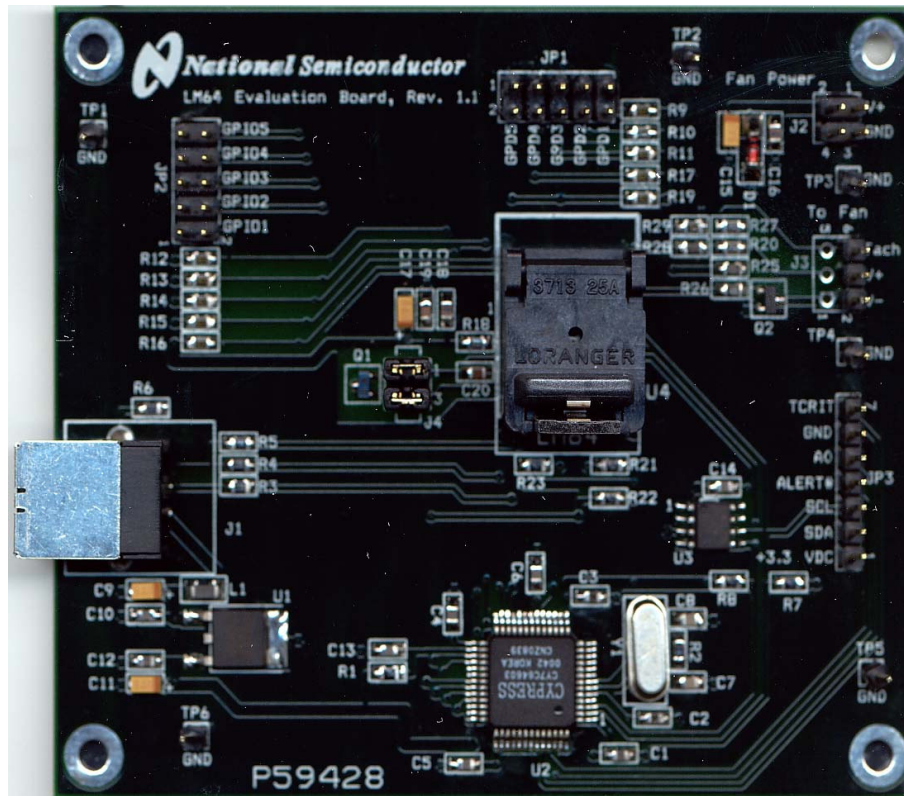




## LM64 Evaluation Board User's Guide



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## 1.0 Introduction

The LM64EVAL kit includes the following items:

1. The LM64 Evaluation Board
2. The SensorEval Software CD, including
  - a. the readme.txt file (read this first)
  - b. the installation setup file,
  - c. the SensorEval Software manual, and
  - d. this manual.
3. Jumpers to use for testing the GPD or GPIO pins if desired.

The LM64 Evaluation Board, as shown in Figure 1 (without the socket lid for clarity), is a complete PCBA (printed circuit board assembly). The board has a USB connector, a voltage regulator circuit, a microcontroller, an EEPROM, and a LM64 Remote Diode Temperature Sensor with Integrated Fan Control. A schematic and bill of materials is included in this User's Guide. Figure 1 shows the location of pin1 for proper orientation of the LM64 in the socket.

