MCP6031
Photodiode PICtail™ Plus
Demo Board
User’s Guide
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<td></td>
</tr>
</tbody>
</table>
INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP6031 Photodiode PICtail™ Plus Demo 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 MCP6031 Photodiode PICtail™ Plus 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” – Provides the important information about the MCP6031 Photodiode PICtail™ Plus Demo Board.
- Chapter 2. “Installation and Operation” – Covers the installation and operation of the MCP6031 Photodiode PICtail™ Plus Demo Board.
- Appendix A. “Schematic and Layouts” – Shows the schematic and board layouts for the MCP6031 Photodiode PICtail™ Plus Demo Board.
- Appendix B. “Bill of Materials (BOM)” – Lists the parts used to build the MCP6031 Photodiode PICtail™ Plus Demo Board.
CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

<table>
<thead>
<tr>
<th>DOCUMENTATION CONVENTIONS</th>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arial font:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italic characters</td>
<td>Referenced books</td>
<td>MILAB® IDE User’s Guide</td>
<td>...is the only compiler...</td>
</tr>
<tr>
<td></td>
<td>Emphasized text</td>
<td>the Output window</td>
<td></td>
</tr>
<tr>
<td>Initial caps</td>
<td>A window</td>
<td>the Settings dialog</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A dialog</td>
<td>select Enable Programmer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A menu selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quotes</td>
<td>A field name in a window or dialog</td>
<td>“Save project before build”</td>
<td></td>
</tr>
<tr>
<td>Underlined, italic text with right angle bracket</td>
<td>A menu path</td>
<td>File&gt;Save</td>
<td></td>
</tr>
<tr>
<td>Bold characters</td>
<td>A dialog button</td>
<td>Click OK</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A tab</td>
<td>Click the Power tab</td>
<td></td>
</tr>
<tr>
<td>N’Rnnnn</td>
<td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td>
<td>4'b0010, 2'hF1</td>
<td></td>
</tr>
<tr>
<td>Text in angle brackets &lt; &gt;</td>
<td>A key on the keyboard</td>
<td>Press &lt;Enter&gt;, &lt;F1&gt;</td>
<td></td>
</tr>
<tr>
<td>Courier New font:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plain Courier New</td>
<td>Sample source code</td>
<td>#define START</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filenames</td>
<td>autoexec.bat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>File paths</td>
<td>c:\mcc18\h</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Keywords</td>
<td>_asm, _endasm, static</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Command-line options</td>
<td>-Opa+, -Opa-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bit values</td>
<td>0, 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Constants</td>
<td>0xFF, ‘A’</td>
<td></td>
</tr>
<tr>
<td>Italic Courier New</td>
<td>A variable argument</td>
<td>file.o, where file can be any valid filename</td>
<td></td>
</tr>
<tr>
<td>Square brackets [ ]</td>
<td>Optional arguments</td>
<td>mcc18 [options] file [options]</td>
<td></td>
</tr>
<tr>
<td>Curly brackets and pipe character: {</td>
<td>Choice of mutually exclusive arguments; an OR selection</td>
<td>errorlevel {0</td>
<td>1}</td>
</tr>
<tr>
<td>Ellipses...</td>
<td>Replaces repeated text</td>
<td>var_name [, var_name...]</td>
<td></td>
</tr>
<tr>
<td>Represents code supplied by user</td>
<td>void main (void) { ... }</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RECOMMENDED READING

This user's guide describes how to use MCP6031 Photodiode PICtail™ Plus Demo Board. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

- MCP6031/2/3/4 Data Sheet, “0.9 μA, High Precision Op Amps” (DS22041) - This data sheet provides detailed information regarding the MCP603X Op Amps.
- AN951, “Amplifying High-Impedance Sensors - Photodiode Example” (DS00951) - This application note shows how to condition the current out of a high-impedance sensor. A photodiode detector illustrates the theory.
- “Signal Chain Design Guide” (DS21825)
- “Explorer 16 Development Board User’s Guide” (DS51589)

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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

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 (September 2008)

- Initial Release of this Document.
Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP6031 Photodiode PICtail™ Plus Demo Board is described by the following:

- Assembly #: 114-00219
- Order #: MCP6031DM-PCTL
- Name: MCP6031 Photodiode PICtail™ Plus Demo Board

Items discussed in this chapter include:

- MCP6031 Photodiode PICtail™ Plus Demo Board Kit Contents
- MCP6031 Photodiode PICtail™ Plus Demo Board Description

1.2 MCP6031 PHOTODIODE PICtail™ PLUS DEMO BOARD KIT CONTENTS

- MCP6031 Photodiode PICtail™ Plus Demo Board (102-00219)
- Important Information “Read First”
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912). It contains:
  - Firmware files
  - Gerber files

FIGURE 1-1: MCP6031 Photodiode PICtail™ Plus Demo Board Kit.
1.3 MCP6031 PHOTODIODE PICtail™ PLUS DEMO BOARD DESCRIPTION

The MCP6031 Photodiode PICtail™ Plus Demo Board demonstrates how to use a transimpedance amplifier, which consists of MCP6031 high precision op amp and external resistors, to convert photo-current ($I_S$) to voltage. The circuit was not calibrated for absolute accuracy.

