



# **TC64X/TC64XB Fan Control Demo Board User's Guide**

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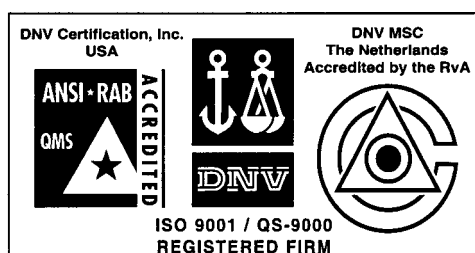
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## Chapter 1. General Information

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### 1.1 INTRODUCTION

Thank you for purchasing the TC64X/TC64XB Fan Control Demo Board from Microchip Technology Inc. The TC64X/TC64XB Fan Control Demo Board allows the user to quickly prototype fan control circuits based on Microchip's pulse width modulation (PWM) Fan Control integrated circuits.

These devices will be referred to as TC64X in this document:

- TC642
- TC646
- TC647
- TC648
- TC649

These devices will be referred to as TC64XB in this document:

- TC642B
- TC646B
- TC647B
- TC648B
- TC649B

A versatile sensor input and output driver circuitry allows the Fan Control Module to be used with virtually any brushless DC fan and standard thermistor. An optional LED status indicator gives a visual indication of a fan fault (stalled, open or unconnected fan) or an overtemperature condition.

The TC64X/TC64XB Fan Control Demo Board has the following features:

1. Complete implementation of TC64X or TC64XB fan control circuitry on a 1.5" x 2.0" board
2. Works with standard thermistors
3. Temperature-proportional fan speed control
4. Overtemperature fault detection
5. Fan fault detection
6. Installs directly into user's end equipment
7. Speeds up prototyping, system development and system thermal characterization

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## 1.2 THE TC64X/TC64XB FAN CONTROL DEMO BOARD

The TC64X/TC64XB Fan Control Demo Board (Figure 1-1) measures only 1.5" x 2.0", allowing direct installation to the user's end equipment for system evaluation. It uses through-hole components for easy assembly and evaluation.

The kit is shipped with the following items:

1. TC64X/TC64XB Fan Control Demo Board
2. Demo and Evaluation Kit Software and Documentation CD, DS51306

The CDROM contains:

- Device Data Sheets
- TC64X/TC64XB Fan Control Demo Board User's Guide, DS21401

3. Sample Devices:

Device	Part Number	
	PDIP	SOIC
<b>TC642B</b>	TC642BEPA	TC642BEOA
<b>TC646B</b>	TC646BEPA	TC646BEOA
<b>TC647</b>	TC647VPA	TC647VOA
<b>TC647B</b>	TC647BEPA	TC647BEOA
<b>TC648</b>	TC648VPA	TC648VOA
<b>TC648B</b>	TC648BEPA	TC648BEOA
<b>TC649</b>	TC649VPA	TC649VOA
<b>TC649B</b>	TC649BEPA	TC649BEOA

The components that are populated on the TC64X/TC64XB Fan Control Demo Board are listed in Table B-1 of the Appendix B section. If any component is damaged or missing, please contact your nearest Microchip sales office, listed on the back of this publication.

## 1.3 REFERENCE DOCUMENTS

The following is recommended reading:

- *Technical Library CD-ROM*, DS00161
- *Analog & Interface Families Data Book 2002*, DS00207
- *2002 Technical Documentation Analog & Interface Product Families CD-ROM*, DS51205
- AN768, “*Redundant Fan Systems Using the TC642 Fan Manager*”, DS00768, Microchip Technology Inc., 2002
- AN770, “*Linear Voltage Fan Speed Control Using Microchip’s TC64X Family*”, DS00770, Microchip Technology Inc., 2003
- AN771, “*Suppressing Acoustic Noise in Pulse Width Modulation (PWM) Fan Speed Control Systems*”, DS00771, Microchip Technology Inc., 2003
- AN772, “*Speed Error in Pulse Width Modulation (PWM) Fan Control Systems*”, DS00772, Microchip Technology Inc., 2003

*TC642 Fan Speed Control Module for TC64X Family Sell Sheet*, DS51251

Other Reference Documents may be obtained by contacting your nearest Microchip sales office (listed on the back of this document).

