

MCP1630
Input Boost Converter
Demo Board
User's Guide

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MCP1630 AUTOMOTIVE INPUT BOOST CONVERTER DEMO 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.

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 MCP1630 Automotive Input Boost Converter 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 MCP1630 Automotive Input Boost Converter Demo Board. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP1630 Automotive Input Boost Converter Demo Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this user's guide and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP1630 Automotive Input Boost Converter Demo Board.
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the MCP1630 Automotive Input Boost Converter Demo Board.
- **Appendix C. "Demo Board Firmware"** – Provides information about the application firmware and where the source code can be found.

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
N'Rnnnn	A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.	4'b0010, 2'hF1
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 New	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}`

RECOMMENDED READING

This user's guide describes how to use MCP1630 Automotive Input Boost Converter Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

MCP1630/MCP1630V Data Sheet, "High-Speed, Microcontroller-Adaptable, Pulse Width Modulator" (DS21896)

This data sheet provides detailed information regarding the MCP1630/MCP1630V product family.

PIC12F683 Data Sheet, "8-Pin Flash-Based, 8-Bit CMOS Microcontrollers with Nano Watt Technology" (DS41211)

This data sheet provides detailed information regarding the PIC12F683 product family.

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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the web site at: http://support.microchip.com

DOCUMENT REVISION HISTORY

Revision B (June 2007)

- Updated Bill of Materials (BOM) for C12, C13, and L1
- Add disclaimer to Bill of Materials regarding RoHS-Compliant part numbers.

Revision A (April 2006)

- Initial Release of this Document.

NOTES:

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Chapter 1. Product Overview

1.1 INTRODUCTION

The proliferation of distributed power supplies is expected to accelerate their use in future generation cars. Distributed power supplies or "point-of-load" power supplies are being used increasingly throughout. These Power Supply Units (PSUs) are responsible for stepping up (or down) a 12V nominal bus, to power a multitude of subsystems. These include telematics/navigation systems, power seats and doors, interior and exterior lighting, electronic braking and engine management control.

Many automotive and industrial applications require higher voltages than are available on the input power supply rail. Supply voltages required for these systems can range from 36V (power seats and windows) to 1.8V (to drive low-voltage microprocessors). In addition, depending on where the PSU operates on the automotive power bus, it may be required to perform under very stringent power requirements.

Automotive subsystems with their inherent high voltage transients and high efficiency requirements place increasing demands on power supply designs. These supplies must provide high power, high efficiency and low noise from a very compact footprint and must maintain a high efficiency over a wide range of operational input voltages.

The MCP1630/V high-speed, microcontroller-adaptable Pulse Width Modulator (PWM) is capable of maintaining output regulation with no adverse effects on system performance or reliability. The MCP1630 Automotive Input Boost Converter Demo Board provides a better choice for automotive application design and high efficiency.

This chapter covers the following topics.

- What is the MCP1630 Automotive Input Boost Converter Demo Board?
- What the MCP1630 Automotive Input Boost Converter Demo Board Kit includes.

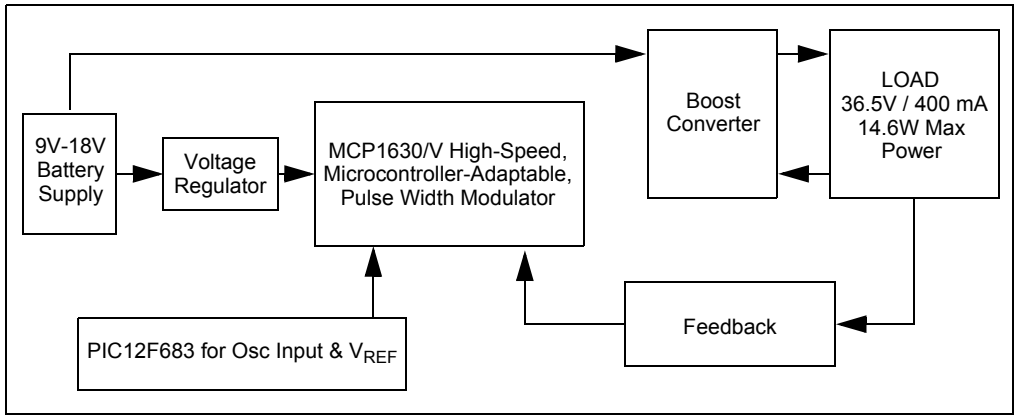


FIGURE 1-1: *MCP1630 Automotive Input Boost Converter Demo Board Block Diagram.*

1.2 WHAT IS THE MCP1630 AUTOMOTIVE INPUT BOOST CONVERTER DEMO BOARD?

The MCP1630 Automotive Input Boost Converter Demo Board demonstrates the use of a conventional boost topology with automotive input. The board also serves as a platform to evaluate the MCP1630/V devices.

