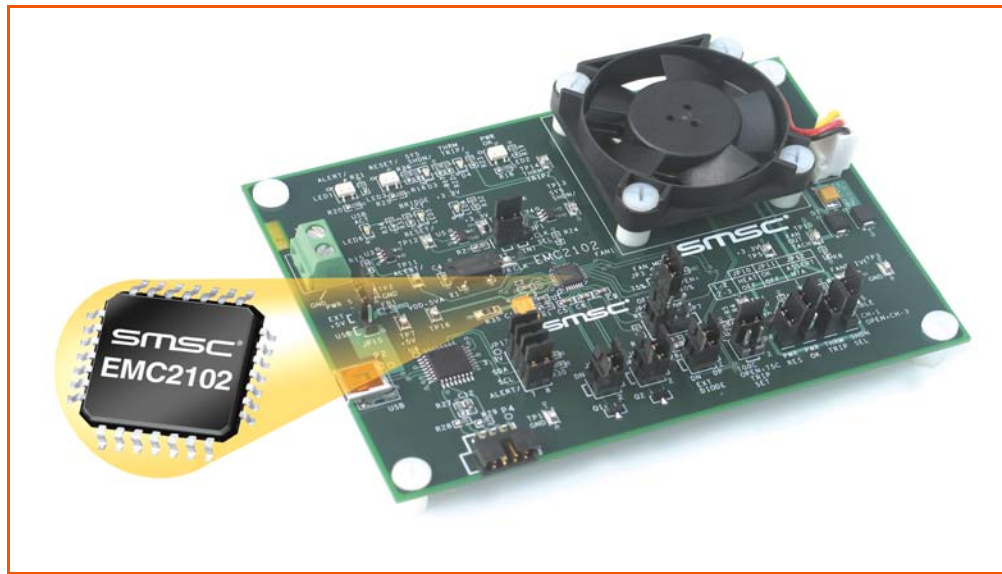




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EVB-EMC2102 User Manual



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1 Overview

The EMC2102 is an SMBus, closed-loop, RPM-based fan controller/driver with temperature monitors, hardware (HW) thermal shutdown and reset controller. The EMC2102 is packaged in a thermally enhanced, compact, 5x5, 28-pin green, lead-free QFN package.

The EMC2102 utilizes Beta Compensation and Resistance Error Correction (REC) to accurately monitor three external temperature zones. These features allow great accuracy for CPU substrate thermal diodes on multiple process geometries as well as with discrete diode-connected transistors. Both Beta Compensation and REC can be disabled on the EMC2102 to maintain accuracy when monitoring AMD thermal diodes.

The EMC2102 includes a closed-loop RPM based Fan Control Algorithm that integrates a linear fan driver capable of sourcing 600mA of current. The fan control algorithm is designed to work with fans that operate up to 16,000 RPMs.

The EMC2102 provides a stand-alone HW thermal shutdown block. The HW thermal shutdown logic can be configured for a few common configurations based on the strapping level of the SHDN_SEL pin on the PCB. The HW thermal shutdown point can be set in 1°C increments by using a discrete resistor divider implemented on the TRIP_SET pin.

The EMC2102 also provides 5V supply 'power good' function with a threshold of 4.5V. This function is provided on the RESET# pin.

All of the modes and functions of the EMC2102 can be tested and observed with the EVB-EMC2102. A block diagram of this EVB is shown in [Figure 1.1](#).

