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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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) 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
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 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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- 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.

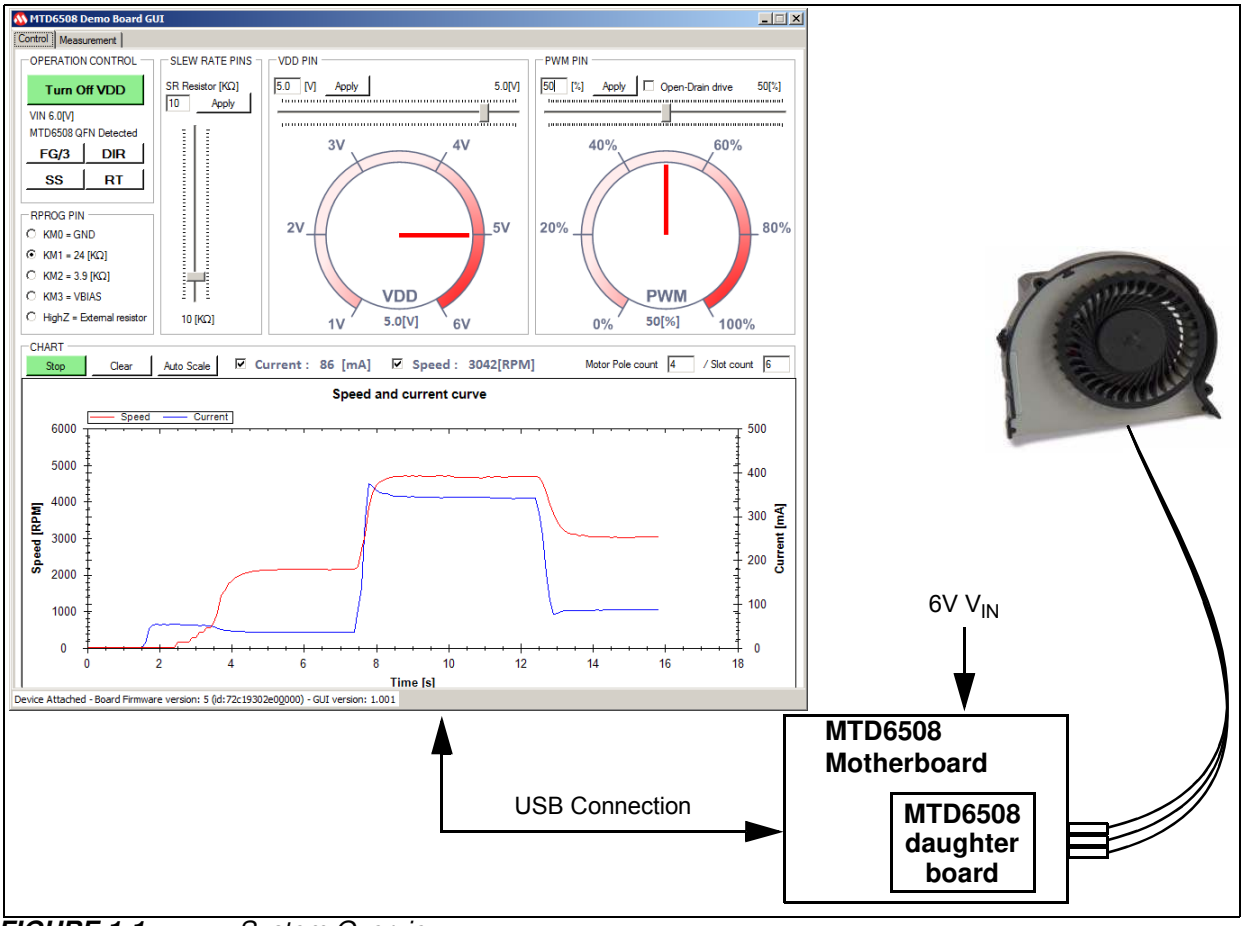


FIGURE 1-1: *System Overview.*

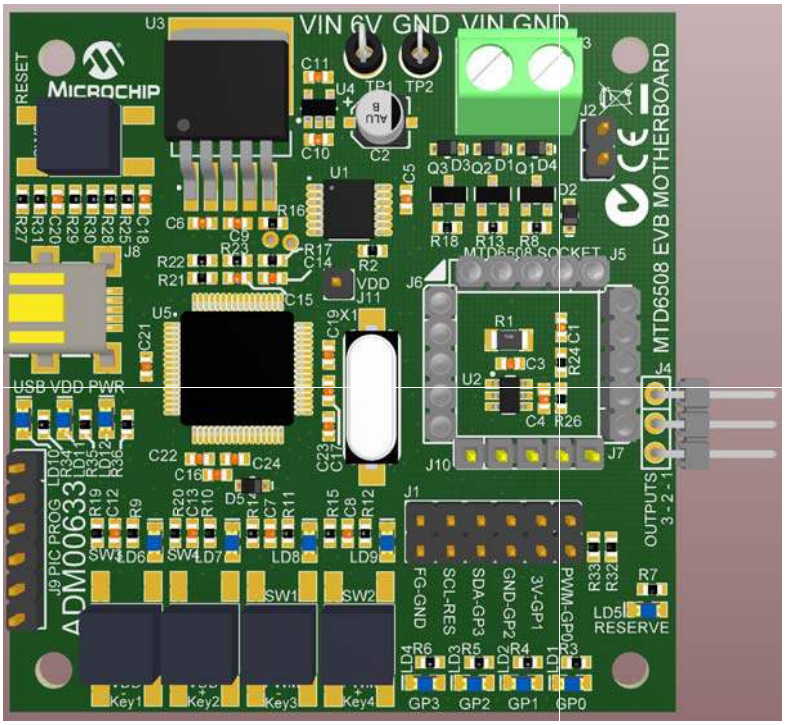


FIGURE 1-2: *MTD6508 3-Phase BLDC Sensorless Fan Controller Demonstration Motherboard (ADM00633) Overview.*

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.