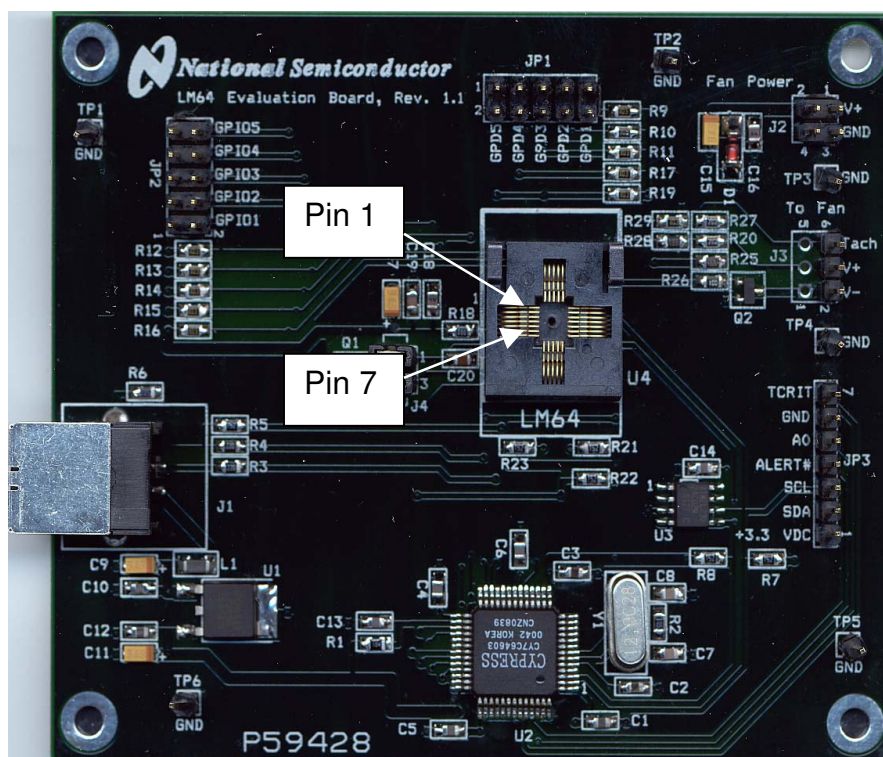


Figure 1. The LM64 Evaluation Board with Open Socket showing pin numbering convention.

The LM64EVAL kit includes the SensorEval software, which is provided by National Semiconductor to communicate with the LM64 Evaluation Board by way of the USB cable (not provided) from the controlling computer. The SensorEval software is used to control the writing and reading of the digital registers in the LM64 for doing the initial register setup, reading the local and remote temperatures, establishing certain temperature limit setpoints, and setting up fan control and tachometer monitoring registers.

## 1.0 Introduction (Continued)

For the installation procedure for the SensorEval software see the readme.txt file on the SensorEval software CD. For detailed use of the LM64 software used with the LM64 Evaluation Board, please refer to the SensorEval software user's guide on the CD. The LM64 datasheet is available at [www.national.com](http://www.national.com).

## 2.0 Getting Started

### 2.1 Required Equipment

In order to use the LM64 Evaluation Board you will need to have the following required pieces of equipment:

1. A computer with at least a Pentium III processor, running Microsoft® Windows® 98/2000/XP<sup>1</sup> operating system, with 20 MB of free disk space, and at least one USB port
2. A standard USB cable (3 foot length should be sufficient) for connecting the computer to the LM64 Evaluation Board.
3. If you plan to test with a 3-terminal fan you must have:
  - a. A 3-terminal DC brushless fan rated at less than 0.40 Amp. Note that provisions are made on the board for either a standard processor fan connector or holes for soldering wires on the board.
  - b. A Power Supply capable of delivering the fan rated voltage (+12 VDC or +5 VDC) at **twice** the rated fan current. A pair of wires from the power supply to a female header connector to connect with J2, Fan Power input, is suggested.

If it is desired to run the software only, **without the LM64 Evaluation board**, omit items 2 and 3 and proceed to paragraph 2.3.

### 2.2 Optional Equipment

Optional pieces of equipment are as follows:

1. Remote Diode with wired connector to connect to a female 2-pin header, 0.1 in centers
2. Test equipment such as a digital voltmeter or oscilloscope.

### 2.3 Test Setup - Software

First, see the readme.txt file on the SensorEval CD for the latest installation instructions. Follow the installation procedures to load the software on the computer and, if desired, to verify the operation of the LM64 Evaluation Board.

The SensorEval icon will be on the desktop window after the software installation.

If it is desired to run the software without the LM64 Evaluation Board please proceed to the Software User's Guide on the SensorEval CD.

For use with the LM64 Evaluation Board disconnect the USB cable from the board and proceed to the next section for the hardware setup.

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<sup>1</sup> Microsoft®, Windows®, and XP® are registered trademarks of Microsoft Corporation.

## 2.0 Getting Started (continued)

### 2.4 Test Setup – Hardware

Figure 2 below shows an example of a typical LM64 Evaluation Board test setup for driving fans, attaching remote diodes, and monitoring the system.

