MCP3905/6
Evaluation Board
User's Guide

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MCP3905/6 EVALUATION BOARD 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.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP3905/6 Evaluation Board. Items discussed in this chapter include:

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

DOCUMENT LAYOUT

This document describes how to use the MCP3905/6 Evaluation Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP3905/6 Evaluation Board.
- **Chapter 2. "Installation and Operation"** – Includes a detailed description of each block and instructions on how to get started with this board.
- **Appendix A. "Schematics and Layouts"** – Shows the schematic and board layout diagrams for the MCP3905/6 Evaluation Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the MCP3905/6 Evaluation Board.

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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
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier New font:		
Plain Courier New	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
	Constants	`0xFF, 'A'`
Italic Courier	A variable argument	`file.o`, where `file` can be any valid filename
Square brackets [ ]	Optional arguments	`mcc18 [options] file [options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`

	Represents code supplied by user	`void main (void)`
		 `{ ...`
		 `}`

RECOMMENDED READING

This user's guide describes how to use MCP3905/6 Evaluation Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP3905 Data Sheet, *"Energy Metering IC with Active Real Power Pulse Output"* **(DS21948)**

This data sheet provides detailed information regarding the MCP3905 device.

AN994 *"IEC Compliant Active Energy Meter Design Using The MCP3905/6"* **(DS00994)**

This application note documents the design decisions associated with this reference design.

MCP3905/6 Energy Meter Reference Design (DS51565)

This reference design is a stand-alone, low-cost energy meter. It can act as either a stand-alone energy meter, or as the analog front-end design for LCD microcontroller-based meters. This reference design is compliant with EMC requirements per energy metering standards IEC62053 and legacy IEC61036, IEC1046 and IEC687.

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- **General Technical Support** – Frequently Asked Questions (FAQs), 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

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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

DOCUMENT REVISION HISTORY

Revision A (August 2005)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the MCP3905/6 Evaluation Board and covers the following topics:

- What is the MCP3905/6 Evaluation Board?
- What the MCP3905/6 Evaluation Board kit includes

1.2 WHAT IS THE MCP3905/6 EVALUATION BOARD?

The MCP3905/6 Evaluation Board is designed to test a variety of meter designs using the MCP3905/06 energy metering Integrated Circuit (IC). Stand-alone MCP3905/6 energy meter designs, as well as those using a PICmicro® Microcontroller Unit (MCU), are easily designed using this evaluation board as the prototype Analog Front-End (AFE).

1.3 WHAT THE MCP3905/6 EVALUATION BOARD KIT INCLUDES

This MCP3905/6 Evaluation Board Kit includes:

- The MCP3905/6 Evaluation Board (with MCP3905 installed)
- MCP3905/6 Evaluation Board User's Guide (DS51567)
- MCP3905 Data Sheet, *"Energy Metering IC with Active Real Power Pulse Output"* (DS21948)
- AN994 *"IEC Compliant Active Energy Meter Design Using The MCP3905/6"* (DS00994)

NOTES:

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP3905/6 Evaluation Board provides easy evaluation of the MCP3905 energy-metering IC to metering customers. High-voltage AC input line and load connections, including the necessary space for current shunt or Current Transformer (CT) evaluation, are all included. Jumpers with shunts and a reset switch are connected to the MCP3905/6 device to further facilitate device evaluation and meter design. Multiple input channel configuration circuits are included for both differential and single-ended signals. LEDs for evaluating the MCP3905/6 output visually are on-board. A standard 14-pin PICtail™ daughter board header is included for a connection to a variety of Microchip PICmicro® microcontroller demonstration (demo) boards, allowing for PIC16, PIC18 and dsPIC® DSC development system meter designs. This connection can also be isolated using an on-board, optical-isolation IC.
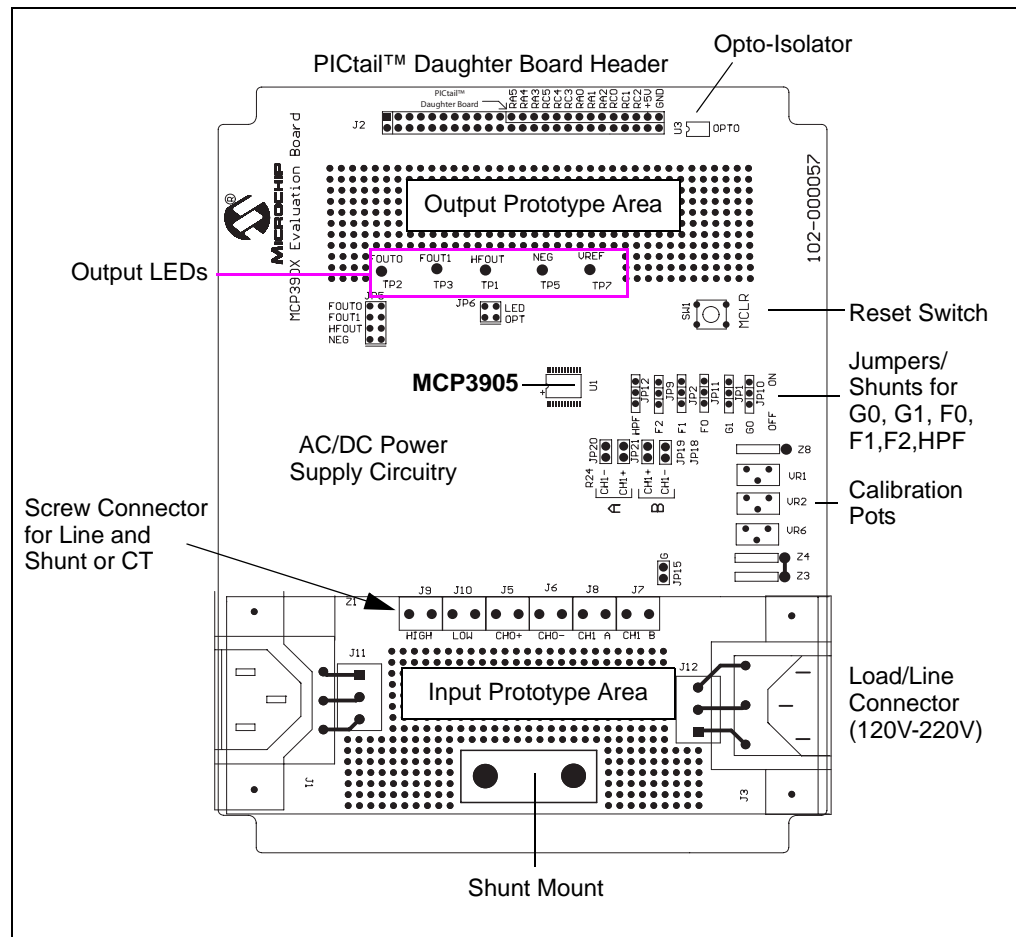
FIGURE 2-1: MCP3905/6 Evaluation Board.

