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TC1303 DFN Adjustable Output Demo Board User's Guide

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TC1303 DFN ADJUSTABLE OUTPUT 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 TC1303 DFN Adjustable Output 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 TC1303 DFN Adjustable Output Demo Board . The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the TC1303 DFN Adjustable Output 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 TC1303 DFN Adjustable Output Demo Board .
- **Appendix B. "Bill Of Materials (BOM)"** – Lists the parts used to build the TC1303 DFN Adjustable Output Demo Board .

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 TC1303 DFN Adjustable Output Demo Board. The following Microchip documents are available and recommended as supplemental reference resources.

TC1303A/TC1303B/TC1303C Data Sheet, *"500mA Synchronous Buck Regulator, + 300mA LDO with Power-Good Output"* (DS21949)

This data sheet provides detailed information regarding the TC1303 product family.

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
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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 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

DOCUMENT REVISION HISTORY

Revision A (July 2006)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

Step-down-converter choices include a variety of linear and switching regulators. The TC1303C Adjustable Output Regulator provides a unique combination of a 500 mA synchronous buck regulator and 300 mA Low-Dropout Regulator (LDO) with a Power-Good (PG) monitor to provide a highly integrated solution of dual supply applications for devices like Cellular Phones, Portable Computers, USB-Powered Devices, Hand Held instruments, etc. The device provides a very cost-effective solution with minimal board space because of the high-frequency operation of the buck converter, which reduces the size requirements of the external inductor and capacitor, the minimal external component requirement by the LDO and the small DFN (dual flat no leads) package size.

The 500 mA synchronous buck regulator switches at a fixed frequency of 2.0 MHz when the load is heavy, providing a low-noise, small-size solution. When the load on the buck output is reduced to light levels, it changes operation to a pulse frequency modulation (PFM) mode to minimize quiescent current drawn from the battery. No intervention is necessary for smooth transition from one mode to another.

The LDO provides a 300 mA auxiliary output that requires a single 1 µF ceramic output capacitor, minimizing board area and cost. Typical dropout voltage for the LDO output is 137 mV for a 200 mA load.

For the TC1303C, the power-good output is based on the regulation of the buck regulator output, the LDO output or the combination of both. Additional protection features include UVLO, overtemperature and overcurrent protection on both outputs.

This chapter covers the following topics.

- What is the TC1303 DFN Adjustable Output Demo Board?
- What the TC1303 DFN Adjustable Output Demo Board Kit includes.

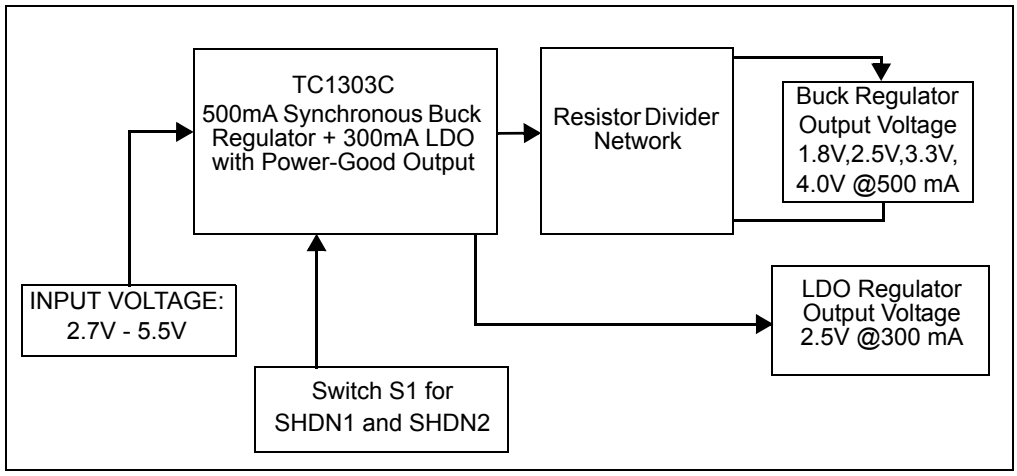


FIGURE 1-1: *TC1303 DFN Adjustable Output Demo Board Block Diagram.*

1.2 WHAT IS THE TC1303 DFN ADJUSTABLE OUTPUT DEMO BOARD?

The TC1303 DFN Adjustable Output demo board demonstrates the use of Microchip's TC1303C device in applications that require dual supply voltage.The demo board is used to evaluate the TC1303C device over the input voltage range, output voltage and current range for both the synchronous buck regulator output and the low dropout linear regulator output.

