MCP8063
12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board User's Guide

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ISBN: 978-1-63276-036-4

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Signed for and on behalf of Microchip Technology Inc. at Chandler, Arizona, USA

Derek Carlson
VP Development Tools

16-July-2013
Date

NOTES:

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Preface

NOTICE TO CUSTOMERS

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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 online help. Select the Help menu, and then Topics to open a list of available online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration 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 MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board as an evaluation tool to debug on a target motor system. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.
- **Appendix A. "Schematics and Layouts"** – Shows the schematic and layout diagrams for the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.
- **Appendix B. "Bill of Materials"** – Lists the parts used to build the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration 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
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}`
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 MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board. Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MCP8063 Data Sheet** – ***"3-Phase Brushless DC Sinusoidal Sensorless Motor Driver"*** **(DS20005257)**

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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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- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

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

DOCUMENT REVISION HISTORY

Revision A (March 2014)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board allows the control and monitoring of Microchip 12V fan driver devices, such as the MCP8063 or MTD6501, using a PC software connected to the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board via a USB connection.

The MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board software provides several features, such as fan driver power supply control and monitoring, pulse-width modulation (PWM) control, and speed and current consumption monitoring. It also allows automatic application testing.

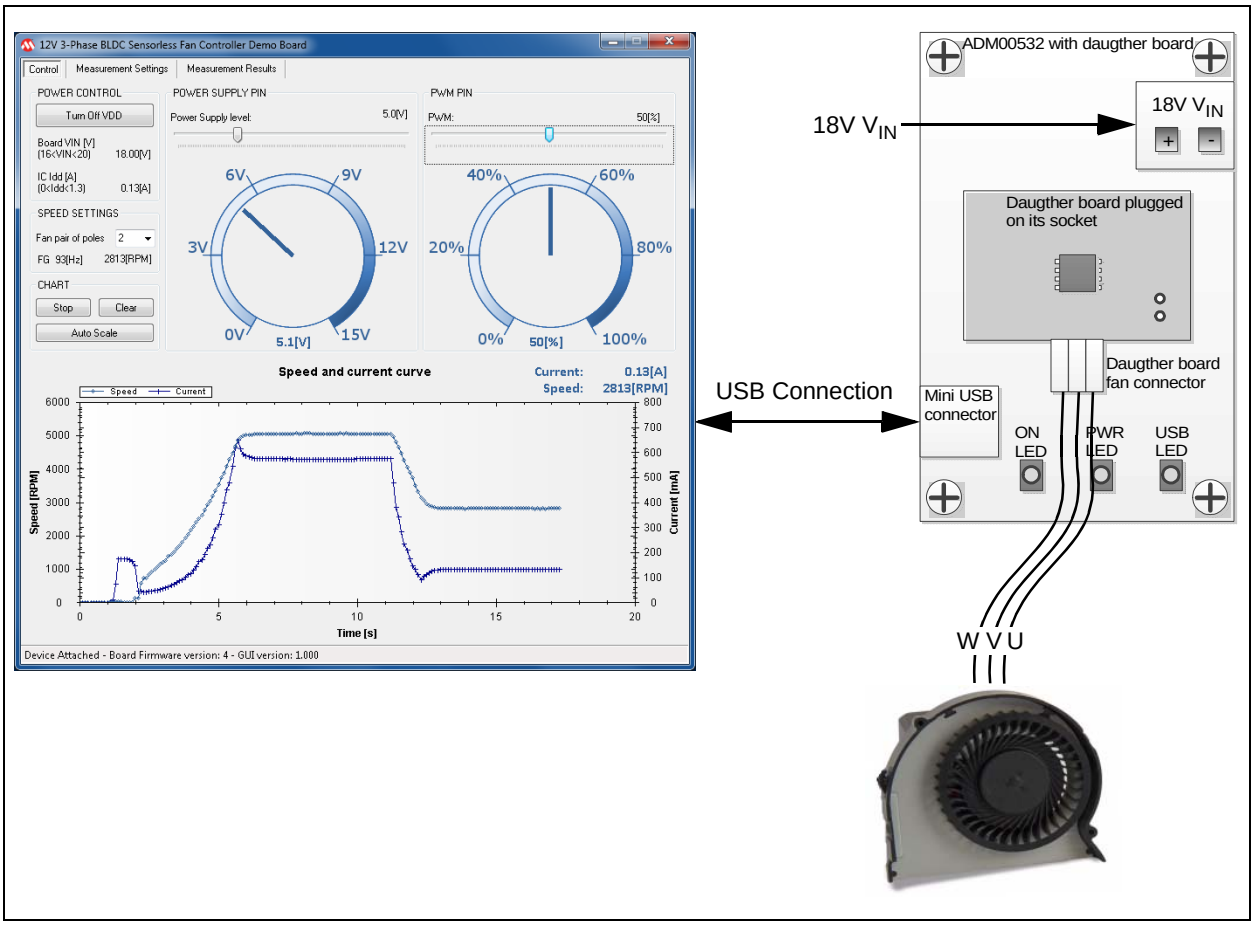


FIGURE 1-1: *System Overview.*

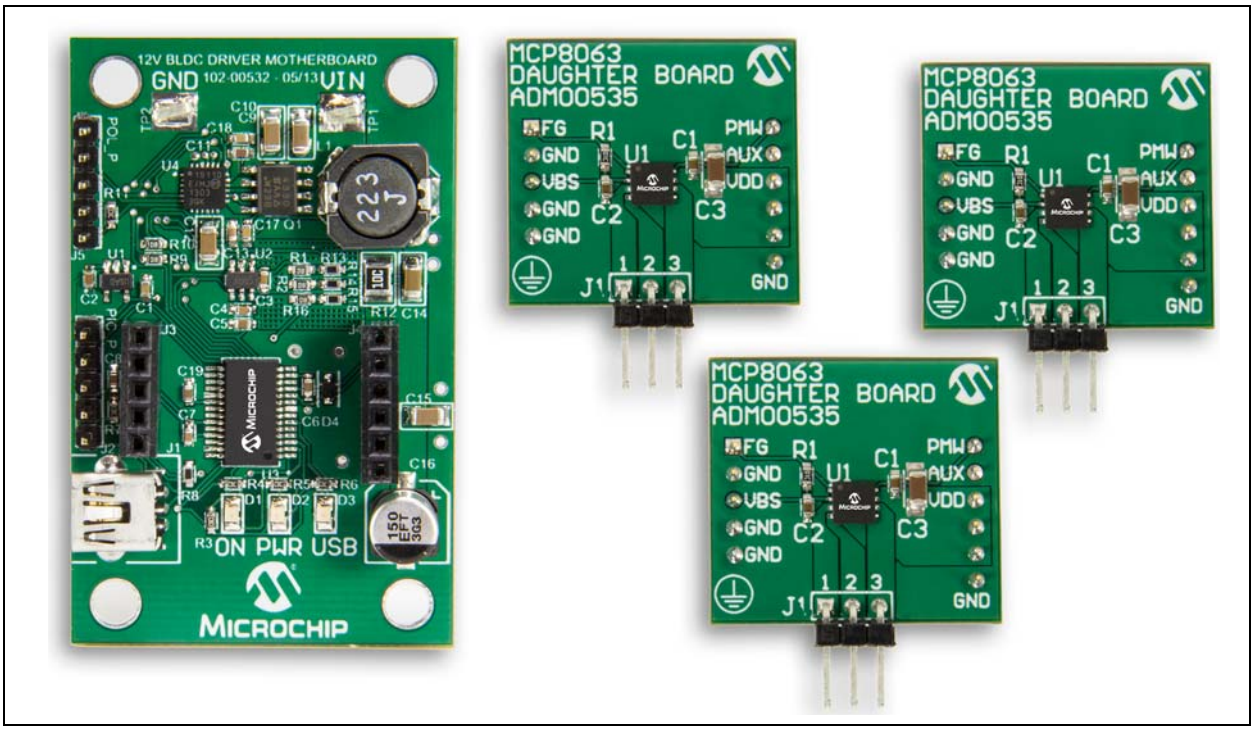


FIGURE 1-2: *MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board Overview.*

MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board Hardware description

The MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board contains several components, such as:

- -PIC24FJ64GB002 microcontroller for USB connection, PWM generation, FG frequency measurement, V_{DD} measurement, activation of other signals and component communication
- -MCP1824 LDO regulator to provide 3.3V to the microcontroller
- -MCP19110 buck regulator to provide power supply to the fan driver
- -MCP3421 Delta-Sigma ADC for sensing the fan driver current consumption

More details on the schematic are available in **Appendix A. "Schematics and Layouts".**

1.2 WHAT THE MCP8063 12V 3-PHASE BLDC SENSORLESS FAN CONTROLLER DEMONSTRATION BOARD KIT INCLUDES

The MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board includes:

- MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board (ADM00532)
- 3 x MCP8063 daughter boards (ADM00535)
- A mini-USB cable
- Important Information Sheet

Chapter 2. Installation and Operation

2.1 GETTING STARTED

The following sections describe how to use the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.