The MCP1630/V inputs were developed to be easily attached to the I/O of a microcontroller. The Microcontroller Unit (MCU) supplies the oscillator pulses and reference voltage (V_{REF}) to the MCP1630/V devices to provide the most flexible and adaptable power system. The power system switching frequency and maximum duty cycle are set using the I/O of the MCU. The reference input to the high-speed PWM can be external, a D/A Converter (DAC) output or as simple as an I/O output from the MCU. This enables the power system to adapt to many external signals and variables in order to optimize performance and facilitate calibration.

This board utilizes Microchip's MCP1630/V (high-speed PICmicro® MCU PWM) integrated with PIC12F683 (Flash MCU SOIC8) in automotive input application. Under normal operation, the vehicle voltage at the supply lines ranges between 9V-18V (12V system). The converter is capable of delivering an output voltage of 36.5V at 400 mA load current with maximum power of 14.6W. The line and load regulation is within the regulation band of 3%.

1.3 WHAT THE MCP1630 AUTOMOTIVE INPUT BOOST CONVERTER DEMO BOARD KIT INCLUDES

This MCP1630 Automotive Input Boost Converter Demo Board kit includes:

- MCP1630 Automotive Input Boost Converter Demo Board (102-00095)
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912)
  - MCP1630 Automotive Input Boost Converter Demo Board User's Guide (DS51608)

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1630 Automotive Input Boost Converter Demo Board demonstrates Microchip's high-speed pulse width modulator used for automotive applications. When used in conjunction with a microcontroller, the MCP1630/V devices will control the power system duty cycle to provide regulated output voltage. The PIC12F683 microcontroller is used to provide oscillator pulses at switching frequency of 500 kHz and set maximum duty cycle. The MCP1630/V devices generate duty cycles based on various external inputs. External signals include the input oscillator pulses from PIC12F683, the reference voltage and the feedback voltage. The output signal is a square wave pulse given to drive the MOSFET.

The PIC12F683 microcontroller is programmable, allowing the user to modify or develop their own firmware routines to further evaluate the MCP1630/V devices in this application.

2.2 FEATURES

The MCP1630 Automotive Input Boost Converter Demo Board has the following features:

- Compact size for an output power of 14.6W
- Tight line and load regulation and high efficiency over entire operating input voltage range
- PIC12F683 is used to generate reference voltage and oscillator signal at 500 kHz frequency at maximum duty cycle
- Proprietary features can be added by modifying the firmware contained in the PIC12F683
- Factory programmed source code is available

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2.3 GETTING STARTED

The MCP1630 Automotive Input Boost Converter Demo Board is fully assembled and tested for automotive input. The board requires the use of an external input voltage source (+9V to 18V) and external load.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE MCP1630 AUTOMOTIVE INPUT BOOST CONVERTER DEMO BOARD

1. Connect the positive side of the input source (+) to TP1.
2. Connect the negative or return side (-) of the input source to TP2. Refer to Figure 2-1. The input voltage source should be limited to the 0V to +18V range. For normal operation, the input voltage should be between +9V to +18V. The input voltage must not exceed an absolute maximum of +20V.