The Microchip web site ([www.microchip.com](http://www.microchip.com)) also contains a wealth of documentation. Individual data sheets, application notes, tutorials and user’s guides are all available for easy download.

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## Chapter 2. Getting Started

This chapter describes the TC64X/TC64XB Fan Control Demo Board's configuration, how it functions and lists typical fan demo board operating configurations for fan applications.

### 2.1 TC64X/TC64XB FAN CONTROL DEMO BOARD TYPICAL MODULE CONFIGURATIONS

#### 2.1.1 Using Bipolar Driver Transistors

All component selections should be made based on the information provided in the Applications section of the TC64X and TC64XB data sheets. Table 2-1 lists typical fan module operating configurations for 12V fan applications. These are provided as a guide only. The values in the table assume the use of low-cost, bipolar transistors, such as 2N2222A, unless stated otherwise.

**TABLE 2-1: SUGGESTED OUTPUT DRIVER/CURRENT SENSE VALUES VS. FAN CURRENT**

Full Speed Fan Current	Darlington Pair (Q <sub>1</sub> , Q <sub>2</sub> )	Single Transistor (Q <sub>3</sub> )	R <sub>5</sub> (Ω)	R <sub>6</sub> (Ω)
50 mA	—	X	2.4 k	9.1
100 mA	—	X	1.1 k	4.7
150 mA	—	X	750	3.0
200 mA	—	X	620	2.4
200 mA	X	—	5.6 k	2.4
250 mA	X	—	4.7 k	2.0
300 mA	X	—	3.9 k	1.8
350 mA	X	—	3.3 k	1.5
400 mA	X	—	3.0 k	1.3
450 mA	X	—	2.4 k	1.2

Fan motors of 50 mA to 150 mA can be driven using the single transistor driver configuration (i.e., Q<sub>3</sub> installed; Q<sub>1</sub> and Q<sub>2</sub> not installed). Fans having a motor current of 200 mA may be driven using either the single transistor or Darlington configurations. If a single transistor is used, care must be taken to select a transistor having a minimum h<sub>FE</sub> of at least 50 to ensure the minimum output current specification (5 mA) of the TC64X and TC64XB devices is sufficient to saturate the transistor when it is conducting the full fan current.

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## 2.1.2 Using Logic Level MOSFETS

Substituting a logic level MOSFET for Q<sub>3</sub> (such as a BS170) results in lower system voltage losses and significantly reduces output loading on the TC64X and TC64XB devices. The low R<sub>DS(ON)</sub> of the MOSFET (1Ω in the case of the BS170) enables it to be used instead of the Darlington configuration in high-current fan applications. Refer to the Applications section of the TC64X and TC64XB data sheets for details.

Population options for single transistor output drivers (using either MOSFET or bipolar transistor) and the two transistor (Darlington) stage are shown in Figure 2-1.