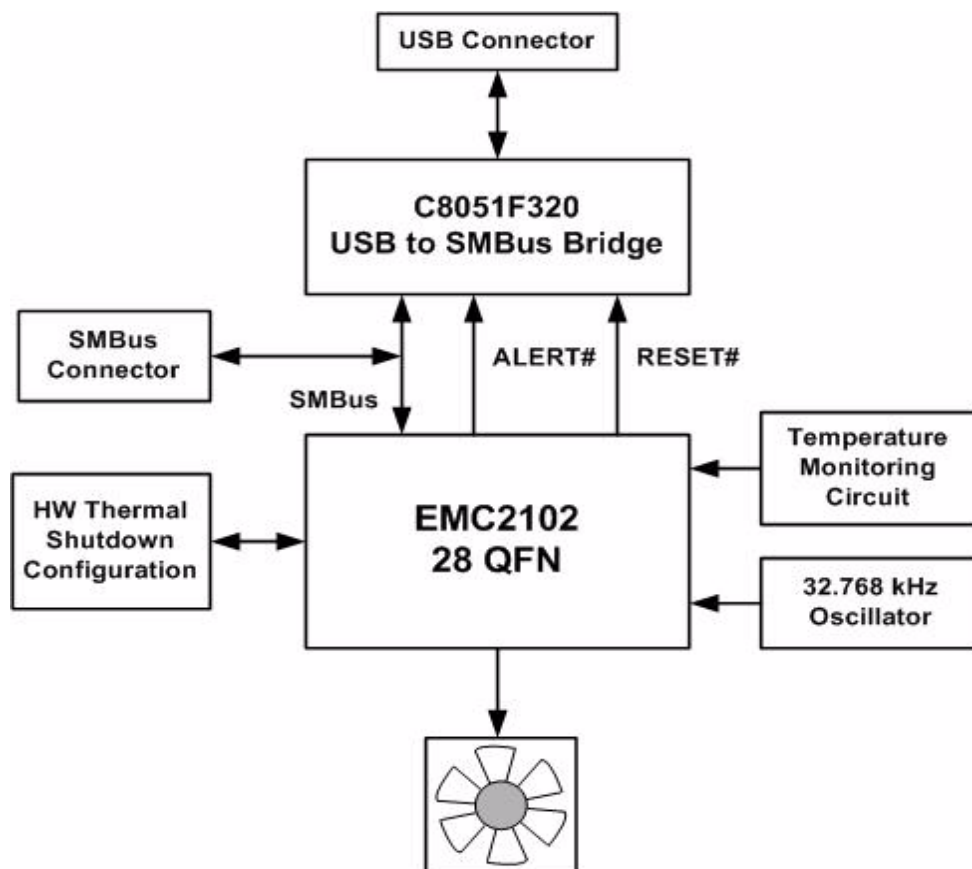


Figure 1.1 EMC2102 EVB Block Diagram



1.1 Related Documents

The EMC2102 evaluation kit CD included with the evaluation board contains the following documents:

- Evaluation Board Checklist
- Bill Of Materials
- Schematic
- Datasheet
- ChipMan Application Software
- Register Definition File (EMC2102.xml)

2 Getting Started

2.1 System Requirements

To use the EVB-EMC2102 you will need:

- A PC running Windows 2000 or XP
- Display resolution 800x600 (or larger to view several windows simultaneously)
- An available USB port

2.2 Feature Summary

- The SMSC ChipMan (Chip Manager) application allows viewing and changing register values
- Graphing of any register
- Headers for connecting a remote diode or CPU/GPU
- Resistance Error Correction verification
- Saving of settings of all registers allowing for quick loading at a later time
- USB communication to evaluation board
- An external SMBus master may also be used via jumper settings

2.3 Installing the EVB

1. Install the ChipMan application and device driver on a PC by running Setup.exe from the EVB-EMC2102 Kit CD. A revision history and install/uninstall notes may be found in the readme.txt file on the disk.
2. Connect the supplied USB cable to an available USB port on the PC. Plug the “mini-B” end of the USB cable into EVB connector P2. The +3.3V and Bridge ACT LEDs on the evaluation board should illuminate. After the EVB is connected to the PC the “Find New Hardware” wizard will pop up for USB driver installation. Follow the instructions on the screen complete the installation process.
3. Start the EVB Software by selecting Start -> Programs -> SMSC -> Chip Manager. The EVB will initialize and the ChipMan Quick Help screen will appear as in [Figure 2.1](#). The USBACT (LED 6) on the evaluation board should be blinking when the control signals and data are transferred between the PC and EVB-EMV2102. For more help with ChipMan, select Help -> Contents for an html based help document as shown in [Figure 2.2](#).
4. The on-board fan will start per JP3's setting (See [Table 3.3](#)) and keep running for 4 second. After that, the Watchdog Timer in the EMC2102 will drive the fan to full speed (~ 8000 rpm for the on-board fan), and the ALERT LED on the EVB will turn to red. To clear the alarm, in the ChipMan window click on EMC2102 -> HWM -> 3: Fan Settings, and then double click on the TACH Target value to input a valid fan speed (4400 rpm ~ 8000 rpm for the on-board fan), and then click on HWM -> 0: Configuration/Status to turn the ALERT LED to green. Refer to [Note 2 on page 10](#) for more details about the Watchdog Timer fuction.
5. Starting the ChipMan application without the USB cable/EVB connected to the PC, an error message "Supported company ID on device not found" will pop-up. Click on “Abort” and then another pop-up window will ask if you want to select an SMSC device. Click on “Yes” and then select the EMC2102 device from the Select SMSC Device window. In the same device selection window the user also has the options to chose the SMBus Slave Address (Default is 7A), the Master Controller type (Default is USB SMBus Bridge, see note 1 below) and if the ChipMan needs to be configured to run in simulation mode. In the simulation mode, users can practice the software functions without connecting a USB cable/EVB to the PC.

Note: 1. The EVB-EMC2102 needs to be configured using the USB SMBus Bridge to work properly. If in the device selection window the Master Controller type is set to I/O Controller Hub then the "Supported company ID on device not found" message will pop-up again.

2. Disconnecting the USB cable and reconnect it without restarting the ChipMan may cause register reading errors (all zeros). This problem can be cleared by re-select the EMC2102 device through the device selection window (Options -> Select Device).

6. The SMSC ChipMan application allows viewing and changing register values for a variety of EVBs including the EMC1001, EMC1002, EMC1033, EMC1043, EMC2101 and EMC2102. The ChipMan software only needs to be installed once to support all of these EVBs. The list of supported EVBs may be found in the pulldown menu under Options -> Select Device.

