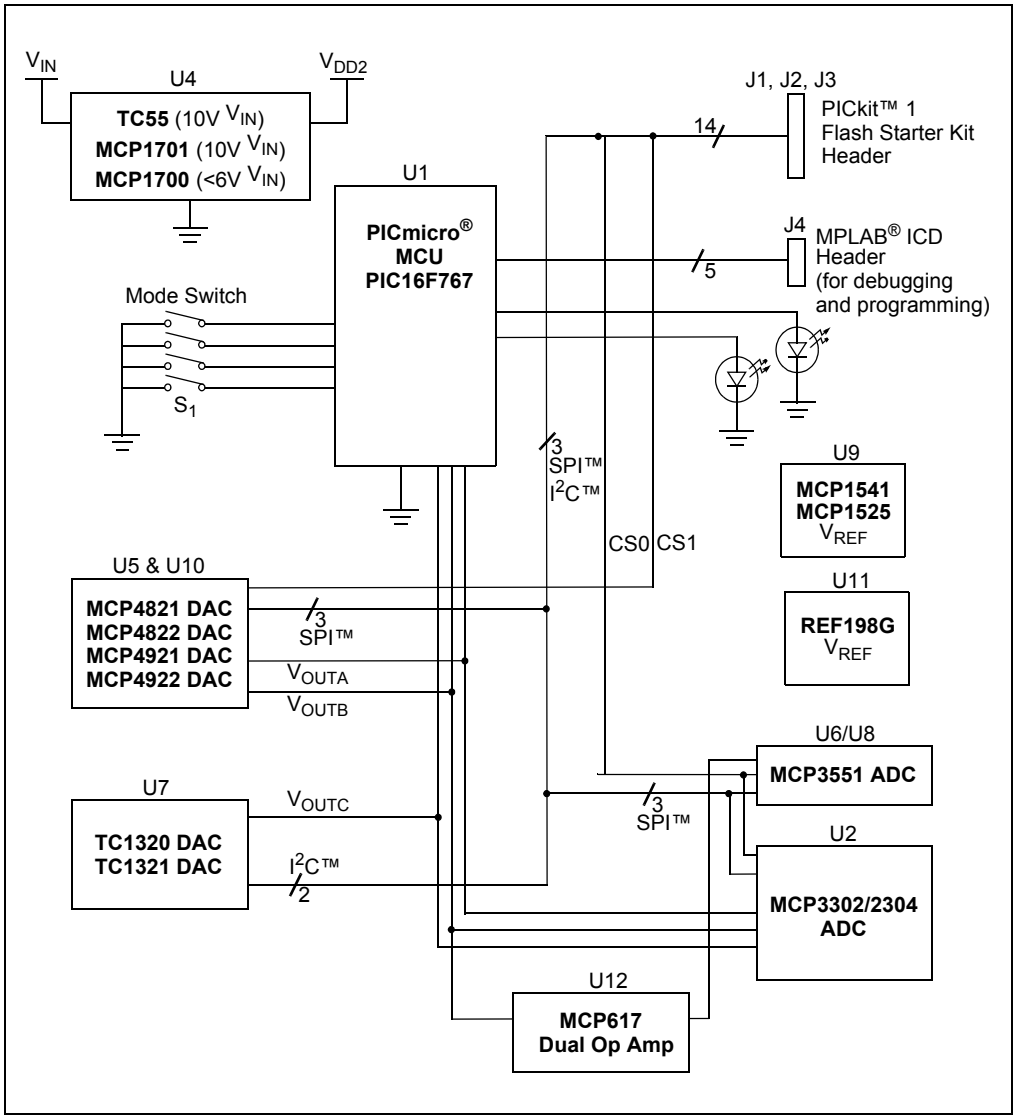

FIGURE 2-1: *Mixed Signal PICtail™ Demo Board Block Diagram.*

2.3.1 The Hardware

Figure 2-2 shows the layout of the Mixed Signal PICtail™ Demo Board with indicators to points of interest, while Table 2-1 details the PICkit™ 1 Flash Starter Kit Header connections. Jumpers JP1-JP5 are fully described in **Section 2.3.2 "The Embedded System Firmware"**.

