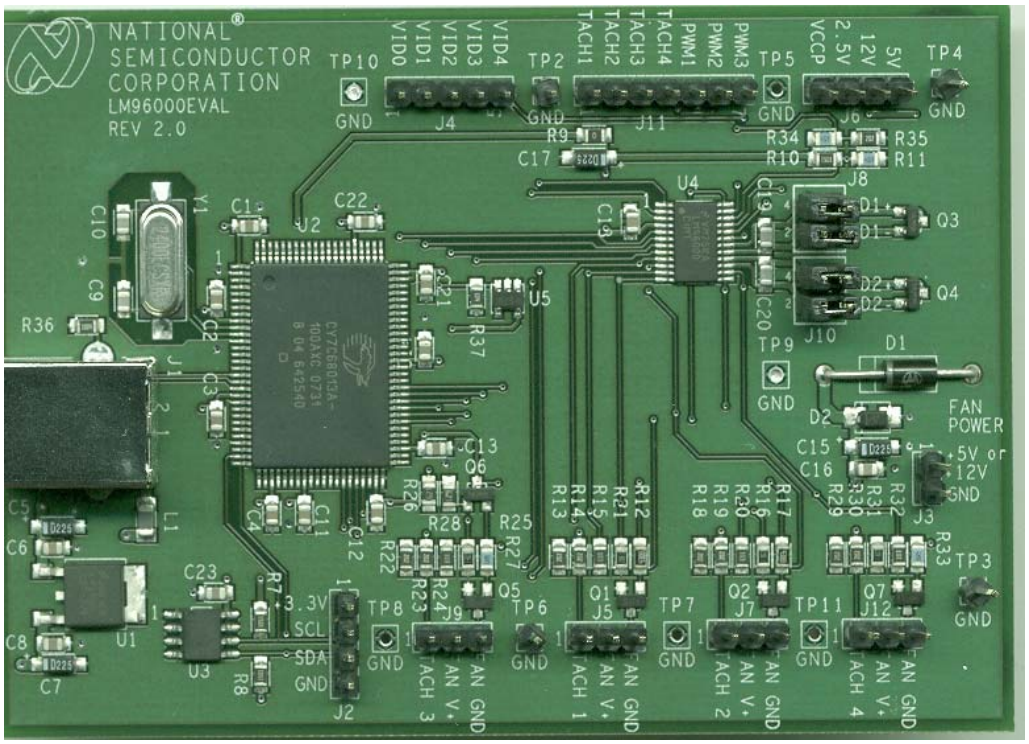
National Semiconductor

Revision A
July 10, 2008

LM96000EVAL NOPB Evaluation Board User's Guide



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LM96000 Evaluation Board User's Guide

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LM96000 Evaluation Board User's Guide

References

1. LM96000 datasheet.

   The latest copy of the LM96000 datasheet can be obtained by going to the National Semiconductor website www.national.com. Search for "LM96000", and then download the LM96000.pdf file.

2. SensorEval Version 1.1.0q or later, Evaluation Board CD containing:
   a. The SensorEval.exe executable program used to run the LM96000EVAL NOPB Evaluation Board.
   b. A softcopy of this User's Guide
   c. A readme.txt file with useful information about the program.
   d. A softcopy of the SensorEval Software manual.

1.0 Introduction

The LM96000EVAL NOPB Evaluation Board is used together with National Semiconductor SensorEval software (provided in the kit), and with a USB cable (not provided in the kit), and with an external personal computer (PC). Power to the LM96000EVAL NOPB Evaluation Board is provided by the +5VDC line of the USB connection. An external power supply for fan power is required for operation of the LM96000EVAL NOPB Evaluation Board with the 3-terminal DC fans. The third terminal of the fan is the open-collector fan tachometer (tach) output. It is recommended that the user only use 2 fans at a time to avoid overloading the USB's 5 V line. See the operational details in this user's guide.

Before connecting the PC to the LM96000EVAL NOPB Evaluation Board through the USB cable, the PC is first turned on and allowed to go through its boot-up procedure. The user installs and initiates the SensorEval software. See Section 4.0 for details.

After the SensorEval software is running, the user can connect the USB cable first to the computer and then to the LM96000EVAL NOPB Evaluation Board.

The PC should be able to recognize the USB board and install the driver from the software.

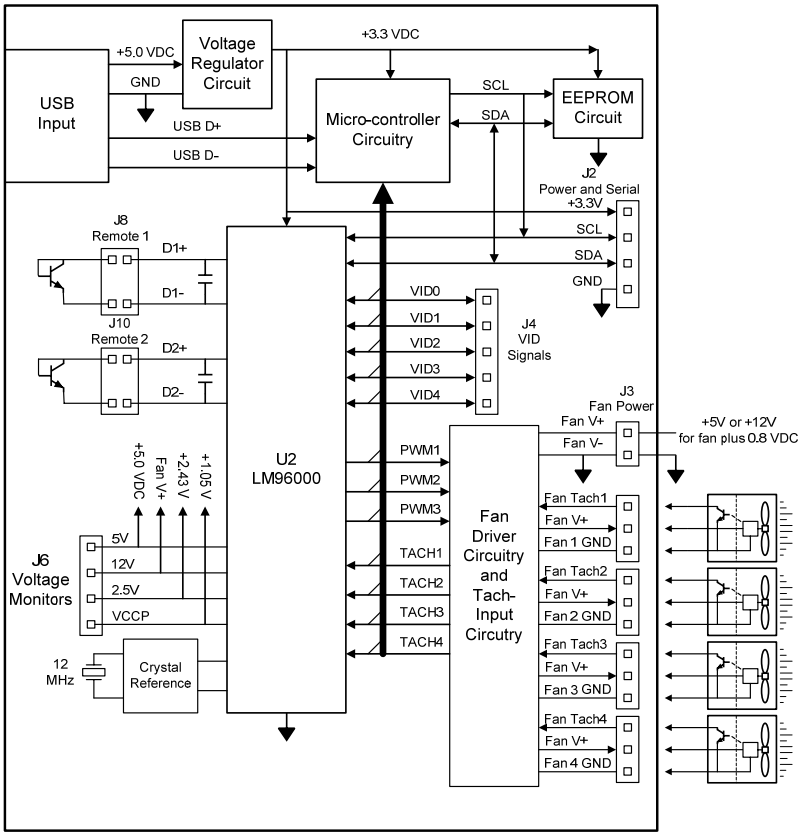
The block diagram below describes the LM96000EVAL NOPB Evaluation Board itself. The USB input provides the +5.0 VDC power to the board, which is regulated down to 3.3 VDC to power the IC's on the board. The EEPROM is programmed at the factory with a unique ID code for this particular board. When the USB cable is plugged in, the PC interrogates the USB devices and can identify this device as the LM96000EVAL NOPB Evaluation Board.

The microcontroller on the board provides the 2-wire serial clock (SC), and serial data (SDA) signals, and relays the information from the LM96000EVAL NOPB to the PC via the USB lines.

Appendix A provides details for each of the connectors and test points and their function.