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2.2   FEATURES

The MCP3905/6 Evaluation Board has the following features:

• Large space for easy connection to AC line and loads provide area for experiments using different current-sensing elements
• Easy connection to both PICDEM™ demonstration boards for a variety of PICmicro® MCU-based meter designs
• Jumpers and shunts for simple device configuration
• On-board, low-cost AC-to-DC power supply circuitry to demonstrate the low-cost MCP3905 AFE design used in the MCP3905/6 Energy Meter Reference Design (DS51565)
• EMC immunity and Printed Circuit Board (PCB) design as used in the MCP3905/6 Energy Meter Reference Design (DS51565)
• Designed to fit inside recommended plastic enclosure for safe, high-voltage demonstrations and experiments (enclosure is optional and is not included)

2.3   GETTING STARTED

The following example is given to describe how to use this evaluation board using a current-sensing shunt, 220 VAC line voltage and a 10A load. All connections described in this section are dependent on the choice of current-sensing element. A 250 µΩ shunt is selected as the current-sensing element.

2.3.1   Step 1: Install Current-Sensing Element and Make Appropriate Input Connections

Use the input prototype area to connect the line/load and current-sensing elements to the appropriate screw-type connector. An example of connecting the shunt is shown in Figure 2-2. Please note that the phase-side of the line should be used as the GND reference to the MCP3905/6 Evaluation Board when using the AC/DC power supply circuit in shunt examples like the one in Figure 2-2.
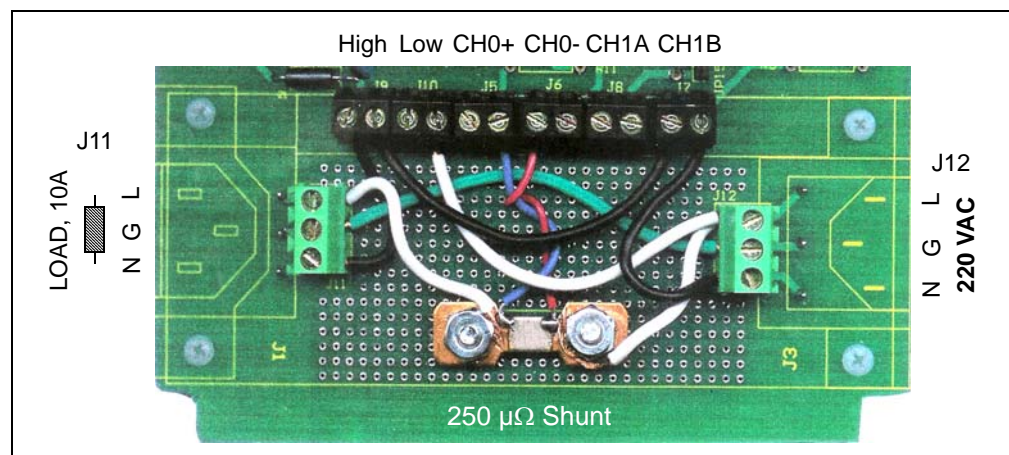
FIGURE 2-2: *Example Input Prototype Area Connections Using Shunt. The system is biased to the line-side of the two-wire power supply.*

2.3.2 Step 2: Select Channel 0 Input Method

Resistor sockets R_{11} and R_{12} should be left open when using a shunt. JP3, JP13 and JP14 should also be open. This configuration puts the shunt across the channel inputs differentially with the users option of a RC filter.

FIGURE 2-3: *Channel 0 Jumpers for 250 μΩ Shunt Selection.*

2.3.3 Step 3: Select Channel 1 Input Method

Using JP18, JP19, JP20 and JP21, select if Channel 1 will be single-ended or differential, and which input will be tied to the voltage divider and potentiometer. In Figure 2-4, the voltage divider and potentiometer are connected to the positive input, while the negative input is connected to A_{GND} through the RC.