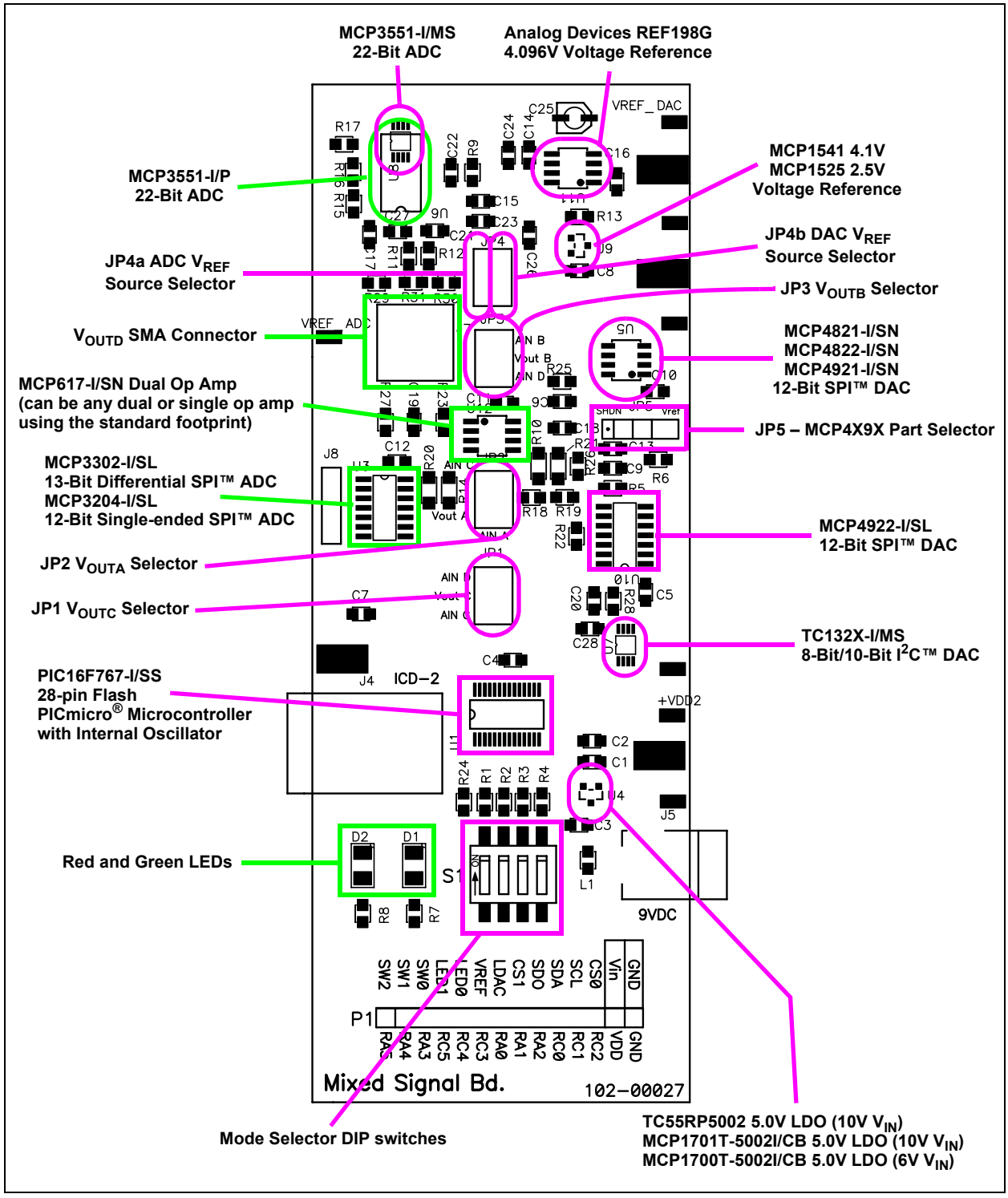

FIGURE 2-2: *Mixed Signal PICtail™ Demo Board.*

TABLE 2-1: PICkit™ 1 FLASH STARTER KIT 14-PIN HEADER INTERFACE PINS

Pin Name	Pin Number	Pin Type	Buffer Type	Description
V_{SS}	14	—	—	Electrical Ground. Both analog and digital.
V_{IN}	13	—	—	Power Supply Input. Refer to **Note 2** in **Appendix A "Schematics and Layouts"**. Do not plug in 9V supply and connect to PICkit™ 1 Flash Starter Kit.
CS0	12	O	—	SPI™ Chip Select signal for the external ADCs. Do not populate both the MCP3551 and the MCP3302 as they share the same CS0 signal.
SCK/SCL	11	O	ST	SPI Clock or I^2C™ Clock Signal. Note that external weak pull-up R_{20} connects this signal to V_{DD2}.
SDI/SDA	10	I/O	ST	SPI Data In or I^2C Data signal (Data Out on ADC). Note that external weak pull-up R_{14} connects this signal to V_{DD2}.
SDO	9	O	—	SPI Data Out Signal (Data In on DAC and ADC)
CS1	8	O	—	SPI Chip Select Signal for the External DACs. Do not populate both the MCP492X and the MCP482X as they share the same CS0 signal.
LDAC	7	O	—	Latches the DAC Output When Low. Note the weak pull-down resistor R_5 if the firmware doesn't drive the pin to a desired state.
V_{REF_ADC}	6	I	—	JP4 selects the V_{REF} source to use as the ADC reference signal. The PICmicro® microcontroller on the PICkit™ 1 Flash Starter Kit may use this for its internal ADC's V_{REF}.
LED0/TX	5	O	—	Active High Red LED Signal. This I/O also has the USART's TX signal multiplexed on it.
LED1/RX	4	I/O	—	Active High Green LED Signal. This I/O also has the USART's RX signal multiplexed on it.
