



**MTD6508 3-Phase BLDC  
Sensorless Fan Controller  
Demo Motherboard (ADM00633)  
User's Guide**

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**Object of Declaration: MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard  
(ADM00633)**

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

  
Derek Carlson  
VP Development Tools

12-Sep-14  
Date

**NOTES:**

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## Table of Contents

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|                                                                                                               |          |
|---------------------------------------------------------------------------------------------------------------|----------|
| <b>Preface .....</b>                                                                                          | <b>7</b> |
| <b>Chapter 1. Product Overview</b>                                                                            |          |
| 1.1 Introduction .....                                                                                        | 11       |
| 1.2 MTD6508 Motherboard Hardware description .....                                                            | 12       |
| 1.3 MTD6508 Daughter Board Hardware Description .....                                                         | 13       |
| 1.4 What the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo<br>Motherboard (ADM00633) Kit includes ..... | 14       |
| <b>Chapter 2. Installation and Operation</b>                                                                  |          |
| 2.1 Getting Started .....                                                                                     | 15       |
| 2.2 Board Setup .....                                                                                         | 15       |
| 2.3 Using the MTD6508 Demonstration Board Kit without the MTD6508<br>Demonstration Board Software GUI .....   | 16       |
| 2.4 Software Installation .....                                                                               | 17       |
| 2.5 Using the MTD6508 Demonstration Board Kit with the MTD6508<br>Demonstration Board Software GUI .....      | 20       |
| <b>Chapter 3. Graphical User Interface Description</b>                                                        |          |
| 3.1 MTD6508 Demonstration Board Software GUI description .....                                                | 21       |
| 3.1.1 Control Tab .....                                                                                       | 21       |
| 3.1.1.1 Operation Control .....                                                                               | 22       |
| 3.1.1.2 RPROG Pin .....                                                                                       | 22       |
| 3.1.1.3 Chart .....                                                                                           | 22       |
| 3.1.1.4 PWM Pin .....                                                                                         | 23       |
| 3.1.1.5 V <sub>DD</sub> Pin .....                                                                             | 23       |
| 3.1.1.6 Slew Rate Pins .....                                                                                  | 23       |
| 3.1.2 Measurement Tab .....                                                                                   | 24       |
| 3.1.2.1 Settings Tab .....                                                                                    | 24       |
| 3.1.2.2 Measurement Results Tab .....                                                                         | 27       |
| 3.1.3 Defining the R <sub>PROG</sub> Value Correctly .....                                                    | 28       |
| 3.1.3.1 Operation .....                                                                                       | 28       |
| <b>Appendix A. Schematics and Layouts</b>                                                                     |          |
| A.1 Introduction .....                                                                                        | 29       |
| A.2 ADM00633 Board – Schematic: LED Part, Key Part and R_Prog Part .....                                      | 30       |
| A.3 ADM00633 Board – Schematic: Current Sense Part, Digipot Part and Power<br>Part .....                      | 31       |
| A.4 ADM00633 Board – Schematic: PIC24F Part .....                                                             | 32       |
| A.5 ADM00633 Board – Schematic: MTD6508 Connector Part, USB Connection<br>Part and Probe Part .....           | 33       |
| A.6 ADM00633 Board – Top Silk .....                                                                           | 34       |
| A.7 ADM00633 Board – Top Copper and Silk .....                                                                | 34       |
| A.8 ADM00633 Board – Bottom Copper and Silk .....                                                             | 35       |

Appendix B. Bill of Materials (BOM)

Worldwide Sales and Service .....39



# MTD6508 3-PHASE BLDC SENSORLESS FAN CONTROLLER DEMO MOTHERBOARD (ADM00633) 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 website ([www.microchip.com](http://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 “DSXXXXXXXXA”, where “XXXXXXXX” 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 MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633). Items discussed in this chapter include:

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

## DOCUMENT LAYOUT

This document describes how to use the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633) as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633).
- **Chapter 2. “Installation and Operation”** – Includes instructions on how to get started with the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633).
- **Appendix A. “Schematics and Layouts”** – Shows the schematic and layout diagrams for the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633).
- **Appendix B. “Bill of Materials (BOM)”** – Lists the parts used to build the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633).

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

| Description                                      | Represents                                                                                          | Examples                                                    |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Arial font:</b>                               |                                                                                                     |                                                             |
| Italic characters                                | Referenced books                                                                                    | <i>MPLAB<sup>®</sup> IDE User's Guide</i>                   |
|                                                  | Emphasized text                                                                                     | ...is the <i>only</i> 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                                                                                         | <u><i>File&gt;Save</i></u>                                  |
| Bold characters                                  | A dialog button                                                                                     | Click <b>OK</b>                                             |
|                                                  | A tab                                                                                               | Click the <b>Power</b> 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>                                         |
| <b>Courier New font:</b>                         |                                                                                                     |                                                             |
| Plain Courier New                                | Sample source code                                                                                  | #define START                                               |
|                                                  | Filenames                                                                                           | autoexec.bat                                                |
|                                                  | File paths                                                                                          | c:\mcc18\h                                                  |
|                                                  | Keywords                                                                                            | _asm, _endasm, static                                       |
|                                                  | Command-line options                                                                                | -0pa+, -0pa-                                                |
|                                                  | Bit values                                                                                          | 0, 1                                                        |
|                                                  | Constants                                                                                           | 0xFF, 'A'                                                   |
| Italic Courier New                               | A variable argument                                                                                 | <i>file.o</i> , where <i>file</i> can be any valid filename |
| Square brackets [ ]                              | Optional arguments                                                                                  | mcc18 [options] <i>file</i> [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)<br>{ ...<br>}                              |



## RECOMMENDED READING

This user's guide describes how to use the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633). Another useful document is listed below. The following Microchip document is available and recommended as a supplemental reference resource.

- **MTD6508 Data Sheet – “3-Phase Sinusoidal Sensorless Brushless Fan Motor Driver” (DS20005359)**

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- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the website at: <http://www.microchip.com/support>.

## DOCUMENT REVISION HISTORY

### Revision A (June 2016)

- Initial Release of this Document.

**NOTES:**

## Chapter 1. Product Overview

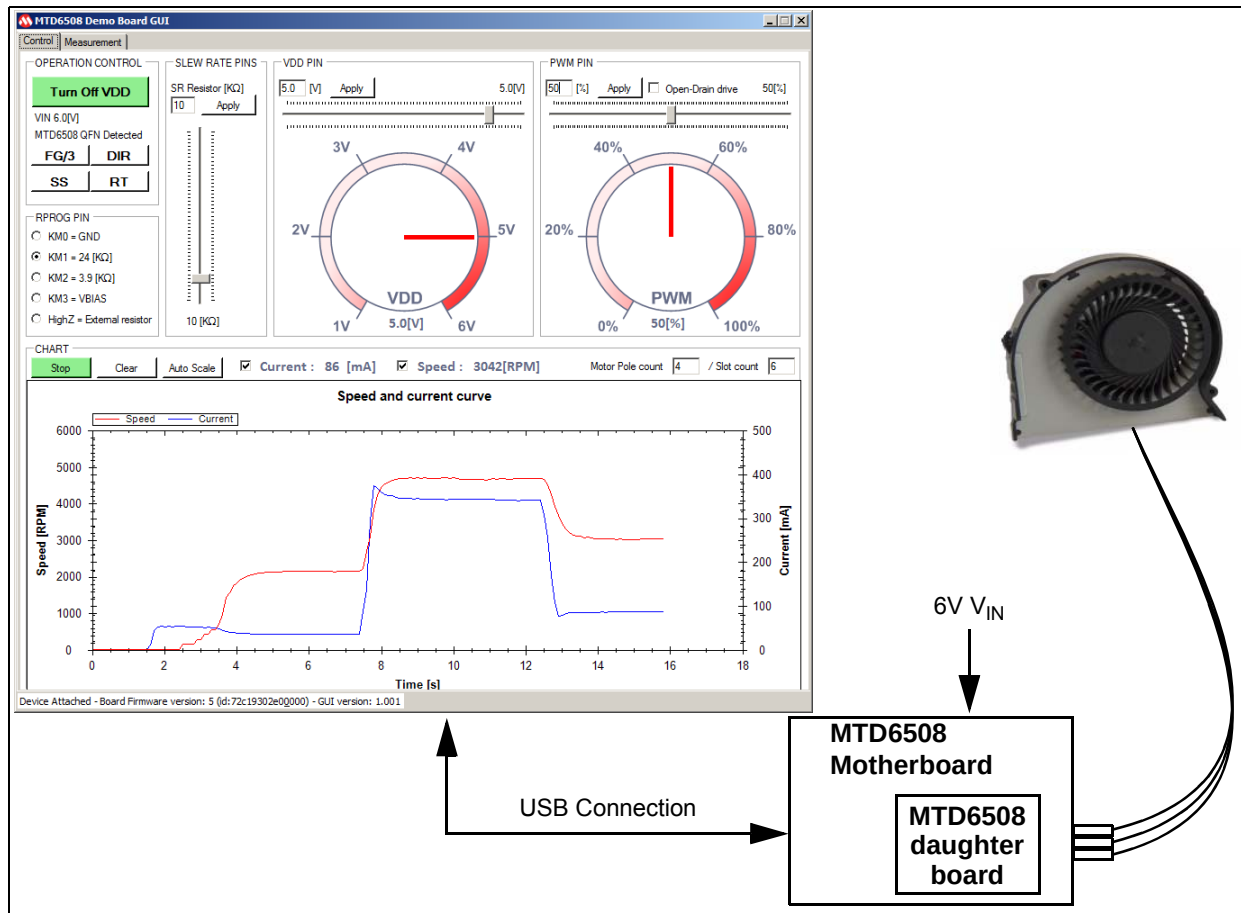
### 1.1 INTRODUCTION

The MTD6508 motherboard allows control of the daughter board (ADM00631) in two ways:

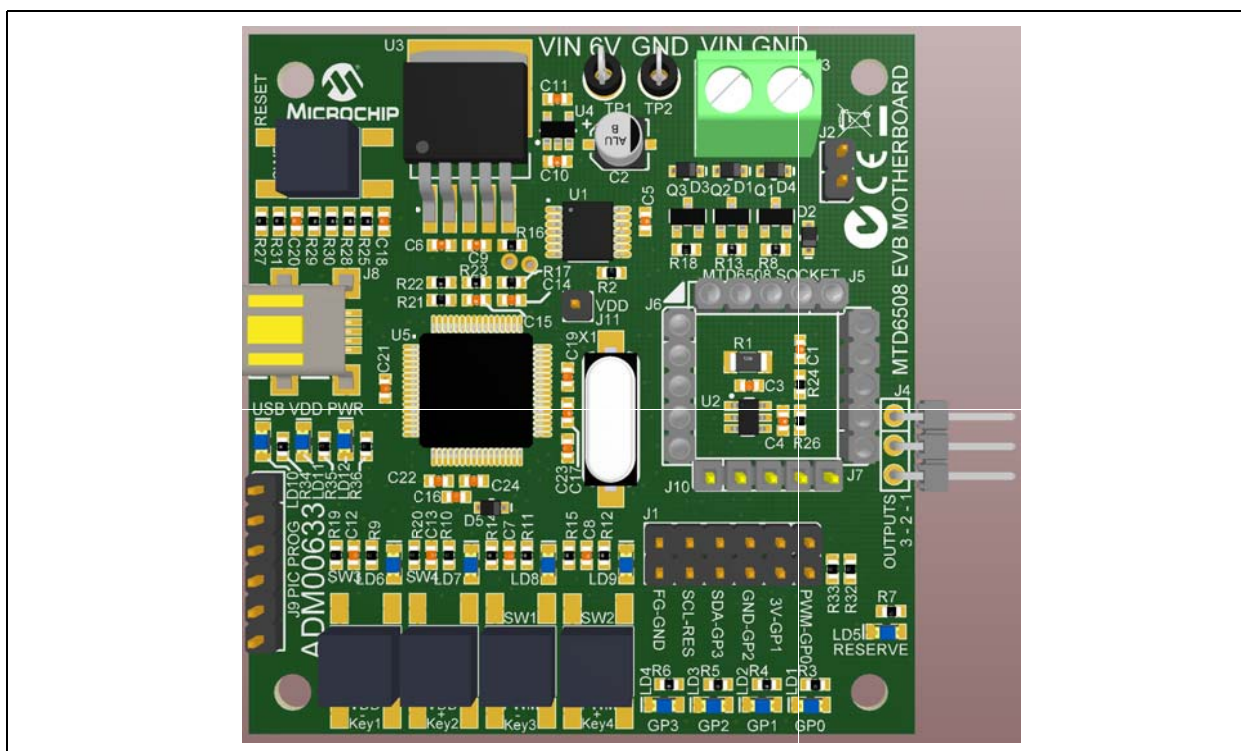
- Directly, by using the keys on the board
- By connecting the MTD6508 motherboard to a computer via a USB port and controlling and monitoring the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633) device through PC software (the MTD6508 Demonstration Board Software GUI).