FIGURE 2-4: *Channel 1 Input Method Example.*

2.3.4 Step 4: Select desired output evaluation method

Jumpers JP5 and JP6 select the output evaluation method. In this example, we are selecting HF_{OUT} connected to the LED for blink.

MCP3905
HF_{OUT} PULSE

OPT
LED
JP6
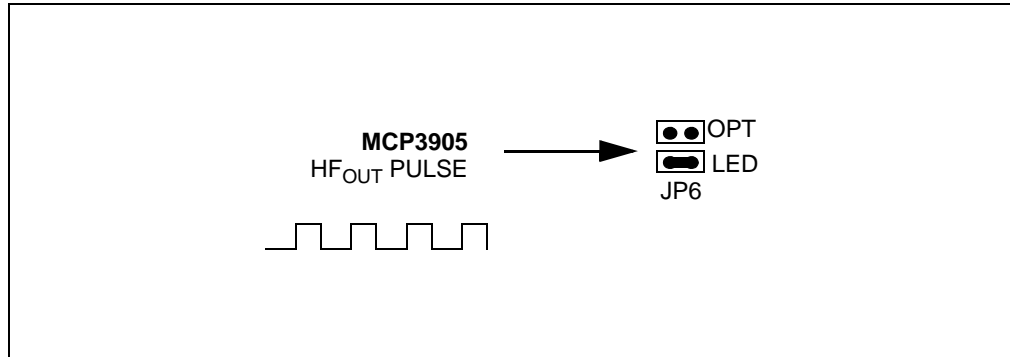
FIGURE 2-5: *Connecting the MCP3905 High-Frequency Output to the LED.*

2.3.5 Step 5: Select +5V Source

With the connections for J9 and J11 made in Figure 2-2, the 220V AC/DC power supply circuit can be used as the +5V supply. Here we put JP4 in the "INT" position for internal connection.

2.3.6 Step 6: Connect Line and Load and Observe MCP3905 Output

Once all jumper positions have been selected, connecting 220V with the correct L,G,N connections and an appropriate load (10A in this example) will power both the MCP3905/6 Evaluation Board and create the MCP3905 output (LED, BLINKING) in Figure 2-5.

2.4   MCP3905/6 EVALUATION BOARD OVERVIEW

The functional blocks of the MCP3905/06 Evaluation Board will be described in this section. For more detailed information regarding design decisions and approaches to IEC1036 compliance, refer to AN994, "IEC Compliant Active Energy Meter Design Using The MCP3905/6" (DS00994). For a detailed circuit schematic, refer to **Appendix A. "Schematics and Layouts"** and **Appendix B. "Bill-Of-Materials (BOM)"** for a list of the parts used to build the MCP3905/6 Evaluation Board.

## 2.5   FUNCTIONAL BLOCK DESCRIPTIONS

2.5.1   Input Prototype Area

All line/load, shunt and CT connections are to be made next to the screw-type connectors J5-J12. This area includes two mounting holes for a standard shunt connector. All high-voltage connections go onto this prototype area.

2.5.2   High-Voltage Input Connections (J5-12)

These screw-type connections are for shunts, CTs, line and load. The shunt resistance should be placed in parallel with J5 and J6. A variety of experiments using shunts and CTs can be performed here in conjunction with the input prototype area.

J9 and J10 feed the AC/DC power supply circuitry. J10 is the reference connection to the entire board. Shunt-type meters should be connected to the line-side. One example is given in the figure below.
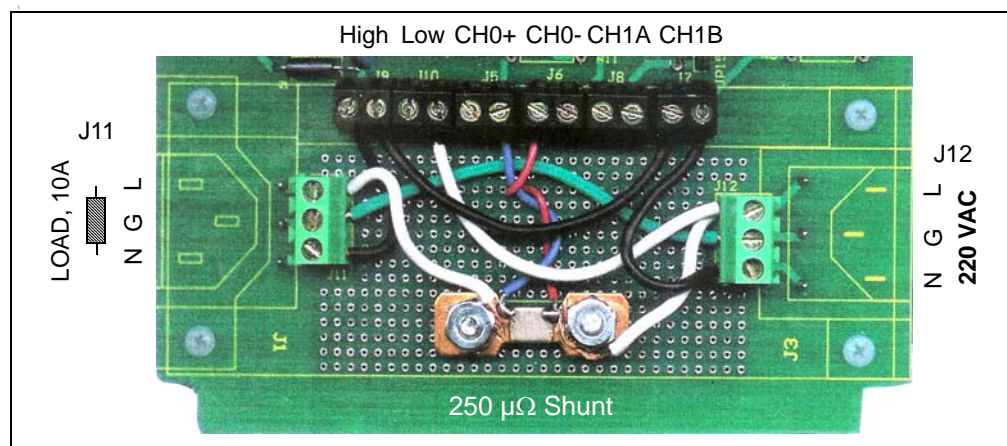
FIGURE 2-6:   Example Wiring Using Two-Wire System with Shunt