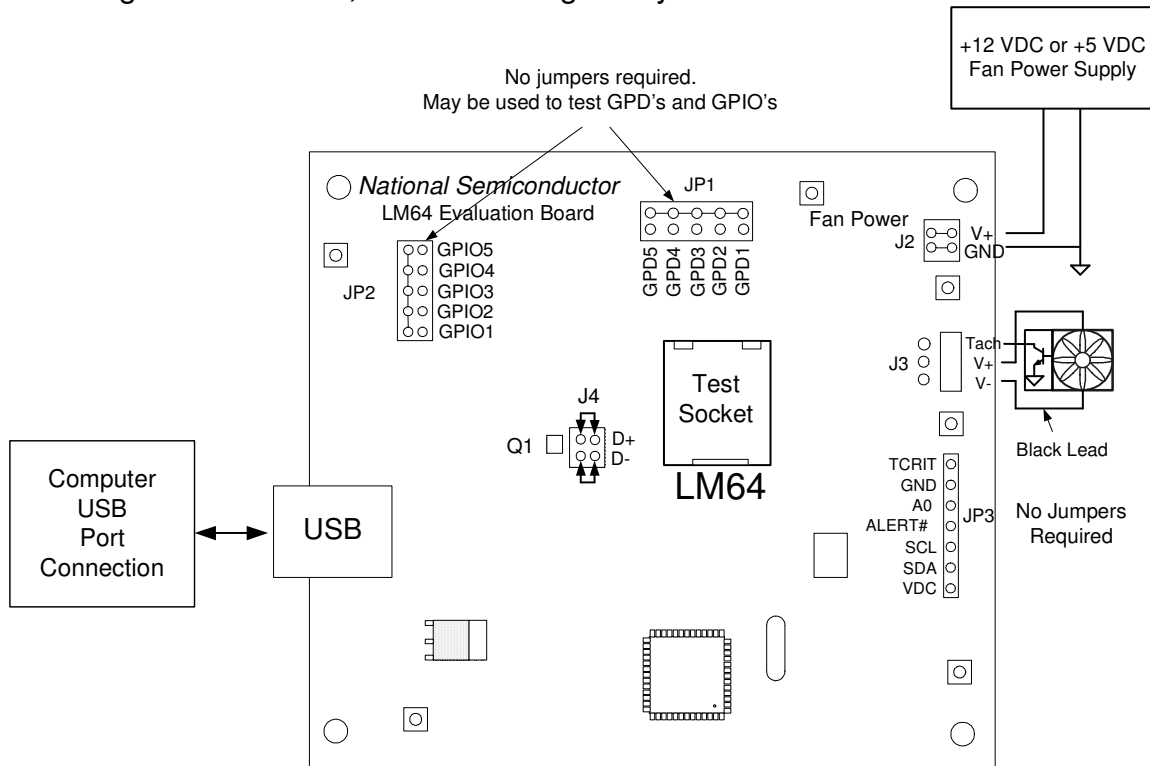


Figure 2. Test Setup using the LM64 Evaluation Board

For the first time user, no jumpers are required on headers JP1, JP2, or JP3 for operation of the basic temperature measuring and fan control functions. Details about these headers, and connections to them, will be discussed later in this User Guide.

### Hardware Test Setup Procedure

1. Before connecting the power supply to the LM64 Evaluation Board, turn it on and set the output voltage to the voltage rating of the fan (+5 or +12 VDC). Turn the power supply off.
2. Connect the power supply to the LM64 Evaluation Board jack J2 as shown in Figure 2. Make sure that the positive terminal is connected to V+ and the negative terminal is connected to the GND of J2.
3. Plug in the fan as shown in Figure 2. This pinout is standard for PC processor fans.
4. The LM64 Evaluation Board comes with jumpers installed on J4, which connects the on-board MMBT3904 diode-connected transistor to the input of the LM64 chip.
5. Connect the USB cable from the computer's USB port to the LM64 Evaluation Board
6. Turn on the fan power supply.
7. Start the SensorEval software.