The RC low-pass filter that is implemented in this circuit can remove the high frequency noise and interference from the signal path prior to the analog-to-digital (A/D) conversion.

The PICmicro® on the Explorer 16 Development Board communicates with the MCP6031 Photodiode PICtail™ Plus Demo Board and completes the analog-to-digital conversion.

**Note:** For high measurement accuracy, an external stand-alone ADC with higher resolution needs to be used.

The measured voltage ($V_{OUT}$) and calculated illuminance ($L$) will be shown on LCD screen on board. The illuminance ($L$) will be calculated by the equation:

**EQUATION 1-1:**

$$L = \text{illuminance (lx)} = \left(\frac{V_{OUT}}{R_i}\right) \times \left(\frac{10000 \ I_S}{70 \ \mu A}\right)$$

Figure 1-2 shows the block diagram of the MCP6031 Photodiode PICtail™ Plus Demo Board.
Figure 1-3 shows the top view of the MCP6031 Photodiode PICtail™ Plus Demo Board.

**FIGURE 1-3:** Top view of MCP6031 Photodiode PICtail™ Plus Demo Board

Figure 1-4 shows the circuit diagram of MCP6031 Photodiode PICtail™ Plus Demo Board. C₁ is for compensation purpose and no need for the board. It may be needed when MCP6031 is replaced by the other Microchip’s op amp.

The DC output voltage due to the source photo-current will be $V_{OUT} = I_S R_1$, where $R_1$ is the feedback resistor. The op amp will contribute a DC offset voltage, $V_{OS} + I_B R_1$, to the output, where $V_{OS}$ is the op amp’s input offset voltage and $I_B$ is the op amp’s input bias current. Select the value of $R_1$ to give a high gain to $I_S$. Usually, this gain is high enough to use most of the op amp’s output voltage swing when $I_S$ is at its extreme values. The op amp needs to have $V_{OS}$ and $I_B$ low enough to not cause a large DC offset. That is the reason why op amp MCP6031 is selected.

**FIGURE 1-4:** MCP6031 Photodiode PICtail™ Plus Demo Board Circuit Diagram.
For the design approach of this board, please refer to AN951, “Amplifying High-Impedance Sensors - Photodiode Example” (DS00951) as reference resource. This application note discusses the analog conditioning circuit used for high-impedance sensors that act like current sensors. The design approach illustrated in this application note, using op amps, is broken down into three design steps: DC, stability compensation, closed-loop gain and noise reduction. A design using a PIN photodiode (light detector) illustrates the principles discussed. Measurement results are provided to support the theory presented. The last sections of this application note contain supplemental information.

MCP6031 Photodiode PICtail™ Plus Demo Board has the following features:

- Supports Microchip MCP6031 high precision op amp
- Uses a transimpedance amplifier as sensor conditioning circuit
- Uses a PIN photodiode (PNZ334) as light detector
- Test points for connecting lab equipment
Chapter 2. Installation and Operation

2.1 INTRODUCTION

This chapter shows how to set up the MCP6031 Photodiode PICtail™ Plus Demo Board and explore the operation of a light sensing application.

Items discussed in this chapter include:

- Required Tools
- MCP6031 Photodiode PICtail™ Plus Demo Board Set-Up
- MCP6031 Photodiode PICtail™ Plus Demo Board Operation

2.2 REQUIRED TOOL

- Explorer 16 Development Board

2.3 MCP6031 PHOTODIODE PICtail™ PLUS DEMO BOARD SET-UP

Insert the MCP6031 Photodiode PICtail™ Plus Demo Board into the Explorer 16 Development Board as shown in Figure 2-1. An exploded view is shown in the Figure 2-2.

FIGURE 2-1: MCP6031 Photodiode PICtail™ Plus Demo Board Set-Up.
2.4 MCP6031 PHOTODIODE PICtail™ PLUS DEMO BOARD OPERATION

Figure 2-2 shows data taken near an incandescent lamp powered by a battery.