SW0	3	I	—	S1's Switch 1. This pin uses the internal pull-up resistor to determine when the switch is open.
SW1	2	I	—	S1's Switch 2. This pin uses the internal pull-up resistor to determine when the switch is open.
SW2	1	I	—	S1's Switch 3. This pin uses the internal pull-up resistor to determine when the switch is open.

Legend: TTL = TTL compatible input ST = Schmitt Trigger input with CMOS levels
I = Input O = Output

2.3.2 The Embedded System Firmware

The Mixed Signal PICtail™ Demo Board firmware utilizes PICmicro® microcontroller assembly language, Microchip MPASM™ assembler and MPLINK™ linker to build the.HEX machine file. `MixedSignal_v100.asm`, `DAC_dtmf.asm`, `p16F767.inc` and `MCP492X_16f767i.lkr` files are needed in your project to build the `MixedSignalPICtail.hex`.

`MixedSignal_v100.asm` contains the main program and most of the subroutines. After initialization of critical PICmicro microcontroller peripherals (including the internal oscillator to 8 Mhz), the main loop polls the four DIP switches to determine the selected mode of operation. The DIP switches create a 4-bit binary number from 0 to 15. If a change of mode is detected for 100 ms during 500 ms of scanning, a new mode is selected and the LEDs are alternately flashed for two seconds. Most of the modes will time-out and re-scan the DIP switches periodically.

Refer to **Appendix C. "MixedSignal_V100.asm Description"** for the commented source code further describing each mode.

