ADM00879
Demonstration Board
User's Guide

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Table of Contents

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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 ADM00879 Fan Controller Demonstration Board. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Warranty Registration
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the ADM00879 Fan Controller Demonstration Board 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 ADM00879 Fan Controller Demonstration Board.
- **Chapter 2. "Installation and Operation"** – Includes instructions on installing and starting the Microchip Thermal Management Utility application.
- **Chapter 3. "Microchip Thermal Management Utility"**– includes instructions on operating the Thermal Management Utility.
- **Chapter 4. "Hardware Description"**– Contains a detailed description of the ADM00879 Fan Controller Demonstration Board
- **Appendix A. "Schematic and Layouts"** – Shows the schematics and layout diagrams for the ADM00879 Fan Controller Demonstration Board.
- **Appendix B. "Bill of Materials (BOM)"** – Lists the parts used to build the ADM00879 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) { ... }`

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RECOMMENDED READING

This user's guide describes how to use the ADM00879 Fan Controller Demonstration Board. Other useful documents are listed below. The following Microchip document is available and recommended as a supplemental reference resource:

EMC1438 Data Sheet – *"1°C Multiple Temperature Sensor with Hardware Controlled Standby and Hottest of Multiple Zones"* (DS20005513A)

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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the web site at:
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DOCUMENT REVISION HISTORY

Revision A (May 2018)

- Initial Release of this Document.

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Chapter 1. Product Overview

1.1 INTRODUCTION

This chapter provides an overview of the ADM00879 Fan Controller Demonstration Board and covers the following topics:

- EMC2305 Device Short Overview
- EMC1438 Device Short Overview
- What Is the ADM00879 Demonstration Board?
- ADM00879 Demonstration Board Kit Contents

1.2 EMC2305 DEVICE SHORT OVERVIEW

The EMC2305 device is an SMBus (System Management Bus) compliant and I^2C (Inter-integrated Circuit) compatible fan controller, with up to five independently controlled PWM (Pulse Width Modulation) fan drivers. Each fan driver is controlled by a programmable frequency PWM driver and FSC (Fan Speed Control) algorithm, which operates in either a closed loop fashion or as a directly PWM-controlled device.

The closed loop FSC algorithm has the capability to detect aging fans and alert the system. Likewise, it detects stalled or locked fans and triggers an interruption.

1.3 EMC1438 DEVICE SHORT OVERVIEW

The EMC1438 device is a high-accuracy, low-cost, SMBus temperature sensor (I^2C compatible). Advanced features such as Resistance Error Correction (REC), Beta Compensation and automatic diode type detection combine to provide a robust solution for complex environmental-monitoring applications.

EMC1438 monitors up to eight temperature channels (up to seven external and one internal). The device provides ±1°C accuracy for the internal and external diode temperatures.

1.4 WHAT IS THE ADM00879 DEMONSTRATION BOARD?

The ADM00879 Fan Controller Demonstration Board provides an example of a fan-control application, by using the EMC2305 fan controller and EMC1438 temperature sensor. There are 5 fan channels, 2 on-board temperature sensors and 6 remote temperature sensor inputs available.

The low-voltage circuits are powered from either the micro USB connector or the 2.1 mm Jack for 12V fan supply (power adapter not included), making it possible to run the PC application and set all the parameters without powering the fan drivers. Test points for the 12V input are also available.

I^2C communication is provided over USB using the on-board MCP2221 USB to I^2C bridge. The Thermal Management Utility graphic user interface (GUI) automatically detects the board and loads the appropriate interface.

An on-board heat source with 4 heat levels is provided for demonstrative purposes.

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The demonstration GUI is equipped with options to manually setup all the parameters for the thermal sensor and the fan controller. The GUI also provides a fully automatic temperature control interface, where any fan channel can be linked to any temperature channel.

1.5 ADM00879 DEMONSTRATION BOARD KIT CONTENTS

The ADM00879 Demonstration Board kit includes the following:

- One ADM00879 Fan Controller Demonstration Board
- Important Information Sheet
- USB cable
- Two NPN transistors in TO-92 package to be used as remote temperature diodes.

Note: An additional power supply or bench supply is needed for powering the fans.

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

This section describes how to install the Microchip Thermal Management Utility GUI, required in order to interact with the ADM00879 Demonstration Board.

2.2 SYSTEM REQUIREMENTS

The ADM00879 Demonstration Board is designed to be used with a personal computer (desktop or laptop) running Microsoft® Windows® 7 or later. For USB connectivity, the minimal physical requirement for the PC is a standard type-A USB 2.0 port.

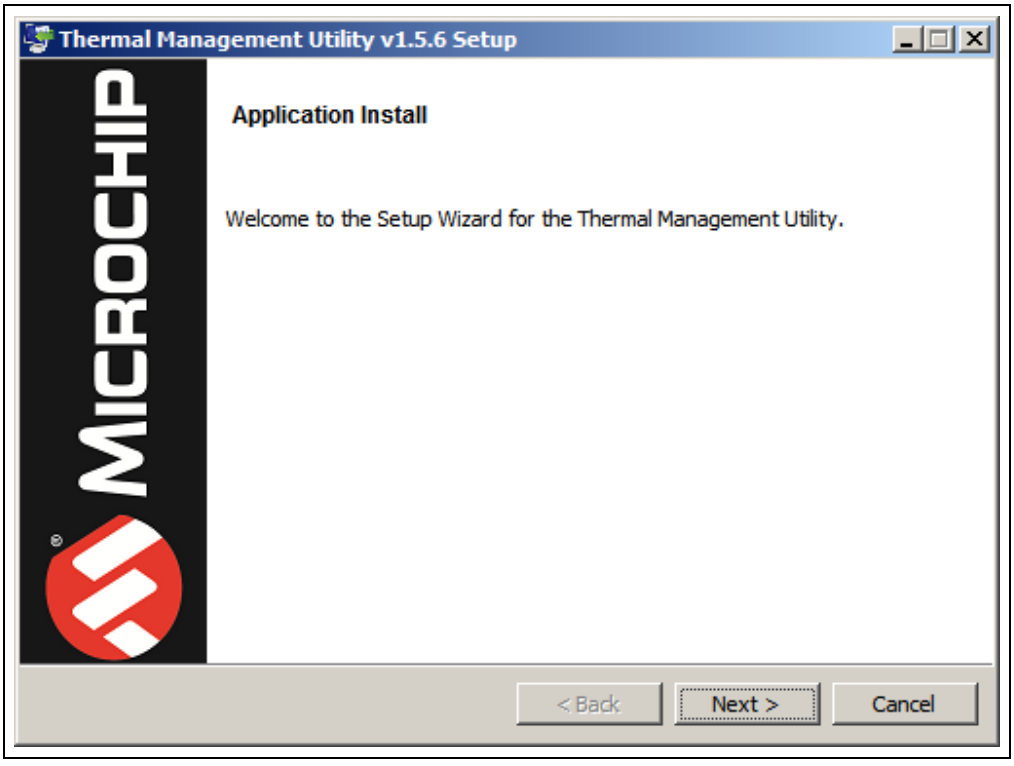
2.3 MICROCHIP THERMAL MANAGEMENT UTILITY GUI INSTALLATION

Go to www.microchip.com and search for EMC2305 or EMC1438 and download the Thermal Management Utility (version 1.5.6 or newer).

If an older version of the software is already installed, you have to remove it before installing the new one.

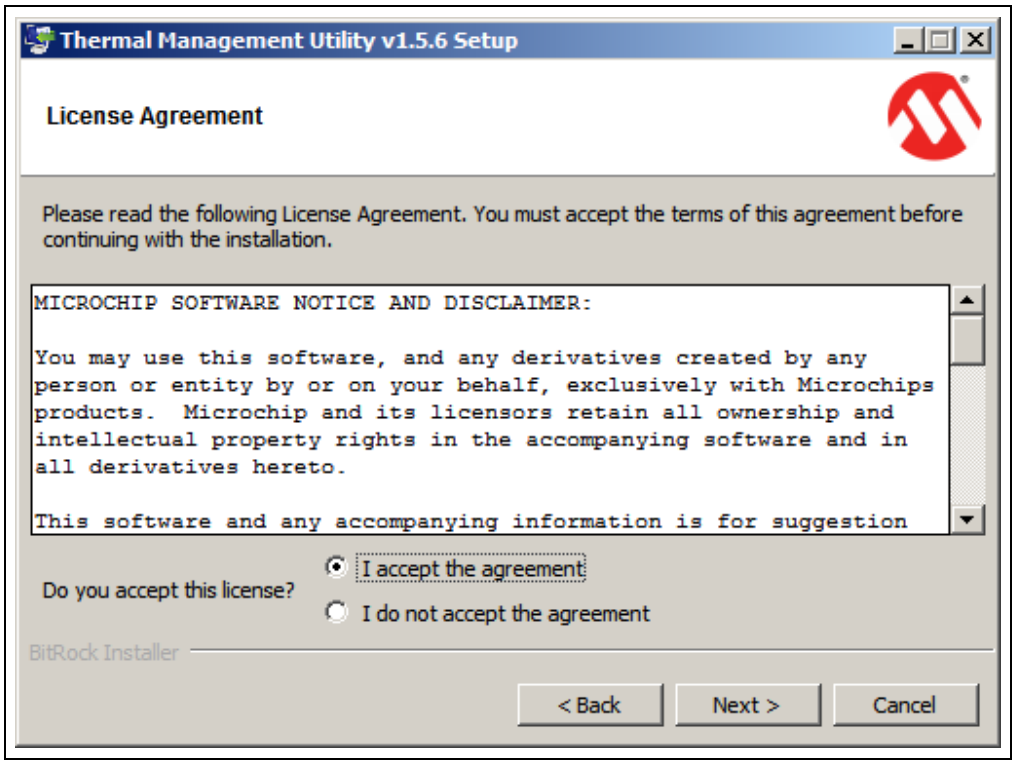
Follow the next steps to proceed with the installation.

FIGURE 2-1: THERMAL MANAGEMENT UTILITY – SETUP WINDOW



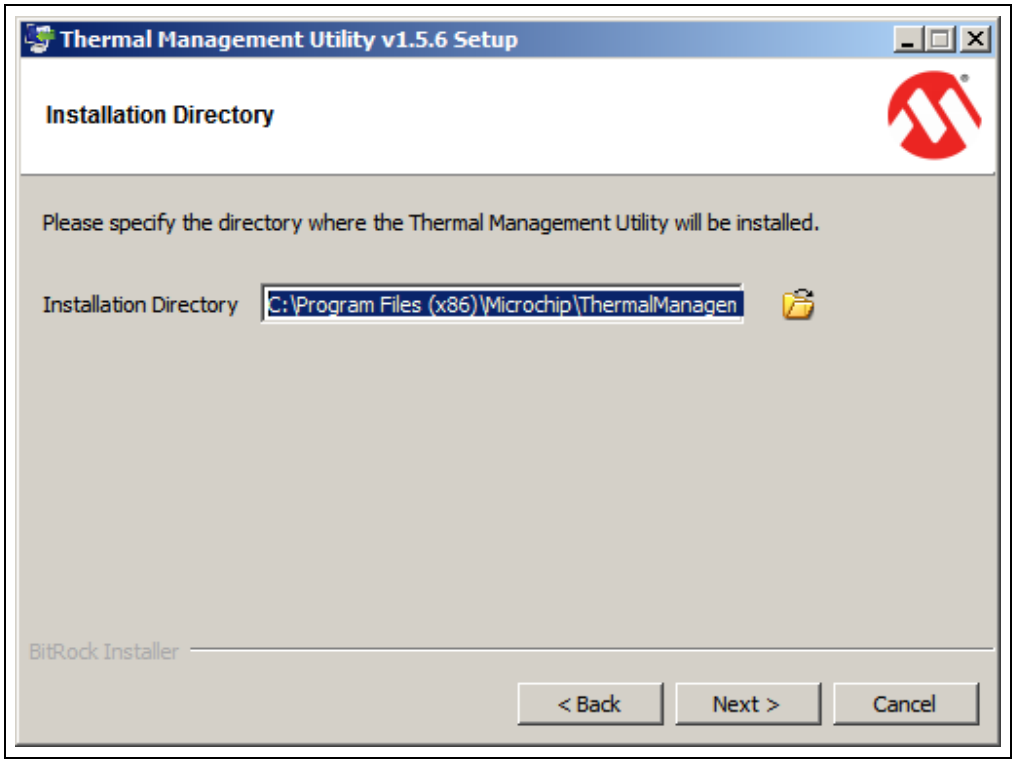
Click the **Next** button to continue.

FIGURE 2-2: THERMAL MANAGEMENT UTILITY – LICENSE AGREEMENT WINDOW



Read and accept the License Agreement. Click the **Next** button to proceed.

FIGURE 2-3: THERMAL MANAGEMENT UTILITY – INSTALLATION DIRECTORY WINDOW



Choose the desired installation directory and click **Next**.