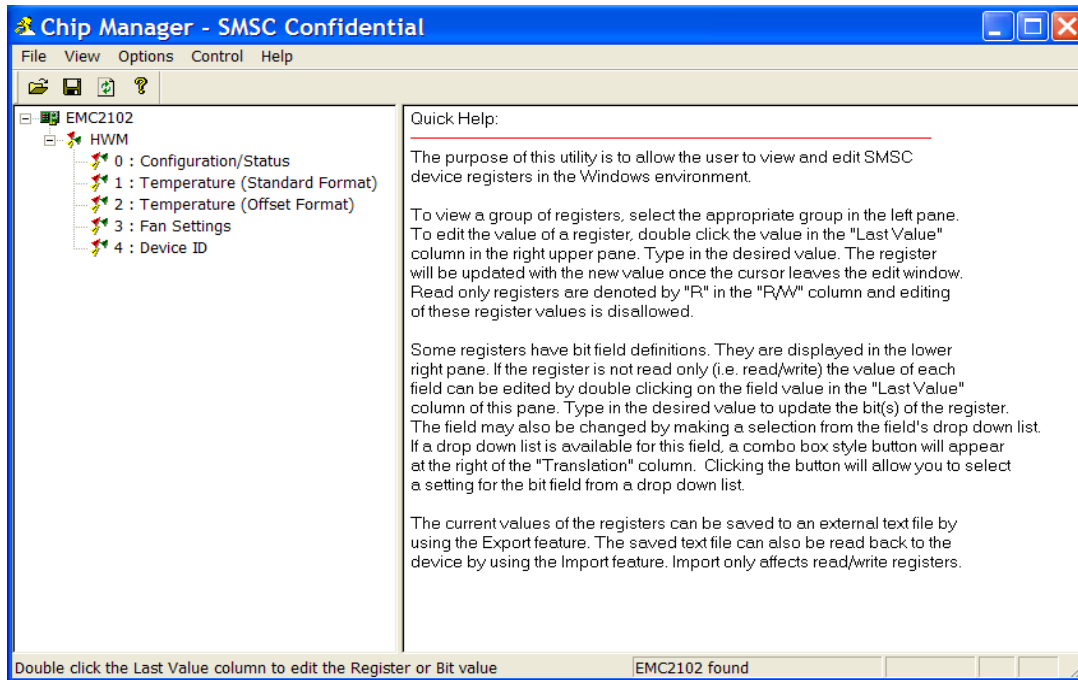


Figure 2.1 ChipMan Quick Help Startup Screen

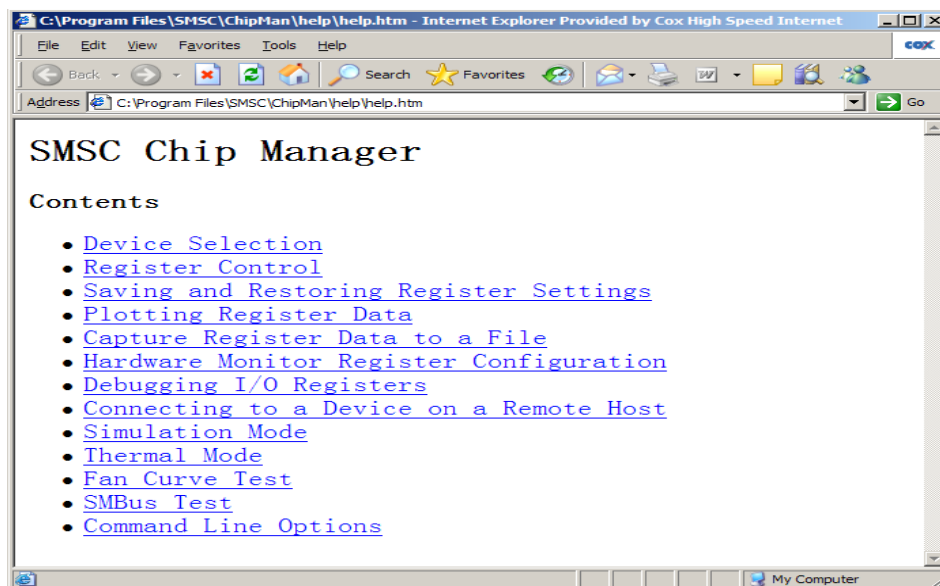


Figure 2.2 .ChipMan Help Screen

2.4 Board Layout

The EVB-EMC2102 was designed for ease of use and user experimentation with easily accessible jumpers and access to the SMBus data lines. [Figure 2.3](#) below shows the jumper and connector highlights for the EVB-EMC2102 board.