Modes 0XXX primarily utilize the MCP492X DAC modes:

1. **Mode0000:** Use the DTMF generation subroutine (located in `DAC_dtmf.asm`) to dial a phone number stored in memory. Analyze output on V_{OUTB} or V_{OUTD}'s SMA connector. See **Appendix F. "DTMF Scope Captures"** for resulting waveform frequency analysis.
2. **Mode0001:** Send 000h and FFFh commands to generate a 100 Hz R-R output on the MCP492X. Probe V_{OUTA} and V_{OUTB} to see the resulting waveforms.
3. **Mode0010:** Send 400h and BFFh commands to generate a 100 Hz output on the MCP492X. Probe V_{OUTA} and V_{OUTB} to see the resulting waveforms.
4. **Mode0011:** DACA = SHDN, DACB = SHDN, PIC = SLEEP. This mode demonstrates the low-power nature of the DAC, the PICmicro microcontroller, the op amp and the LDO. A power cycle is required after the mode switch is changed to exit this mode.
5. **Mode0100:** DACB and DACA = 800h and Read w/PIC16F767 10b ADC, "broadcast on USART". This mode is useful for evaluating the PICmicro microcontroller's ADC. A_{IN_B} can be injected with an alternative signal and the result can be analyzed through the 19200 baud async, 9-bit transmission. Microchip's Data View analysis tool, along with the MCP3551 USB evaluation board, provide a "canned" analysis solution.
6. **Mode0101:** DACB = 801h, DACA = 800h and Read w/MCP3302 13b Dif, "broadcast on USART". This mode is useful for evaluating the MCP3302 or the MCP3204 ADC. A_{IN_B} can be injected with an alternative signal and the result can be analyzed through the 19200 baud async, 9-bit transmission. Microchip's Data View analysis tool, along with the MCP3551 USB evaluation board, provide a "canned" analysis solution.
7. **Mode0110:** DACB and DACA = 800h and Read w/MCP3551, "broadcast on USART". This mode is useful for evaluating the MCP3551 ADC or the MCP1541 V_{REF}. A_{IN_B} can be injected with an alternative signal and the result can be analyzed through the 19200 baud async, 9-bit transmission. Microchip's Data View analysis tool, along with the MCP3551 USB evaluation board, provide a "canned" analysis solution.
8. **Mode0111:** Open for user to define their own routine.

Modes 1XXX primarily utilize TC132X DAC modes:

1. **Mode1000:** Generate a 100 Hz 32-step sine wave on the TC132X. Analyze output on V_{OUTC}. See **Appendix H. "Sine Wave and Filtered DTMF Scope Captures"** for resulting unfiltered waveform.
2. **Mode1001:** Send 000h and FFFh commands to generate a 100 Hz R-R output on the TC132X. Probe V_{OUTC} to see the resulting waveforms.
3. **Mode1010:** Send 400h and BFFh commands to generate a 100 Hz output on the TC132X. Probe V_{OUTC} to see the resulting waveforms.
4. **Mode1011:** DAC = SHDN, PIC = SLEEP. This mode demonstrates the low-power nature of the DAC, the PICmicro microcontroller, the op amp and the LDO. A power cycle is required after the mode switch is changed to exit this mode.
5. **Mode1100:** DAC = 200h and Read with PIC16F767 10b ADC, "broadcast on USART". A_{IN_C} can be analyzed using Microchip's Data View analysis tool, which, along with the MCP3551 USB evaluation board, provides a "canned" analysis solution.
6. **Mode1101:** DAC = 200h and Read with MCP3302 13b single-ended, "broadcast on USART". A_{IN_C} can be analyzed using Microchip's Data View analysis tool, which, along with the MCP3551 USB evaluation board, provides a "canned" analysis solution.
7. **Mode1110:** Open for user to define their own routine.
8. **Mode1111:** Open for user to define their own routine.

Refer to **Appendix C. "MixedSignal_V100.asm Description"** to view source code and comments.

Refer to **Appendix D. "DAC_dtmf.asm Source Code"** to view source code and comments.

Refer to **Appendix E. "MixedSignal_16f767i.lkr Source Code"** to view the script.

Refer to the `p16F767.inc` standard include file located in your "\MPLAB IDE\MCHIP_Tools\" folder.

2.4 RUNNING THE DEMOS

The Mixed Signal PICtail™ Demo Board was designed to utilize the PIC16F767 located on the PCB or a PICmicro microcontroller operating on the PICkit™ 1 Flash Starter Kit board. This Mixed Signal PICtail™ Demo Board User's Guide will only discuss the stand-alone operation utilizing the PIC16F767.