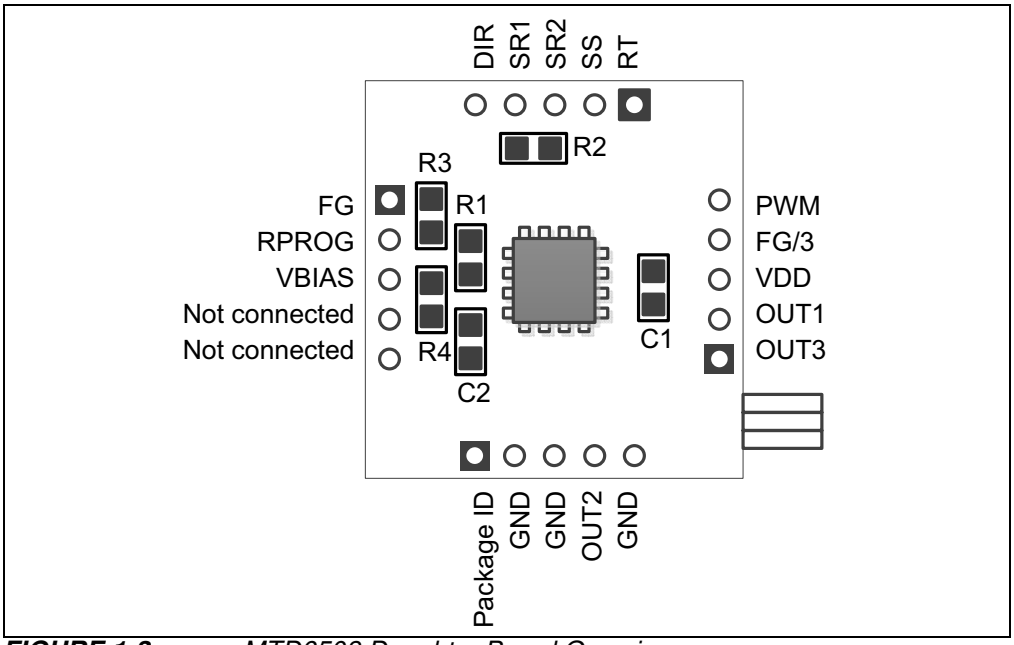


FIGURE 1-3: *MTD6508 Daughter Board Overview.*

- 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

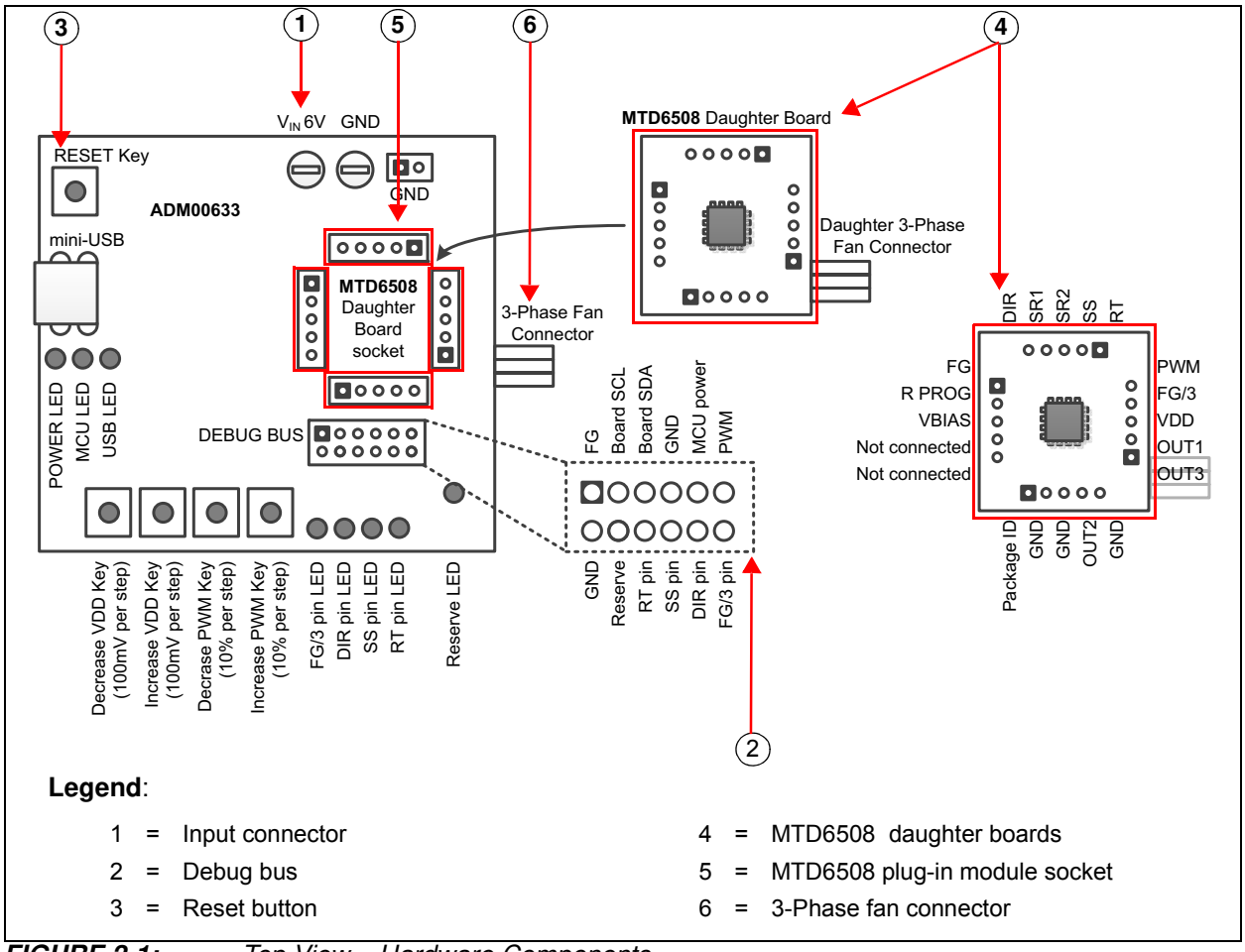
Chapter 2. Installation and Operation

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.



Legend:

1 = Input connector
2 = Debug bus
3 = Reset button
4 = MTD6508 daughter boards
5 = MTD6508 plug-in module socket
6 = 3-Phase fan connector

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 ±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.