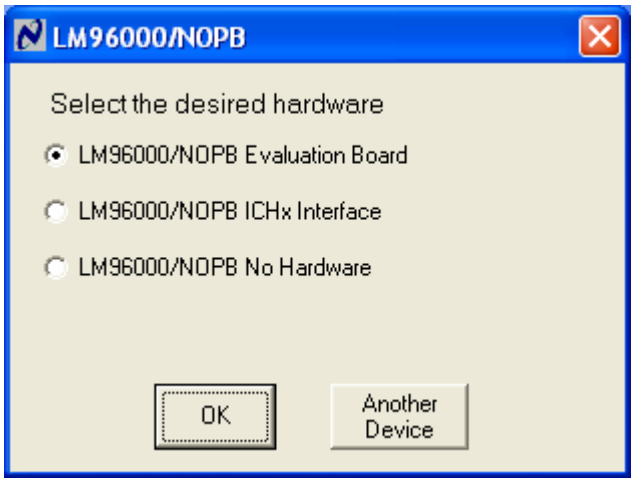
Read this user's guide completely before using the LM96000EVAL NOPB Evaluation Board.

1.1 Block Diagram



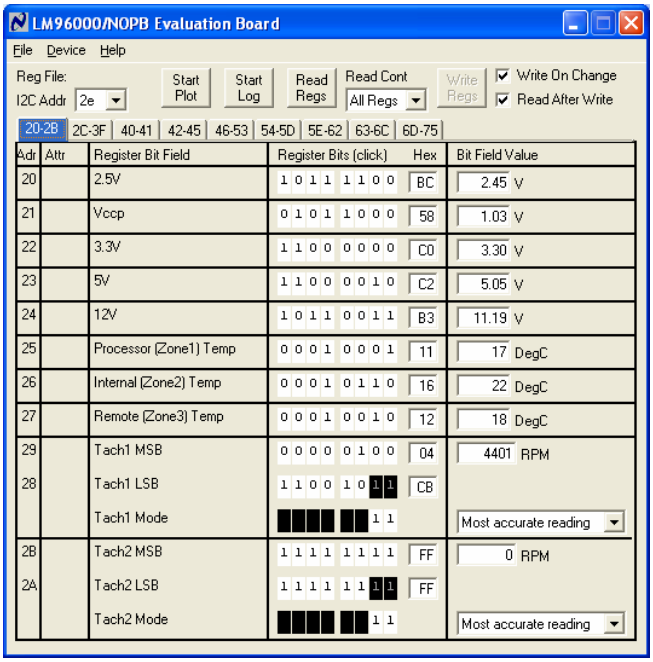
2.0 Quick Start

1. Install the CD into the CD drive of the computer and install the SensorEval software (see Section 4.0).
2. Hookup the USB cable between the PC or notebook computer as shown in the Quick Start Diagram in Section 2.1.
3. Run the SensorEval software by clicking on the icon on the desktop. LM96000 Example: the first screen should look like this:



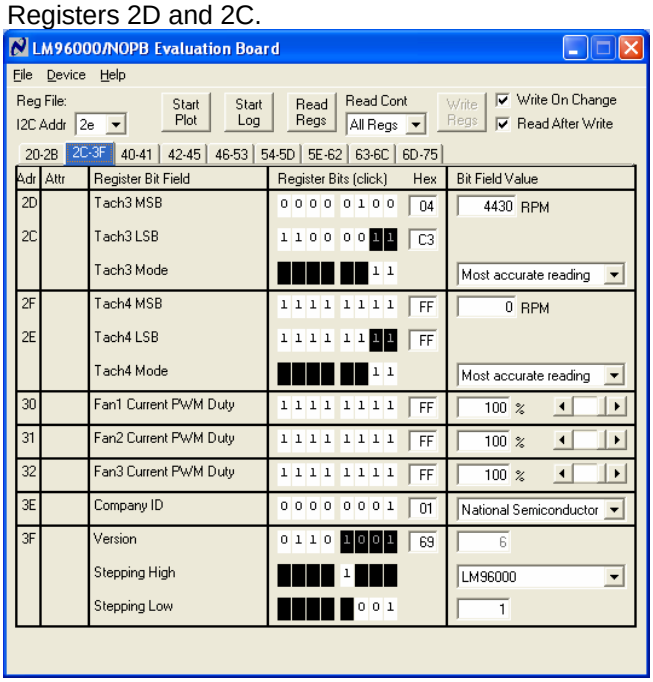
Select the LM96000 Evaluation Board radio button.
Click OK.

4. The next screen will look like this:

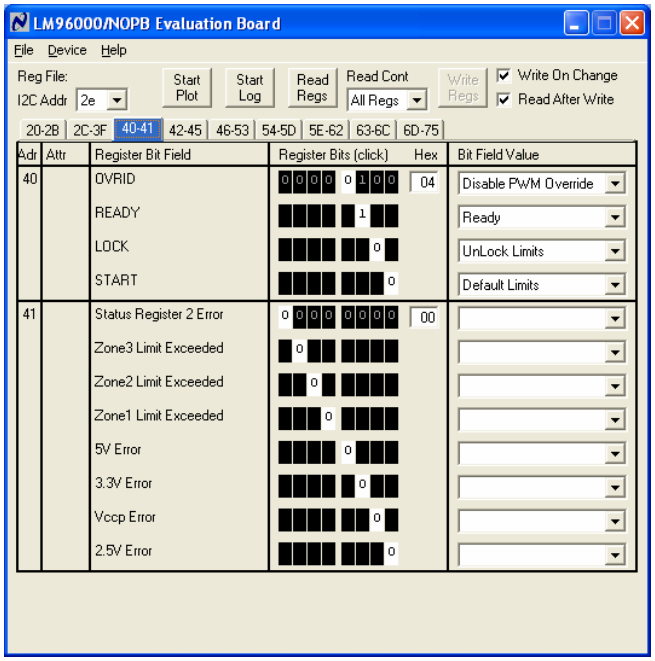


Select the Read Continuous (Cont) box to refresh the data continuously. Note that the temperature readings of the 3 zones (the internal temperature of the temperature sensor device, or the temperature of one of the MMBT3904's). Notice the DC voltages on the voltage monitoring registers and pins. (See the Schematic in Section 5.2). The "12V" pin is connected to the Fan+ Voltage. This screen also shows the Fan 1 and Fan 2 tachometer readings if the fans are connected and the power is on.

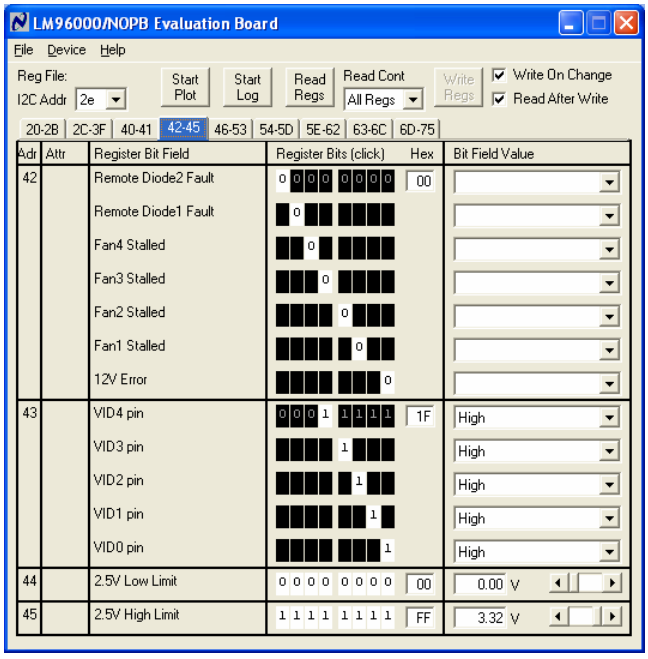
5. When the 2C-3F tab is selected the screen looks like this. Note that the fan is connected to the Fan3 connector. The Tach output from the fan is stored in Registers 2D and 2C.



