Three Remote Temperature Sensors and One Fan Controllers with SMBus Serial Interface and System Reset Circuit

Features

- **Measures Three Remote Temperatures**
- **Adjustable Offset for Each Sensor via SMBus**
- **Accuracy: ±1°C (+ 60°C to + 100°C)**
  ±3°C (- 10°C to + 120°C)
- **+4.5V to +5.5V Supply Range**
- **Programmable Hardware Thermal Shutdown for Sensor 2 and Programmable Software Thermal Shutdown for Sensor 1, 3.**
- **SMBus 2-Wire Serial Interface With Writting Protection Function.**
- **Alert Signal for Diode Fault, Fan Fail, and Fan Out of Control**
- **Supports SMBus Alert Response**
- **Fan Drivers Using Linear Control Algorithm with Built-in MOSFET**
- **Closed Loop Speed Control and programmable 8 Bits Open Loop Voltage Control for Fan1**
- **Wide speed control range for Fan1, Accuracy within 2%, when SET_CNT1 > 50**
- **Internal Current- limit and Over-temperature Protection for the Fan**
- **Reset Function Precision Monitoring of 5V Power-Supply Voltage**
- **20-Pin SSOP Package**

Applications

- **Desktop and Notebook**
- **Central Office Computers**
- **Telecom Equipment**
- **Smart Battery Packs**
- **Industrial Controls**
- **LAN Servers**

General Description

The G792 contains 3 precise digital thermometers, one fan controllers, hardware and software thermal shutdown, and a system-reset circuit.

The thermometers report the temperature of 3 remote sensors. The remote sensors are diode-connected transistors typically a low-cost, easily mounted 2N3904 NPN type or the diode built-in in CPU. Remote accuracy is ±1°C for multiple transistor manufacturer. The G792 also support offset adjust function via SMBus to fix the error due to different CPU diode or parasitic resistors.

The 2-wire serial interface accepts standard System Management Bus (SMBus™) Write Byte, Read Byte, Send Byte, and Receive Byte commands. The SMBus address is 7ah for write and 7bh for read, and supports writting protection function by command 20h to prevent error behavior of µP.

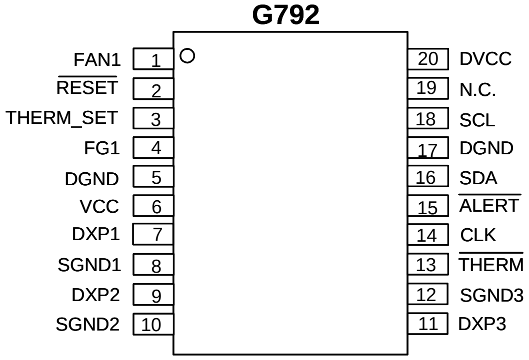
G792 contains one fan controllers. FAN1 controller performs closed-loop and open-loop control. G792 determines the current fan speed based on the FG inputs and an externally supplied 32.768KHz clock. The driving ability of FAN1 is 500mA. G792 also provide ALERT for fan fail and out of control event.

The G792 provides hardware and software thermal shutdown. The hardware thermal shutdown is for the sensor 2. The trigger point is set by external resistors. The trigger points of software thermal shutdown are set via SMBus. If thermal shutdown event occurs, THERM pin outputs low.

The G792 contains a microprocessor (µP) supervisory circuit used to monitor the power supplies in µP and digital systems. Reset threshold is set to 4.38V typical.

Pin Configuration

G792



SSOP-20

Ordering Information

ORDER NUMBER (Pb free/Green)	MARKING	TEMP. RANGE	PACKAGE
G792SFUf	G792	-55°C to +125°C	SSOP-20

Note: SF: SSOP-20 U: Tape & Reel

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Absolute Maximum Ratings

VCC to DGND. . . . .-0.3V to +6V
DXP to SGND. . . . .-0.3V to VCC + 0.3V
SMBCLK, SMBDATA, $\overline{ALERT}$, $\overline{THERM}$, FG1,
THERM_SET to DGND. . . . . .0.3V to +6V
SMBDATA, $\overline{ALERT}$ $\overline{THERM}$ Current. . . -1mA to +50mA
Thermal Resistance Junction to Ambient, (θ_{JA})
SSOP-20. . . . . 100°C/W

Continuous Power Dissipation (T_A=+70°C)
SSOP-20 (derate 8.89mW/°C above 70°C). 800mW
Operating Temperature Range. . . . . . -55°C to +125°C
Junction Temperature. . . . .+150°C
Storage temperature Range. . . . . -65°C to +165°C
ESD Protection (human body model) 2000V
Reflow Temperature (soldering, 10sec) . . . .+260°C

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Electrical Characteristics

(V_{CC} = + 5V, T_A = 60°C, unless otherwise noted.)