Test points are provided to monitor the Input voltage, Output voltage, shut down control and power good signal.

1.3 WHAT THE TC1303 DFN ADJUSTABLE OUTPUT DEMO BOARD KIT INCLUDES

This TC1303 DFN Adjustable Output Demo Board kit includes:

- TC1303 DFN Adjustable Output Demo Board (102-00092)
- TC1303 DFN Adjustable Output Demo Board User's Guide (Electronic version on CD-ROM)
- Analog and Interface Products Demonstration Boards CD-ROM (DS21912)

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The TC1303 DFN Adjustable Output Demo Board demonstrates the use of Microchip's TC1303C 500 mA Synchronous Buck Regulator, + 300 mA LDO with Power-Good output device for dual supply voltage applications.

2.2 FEATURES

TheTC1303 DFN Adjustable Output Demo Board has the following features.

- Test points for applying Input voltage (2.7V to 5.5V)
- Using Potentiometer, one can set the Buck regulator output voltage from 1.8V to 4.0V
- Fixed LDO regulator output voltage of 2.5V
- Test points for connecting external loads:
  - Buck regulator Output V_{OUT1} = 0 mA to 500 mA
  - LDO regulator Output V_{OUT2} = 0 mA to 300 mA
- Test points for monitoring:
  - Power-Good Output for both V_{OUT1} and V_{OUT2}
  - Shutdown for V_{OUT1} and Shutdown for V_{OUT2}
  - Feedback voltage
- Switch S1 can used to perform the shutdown operation on V_{OUT1} and V_{OUT2}

2.3 GETTING STARTED

The TC1303 DFN Adjustable Output Demo Board is fully assembled and tested for evaluating the TC1303C device. The board requires the use of an external input voltage source of (2.7V to 5.5V) and maximum external load of 500 mA for buck regulator output and 300 mA for LDO regulator output.

2.3.1 Power Input and Output Connection

2.3.1.1 POWERING THE TC1303 DFN ADJUSTABLE OUTPUT DEMO BOARD

For normal operation, it is necessary to pull up the shutdown pins of TC1303C device, the pull up is provided through switch S1 provided on-board.

1. Apply the Input voltage (2.7V to 5.5V for normal operation) to the board test points to TP1 ($+V_{IN}$) and TP2 (P_{GND}) (refer to Figure 2-1).
2. Connect the buck regulator load (0 mA to 500 mA for normal operation) to the board test points TP3 (V_{OUT1}) and TP4 (P_{GND}).The output voltage can be varied from 1.8V to 4.0V using the potentiometer provided on-board. By turning the potentiometer clockwise or counterclockwise, the voltage can be increased or decreased within the 1.8V to 4.0V range.
3. Connect the LDO regulator load (0 mA to 300 mA for normal operation) to test point TP6 (V_{OUT2}) and TP10 (A_{GND}). The LDO regulator provides a fixed output voltage of 2.5V.

4. The power-good output signal is available on the test point TP5 (PG).
5. The switch S1, position 1 and position 2 are used to determine the $\overline{SHDN1}$ and $\overline{SHDN2}$ modes for the TC1303C device.
6. With switch S1, position 1 pushed to the right, the $\overline{SHDN1}$ pin is pulled up and the output V_{OUT1} of the TC1303C device is enabled. When switch S1, position 1 is to the left, the TC1303C device is in low quiescent current $\overline{SHDN1}$ mode and the output V_{OUT1} is disabled. The signal is available on test point TP8.
7. Similarly with switch S1, position 2 pushed to the right, the $\overline{SHDN2}$ pin is pulled up and the output V_{OUT2} of the TC1303C device is enabled. When switch S1, position 2 is to the left, the TC1303C device is in low quiescent current $\overline{SHDN2}$ mode and the output V_{OUT2} is disabled. The signal is available on test point TP7.