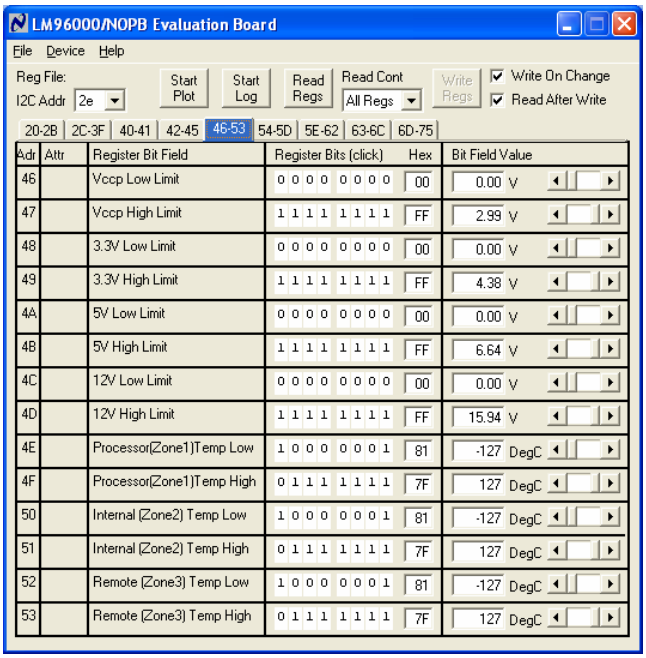
6. When the 40-41 tab is selected the screen looks like this. For Register 40 “START”, select “Register Limits” from the pull-down menu.



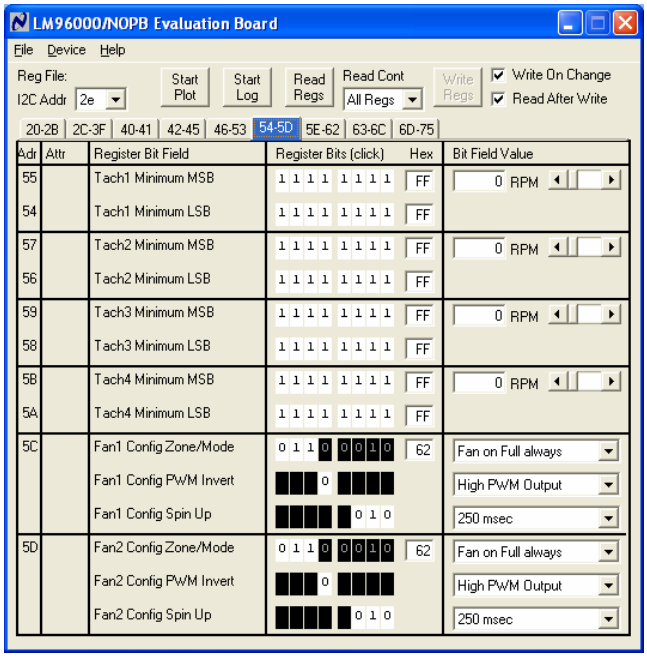
7. When the 42-45 tab is selected the screen looks like this:



8. When the 46-53 tab is selected the screen looks like this:



9. When the 54-5D tab is selected the screen looks like this:



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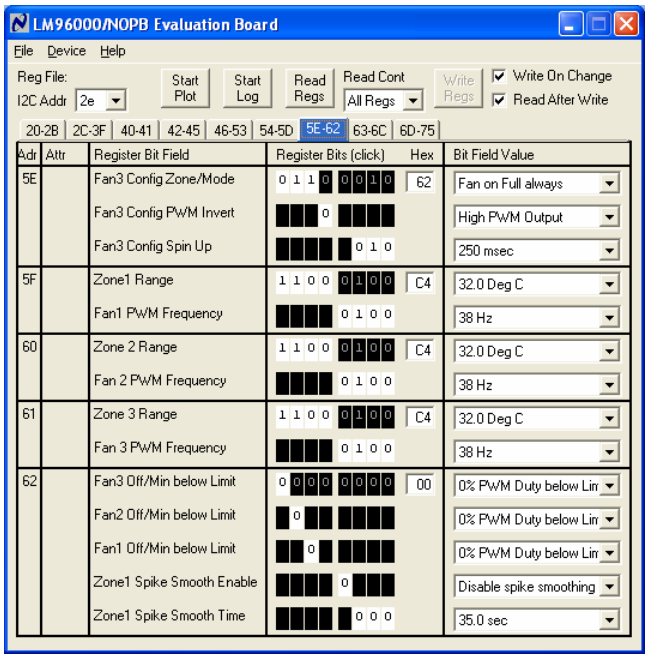
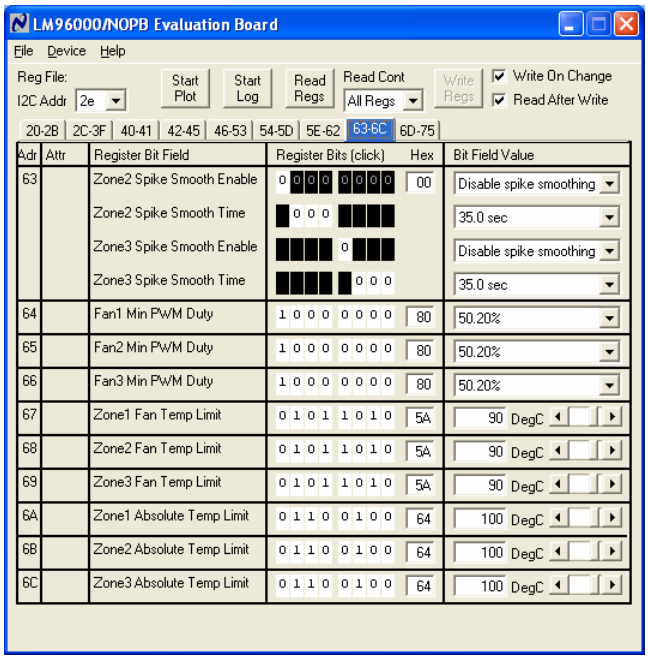
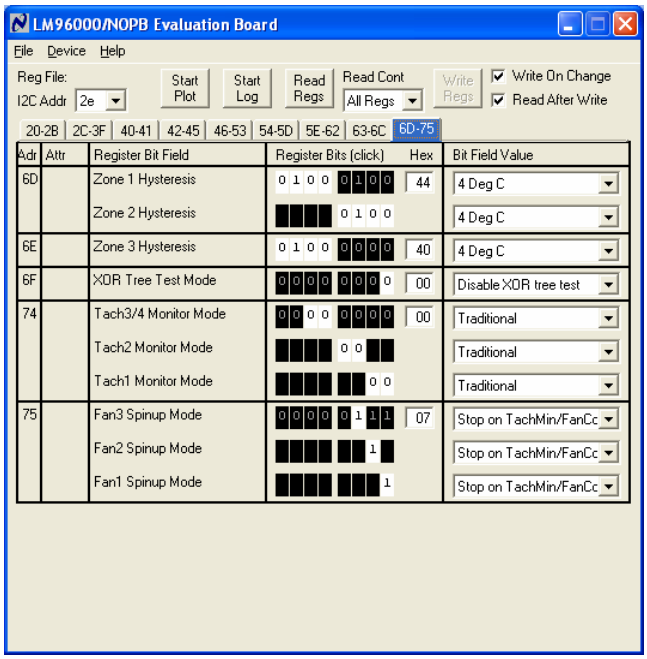
10. When the 5E-62 tab is selected the screen looks like this:



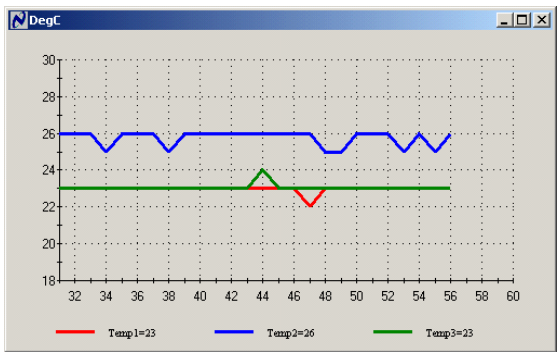
11. When the 63-6C tab is selected the screen looks like this:

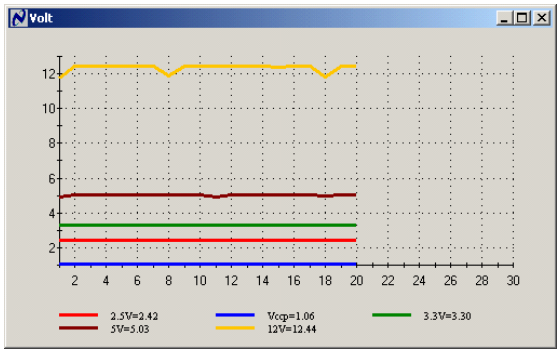


12. When the 6D-75 tab is selected the screen looks like this**:**



13. One of the features of the SensorEval software is the plotting feature. If the user clicks on the Start Plot button a graph box will appear and will graph the temperatures, Voltages, RPM, and % Duty Cycle. An example of the four plots is shown below.





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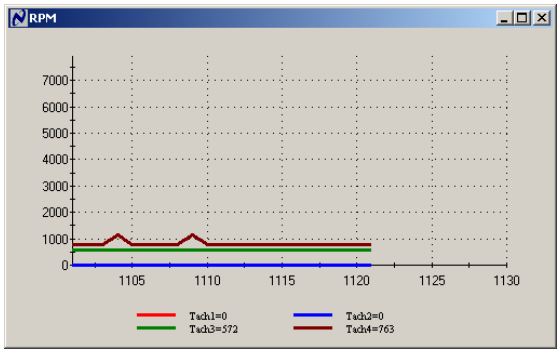
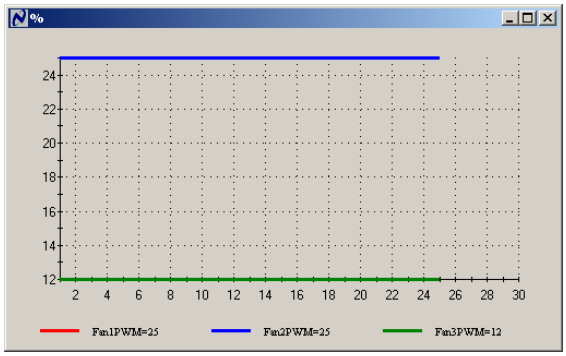
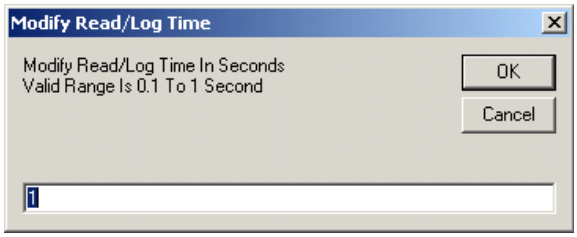


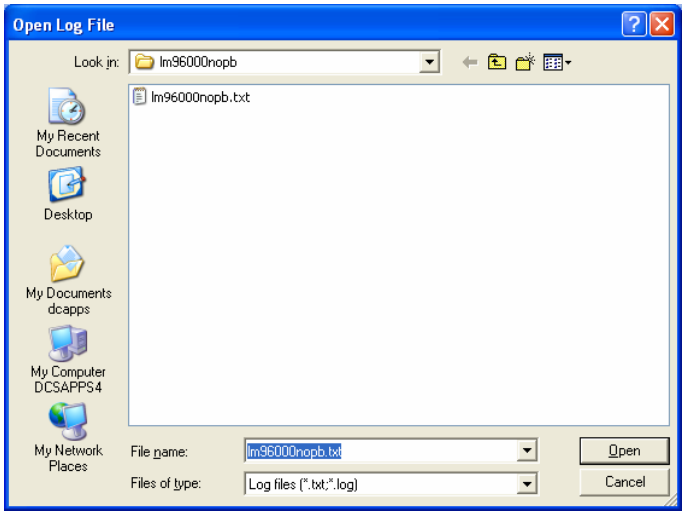


10. The user can change the time interval for the data to be taken. Simply select File, then Set Read Time, and the following block will appear.



When the user makes the selection and clicks on OK that interval is set from that time on while the program is running.

11. If the user clicks on the Start Log button the screen shown below will appear. The user selects the directory that the datafile is to be written into and the filename. When “Open” is clicked the data is taken and logged into the datafile at whatever rate is set in the Set Read Time menu.



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2.1 Quick Start Diagram

Important! ***An EXTERNAL POWER SUPPLY is required for operation of the fans! WARNING! Use only 2 fans at a time during the tests to avoid overloading the +5V line coming from the USB terminal. It is suggested that the user use either Fans 1 and 2, or Fans 3 and 4, during the tests. Fans may be of the 5 volt or 12 volt 3-terminal variety but the current rating of each fan must be under 200 mA.***