2.4.1 Power

The Mixed Signal PICtail™ Demo Board can be powered by either the PICkit™ 1 Flash Starter Kit's V_{DD} and V_{SS} signals or by a DC power supply 9V (5V minimum and 10V maximum). The onboard TC55 5.0V LDO produces a regulated 5.0V supply to operate the analog devices under test. The Mixed Signal PICtail™ Demo Board User's Guide assumes the standard 9V power supply that comes with many of Microchip's development tools (including the MPLAB® ICD 2) is utilized. The standard 9V DC connector is provided for your convenience.

With the default firmware programmed into the PIC16F767, the LED's should alternately flash for approximately two seconds upon power-up.

2.4.2 Selecting the Mode

S_1 is a 4-position DIP switch numerically labeled 1, 2, 3 and 4. These contact switches have one terminal tied to V_{SS} and one terminal connected to a 1 kΩ resister in series with the PIC16F767 PORTB<4:7> I/O port. These pins have an internal weak pull-up to prevent the I/O from floating when the corresponding DIP switch is open. The DIP switch is labeled with an arrow indicating the "on" (or closed) position of the switch. When the DIP switch is on, the I/O pin is pulled down to V_{SS}. The default firmware will interpret this as a "0". The binary combination of these four DIP switches determine the mode of operation.

Note: Selecting the mode requires the user to not "read" the switches as a binary number. Switch 1 is on the left, while switch 4 is on the right. Typically, the most significant digit is on the left, unlike this configuration. In addition, the "on" position represents a "0", which is also counterintuitive. The user could alter the default firmware to interpret the mode switches differently (change the jump table's order) or simply look at the board with the 14-pin header located at the top.

Refer to **Section 2.3.2 "The Embedded System Firmware"** for operational details for each mode.

2.4.3 Jumper JP1 Selection

Jumper JP1 is located in the center of the board closest to the PICmicro microcontroller and its MPLAB ICD 2 connector. JP1 consists of three pairs of jumper pins. The lower-two pins are connected to A_{IN_C}. The two center pins are connected to V_{OUTC}. The top-two pins are connected to A_{IN_D}.

Refer to Figure 2-2 and **Appendix A. "Schematics and Layouts"**.

If the user would like to read the output of Microchip's TC132X DAC using either the MCP3302 or MCP3204, place a jumper from one of the middle two pins to either of the outer pins, depending on which ADC input channel you are using.

Note: The default firmware Mode1101 requires JP1 to be connected to A_{IN_C}.

2.4.4 Jumper JP2 Selection

Jumper JP2 is located in the center of the board above JP1. JP2 consists of three pairs of jumper pins. The lower two pins are connected to A_{IN_A}. The middle two pins are connected to V_{OUTA}. The top two pins are connected to A_{IN_C}. Refer to Figure 2-2 and **Appendix A. "Schematics and Layouts"**.

If the user would like to read Microchip's MCP492X or MCP482X DAC A output with either the MCP3302 or MCP3204, place a jumper from one of the middle two pins to either of the outer pins, depending on which ADC input channel you are using.

2.4.5 Jumper JP3 Selection

Jumper JP3 is located in the center of the board just above the 8-pin, dual op amp MCP617 and to the right of the SMA connector's footprint. JP3 consists of three pairs of jumper pins. The lower two pins are connected to A_{IN_D}. The middle two pins are connected to V_{OUTB}. The top two pins are connected to A_{IN_B}. Refer to Figure 2-2 and **Appendix A. "Schematics and Layouts"** to view the schematic.

If the user would like to read Microchip's MCP492X or MCP482X DAC B output with either the MCP3302 or MCP3204, place a jumper from one of the middle two pins to either of the outer pins, depending on which ADC input channel you are using.

Note: The default firmware Mode0101 requires JP3 to be connected to A_{IN_B} to read V_{OUTB} with the MCP3302 or MCP3204.