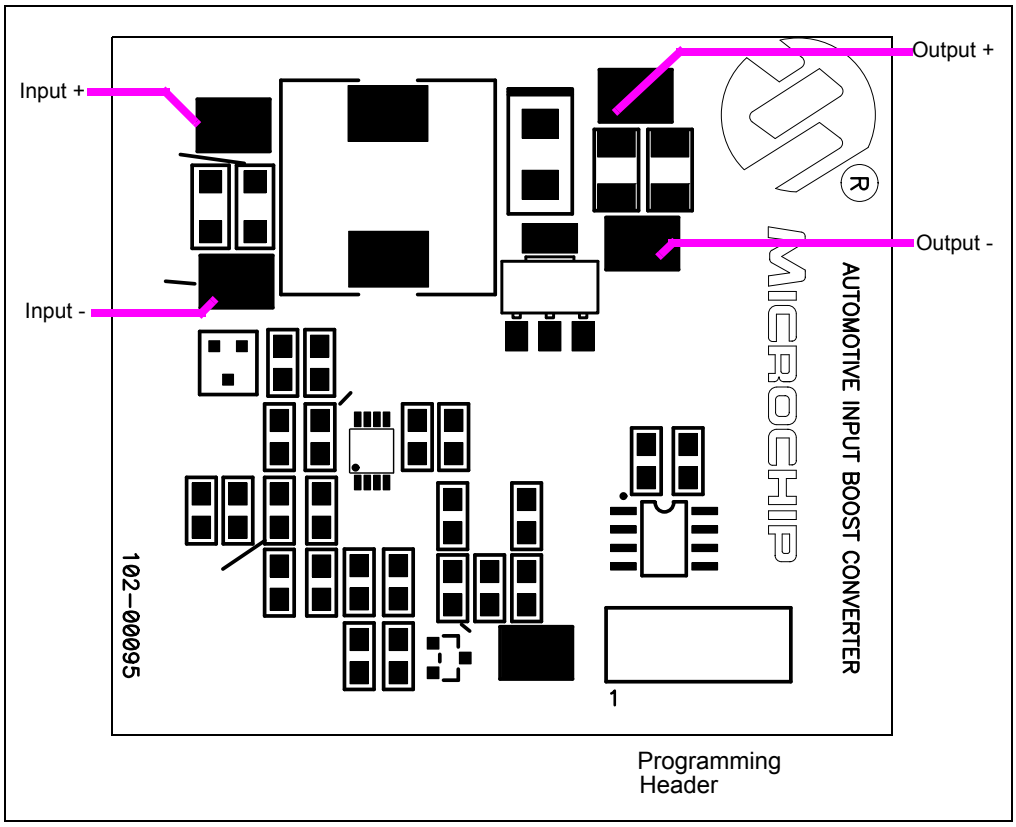


FIGURE 2-1: *Set-up Configuration Diagram.*

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2.3.1.2 APPLY LOAD TO MCP1630 AUTOMOTIVE INPUT BOOST CONVERTER DEMO BOARD

A variable resistive load can be used to verify the line and load regulation. The load resistance is connected between the points TP3 and TP4. To measure the output voltage, connect the common point of a multimeter to TP4 and the positive terminal to TP3. By varying the load, the load regulation can be verified by measuring the output voltage over the entire load range of 0 mA to 400 mA. Similarly, the line regulation can be calculated by varying the line voltage from 9V to 18V and checking the output voltage.

Evaluating the Application

The best way to evaluate the MCP1630 is to dig into the circuit and measure voltages and currents with a Digital Voltage Meter (DVM) and probe the board with an oscilloscope.

The firmware program in the PIC12F683 can also be edited to modify the operation of the application.

Firmware

The PIC12F683 comes pre-programmed with firmware to operate the system as described above. The file listing and firmware flow diagram are shown in **Appendix C. "Demo Board Firmware"**.

The program is fairly simple and straight forward. There is an initialization routine at the beginning of the program.

The TRISIO register controls the direction of GPIO pins, and is configured to set GP2 (oscillator pulses to the MCP1630/V) and GP5 (V_{REF} voltage to MCP1630/V) as an output port.

The Capture/Compare/PWM (CCP) module contains a 16-bit register which can operate in PWM mode. The PWM period can be calculated by writing to the PR2 register. The PWM duty cycle is specified by writing to the CCPR1L register and to the CCP1CON <5:4> bits. Up to 10-bit resolution is available. The CCPR1L contains the eight MSbs and the CCP1CON <5:4> contains the two LSbs. This 10-bit value is represented by CCPR1L:CCP1CON<5:4>. The switching frequency is set to 500 kHz.

The user can obtain different output voltages by programming the MCU to obtain different V_{REF} voltages.

Programming

Header J1 is provided for in-circuit programming. This is an optional feature since the MCP1630 Automotive Input Boost Converter Demo Board comes pre-programmed with firmware to operate the system. The PIC12F683 can be reprogrammed with the Baseline Flash Microcontroller Programmer (BFMP).