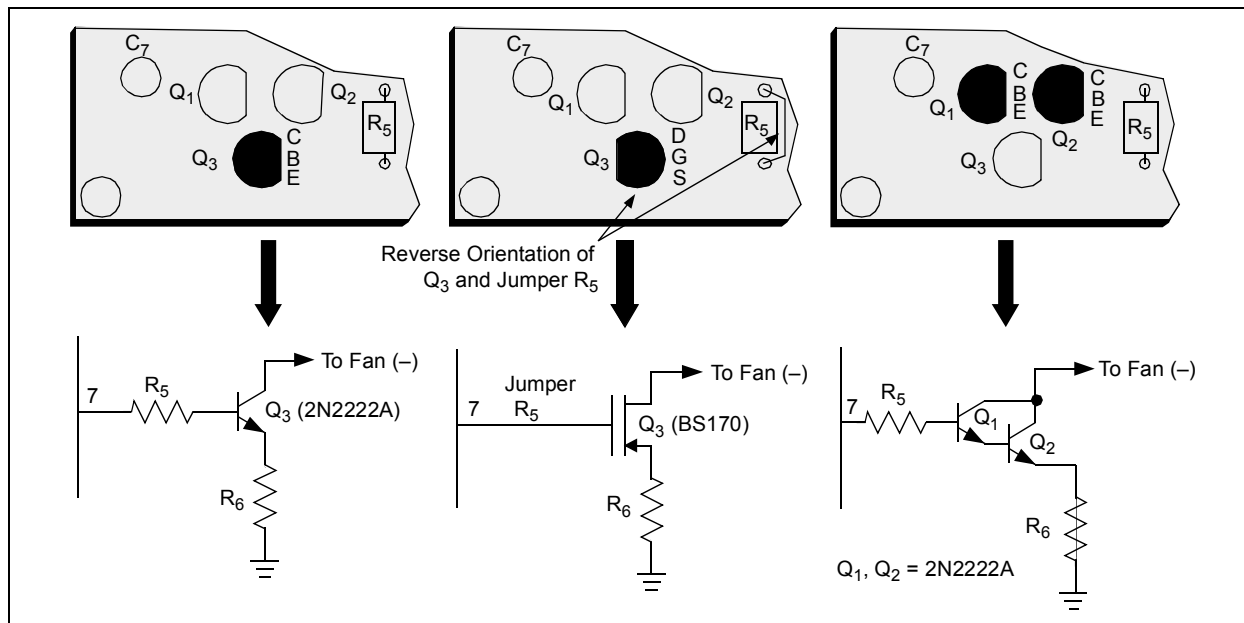


FIGURE 2-1: Output Driver Configuration Options

## 2.2 SYSTEM CONNECTION FOR +5V OPERATION

Figure 2-2 shows typical wiring connections to the fan control module. The fan operating voltage is +12V, while the fan control module operates from a supply voltage of +5V. A NTC thermistor connects from the SENSOR input of the fan control module to V<sub>DD</sub>. Fan control module resistors R<sub>1</sub> and R<sub>2</sub> (See Figure A-2), in conjunction with characteristics of the NTC thermistor, determine the fan speed versus the temperature profile of the system.

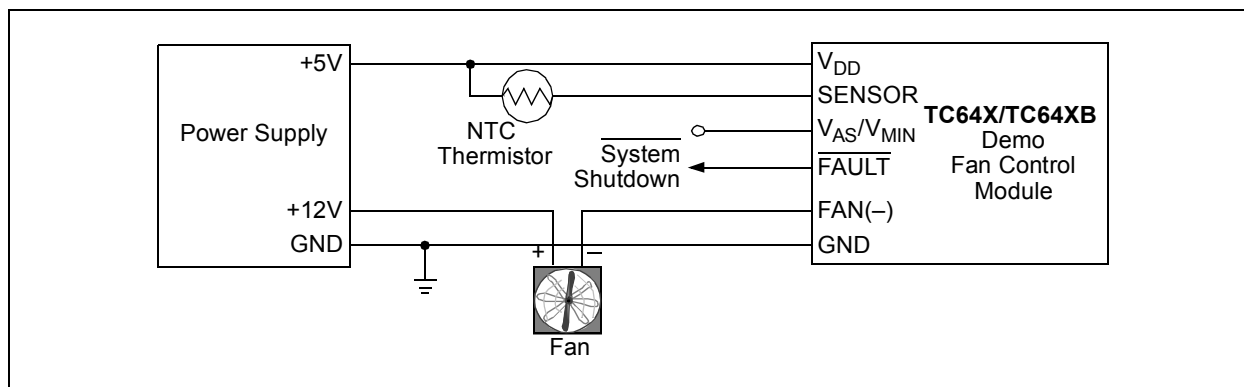


FIGURE 2-2: Typical Wiring Connections to Fan Module for +12V Fan and +5V Module Supply