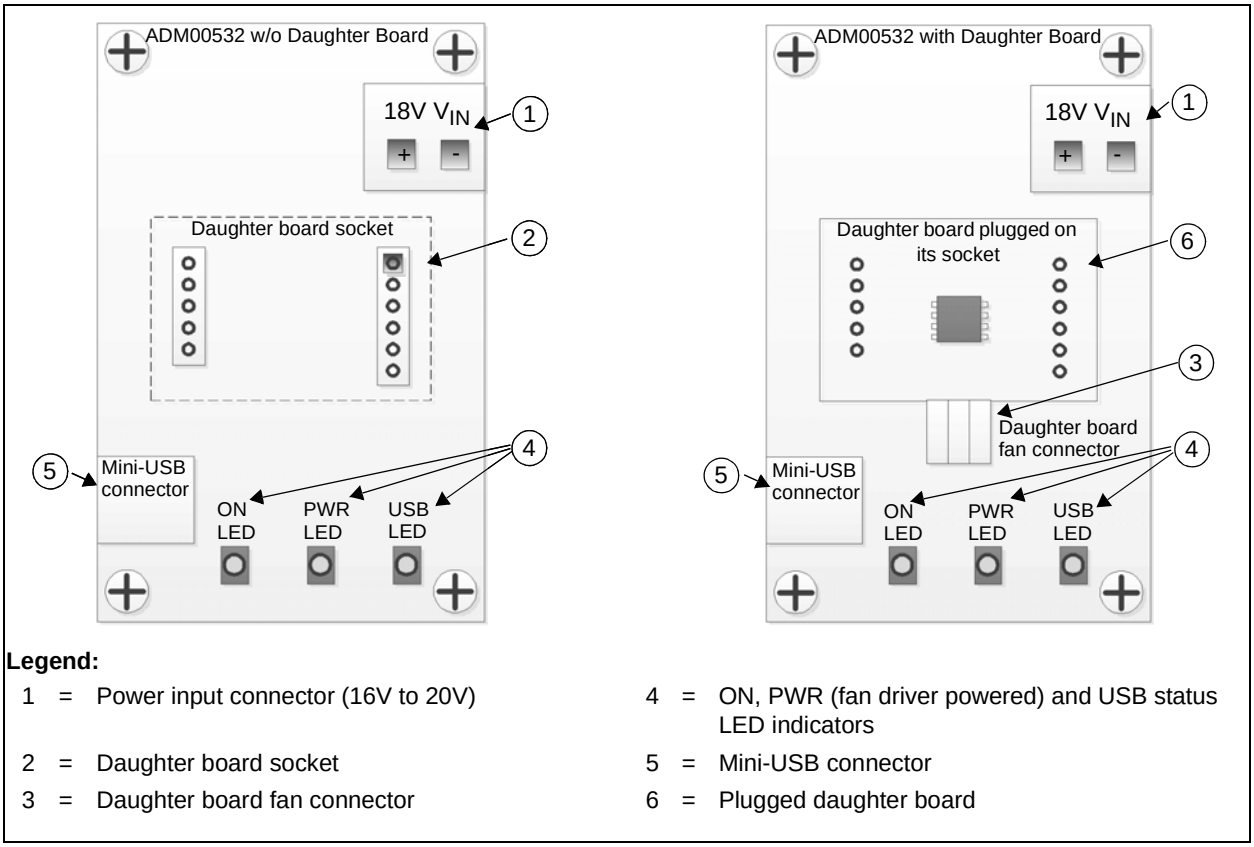
2.1.1 Software Installation

Download the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board software installer from the board web page. The GUI can also be downloaded from this web page.

Note:	This application requires Microsoft .NET Framework 3.5 or later.

2.1.2 Board Installation

Figure 2-1 identifies the required points for using the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.



Legend:

1 = Power input connector (16V to 20V)
2 = Daughter board socket
3 = Daughter board fan connector
4 = ON, PWR (fan driver powered) and USB status LED indicators
5 = Mini-USB connector
6 = Plugged daughter board

FIGURE 2-1: *Top View - Hardware Components.*

To use the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board, follow these steps:

1. Plug in a daughter board on its socket (see Figure 2-1).
2. To plug in a 3-phase BLDC sensorless fan, use the daughter board fan connector. Note that the connection can be done in normal or reverse mode. If the fan rotates in reverse mode, the connector can be flipped to rotate in normal mode.
3. Start the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board software.
4. Plug the mini-USB cable from the USB port of a computer to the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board connector. The ON LED should light up.
5. If required, let the computer identify the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board. The USB LED should light up once if the USB connection is ready.
6. Restart the computer, if required.
7. Connect the power supply to the V_{IN} test point. V_{IN} value is 18V ±10%. The power supply should be able to deliver up to 1.0A. The GUI should report the V_{IN} value of the board.

Note: The order of these steps is provided as an example and can be changed.

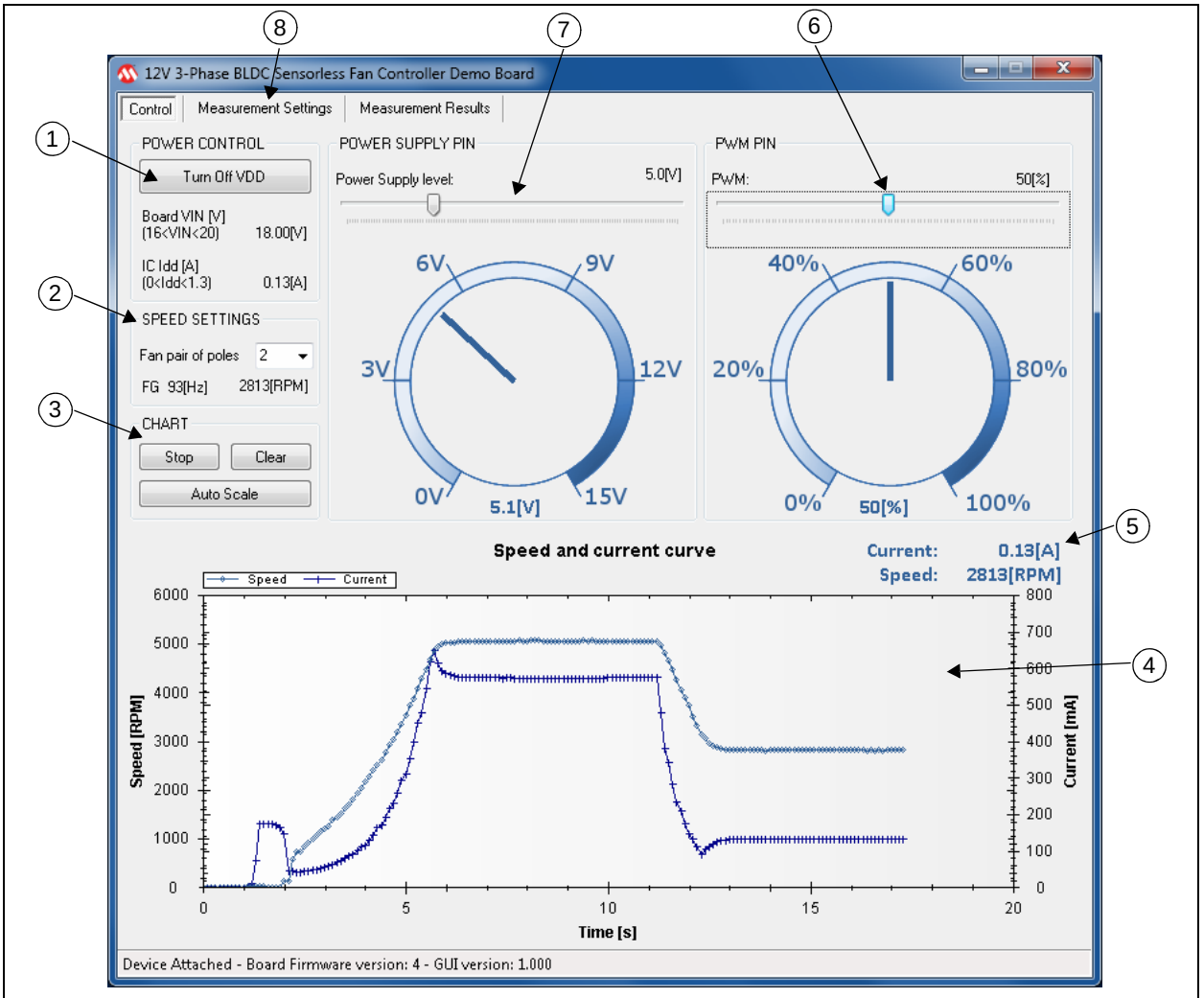
2.2 MCP8063 12V 3-PHASE BLDC SENSORLESS FAN CONTROLLER DEMONSTRATION BOARD SOFTWARE DESCRIPTION

The MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board software window contains three tabs. The first tab is for controlling and monitoring the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board, the second tab is the **Measurement Settings** tab and the third tab is the **Measurement Results** tab.

2.2.1 Control Tab

Figure 2-2 shows the options and functions available to control and monitor the board.

Note: All functions presented in Figure 2-2 are enabled only when the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board is connected to the PC via a USB connection.



Legend:

1	=	Power Control group box	5	=	Instant current and speed measurement
2	=	Speed Settings group box	6	=	PWM duty cycle signal control
3	=	Chart group box	7	=	Fan driver power supply level control
4	=	Current and speed chart display	8	=	Buttons for access to other tabs

FIGURE 2-2: *GUI – Control Tab.*

2.2.1.1 POWER CONTROL

The Power Control group box contains the **Turn On/Off VDD** button which allows the power supply of the fan driver to be enabled/disabled.

Before enabling the fan driver power, verify the input voltage level indicated for the board. It should be between 16V to 20V. Running outside this range may work, but stability cannot be guaranteed. The power supply part on the board is not able to generate a voltage level above the input voltage level.

The current is monitored and the fan driver power supply will shut down if the current goes above 2.5A.

2.2.1.2 SPEED SETTINGS

This group box allows monitoring the FG pin frequency from the fan driver in hertz. This frequency is converted to mechanical speed (Revolutions Per Minute - RPM) by considering the plugged fan is a 4P/6S fan (two pairs of poles). If the plugged motor contains a different number of poles, the value can be adapted in order to display the correct mechanical RPM.

2.2.1.3 CHART

This part allows controlling the chart described in **Section 2.2.1.4 "Display Chart"**. The chart adds 10 values per second. The three buttons have the following functions:

- **Start/Stop** – Allows the value acquisition to start or stop
- **Clear** – Removes all the values added to the chart
- **Auto Scale** – Allows the default scaling to be restored. In Default Scaling mode, the chart will automatically adjust the scaling to ensure the complete view of all the added values. In addition, when selecting a part of the chart with the mouse, it is possible to zoom in the selection. The mouse wheel zoom in/out is also enabled.

2.2.1.4 DISPLAY CHART

Once enabled, the chart will display the speed curve in RPM and the measured current curve in mA over time. The chart adds 10 values per second.

2.2.1.5 CURRENT AND SPEED INDICATOR

This part clearly shows the instant current consumption and the instant speed.

2.2.1.6 PWM PIN

The PWM Pin box provides a slide bar to set the PWM duty cycle on the fan driver PWM pin. The gauge below indicates the PWM duty cycle currently applied by the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.

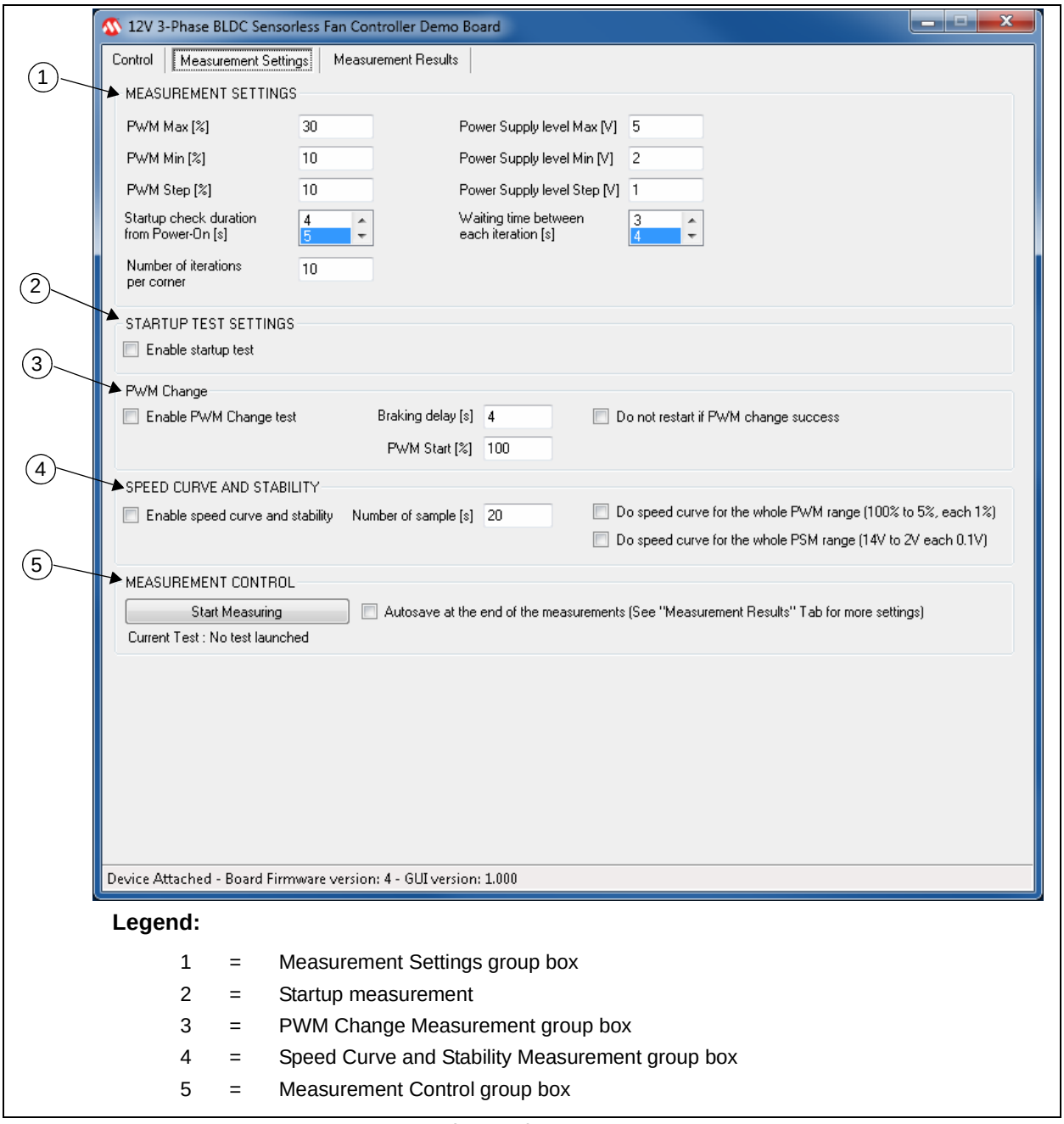
2.2.1.7 FAN DRIVER POWER SUPPLY LEVEL CONTROL

The fan driver Power Supply Pin box also provides a slide bar to set the desired voltage value for the fan driver. The gauge below indicates the instant fan driver power supply value measured by the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board.