The MTD6508 Demonstration Board Software GUI provides several features, such as  $V_{DD}$  control and monitoring, pulse-width modulation (PWM) control as well as speed and current consumption monitoring. It also allows the user to control the following parameters:

- The  $R_{PROG}$  resistor value for fan fitting
- The  $R_{SR}$  resistor value for output PWM slew rate control
- All remaining digital pins.



**FIGURE 1-1:** System Overview.



**FIGURE 1-2:** MTD6508 3-Phase BLDC Sensorless Fan Controller Demonstration Motherboard (ADM00633) Overview.

## 1.2 MTD6508 MOTHERBOARD HARDWARE DESCRIPTION

The MTD6508 motherboard contains several components:

- A microcontroller (PIC24FJ64GB) for USB connection, PWM generation, FG frequency measurement,  $V_{DD}$  measurement, activations of other signals and component communication.
- An LDO (MCP1827) adjustable with a digital potentiometer (MCP4652) to provide the  $V_{DD}$  to the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633) device. The LDO can be enabled or disabled by the microcontroller. The digital potentiometer is also used to set the  $R_{PROG}$  and  $R_{SR}$  resistor values.
- A Delta-Sigma (MCP3421) combined with a shunt resistor for sensing current consumption on the  $V_{DD}$  pin.

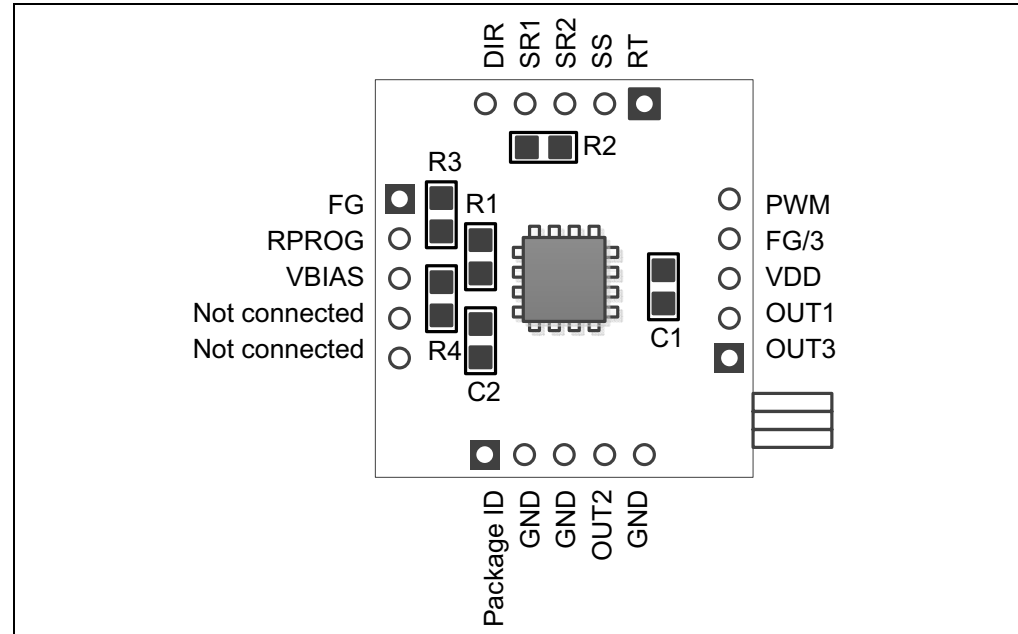
More details on the schematic are available in [Appendix A. "Schematics and Layouts"](#).

## 1.3 MTD6508 DAUGHTER BOARD HARDWARE DESCRIPTION

The MTD6508 motherboard is made to drive the MTD6508 daughter board (ADM00631). The latter contains a 16-Lead UQFN 4x4 MTD6508 and the components required to operate with the UQFN MTD6508 device. Note that the ADM00631 needs to be purchased separately.

We strongly recommend to use the daughter board in conjunction with the motherboard (ADM00633). However, the MTD6508 daughter boards can also be used independently as stand-alone boards. This section provides a brief description of the MTD6508 daughter board.

Figure 1-3 provides an overview of the MTD6508 daughter board.



**FIGURE 1-3:** MTD6508 Daughter Board Overview.

- R1 is the FG pull-up resistor
- C1 and C2 are respectively the  $V_{DD}$  and the  $V_{BIAS}$  decoupling capacitors
- R2 is the slew rate resistor ( $R_{SR}$ ) and is available only for the MTD6508 daughter board with a 16-Lead UQFN 4x4 MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633) (ADM00631). This resistor is handled by the MTD6508 motherboard via the MTD6508 Demonstration Board Software GUI. This footprint has to be assembled only if the MTD6508 daughter board is not plugged into a MTD6508 motherboard. A 4.7K to 47K resistor is required.
- R3 allows connecting the  $R_{PROG}$  pin to GND. This resistor is handled by the MTD6508 motherboard via the MTD6508 Demonstration Board Software GUI. This footprint has to be assembled only if the  $R_{PROG}$  resistor is not set by the MTD6508 Demonstration Board Software GUI. A 0R resistor must be used.
- R4 allows setting the  $R_{PROG}$  resistor. This resistor is handled by the MTD6508 motherboard via the MTD6508 Demonstration Board Software GUI. This footprint has to be assembled only if the  $R_{PROG}$  resistor is not set by the MTD6508 Demonstration Board Software GUI. A 24K, 3.9K or 0R resistor is required to connect the  $R_{PROG}$  pin to  $V_{BIAS}$ .

More details of the schematic are available in [Appendix A. "Schematics and Layouts"](#).

## **1.4 WHAT THE MTD6508 3-PHASE BLDC SENSORLESS FAN CONTROLLER DEMO MOTHERBOARD (ADM00633) KIT INCLUDES**

The MTD6508 3-Phase BLDC Sensorless Fan Controller Motherboard package (ADM00633) includes:

- MTD6508 Motherboard (ADM00633)
- One mini-USB cable
- One 3-Phase BLDC fan (use with KM = 2)
- Important Information Sheet

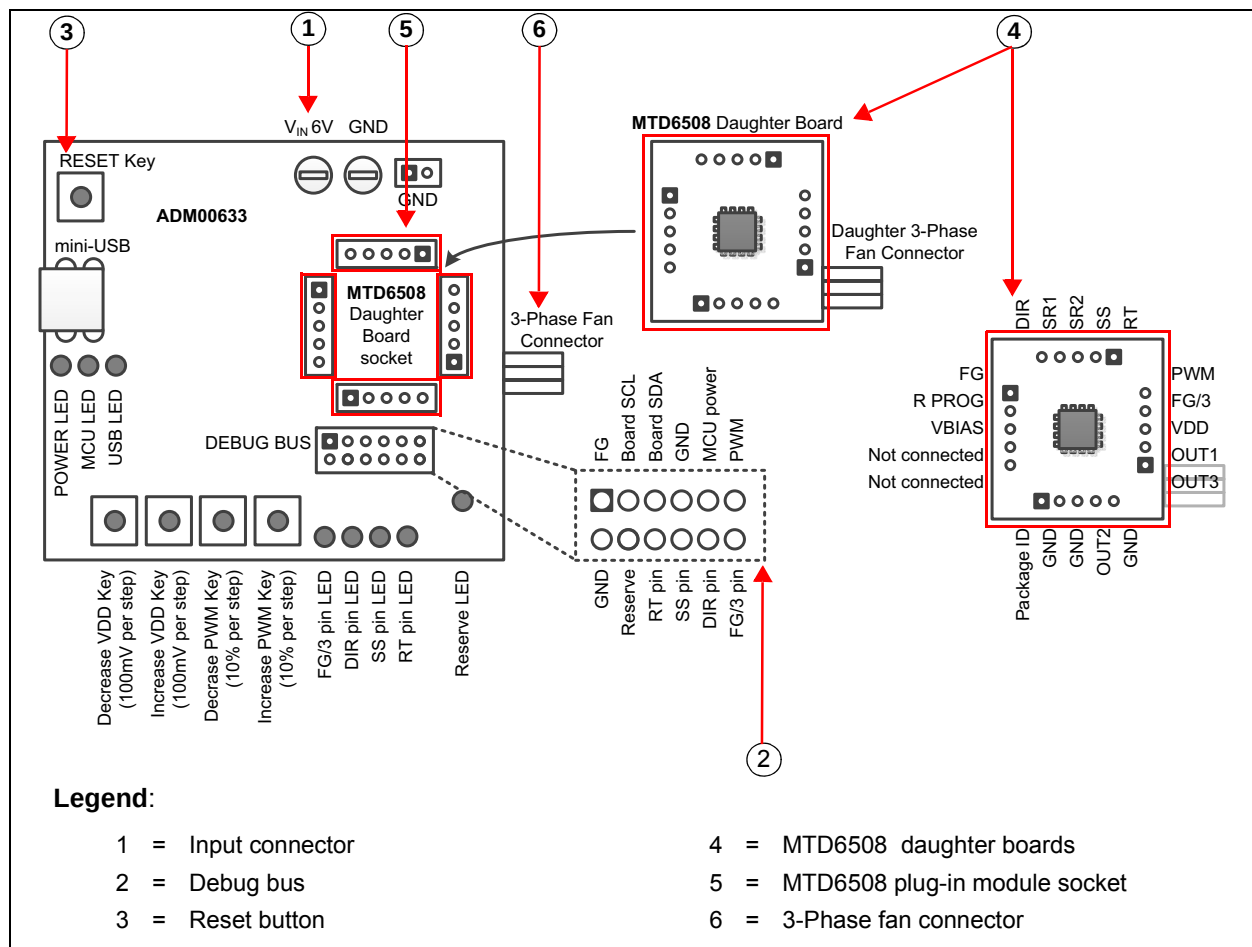
## Chapter 2. Installation and Operation

### 2.1 GETTING STARTED

The following sections describe how to install and use the MTD6508 Demonstration Board Kit either without or in conjunction with the MTD6508 Demonstration Board Software GUI.

### 2.2 BOARD SETUP

Figure 2-1 identifies the required points for using the MTD6508 Demonstration Board Kit.