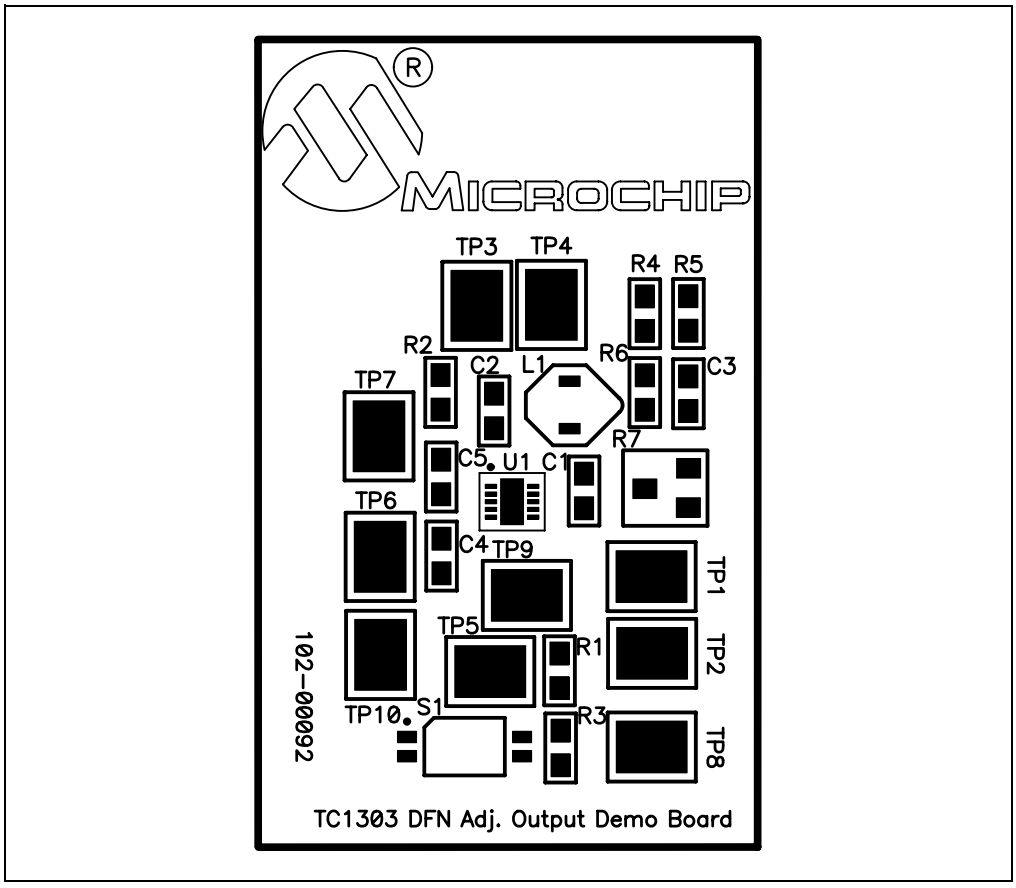


FIGURE 2-1: *Setup Configuration Diagram*

2.3.1.2 APPLYING LOAD TO TC1303 DFN ADJUSTABLE OUTPUT 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 for the buck regulator. To measure the output voltage, connect the common point of multi-meter to TP4 and the positive terminal to TP3. By varying the load one can verify the load regulation by measuring the output voltage over entire load range of 0 mA to 500 mA. Similarly, by varying the line voltage from 2.7V to 5.5V and checking the output voltage, the line regulation can be calculated.

The best way to evaluate the TC1303 DFN Adjustable Output Demo Board is to dig into the circuit. Measure voltages and currents with a DVM and probe the board with an oscilloscope.

Calculating Adjustable Output Voltage

The buck regulator output voltage is adjustable by using two external resistors as a voltage divider. For adjustable-output voltages, it is recommended that the top resistor divider value be 200 kohm. The bottom resistor can be calculated using the following formula.

EQUATION 2-1:

$$R_{BOT} = R_{TOP} \times \left(\frac{V_{FB}}{V_{OUT1} - V_{FB}} \right)$$

Where:

R_{TOP} = Top resistor (200 kohm)
V_{OUT1} = Output Voltage
V_{FB} = 0.8V
R_{BOT} = Bottom resistor

Example

For setting the output voltage to 3.2V.