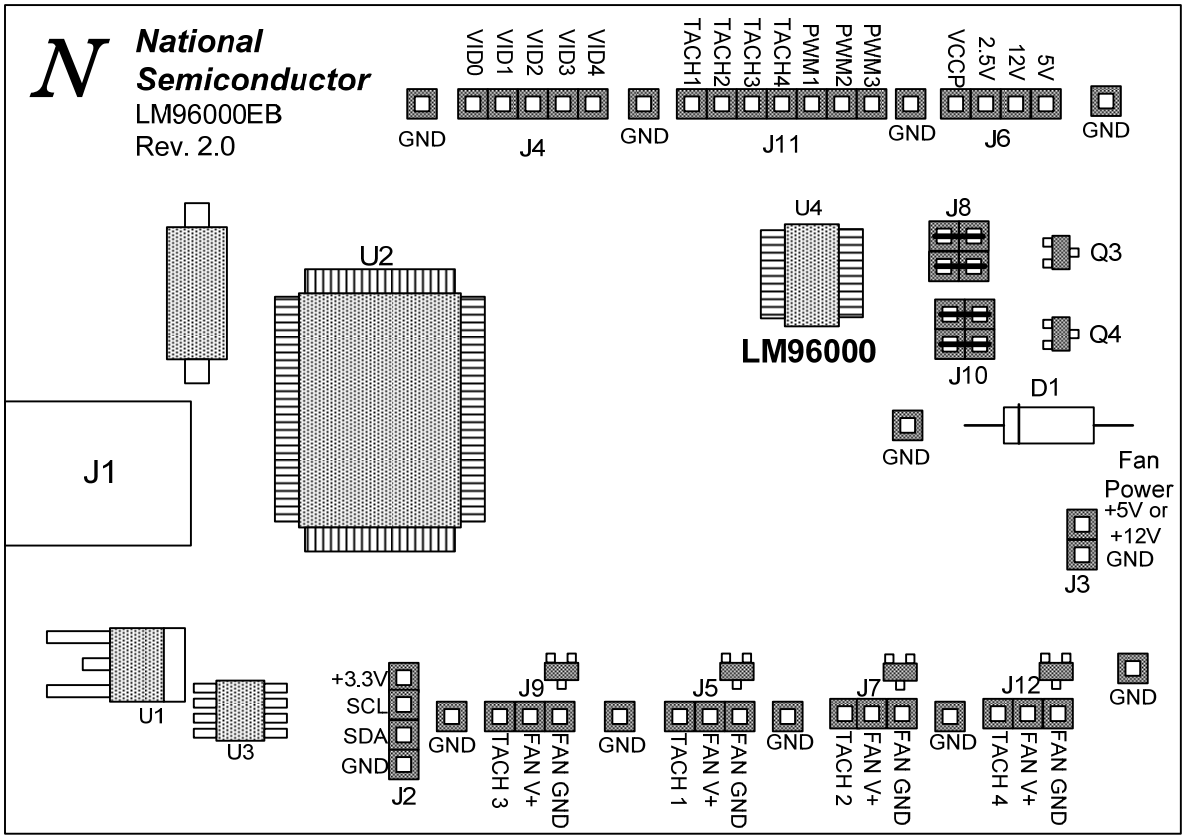


Figure 2.1.1 Physical Layout of the LM96000EVAL NOPB Evaluation Board

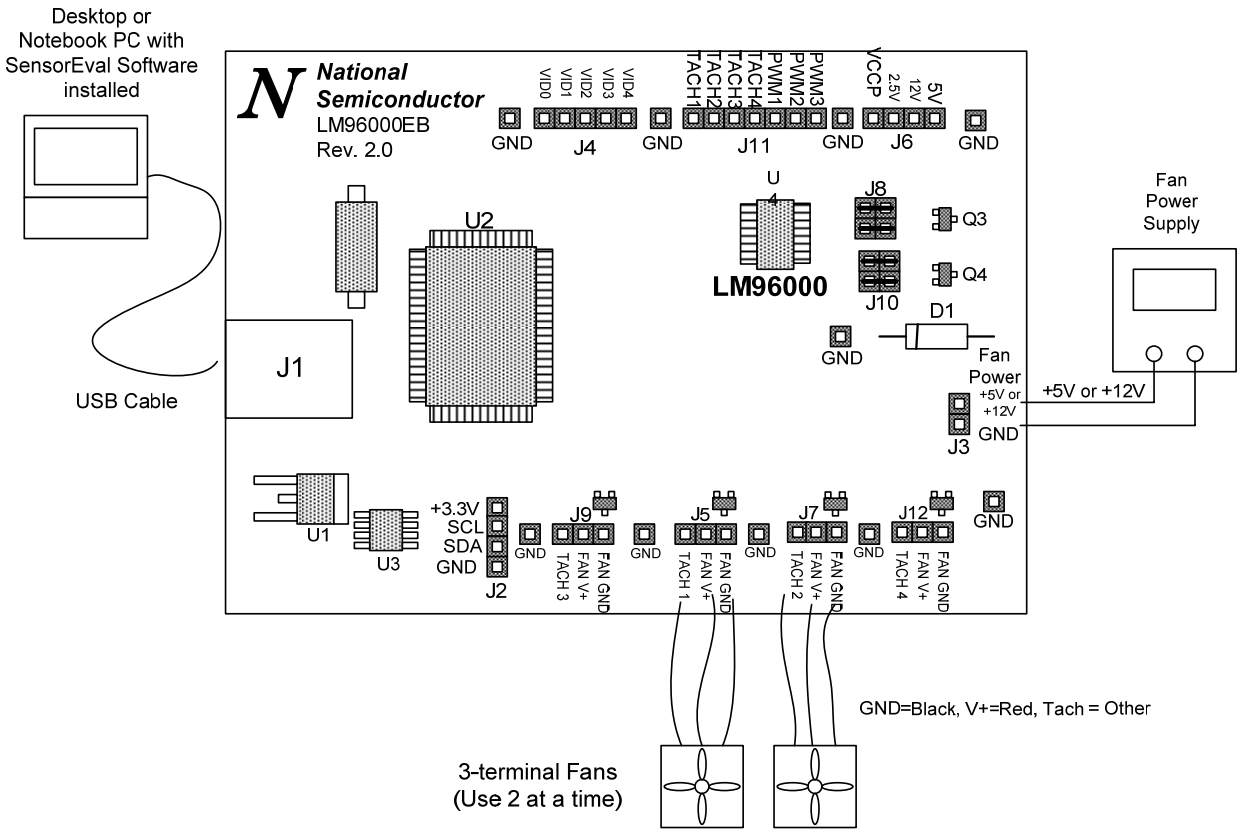


Figure 2.1.2 Wiring Diagram for the LM96000EVAL NOPB Evaluation Board

3.0 Functional Description

The LM96000EVAL NOPB Evaluation Board, along with the SensorEval Software, provides the system designer with a convenient way to learn about the operation of the LM96000 Temperature Sensor chip. The user simply has to install the SensorEval software on his PC, run it, connect the USB cable from the PC to the Evaluation Board, and the user can read temperatures, experiment with fan control, and set limits all according to the latest datasheet. It's that simple! The user has to provide the +5 or +12 VDC, depending on the fan's rated voltage, from an external power supply, to the Fan Power input connector of the evaluation board.

Power to the LM96000EVAL NOPB Evaluation Board is taken from the USB 5-Volt line. This +5VDC is the input to the on-board LM2950 low dropout voltage regulator, which regulates the output voltage to +3.3 VDC. This output voltage powers the LM96000, the on-board microcontroller, the EEPROM chip where the board ID information is stored, and some of the fan driver circuitry. The fan tachometer outputs, all open-drain, are pulled up with resistor to the Fan Power voltage and then voltage divided down to acceptable voltage input levels for the LM96000 "Tach" inputs.

The external 3-terminal DC fans are either +5V or +12 VDC brushless DC fans with a rated current of 200 mA or less. Fans 1 and 2 are controlled independently. Fan 3 and 4 are driven by the same PWM3 signal from the device.

The microcontroller provides the two-wire SMBus communications to the LM96000. For all of the details of this communication protocol see the latest LM96000 datasheet, available at www.national.com.

3.1 LM96000EVAL NOPB Evaluation Board Connection Table

See Appendix A for the description of all Connectors and Test Points, their function and requirements.

4.0 Software Installation and Operation

4.1 Installation

The CD provided in the LM96000EVAL NOPB Evaluation Board Kit contains the SensorEval software used to make the LM96000EVAL NOPB Evaluation Board operate with the user's PC. It is assumed that the user will be using a PC with a Pentium® III or higher processor and Microsoft Windows® XP/2000/98/ME operating system.

The software is installed as follows:

1. Insert the SensorEval CD into the CD drive of the PC. See details in the readme.txt file.
2. The software manual, provided on the CD, may be useful to the user during this process.
3. The installation process will put an icon on the PC desktop so that the SensorEval program will run when the icon is double-clicked.

4.2 Operation

Follow the following procedure for operating the LM96000EVAL NOPB Evaluation Board using the SensorEval software:

1. Run the SensorEval program by either double-clicking on the icon on the desktop or by selecting Start, Run, and browse to find the SensorEval.exe file.
2. Plug in the USB cable on both the PC and the LM96000EVAL NOPB Evaluation Board.

Follow the register setup steps given in Section 2.0 Quick Start of this User's Guide. Make sure that you are following the given procedure for the specific evaluation board you are working with.