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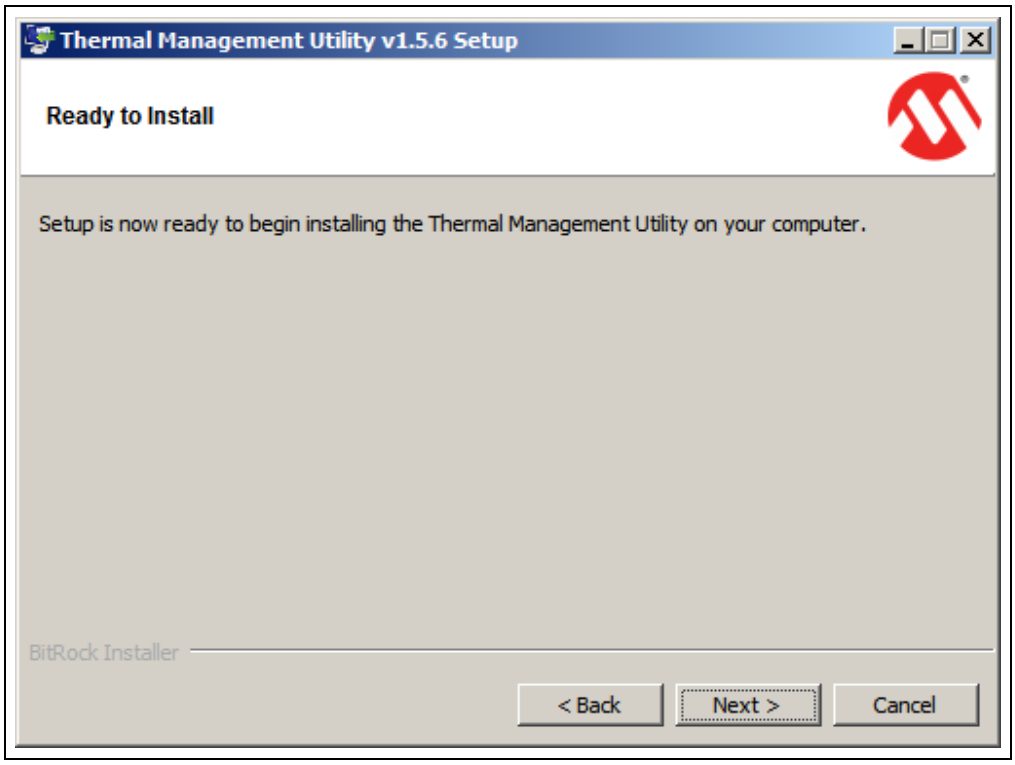
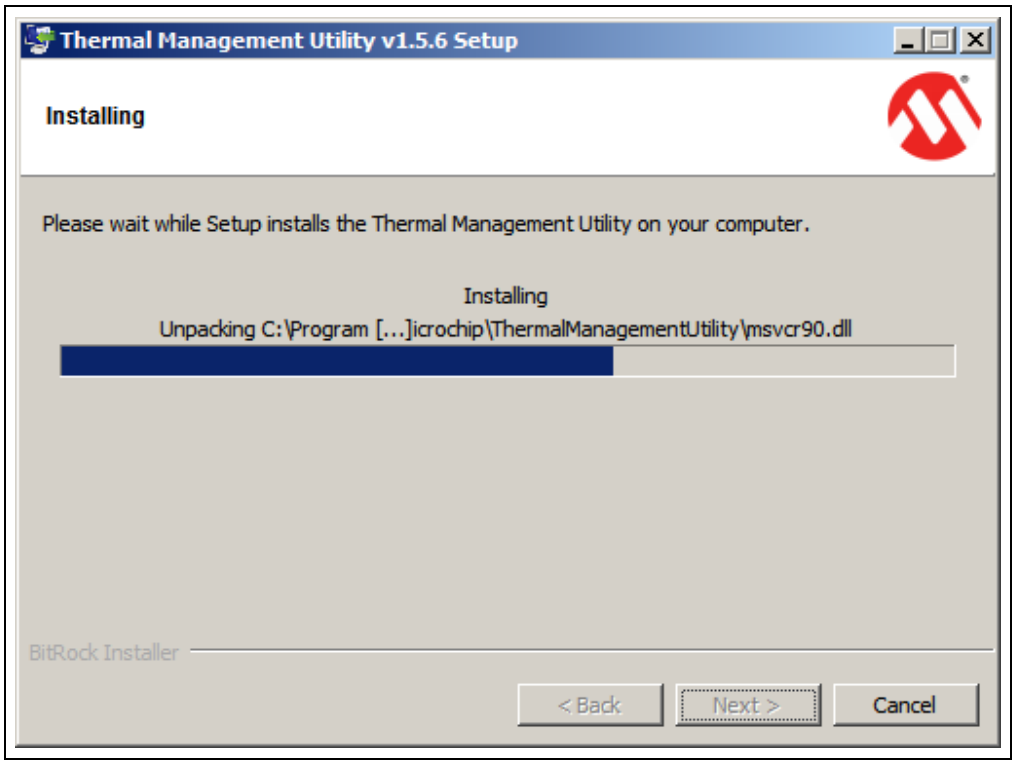
FIGURE 2-4: THERMAL MANAGEMENT UTILITY – READY TO INSTALL WINDOW



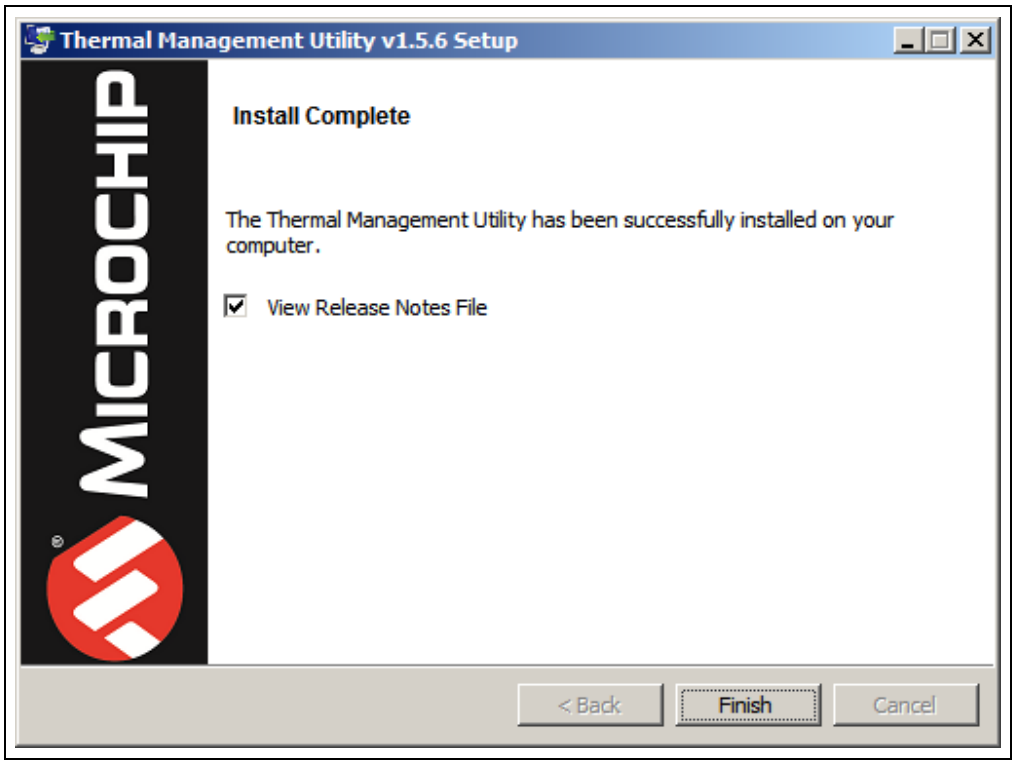
Once the installation directory has been chosen, click **Next** to begin the installation.

FIGURE 2-5: THERMAL MANAGEMENT UTILITY – INSTALLING WINDOW



Wait for the setup wizard to finish the installation.

FIGURE 2-6: THERMAL MANAGEMENT UTILITY – INSTALL COMPLETE WINDOW



Once the installation is completed, click **Finish** to exist the setup wizard.

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Chapter 3. Microchip Thermal Management Utility

3.1 INTRODUCTION

The Microchip Thermal Management Utility GUI allows the user to evaluate the EMC2305 and EMC1438 devices for temperature and fan control applications.

3.2 FIRST LAUNCH

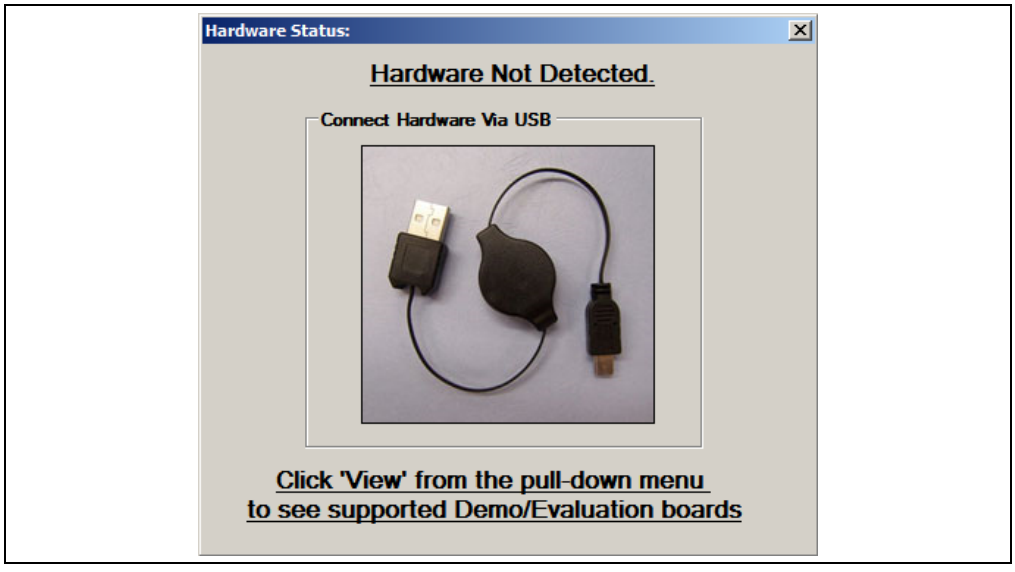
The ADM00879 Demonstration Board is required, in order to start the graphical user interface.

When the GUI is launched for the first time after the installation, or a new board is connected, it contains the fan driver and the temperature sensor currently set values. To use the Demo mode, as described in **Section 3.4 "Demo View"**, the proper settings must be loaded. The installer automatically adds the `ADM00879_Default_Settings.bin` file in the *C:\Users\<username>\Documents\ThermalManagementUtility\Board Settings* folder. Use the **Load** button from the top menu to open the file and apply these settings to your board.

Once the hardware is connected, the software recognizes the device ID and displays the corresponding GUI for the ADM00879 Fan Controller Demonstration Board. When a board is connected, its fan driver and temperature sensor settings are read and displayed in the GUI.

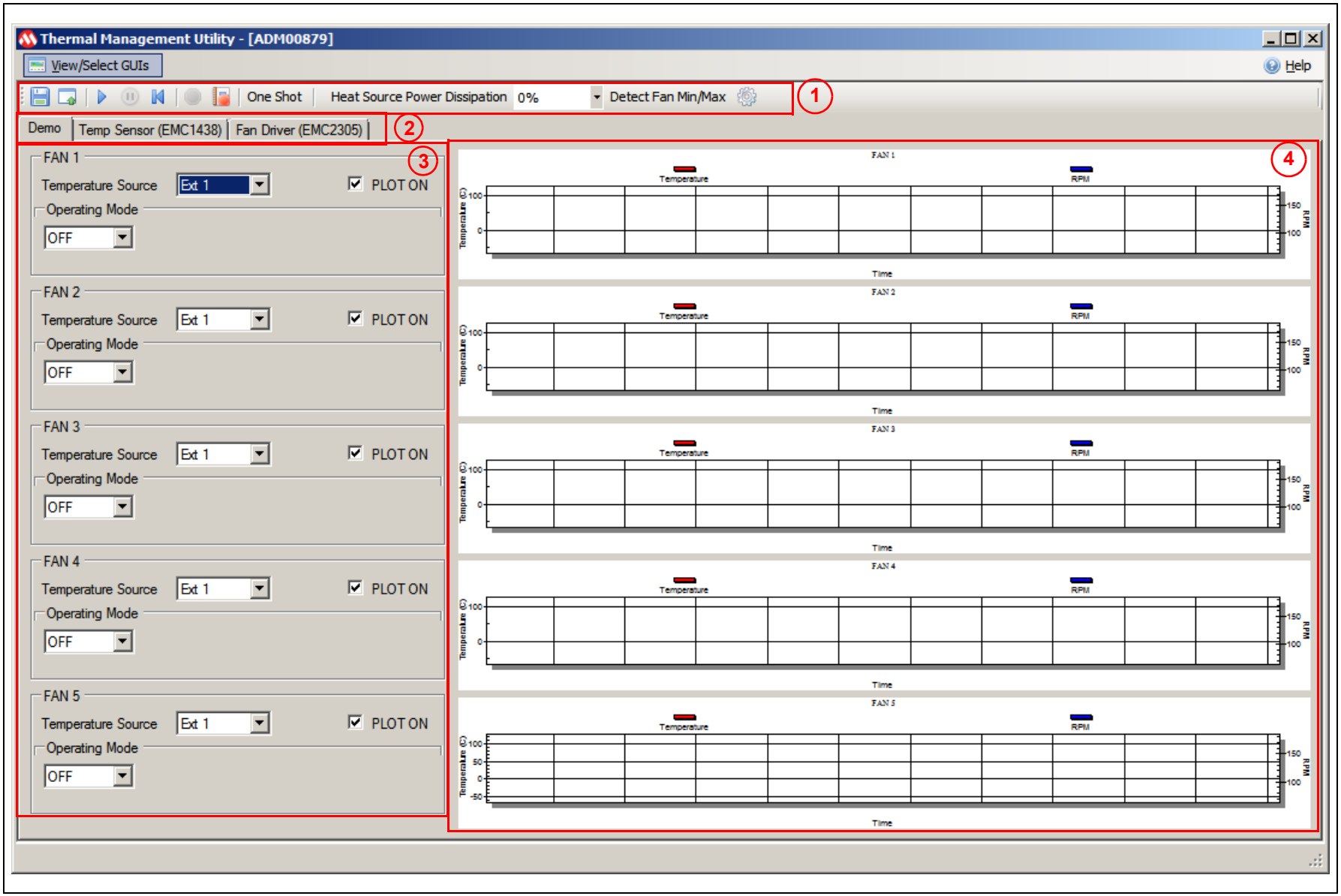
Disconnecting the USB will close the GUI and display a Hardware Not Detected dialog box, as displayed in Figure 3-1.

FIGURE 3-1: HARDWARE NOT CONNECTED DIALOG BOX



The Thermal Management Utility main window (Figure 3-2) consists of a Control Toolbar (marked in Figure 3-2 with the number 1), a View Selection section (marked by the number 2), a Demo Options section (3) and a Temperature/RPM Plots section (4).

FIGURE 3-2: THERMAL MANAGEMENT UTILITY MAIN WINDOW



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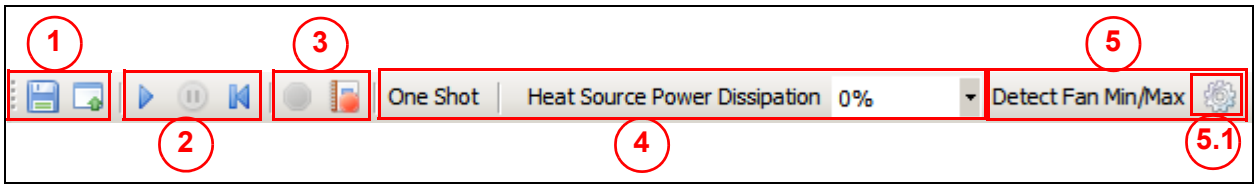
3.3 CONTROL TOOLBAR

FIGURE 3-3: CONTROL TOOLBAR SECTION



3.3.1 Save/Load Settings

The Save/Load Settings section is noted in Figure 3-3 with the number 1. This section allows the saving of all the currently configured GUI settings. The settings will be stored in a *file*.bin file and can be reloaded to reconfigure the board. The loading process repopulates all the available fields and writes the settings into the connected ADM00879 Demonstration Board. This process takes up to 30 seconds to complete.