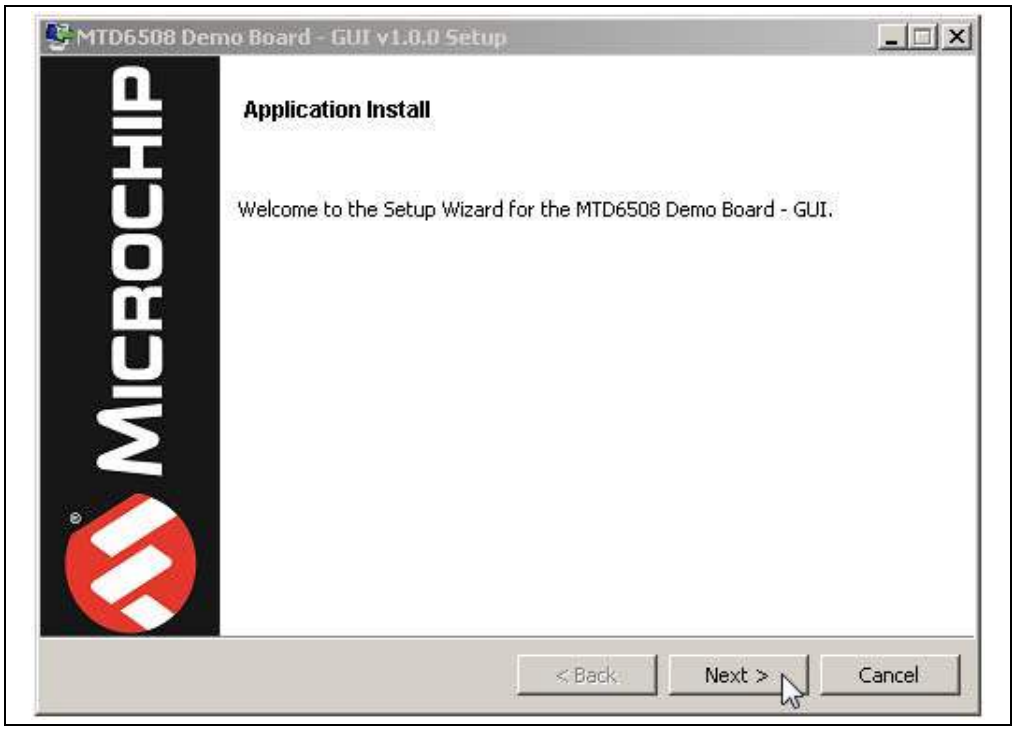


FIGURE 2-2: *MTD6508 Demonstration Board Software GUI – Welcome Screen.*

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.**

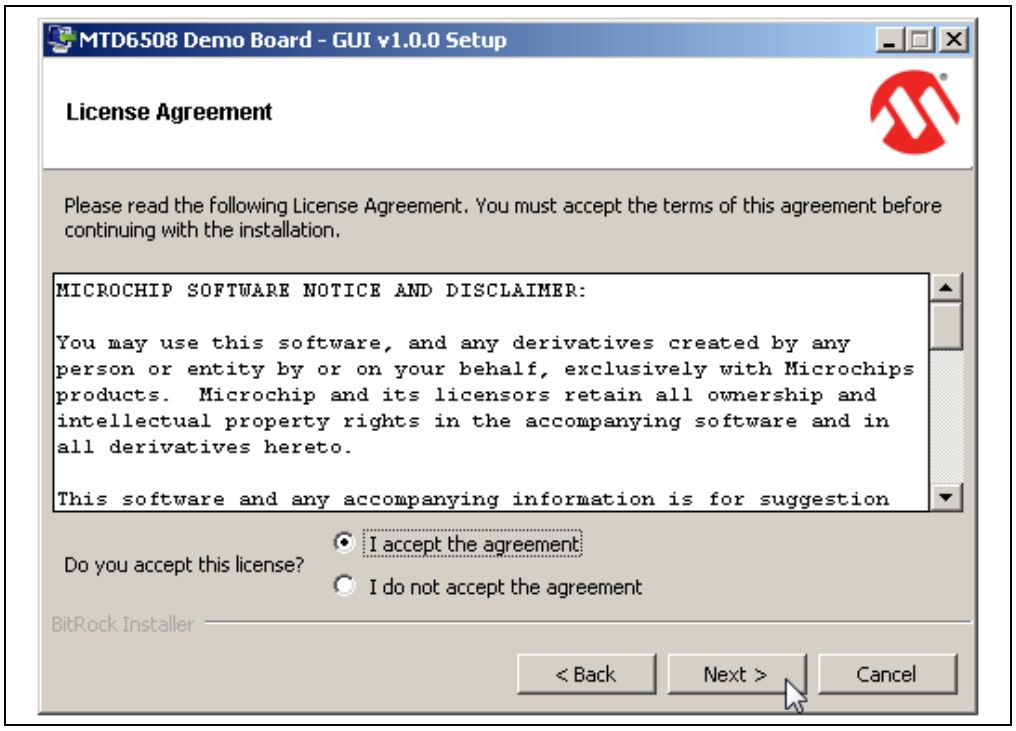


FIGURE 2-3: *MTD6508 Demonstration Board Software GUI – License Agreement Screen.*

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

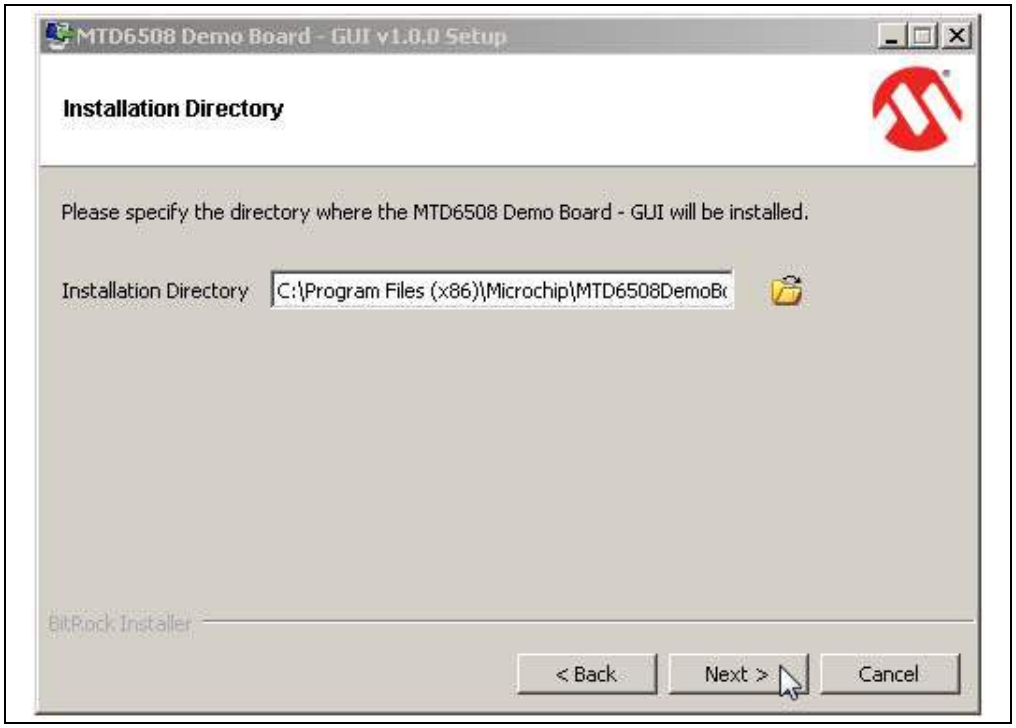


FIGURE 2-4: *MTD6508 Demonstration Board Software GUI – Installation Directory Dialog.*

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

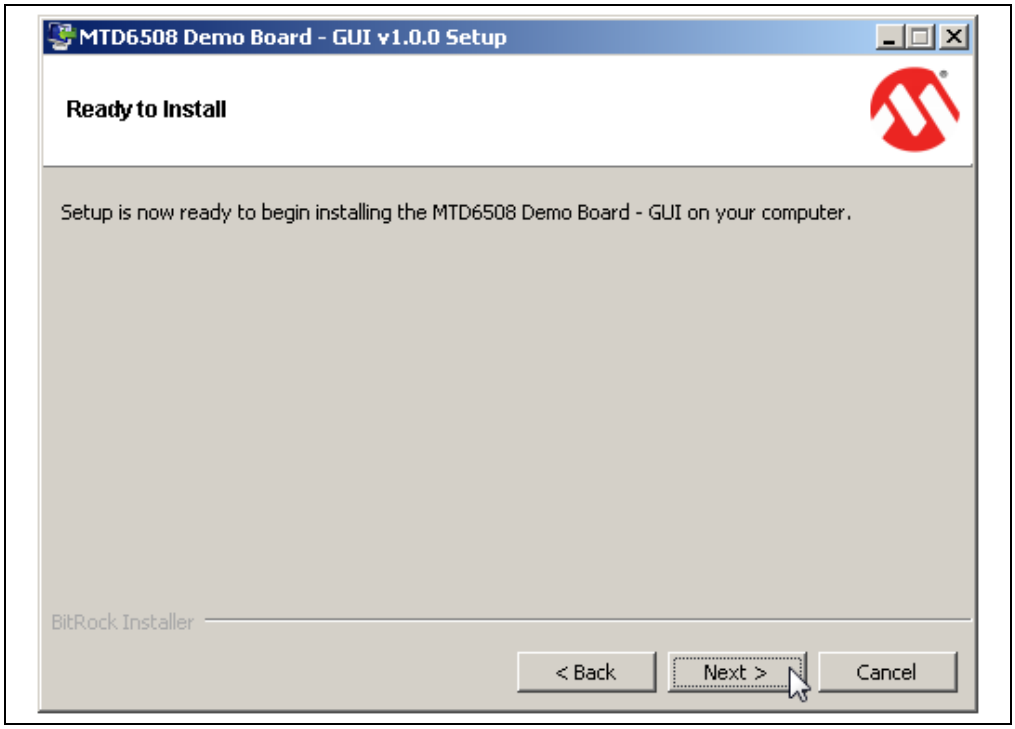


FIGURE 2-5: *MTD6508 Demonstration Board Software GUI – Ready to Install Screen.*

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

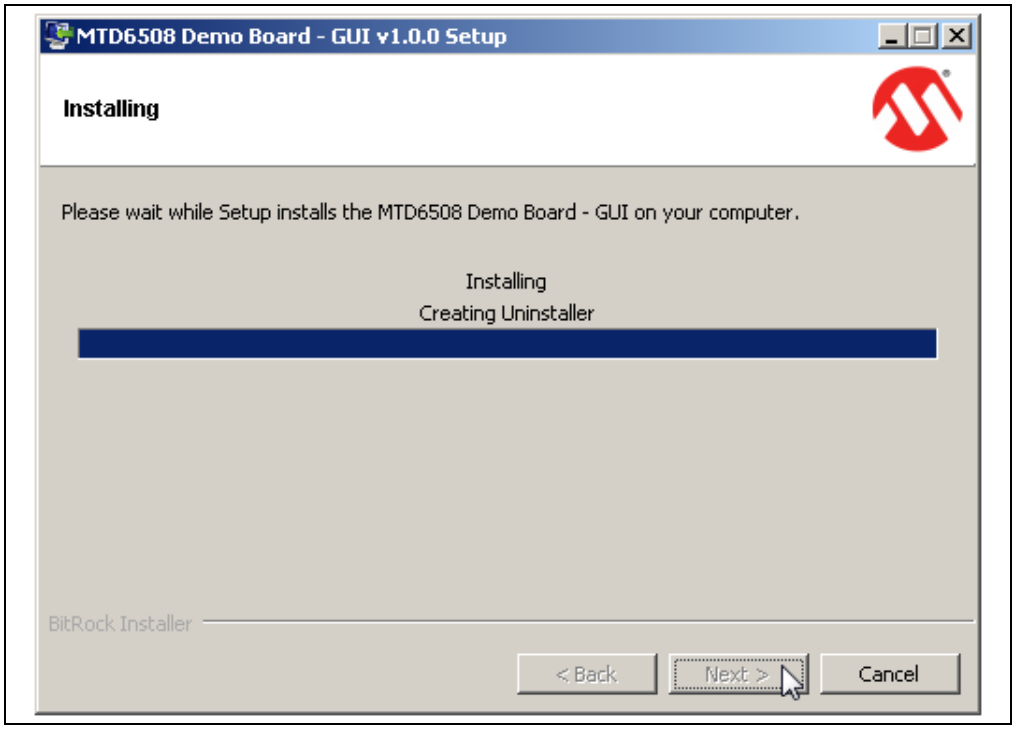


FIGURE 2-6: *MTD6508 Demonstration Board Software GUI – Installation Status Window.*