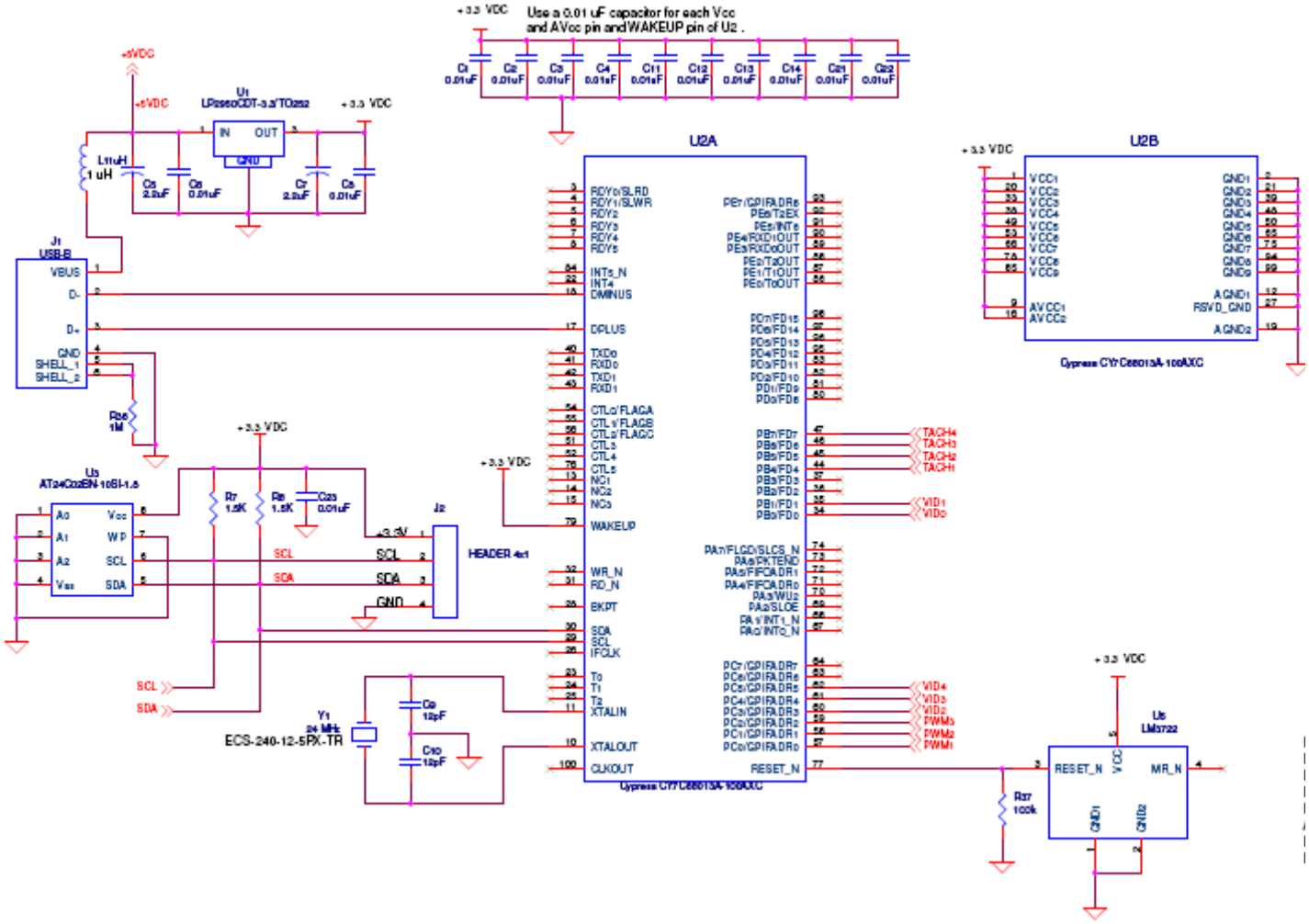
Refer to the electrical schematic, layout and connector diagrams for proper connections to external remote thermal diodes.

5.0 Electrical and Mechanical Specifications

5.1 Electrical Specifications

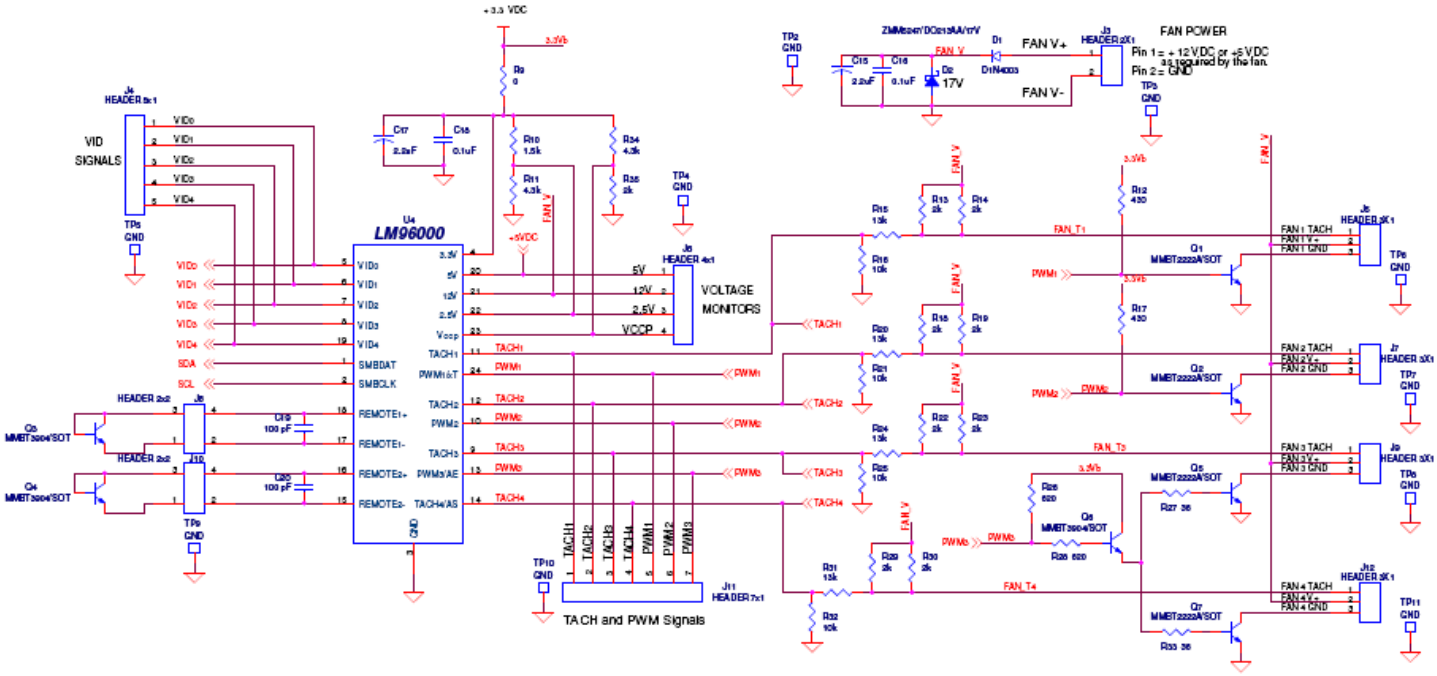
Power Requirements	
The Board uses the +5.0 VDC and GND lines from the USB connection. This +5.0 VDC voltage is regulated down to +3.3 VDC for board power.	+5.0 ± 0.1 V, 100 mA max.
Fan Power – External Power Supply set to +5 VDC or +12 VDC, whichever the fan voltage rating is. Each fan must be rated at 200 mA or less. *** USE ONLY 2 FANS AT A TIME – Either Fans 1 and 2 or Fans 3 and 4. ***	+5.0 ± 0.1 V, or +12.0 ± 0.1 V, at 500 mA max