2.4.6 Jumper JP4 Selection

Jumper JP4 is located in the center of the board, farthest away from the PICmicro microcontroller and its MPLAB ICD 2 connector. JP4 consists of three pairs of jumper pins. The lower two pins are connected to the MCP1541's 4.1V V_{REF} output. The top two pins are connected to the REF198G's 4.1V V_{REF} output. The middle two pins are NOT connected, similar to J1, J2 or J3. The middle left pin selects the V_{REF_ADC} source while the middle right pin selects the V_{REF_DAC} source. Refer to Figure 2-2 and **Appendix A. "Schematics and Layouts"**.

If the user employs the REF19G as the V_{REF} source for Microchip's MCP492X or TC132X DACs, a jumper connecting the top right pin with the middle right pin is required. If the user would like to use the MCP1541 as the V_{REF} source for Microchip's MCP492X, MCP482X or TC132X DACs, a jumper connecting the bottom right pin with the middle right pin is required.

Note: The default firmware requires a V_{REF_DAC} jumper to function for almost all modes.

If the user employs the REF19G as the V_{REF} source for Microchip's MCP3302, MCP3204 or PIC16F767 ADCs, a jumper connecting the top right pin with the middle right pin is required. If the user employs the MCP1541 as the V_{REF} source for Microchip's MCP492X, MCP482X or TC132X DACs, a jumper connecting the bottom right pin with the middle right pin is required.

Note: The default firmware Modes0100, 0101, 1100 and 1101 require V_{REF_ADC} to be selected in order to function.

2.4.7 Jumper JP5 Selection

Jumper JP5 is located along the right side of the board, just above the 14-pin MCP492X footprint. JP5 consists of three jumper pins.

JP5 is used to configure the board for the Microchip SPI DAC that gets soldered onto the board. Refer to Figure 2-2 and **Appendix A. "Schematics and Layouts"**.

- If the MCP4922 is used, no jumper is required.
- If the MCP4921 is used, a jumper on the right two pins is required.
- If the MCP4822 is used, no jumper is required.
- If the MCP4821 is used, a jumper on the left two pins is required.

2.4.8 Probe Connections

The most commonly probed signals are available using the surface-mount test points located along the sides of the board. These test points are labeled by the silk-screen. Note that four of these test points are oversized (2x) and are on both sides of the board. This is convenient for connecting probe ground "alligator" clips. These ground connections are critical for minimizing probe noise. The MCP3551 22b ADC is sensitive enough to "see" these noise signals enough to significantly reduce performance. J7 is a SMA connector to allow a fully-shielded connection from the ADC input (V_{OUTD}) to your scope. **Appendix G. "Scope Probe Noise Captures"** illustrates the difference between a normal probe connection and the SMA connection. As you can see, the noise is a product of the scope connection, not the op amp buffer or ADC.

2.4.9 MPLAB ICD 2 Header J4

When using the PIC16F767 (or any other Flash, 28-pin, PICmicro microcontroller with compatible footprint) the MPLAB ICD 2 is a low-cost development tool that can be utilized for code development. The MPLAB ICD 2 has defined a standard connector to simplify In-Circuit Debugging and In-Circuit Serial Programming (ICSP™) of the PICmicro microcontroller.

The MPLAB ICD 2 system is particularly advantageous when developing mixed signal solutions. The MPLAB ICD 2 does not introduce any stray inductance or capacitance typical of emulators' adapters, cables and interface boards. The PICmicro microcontroller can be soldered onto the board just as it would for standard production. The MPLAB ICD 2 signals remain static during normal operation, therefore adding no noise to the system while executing code.

This RJ11 connector would not be used if the PICkit™ 1 Flash Starter Kit is used for development.

NOTES:

Appendix A. Schematics and Layouts

A.1 INTRODUCTION

This appendix contains the schematics and layouts for the Mixed Signal PICtail™ Demo Board.