EQUATION 2-2:

$$R_{BOT} = 200\ kohm \times \left(\frac{0.8V}{3.2V - 0.8V} \right)$$

$$= 66.66\ kohm$$

Where:

R_{TOP} = 200 kohm
V_{OUT1} = 3.2V
V_{FB} = 0.8V

The R_{BOT} resistor can be set using the potentiometer (R7) provided on board so as to provide an output voltage of 3.2V.

NOTES:

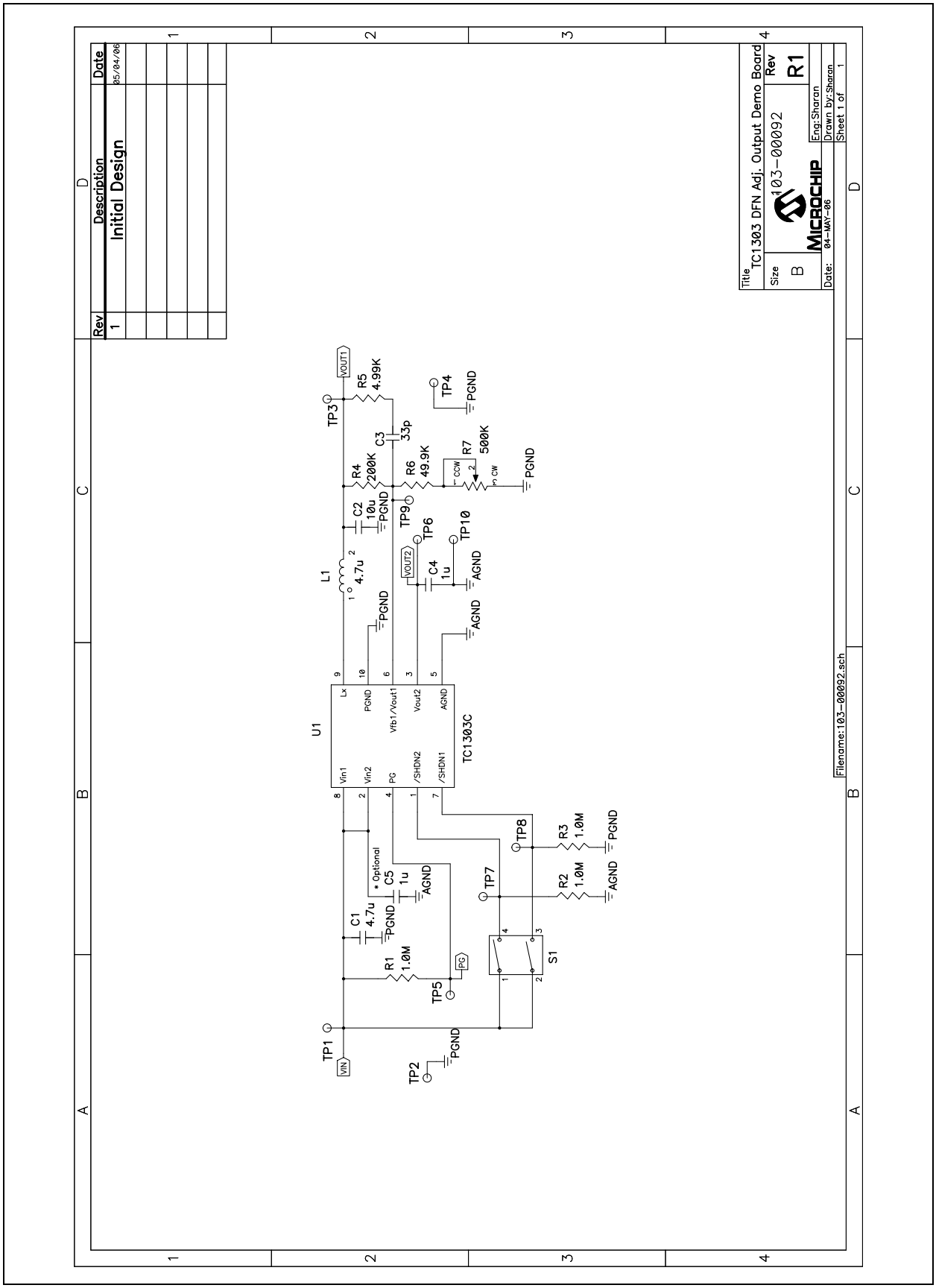
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