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

**Note:** The MTD6508 daughter boards (ADM00631) are not included in the ADM00633 kit and must be purchased separately.

## **2.3 USING THE MTD6508 DEMONSTRATION BOARD KIT WITHOUT THE MTD6508 DEMONSTRATION BOARD SOFTWARE GUI**

To use the MTD6508 motherboard without the MTD6508 Demonstration Board Software GUI, follow these steps:

1. Plug the MTD6508 daughter board into its dedicated socket on the MTD6508 motherboard (see [Figure 2-1](#)).
2. To plug in a 3-phase BLDC sensorless fan, choose one of these connections:
  - the 3-phase fan connector on the MTD6508 motherboard (J1)
  - the fan connector on the MTD6508 daughter board.
3. Connect the power supply to the  $V_{IN}$  test point. The necessary  $V_{IN}$  value is  $+6V \pm 5\%$ . The power supply has to deliver up to 1.0A.
4. Turn on the power switch. The POWER LED and the MCU LED will light up. The fan will start rotating with these default parameters:
  - KM = High Z (needs the assembly of an  $R_{PROG}$  resistor)
  - $V_{DD} = 5V$
  - PWM = 100%
  - $R_{SR}$  resistor = 10K
  - FG/3 = DIR = SS = RT = GND.
5. To adjust the fan speed, use the  $V_{DD}$  keys to increase or decrease  $V_{DD}$  in conjunction with the PWM keys to increase or decrease the PWM.



## 2.4 SOFTWARE INSTALLATION

In order to use the MTD6508 motherboard with a PC software, the MTD6508 motherboard GUI needs to be installed. This section describes the installation procedure.

The MTD6508 motherboard software installer can be downloaded from the Microchip website at <http://www.microchip.com>. Search for the evaluation board on the website by part number ADM00633. The GUI can be downloaded from the board web page.

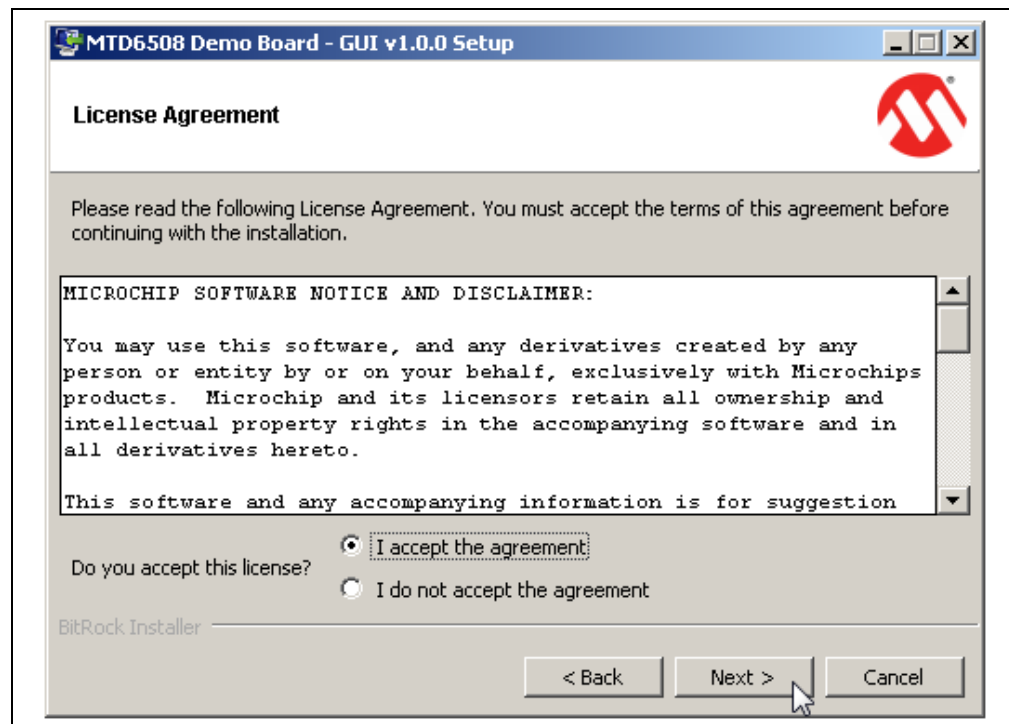
**Note:** This application requires Microsoft® .NET Framework 4 or later. The installer will automatically install the Framework if it is not present.

1. Unzip the archive and open the .exe file. The MTD6508 Demonstration Board Software GUI will initiate. Click **Next** to start the installation.



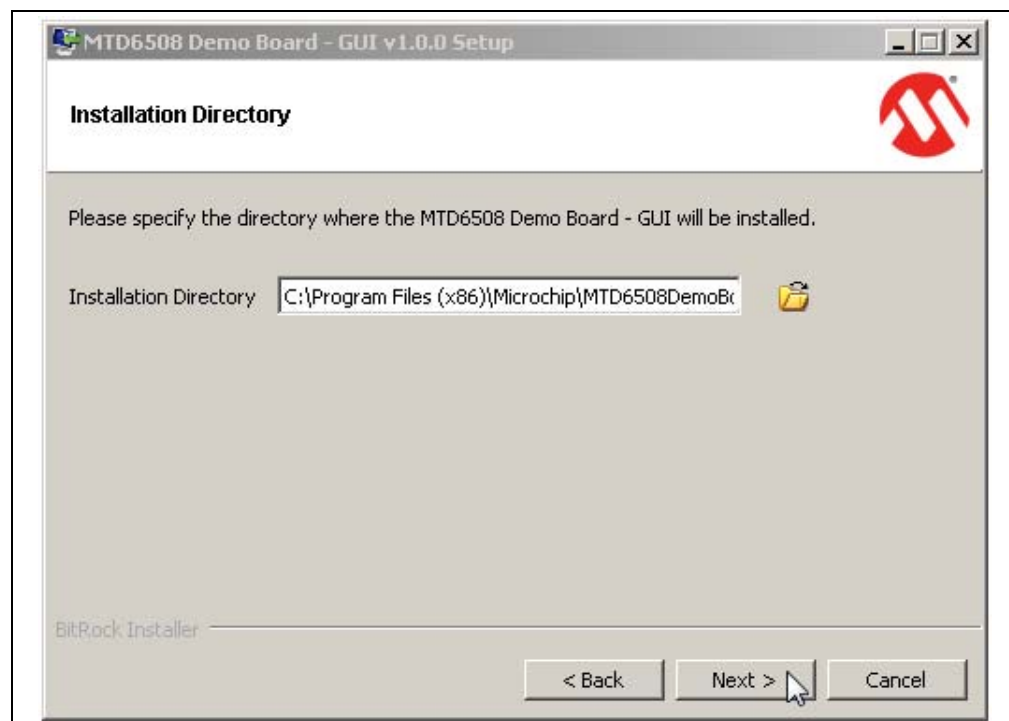
**FIGURE 2-2:** MTD6508 Demonstration Board Software GUI – Welcome Screen.

2. To proceed with the installation, read the License Agreement and accept by clicking the radio button corresponding to "I accept the agreement" then click **Next**.



**FIGURE 2-3:** MTD6508 Demonstration Board Software GUI – License Agreement Screen.

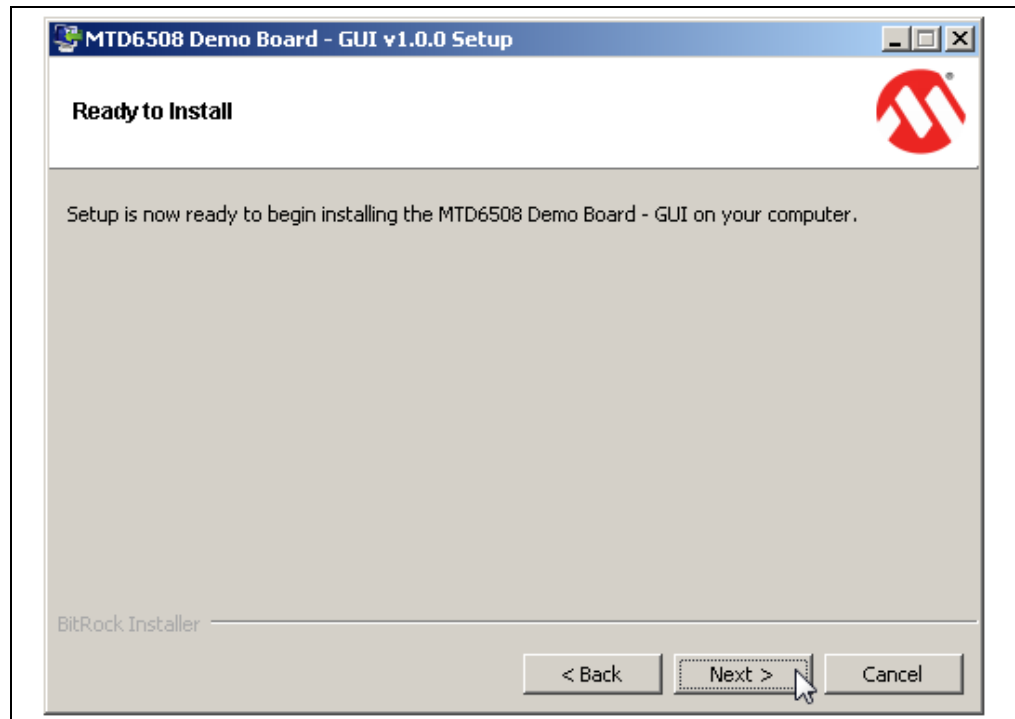
3. On the Installation Directory dialog, browse for the desired location, or click **Next** to install in the default location.