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

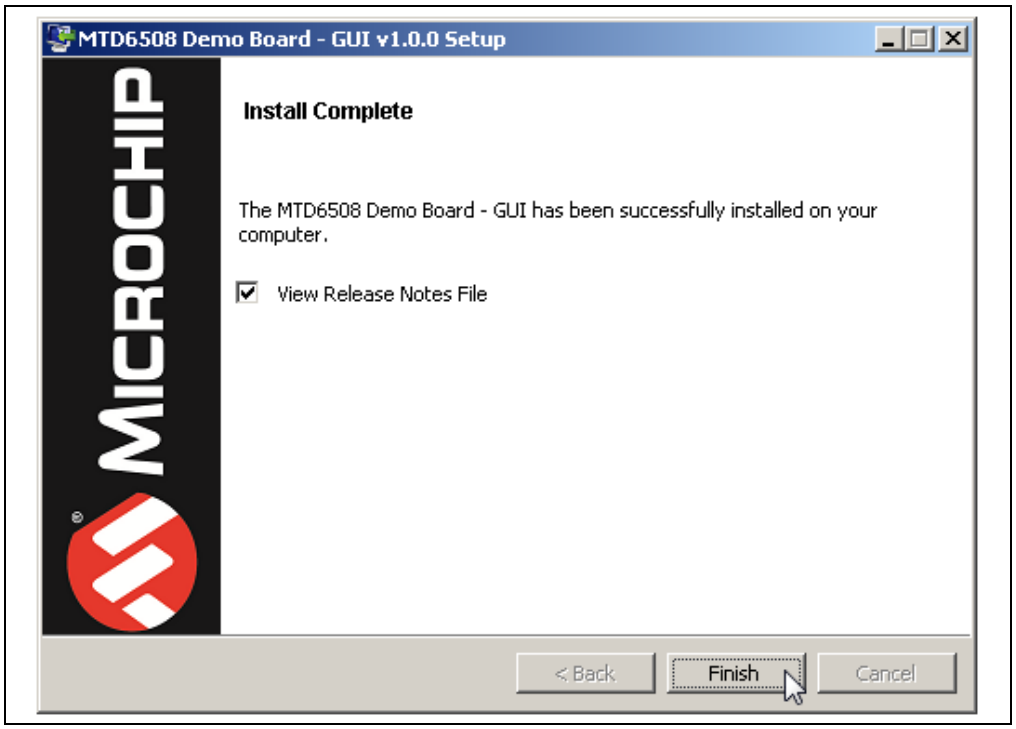


FIGURE 2-7: *MTD6508 Demonstration Board Software GUI – Install Complete Screen.*

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 ±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

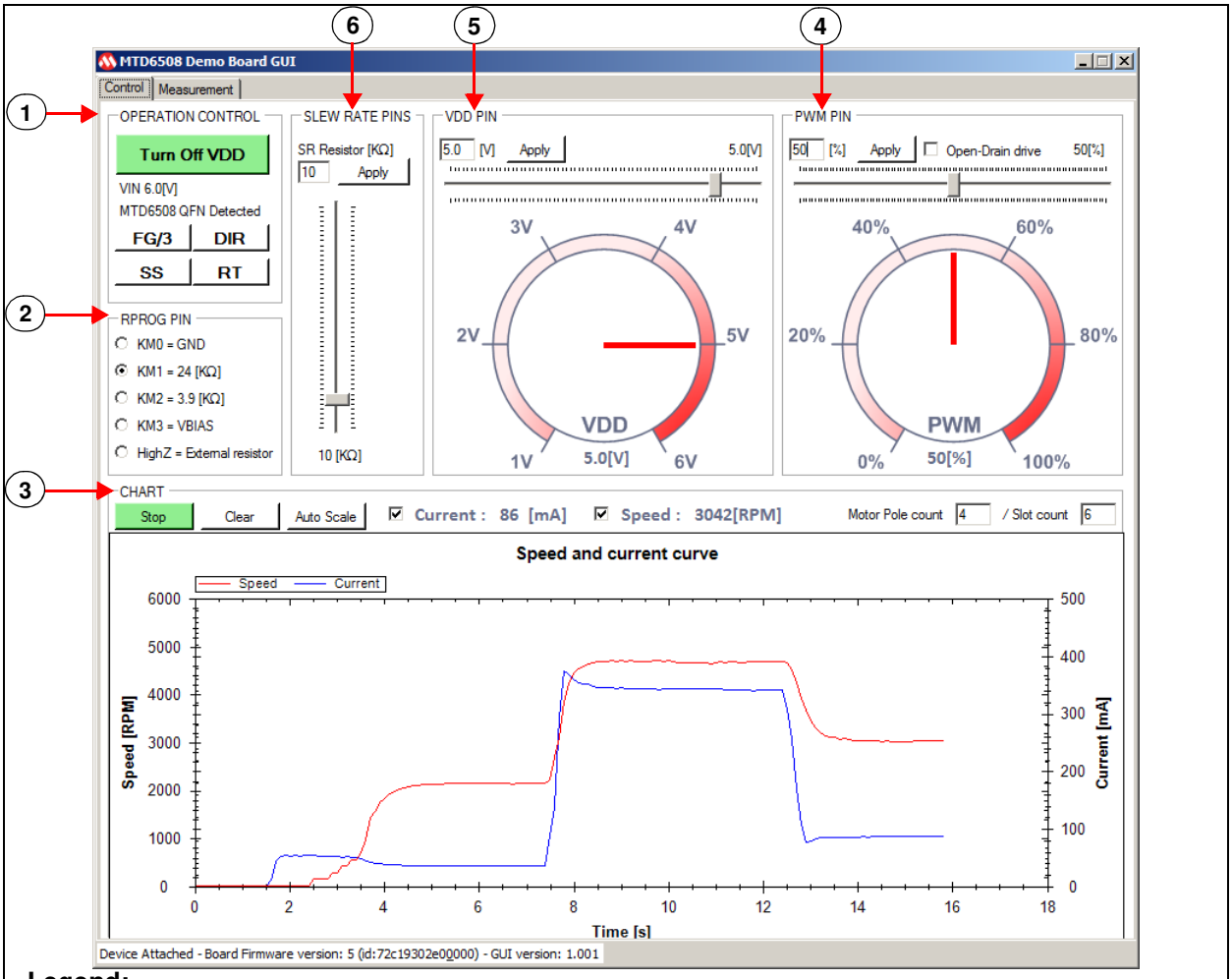
3.1 MTD6508 DEMONSTRATION BOARD SOFTWARE GUI DESCRIPTION

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.



Legend:

1 = Operation Control group box
2 = R_{PROG} Pin group box
3 = Chart group box
4 = PWM Pin Control group box
5 = V_{DD} Pin Control group box
6 = Slew Rate Pins Control group box

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 KM 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.