5.2 Electrical Schematic



Page 1 of 2 Pages of the Schematic of the LM96000EVAL NOPB Evaluation Board

5.2 Electrical Schematic (continued)



Page 2 of 2 Pages of the Schematic of the LM96000EVAL NOPB Evaluation Board

5.3 Evaluation Board Layout

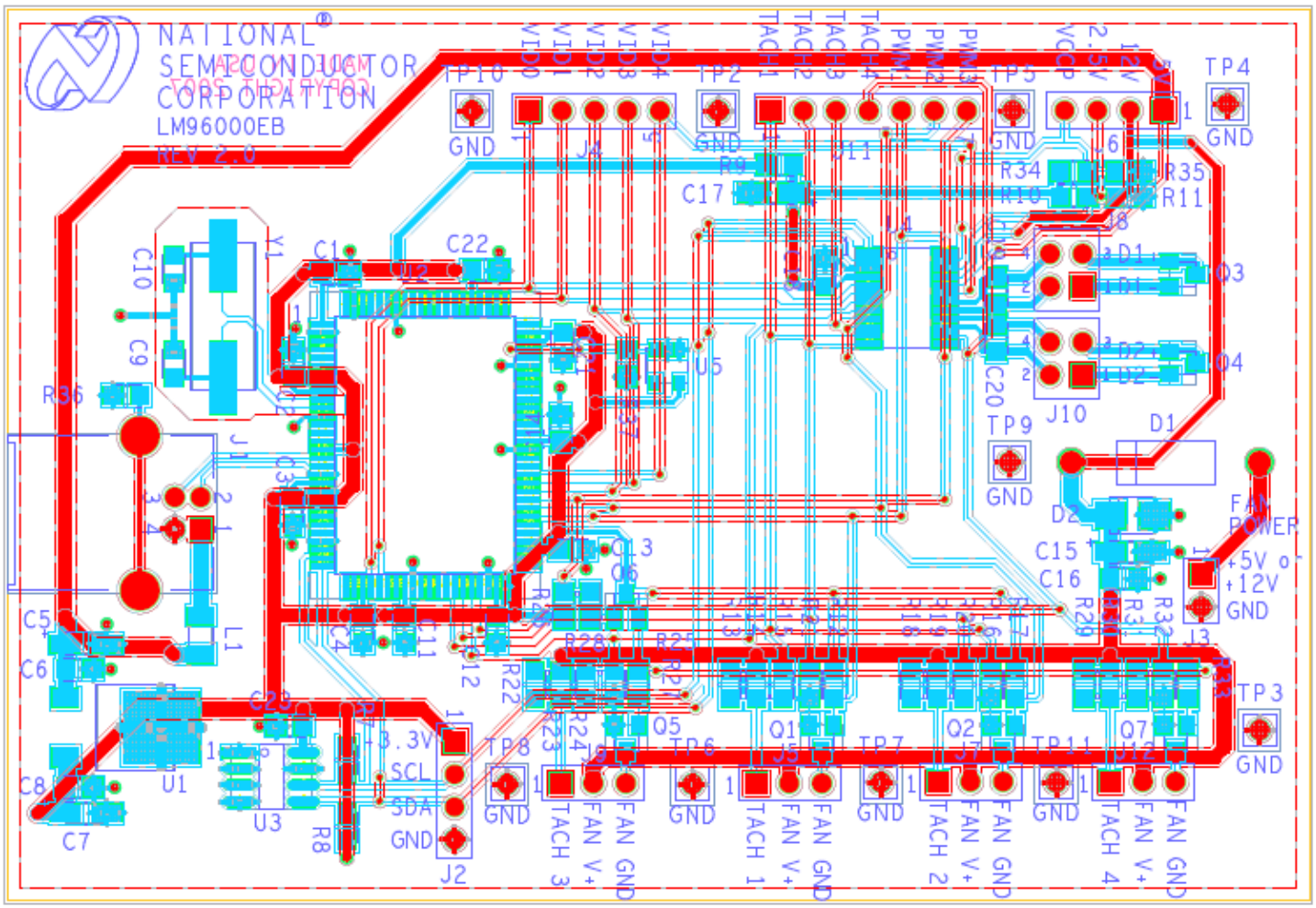


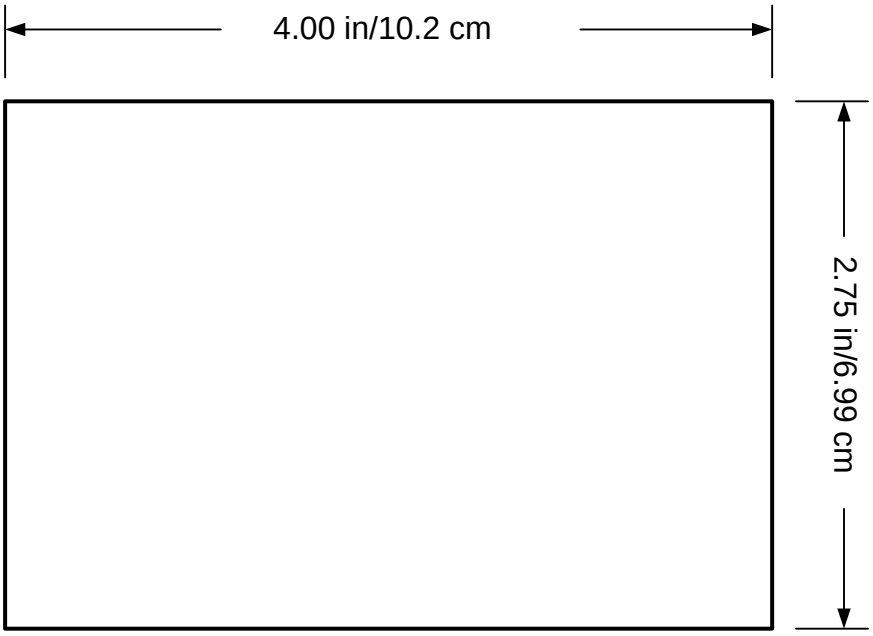
Figure 5.3 Layout diagram of the LM96000EVAL NOPB Evaluation Board