2.2.2 Measurement Settings Tab

The **Measurement Settings** tab is used to check if the fan is correctly adapted to the fan driver by testing the fan behavior in different tests, several times, under different conditions.

Figure 2-3 shows the **Measurement Settings** tab. See the sections below for further details.



Legend:

1	=	Measurement Settings group box
2	=	Startup measurement
3	=	PWM Change Measurement group box
4	=	Speed Curve and Stability Measurement group box
5	=	Measurement Control group box

FIGURE 2-3: *GUI - Measurement Settings Tab.*

2.2.2.1 MEASUREMENT SETTINGS

The **Measurement Settings** Group box is used to specify the measurement corners required. Once the automatic measurement starts (see **2.2.2.5 "Measurement Control"**), all specified corners will be tested for all selected tests. The list below details the available corner settings:

- **PWM Corners Measurement** – Requires the PWM Max (%), PWM Step (%) and PWM Min (%) values setting. The software will start with the maximum value entered, and will decrease the PWM by the step value until it reaches the minimum entered PWM value.
- **Power Supply level corners** are similar to the PWM corners. A power supply level corner includes all PWM corners. This means that all PWM corners are measured for one power supply voltage level.
- **Startup check duration from Power-On [s]** – If the speed of the fan is measured as 0 RPM after this delay, the startup is considered a fail. The recommended value for this field is 5s.
- **Waiting time between each iteration [s]** – Specifies how many seconds are allocated to stop the fan between two tests. This value will depend on the fan lag.
- **Number of iterations per corner** – Number of iterations for one corner.

2.2.2.2 STARTUP TEST SETTINGS

When the **Enable startup test** box is checked, the startup measurements are enabled, measuring every corner for this test. If **Enable startup test** is not enabled, the startup test is skipped. The other tests will be executed if they are enabled.

2.2.2.3 PWM CHANGE

The PWM Change measurement starts up with a PWM value of 100%. After the specified startup delay (entered in the **Startup check duration from Power-On [s]** field), the PWM changes depending on the PWM corner specified. The software will then verify if the fan is still running. This last check will occur after a delay value is specified in the **Braking Delay [s]** field.

In order to save time, it is possible to not stop and restart the fan, if the last PWM change has been done successfully by checking the **Do not restart if PWM change success** check box.

2.2.2.4 SPEED CURVE AND STABILITY

This measurement requires a specified number of samples in a specified condition to check speed stability. If the **Do speed curve for the whole PWM range (100% to 5%, each 1%)** and/or the **Do speed curve for the whole PSM range (14V to 2V, each 0.1V)** check boxes are not checked, the corners previously set are measured. For this test, the iterations numbering will always be 1. When one of these check boxes is checked, the software will override the specified settings.

This test will report the current average, the maximum and minimum measured speed, the stability in % and the sigma variation.

2.2.2.5 MEASUREMENT CONTROL

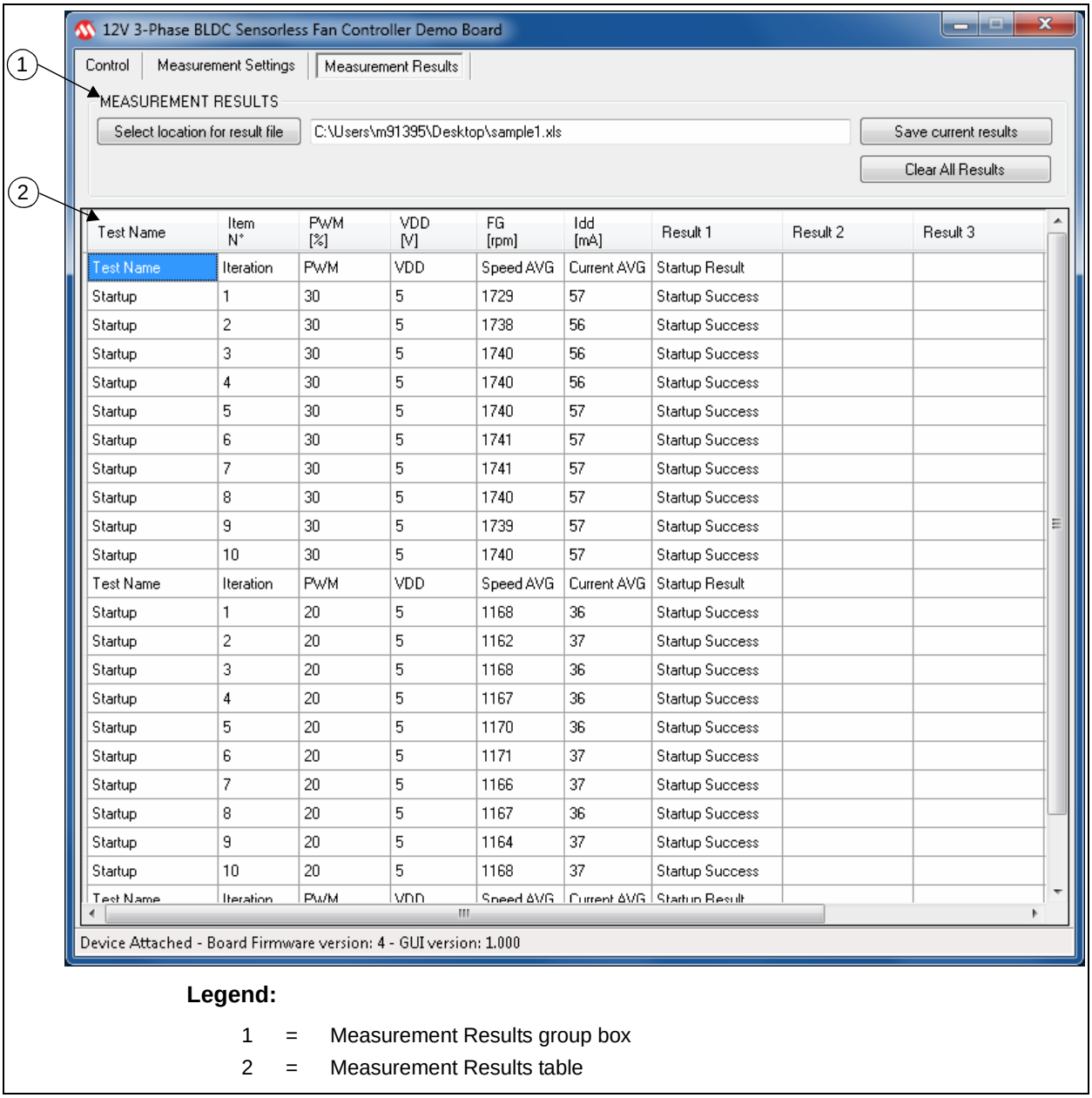
This group box contains a check box and a button that allows the user to control the test work flow:

- **Stop Measuring** – Starts and stops the required measuring
- **Autosave at the end of the measurements** – If checked, a measurement result file will be automatically done when all the tests has been done. See **2.2.3.1 "Measurement Results"** for the file location.

2.2.3 Measurement Results tab

The **Measurement Results** tab is used to check the results of the test and manage where the data will be stored.