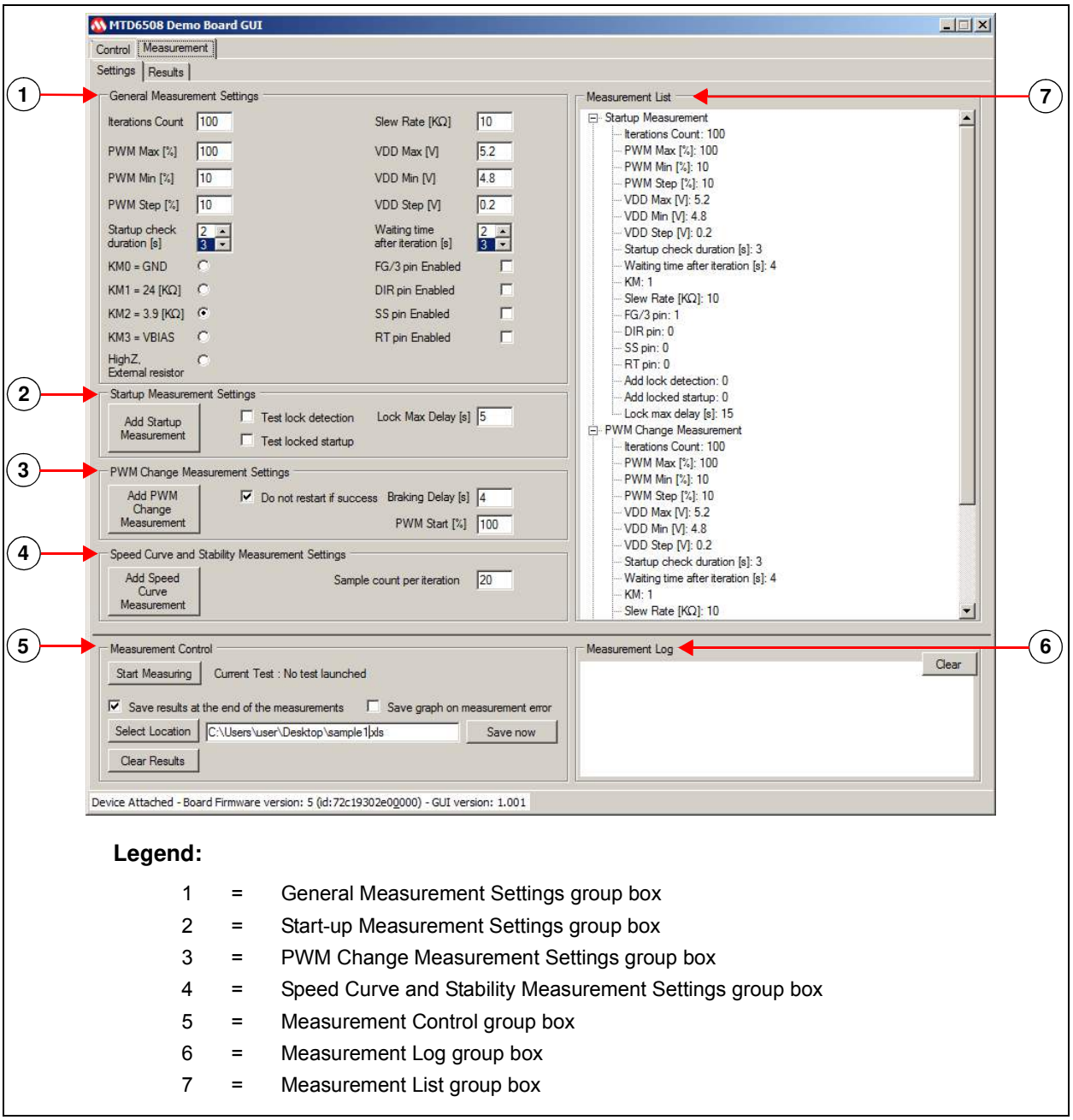
3.1.2 Measurement Tab

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.



Legend:

1	=	General Measurement Settings group box
2	=	Start-up Measurement Settings group box
3	=	PWM Change Measurement Settings group box
4	=	Speed Curve and Stability Measurement Settings group box
5	=	Measurement Control group box
6	=	Measurement Log group box
7	=	Measurement List group box

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

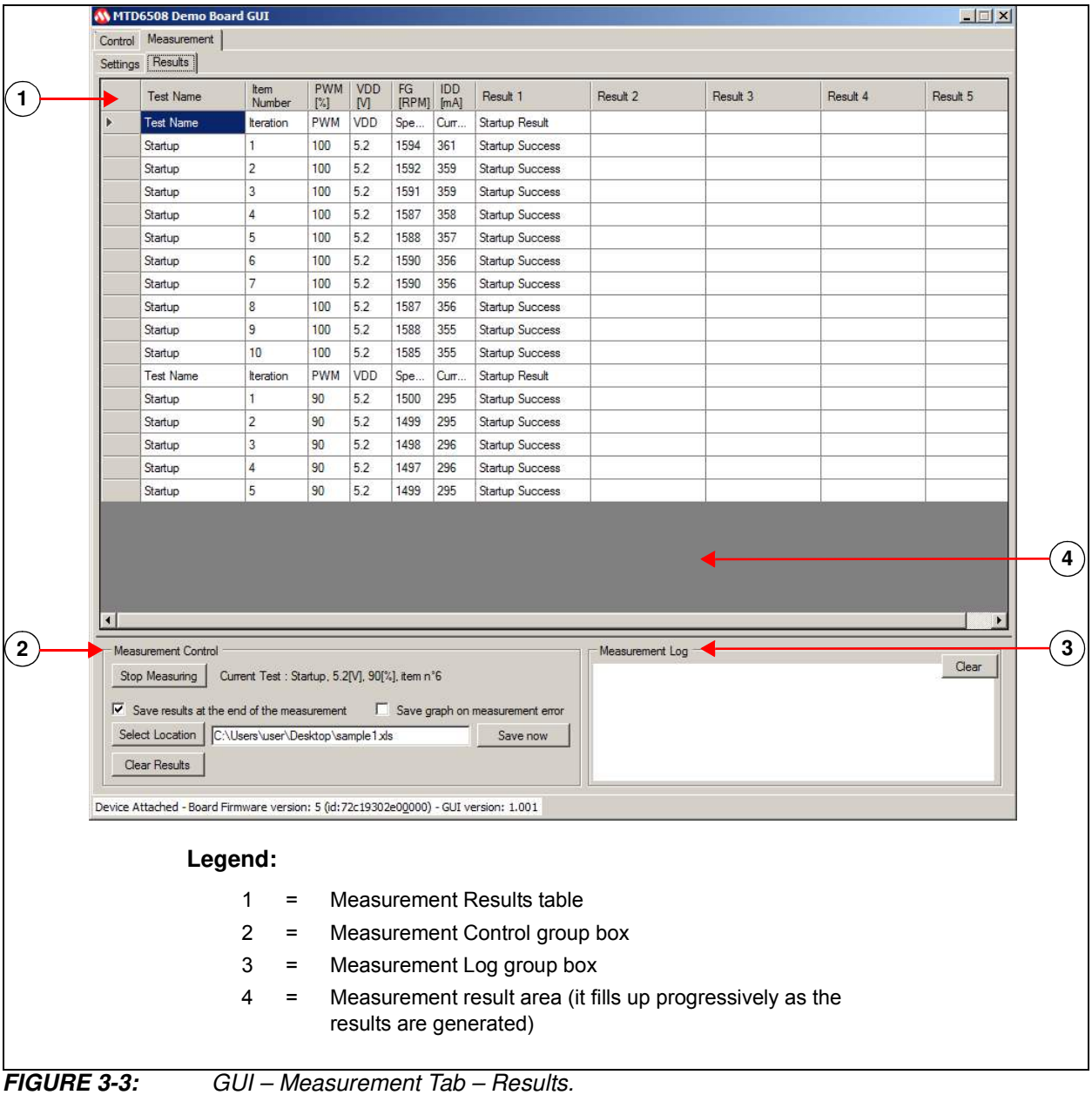
This group box consists of a tree view that summarizes all measurements that have been selected by the user.

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.

3.1.2.2 MEASUREMENT RESULTS TAB

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



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_{PROG} Value Correctly

This section explains how to define the K_M value correctly for a specific fan. K_M is linked to R_{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_{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_{PROG} values.