## 2.0 Getting Started (continued)

### 2.5 Test Setup – System

For proper fan control follow the following procedure, using SensorEval as described in the SensorEval software manual.

#### ***IMPORTANT!***

Registers 4A, 4B, 4D and then **either** 4C (PWM Value) **or** the Lookup Table in Registers 4F through 5F must be programmed in that order for the initial fan control setup. If the Lookup Table was selected then write Register 4A, bit 5.  
[Note: In the example on the following pages we will be selecting bit(s) in Register 4C]

Change Register 4A as follows:

1. Set the PWM Clock Select to 1.4 kHz
2. Change the Tachometer Mode to the most accurate reading mode
3. You may change the polarity, if desired, but the traditional mode is with the fan off at 0V.

Change Register 4B, if desired, to change the Fan Spinup PWM Duty Cycle and Spinup Time.

Change Register 4C to 10 hex.

The fan should now start running.

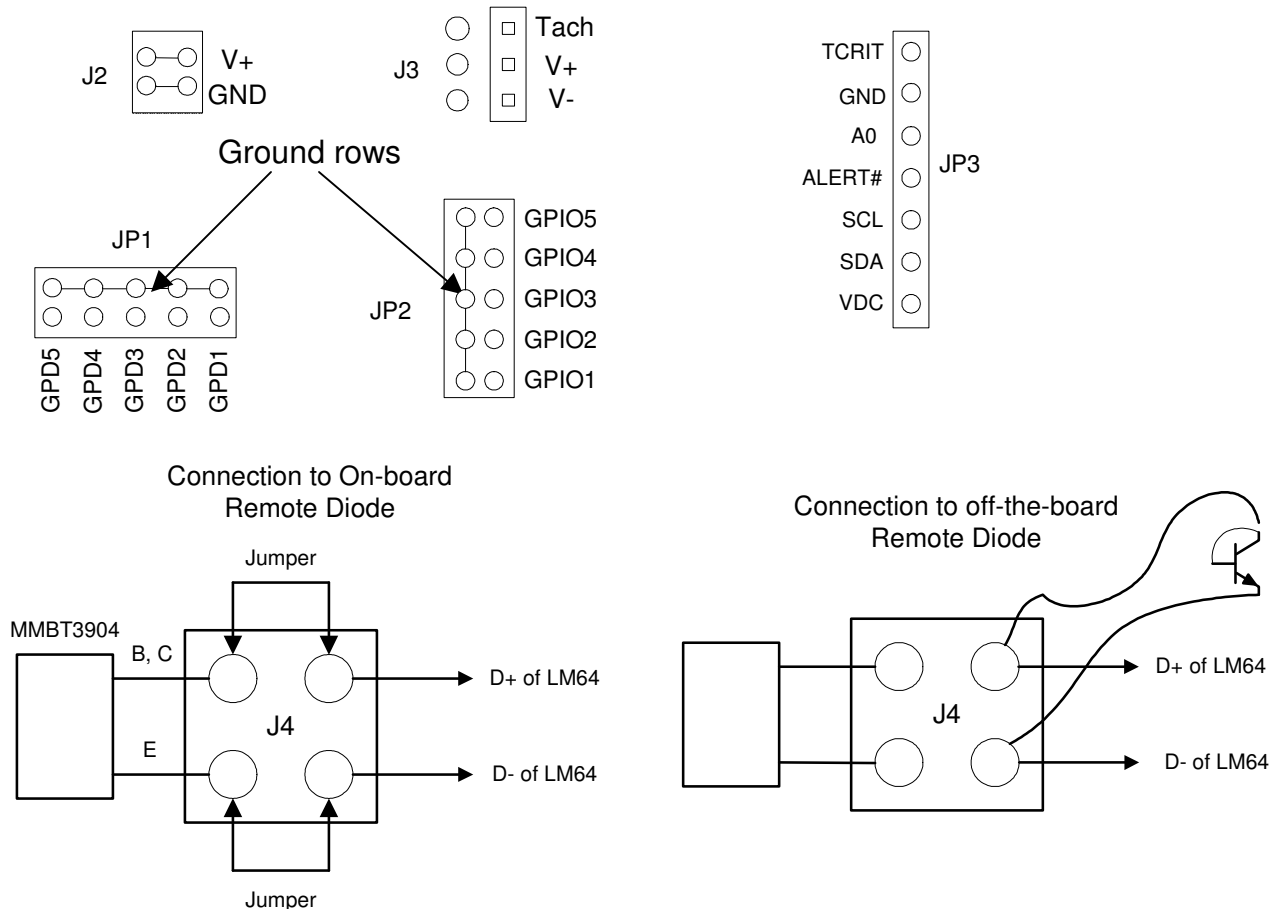
For continuous temperature and tach readings select the read continuous check box. You may also log the data to a file.