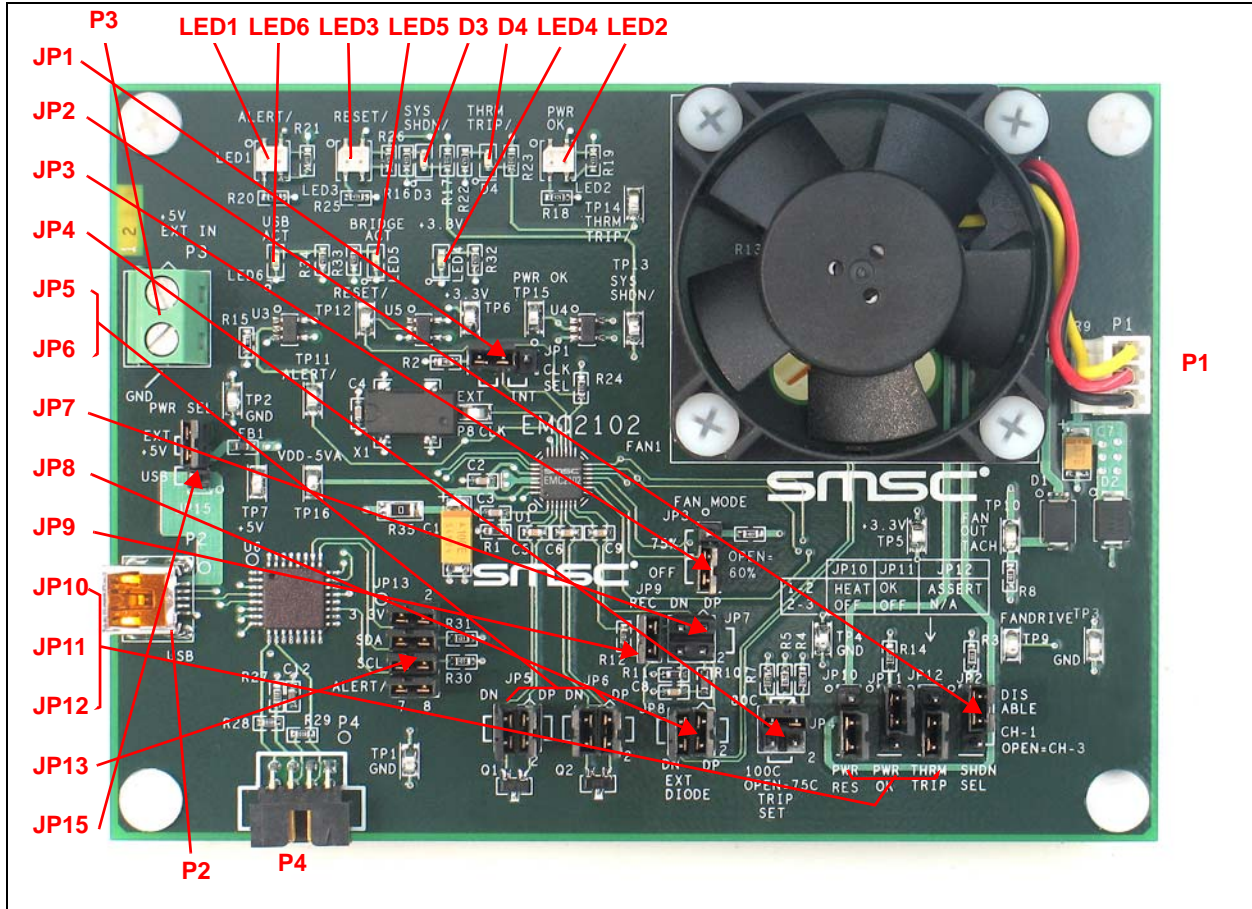


Figure 2.3 EMC2102 Board Jumper and Connector Highlights

3 Hardware Description

3.1 Introduction

The EVB-EMC2102 provides the means to demonstrate EMC2102 features and to view and modify registers. A +5V fan with the RPM capability range of 4400 rpm ~ 8000 rpm is provided to demonstrate the fan control functionality. LEDs indicate status information and test points are included to monitor system voltages with a user provided voltmeter or oscilloscope.

3.2 EMC2102

The EMC2102 is an SMBus fan controller and temperature monitor with 1 internal and 3 external sensors in an 28-pin, 5x5 QFN package. Communications with the EMC2102 is via the SMBus.

3.3 USB to SMBus Bridge

The USB to SMBus bridge is based on an 8051 microcontroller with integrated USB and SMBus interfaces as well as internal flash and RAM. During EVB manufacture, firmware is loaded into the bridge that provides the interface between the USB and the SMBus. Power is sourced to the microcontroller from the USB interface for device power and communication.

3.3.1 Direct SMBus Connect Option

It is also possible to connect an external SMBus master to the EVB-EMC2102. A few jumper settings are all that is required to drive the EMC2102:

- Simply remove the jumpers on JP13 and connect the SMBus master to the SCL, SDA and $\overline{\text{ALERT}}$ pins, as well as an external supply for +3.3V.
- The +3.3V can be supplied by the SMBus bridge by leaving the +3.3V jumper in place and retaining the USB connection.

3.4 Remote Diodes and Zone Heater

The EVB-EMC2102 has 3 on-board temperature sensing diodes (Q1, Q2 and Q3), which are MMBT3904 transistors in a diode-connected configuration. Diode Q3 has an associated “zone” heater to demonstrate the temperature measurement. This “zone” heater is a power resistor thermally bonded to the temperature sensing diode. When enabled, the power resistor will increase the diode temperature by over 50°C.

To activate the heater, move the jumpers on JP10 from their storage locations (pins 2-3) to the “enabled” position (pins 1-2). See [Table 3.3 Jumper Settings](#) or the schematic for more details.

Warning: The heating resistor consumes about 280 mA current from the on-board +5V. If the EVB is connected with a high current (> 200 mA) fan on P1 and the user wants to activate the heater, the external power supply option (see section 3.6) must be selected to avoid over driving the USB cable. The on-board 5V fan provided by SMSC consumes less than 200 mA current therefore it is safe to run it with the heating resistor using one single standard USB cable.

The on-board thermal diodes may be disconnected by removing the jumpers on JP5 (remote 1), JP6 (remote 2) or JP8 (remote 3). Disconnecting the on-board thermal diodes permits connection of external temperature sensing diodes to JP5, JP6, JP7 or JP8. See [Table 3.3 Jumper Settings](#) or the schematic for more details.