5.4 Bill of Materials for LM96000EVAL NOPB Evaluation Board

Item	Quantity	Reference	Part
1	13	C1, C2, C3, C4, C6, C8, C11, C12, C13, C14, C21, C22, C23	Capacitor, Ceramic, 0.01 uF
2	4	C5, C7,C15, C17	Capacitor, electrolytic, 2.2 uF
3	2	C9, C10	Capacitor, ceramic, 12 pF
4	2	C16, C18	Capacitor, ceramic, 0.1 uF
5	2	C19, C20	Capacitor, ceramic, 100 pF
6	1	D1	Diode, Rectifier, 1N4003
7	1	D2	Diode, Zener, 17V, ZMM5247/DO2113AA/17V
8	1	J1	Connector, USB-B
9	2	J2, J6	Header, 1X4, 0.1 in centers
10	1	J3	Header, 1X2, 0.1 in centers
11	1	J4	Header, 1X5, 0.1 in centers
12	4	J5, J7, J9, J12	Header, 1X3, 0.1 in centers
13	2	J8, J10	Header, 2X2, 0.1 in centers
14	1	J11	Header, 1X7, 0.1 in centers
15	1	L1	Filter, 1uH, Stewart MI1206K900R-00
16	4	Q1, Q2, Q5, Q7	MMBT2222A/SOT Transistor, NPN
17	3	Q3, Q4, Q6	MMBT3904/SOT Transistor, NPN
18	2	R7, R8, R10	Resistor, SMT, 1.5k, 0805
19	1	R9	Resistor, SMT, 0 Ohm, 0805
20	4	R11, R34	Resistor, SMT, 4.3 k, 0805
21	2	R12, R17	Resistor, SMT, 430 Ohm, 0805
22	9	R13, R14, R18, R19, R22, R23, R29, R30, R35	Resistor, SMT, 2k Ohm, 0805
23	4	R15, R20, R24, R32	Resistor, SMT, 10k, 0805
24	4	R16, R21, R25, R31	Resistor, SMT, 13k Ohm, 0805
25	2	R26, R28	Resistor, SMT, 620 Ohm, 0805
26	2	R27, R33	Resistor, SMT, 36 Ohm, 0805
27	1	R36	Resistor, SMT, 1M, 0805
28	1	R37	Resistor, SMT, 100k, 0805
29	10	TP2 – TP11	Test Point (Header, 1X1) for Ground
30	1	U1	IC, Voltage Regulator, National LP2950CDT-3.3
31	1	U2	IC, Microcontroller, Cypress CY7C68013A-100AXC
32	1	U3	IC, EEPROM, Atmel AT24C02-10SI-1.8
33	1	U4	LM96000CIMF Device Under Test (DUT)
34	1	U5	LM3722 Reset IC
35	1	Y1	Crystal, 24 MHz, ECS-240-12-5PX-TR
36	1	--	Circuit Board, Fabricated, LM96000EVAL NOPB Evaluation Board, Rev. 1

5.5 Mechanical Specifications

5.5.1 LM96000EVAL NOPB Evaluation Board Basic Dimensions



5.5.3 Electrostatic Discharge (ESD) Precautions

The user shall use ESD precautions as specified in National Semiconductor ESD control document (SC)CSI-3-038 available through www.national.com.

APPENDIX A

LM96000EVAL NOPB Evaluation Board Connectors and Test Points

J1 USB-B Connector

PIN #	NAME	DESCRIPTION
1	VBUS	+5 VDC on USB Bus
2	USBD-	USB Signal Input
3	USBD+	USB Signal Input
4	GND	System Ground
5, 6	Shell	Connected to ground through a 1 Meg Resistor

J2 SMBus Test Connector – 1X4 Header

PIN #	NAME	DESCRIPTION
1	+3.3V	+3.3 VDC chip supply
2	SCL	Serial Clock signal for the SMBus
3	SDA	Serial Data signal for the SMBus
4	GND	System Ground

J3 Fan Power Connector – 1X2 Header

PIN #	NAME	DESCRIPTION
1	Fan V+	+5 or +12 VDC supply as required by the fans
2	Fan V-	Return line for the Fan supply. Connected to system ground.

J4 VID Signals Test Connector – 1X5 Header

PIN #	NAME	DESCRIPTION
1	VID0	Voltage ID signal 0
2	VID1	Voltage ID signal 1
3	VID2	Voltage ID signal 2
4	VID3	Voltage ID signal 3
5	VID4	Voltage ID signal 4

J5 Fan 1 Connector – 1X3 Header

PIN #	NAME	DESCRIPTION
1	Tach1	For 3-terminal fans – Open collector tach out – usually a yellow, green, or blue lead.
2	Fan 1 V+	+5 or +12VDC required fan voltage – red lead
3	Fan 1 GND	Fan Voltage return – black lead

J6 Voltage Monitors Test Connector – 1X4 Header

PIN #	NAME	DESCRIPTION
1	5V	Connected to the USB +5V input for chip input.
2	12V	Connected to the Fan Power V+ input for chip input.
3	2.5V	Connected to a voltage divider for chip input.
4	VCCP	Connected to a voltage divider for chip input.

APPENDIX A (Continued)
LM96000EVAL NOPB Evaluation Board Connectors and Test Points

J7 Fan 2 Connector – 1X3 Header

PIN #	NAME	DESCRIPTION
1	Tach2	For 3-terminal fans – Open collector tach out – usually a yellow, green, or blue lead.
2	Fan 2 V+	+5 or +12VDC required fan voltage – red lead
3	Fan 2 GND	Fan Voltage return – black lead

J8 Remote Temperature Diode Input 1 Connector – 2X2 Header

PIN #	NAME	DESCRIPTION
1	D1-	Connect to cathode of Q3. Shunt 1 and 2 to connect Q3 cathode to Remote 1-.
2	Remote 1-	DUT input from remote diode cathode.
3	D1+	Connect to anode of Q3. Shunt 3 and 4 to connect Q3 anode to Remote 1+.
4	Remote 1+	DUT input from remote diode anode.

J9 Fan 3 Connector – 1X3 Header

PIN #	NAME	DESCRIPTION
1	Tach3	For 3-terminal fans – Open collector tach out – usually a yellow, green, or blue lead.
2	Fan 3 V+	+5 or +12VDC required fan voltage – red lead
3	Fan 3 GND	Fan Voltage return – black lead

J10 Remote Temperature Diode Input 2 Connector – 2X2 Header

PIN #	NAME	DESCRIPTION
1	D2-	Connect to cathode of Q4. Shunt 1 and 2 to connect Q4 cathode to Remote 2-.
2	Remote 2-	DUT input from remote diode cathode.
3	D2+	Connect to anode of Q4. Shunt 3 and 4 to connect Q4 anode to Remote 2+.
4	Remote 2+	DUT input from remote diode anode.

J11 Tach and PWM Test Connector – 1X4 Header

PIN #	NAME	DESCRIPTION
1	TACH1	Pulled up, and voltage-divided, Fan 1 tach output.
2	TACH2	Pulled up, and voltage-divided, Fan 2 tach output.
3	TACH3	Pulled up, and voltage-divided, Fan 3 tach output.
4	TACH4	Pulled up, and voltage-divided, Fan 4 tach output.
5	PWM1	Pulled up open-collector output of DUT to Fan 1 driver circuit.
6	PWM2	Pulled up open-collector output of DUT to Fan 2 driver circuit.
7	PWM3	Pulled up open-collector output of DUT to Fan 3 and Fan 4 driver circuit.

APPENDIX A (Continued)
LM96000EVAL NOPB Evaluation Board Connectors and Test Points

J12 Fan 4 Connector – 1X3 Header

PIN #	NAME	DESCRIPTION
1	Tach4	For 3-terminal fans – Open collector tach out – usually a yellow, green, or blue lead.
2	Fan 4 V+	+5 or +12VDC required fan voltage – red lead
3	Fan 4 GND	Fan Voltage return – black lead

TP1 – TP11 Ground Connector – 1X1 Header

PIN #	NAME	DESCRIPTION
1	GND	System ground.

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National Semiconductor
The Sight & Sound of Information

National Semiconductor Corporation
Americas Customer Support Center
Tel: 1-800-272-9959
Email: new.feedback@nsc.com

National Semiconductor Europe Customer Support Center
Fax: +49 (0) 1 80-530 85 86
Email: europe.support@nsc.com
Deutsch Tel: +49 (0) 699508 6208
English Tel: +49 (0) 870 24 0 2171
Français Tel: +49 (0) 141 91 8790

National Semiconductor Asia Pacific Customer Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Customer Support Center
Tel: 81-3-5639-7560
Fax: 81-3-5639-7507
Email: jpn.feedback@nsc.com

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