3.3.2 Data Acquisition

The Data Acquisition section (noted in Figure 3-3 with the number 2) provides controls for starting, stopping and resetting the chart data.

Starting the data capture provides continuous reading of data from the temperature sensor and fan driver, updates the charts and activates the Demo View functionality. When data capture is stopped, the three demonstration modes (auto, constant and manual) are not operational.

The **Reset Plot Data** button clears the data from any visible chart in the currently selected view.

3.3.3 Data Logging

The Data Logging section (number 3) enables or disables the data logging. Clicking the **Record Acquisition** button opens a file selection window, where the destination of the log file can be set. The logs are saved as *file*.txt files and contain the temperature readings for all of the EMC1438's channels.

3.3.4 Temperature Related Options

The Temperature Related Options section is marked in Figure 3-3 with the number 4.

The **One Shot** button writes to the One Shot Register of the EMC1438's temperature sensor. This can be used to trigger an update for the temperature measurements when the device is in Standby mode. To view the measurements, click the **Update Registers** button from the Temp Sensor tab. In Active mode, the functionality of the **One Shot** button is disabled.

The Heat Source Power Dissipation controls the on-board heat source connected to channel 1 of the temperature sensor. Table 3-1 shows the approximate temperatures that can be reached when heating is enabled.

TABLE 3-1: HEAT SOURCE TEMPERATURES

Heat %	Temperature (°C)	
	Fan 1 – OFF	Fan 1 – 100%
0	Ambient temperature	–
25	33–33.5	30.5–0.75

TABLE 3-1: HEAT SOURCE TEMPERATURES (CONTINUED)

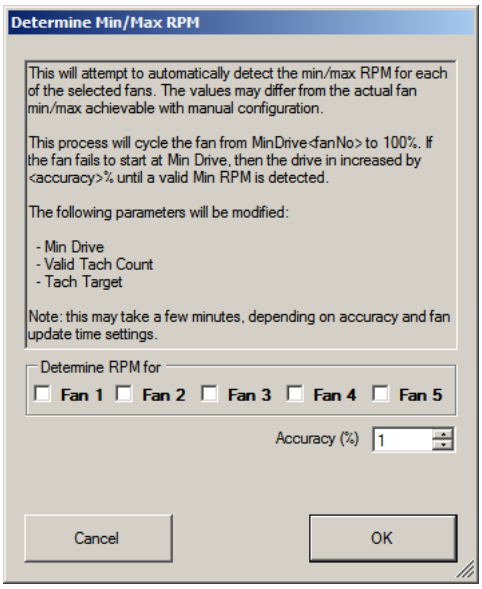
Heat %	Temperature (°C)	
	Fan 1 – OFF	Fan 1 – 100%
50	40.875–41.125	34.75–35
75	50–51	38.875–39.125
100	60–61	44.25–44.5

3.3.5 Fan Related Options

The Fan Related Options section is marked by the number 5.

The **Detect Fan Min/Max** button opens a dialog box (Figure 3-4), which allows the detection of the minimum and maximum RPM (Revolutions Per Minute) values for one or several connected fans. Each selected fan is initially set to the minimum drive value (configured in the **Fan Driver** tab, under the Min Drive percentage field), the RPM being measured subsequently. If the fan doesn't start, then the Min Drive percentage needs to be increased with the selected Accuracy step, until the fan starts. After the minimum RPM, Valid Tachometer count and minimum Drive values are determined, they are stored. In order to determine the maximum RPM value, the fan drive is set to 100% and the RPM is measured. Note that, considering that some fans reach their rated maximum speed after a longer run time, the maximum RPM value detected can be slightly lower than the fan specification.

FIGURE 3-4: DETERMINE FAN MIN/MAX RPM DIALOG BOX



The **Demo RPM Offset** button (marked as 5.1 in Figure 3-3) opens a dialog box (Figure 3-5), where the Min RPM offset values can be configured. This relates only to the fan control algorithm implemented in software for the demo application example. For the Auto and Constant demo modes, the algorithm uses a minimum RPM target that consists of the minimum RPM value specified in the fan configuration tab (Figure 3-15, number 6) summed with the Offset value. Due to the RPM jitter, if the fan target is set to the Min RPM value, a false fan stall detection may occur, causing the fan to be sped up unnecessarily, as the drive level used for the initial spin-up (Figure 3-15, number 5) has a minimum value of 30% (which is larger than the Min Drive setting).

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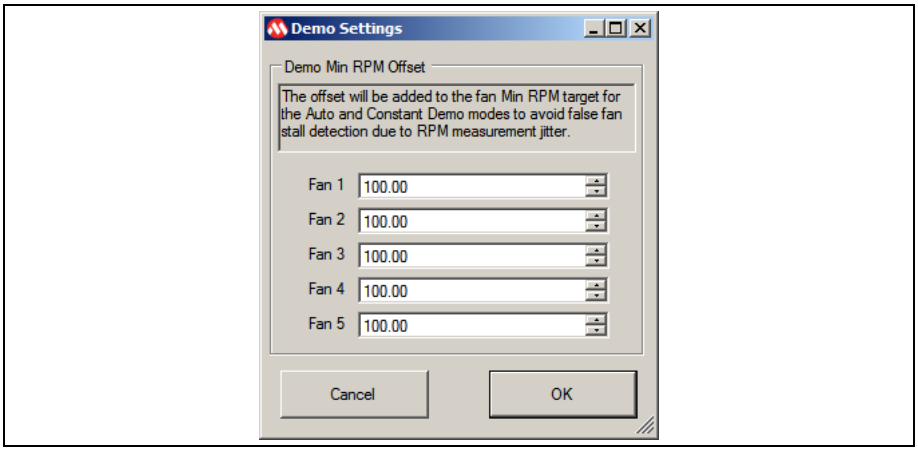
This jitter is fan dependent, so each fan channel has its own offset value. The required offset value can be identified using the Fan Configuration or the Manual mode, which can drive the fan target up to the Min RPM value.

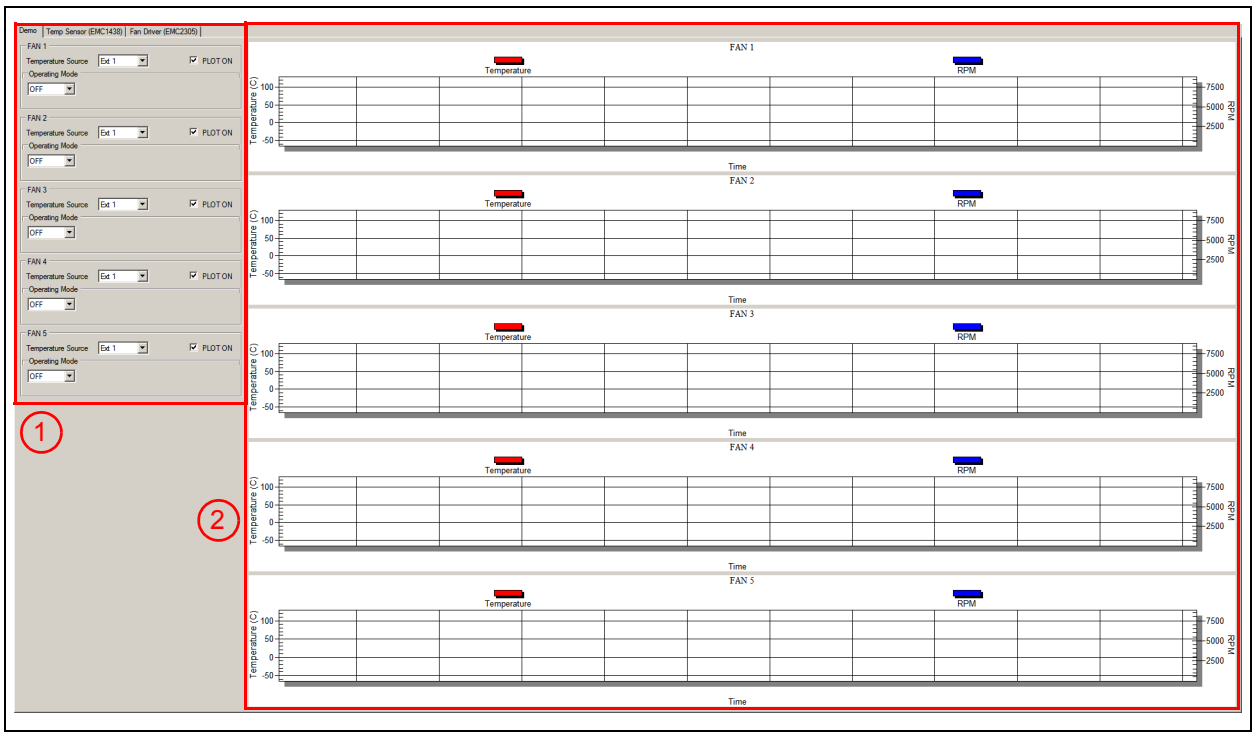
FIGURE 3-5: DEMO SETTINGS DIALOG BOX



3.4 DEMO VIEW

The Demo View section (Figure 3-6) consists of a Demo Options area (1) and a Temp/RPM Charts area (2).

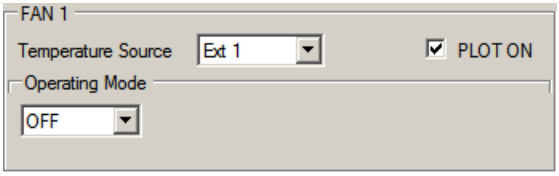
FIGURE 3-6: DEMO VIEW SECTION



3.4.1 Demo Options

This section provides control over the operating mode of each fan and its associated temperature source.

FIGURE 3-7: DEMO OPTIONS FAN 1



3.4.1.1 TEMPERATURE SOURCE

Each fan can be configured to monitor one of the eight available temperature channels of the EMC1438 device. The Ext1 channel is tied to the on-board heat source.

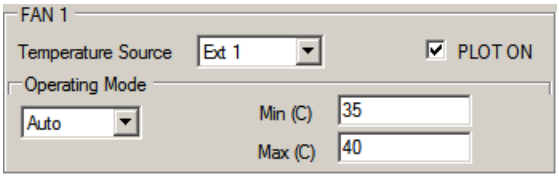
3.4.1.2 OPERATING MODE

This demonstration offers three main operating modes: Auto, Constant and Manual. The Auto and Constant modes are implemented in software by reading the temperature from the EMC1438 device and adjusting the fan speed based on this input.

In Auto Mode, the fan speed is adjusted as follows:

- If the temperature is below the minimum temperature value, the fan is turned OFF.
- If the temperature is between the minimum and maximum values, the fan runs at the minimum RPM value summed with the Offset value.
- When the temperature exceeds the maximum value, the fan speed is adjusted, in order to keep the temperature at the maximum limit, with a hysteresis of ±0.125°C. This outcome is dependent on the cooling solution (appropriate heat sink to dissipate the heat).

FIGURE 3-8: DEMO OPTIONS FAN 1 – AUTO MODE



In Constant Mode, the fan speed is adjusted as follows:

- If the temperature is below the target temperature value, the fan is running at the minimum RPM value summed with the Offset value.
- When the temperature exceeds the target value, the fan speed is adjusted, in order to keep the temperature at the target limit with a hysteresis of ±0.125°C. This outcome is dependent on the cooling solution (appropriate heat sink to dissipate the heat).

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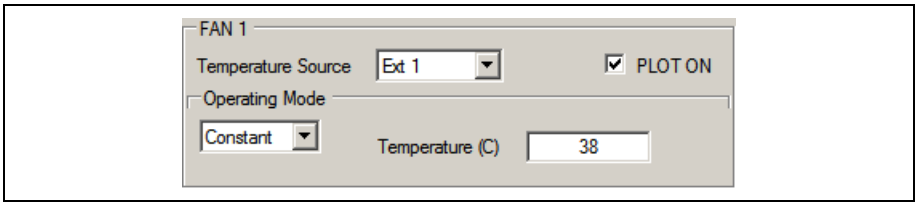
FIGURE 3-9: DEMO OPTIONS FAN 1 – CONSTANT MODE

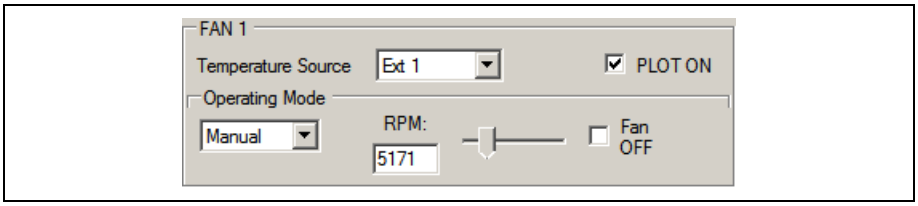


In Manual Mode, the fan RPM can be adjusted from minimum to maximum, by using the slider or by directly writing in the designated RPM field. The fan can be stopped by checking the Fan OFF check-box.

When setting the target to minimum RPM in Manual Mode, the fan can start to oscillate. This mode uses the driver's fan speed algorithm, so if the target is set at the minimum RPM value and the RPM goes slightly below this value (thus going over the Valid Tachometer value), a fan stall condition is detected and the driver starts to spin up the fan.

This spin-up is occurring because the minimum PWM duty cycle for the initial spin-up (or a fan stall condition) is at 30%, while the minimum rated fan speed is at 16% duty cycle. In the current demonstration configuration, this relates to a minimum fan spin-up voltage of 9.5V.

FIGURE 3-10: DEMO OPTIONS FAN 1 – MANUAL MODE

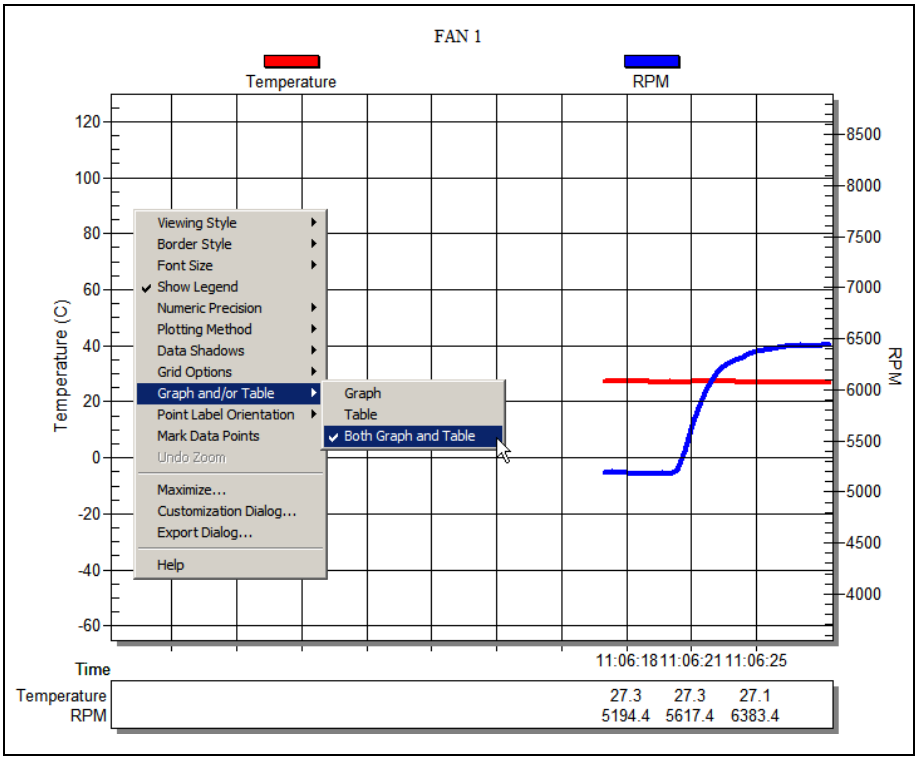


3.4.2 Temperature Charts

This section displays the fan RPM and its corresponding heat source value (°C). The chart visibility can be toggled from the corresponding fan Plot On check box, located in the Demo Options section (Figure 3-6).