NOTES:

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Appendix A. Schematic and Layouts

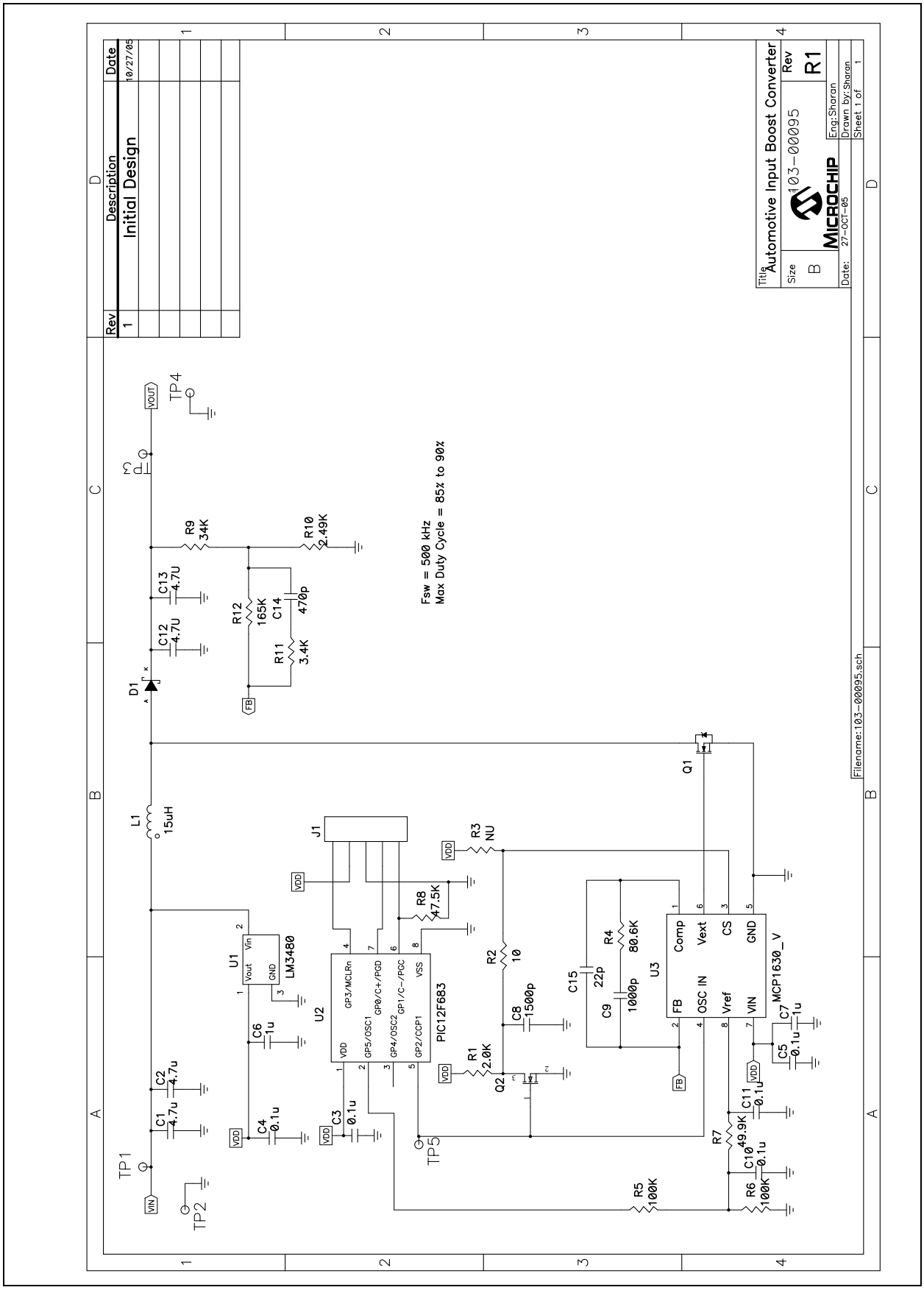
A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the MCP1630 Automotive Input Boost Converter Demo Board:

- Board – Schematic
- Board – Top Silk Layer
- Board – Top Metal Layer
- Board – Bottom Metal Layer