2.5.3   Jumpers and Shunts for MCP3905 Gain and Frequency Constant F_C Selection (JP1, 2, 9-12)

Jumpers and shunts for both logic-high and logic-low are included for all gain and frequency constant selections, with filter options Off and On columns being clearly labelled.
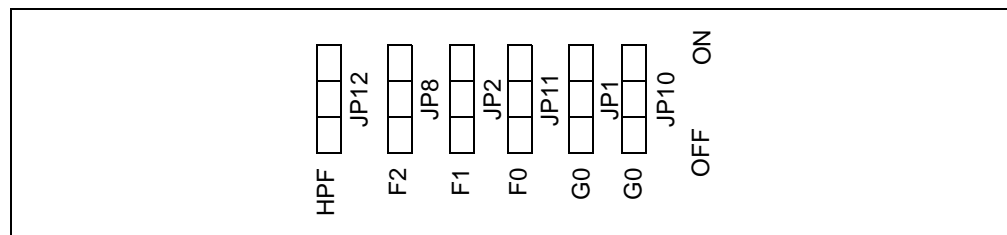
FIGURE 2-7:   MCP3905 Jumper Selections

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2.5.4 Jumpers and Shunts for MCP3905 Channel 0 Input Configurations (JP5, JP6, ZN-N)

Channel 0 is a differential input to the MCP3905 device and is intended for the current-sensing channel of the energy meter. Channel 0 on this evaluation board contains resistor sockets for CT burden resistors, as well as a RC filter on each input, with the option of shorting either input to ground. Two examples of jumper configuration are given in Figure 2-8 and Figure 2-9.
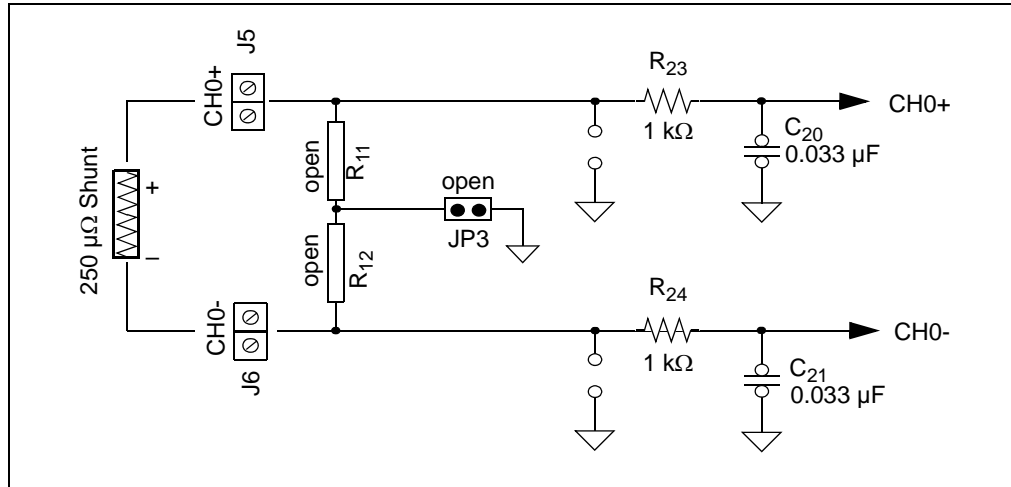
FIGURE 2-8: *Channel 0 Jumpers for 250 μΩ Shunt Selection.*
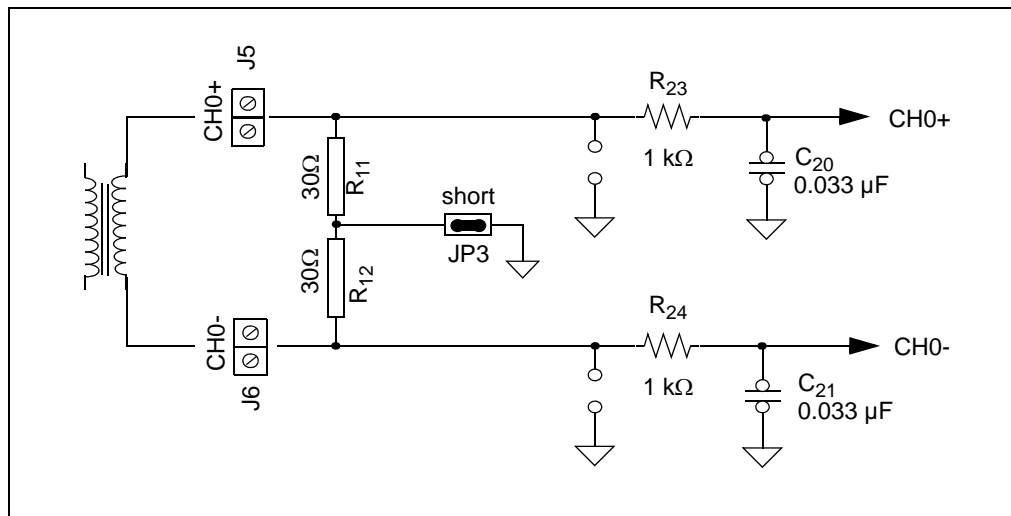
FIGURE 2-9: *Example of Channel 0 Jumpers with 60Ω Burden Resistor for Connection to Current Transformer.*

2.5.5 Channel 1 RC Circuit with A_{GND} Option – Circuit A

Channel 1 is a differential input with two possible circuit selections for each single-ended input (circuit A and circuit B). Using the MC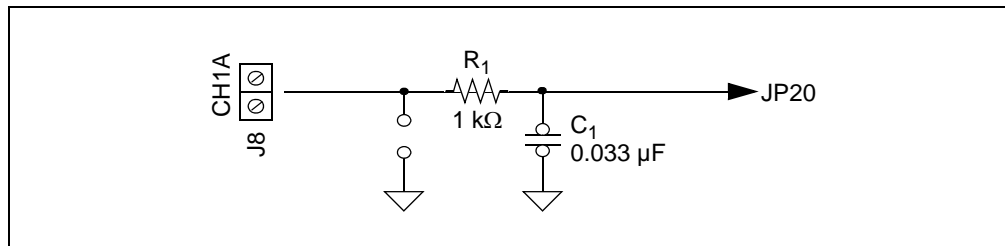P3905/6 Evaluation Board, either of the inputs can be connected to the RC or to A_{GND}, allowing single-ended or differential experiments. JPX should be shorted to ground for all single-ended input configurations.