TABLE 3-1: R_{PROG} VALUE

R_{PROG}	K_M	K_M Range (mV/Hz)
V_{BIAS} (0Ω)	3	26 - 52
3.9 kΩ	2	13 - 26
24 kΩ	1	6.5 - 13
GND	0	3.25 - 6.5

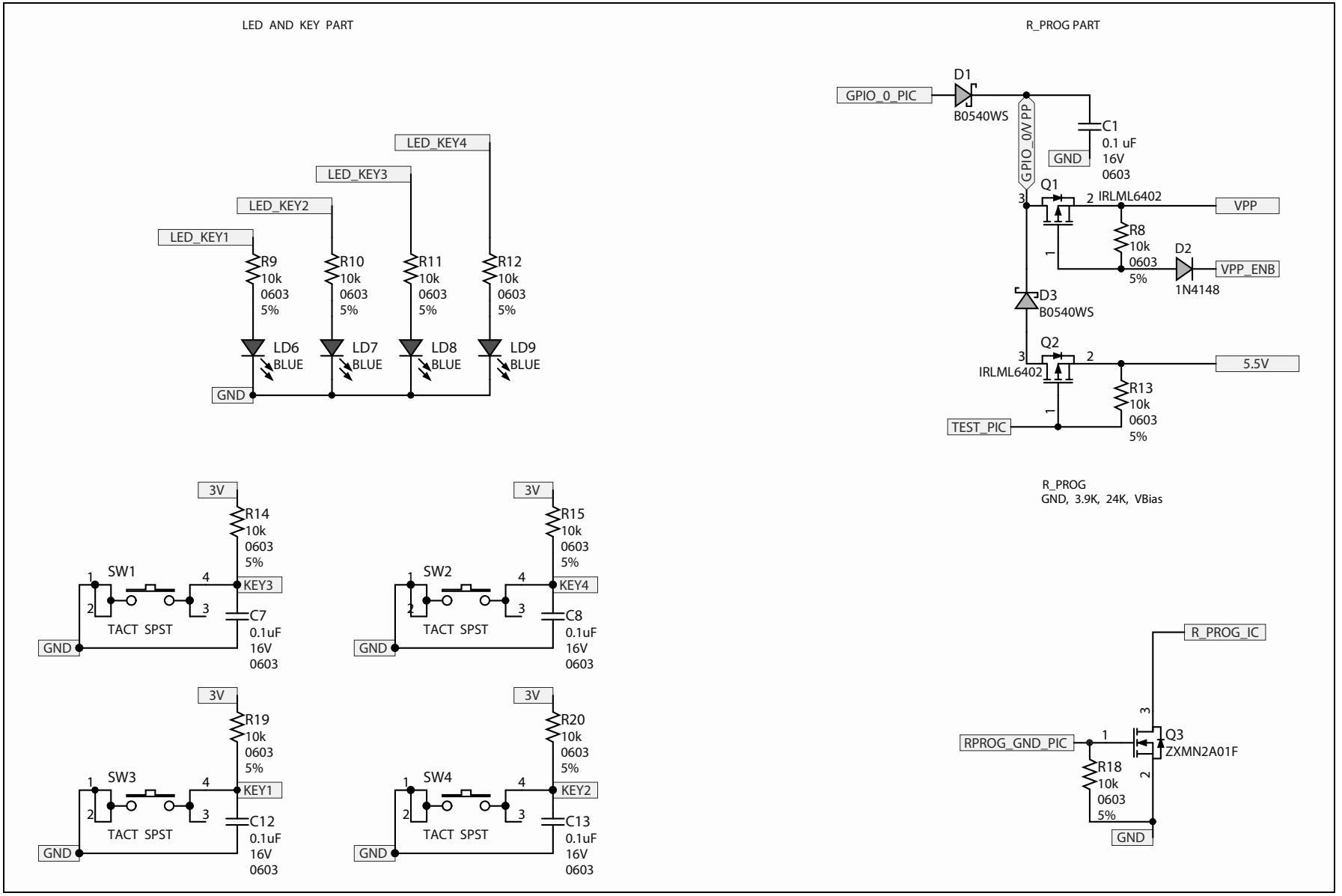
Appendix A. Schematics and Layouts

A.1 INTRODUCTION

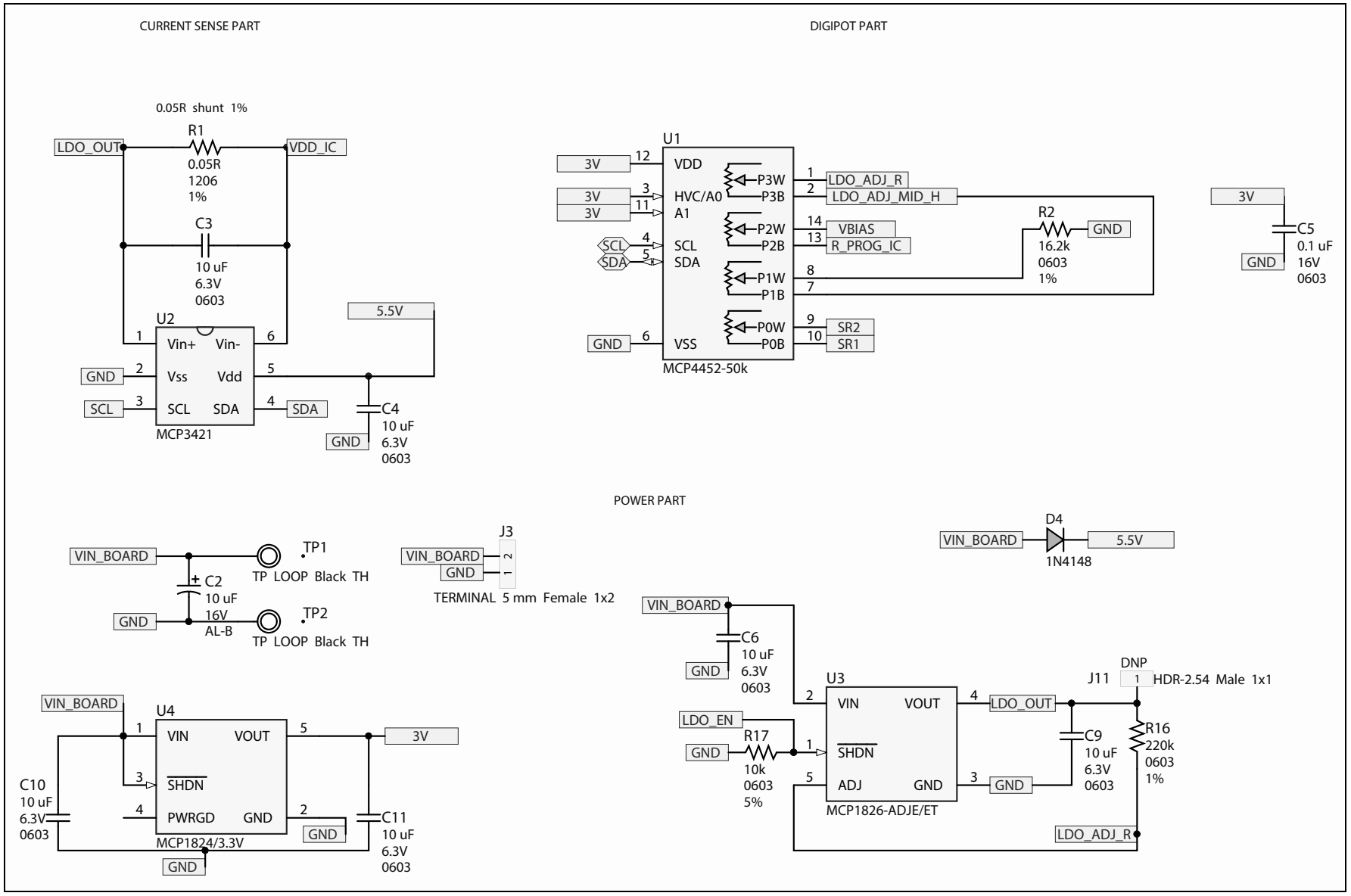
This appendix contains the schematics and layouts for the MTD6508 3-Phase BLDC Sensorless Fan Controller Demo Motherboard (ADM00633):