For a better visibility of the plotted values, a data table can be enabled from the chart's context menu. Right Click on the plot in order to trigger this menu and select the Both Graph and Table option, as displayed in Figure 3-11.

FIGURE 3-11: CHART OPTIONS



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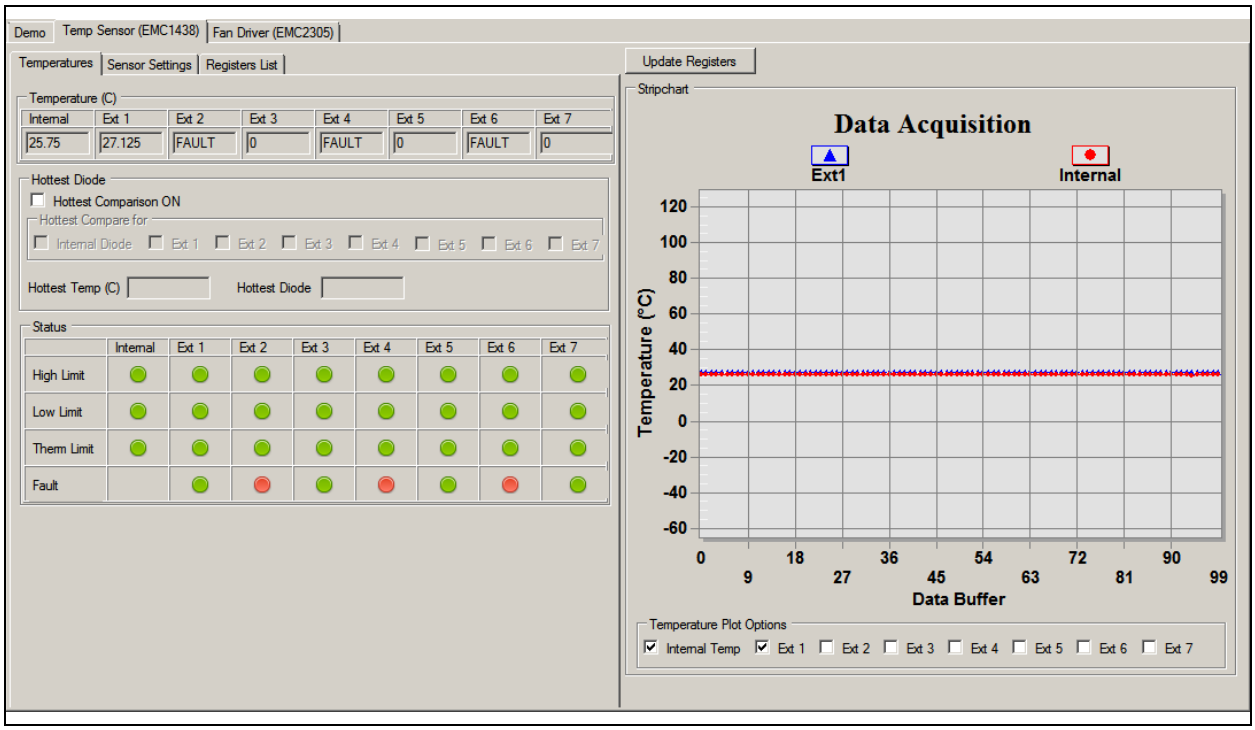
3.4.2.1 TEMPERATURE SENSOR (EMC1438) VIEW

This view contains all values and settings related to the on-board temperature sensor.

FIGURE 3-12: TEMPERATURE SENSOR VIEW – TEMPERATURES TAB

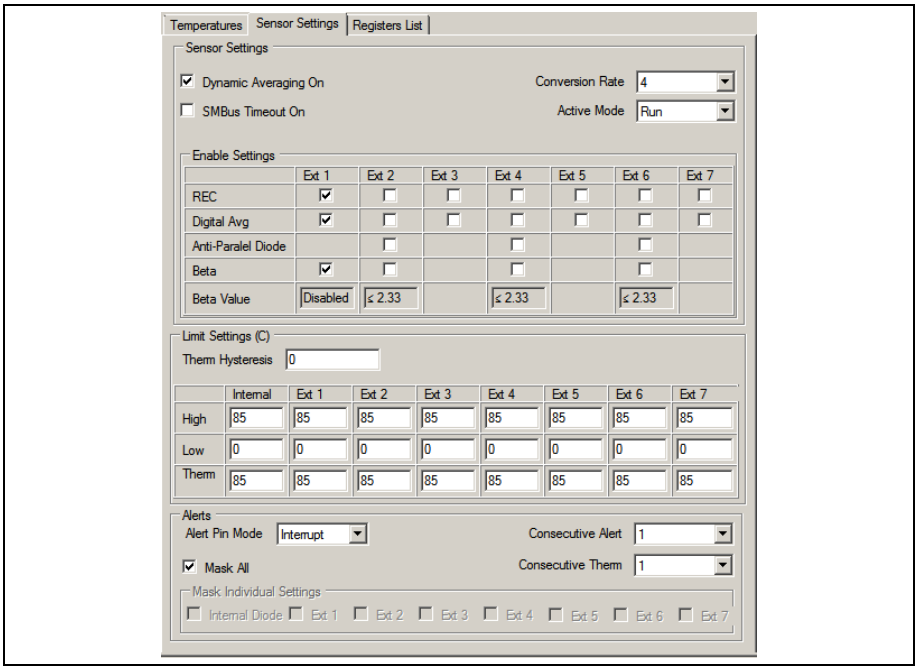


The Temperatures tab of the Temperature Sensor View provides an overview of all the temperature related readings from the EMC1438 device:

- The temperature values are presented in both the Temperature table and in the Data Acquisition chart. The chart can be configured to display any combination of the device channels by enabling the corresponding channel check box from the Temperature Plot Options section.
- The Hottest Diode section allows turning the hottest diode detection ON or OFF and provides information about the hottest temperature and the diode it was detected on.
- The device's status is displayed in the Status section, where a green icon represents normal operation (limit not exceed, no fault condition) and a red icon signals that a limit has been reached or a fault condition has been detected.
- The device data can be read continuously, by clicking the **Start** button from the toolbar or manually sampled by clicking the **Update Registers** button. The chart is only updated during continuous sampling.

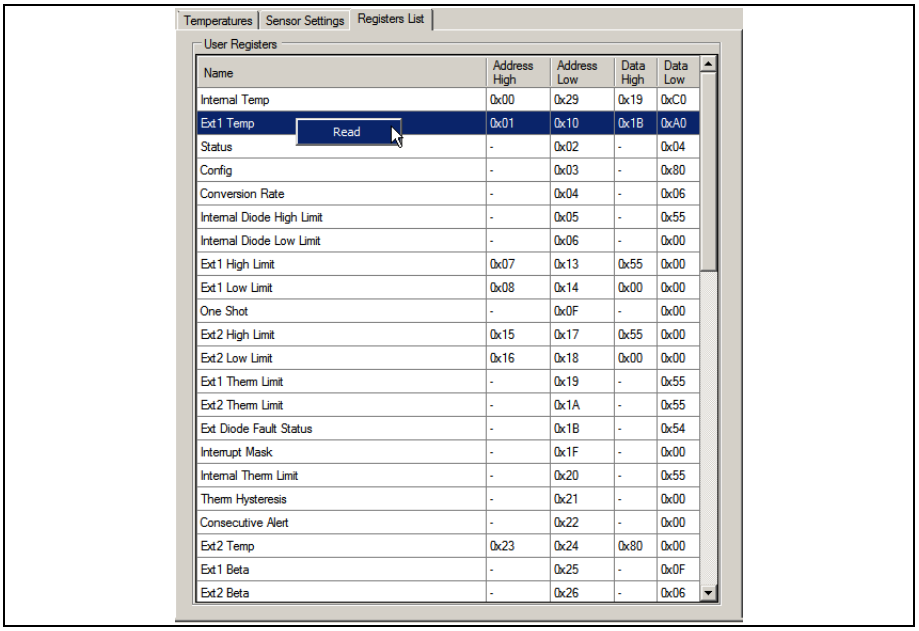
The Sensor Settings tab provides access to all of the device's settings, limit configuration and alert options.

FIGURE 3-13: SENSOR SETTINGS TAB



The Register List tab gives an overview of all the device registers, their addresses and their values. The values are updated continuously after the **Start** button is clicked or updated after clicking the **Update Registers** button from the EMC1438 tab. Each register can also be individually read by selecting the register and right-clicking, then selecting Read.

FIGURE 3-14: REGISTERS LIST TAB



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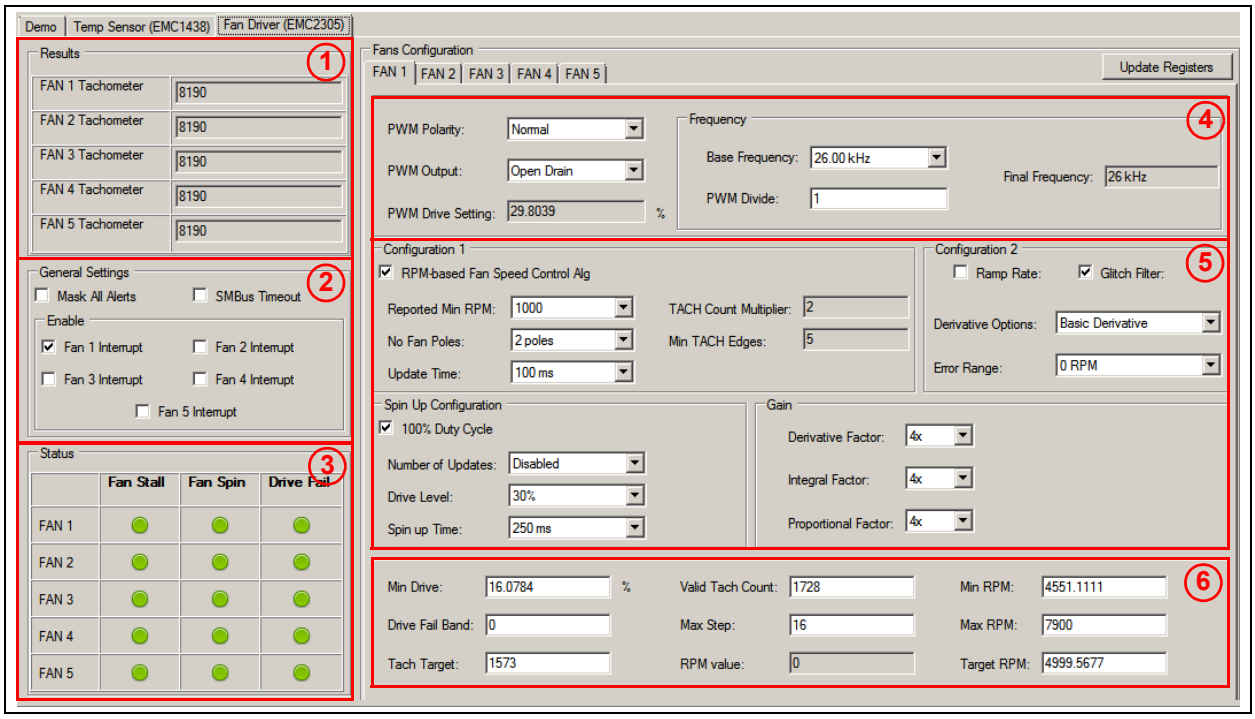
3.4.3 Fan Driver Tab

The Fan Driver tab (Figure 3-15) provides easy access to the EMC2305 device's settings and readings.

Each section of the Fan Driver tab is highlighted in Figure 3-15 by a red rectangle and a number, with each corresponding number being described below.

FIGURE 3-15: FAN DRIVER TAB



1. The Fan Tachometer Results section shows the last read values of the tachometer for all fan driver channels.
2. The General Settings section allows toggling the alert settings and the SMBus timeout.
3. The Status table displays the status of the fan driver: a green icon indicates normal operation and a red icon indicates a flagged fan event.
4. The PWM Settings section contains all PWM related settings for the selected fan driver channel.
5. The General Configuration section gives access to the rest of the driver's settings.
6. The Fan Related Settings section contains the drive and RPM/Tach options needed to properly drive the connected fan. The Min RPM field is connected to the Valid Tach Count field; if either value is changed, the other is updated as well. The same is true for the Target RPM field and the Tach Target field. The RPM value represents the read RPM value of the fan.

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Chapter 4. Hardware Description

4.1 ADM00879 DEMONSTRATION BOARD DESCRIPTION

The printed circuit board form factor is compatible with a PCI (Peripheral Component Interconnect) card slot in a desktop PC. With the addition of a PCI bracket and an IDE (Integrated Drive Electronics) connector (J7 - not populated), the board can be mounted inside a desktop PC case. The J10 connector footprint is compatible with an on-board USB connector.