The Beta Compensation function is designed for CPU substrate diodes and is not compatible with diode-connected transistors such as the MMBT3904. For this reason, the EMC2102 default settings are over-ridden by the ChipMan’s initialization code so that Beta Compensation is disabled on the evaluation board. When connecting to a CPU’s thermal diode, the Beta Compensation function can be turned on with different values through the ChipMan software (EMC2102 -> HWM -> 0: Configuration/Status -> External Diode 1/2 Beta).

If connecting to a CPU's thermal diode, it is necessary to provide a common ground. Also, it is usually necessary to bias the appropriate CPU Vcc plane above this common ground to avoid forward-biasing the ESD diodes with the temperature sensor signals. Test point TP1 - TP4 on the evaluation board can provide ground connections. Consult the CPU manufacturer's datasheet for guidance on interfacing to the thermal diode.

The EVB-EMC2102 also has one on-board thermistor. JP7 and JP8 can be used to select either the thermistor or Q3, but not both, to be connected to the EMC2102 device. Refer to [Table 3.3 Jumper Settings](#) or the EVB schematic for more details.

Note: The thermistor function should not be used for EMC2102 Revision A device due to a known issue on the device. The issue will be fixed in the future release of the device.

3.5 Resistance Error Correction (REC)

The remote diode Q3 signal path has a 100 ohm series resistor to demonstrate the EMC2102's REC feature. The resistor may be effectively removed from the circuit by installing a jumper on JP9. See [Table 3.3](#) for details on the REC jumper settings.

3.6 Power Source

The EVB-EMC2102 requires the USB cable or an external +5V supply to operate. The USB-SMBus bridge regulates the +5V USB or external power to +3.3V which is used by the EMC2102 and other EVB circuitry. The on-board fan is also powered by the same +5V, from the USB or external supply. The EVB will need less than 500 mA current while using the on-board fan. If a high current fan is connected to the EVB through terminal P1, the external power supply must be used. See [Table 3.3](#) for power source selection jumper settings.

3.7 System Connectors

There are 4 system connectors on the EVB-EMC2102, as listed in [Table 3.1](#) below.

Table 3.1 System Connectors

PLUG/HEADER	DESCRIPTION	CONNECTOR TYPE
P1	Fan Header	3-pin header, latching (1x3)
P2	USB Port	USB type mini-B
P3	Power Conn. +5V DC	2-pos. screw terminal
P4	C8051F320 Program Port	8-pin programming header (2x4)

3.8 LED Indicators

There are 8 LEDs on the EVB-EMC2102 to indicate the status of the board, as listed in [Table 3.2](#).

Table 3.2 LED Status Indicators

LED	SIGNAL	OFF	GREEN	RED
LED1	$\overline{\text{ALERT}}$	+3.3V power OFF	No $\overline{\text{ALERT}}$	$\overline{\text{ALERT}}$ asserted
LED2	POWER_OK	+3.3V power OFF	POWER_OK asserted	POWER_OK not asserted
LED3	$\overline{\text{RESET}}$	+3.3V power OFF	$\overline{\text{RESET}}$ not asserted	$\overline{\text{RESET}}$ asserted
LED4	+3.3V	+3.3V power OFF	+3.3V power ON	N/A
LED5	Bridge Activity	No Activity on USB/SMBus Bridge	Activity on USB/SMBus Bridge	N/A
LED6	USB Activity	No Activity on USB port	Activity on USB port	N/A
D3	$\overline{\text{SYS_SHDN}}$	$\overline{\text{SYS_SHDN}}$ not asserted	N/A	$\overline{\text{SYS_SHDN}}$ asserted

Table 3.2 LED Status Indicators

LED	SIGNAL	OFF	GREEN	RED
D4	THERMTRIP	THERMTRIP not asserted	N/A	THERMTRIP asserted

3.9 Jumper Settings

There are 14 jumpers on the EVB-EMC2102 to provide the users with different configurations to evaluate all of the features of the EMC2102.

Table 3.3 Jumper Settings shows the functions of all 14 jumpers and identifies the default jumper positions when the EVB is shipped. These default settings are the recommended configurations for normal evaluation and may be changed as needed.

Note: The dashed line --- shown in the SETTINGS column indicates the board's default jumper setting.

Table 3.3 Jumper Settings

JUMPER	DESCRIPTION	SETTINGS	
JP1	Clock Selection ¹	1 2 2---3	Internal Oscillator Selected External 32.768 kHz Clock Selected
JP2	SHDN Selection ¹	1---2 2 3 Open	Disabled Channel 1 Channel 3
JP3	FAN_MODE ²	1 2 2---3 Open	Fan is at 75% full-scale on startup Fan is OFF Fan is at 60% full-scale on startup
JP4	TRIP_SET	1 3 2 4 Open	80°C 100°C 75°C (default)
JP5	Remote Diode 1 Isolation	1---2 3---4	Connect the on-board remote diode Q1 to DP1 Connect the on-board remote diode Q1 to DN1
JP6	Remote Diode 2 Isolation	1---2 3---4	Connect the on-board remote diode Q2 to DP2 Connect the on-board remote diode Q2 to DN2
JP7	Thermistor Isolation ³	1 2 3 4	Connect the on-board thermistor to DP3 Connect the on-board thermistor to DN3
JP8	Remote Diode 3 Isolation	1---2 3---4	Connect the on-board remote diode Q3 to DP3 Connect the on-board remote diode Q3 to DN3
JP9	Resistance Error Correction (REC) Control	1---2 Open	100-ohm resistor is not used in the remote diode path (shorted) 100-ohm resistor is connected in the remote diode path
JP10	Heater Enable	1 2 2---3	Enables Heater (consumes ~280mA) ⁴ Ambient temp on diode (jumper storage)
JP11	POWER_OK Selection	1---2 2 3	Enables POWER_OK indication Force POWER_OK signal to low (power not ok)
JP12	THERMTRIP# Indication Control	1 2 2---3	THERMTRIP# Asserted THERMTRIP# De-asserted (jumper storage)
JP13	SMBus Isolation Jumper	1---2 3---4 5---6 7---8	+3.3V connected to bridge (default) SDA connected to bridge (default) SCL connected to bridge (default) Alert/ connected to bridge (default)
JP14		N/A	
JP15	EVB Power Selection	1---2 2 3	EVB is powered by USB EVB is powered by external +5V