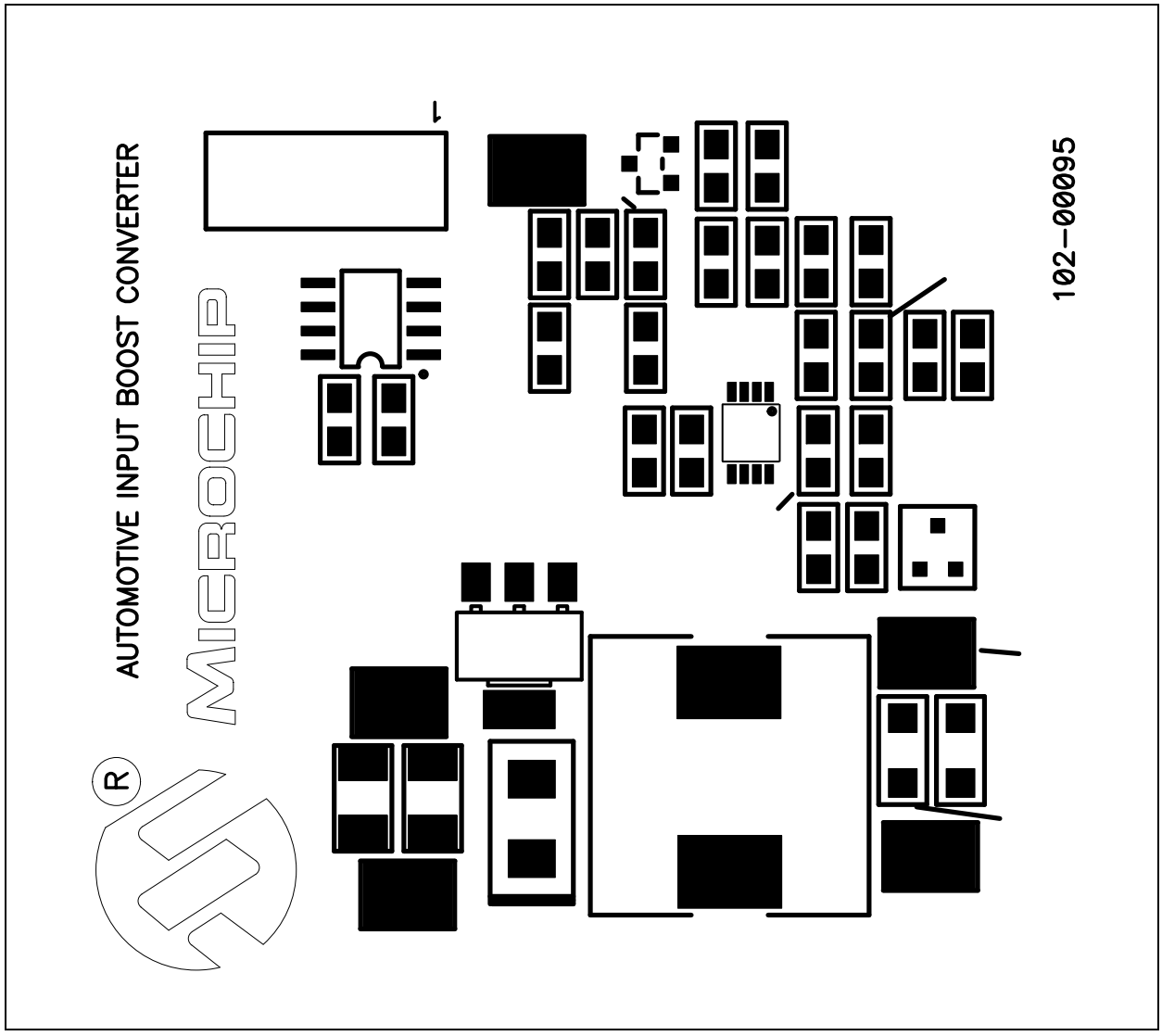
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A.2 BOARD – SCHEMATIC