**FIGURE 2-4:** MTD6508 Demonstration Board Software GUI – Installation Directory Dialog.

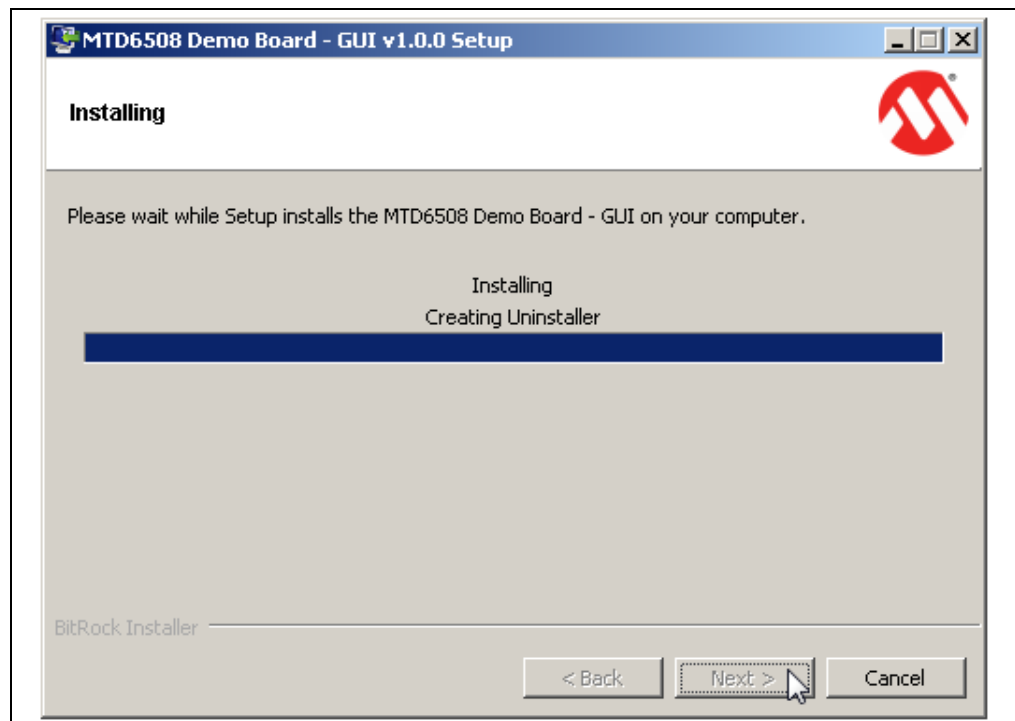
# Installation and Operation

4. Once the installation path is chosen, the software is ready to install. Click **Next** to proceed.



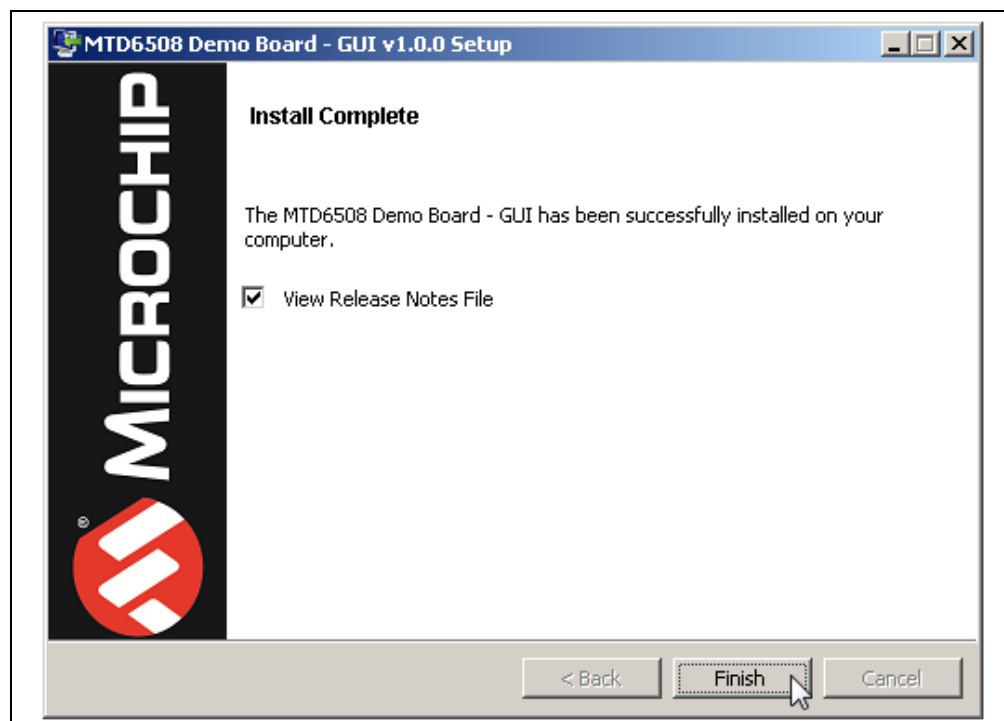
**FIGURE 2-5:** MTD6508 Demonstration Board Software GUI – Ready to Install Screen.

5. The Installation Status window appears, showing the installation progress. After the installation has completed, click **Next** to continue.



**FIGURE 2-6:** MTD6508 Demonstration Board Software GUI – Installation Status Window.

6. Once the **Install Complete** screen appears, click **Finish** to exit the Installer.



**FIGURE 2-7:** MTD6508 Demonstration Board Software GUI – Install Complete Screen.

7. Start the software by either going to *Windows Start button > All Programs > Microchip > MTD6508 Demo Board -GUI* or by double-clicking the software icon on the desktop (🖱️).

## 2.5 USING THE MTD6508 DEMONSTRATION BOARD KIT WITH THE MTD6508 DEMONSTRATION BOARD SOFTWARE GUI

To use the MTD6508 Demonstration Board Kit with the MTD6508 Demonstration Board Software GUI, follow these steps:

1. Plug the MTD6508 daughter board into its dedicated socket on the MTD6508 motherboard (see [Figure 2-1](#)).
2. To plug in a 3-phase BLDC sensorless fan, choose one of the following connections:
  - the 3-phase fan connector on the MTD6508 motherboard (J1)
  - the fan connector on the MTD6508 daughter board
3. Connect the power supply to the  $V_{IN}$  test point. The required  $V_{IN}$  value is  $+6V \pm 5\%$ . The power supply has to deliver up to 1.0A.
4. Turn on the power switch. The POWER LED and the MCU LED will light up.
5. Plug a mini-USB cable attached to the USB port of a computer to the MTD6508 motherboard connector.
6. If required, let the computer identify the MTD6508 motherboard.
7. Restart the computer, if necessary.
8. Start the MTD6508 Demonstration Board Software GUI.

**Note:** The order of these steps is provided as an example and can be changed. It is also possible to start the MTD6508 Demonstration Board Software GUI before enabling the board.

## Chapter 3. Graphical User Interface Description

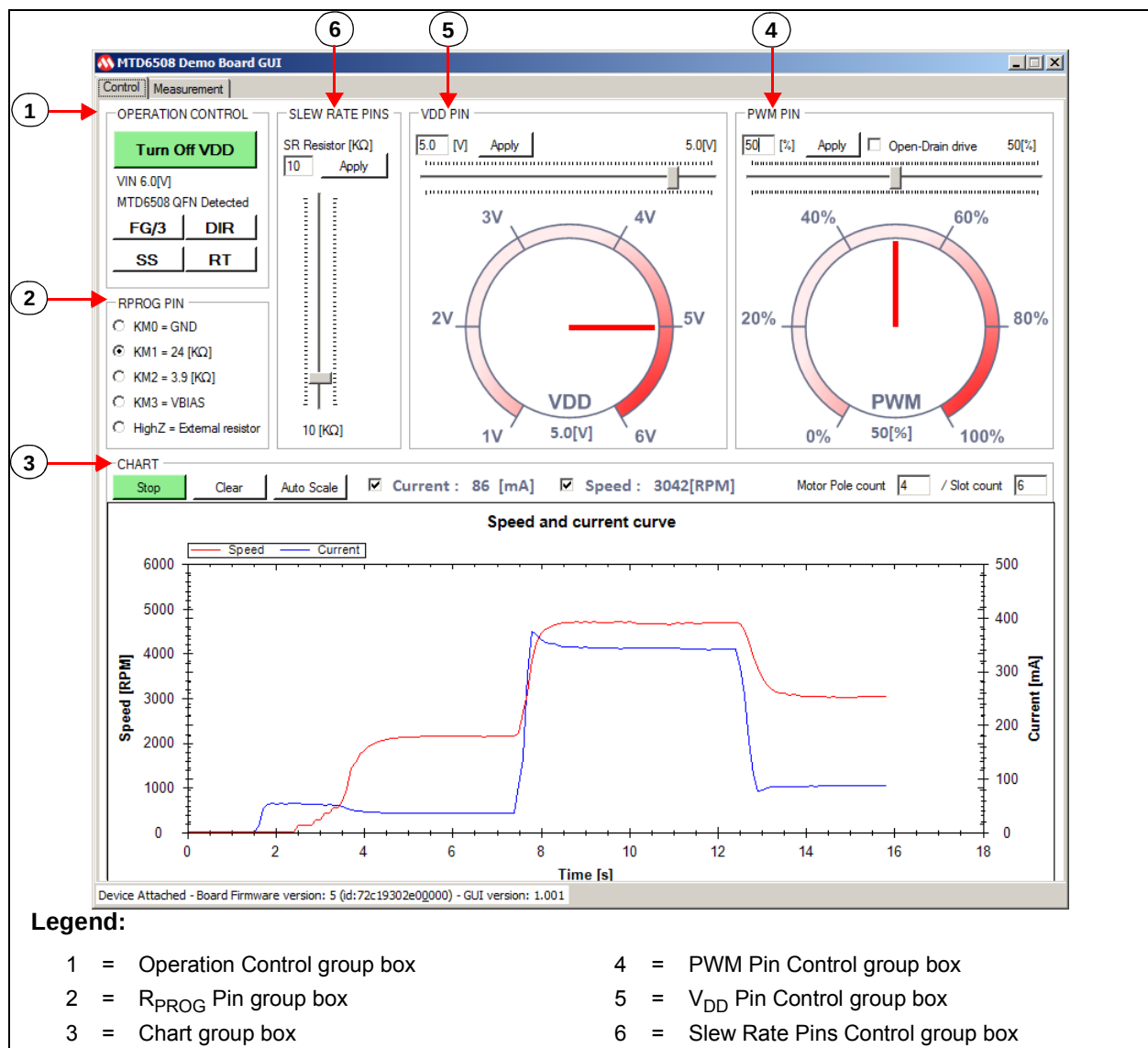
### 3.1 MTD6508 DEMONSTRATION BOARD SOFTWARE GUI DESCRIPTION

The MTD6508 Demonstration Board Software GUI window has two tabs:

- Control: contains the necessary tools to control and monitor the MTD6508 Demonstration Board.
- Measurement: provides the necessary tools to determine if the fan is correctly adapted to the MTD6508 by testing it several times under different conditions.

#### 3.1.1 Control Tab

Figure 3-1 shows the options and functions available for controlling and monitoring the board.



**FIGURE 3-1:** GUI – Control Tab.

**Note:** All functions presented in [Figure 3-1](#) are enabled only when the MTD6508 Demonstration Board is connected to the PC via a USB connection.

#### 3.1.1.1 OPERATION CONTROL

The Operation Control group box contains five buttons:

- **Turn On/Off VDD** button enables/disables the power supply on the  $V_{DD}$  pin of the MTD6508. If the  $V_{DD}$  pin is supplied, the button color will turn green.
- **FG/3** is used to invert the FG/3 pin state. When the pin state is set high, the button color will turn green. If the pin state is set low, the button will gray out.
- **DIR** is used to invert the DIR pin state. Setting the pin state high will cause the button color to turn green. Setting the pin state low will switch the button color to gray.
- **SS** is used to invert the SS pin state. When the pin state is set high, the button will be displayed in green. If the pin state is set low, the button will be displayed in gray.
- **RT** is used to invert the RT pin state. Setting the pin state high will cause the button color to turn green. Setting the pin state low will switch the button color to gray.

**Note:** Please refer to the **MTD6508 Data Sheet – “3-Phase Sinusoidal Sensorless Brushless Fan Motor Driver” (DS20005359)** for more details on the FG/3, DIR, SS and RT pin functionality.

#### 3.1.1.2 $R_{PROG}$ PIN

The  $R_{PROG}$  Pin group box allows the selection of the desired  $R_{PROG}$  resistor value. This value depends on the  $K_M$  (mV/Hz) of the fan.

**Note:** Please refer to section [Section 3.1.3 “Defining the  \$R\_{PROG}\$  Value Correctly”](#) for more information on the  $R_{PROG}$  selection.

The High Z mode allows setting an external  $R_{PROG}$  resistor value directly on the MTD6508 daughter board. This is the default mode used by the MTD6508 Demonstration Board to let the user set the board's  $R_{PROG}$  resistor value when the board is used in Stand-alone mode. Therefore, it is important to specify a  $K_M$  before doing any test when using the MTD6508 Demonstration Board Software GUI.

#### 3.1.1.3 CHART

This section of the GUI graphically represents the current consumption (in mA) of the MTD6508 device on the  $V_{DD}$  pin. It also charts the fan speed in Revolutions Per Minute (RPM) by measuring the FG frequency. The chart adds ten values per second. The three buttons in this group 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 restoring the default scaling  
In Default Scaling mode, the chart will automatically adjust scaling to ensure that all added values are displayed in the same view. It is also possible to select a part of the chart with your mouse and zoom into the selection. The mouse wheel zoom function is also enabled.