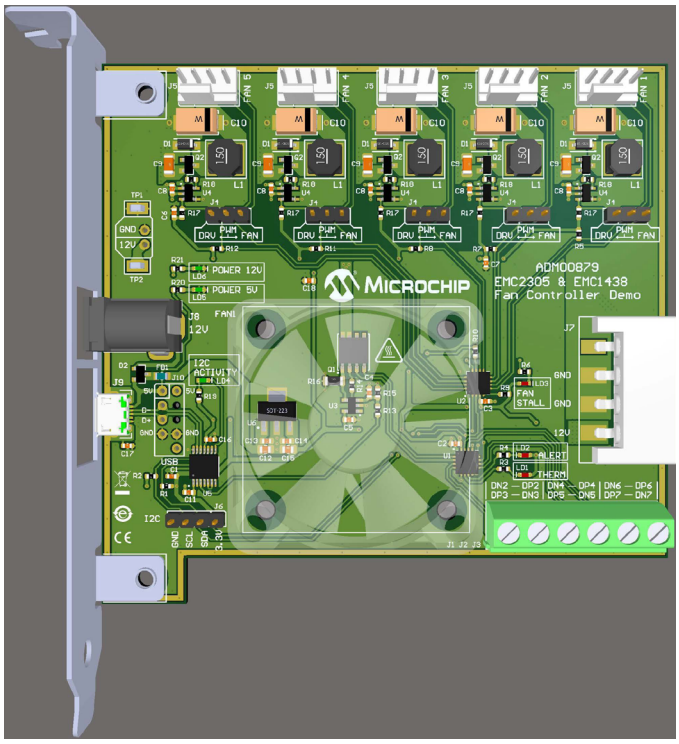
Power for this board can come from four sources. The 2.1 mm jack (J8) is used to power the board during normal operation with 12V, while the micro USB connector (J9) is used for powering the low-voltage digital circuits, in case the 12V supply is missing. There are also two test points (TP1 and TP2) available that are connected in parallel with the jack, for a direct connection to a lab power supply. The IDE connector J7 (not populated) can also be used to draw 12V to the board.

The maximum voltage supported on the jack and the power test point connections is 16V, limited by the 3.3V regulator that is powering the low voltage circuits.

The communication with the PC is provided through the MCP2221 device, an USB to I^2C bridge.

There are five fan channels available, each with its own switch mode PWM driver and 6 remote diode channels accessible through J1, J2 and J3 connector blocks. All five fan driver channels are symmetrical and share the same designators on the silkscreen.

FIGURE 4-1: ADM00879 DEMONSTRATION BOARD TOP VIEW



4.1.1 Fan Connection Options

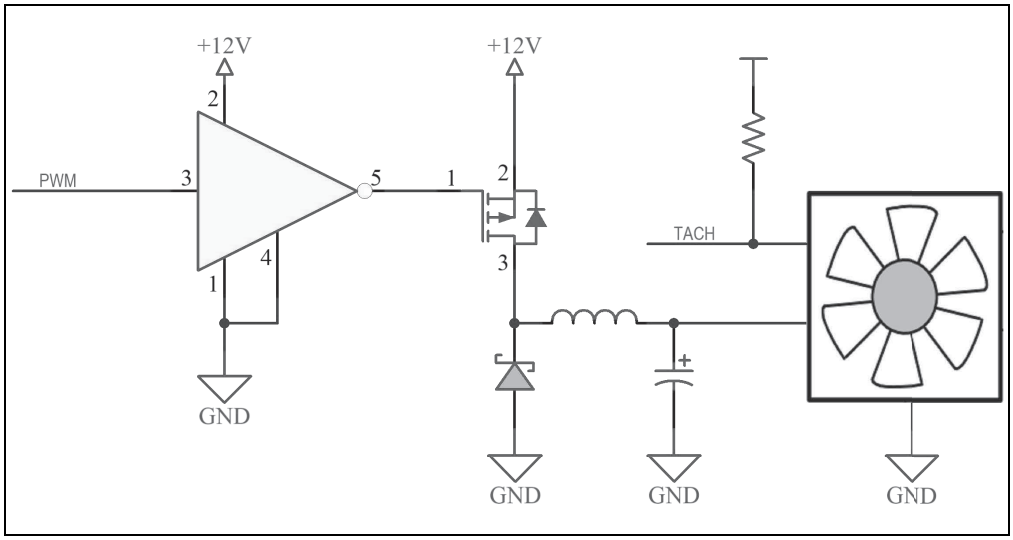
The fan connectors are compatible with both 3-wire and 4-wire fans. Below each fan driver is a 3-pin jumper that connects the PWM output from the EMC2305 fan controller to the fan driver circuit (DRV) or the PWM input of the 4-wire fan (FAN).

If no jumper selection is made, the fan driver provides an unregulated 12V output.

4.1.2 PWM Fan Driver

All five fan driver channels use an efficient high side DC/DC drive topology that maintains the GND connection for the fan tachometer output.

FIGURE 4-2: PWM FAN DRIVER



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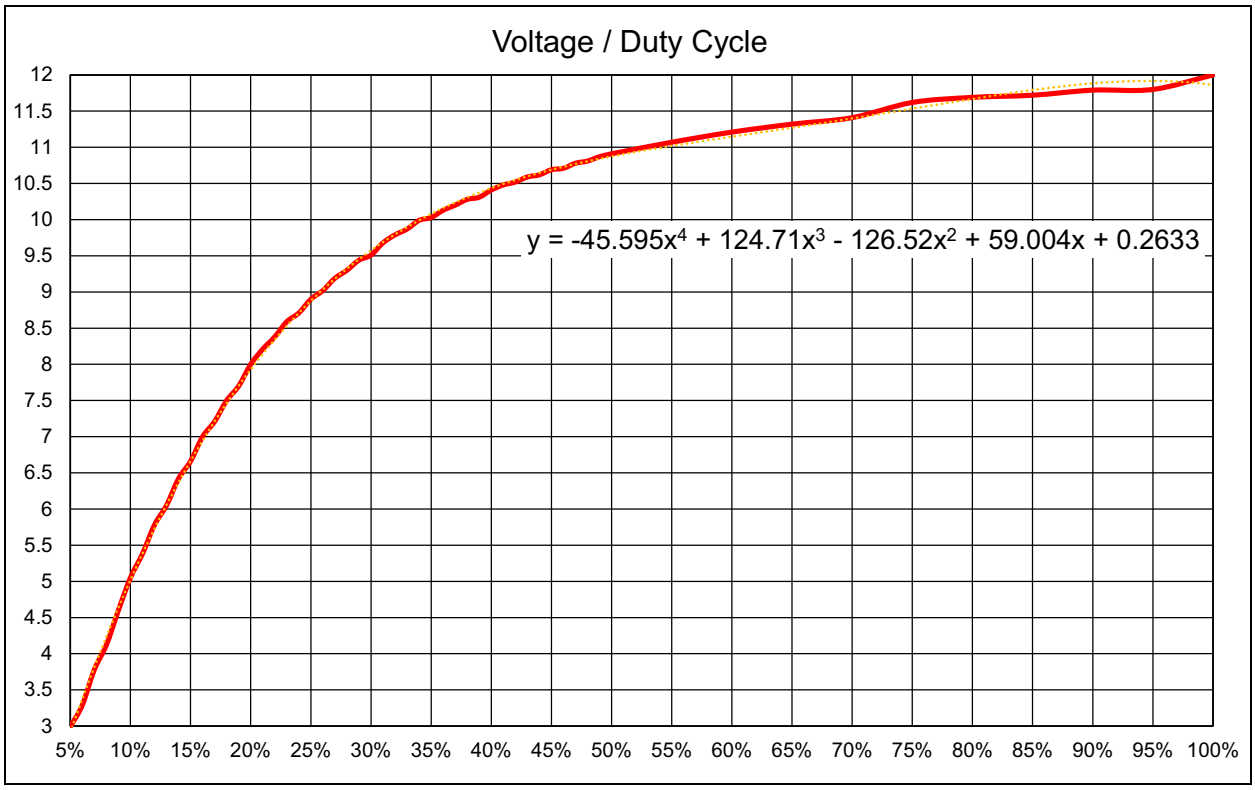
The output voltage versus the PWM duty cycle for the fan provided in the kit is characterized in Figure 4-3.

FIGURE 4-3: PWM DUTY CYCLE TO VOLTAGE CORRESPONDENCE



Considering that the minimum specified voltage for the provided fan is 7V, the minimum drive setting needs to be set at 16%, in order to ensure a reliable fan operation and tachometer reading.

This minimum drive setting and Voltage per Duty cycle behavior is dependent on the drawn current and varies from fan to fan. Figure 4-3 is provided only for reference on how this particular driver and fan combination behaves and to help with understanding the relationship between the output voltage and the PWM duty cycle.

It can be noticed that, by setting the PWM duty cycle at 50%, the fan RPM won't be set at 50%. This is where the EMC2305 RPM-based Fan Speed Control Algorithm solves the problem, by automatically adjusting the PWM duty cycle to achieve a target RPM.

4.1.3 On-Board Temperature Channels

Two out of the 8 temperature channels of the EMC1438 device are connected on fixed sensors on the ADM00879 Demonstration Board:

1. The internal temperature channel inside the EMC1438 (U1)
2. The demonstration heat source and remote diode transistor Q1.

4.1.4 On-Board Demonstration Heat Source and Remote Diode

The Q1 dual NPN transistor is used both as a heat source and as a remote diode, in order to help provide an out-of-the-box demonstration of the implemented PID (proportional-integral-derivative) controller in the Thermal Management Utility GUI.

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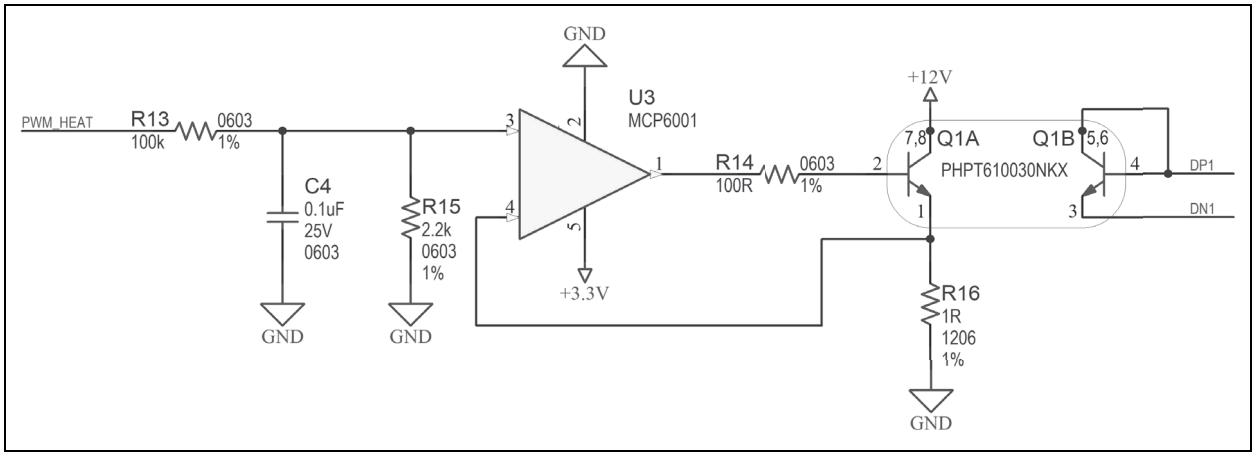
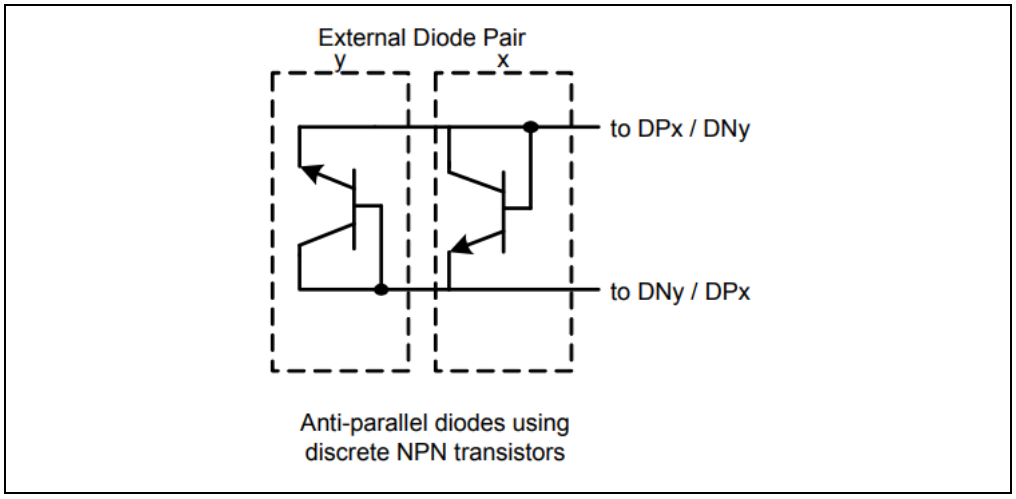
FIGURE 4-4: HEAT SOURCE SCHEMATIC



4.1.5 External Temperature Remote Diode Connections

There are 6 remote-temperature channels accessible through three terminal blocks, each connector being able to support two anti-parallel diodes.

FIGURE 4-5: REMOTE DIODE CONNECTION DIAGRAM



4.1.6 Optional Desktop PC Integration

The board has the necessary form factor to fit into a PCI slot inside a desktop PC. The mounting bracket and PC connectors are not included but are listed in the bill of materials (BOM) for reference.