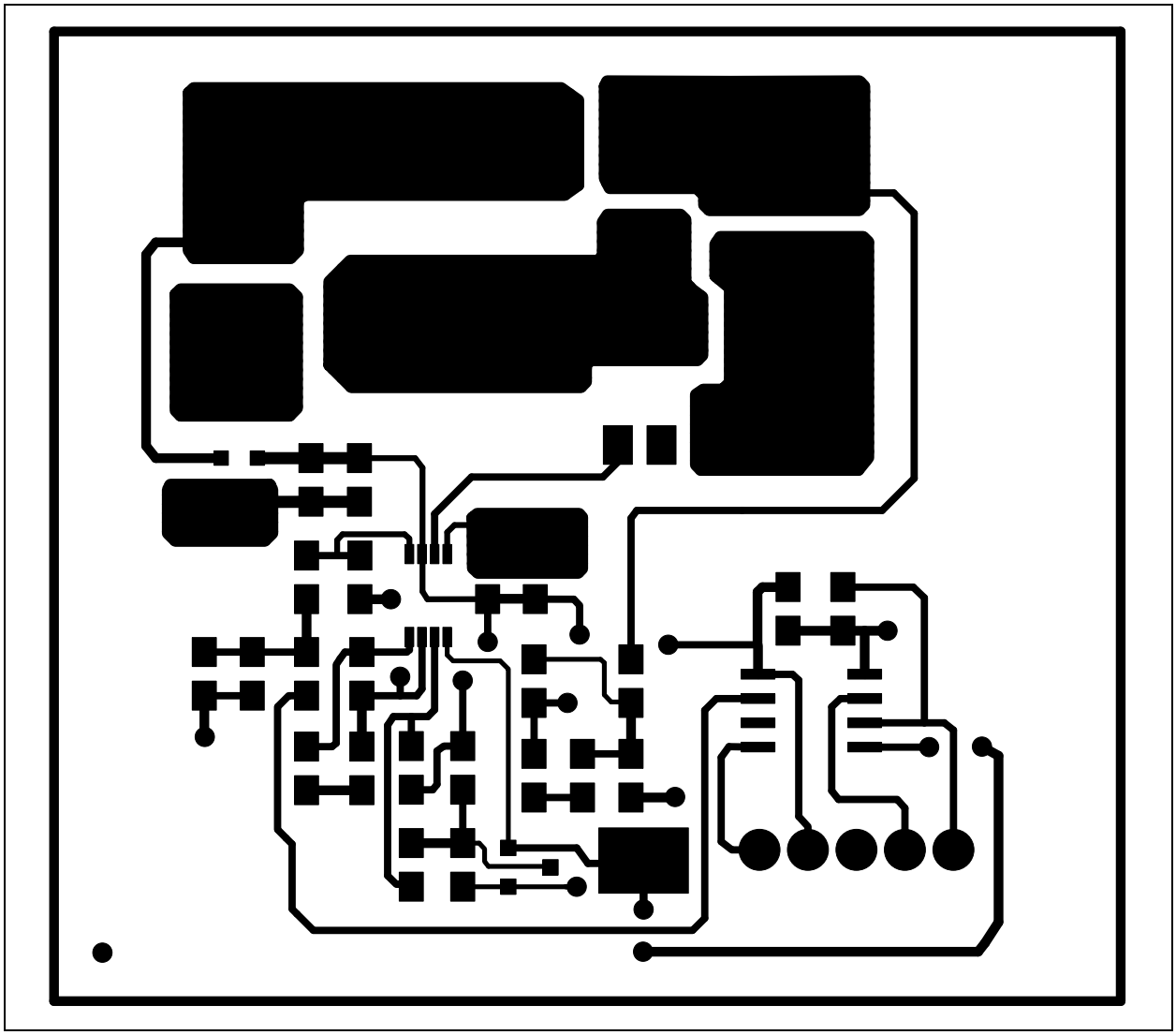


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A.3 BOARD – TOP SILK LAYER

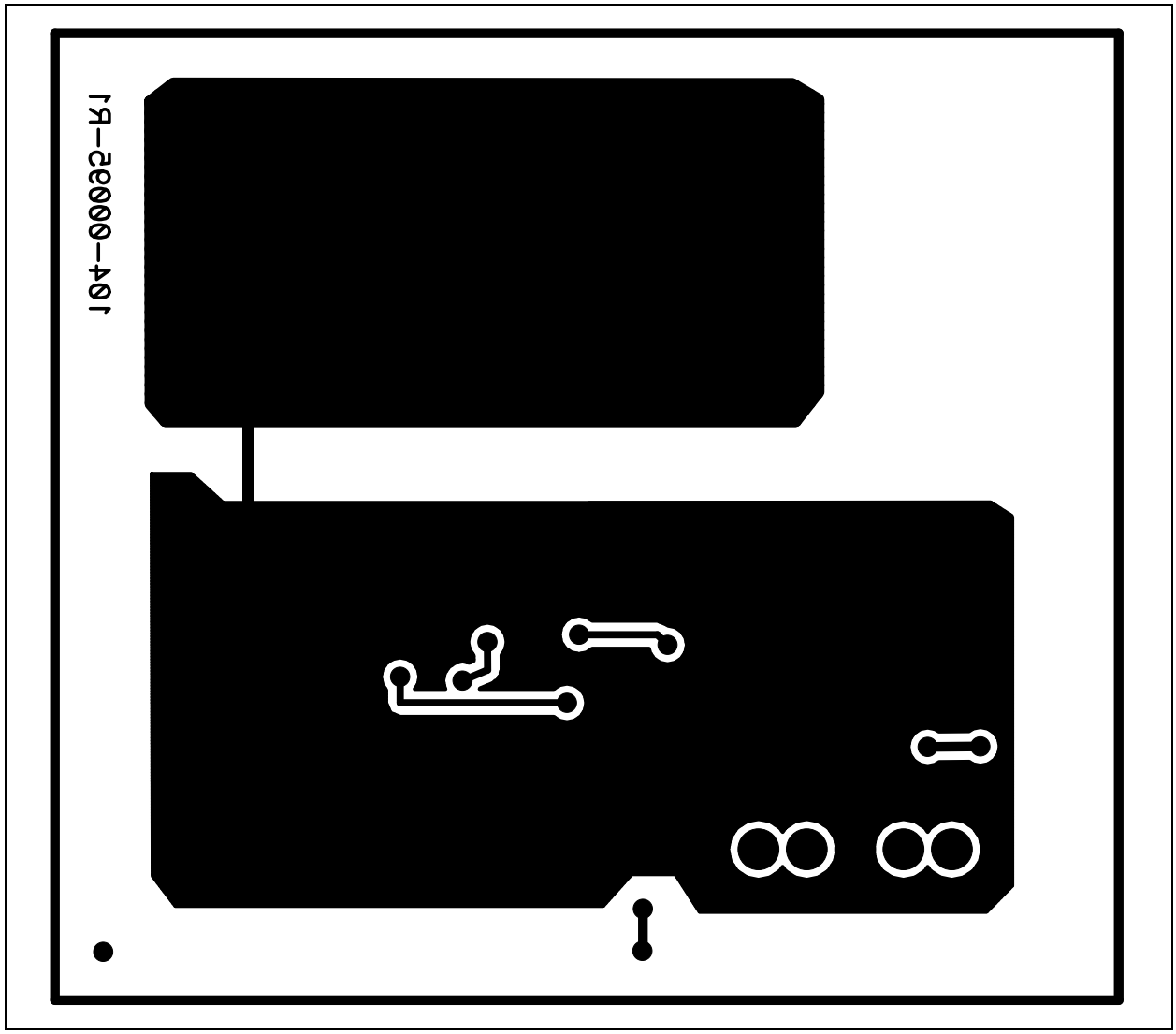


A.4 BOARD – TOP METAL LAYER



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A.5 BOARD – BOTTOM METAL LAYER



NOTES:

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Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
2	C1, C2	Cap 4.7uF 25V Ceramic X5R 1206	Panasonic® - ECG	ECJ-3YB1E475M
5	C3, C4, C5, C10, C11	Cap 0.1uF 16V Ceramic X7R 0805	Panasonic - ECG	ECJ-2VB1C104K
2	C6, C7	Cap 1uF 16V Ceramic X7R 0805	Panasonic - ECG	ECJ-2FB1C105K
1	C8	Cap 1500pF 100V Ceramic X7R 0805	Panasonic - ECG	ECJ-2VB2A152K
1	C9	Cap 1000pF 50V Cerm Chip 0805	Panasonic - ECG	ECJ-2VC1H102J
2	C12, C13	Cap Cer 4.7uF 50V 10% X7R 1210	Murata	GRM32ER71H475KA88L
1	C14	Cap 470pF 50V Cerm Chip 0805 SMD	Panasonic - ECG	ECJ-2VC1H471J
1	C15	Cap 22pF 50V Cerm Chip 0805 SMD	Panasonic - ECG	ECJ-2VC1H220J
1	D1	Diode Schottky 60V 1A SMB	International Rectifier	10BQ060
1	J1	Conn Header 5 Pos.100 Vert Tin	Molex	22-03-2051
1	L1	Inductor Shielded Drum Power 15uH SMD	Coiltronics	DR125-150-R
1	Q1	MOSFET N-CH 55V 3.1A SOT-23	International Rectifier	IRLL024N
1	Q2	MOSFET N-CH 60V 280mA SOT-33	Fairchild Semiconductor®	NDS7002A
1	R1	Res 2.00K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF2001V
1	R2	Res 10.0K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF10R0V
1	R3	Not Used	—	—
1	R4	Res 80.6K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF8062V
2	R5, R6	Res 100K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1003V
1	R7	Res 49.9K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4992V
1	R8	Res 47.5K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4752V
1	R9	Res 34.0K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF3402V
1	R10	Res 2.49K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF2491V
1	R11	Res 3.40K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF3401V
1	R12	Res 165K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF1653V
5	TP1,TP2, TP3,TP4, TP5	PC Test point compact SMT	Keystone Electronics®	5016
1	U1	IC 5.0 100 mA LDO Vreg SOT23	National Semiconductor®	LM3480IM3-5.0
1	U2	IC MCU Flash 2KX14 8SOIC	Microchip Technology Inc	PIC12F683-I/SN
1	U3	IC PWM HS MCU-Adaptable 8MSOP	Microchip Technology Inc	MCP1630V-E/MS