The Current axis shows the instant current consumption measured in mA. The Speed axis displays the instant speed measurement in RPM. By default, the displayed RPM is valid for motors with two pair of poles and six slots (4P/6S). If the connected motor has different parameters, the number of poles and slots can be adjusted.

## 3.1.1.4 PWM PIN

The PWM Pin group box features a slide bar which allows the user to set the PWM ratio on the MTD6508 PWM pin. The gauge placed below the slide bar indicates the current PWM applied.

## 3.1.1.5 $V_{DD}$ PIN

The  $V_{DD}$  Pin group box features a slide bar that allows the user to set the desired  $V_{DD}$  value. The gauge below the slide bar indicates the instant  $V_{DD}$  value measured by the MTD6508 Demonstration Board.

## 3.1.1.6 SLEW RATE PINS

The Slew Rate group box provides a slide bar to set the desired  $R_{SR}$  value.

3.1.2 Measurement Tab

The **Measurement** tab provides the tools necessary to determine if the fan is correctly adapted to the MTD6508 and its settings. These tools are organized in two sub-tabs:

- Settings
- Results

3.1.2.1 SETTINGS TAB

Figure 3-2 shows the **Settings** tab.

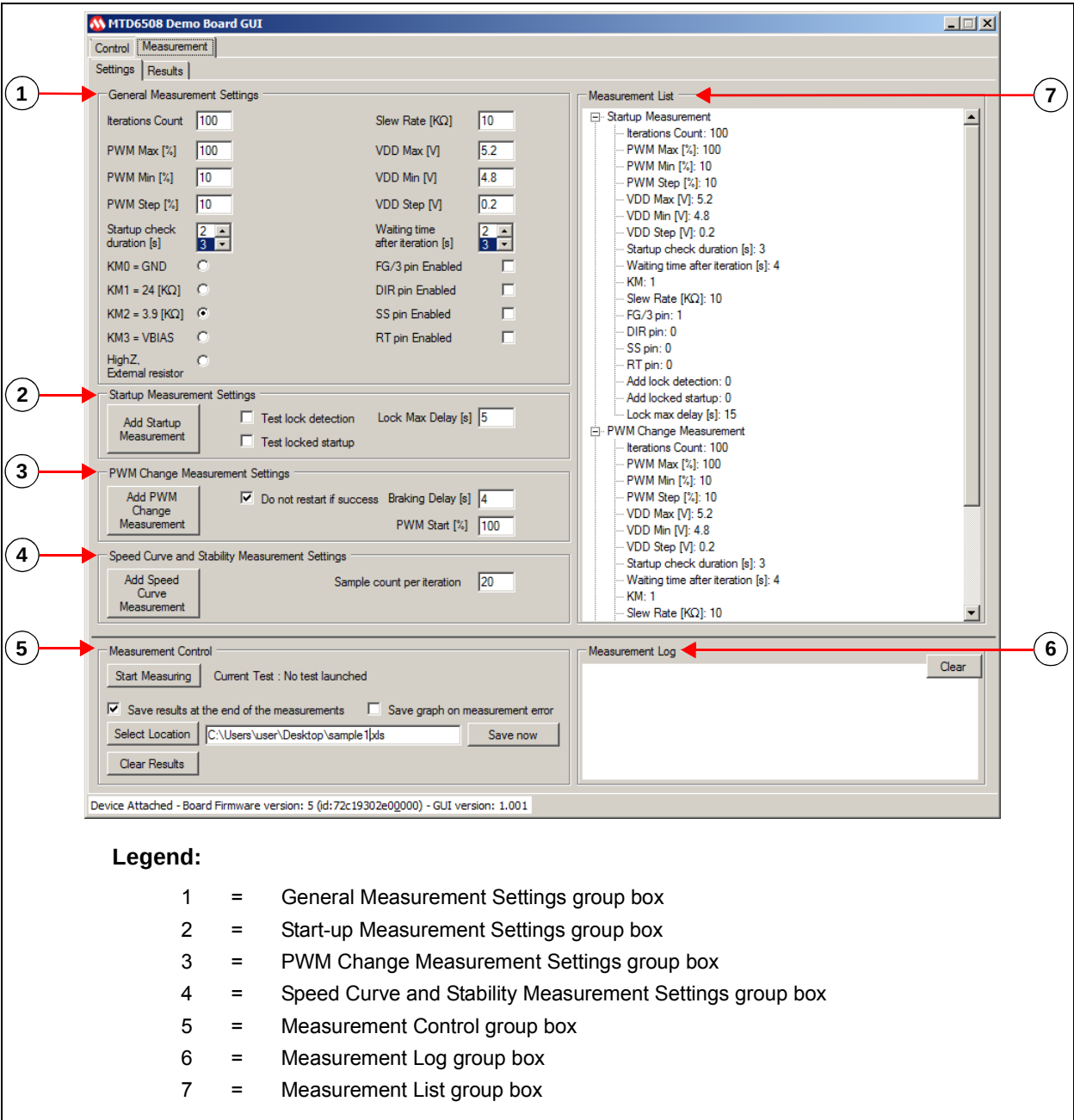


FIGURE 3-2: GUI – Measurement Tab – Settings.



## 3.1.2.1.1 Measurement Settings

The General Measurement Settings group box is used to specify the measurement corners required:

- Iterations Count – for one corner
- 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.
- $V_{DD}$  corners are similar to PWM corners. A  $V_{DD}$  corner includes all PWM corners. This means that for one  $V_{DD}$  corner, all PWM corners are measured.
- Start-up Check Duration [s] – if the speed of the fan is measured as 0 RPM after this delay, the start-up is considered a fail. The recommended value for this field is 3s.
- 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.

## 3.1.2.1.2 Start-up Measurement Settings

The Start-up Measurement Settings group box is used to define several start-up measurement specific parameters.

The **Add Start-up Measurement** button will create a new start-up measurement item in the list of measurements. The newly-created item will use both parameters set in this group box as well as those in the General Measurement Settings group box.

By selecting the “Test lock detection” checkbox, the start-up test will also verify if the MTD6508 can detect a rotor lock after a successful start-up. After the rotor lock has occurred, the system checks that the FG output has stopped switching before the time defined in the “Lock Max Delay [s]” field. The rotor has to be locked by means of an external motor lock system such as an electromagnetic hammer. The reserve pin of the MTD6508 Demonstration Board (see [Section 2.2 “Board Setup”](#), [Figure 2-1](#), item 2) must be used for handling the lock signal. The lock signal is open-drain (5.5V tolerant) and active-high.

By selecting the “Test locked start-up” checkbox, the start-up test will also verify if the MTD6508 can detect a locked rotor during start-up. After the rotor lock has occurred, the system powers up the MTD6508 and checks that the switching FG output has been stopped before the time specified in the “Lock Max Delay [s]” field. The rotor has to be locked by means of an external motor lock system such as an electromagnetic hammer. The reserve pin of the MTD6508 Demonstration Board must be used for handling the lock signal. The lock signal is open-drain (5.5V tolerant) and active-high. This locked start-up test is an additional test that will initiate a new power cycle. Thus, it will not override the regular start-up test.

## 3.1.2.1.3 PWM Change Measurement Settings

The **Add PWM Change Measurement** button will add a new PWM change measurement item into the measurements list. The new item will use the parameters defined in this group box as well as those in the General Measurement Settings group box.

The PWM Change Measurement starts with the PWM value entered in the “PWM Start [%]” field. After the specified start-up delay (defined in the “start-up check duration [s]” field in the General Measurement Settings group box), the PWM starts changing depending on the PWM corner specified. The software will then verify if the fan is still running. This last check will occur after the delay set in the “Braking Delay [s]” field.

If the PWM change has been successful and the “Do not restart if success” checkbox has been selected, the test will simply restore the PWM Start value for the next test instead of completely restarting the fan.

#### 3.1.2.1.4 Speed Curve and Stability Measurement Settings

Use the **Add Speed Curve Measurement** button to add a new speed curve and stability measurement item into the list of measurements. The new item will use both the parameters of this group box as well as those set in the General Measurement Settings group box.

This measurement requires a number of samples defined in the “Sample count per iteration” field for checking the speed stability.

#### 3.1.2.1.5 Measurement Control

This group box contains three buttons that allows the user to control the work flow:

- **Start Measuring** – starts and stops the required measurements
- **Clear Result** – clears the current result displayed on the screen
- **Save Now** – stores the current measurement in a Microsoft® Excel® file into the specified folder

If the “Save results at the end of the measurement” checkbox is selected, a copy of the results will automatically be stored once all measurements have been completed. The results will be stored in an Excel file in the specified folder.

If the “Save graph on measurement error” checkbox is checked, a copy of the graph generated by the chart (see [Figure 3-2](#), item 5) will be saved as a picture in the specified folder in order to diagnose the issue afterwards.

#### 3.1.2.1.6 Measurement Log

This group box contains a log that displays a summary of the issues detected during measurements.

#### 3.1.2.1.7 Measurement List

This group box consists of a tree view that summarizes all measurements that have been selected by the user.

The order of the measurements in the list can be edited by right-clicking the selected items. Right-clicking the measurement items will also allow the user to remove them individually. The measurement parameters can be edited by double clicking on them.

If the measurement list is edited during an ongoing test, the updated parameters will be applied only to the upcoming measurements.

# Graphical User Interface Description

## 3.1.2.2 MEASUREMENT RESULTS TAB

Figure 3-3 shows the **Results** sub-tab:

The screenshot displays the MTD6508 Demo Board GUI with the Results sub-tab selected. The interface is divided into several sections:

- Results Table (1):** A table with columns: Test Name, Item Number, PWM [%], VDD [V], FG [RPM], IDD [mA], Result 1, Result 2, Result 3, Result 4, and Result 5. It contains two sets of data for 'Startup' tests.
- Measurement Control (2):** A group box containing buttons for 'Stop Measuring', 'Select Location', 'Clear Results', and 'Save now'. It also includes checkboxes for 'Save results at the end of the measurement' and 'Save graph on measurement error'.
- Measurement Log (3):** A text area for logging measurement results, with a 'Clear' button.
- Measurement result area (4):** A large, empty area at the bottom of the table, intended for displaying measurement results as they are generated.

**Legend:**

- 1 = Measurement Results table
- 2 = Measurement Control group box
- 3 = Measurement Log group box
- 4 = Measurement result area (it fills up progressively as the results are generated)

**FIGURE 3-3:** GUI – Measurement Tab – Results.

The test results are displayed in this table. All the tests have the first six columns in common. The other columns are relevant only for specific tests. The buttons that control the management of the results (**Select Location**, **Save now** and **Clear Results**) are visible in this tab as well as in the Measurements Settings Tab > Measurement Control group box (see description in [Section 3.1.2.1.5 “Measurement Control”](#)).

### 3.1.3 Defining the $R_{\text{PROG}}$ Value Correctly

This section explains how to define the  $K_M$  value correctly for a specific fan.  $K_M$  is linked to  $R_{\text{PROG}}$  (see [Table 3-1](#)). Setting an incorrect  $K_M$  value may result in a number of issues, including a reduction in efficiency.