**FIGURE 2-2:** MCP6031 Photodiode PICtail™ Plus Demo Board Operation.
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP6031 Photodiode PICtail™ Plus Demo Board:

- Board – Schematic
- Board – Top Silk Layer
- Board - Top Metal And Top Silk Layers
- Board – Bottom Metal Layer
A.5  BOARD - BOTTOM METAL LAYER
### Appendix B. Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS (102-00219)**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Reference</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C2</td>
<td>CAP 33,000PF 50V CERM X7R 0805</td>
<td>Panasonic®</td>
<td>ECJ-2VB1H333K</td>
</tr>
<tr>
<td>2</td>
<td>C3, C4</td>
<td>CAP .1UF 25V CERAMIC X7R 0805</td>
<td>Panasonic®</td>
<td>ECJ-2VB1E104K</td>
</tr>
<tr>
<td>1</td>
<td>C5</td>
<td>CAP 1.0UF 16V CERAMIC X7R 0805</td>
<td>Kemet® Electronics Corp.</td>
<td>C0805C105K4RACTU</td>
</tr>
<tr>
<td>1</td>
<td>D1</td>
<td>PIN PHOTODIODE</td>
<td>Panasonic®</td>
<td>PNZ334</td>
</tr>
<tr>
<td>1</td>
<td>R1</td>
<td>RES 42.2K OHM 1/10W 1% 0805 SMD</td>
<td>Panasonic®</td>
<td>ERJ-6ENF4222V</td>
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<tr>
<td>1</td>
<td>R2</td>
<td>RES 10.0K OHM 1/10W 1% 0805 SMD</td>
<td>Panasonic®</td>
<td>ERJ-6ENF1002V</td>
</tr>
<tr>
<td>3</td>
<td>TP1—TP3</td>
<td>TEST POINT PC COMPACT SMT</td>
<td>Keystone Electronics</td>
<td>5016</td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>MCP6031, SOT-23-5</td>
<td>Microchip Technology Inc.</td>
<td>MCP6031T-E/OT</td>
</tr>
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*Note:* The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

**TABLE B-2: BILL OF MATERIALS - UNPOPULATED PARTS**

<table>
<thead>
<tr>
<th>Qty</th>
<th>Reference</th>
<th>Description</th>
<th>Manufacturer</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>Not Populated when shipped to customer</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*Note:* The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.
### AMERICAS
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  Fax:  678-957-1455
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  Fax:  774-760-0088
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  Fax:  630-285-0075
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  Addison, TX  
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  Fax:  972-818-2924
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  Fax:  248-538-2260
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  Santa Clara, CA  
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  Fax:  905-673-6509

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Fax: 852-2401-3431

- Australia - Sydney  
  Tel: 61-2-9868-6733  
  Fax: 61-2-9868-6755
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  Tel: 86-10-8528-2100  
  Fax: 86-10-8528-2104
- China - Chengdu  
  Tel: 86-28-8665-5511  
  Fax: 86-28-8665-7889
- China - Hong Kong SAR  
  Tel: 852-2401-1200  
  Fax: 852-2401-3431
- China - Nanjing  
  Tel: 86-25-8473-2460  
  Fax: 86-25-8473-2470
- China - Qingdao  
  Tel: 86-532-8502-7355  
  Fax: 86-532-8502-7205
- 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 - Wuhan  
  Tel: 86-27-5980-5300  
  Fax: 86-27-5980-5118
- China - Xi'an  
  Tel: 86-26-9833-7252  
  Fax: 86-26-9833-7256
- China - Zhuhai  
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  Fax: 86-756-3210049

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Fax: 91-80-4182-8422

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  Tel: 91-11-4160-8631  
  Fax: 91-11-4160-8632
- India - Pune  
  Tel: 91-20-2566-1512  
  Fax: 91-20-2566-1513
- Japan - Yokohama  
  Tel: 81-45-471-6166  
  Fax: 81-45-471-6122
- Korea - Daegu  
  Tel: 82-53-744-4301  
  Fax: 82-53-744-4302
- Korea - Seoul  
  Tel: 82-2-554-7200  
  Fax: 82-2-558-5932 or 82-2-558-5934
- Malaysia - Kuala Lumpur  
  Tel: 60-3-6201-9857  
  Fax: 60-3-6201-9859
- Malaysia - Penang  
  Tel: 60-4-227-8870  
  Fax: 60-4-227-4068
- Philippines - Manila  
  Tel: 63-2-634-9065  
  Fax: 63-2-634-9069
- Singapore  
  Tel: 65-6334-8870  
  Fax: 65-6334-8850
- Taiwan - Hsin Chu  
  Tel: 886-3-572-9526  
  Fax: 886-3-572-6459
- Taiwan - Kaohsiung  
  Tel: 886-7-536-4818  
  Fax: 886-7-536-4803
- Taiwan - Taipei  
  Tel: 886-2-2500-6610  
  Fax: 886-2-2508-0102
- Thailand - Bangkok  
  Tel: 66-2-694-1351  
  Fax: 66-2-694-1350

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