- 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

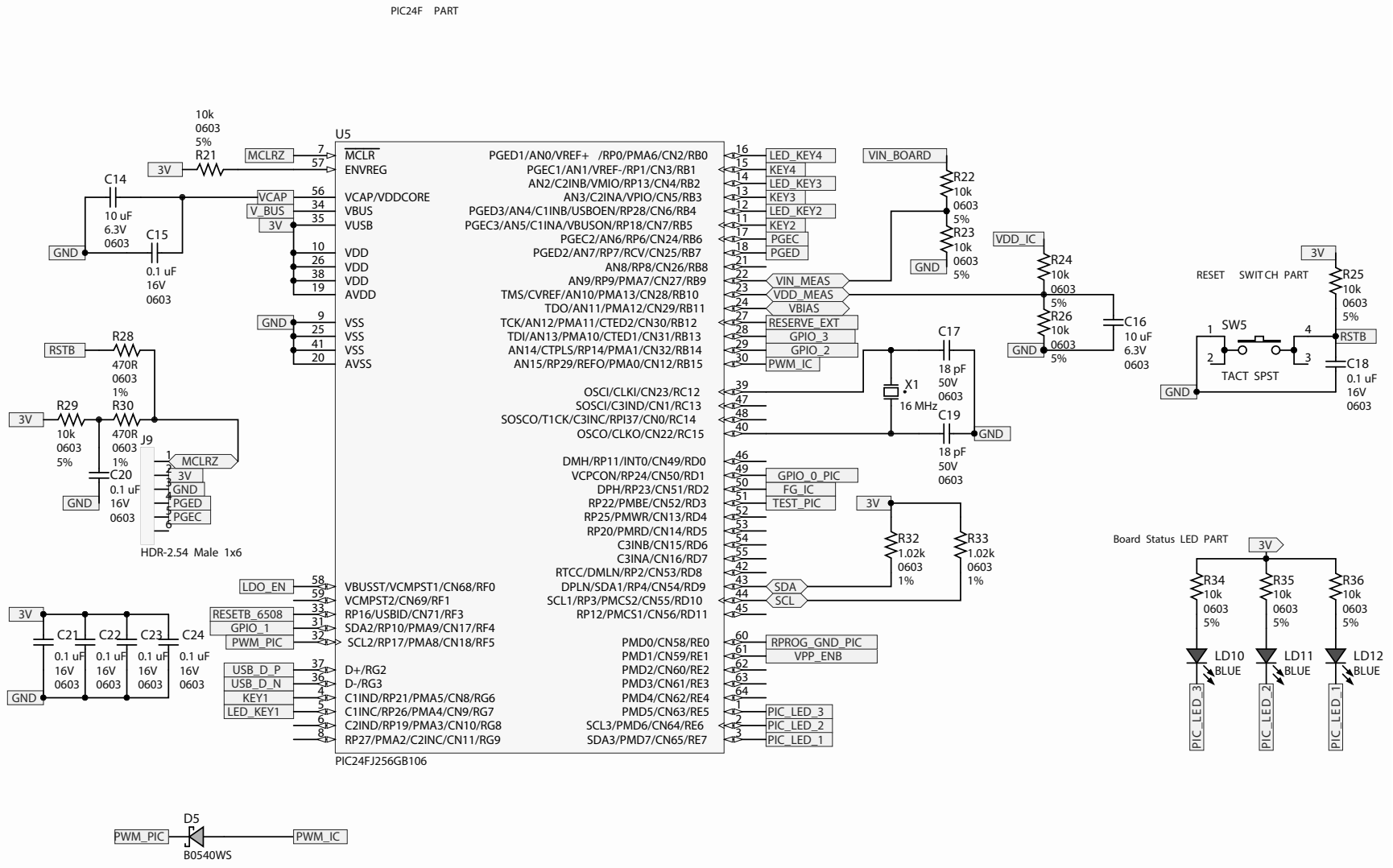
A.2 ADM00633 BOARD – SCHEMATIC: LED PART, KEY PART AND R_PROG PART



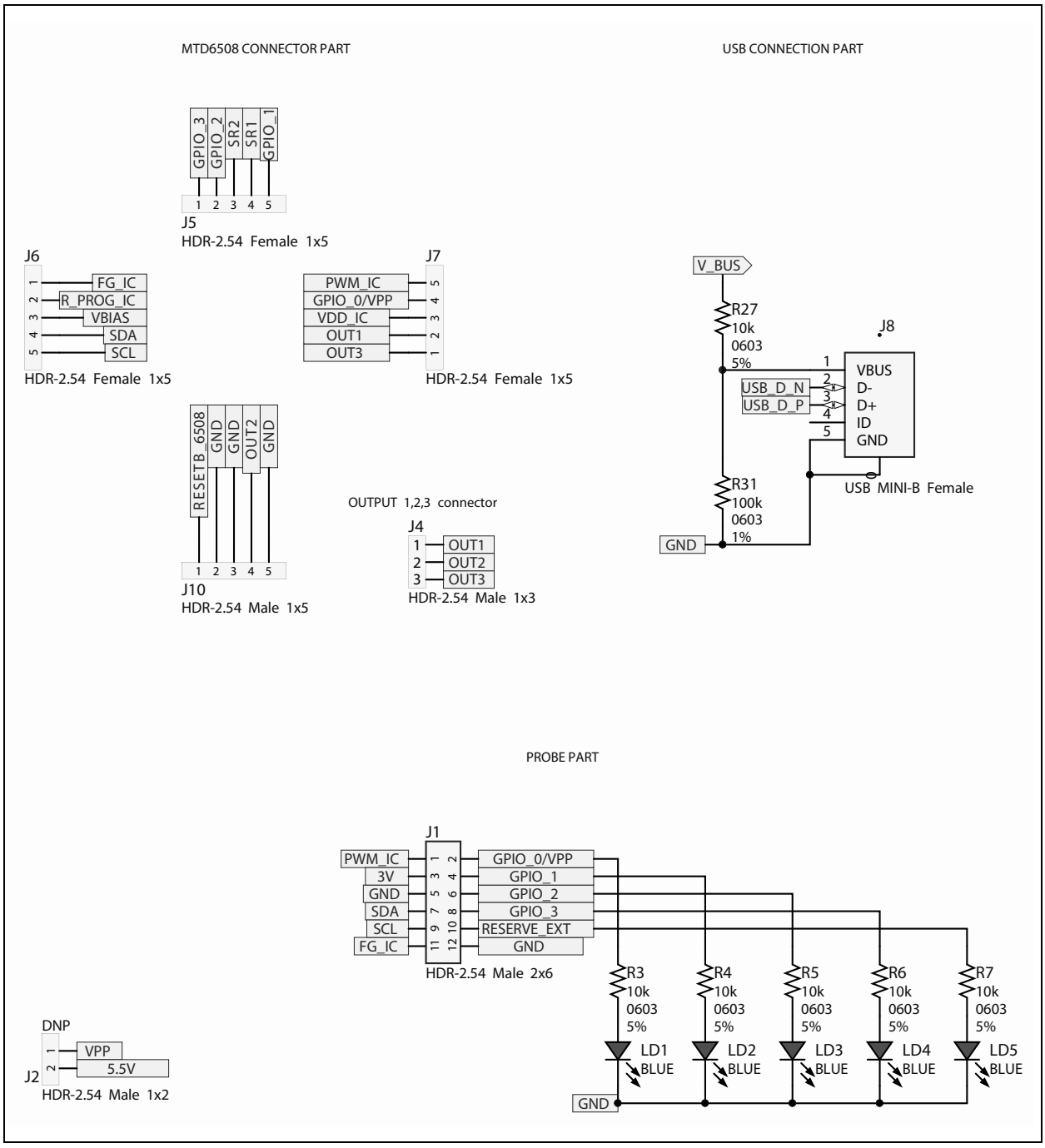
A.3 ADM00633 BOARD – SCHEMATIC: CURRENT SENSE PART, DIGIPOT PART AND POWER PART



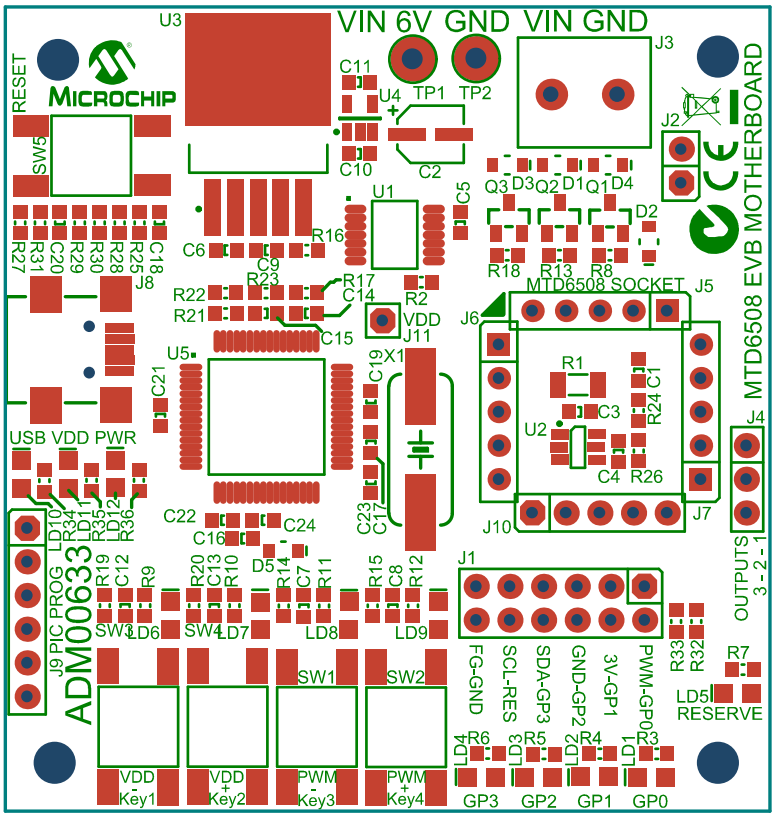
A.4 ADM00633 BOARD – SCHEMATIC: PIC24F PART



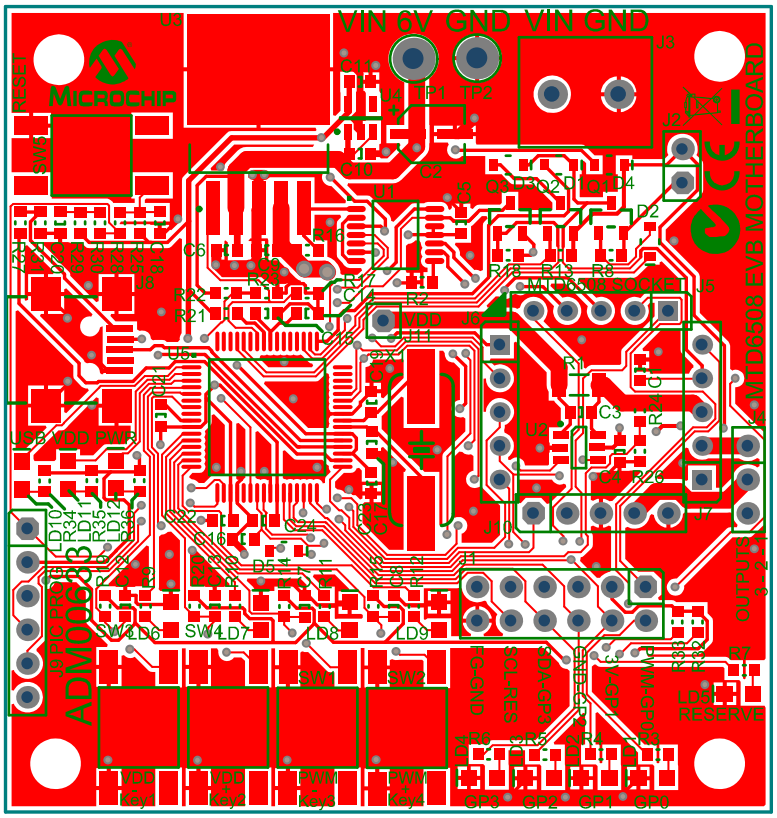
A.5 ADM00633 BOARD – SCHEMATIC: MTD6508 CONNECTOR PART, USB CONNECTION PART AND PROBE PART



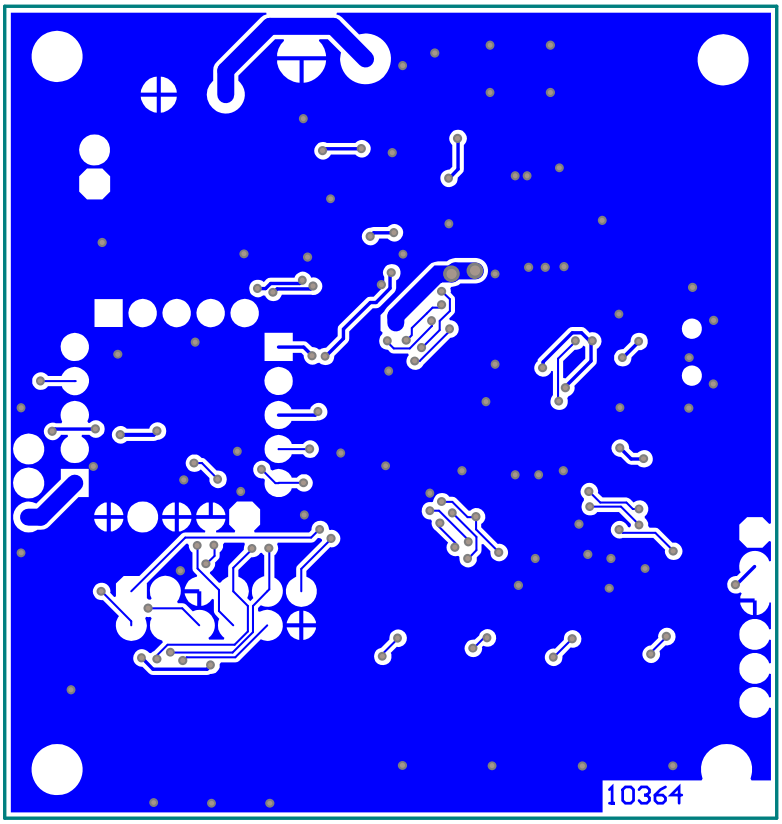
A.6 ADM00633 BOARD – TOP SILK



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 µF 16V 10% X7R SMD 0603	AVX Corporation	0603YC104KAT2A
1	C2	Cap. aluminum 10 µF 16V 20% SMD B	Panasonic® – ECG	EEE-1CA100SR
7	C3, C4, C6, C9, C10, C11, C14	Cap. ceramic 10 µF 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 SCTKY 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.

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 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 MCP4452-503E/ST TSSOP-14	Microchip Technology Inc.	**MCP4452-503E/ST**
1	U2	MCHP Analog ADC-DELTASIGMA 18-bit MCP3421A1T-E/CH SOT-23-6	Microchip Technology Inc.	**MCP3421A1T-E/CH**
1	U3	MCHP Analog LDO ADJ MCP1826S-ADJE/ET DDPAK-5	Microchip Technology Inc.	**MCP1826-ADJE/ET**
1	U4	MCHP Analog LDO 3.3V MCP1824T-3302E/OT SOT-23-5	Microchip Technology Inc.	**MCP1824T-3302E/OT**
1	U5	MCHP MCU 16-BIT 32 MHz 256 kB 16 kB PIC24FJ256GB106-I/PT TQFP-64	Microchip Technology Inc.	**PIC24FJ256GB106T-I/PT**
1	Q3	Trans. FET N-CH ZXMN2A01F 20V 1.9A 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.

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