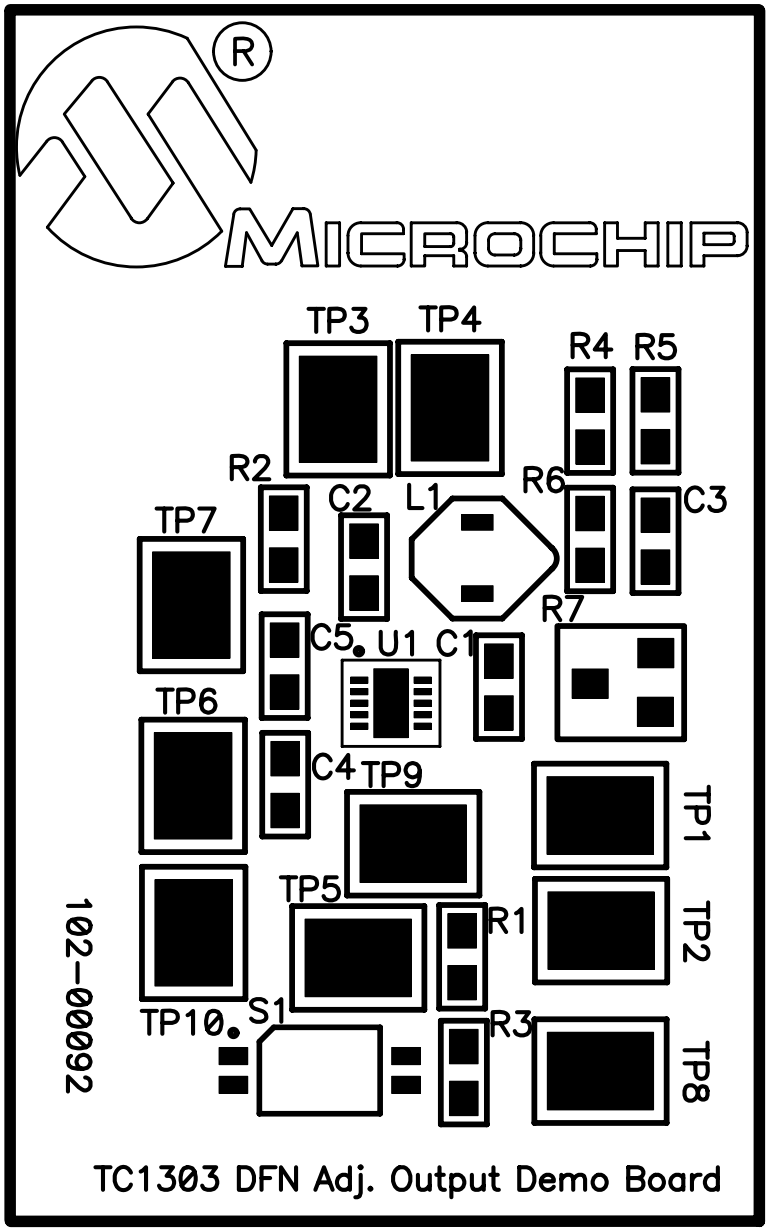
This appendix contains the following schematics and layouts for the TC1303 DFN Adjustable Output Demo board:

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

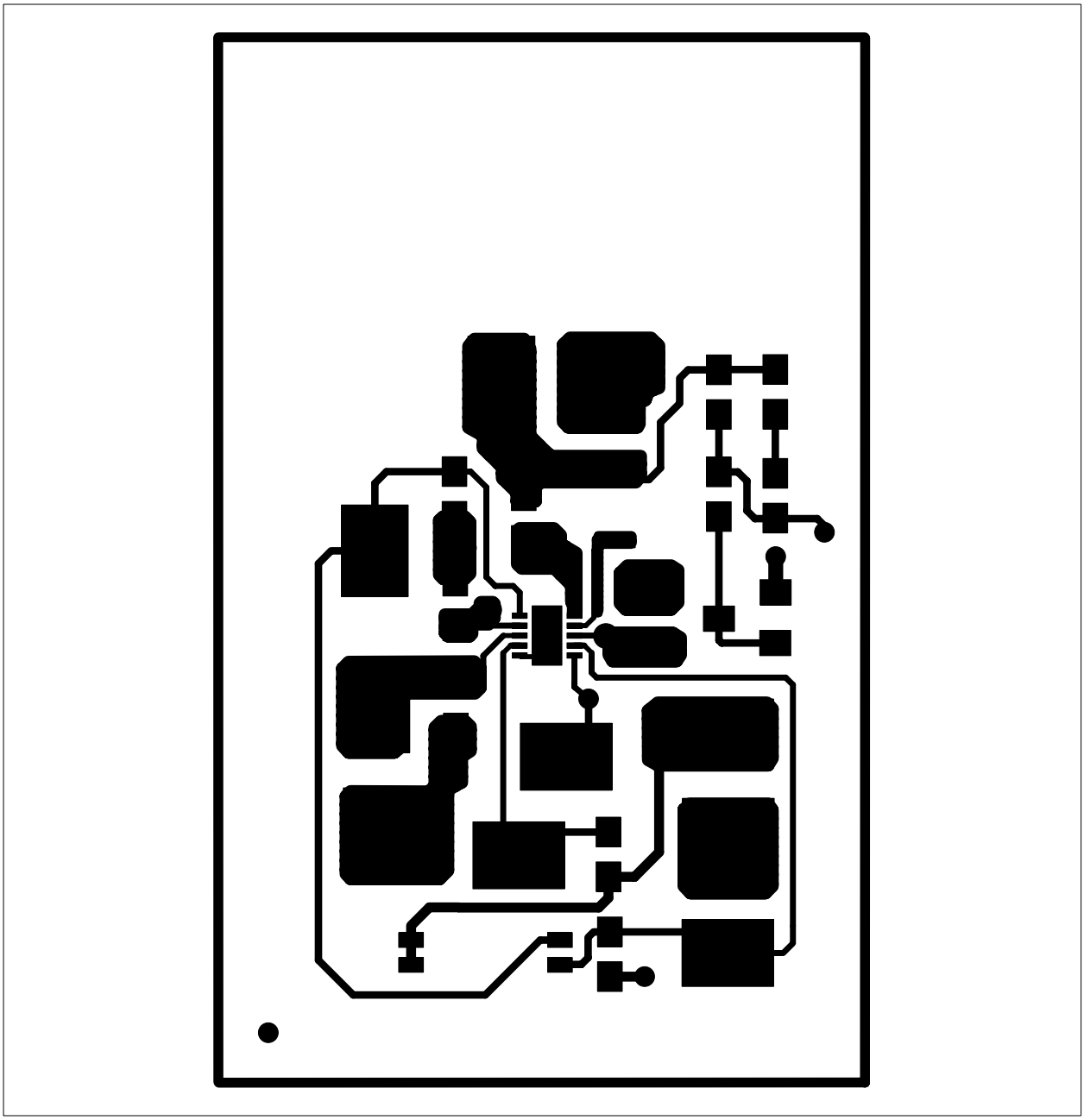
A.2 BOARD – SCHEMATIC



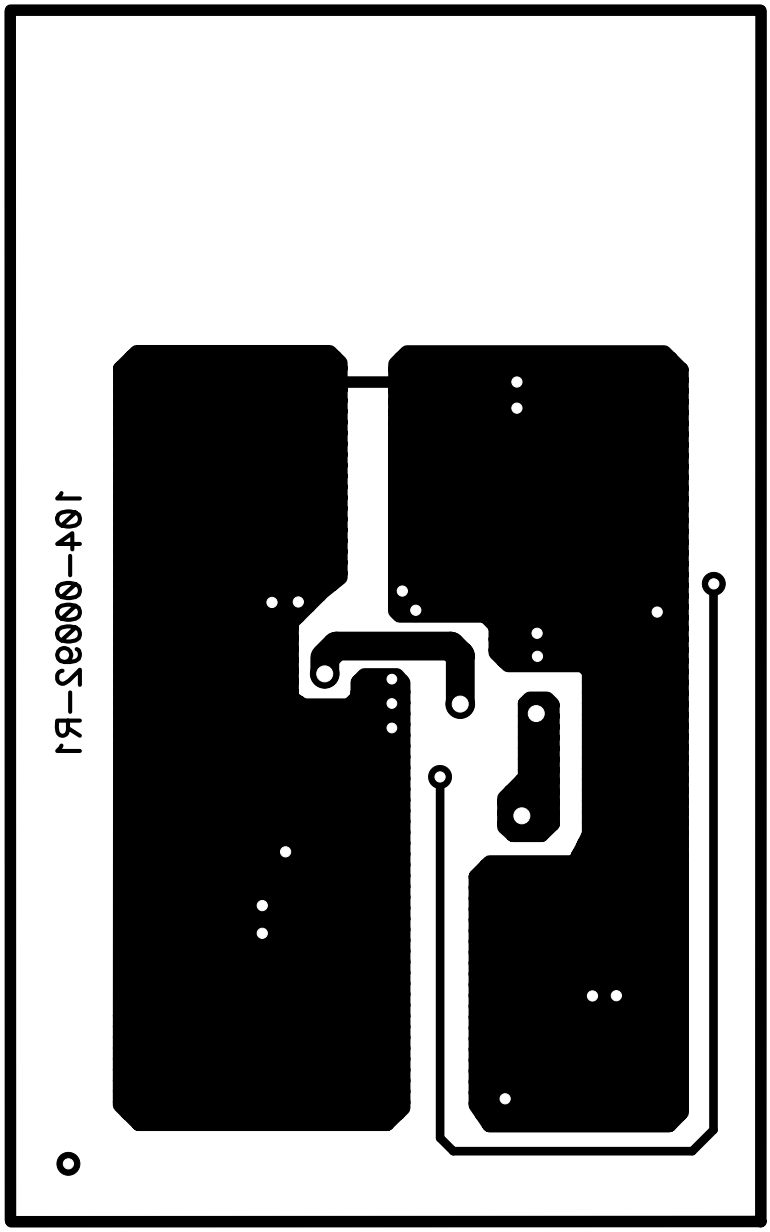
A.3 BOARD – TOP SILK SCREEN LAYER



A.4 BOARD – TOP METAL LAYER



A.5 BOARD – BOTTOM METAL LAYER



NOTES:

Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS (BOM)

QTY	Reference	Description	Manufacturer	Part Number
1	C1	Cap Ceramic 4.7µF 6.3V X5R 0805	Panasonic® - ECG	ECJ-2FB0J475K
1	C2	Cap 10uF 6.3V Ceramic X5R 0805	Panasonic - ECG	ECJ-2FB0J106M
1	C3	Cap 33pF 50V Cerm Chip 0805 SMD	Panasonic - ECG	ECJ-2VC1H330J
2	C4,C5	Cap 1uF 16V Ceramic 0805 X5R	Panasonic - ECG	ECJ-2FB1C105K
1	L1	Inductor power shield 4.7µH	Coiltronics/Div of Cooper/Bussmann	SD3118-4R7-R
3	R1, R2, R3	Res 1.0M Ohm 1/8W 5% 0805 SMD	Panasonic - ECG	ERJ-6GEYJ105V
1	R4	Res 200K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF2003V
1	R5	Res 4.99K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4991V
1	R6	Res 49.9K Ohm 1/8W 1% 0805 SMD	Panasonic - ECG	ERJ-6ENF4992V
1	R7	Trimpot 500K Ohm 11 Trn 5mm Top	Murata Electronics® North America	PVG5A504C01R00
1	S1	Switch Dip 2 Pos half pitch SMT	ITT Industries / C&K Div	TDA02H0SK1
10	TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10	PC Test point compact SMT	Keystone® Electronics	5016
1	U1	IC PWM 500mA/ LDO 300mA 10 DFN	Microchip Technology Inc	TC1303C-ZI0EMF

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