Figure 2-4 shows the **Measurement Results** sub-tab:



Legend:

1 = Measurement Results group box

2 = Measurement Results table

FIGURE 2-4: *GUI - Measurement Results Tab.*

2.2.3.1 MEASUREMENT RESULTS

This group box contains three buttons that allow the user to control the result data storage:

- **Select location for result file** – Opens a window allowing the user to specify where the result file will be stored. Please verify that the selected location has write access. In addition, Microsoft® Excel® 2003 or later has to be installed in order for the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board Software to create a Microsoft Excel file. If Microsoft Excel is not installed, it is possible to copy the data from the result table and paste it in an appropriate software.
- **Save current results** – Stores the current measurement displayed in the result table in a Microsoft Excel file.
- **Clear All Results** – Clears the current results from the result table.

2.2.3.2 RESULT TABLE

The results are stored in this table. All the tests have the first six columns in common, while the other columns are significant only for a specific test.

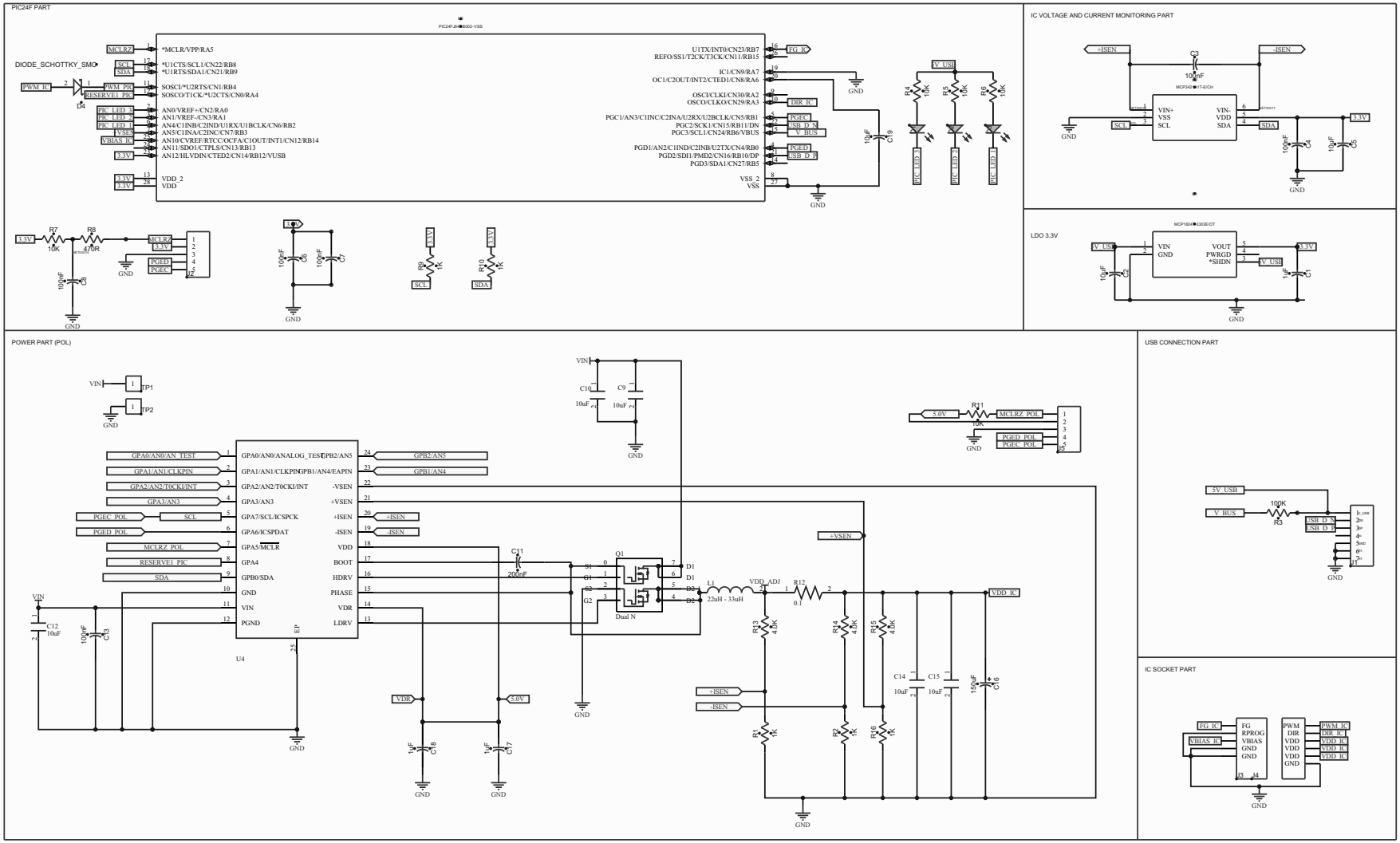
Appendix A. Schematics and Layouts

A.1 INTRODUCTION

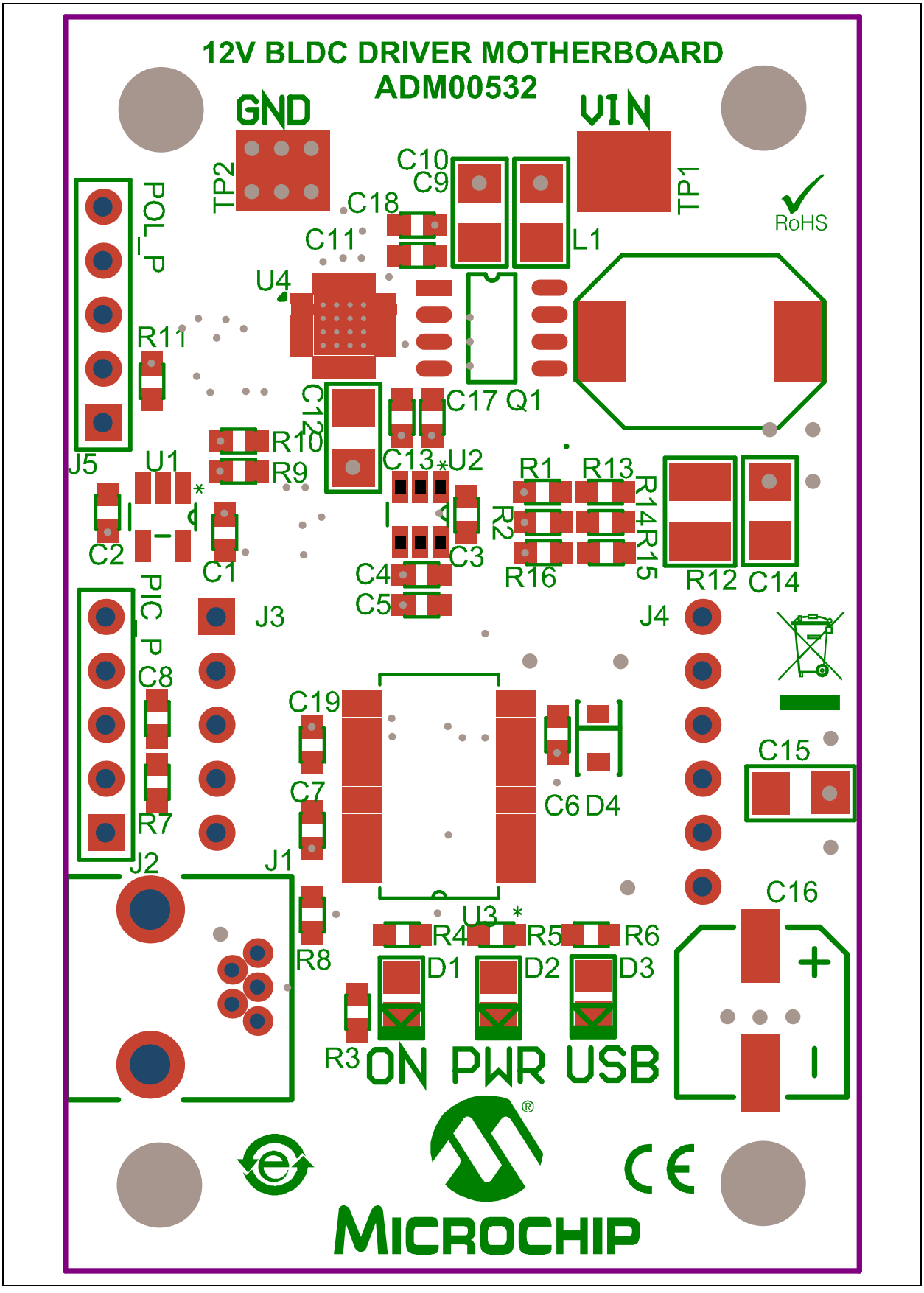
This appendix contains the following schematics and layouts for the MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board:

- Board – Schematic
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silk

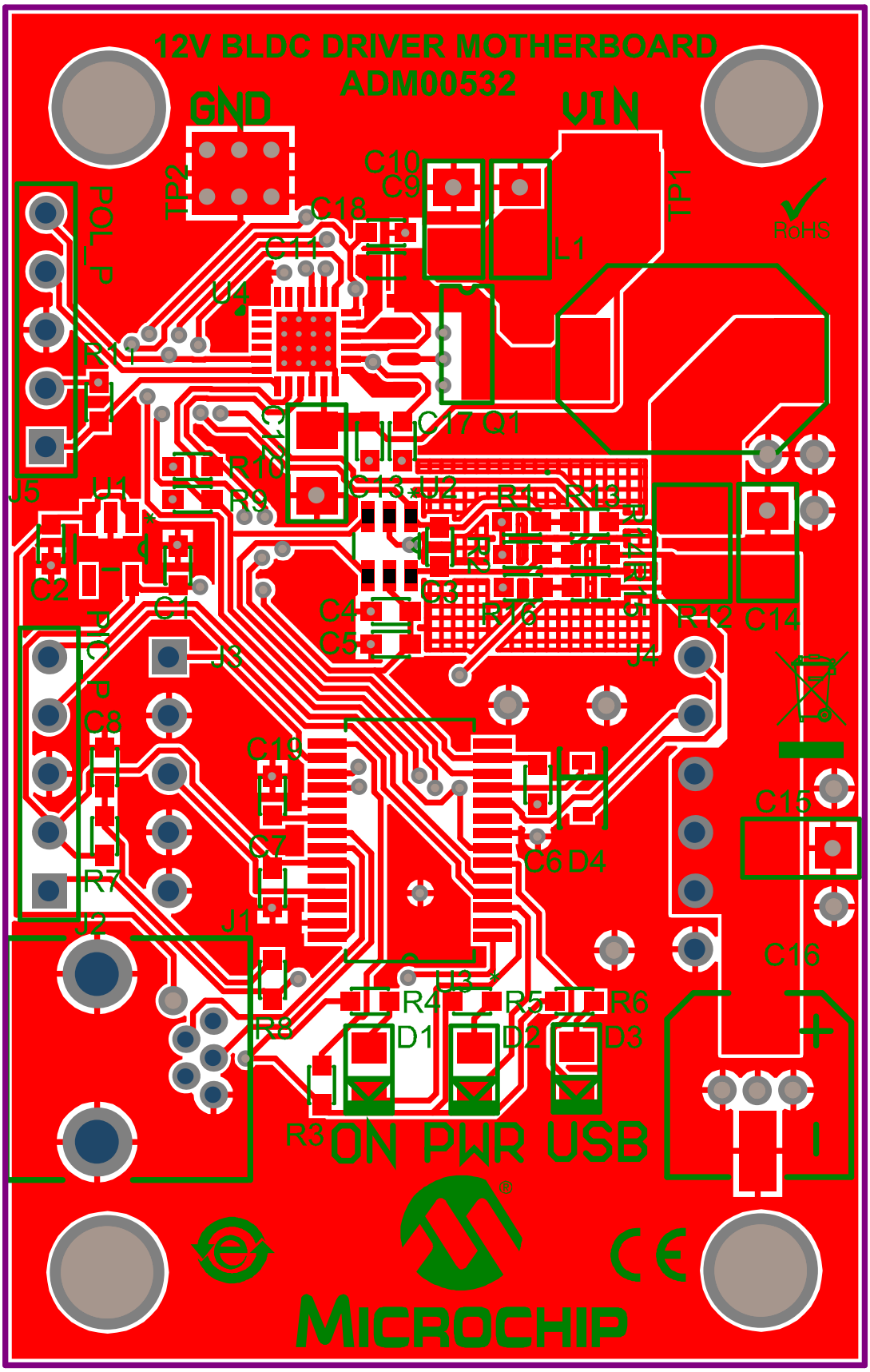
A.2 BOARD – SCHEMATIC



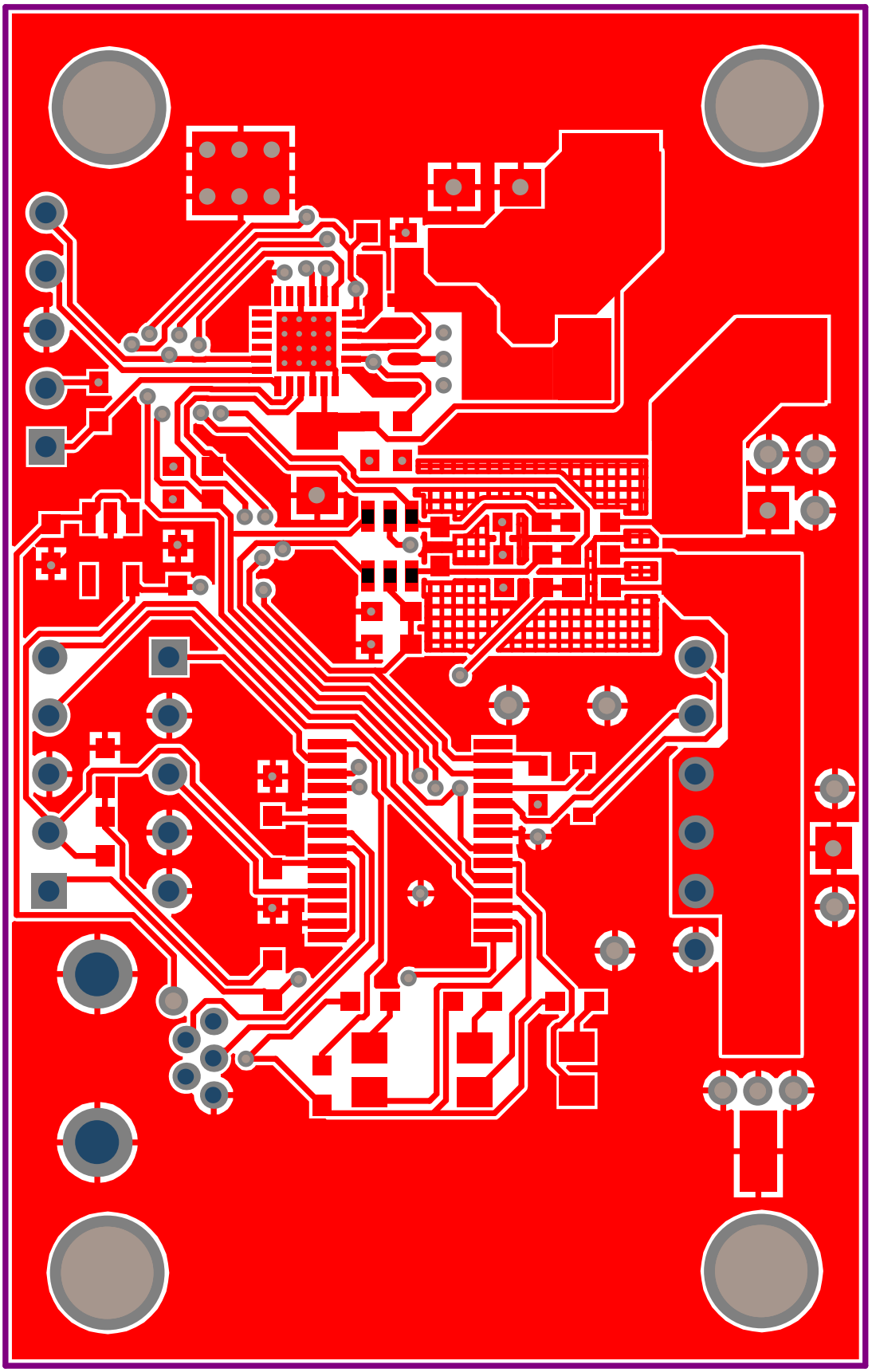
A.3 BOARD – TOP SILK



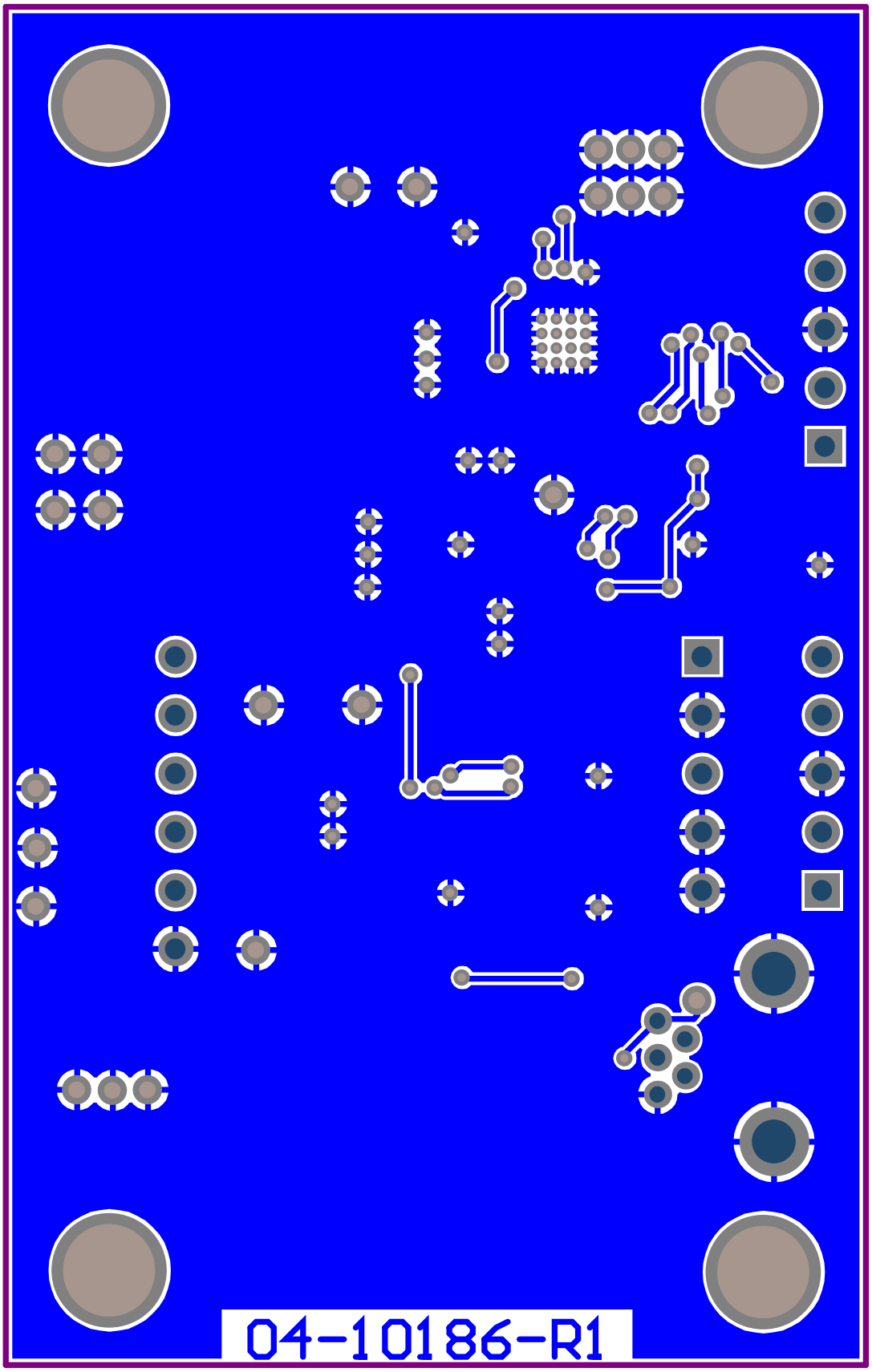
A.4 BOARD – TOP COPPER AND SILK



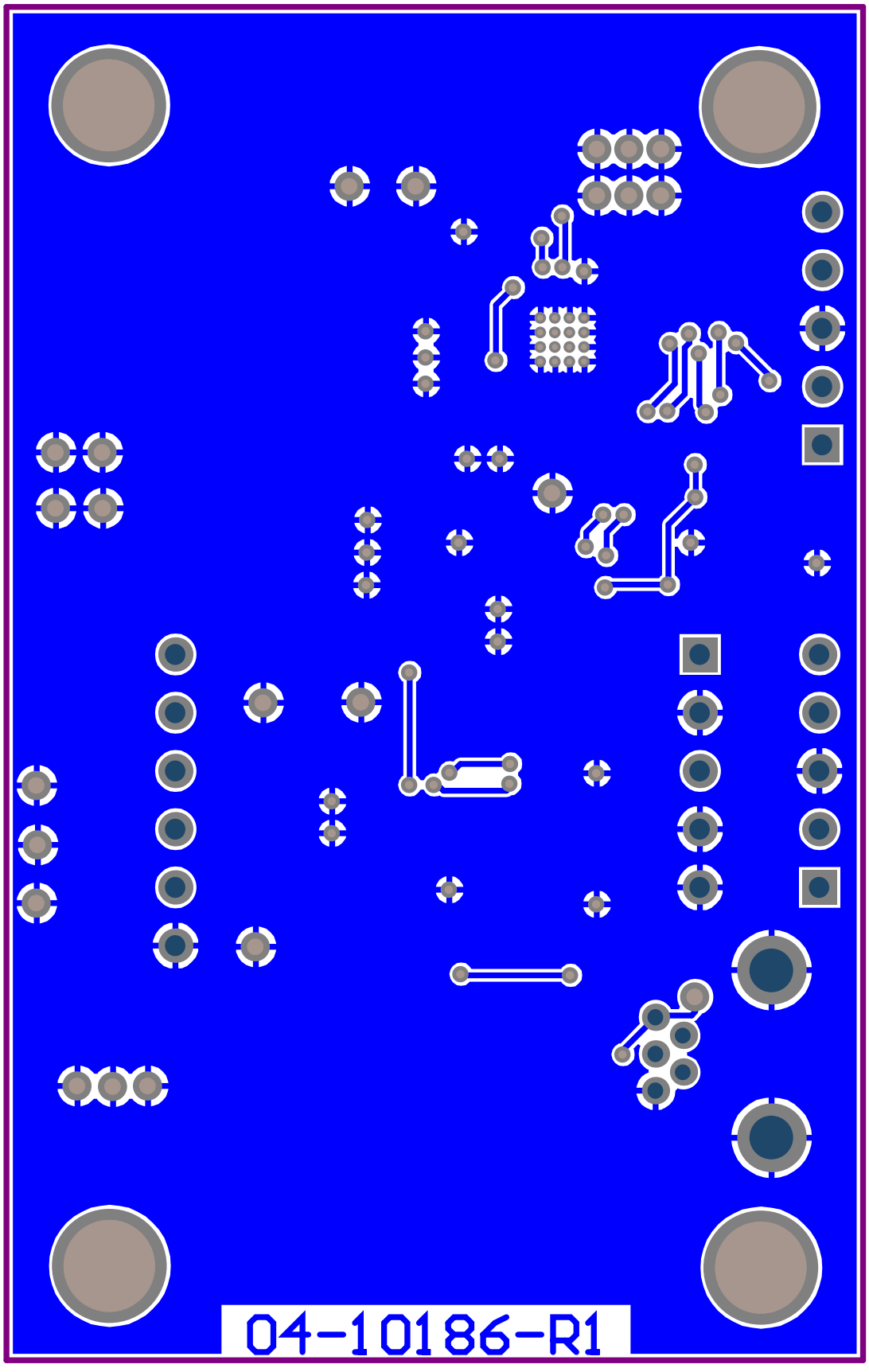
A.5 BOARD – TOP COPPER



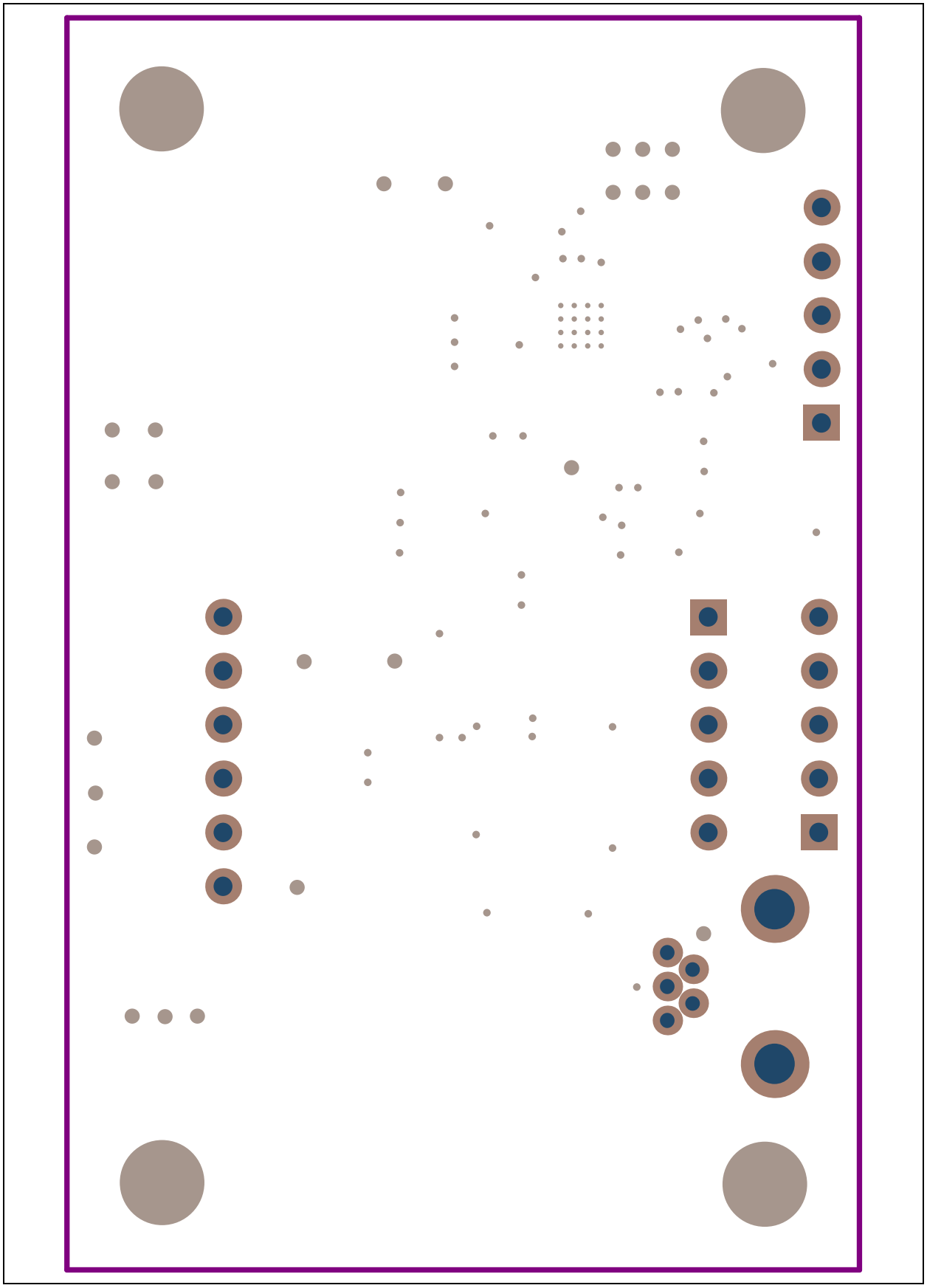
A.6 BOARD – BOTTOM COPPER



A.7 BOARD – BOTTOM COPPER AND SILK



A.8 BOARD – BOTTOM SILK



Appendix B. Bill of Materials

TABLE B-1: BILL OF MATERIALS (BOM)

Qty	Reference	Description	Manufacturer	Part Number
3	C1, C17 – C18	Cap. ceramic 1 µF 6.3V 10% X5R 0603	TDK Corporation	C1608X5R0J105K
3	C2, C5, C19	Cap. ceramic 10 µF 6.3V 20% X5R 0603	TDK Corporation	C1608X5R0J106M080AB
6	C3 – C4, C6 – C8, C13	Cap. ceramic 0.1 µF 25V 20% X7R 0603	TDK Corporation	C1608X7R1E104M080AA
1	C11	Cap. ceramic 0.22 µF 16V 10% X7R 0603	TDK Corporation	C1608X7R1C224K080AC