FIGURE 2-10: *Channel 1 RC Circuit A.*

2.5.6 Channel 1 Voltage Divider Circuit and Calibration Potentiometer – Circuit B

Circuit B includes 4 resistor sockets and a mechanical potentiometer. This allows for experiments calibrating the output of the MCP3905 by changing Channel 1's input signal amplitude.
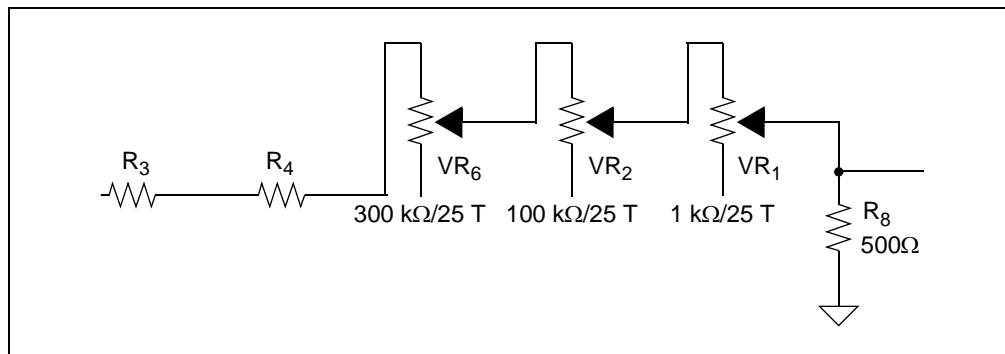
FIGURE 2-11: *Voltage Divider on Channel 1 Including Potentiometers VR_1, VR_2 and VR_6 for Calibration Experiments, Labeled Circuit B on the PCB Silk-Screen.*

2.5.7 MCP3905

Center-of-board, 24-lead surface-mount package. Refer to the MCP3905 Data Sheet, *"Energy Metering IC with Active Real Power Pulse Output"* (DS21948) for a detailed description.

2.5.8   DC Power Supply

A low-cost DC power supply circuit is included on the MCP3905/6 Evaluation Board. This is the same DC power supply circuit used in the MCP3905/6 Energy Meter Reference Design. The DC power supply is created from a half-wave zener diode-limited AC signal feeding a 7805 +5V regulator.

C_{17} and C_{16} divide the AC signal coming directly from the line, with their values depending on the AC source expected. The board comes populated with a series capacitor of 0.47 µF, designed to divide down an AC line voltage of 220 V_{RMS}. If the DC power supply is to be used with a 120 V_{RMS} AC source capacitor, C_{16} should change to 1 µF. Refer to **Appendix B. "Bill-Of-Materials (BOM)"** for detailed part information.

For more detail on this circuit design, as well as for 120V circuit specifications, refer to AN994 "IEC Compliant Active Energy Meter Design Using The MCP3905/6" (DS00994).

2.5.9   Output Prototype Area

A second prototype area is included for experiments using the MCP3905 output. All MCP3905 outputs (F_{OUT0}, F_{OUT1}, HF_{OUT}, REVP) are brought out to the prototype area.

2.5.10   Connecting the MCP3905/6 Evaluation Board to a PICDEM™ Demonstration Board

A standard 14-pin PICtail™ daughter board connector is included on this board, as shown in Figure 2-12. Any number of MCP3905 with PICmicro MCU meter designs can be developed. An optical isolator is included with the MCP3905/6 Energy Meter Reference Design as an additional level of protection for direct-connect meters using a shunt. It is connected to the selected output of the MCP3905 via JP5. A pull-up resistor is required on the output of the optical isolator to allow the selected logic signal to appear on the PICmicro MCU-based demo board, which is isolated entirely from the MCP3905/6 Evaluation Board. The output of the optical isolator is connected to RC0 on this connector, as shown in Figure 2-12. RC0 was chosen to be the default output due to the timer1 clock input on many PICmicro® MCUs.
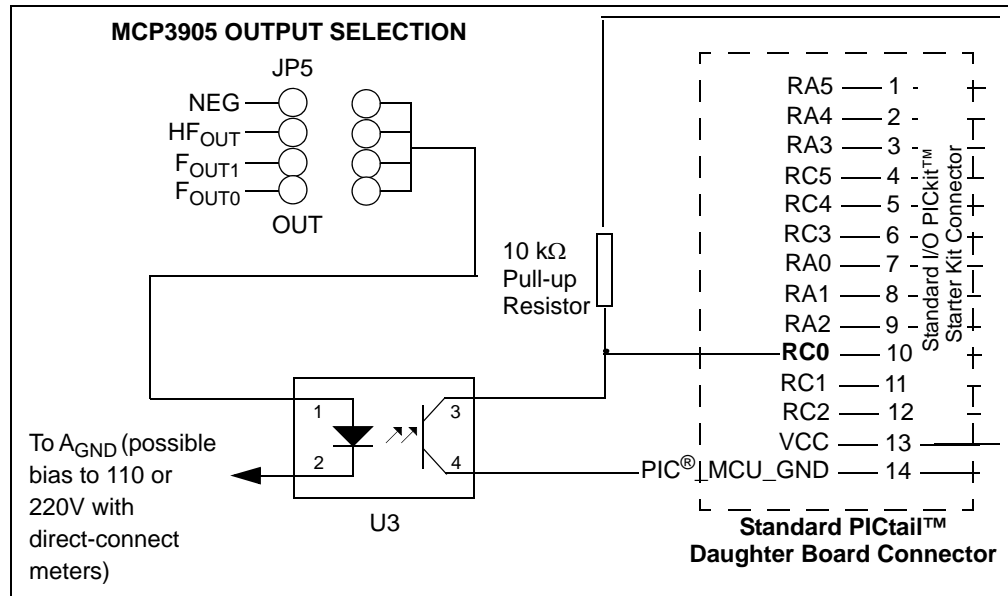
FIGURE 2-12:   *Optical isolation of the MCP3905 outputs to the PICkit™ header. The output is connected to RC0 using a 10 kΩ pull-up resistor to the PICtail™ daughter board header +5V and the PICmicro® MCU header, GND.*