Note: 1. The states of JP1 and JP2 are monitored/decoded by the EMC2102 only at power-up

2. The fan will start per JP3's setting after power-up. If four (4) seconds elapse without the system host programming the device after power-up, the Watchdog Timer in the EMC2102 will override the JP3's setting and set the device fan driver to full scale drive. Please see the EMC2102 datasheet section 5.4, Watchdog Timer, for more details about the watchdog timer and how to disable it.
3. The thermistor function should not be used for EMC2102 Revision A device due to a known issue on the device. This issue will be fixed in the future release of the device.
4. See Warning on [page 7](#).

3.10 Test Points

The EVB-EMC2102 provides 16 test points for users to evaluate the EMC2102's features and performances, as listed in [Table 3.4](#).

Table 3.4 Test Points

TP #	DESCRIPTION	CONNECTION
TP1 - TP4	GND	Ground
TP5, TP6	+ 3.3 V	+3.3V power (from USB Bridge IC C8051F320)
TP7	+ 5 V	+5V power (from USB cable or ext. power source)
TP8	CLK_IN	32.768 kHz clock
TP9	FAN_DRIVE	Fan drive signal
TP10	FAN_TACH	EMC2102 Input from the tachometer of the fan
TP11	ALERT#	EMC2102 interrupt (active low)
TP12	RESET#	Reset output from EMC2102
TP13	SYS_SHDN#	Critical system shutdown output from EMC2102
TP14	THERMTRIP#	Critical temperature limit signal from the CPU or chipset
TP15	POWER_OK	Power good signal
TP16	VDD-5VA	EMC2102 +5V power

3.11 Other Sensor Features

Other features such as Beta Compensation, Conversion Rate, Fault Queue and RPM Based Fan Control Algorithm can be controlled with EMC2102 registers. See the EMC2102 datasheet Chapter 6, Register Set, for more details.

4 Software Description

4.1 ChipMan Overview

The ChipMan application initially displays the main Help screen, where detailed description of the application's features may be found. The Help screens can be displayed at any time by selecting Help from the menubar. ChipMan enables the user to display temperature readings, set temperature limits, control fan speed and read/write configuration register values.

To display register names, in the ChipMan window ([Figure 2.1](#)) click on EMC2102 and then click on HMW to expand the left panel menu, and then select register groups.

The register values displayed on the ChipMan window can be automatically updated by selecting Option -> Autorefresh Registers.

4.2 Temperature/Fan Speed/Register History Graph

To open a Temperature or Fan Speed or Register History Graph window, simply right click the mouse over a register's name to add it to the graph. Using shift key can highlight multiple register names and right click the mouse to select them together. Another method to open a graph is to select Options -> Plot Register Data from the menubar, and then the Select Registers to Plot window will pop-up. Add the registers to the right side window and click OK. Once the graph appears, select Control -> Start to begin plotting data. The history plot continuously updates the register data reported by the EMC2102.

[Figure 4.1](#) is a typical Temperature History with the external diode (diode 3) starting at room temp without running the on-board fan, and then being heated by the "zone" heater, and then being cooled down by the on-board fan with different speeds.

[Figure 4.2](#) is a typical Fan Speed History Graph. The fan speed target (black) was set from 4200 rpm and then 5400 rpm and then 7200 rpm and then dropped to 4800 rpm. The blue line is the TACH reading values (measured real fan speed).

The response time and overshoot/undershoot in the Fan Speed History Graph will vary depending on the fan's characteristics and EMC2102's configurations. The results in [Figure 4.2](#) are based on the +5V on-board fan, with all EMC2102 registers having their power-up default values.

Modifying the EMC2102 fan control parameters (UPDATE and Fan Step) can help to achieve a better fan speed control. In [Figure 4.3](#), register 0x52 (FCONFIG) is changed to 0xCD (UPDATE = 800 ms) from the original setting of 0xCB (UPDATE = 400 ms). It is clear that the overshoot/undershoot is much smaller. Please refer to EMC2102 datasheet for more details about the fan control parameters.