### 3.0 Connection Details

Table 1 below describes all the connections and test points of the LM64.

**Table 1. LM64 Evaluation Board Connections and Test Points**

Symbol	Description of the Connections
J2	Fan Power – connect the power supply for the fan to the V+ pin (+12 or +5) and the negative to GND.
J3	Connect the 3-terminal fan to the header, paying attention to the black lead going to the V- pin. Three holes are provided on the circuit board if the user wants to solder the fan leads to the board.
J4	This allows the user to either: (1) connect jumpers horizontally to the top and bottom pin pairs to connect to the on-board MMBT3904 <b>or</b> (2) to remove the jumpers and connect a remote diode directly to the input of the LM64.
JP1	General Purpose Default (GPD) pins on the bottom row can be manually jumpered to ground (to row of pins).
JP2	General Purpose Input/Output (GPIO) pins (right vertical row of pins) can be manually jumpered to ground (left vertical row of pins).
JP3	TCRIT and ALERT# are the open drain LM64 output pins. A0, the LM64 input address pin, can be manually jumpered to the GND pin to test the A0 function. VDC (+3.3 VDC), and the SMBus Clock and Data signals are available to the user for system monitoring.



**Figure 3. Header Connectors on the LM64 Evaluation Board**

## 4.0 Schematic of the LM64 Evaluation Board

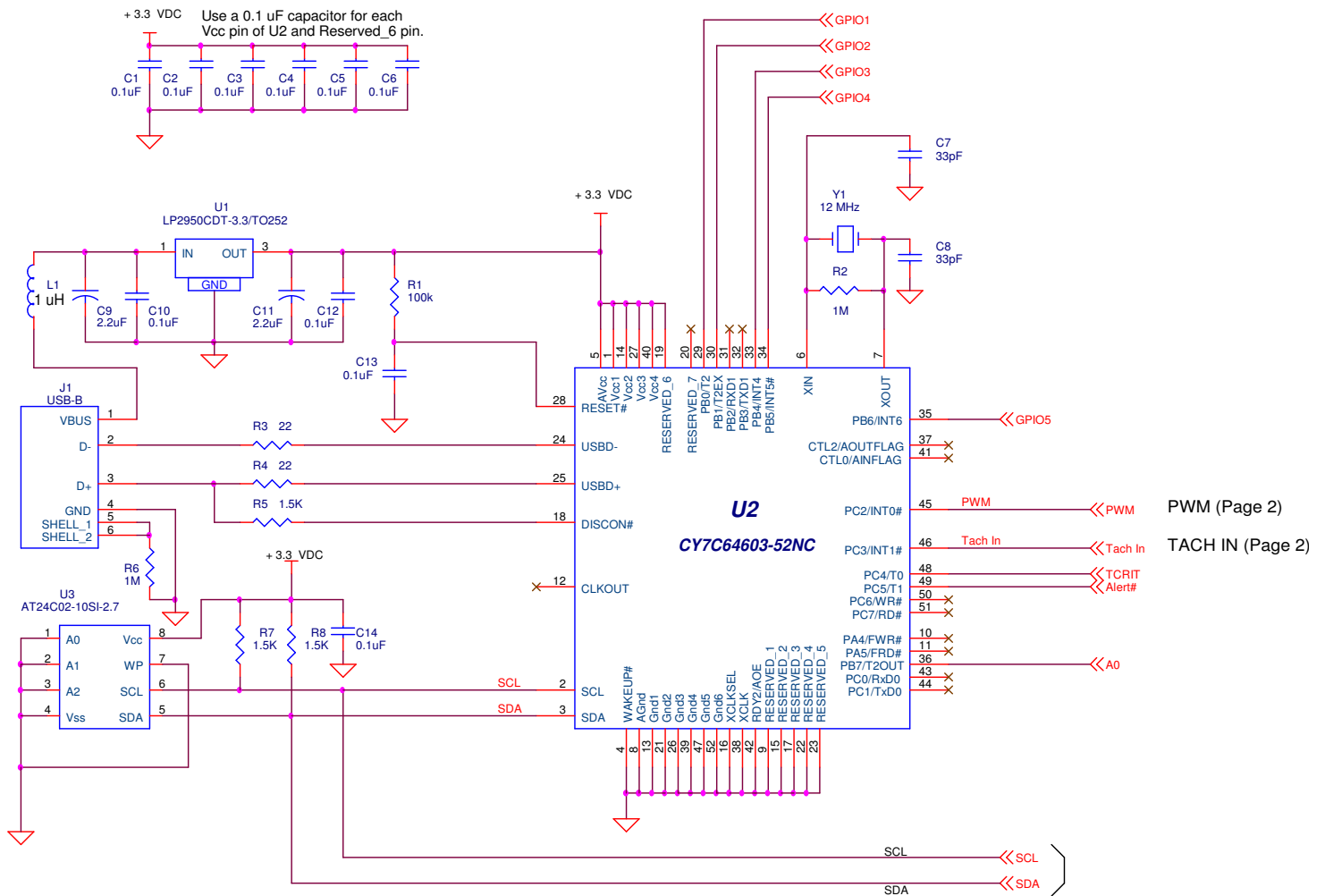


Figure 5a. LM64 Evaluation Board Schematic, Page 1 of 2

## 4.0 Schematic of the LM64 Evaluation Board (Continued)

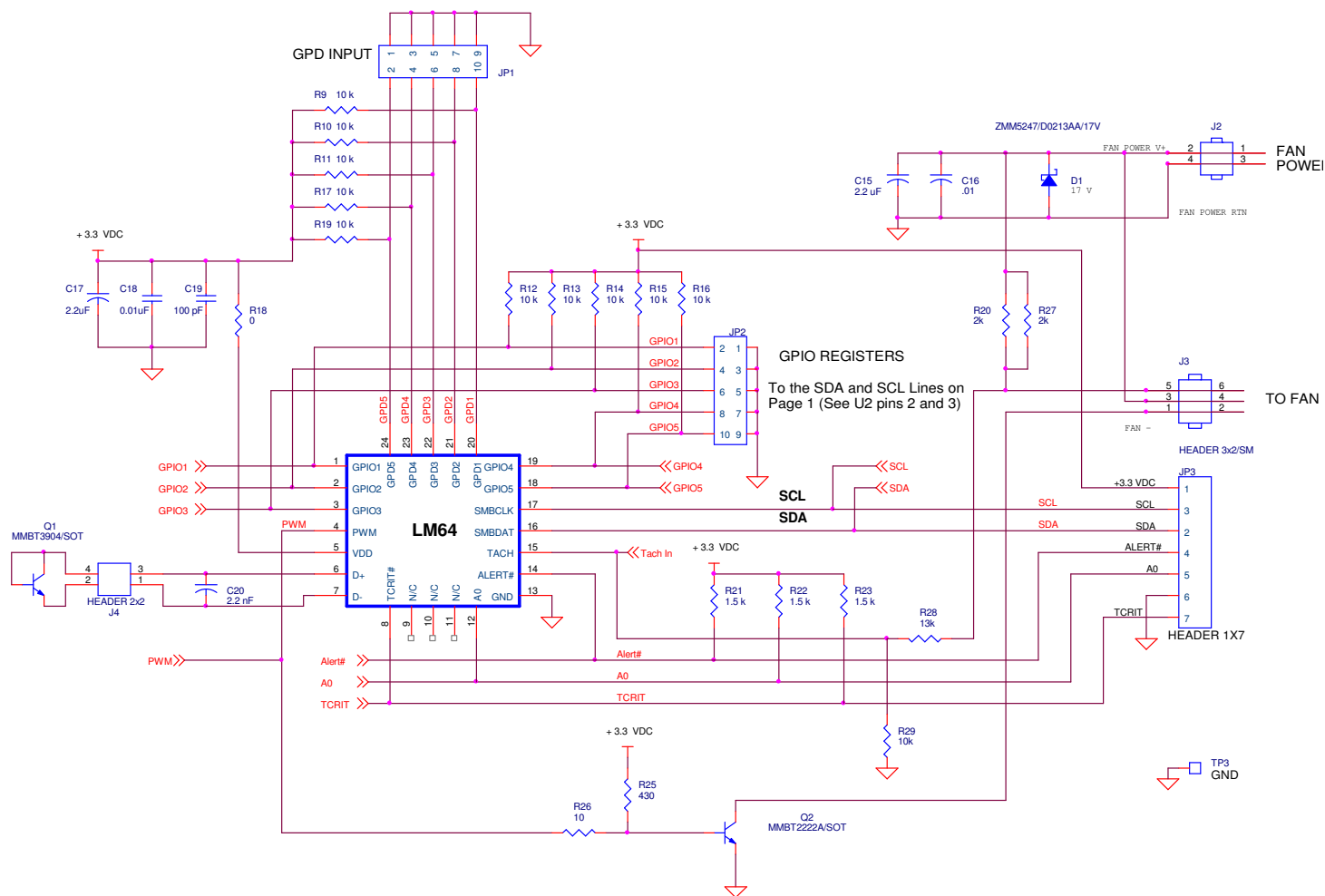


Figure 5b. Schematic of LM64 Evaluation Board – Page 2 of 2

## 5.0 LM64 Evaluation Board - Bill of Materials

Item	Quantity	Reference	Part
1	10	C1,C2,C3,C4,C5,C6,C10,	Capacitor, ceramic, 0.1uF
		C12,C13,C14	
2	2	C7,C8	Capacitor, ceramic, 33pF
3	4	C9,C11, C15, C17	Capacitor, ceramic, 2.2uF
4	2	C16, C18	Capacitor, ceramic, .01 uF
5	1	C19	Capacitor, ceramic, 100 pF
6	1	C20	Capacitor, ceramic, 2.2 nF
7	1	D1	Zener Diode ZMM5247/17V
8	2	JP1,JP2	HEADER, 2X5
9	1	JP3	HEADER, 1X7