Appendix A. Schematics and Layouts

A.1   INTRODUCTION

This appendix contains the following schematics and layouts for the MCP3905/6 Evaluation Board User's Guide:

- Board Schematic
- Board – Top Layer and Silk-Screen
- Board – Bottom Layer

A.2   SCHEMATICS AND PCB LAYOUT

The layer order is shown in Figure A-1.
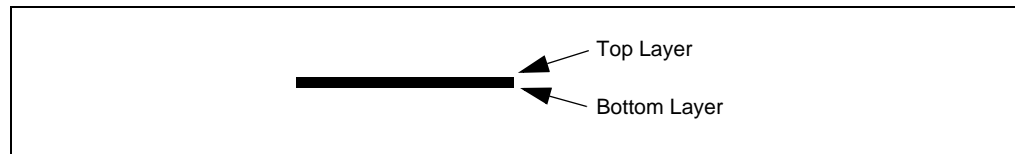
FIGURE A-1:   *Layer Order*

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A.3   BOARD SCHEMATIC

A.4 BOARD LAYOUT – TOP LAYER AND SILK-SCREEN

A.5   BOARD LAYOUT – BOTTOM LAYER

104-00057R2

Appendix B. Bill Of Materials (BOM)

TABLE B-1:   BILL OF MATERIALS (BOM)