#### 3.1.3.1 OPERATION

Follow the next steps to define the right  $R_{\text{PROG}}$  value:

1. Apply a constant stream of air to a fan that is not connected.
2. Using an oscilloscope, measure the waveform between two phases when the fan is rotating.
3. Measure the generated peak-to-peak voltage ( $V_{p-p}$ ) value and the frequency ( $f$ ).
4. Compute  $K_M$  based on the measured  $V_{p-p}$  and  $f$  (in mV/Hz) by using this equation:

#### EQUATION 3-1: CALCULATING $K_M$

$$K_M = \frac{V_{p-p}}{2f}$$

$K_M$  should remain constant for all fan rotation speeds, but when measuring the  $K_M$  value, the fan rotation speed due to the air stream should be close to the nominal fan rotation speed.

[Table 3-1](#) shows the corresponding  $K_M$  for different  $R_{\text{PROG}}$  values.

**TABLE 3-1:  $R_{\text{PROG}}$  VALUE**

| $R_{\text{PROG}}$               | $K_M$ | $K_M$ Range (mV/Hz) |
|---------------------------------|-------|---------------------|
| $V_{\text{BIAS}}$ ( $0\Omega$ ) | 3     | 26 - 52             |
| 3.9 k $\Omega$                  | 2     | 13 - 26             |
| 24 k $\Omega$                   | 1     | 6.5 - 13            |
| GND                             | 0     | 3.25 - 6.5          |



# MTD6508 3-PHASE BLDC SENSORLESS FAN CONTROLLER DEMO MOTHERBOARD (ADM00633) USER'S GUIDE

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## Appendix A. Schematics and Layouts

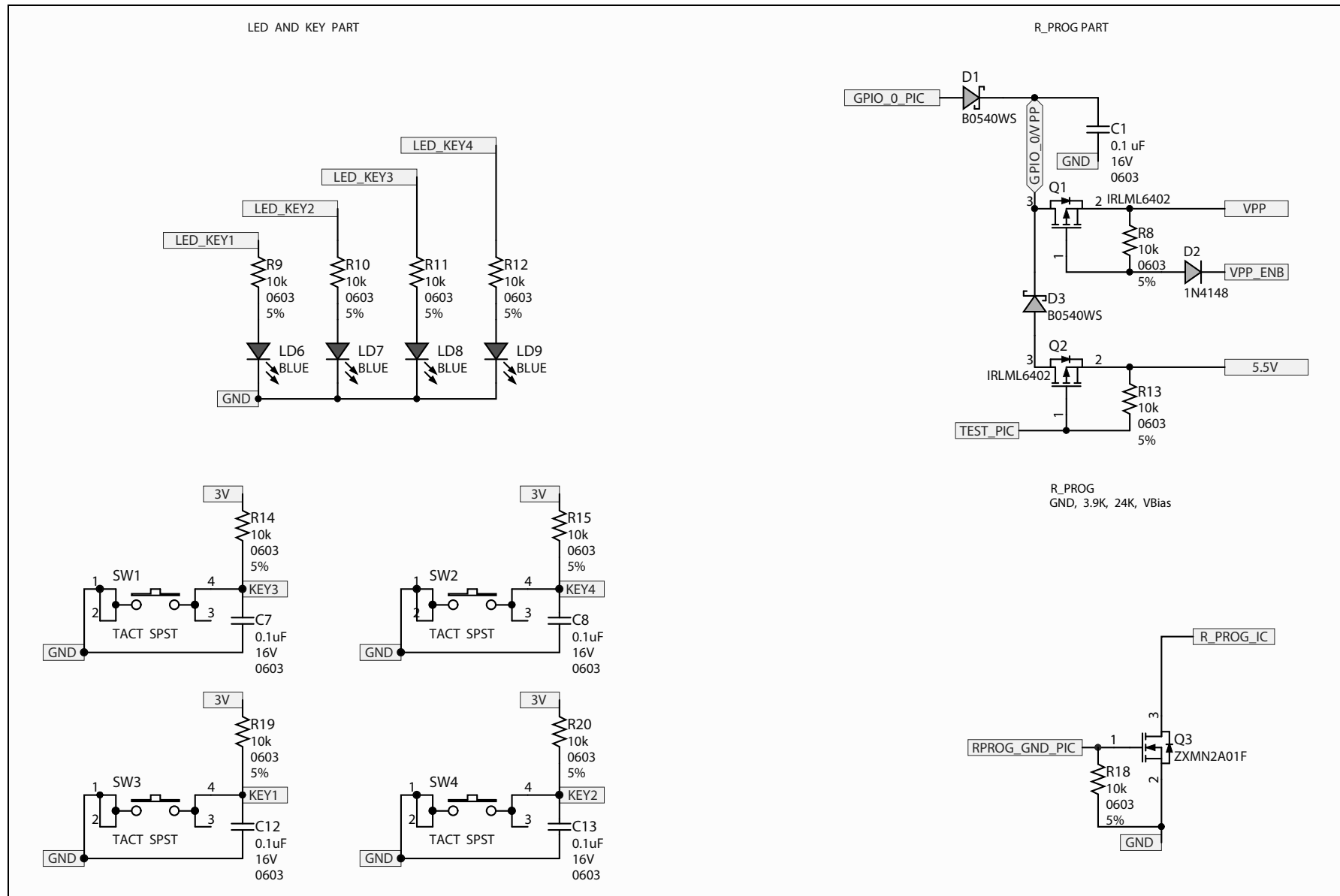
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### A.1 INTRODUCTION

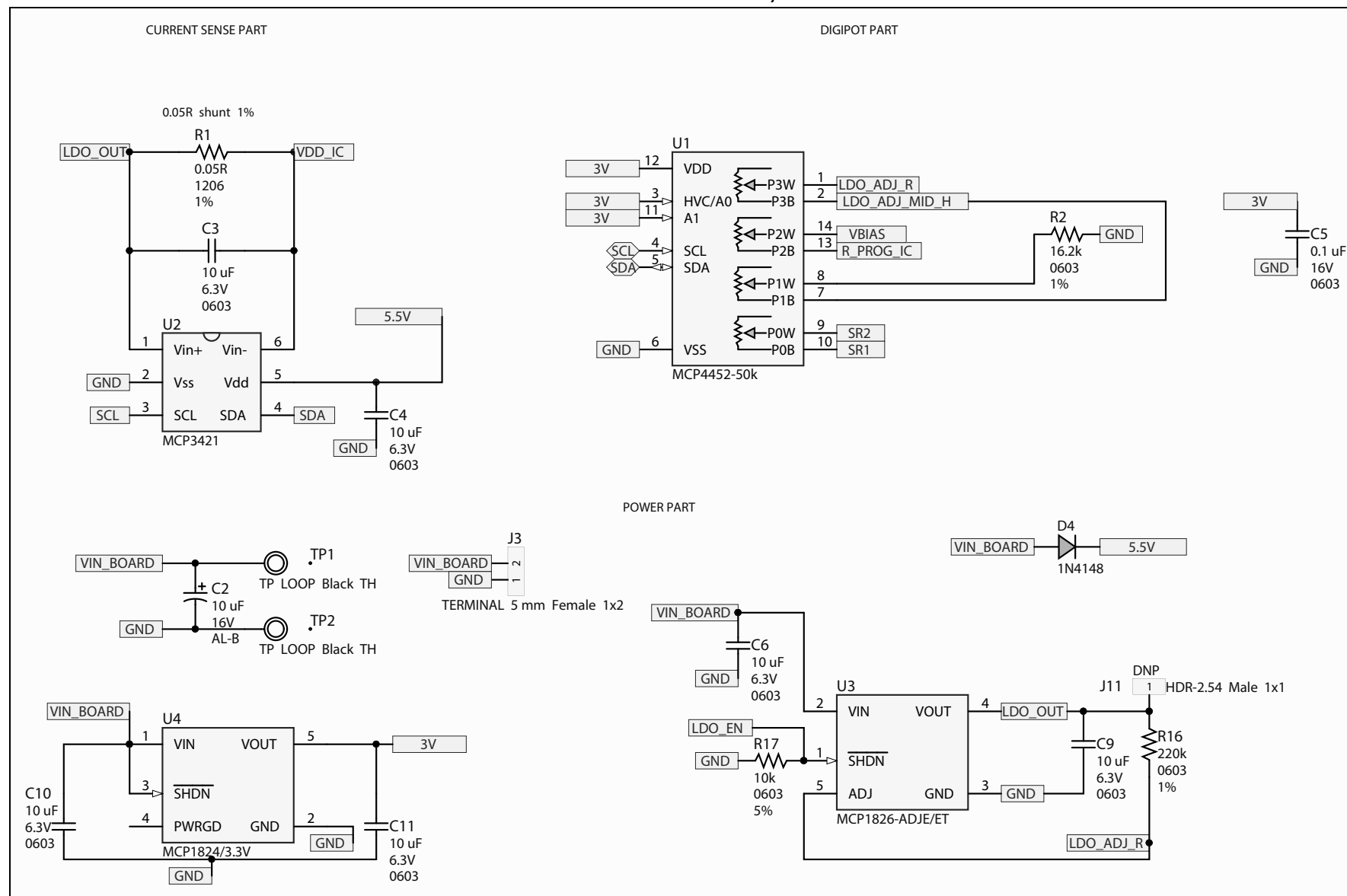
This appendix contains the schematics and layouts for the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633):

- ADM00633 Board – Schematic: LED Part, Key Part and R\_Prog Part
- ADM00633 Board – Schematic: Current Sense Part, Digipot Part and Power Part
- ADM00633 Board – Schematic: PIC24F Part
- ADM00633 Board – Schematic: MTD6508 Connector Part, USB Connection Part and Probe Part
- ADM00633 Board – Top Silk
- ADM00633 Board – Top Copper and Silk
- ADM00633 Board – Bottom Copper and Silk