Note 1: 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.

NOTES:

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Appendix C. Demo Board Firmware

C.1 DEVICE FIRMWARE

For the latest copy of the MCP1630 Automotive Input Boost Converter Demo Board User's Guide firmware, visit our web site at www.microchip.com

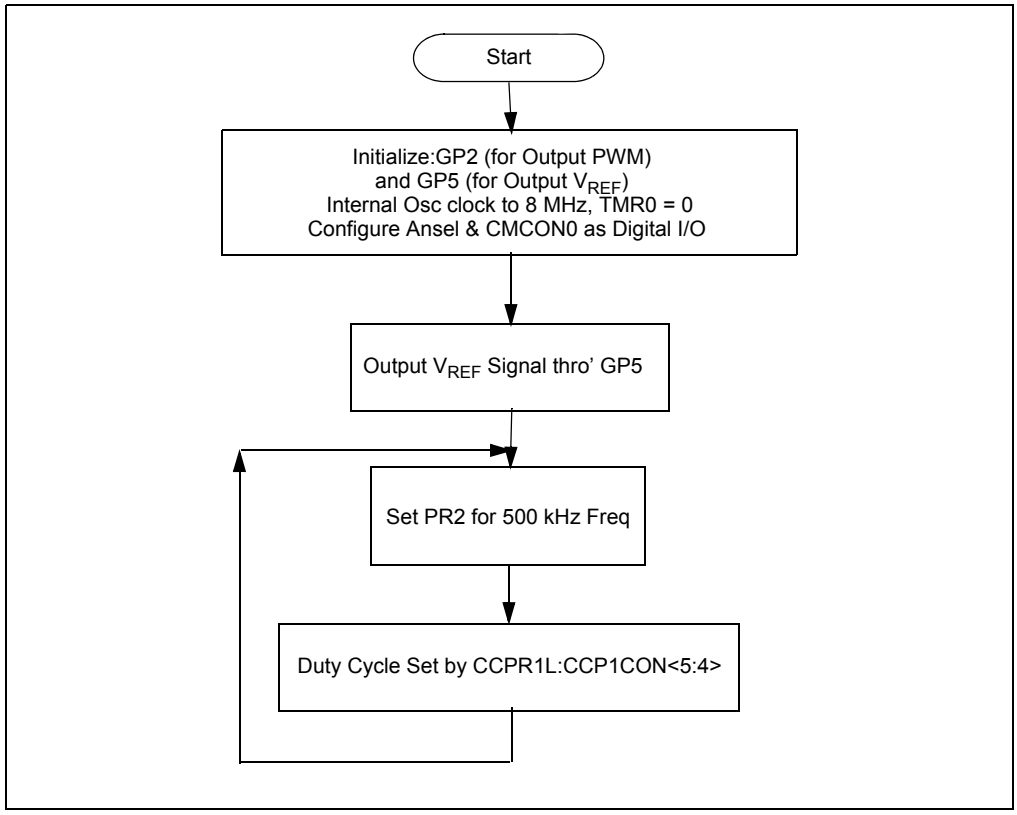


FIGURE C-1: *Firmware Flowchart.*

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