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Appendix A. Schematics and Layouts

A.1 INTRODUCTION

This appendix contains the following schematics and layouts for ADM00879 Demonstration Board:

- Board – Schematic – EMC2305 and EMC1438
- Board – Schematic – Fan Driver (Fan 1)
- Board – Schematic – Fan Driver (Fan 2)
- Board – Schematic – Fan Driver (Fan 3)
- Board – Schematic – Fan Driver (Fan 4)
- Board – Schematic – Fan Driver (Fan 5)
- Board – Schematic – Interface and Power
- Board – Schematic – Mechanical
- Board – Top Silk
- Board – Top Copper and Silk
- Board – Top Copper
- Board – Bottom Copper
- Board – Bottom Copper and Silk
- Board – Bottom Silk

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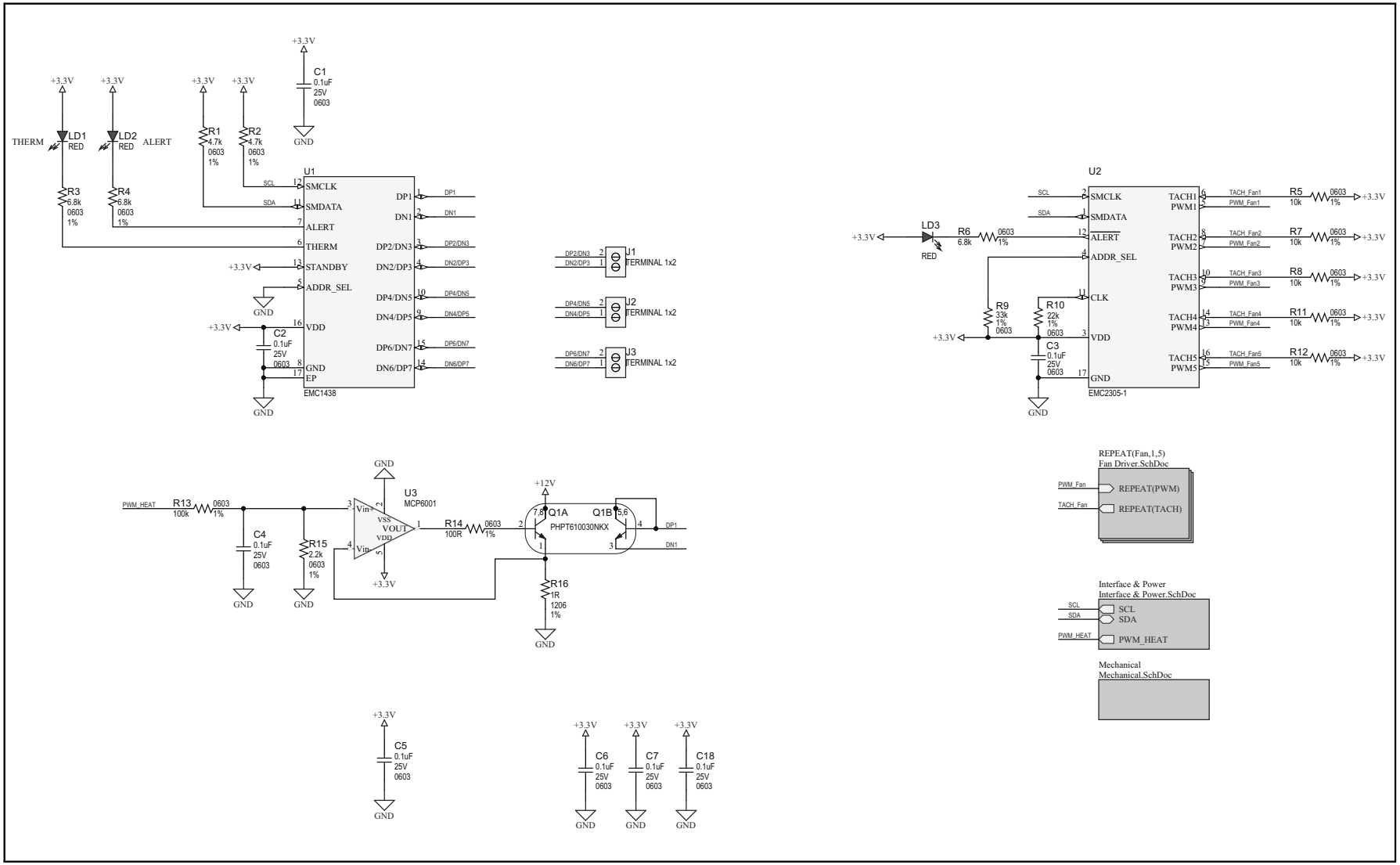
A.2 BOARD – SCHEMATIC – EMC2305 AND EMC1438



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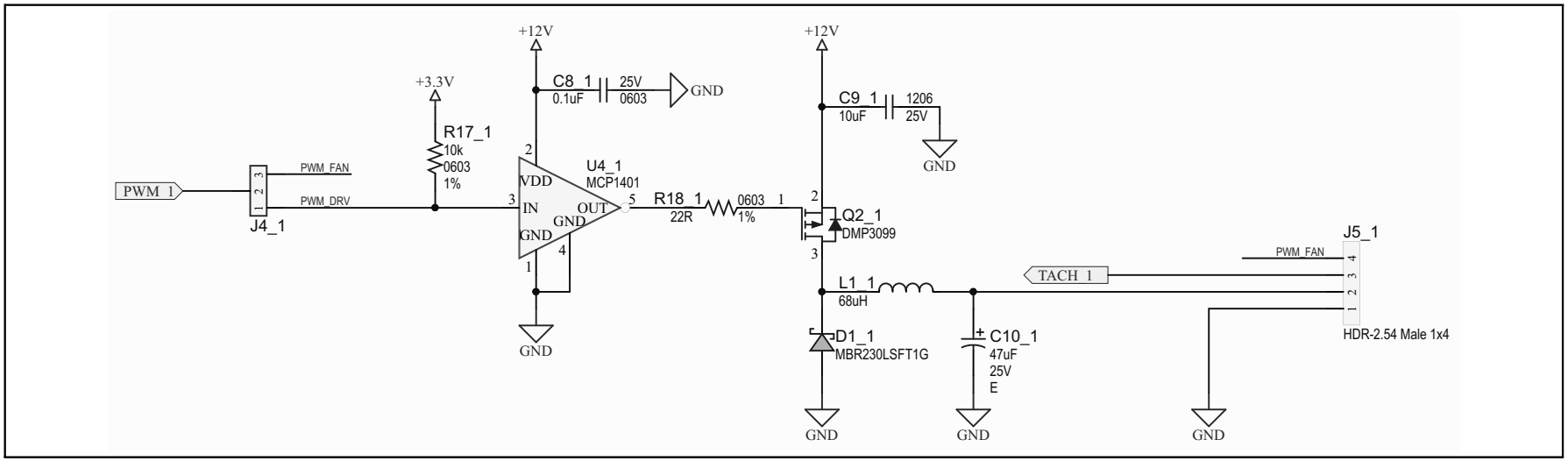
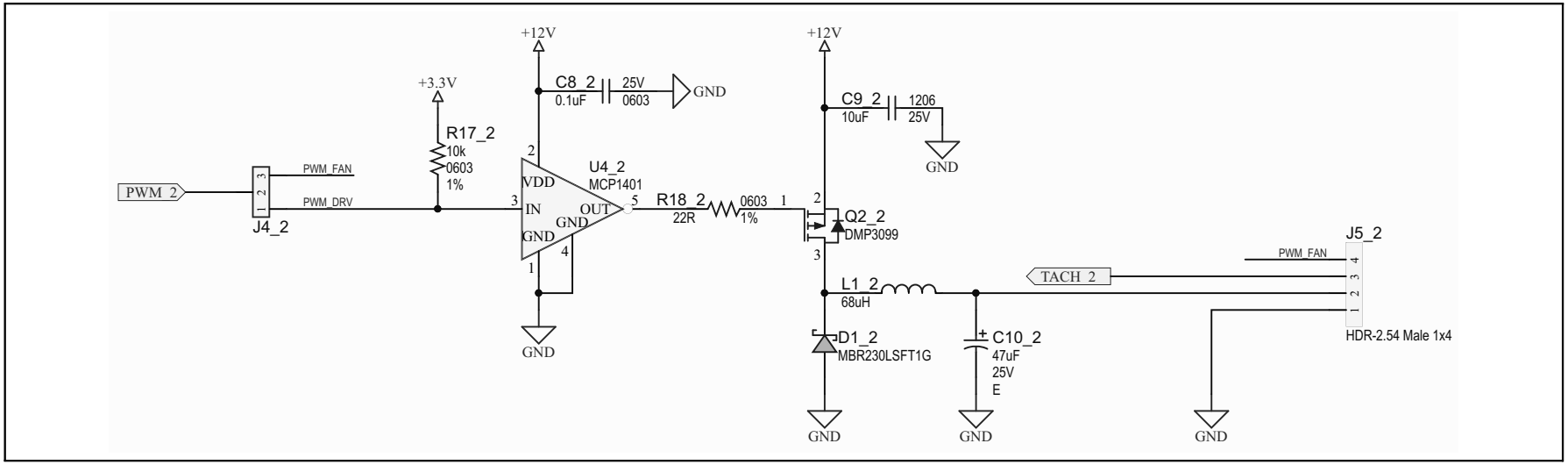
A.3 BOARD – SCHEMATIC – FAN DRIVER (FAN 1)



A.4 BOARD – SCHEMATIC – FAN DRIVER (FAN 2)



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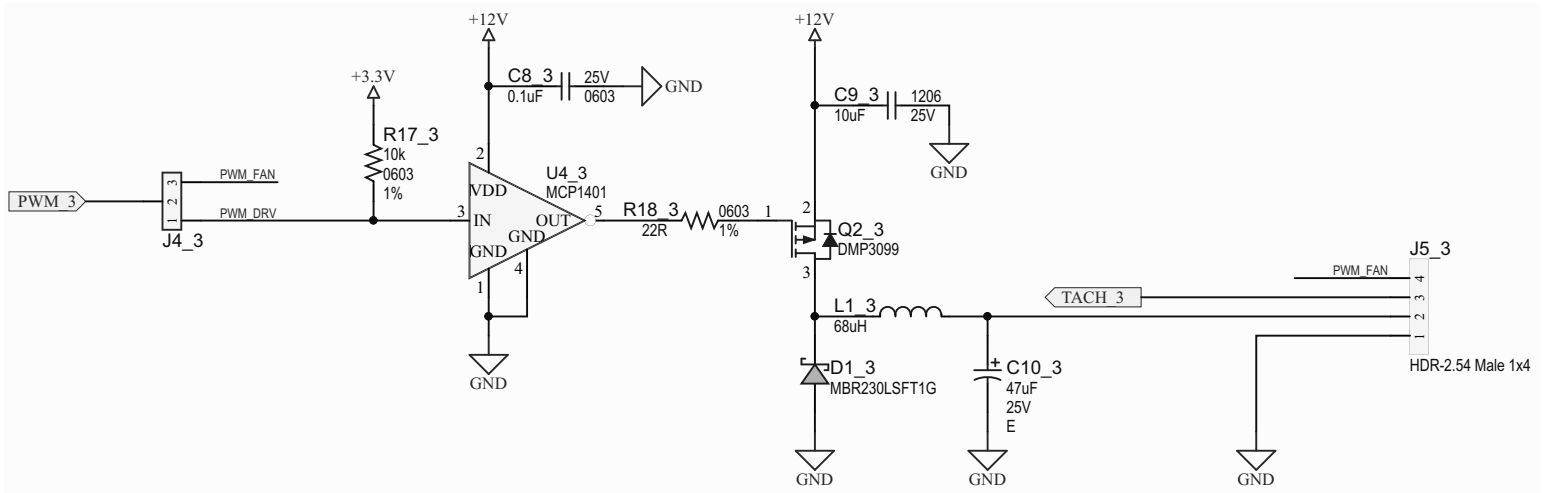
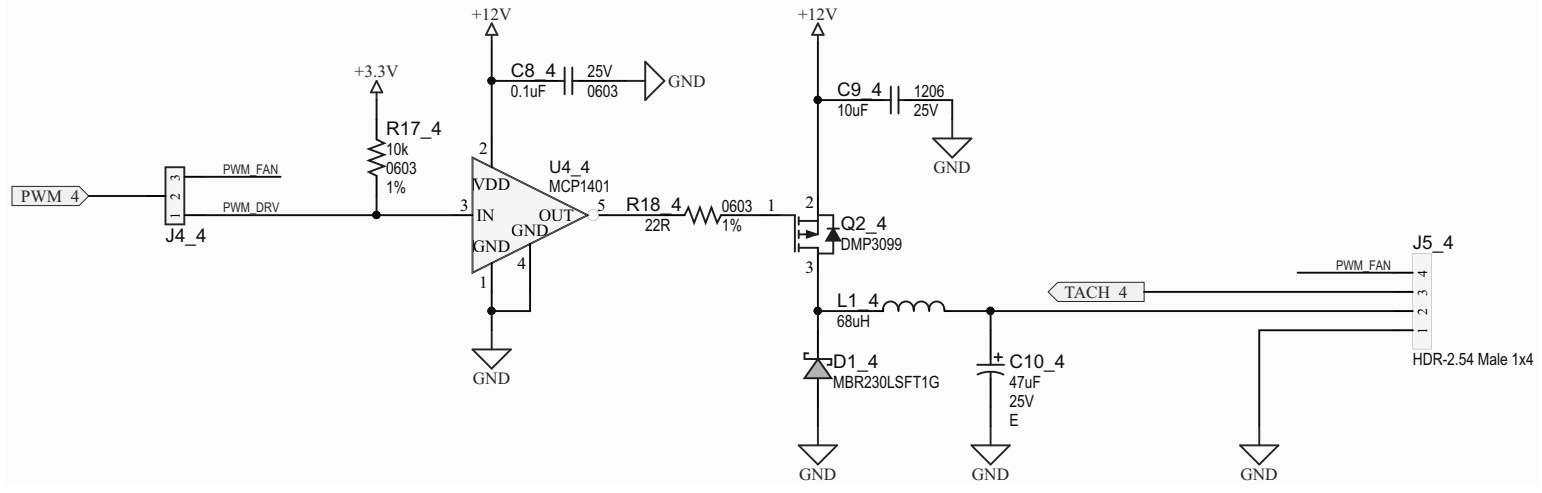
A.5 BOARD – SCHEMATIC – FAN DRIVER (FAN 3)



A.6 BOARD – SCHEMATIC – FAN DRIVER (FAN 4)



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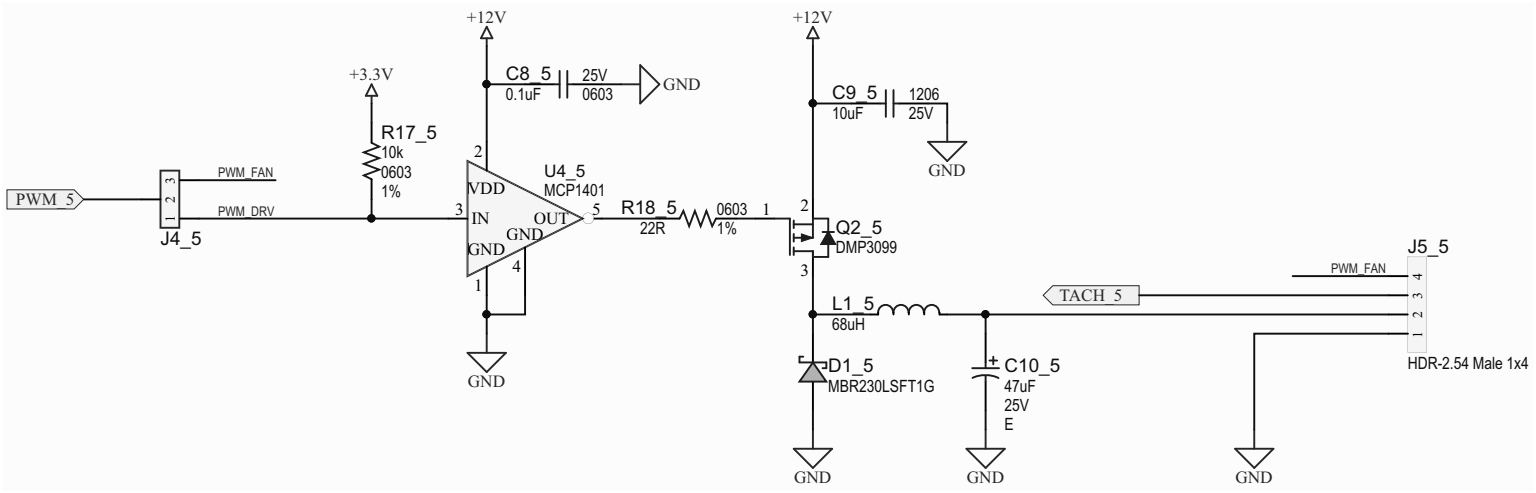
A.7 BOARD – SCHEMATIC – FAN DRIVER (FAN 5)