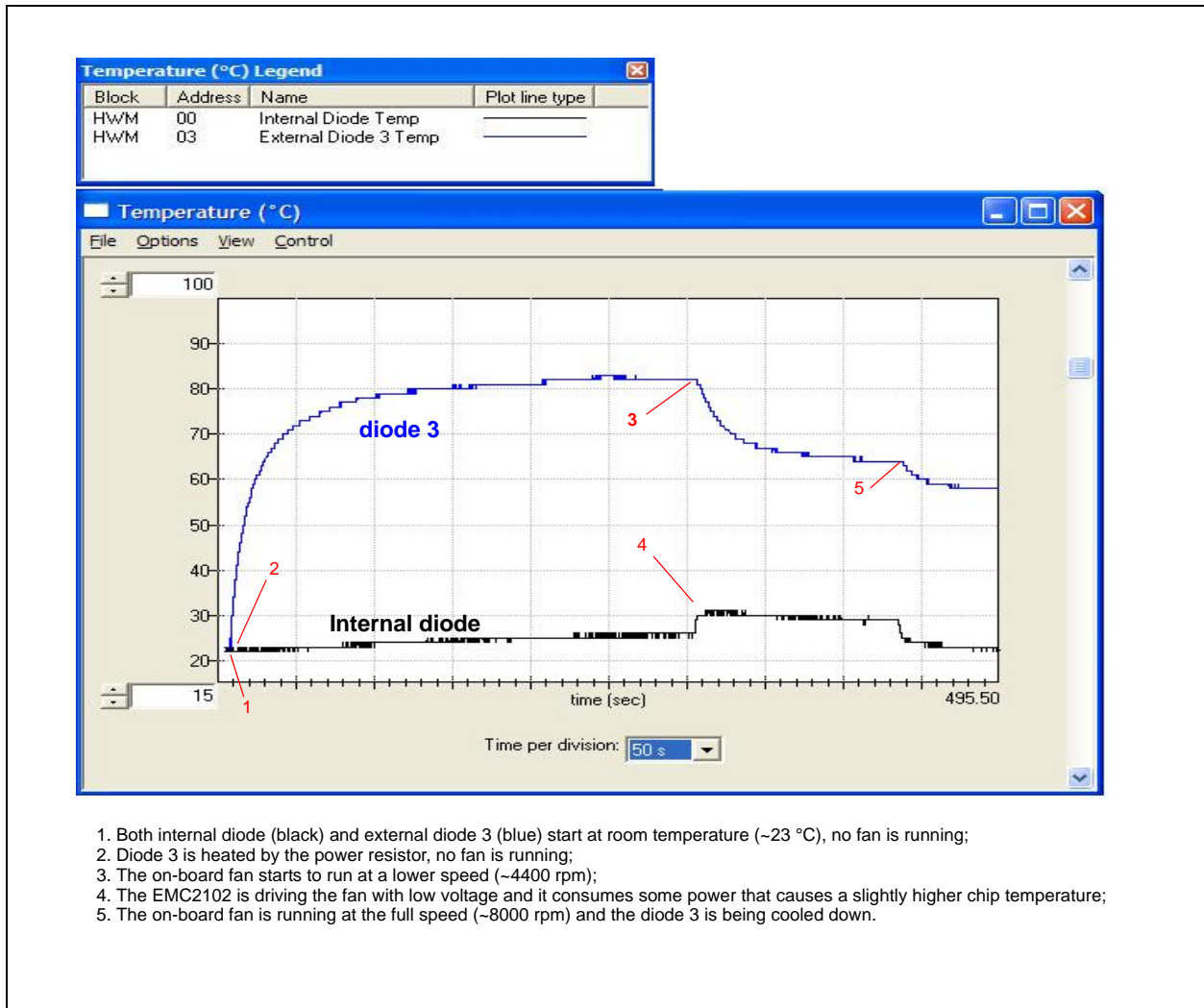


Figure 4.1 EMC2102 Temperature History Graph

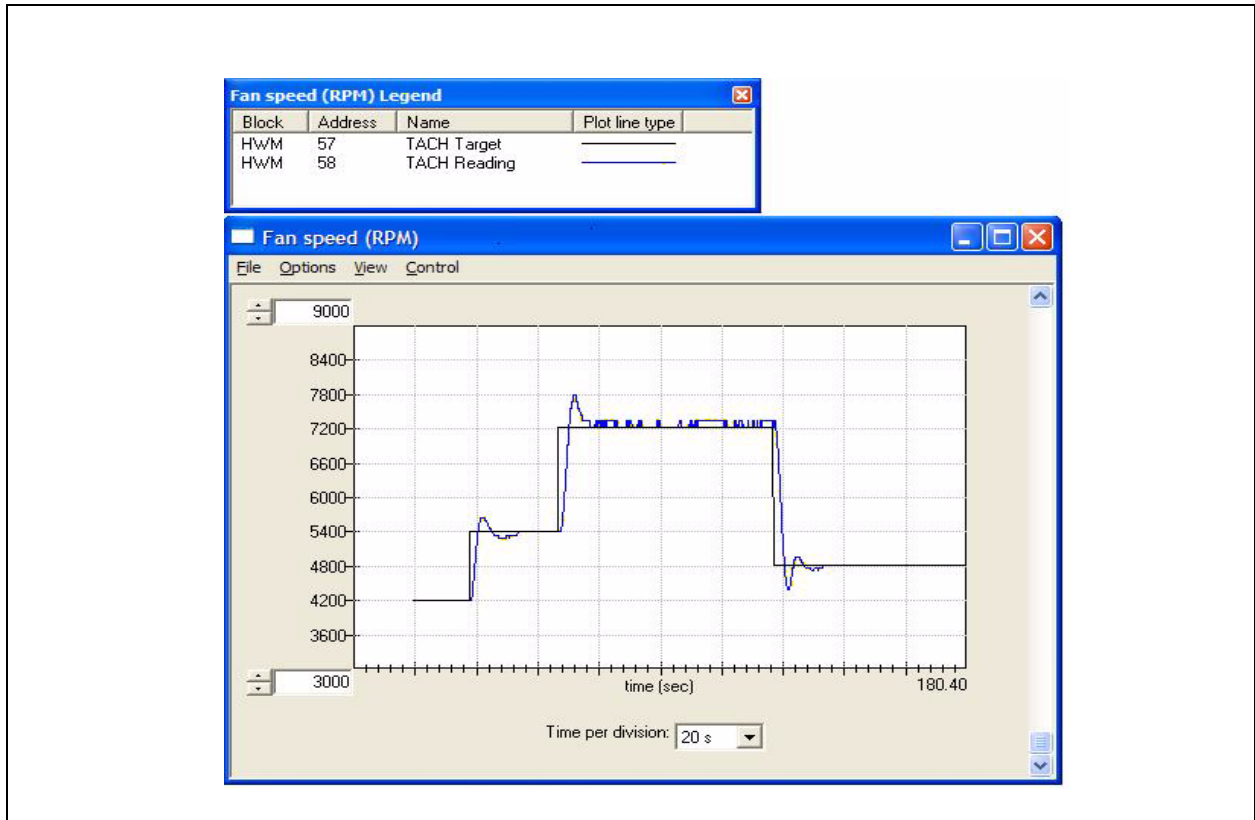