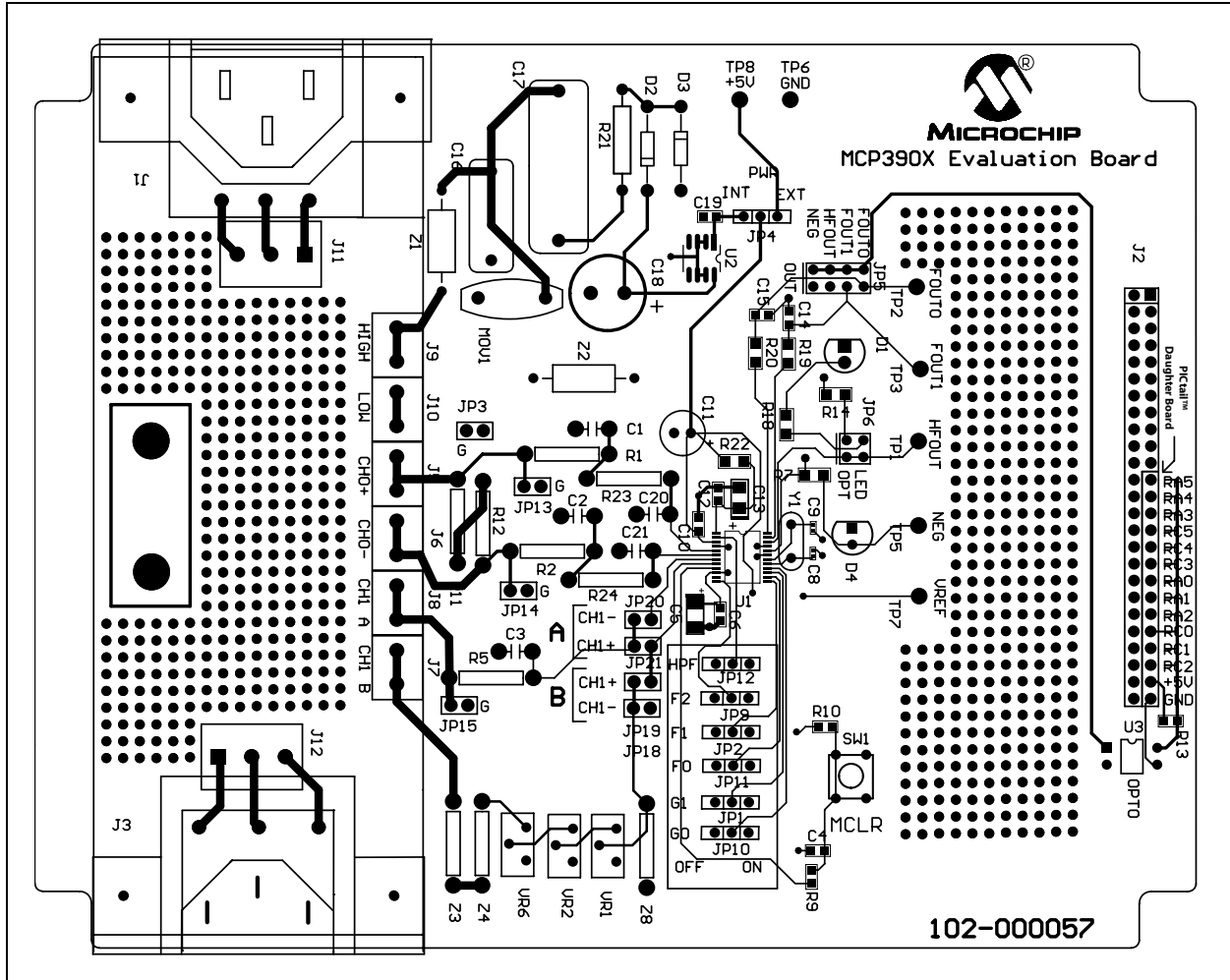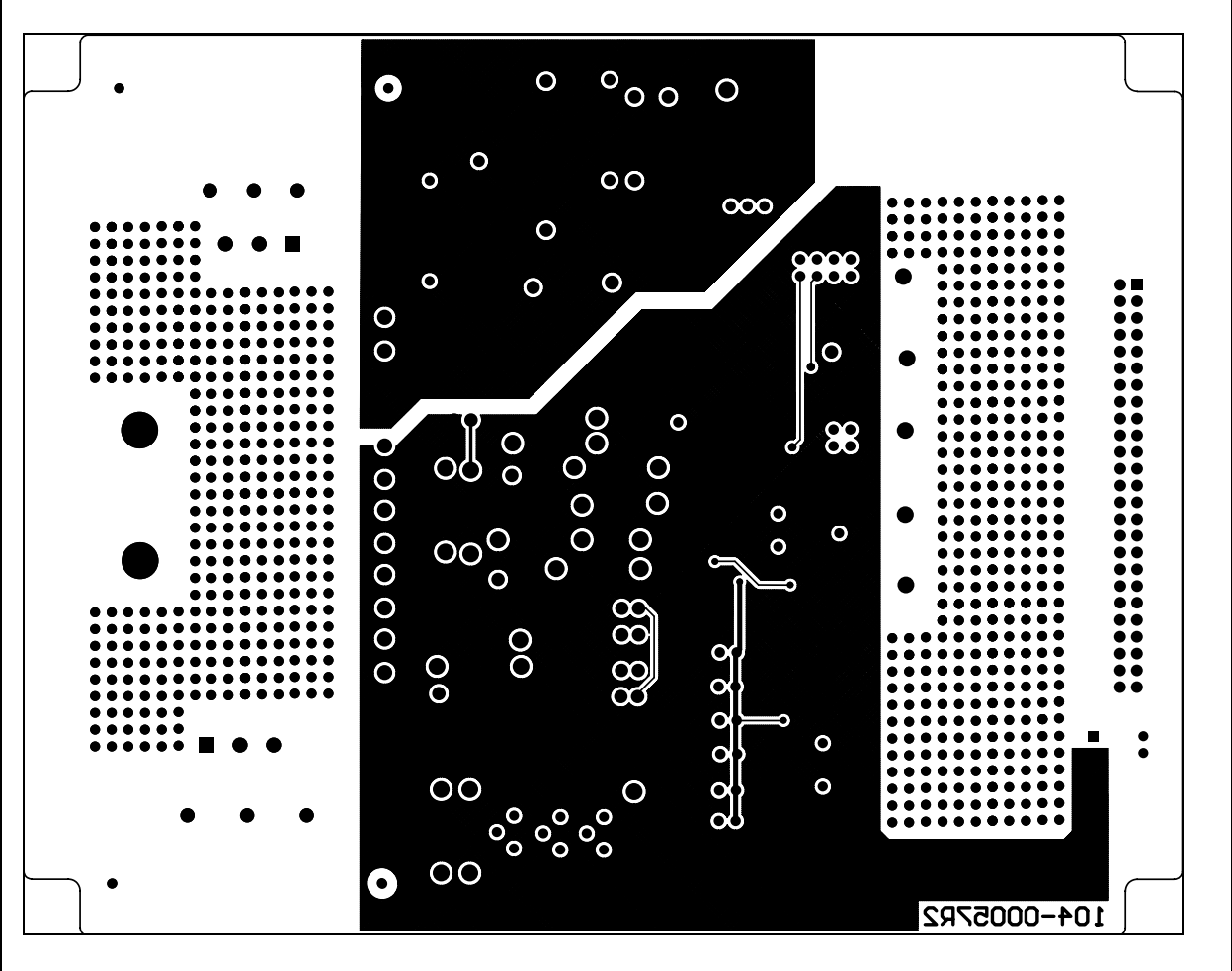| Qty	Reference	Description	Manufacturer	Part Number
7	C4,C6,C10, C12,C14,C15, C19	CAP .1µF 16V CERAMIC X7R 0805	Panasonic® - ECG	ECJ-2VB1C104K
1	C16	01µF INTERFERFENCE METAL CAP	Panasonic - ECG	ECQ-U2A103MN
5	C1,C2,C3,C20, C21	CAP 33000PF 50V CERM X7R 0805	Panasonic - ECG	ECJ-2VB1H333K
1	C17	47UF/630VDC METAL POLY CAP	Panasonic - ECG	ECQ-E6474KF
1	C18	CAP 470µF 35V ELECT FC RADIAL	Panasonic - ECG	EEU-FC1V471
1	C22	CAP 220µF 10V ELECT FC RADIAL	Panasonic - ECG	EEU-FC1A221S
2	C8,C9	CAP 22PF 50V CERAMIC 0402 SMD	Panasonic - ECG	ECJ-0EC1H220J
2	C5,C13	CAP 10µF 6.3V TANT TE SERIES	Panasonic - ECG	ECS-T0JY106R
5	R1,R2,R5,R23, R24	RES 1.00K OHM 1/4W 1% METAL FILM	Yageo America	MFR-25FBF-1K00
1	R10	RES 4.75K OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4751V
1	R22	RES 10 OHM 1/8W 1% 1206 SMD	Panasonic - ECG	ERJ-8ENF10R0V
1	R13	RES 1.0K OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1001V
2	R19,R20	RES 20.0 OHM 1/8W 1% 1206 SMD	Panasonic - ECG	ERJ-8ENF20R0V
1	R9	RES 475 OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4750V
3	R7,R12,R14	RES 825 OHM 1/10W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF8250V
2	R11,R12	RES 30.1 OHM 1/4W 1% METAL FILM	Yageo America	MFR-25FBF-30R1
1	R21	RES 470 OHM 1W 5% METAL OXIDE	Panasonic - ECG	ERG-1SJ471
1	Z8	RES 499 OHM 1/4W 1% METAL FILM	Yageo America	MFR-25FBF-499R
2	Z3,Z4	RES 332K OHM 1/4W 1% METAL FILM	Yageo America	MFR-25FBF-332K
2	Z1,Z2	BEAD CORE SINGLE 3.5X9 MM AXIAL	Panasonic - ECG	EXC-ELSA39
1	VR1	POT 1.0K OHM 3/8" SQ CERM SL MT	Bourns® Inc.	3296Y-1-102
1	VR2	POT 100K OHM 3/8" SQ CERM SL MT	Bourns Inc.	3296Y-1-104
1	VR6	POT 500K OHM 3/8" SQ CERM SL MT	Bourns Inc.	3296Y-1-504
1	Y1	CRYSTAL 3.579545 MHZ 17PF HC49/US	ECS™ Inc	ECS-35-17-4
1	J3	AC INPUT CONN	Schurter	GSP1.8101.1
1	J1	AC OUTPUT CONN	Schurter	4300.0251
1	J2	Not Installed	-	-
1	MOV1	Suppressor - Metal Oxide Varistor; Clamping Voltage Max. 710V; Peak Surge	Epcos	SIOV-S20K275
1	D1	LED GREEN DIFFUSED ROUND LONG	Panasonic - SSG	LN31GPH
1	D4	LED RED DIFFUSED ROUND LONG	Panasonic - SSG	LN21RPH
1	D2	RECTIFIER GPP 400V 1A DO-41	Diodes Inc	1N4004-T