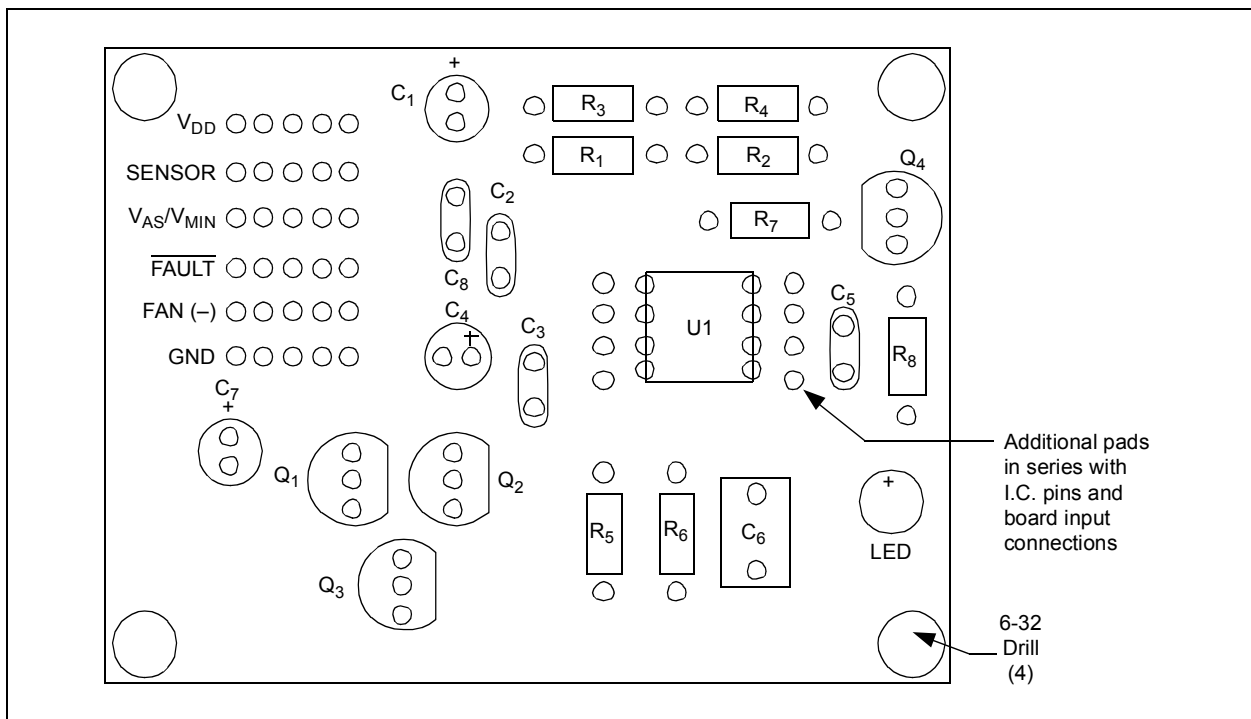
**Appendix A. Board Layout and Schematic**

**A.1 INTRODUCTION**

This appendix contains general information concerning the layout, schematic and components for the TC64X/TC64XB Fan Control Demo Board.