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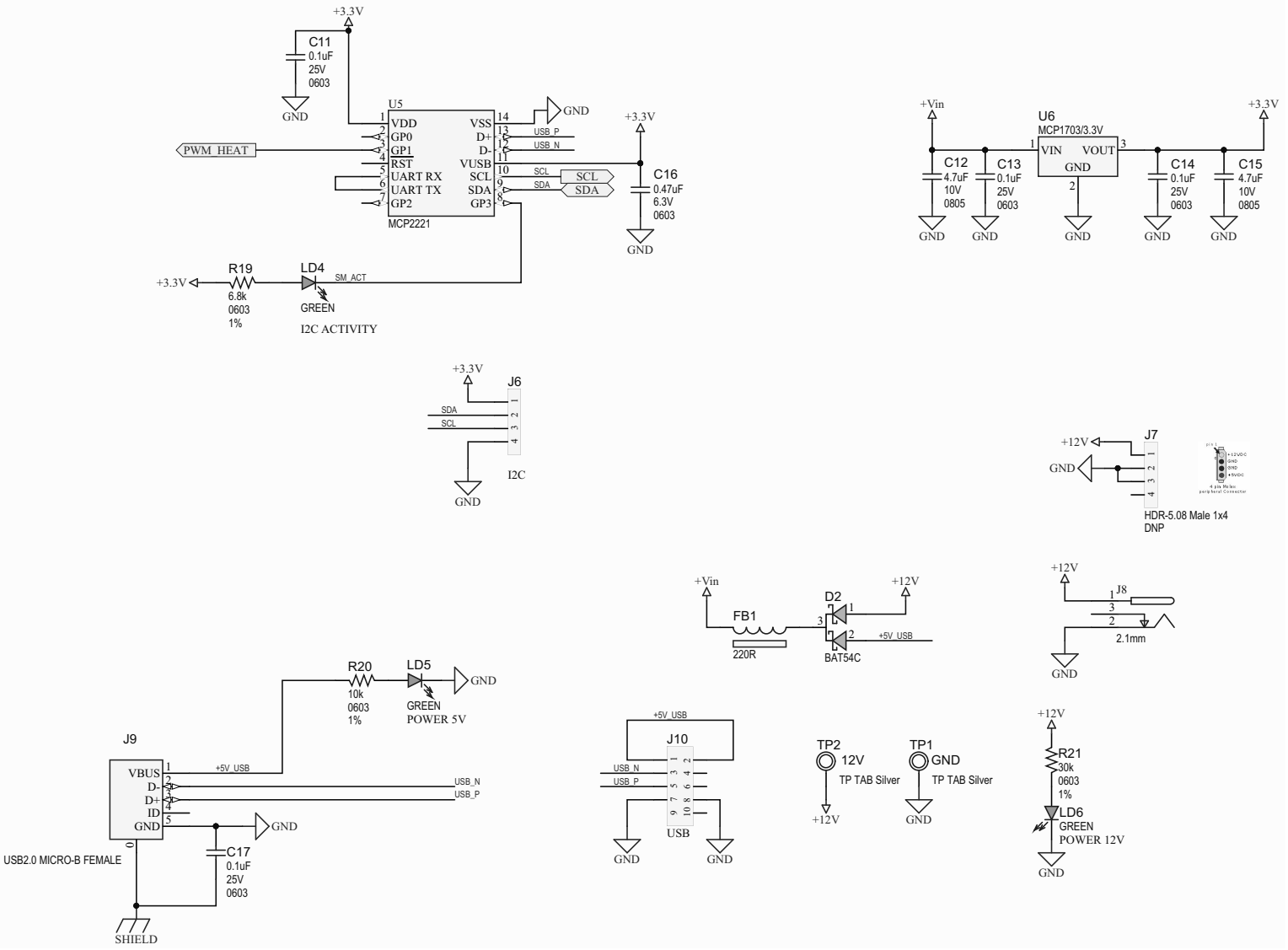
A.8 BOARD – SCHEMATIC – INTERFACE AND POWER



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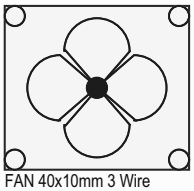
A.9 BOARD – SCHEMATIC – MECHANICAL

FAN1



FAN 40x10mm 3 Wire

Crimp Terminal 22-30AWG

Header Housing Female 2.54mm 1x3

PAD1

RUBBER PAD D9.4 H4.8

PAD2

RUBBER PAD D9.4 H4.8

PAD3

RUBBER PAD D9.4 H4.8

PAD4

RUBBER PAD D9.4 H4.8

SCR1

Screw M3x16mm Nylon

SCR2

Screw M3x16mm Nylon

SCR3

Screw M3x16mm Nylon

SCR4

Screw M3x16mm Nylon

STANDOFF1

Standoff M3 Nylon 10mm

STANDOFF2

Standoff M3 Nylon 10mm

STANDOFF3

Standoff M3 Nylon 10mm

STANDOFF4

Standoff M3 Nylon 10mm

NUT1

Nut M3 Nylon

NUT2

Nut M3 Nylon

NUT3

Nut M3 Nylon

NUT4

Nut M3 Nylon

CBL1

USB Male-A to Male Micro-B

JP1 JP2 JP3 JP4 JP5

Shunt 2.54mm 1x2 Handle

BRACKET1

PCI Bracket DNP

SCR5

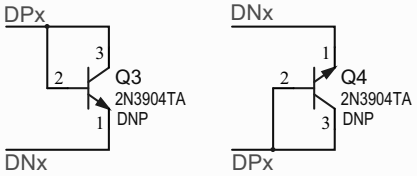
DNP

Phillips Screw 1/4"

SCR6

DNP

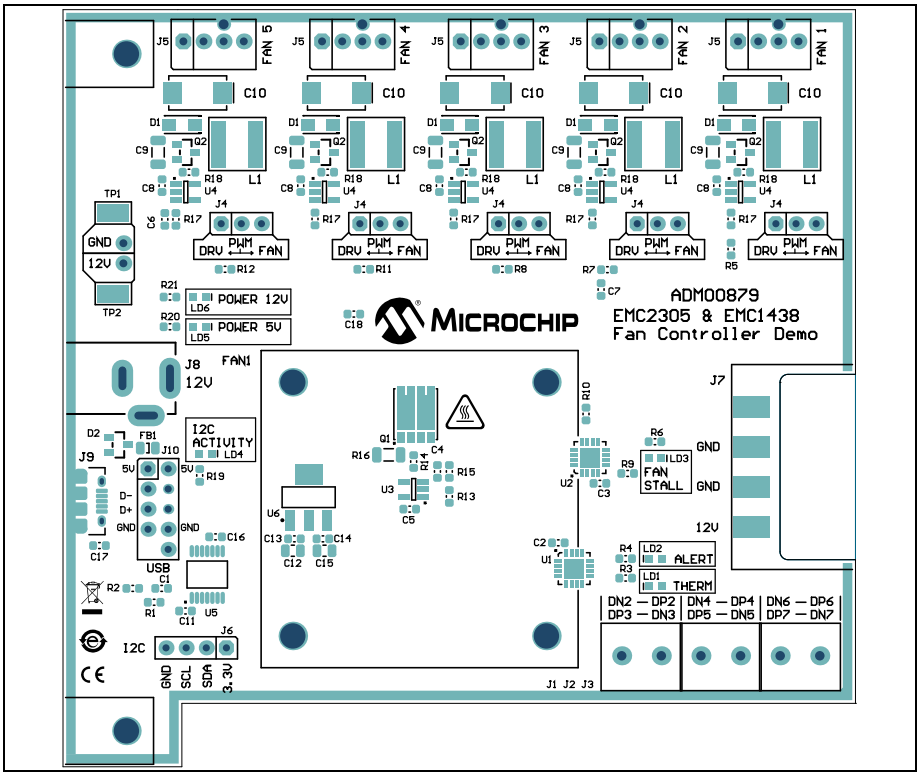
Example of remote diodes using NPN transistors



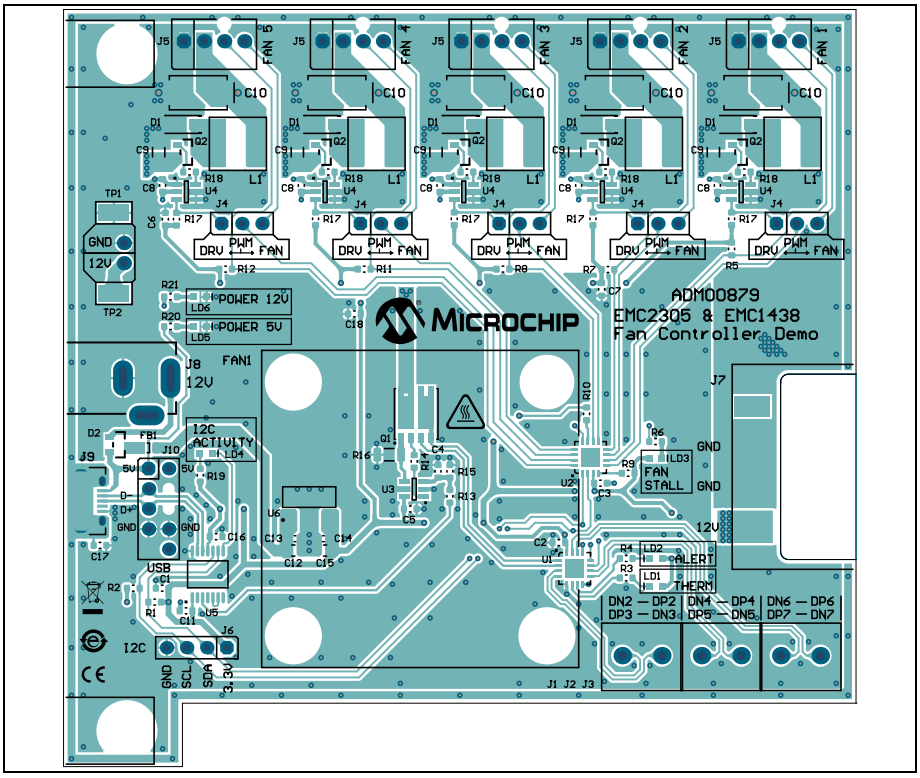
LABEL1

Label Need Help Large

A.10 BOARD – TOP SILK



A.11 BOARD – TOP COPPER AND SILK



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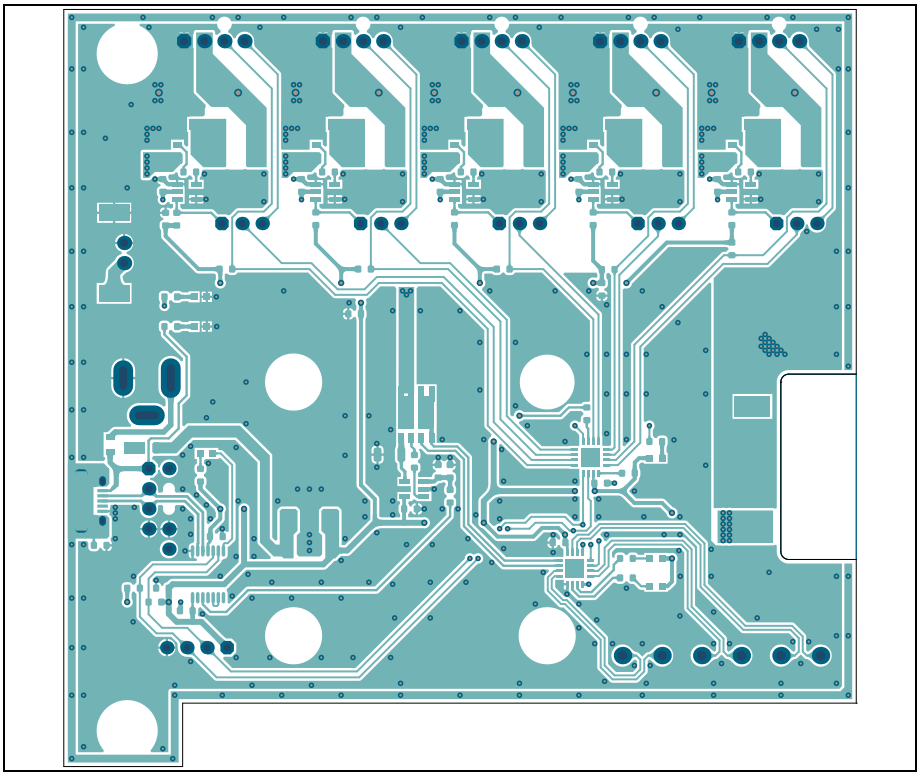
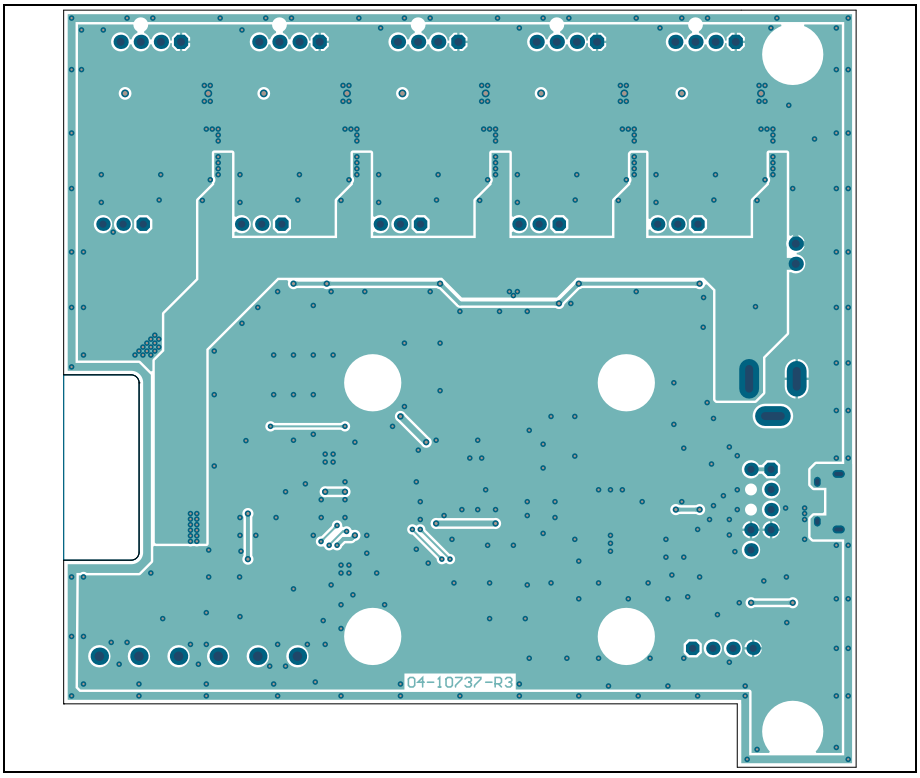
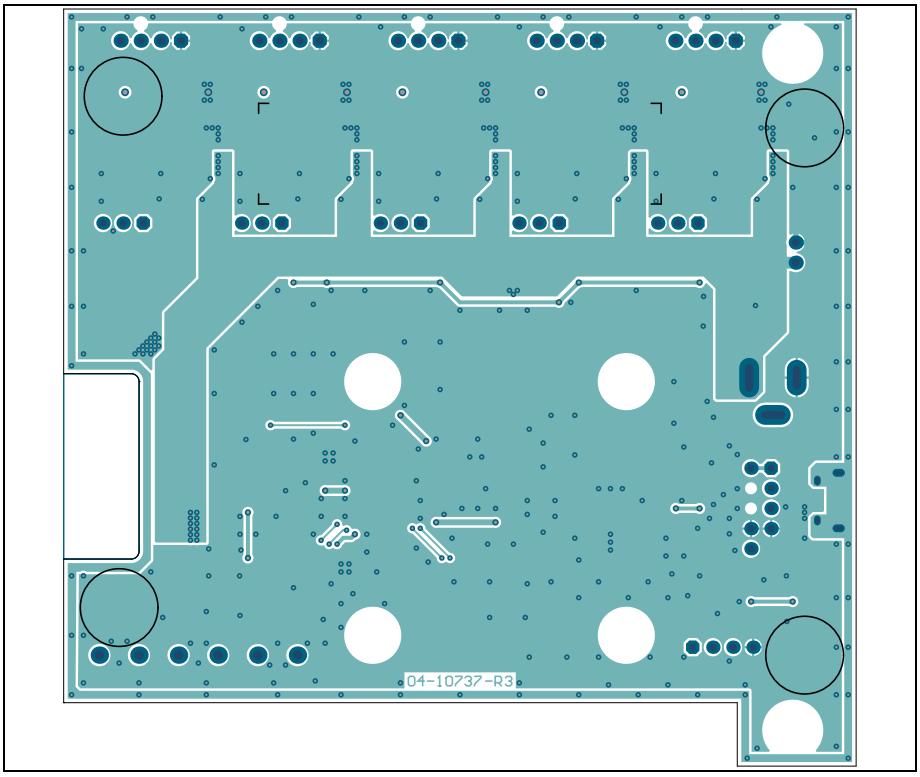
A.12 BOARD – TOP COPPER