Diagrams included in this appendix:

- Board Schematic
- Board - Top + Silk Screen Layer
- Board - Power Layer
- Board - Top Layer
- Board - Bottom Layer
- Board - Ground Layer

FIGURE A-1: BOARD SCHEMATIC - PAGE 1

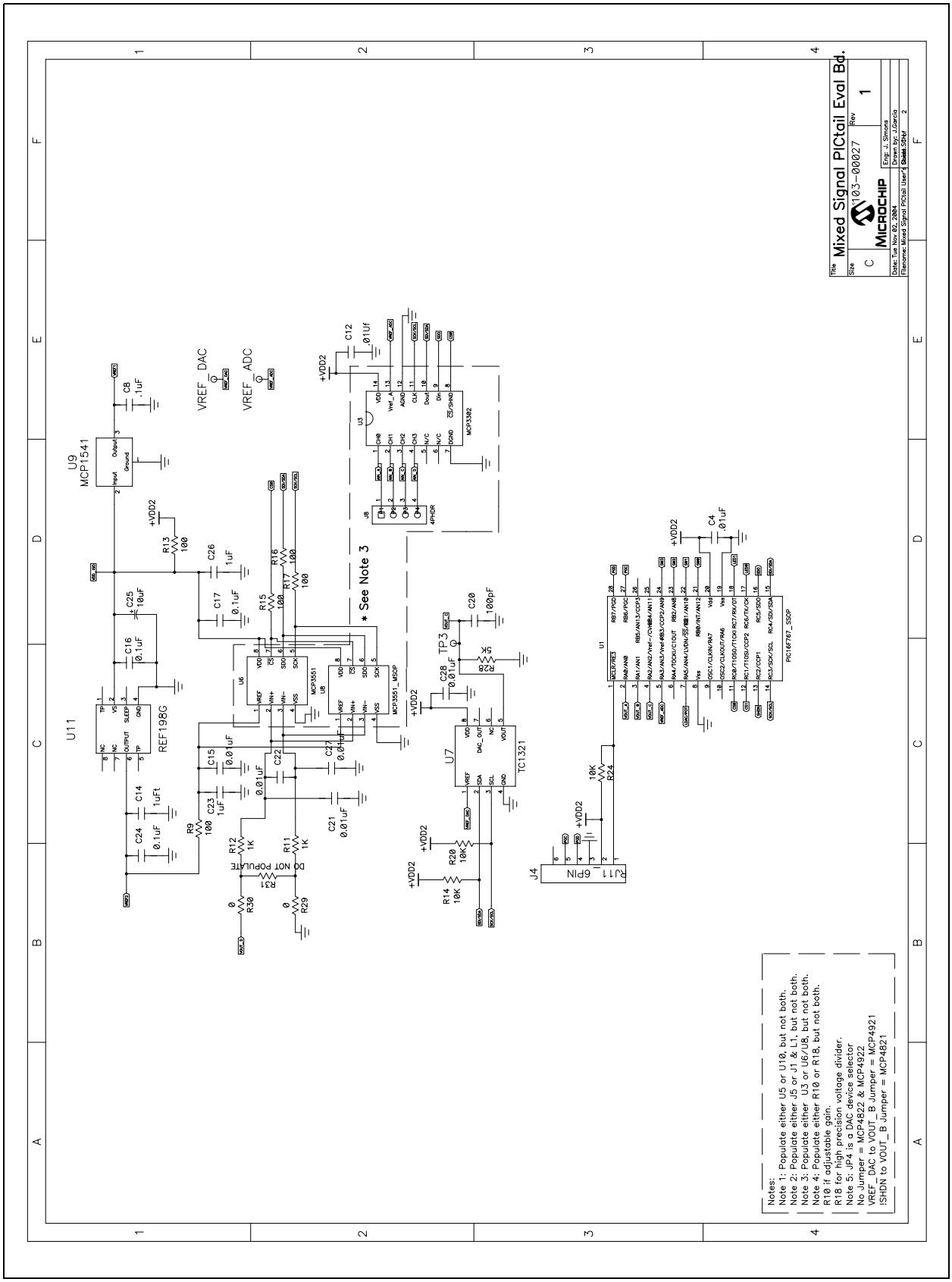

FIGURE A-1: BOARD SCHEMATIC - CONTINUED