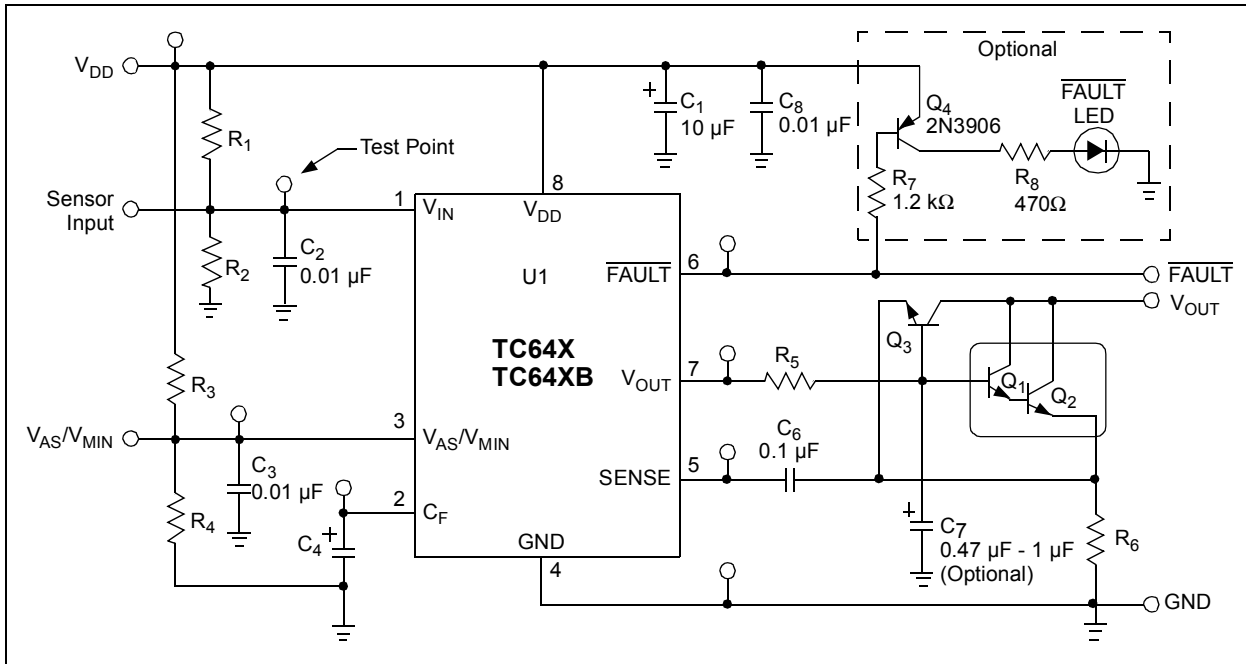
**A.2 BOARD LAYOUT AND SCHEMATIC**

Figure A-1 depicts the layout for the TC64X/TC64XB Fan Control Demo Board. Figure A-2 shows the schematic for the TC64X/TC64XB Fan Control Module.



**FIGURE A-1:** TC64X/TC64XB Fan Control Demo Board Layout

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**FIGURE A-2:** TC64X/TC64XB Fan Control Demo Board Schematic



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## Appendix B. Bill-of-Materials (BOM)

### B.1 DEMO BOARD COMPONENTS

Table B-1 lists typical components and the associated values that comprise the TC64X/TC64XB Fan Control Demo Board.

**TABLE B-1: FAN CONTROL MODULE COMPONENTS LIST**

Component	Typical Value	Comments
C <sub>1</sub>	10 $\mu$ F Radial Electrolytic Capacitor	Power supply filter.
C <sub>2</sub>	0.01 $\mu$ F Ceramic Disk Capacitor	Bypass capacitor.
C <sub>3</sub>	0.01 $\mu$ F Ceramic Disk Capacitor	Bypass capacitor.
C <sub>4</sub>	1.0 $\mu$ F Ceramic Capacitor	PWM capacitor. Typical value is 1.0 $\mu$ F (PWM frequency of 30 Hz).
C <sub>5</sub>	Not used	—
C <sub>6</sub>	0.1 $\mu$ F Ceramic Disk Capacitor	SENSE input coupling capacitor.
C <sub>7</sub>	0.47 $\mu$ F to 1 $\mu$ F Radial Electrolytic Capacitor	Fan acoustic noise suppression capacitor. (Optional)
C <sub>8</sub>	0.01 $\mu$ F Ceramic Disk Capacitor	Bypass capacitor.
LED	10 mA Miniature LED	LED lights when <u>FAULT</u> output is LOW (active). (Optional)
Q <sub>1</sub> , Q <sub>2</sub>	2N2222A NPN Transistor	Darlington pair output option. If used, Q <sub>3</sub> location MUST be left open.
Q <sub>3</sub>	See Applications section of TC64X and TC64XB data sheets.	Single transistor output option. Can be bipolar transistor or logic level MOSFET (depending on cost constraints and fan current). If used, Q <sub>1</sub> and Q <sub>2</sub> locations MUST be left open.
Q <sub>4</sub>	2N3906 (or Equivalent) PNP Transistor	LED Driver transistor (Optional).
R <sub>1</sub> , R <sub>2</sub>	See the Applications section of the TC64X and TC64XB data sheets.	Value depends on the type of sensor used and the desired fan speed vs. temperature profile.
R <sub>3</sub> , R <sub>4</sub>	See the Applications section of the TC64X and TC64XB data sheets.	Value depends on the desired minimum fan speed setting (TC642/2B, TC647/7B) or auto-shutdown temperature (TC646/6B, TC648/8B, TC649/9B).
R <sub>5</sub>	See the Applications section of the TC64X and TC64XB data sheets.	Base current limiting resistor. Value depends on the type of fan and driver used. Typical values appear in Table B-1.
R <sub>6</sub>	See Applications section of the TC64X and TC64XB data sheets.	Fan Current sensing resistor. Value depends on full-speed fan current. Typical values are shown in Table B-1.
R <sub>7</sub>	1.2 k $\Omega$ , 1/4 Watt, 5% Resistor	LED Drive transistor base resistor (Optional).
R <sub>8</sub>	470 $\Omega$ , 1/4 Watt, 5% Resistor	LED Drive transistor series-limiting resistor (Optional).
U <sub>1</sub>	TC642/B, TC646/B, TC647/B, TC648/B or TC649/B Fan Control devices	



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