TABLE B-1: **BILL OF MATERIALS (BOM) (CONTINUED)**

Qty	Reference	Description	Manufacturer	Part Number
1	D3	DIODE ZENER 15V 1W 5% DO-41	Diodes Inc	1N4744A-T
1	U1	MCP3905 Energy Metering IC	Microchip Technology Inc.	MCP3905-I/SS
1	U2	IC VOLT REG 5V 100MA 8-SOIC	National Semiconductor™	LM78L05ACM
1	U3	1 CHANNEL OPTO COUPLER TRANS DIP	NEC	PS2501-1
1	SW1	SWITCH TACT 6MM MOM 100GF	Omron® Electronics Inc-ECB Div	B3F-1000
7	JP1,JP2,JP4 JP9,JP10,JP11 JP12	"HEADER, .1""ST MALE, 1RW, 3PIN, (10) .025""PST, .23""GOLDTAIL	Jameco Valuepro	7000-1X3SG
1	JP5	"HEADER,.1""ST MALE,2RW,8PIN, .025""PST,.23""GOLDTAIL (10)	Jameco Valuepro	0-2X4SG
1	JP6	"HEADER, ST MALE, 2RW, 4PIN, 1""CTR, .025 PST	Jameco Valuepro	2X2SG
10	JP3,JP16,JP15 JP13,JP14, JP18,JP20, JP21,JP19, JP17	"HEADER, .1""ST MALE, 1RW, 2PIN, (10) .025""PST, .21""GOLDTAIL	Jameco Valuepro	"7000-1X2SG "
6	TP1,TP2,TP3, TP5,TP7,TP6	TEST POINT PC MULTI PURPOSE WHT	Keystone Electronics®	5012
6	J5,J6,J7,J8 J9,J10	TERMINAL BLOCK 5 MM VERT 2POS PCB	Onshore Technology	ED350/2
2	J11,J12	TERMINAL BLOCK 5 MM VERT 3POS PCB	Onshore Technology	ED350/3
30	C1,C2,C3,C20,C 21,R1,R2,R5,R2 3,R24,Z3,Z4 Z8,R11,R12	PINRECPT.015/.025DIA0252SER Note* 2 Pins per Location	Mill-Max® Manufacturing Corp.	0252-0-15-01-3027100
4	J1 & J3	SCREW MACH PHIL 4-40X3/8 NYLON	Building Fasteners	NY PMS 440 0038 PH
4	J1 & J3	NUT HEX 4-40 NYLON	Building Fasteners	NY HN 440

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Fax: 765-864-8387

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