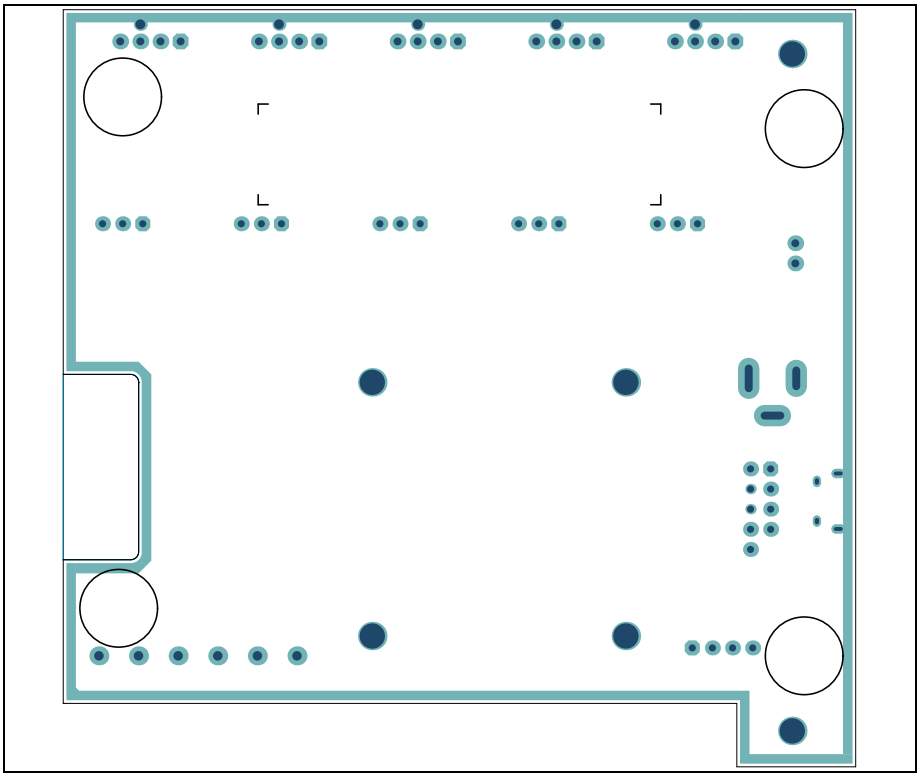
A.13 BOARD – BOTTOM COPPER



A.14 BOARD – BOTTOM COPPER AND SILK



A.15 BOARD – BOTTOM SILK



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Appendix B. Bill of Materials (BOM)

TABLE B-1: ADM00879 DEMONSTRATION BOARD BILL OF MATERIALS

Qty.	Reference	Description	Manufacturer	Part Number
17	C1, C2, C3, C4, C5, C6, C7, C8_Fan1, C8_-Fan2, C8_Fan3, C8_-Fan4, C8_Fan5, C11, C13, C14, C17, C18	Capacitor, Ceramic, 0.1 µF, 25V, 10%, X7R, SMD, 0603	TDK Corporation	C1608X7R1E104K080AA
5	C10_Fan1, C10_Fan2, C10_Fan3, C10_Fan4, C10_Fan5	Capacitor, Tantalum, 47 µF, 25V, 10%, 0.6R, SMD, E	Vishay Sprague	293D476X9025E2TE3
2	C12, C15	Capacitor, Ceramic, 4.7 µF, 10V, 10%, X5R, SMD, 0805	Panasonic® - ECG	ECJ-GVB1A475M
1	C16	Capacitor, Ceramic, 0.47 µF, 6.3V, 10%, X5R, SMD, 0603	Murata Electronics North America, Inc.	GRM188R60J474KA01D
5	C9_Fan1, C9_Fan2, C9_Fan3, C9_Fan4, C9_Fan5	Capacitor, Ceramic, 10 µF, 25V, 10%, X7R, SMD, 1206	Taiyo Yuden Co., Ltd.	TMK316B7106KL-TD
5	D1_Fan1, D1_Fan2, D1_Fan3, D1_Fan4, D1_Fan5	Diode, Schottky, 430 mV, 2A, 30V, SMD, SOD-123FL	ON Semiconductor®	MBR230LSFT1G
1	D2	Diode, Schottky, 530 mV, 200 mA, 30V, SOT-23-3	Diodes Incorporated®	BAT54CTA
1	FB1	Ferrite, 2A, 220R SMD, 0805	Murata Electronics North America, Inc.	BLM21PG221SN1D
3	J1, J2, J3	Connector Terminal, 5 mm, 1x2, Female, 12-26AWG, 18A, TH, R/A	PHOENIX CONTACT	1935161
5	J4_Fan1, J4_Fan2, J4_Fan3, J4_Fan4, J4_Fan5	Connector, HDR-2.54, Male, 1x3, Gold, 5.84 MH, TH, VERT	FCI	68000-103HLF
5	J5_Fan1, J5_Fan2, J5_Fan3, J5_Fan4, J5_Fan5	Connector, HDR-2.54, Male, 1x4, Tin, Lock, 7.49 MH, TH, VERT	Molex® Connector Corporation	0470531000
1	J6	Connector, HDR-2.54, Male, 1x4, Gold, 5.84 MH, TH, VERT	Wurth Elektronik	61300411121
1	J8	Connector, Power, 2.1 mm, 5.5 mm, Switch, Slotted, TH, R/A	MPD – Memory Protection Devices, Inc.	EJ508A
1	J9	Connector, USB 2.0 MICRO-B, Female, TH/SMD, R/A	FCI	10118194-0001LF

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: ADM00879 DEMONSTRATION BOARD BILL OF MATERIALS (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
5	L1_Fan1, L1_Fan2, L1_Fan3, L1_Fan4, L1_Fan5	Inductor, 68 µH, 0.95A, 20%, SMD, L6W6H4.5	Taiyo Yuden Co., Ltd.	NRS6045T680MMGK
3	LD1, LD2, LD3	Diode, LED, Red, 2V, 20 mA, 250 mcd, Clear, SMD, 0603	Wurth Elektronik	150060RS75000
3	LD4, LD5, LD6	Diode, LED, Green, 3.2V, 20 mA, 430 mcd, Clear, SMD, 0603	Wurth Elektronik	150060GS75000
1	PCB1	ADM00879 Demonstration Board - Printed Circuit Board	Microchip Technology Inc.	**04-10737-R3**
1	Q1	Transistor, BJT, Dual, NPN+NPN, 100V, 3A, 1.25W, LFPAK56D-8	Nexperia USA Inc.	PHPT610030NKX
5	Q2_Fan1, Q2_Fan2, Q2_Fan3, Q2_Fan4, Q2_Fan5	Transistor, FET, P-CH, -30V, -3.8A, 1.08W, SOT-23-3	Diodes Incorporated®	DMP3099L-7
2	R1, R2	Resistor, TKF, 4.7 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF4701V
1	R10	Resistor, TKF, 22 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF2202V
1	R13	Resistor, TKF, 100 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF1003V
1	R14	Resistor, TKF, 100R, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF1000V
1	R15	Resistor, TKF, 2.2kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF2201V
1	R16	Resistor, TKF, 1R, 1%, 1/4W, SMD, 1206	Yageo Corporation	RC1206FR-071RL
5	R18_Fan1, R18_Fan2, R18_Fan3, R18_Fan4, R18_Fan5	Resistor, TKF, 22R, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF22R0V
1	R21	Resistor, TKF, 30 kΩ, 1%, 1/10W, SMD, 0603	Stackpole Electronics, Inc.	RMCF0603FT30K0
4	R3, R4, R6, R19	Resistor, TKF, 6.8 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF6801V
11	R5, R7, R8, R11, R12, R17_Fan1, R17_Fan2, R17_Fan3, R17_Fan4, R17_Fan5, R20	Resistor, TKF, 10 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF1002V
1	R9	Resistor, TKF, 33 kΩ, 1%, 1/10W, SMD, 0603	Panasonic® - ECG	ERJ-3EKF3302V
4	STANDOFF1, STAND-OFF2, STANDOFF3, STANDOFF4	Mechanical, HW, Stand-off, M3x10 mm, M/F, HEX, Nylon	Essentra Components	NTS-10
2	TP1, TP2	Connector, TP, TAB, Silver, Mini, 3.8 x 2.03, 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.

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TABLE B-1: ADM00879 DEMONSTRATION BOARD BILL OF MATERIALS (CONTINUED)

Qty.	Reference	Description	Manufacturer	Part Number
1	U1	MCHP Analog Temperature Sensor, -40°C to +125°C, EMC1438-2-AP-TR, QFN-16	Microchip Technology inc.	**EMC1438-2-AP-TR**
1	U2	MCHP Analog Fan Controller, 5-Channel EMC2305-1-AP-TR, QFN-16	Microchip Technology Inc.	**EMC2305-1-AP-TR**
1	U3	MCHP Analog OPAMP 1-Channel, 1 MHz MCP6001T-I/OT, SOT-23-5	Microchip Technology Inc.	**MCP6001T-I/OT**
5	U4_Fan1, U4_Fan2, U4_Fan3, U4_Fan4, U4_Fan5	MCHP Analog Fet Driver, Single-Inverting, MCP1401T-E/OT, SOT-23-5	Microchip Technology Inc.	**MCP1401T-E/OT**
1	U5	MCHP Interface USB I^2C UART MCP2221-I/ST, TSSOP-14	Microchip Technology Inc.	**MCP2221-I/ST**
1	U6	MCHP Analog LDO, 3.3V, MCP1703T-3302E/DB, SOT-223-3	Microchip Technology Inc.	**MCP1703T-3302E/DB**

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-2: BILL OF MATERIALS – MECHANICAL PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	CBL1	Mechanical, HW, Cable, USB Male-A to Male Micro-B, Clear 4	DongGuan ZanXin	A006ZX021
1	FAN1	Mechanical, HW, Fan, 12VDC, 40 x 10 mm, 8000 RPM, Tachometer 3, Wire	Delta Electronics, Inc.	ASB0412VHA-AF00
1	J11	Mechanical, HW, Connector Header Housing, Female, 2.54 mm 1x3	Molex® Connector Corporation	22-01-3037
3	J12, J13, J14	Mechanical, HW, CRIMP, Terminal, Female, 22-30AWG, Tin	Molex® Connector Corporation	0008500113
5	JP1, JP2, JP3, JP4, JP5	Mechanical, HW, Jumper, 2.54 mm, 1x2, Handle, Gold	TE Connectivity, Ltd.	881545-2
1	LABEL1	LABEL	—	—
4	NUT1, NUT2, NUT3, NUT4	Mechanical, HW, NUT, M3, Nylon	Keystone Electronics Corp.	4688
4	PAD1, PAD2, PAD3, PAD4	Mechanical, HW, Rubber Pad, Cylindrical, D9.4, H4.8, Clear	Multicomp Inc.	2565
2	Q3, Q4	Transistor, BJT, NPN, 40V, 0.2A, 0.625W, TO-92-3	Fairchild Semiconductor®	2N3904TA
4	SCR1, SCR2, SCR3, SCR4	Mechanical, HW, Screw, M3 x 16 mm, Pan, Slotted, Nylon	Keystone Electronics Corp.	29346

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-3: BILL OF MATERIALS – DO NOT POPULATE PARTS

Qty.	Reference	Description	Manufacturer	Part Number
1	BRACKET1	Mechanical, HW, Bracket, PCI	Keystone Electronics Corp.	9203-1
1	J7	Connector, HDR-5.08, Male, 1x4, Tin, 7.49 MH, SMD	Molex Connector Corporation	0015244455
1	J10	Connector, HDR-2.54, Male, 2x5 0.100" (2.54 mm), TH, VERT	Samtec, Inc.	TSW-105-07-G-D
2	SCR5, SCR6	Machine Screw Pan, Phillips, 4-40	Keystone Electronics Corp.	9900

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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