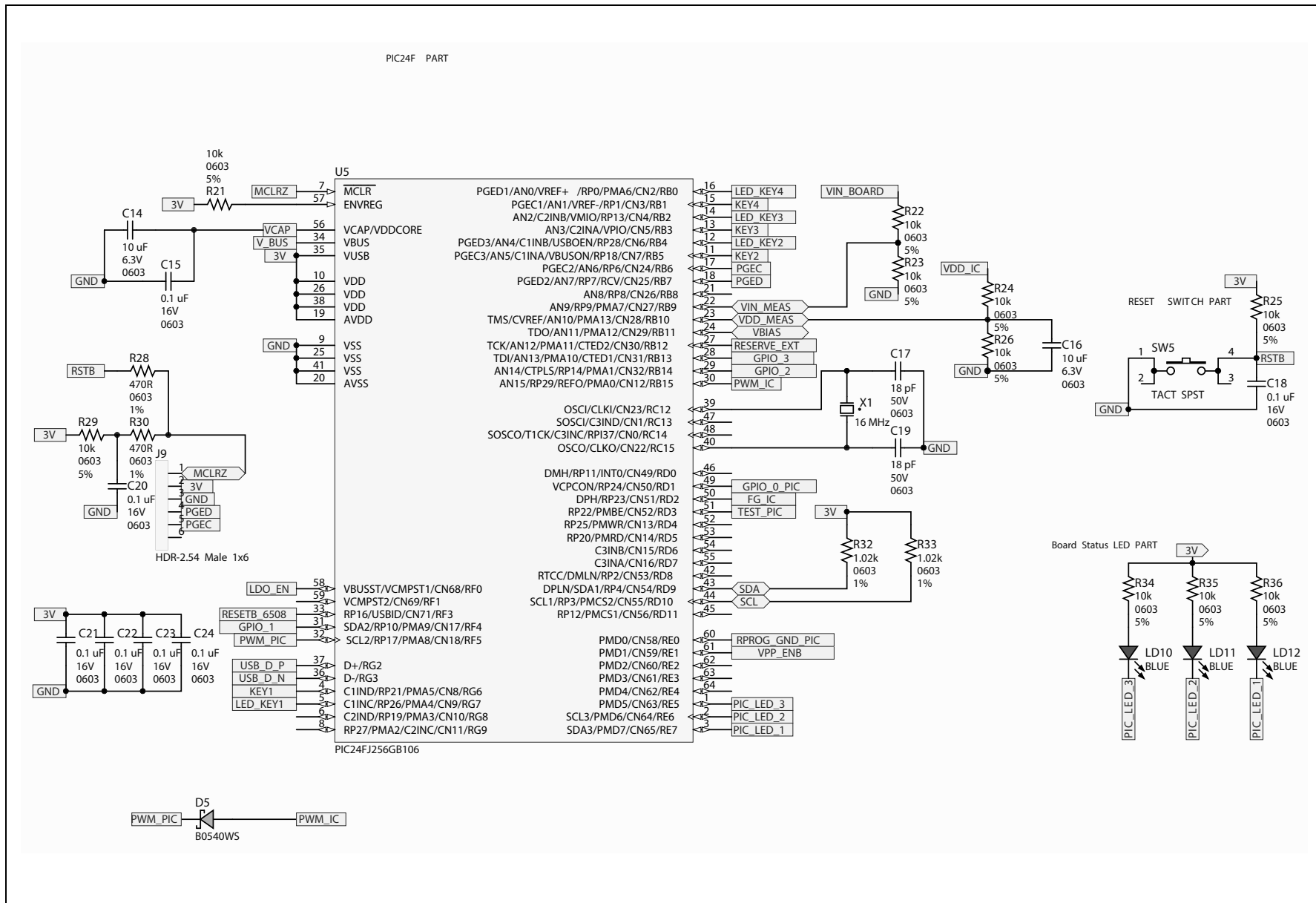
## A.2 ADM00633 BOARD – SCHEMATIC: LED PART, KEY PART AND R\_PROG PART



## Schematics and Layouts

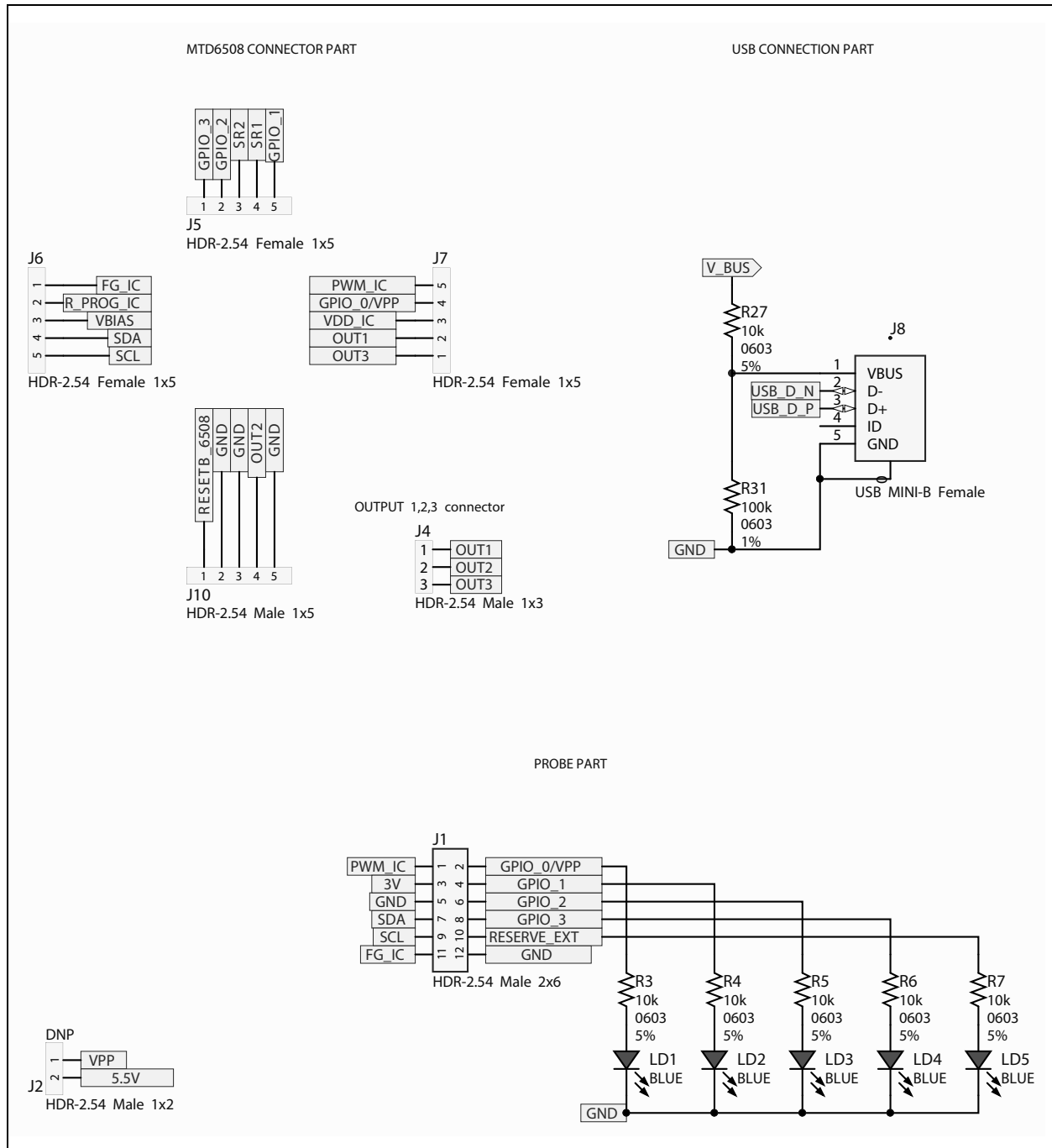


#### A.4 ADM00633 BOARD – SCHEMATIC: PIC24F PART

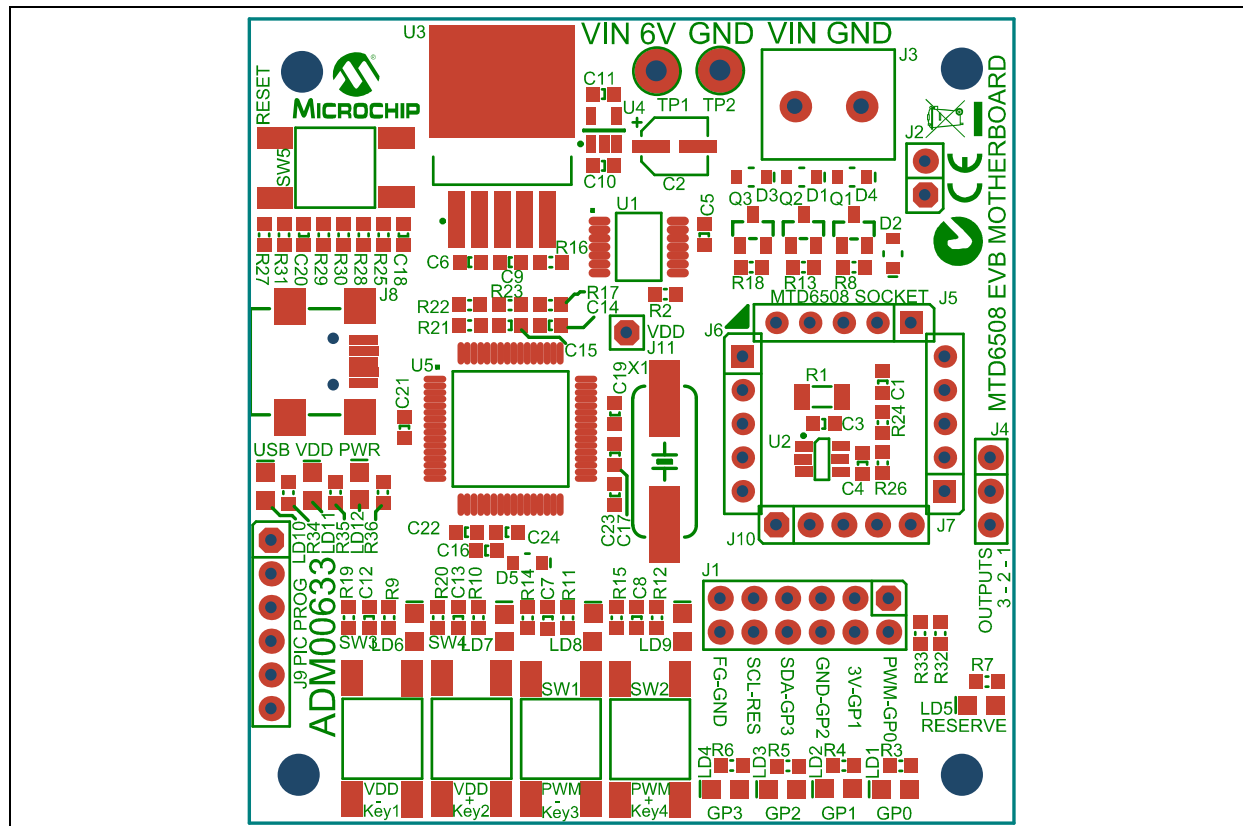




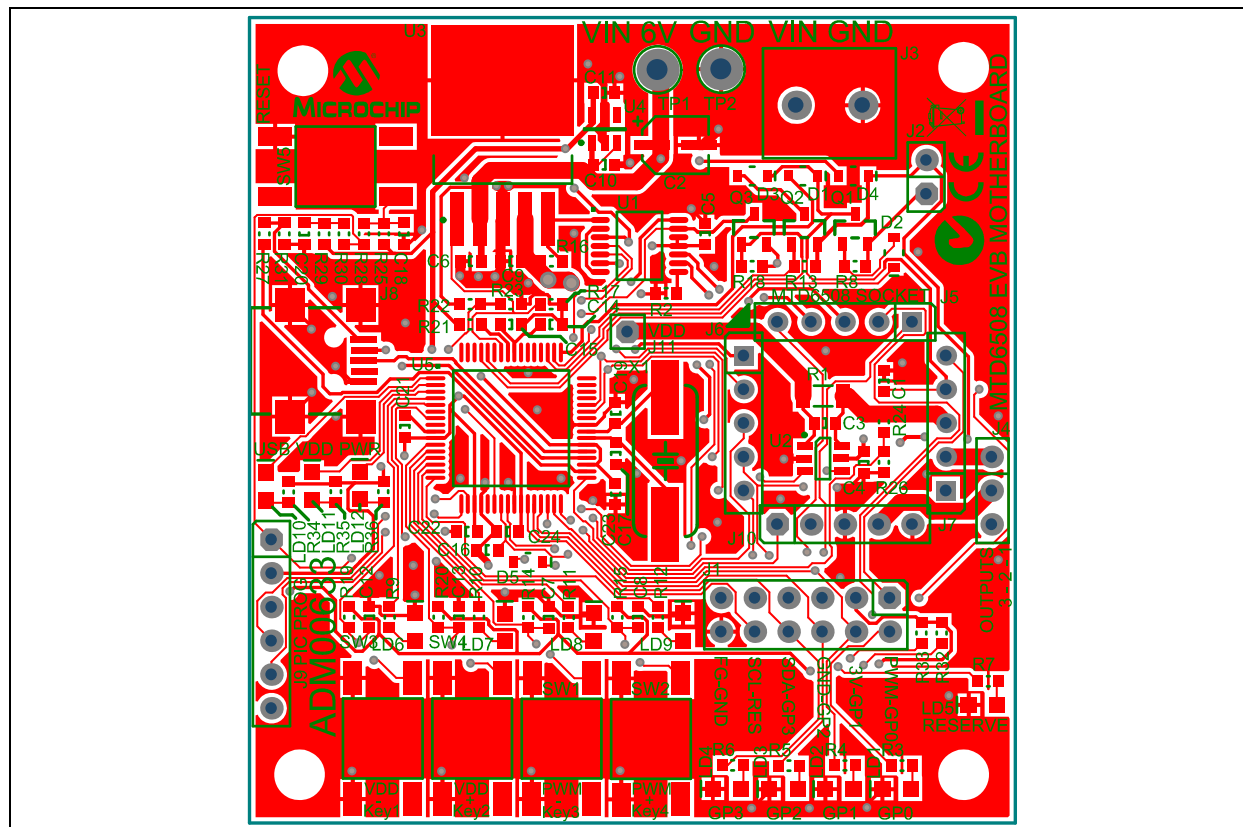
## A.5 ADM00633 BOARD – SCHEMATIC: MTD6508 CONNECTOR PART, USB CONNECTION PART AND PROBE PART