Figure 4.2 EMC2102 Fan Speed History Graph

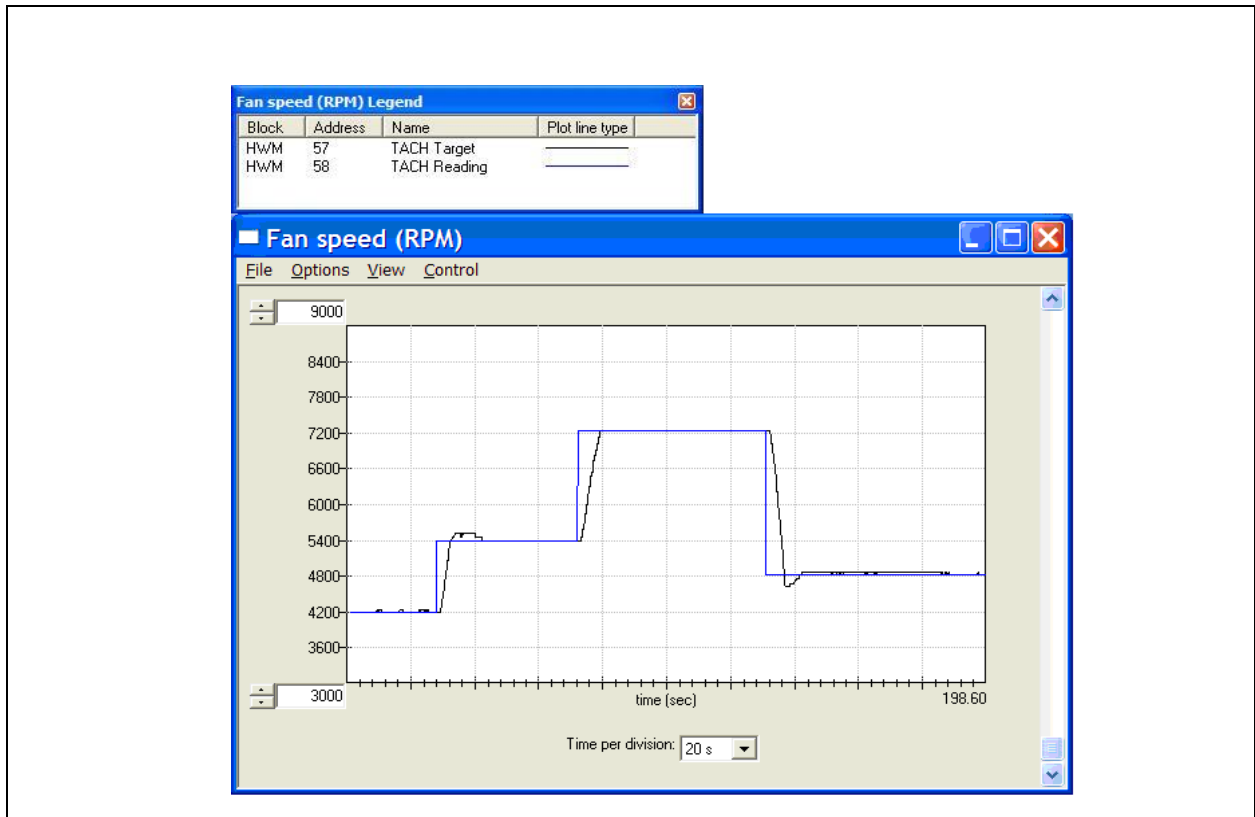


Figure 4.3 EMC2102 Fan Speed History Graph (Enhanced Control)