5	C9 – C10, C12, C14 – C15	Cap. ceramic 10 µF 10V Y5V 1206	TDK Corporation	C3216Y5V1A106Z/1.15
1	C16	Cap. alum. 150 µF 25V 20% SMD	Panasonic® - ECG	EEE-FTE151XAP
3	D1 – D3	LED chip-led 633 NM red 0805 SMD	OSRAM Opto Semiconductors GmbH.	LS R976-NR-1
1	D4	Schottky diode 30V 0.2A SOD323	NXP Semiconductor	1PS76SB10,115
1	J1	Conn. USB recept. 5 POS rt. angle	Molex®	548190519
2	J2, J5	Conn. header 5 POS 0.050" T/H gold	Samtec, Inc.	TMS-105-02-G-S
1	J3	Conn. recept. 5 POS 0.100 vert. gold	TE Connectivity, Ltd.	5-534237-3
1	J4	Conn. recept. 6 POS 0.100 vert. gold	TE Connectivity, Ltd.	534237-4
1	L1	Inductor power 22 µH 30% shield SMD	Bourns®, Inc.	SRU1048-220Y
	PCB	Printed Circuit Board – MCP8063 12V 3-Phase BLDC Sensorless Fan Controller Demonstration Board	—	104-00532
1	Q1	MOSFET N-Channel dual 30V 8-SOIC	Vishay Siliconix	SI4330DY-T1-E3
5	R1 – R2, R9 – R10, R16	Res. 1.00 kΩ 1/10W 1% 0603	TE Connectivity, Ltd.	1622866-1
1	R3	Res. 100 kΩ 1/10W 1% 0603	TE Connectivity, Ltd.	1622827-1
5	R4 – R7, R11	Res. 10.0 kΩ 1/10W 1% 0603	TE Connectivity, Ltd.	1622829-1
3	R13 – R15	Res. 4.02 kΩ 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4021V
1	R8	Res. 470Ω 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4700V
1	R12	Res. 0.1Ω 1/3W 1% 1210 SMD	Panasonic - ECG	ERJ-L14KF10CU
2	TP1 – TP2	PC test point mini SMD	Keystone Electronics Corp.	5019

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.

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

Qty	Reference	Description	Manufacturer	Part Number
1	U1	IC reg. LDO 3.3V 0.3A 5-lead SOT-23	Microchip Technology Inc.	**MCP1824T-3302E/OT**
1	U2	IC ADC 18 bit 3.75 SPS 1 ch. 6-lead SOT-23	Microchip Technology Inc.	**MCP3421A1T-E/CH**
1	U3	IC MCU 16 bit 64 KB Flash 28-lead SSOP	Microchip Technology Inc.	**PIC24FJ64GB002-1/SS**
1	U4	IC reg. controller Buck PWM 24-lead QFN	Microchip Technology Inc.	**MCP19110-E/MJ-ND**

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.

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