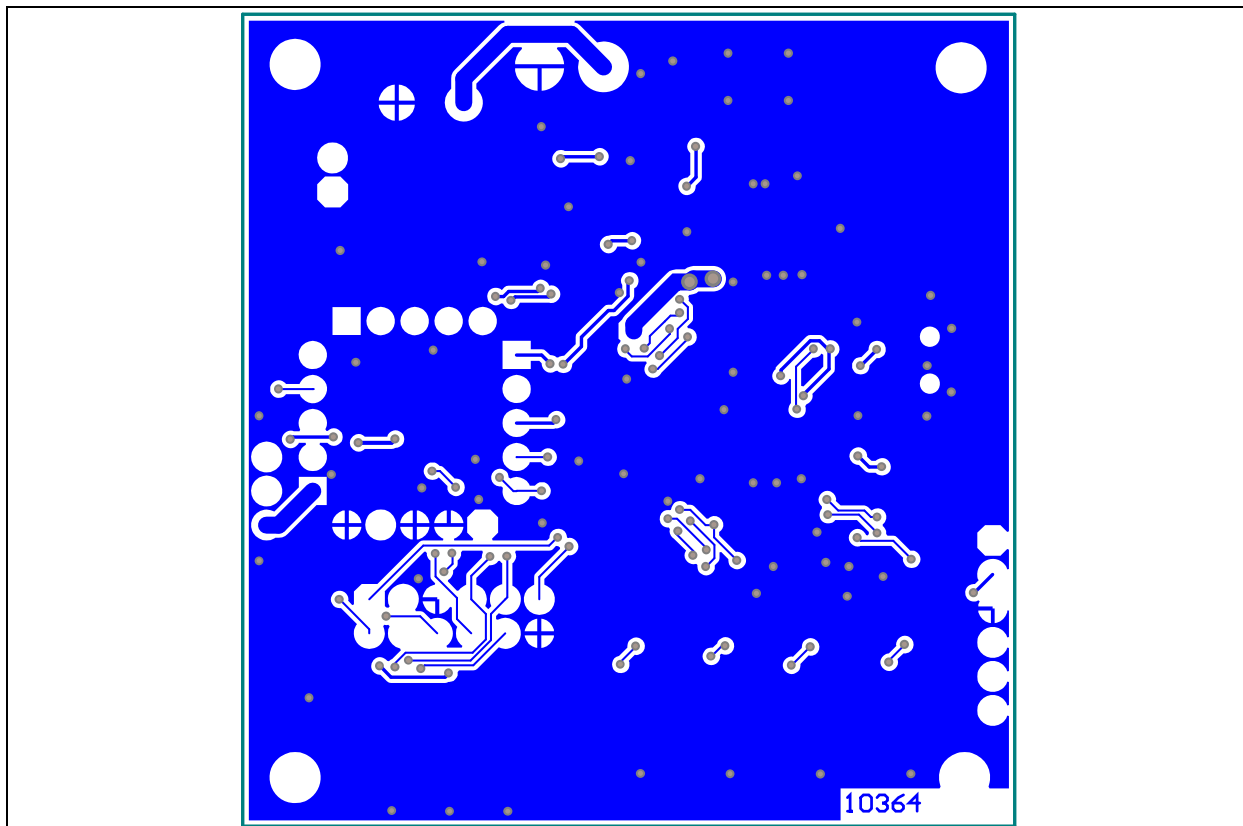
## A.6 ADM00633 BOARD – TOP SILK



## A.7 ADM00633 BOARD – TOP COPPER AND SILK



## A.8 ADM00633 BOARD – BOTTOM COPPER AND SILK



## Appendix B. Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS (BOM) – MTD6508 Demonstration Board (ADM00633)**

| Qty | Reference                                                        | Description                                        | Manufacturer                    | Part Number          |
|-----|------------------------------------------------------------------|----------------------------------------------------|---------------------------------|----------------------|
| 13  | C1, C5, C7, C8, C12, C13, C15, C16, C18, C20, C21, C22, C23, C24 | Cap. ceramic 0.1 $\mu$ F 16V 10% X7R SMD 0603      | AVX Corporation                 | 0603YC104KAT2A       |
| 1   | C2                                                               | Cap. aluminum 10 $\mu$ F 16V 20% SMD B             | Panasonic® – ECG                | EEE-1CA100SR         |
| 7   | C3, C4, C6, C9, C10, C11, C14                                    | Cap. ceramic 10 $\mu$ F 6.3V 20% X5R SMD 0603      | AVX Corporation                 | 06036D106MAT2A       |
| 2   | C17, C19                                                         | Cap. ceramic 18 pF 50V 5% NP0 SMD 0603             | KEMET®                          | C0603C180J5GACTU     |
| 3   | D1, D3, D5                                                       | Diode SCKY B0540WS 480 mV 500 mA 40V SOD-323       | Diodes® Incorporated            | B0540WS-7            |
| 2   | D2, D4                                                           | Diode RECT 1N4148 855 mV 300 mA 75V SOD-323        | Diodes Incorporated             | 1N4148WS-7           |
| 1   | J1                                                               | Conn. header - 2.54 Male 2x6 Gold 5.84 MH TH vert. | Samtec®, Inc.                   | TSW-106-07-G-D       |
| 1   | J3                                                               | Conn. terminal 5 mm 18A Female 1x2 TH R/A          | PHOENIX CONTACT                 | 1935161              |
| 1   | J4                                                               | Conn. header - 2.54 Male 1x3 Gold 5.84 MH TH R/A   | Samtec, Inc.                    | TSW-103-08-F-S-RA    |
| 3   | J5, J6, J7                                                       | Conn. header - 2.54 Female 1x5 Gold TH             | Mill-Max® Mfg. Corporation      | 801-43-005-10-001000 |
| 1   | J8                                                               | Conn. USB mini-B Female SMD R/A                    | Hirose Electric Co., Ltd.       | UX60-MB-5ST          |
| 1   | J9                                                               | Conn. header - 2.54 Male 1x6 Gold 5.84 MH TH vert. | FCI® Electronics                | 68001-106HLF         |
| 1   | J10                                                              | Conn. header - 2.54 Male 1x5 Tin 5.84 MH TH vert.  | Samtec, Inc.                    | TSW-105-07-T-S       |
| 12  | LD1, LD2, LD3, LD4, LD5, LD6, LD7, LD8, LD9, LD10, LD11, LD12    | Diode LED Blue 2.8V 20 mA 104mcd Clear SMD 0805    | Lite-On® Technology Corporation | LTST-C170TBKT        |
| 2   | Q1, Q2                                                           | Trans. FET P-CH IRLML6402 -20V -3.7A 1.3W SOT-23-3 | International Rectifier         | IRLML6402TRPBF       |
| 1   | R1                                                               | Res. MS 0.05R 1% 1W SMD 1206                       | Vishay® Intertechnology, Inc.   | WSLP1206R0500FEA     |
| 1   | R2                                                               | Res. TKF 16.2k 1% 1/10W SMD 0603                   | Panasonic – ECG                 | ERJ-3EKF1622V        |

**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.

# Bill of Materials (BOM)

**TABLE B-1: BILL OF MATERIALS (BOM) – MTD6508 Demonstration Board (ADM00633)**

| Qty | Reference                                                                                                                           | Description                                                         | Manufacturer               | Part Number                  |
|-----|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|----------------------------|------------------------------|
| 28  | R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R17, R18, R19, R20, R21, R22, R23, R24, R25, R26, R27, R29, R34, R35, R36 | Res. TKF 10k 5% 1/10W SMD 0603                                      | Panasonic – ECG            | ERJ-3GEYJ103V                |
| 1   | R16                                                                                                                                 | Res. TKF 220k 1% 1/10W SMD 0603                                     | Panasonic – ECG            | ERJ-3EKF2203V                |
| 2   | R28, R30                                                                                                                            | Res. TKF 470R 1% 1/10W SMD 0603                                     | Yageo® Corporation         | RC0603FR-07470RL             |
| 1   | R31                                                                                                                                 | Res. TF 100k 1% 1/8W SMD 0603                                       | Vishay Intertechnology     | MCT06030C1003FP500           |
| 2   | R32, R33                                                                                                                            | Res. TKF 1.02k 1% 1/10W SMD 0603                                    | Panasonic – ECG            | ERJ-3EKF1021V                |
| 5   | SW1, SW2, SW3, SW4, SW5                                                                                                             | Switch tact. SPST 12V 50 mA<br>TL3301NF160QG/TR SMD                 | E-Switch®, Inc.            | TL3301NF260QG/TR             |
| 2   | TP1, TP2                                                                                                                            | Conn. TP Loop Black TH                                              | Keystone Electronics Corp. | 5011                         |
| 1   | U1                                                                                                                                  | MCHP Analog DIGIPOT Rheostat 4-Ch 50k<br>MCP4452-503E/ST TSSOP-14   | Microchip Technology Inc.  | <b>MCP4452-503E/ST</b>       |
| 1   | U2                                                                                                                                  | MCHP Analog ADC-DELTASIGMA 18-bit<br>MCP3421A1T-E/CH SOT-23-6       | Microchip Technology Inc.  | <b>MCP3421A1T-E/CH</b>       |
| 1   | U3                                                                                                                                  | MCHP Analog LDO ADJ<br>MCP1826S-ADJE/ET DDPACK-5                    | Microchip Technology Inc.  | <b>MCP1826-ADJE/ET</b>       |
| 1   | U4                                                                                                                                  | MCHP Analog LDO 3.3V<br>MCP1824T-3302E/OT SOT-23-5                  | Microchip Technology Inc.  | <b>MCP1824T-3302E/OT</b>     |
| 1   | U5                                                                                                                                  | MCHP MCU 16-BIT 32 MHz 256 kB 16 kB<br>PIC24FJ256GB106-I/PT TQFP-64 | Microchip Technology Inc.  | <b>PIC24FJ256GB106T-I/PT</b> |
| 1   | Q3                                                                                                                                  | Trans. FET N-CH ZXMN2A01F 20V 1.9A<br>625 mW SOT-23-3               | Diodes Incorporated        | ZXMN2A01FTA                  |
| 1   | X1                                                                                                                                  | Crystal 16 MHz 18 pF SMD HC49/US                                    | Abracon® Corporation       | ABLS-16.000MHZ-B4-T          |

**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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