10	1	J1	Connector, USB-B
11	2	J2, J4	HEADER 2x2
12	1	J3	HEADER 3x2
13	1	L1	Filter, 1uH, Stewart MI1206K900R-00
14	1	Q1	Transistor, NPN, MMBT3904/SOT
15	1	Q2	Transistor, NPN, MMBT2222A/SOT
16	1	R1	Resistor, SMT, 100k
17	2	R2,R6	Resistor, SMT, 1M
18	2	R4,R3	Resistor, SMT, 22 Ohm
19	3	R5,R7,R8	Resistor, SMT, 1.5 k
20	11	R9,R10,R11,R12,R13,R14,	Resistor, SMT, 10 k
		R15,R16,R17,R19, R29	
21	1	R18	Resistor, SMT, 0 Ohm
22	2	R27,R20	Resistor, SMT, 2k
23	3	R21,R22,R23	Resistor, SMT, 1.5 k
24	1	R25	Resistor, SMT, 430 Ohm
25	1	R26	Resistor, SMT, 10 Ohm
26	1	R28	Resistor, SMT, 13k
27	1	S1	LM64 Test Socket, Loranger custom, \$36.00
28	6	TP1,TP2,TP3,TP4,TP5,TP6	T POINTS (1X1 Headers)
29	1	U1	IC, 3.3 VDC Voltage Regulator, National LP2950CDT-3.3
30	1	U2	IC, microcontroller, Cypress CY7C64603-52NC
31	1	U3	IC, EEPROM, Atmel AT24C02-10SI-2.7
32	1	U4	LM64CILQ Device Under Test
33	1	Y1	Crystal, 12 MHz, Pletronics 2S1200G140
34	1		Circuit Board, Fabricated, LM64 Evaluation Board, Rev 1.1

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