PARAMETER	CONDITION		MIN	TYP	MAX	UNIT
Supply-Voltage Range			4.5	5	5.5	V
Temperature Sensor						
Temperature Resolution (Note1)			---	0.125	---	°C
Temperature Error, Remote Diode (Notes 2 and 3)	T_R = 0°C to +125°C		-3	---	3	°C
	T_R = 60°C to +100°C		-1	---	1	
Under-voltage Lockout Threshold	V_{CC} input, disables A/D conversion, rising edge		---	2.7	---	V
Under-voltage Lockout Hysteresis			---	1	---	mV
Power-On Reset Threshold	V_{CC}, falling edge		1.4	2.2	---	V
POR Threshold Hysteresis			---	1.4	---	V
Standby Supply Current	Logic inputs forced to V_{CC} or GND	SMBus static	---	3	---	µA
		Hardware or software standby, SMBCLK at 10kHz	---	60	110	
Average Operating Supply Current	Auto-convert mode, average measured over 4sec. Logic inputs forced to V_{CC} or GND	0.25 conv/sec	---	170	---	µA
		2.0 conv/sec	---	350	500	
Conversion Time	From stop bit to conversion complete (all channels)		---	300	---	ms
Conversion Rate Timing Error	Auto-convert mode		-25	---	25	%
Remote-Diode Source Current	DXP forced to 1.5V	High level	160	210	256	µA
		Low level	10	13.2	16	
Fan Controller						
Fan1 driver MOSFET on resistance	SETFAN1=FFh, I_{FAN1}=500mA		---	0.6	---	Ω
Fan1 driver over current limit	SETFAN1=FFh, FAN1=2V		550	800	1050	mA
Fan open loop control output accuracy	SETFAN1=00h~FFh, I_{FAN1}=250mA		---	2	---	%
CLK pin input clock frequency	CLK		---	32.768	---	KHz
FG input Positive-going threshold voltage	V_{CC}=5V		---	1.0	1.25	V
FG input Negative-going threshold voltage	V_{CC}=5V		130	230	---	mV

Electrical Characteristics (continued)

(V_{CC} = + 5V, T_A = 60°C, unless otherwise noted.)

PARAMETER	CONDITION		MIN	TYP	MAX	UNIT
SMBus Interface						
Logic Input High Voltage	SMBCLK, SMBDATA; V_{CC} = 4.5V to 5.5V		2.4	---	---	V
Logic Input Low Voltage	SMBCLK, SMBDATA; V_{CC} = 4.5V to 5.5V		---	---	0.8	V
$\overline{\text{ALERT}}$ Logic Output Low Current	$\overline{\text{ALERT}}$, SMBDATA forced to 0.4V		6	---	---	mA
$\overline{\text{ALERT}}$ Output High Leakage Current	$\overline{\text{ALERT}}$ forced to 5.5V		---	1	---	µA
Logic Input Current	Logic inputs forced to V_{CC} or GND		-2	---	2	µA
SMBus Input Capacitance	SMBCLK, SMBDATA		---	5	---	pF
SMBus Clock Frequency			100	---	100K	Hz
SMBCLK Clock Low Time	t_{LOW} , 10% to 10% points		4.7	---	---	µs
SMBCLK Clock High Time	t_{HIGH} , 90% to 90% points		4	---	---	µs
SMBus Start-Condition Setup Time			4.7	---	---	µs
SMBus Repeated Start-Condition Setup Time	$t_{SU:STA}$, 90% to 90% points		500	---	---	ns
SMBus Start-Condition Hold Time	$t_{HD:STA}$, 10% of SMBDATA to 90% of SMBCLK		4	---	---	µs
SMBus Start-Condition Setup Time	$t_{SD:STO}$, 90% of SMBDATA to 10% of SMBDATA		4	---	---	µs
SMBus Data Valid to SMBCLK Rising-Edge Time	$t_{SU:DAT}$, 10% or 90% of SMBDATA to 10% of SMBCLK		800	---	---	ns
SMBus Data-Hold Time	$t_{HD:DAT}$		0	---	---	µs
SMBCLK Falling Edge to SMBus Data-Valid Time	Master clocking in data		---	---	1	µs
RESET Function						
Reset Threshold High	V_{TH}		4.3	4.38	4.46	V
Reset Threshold Low	V_{TL}		4.2	---	---	V
Reset Active Timeout Period			100	220	300	ms
$\overline{\text{RESET}}$ Output Voltage Low	V_{OL}	V_{CC}=V_{TH} min, I_{SINK}=3.2mA	---	---	0.4	V
$\overline{\text{RESET}}$ Output Voltage High	V_{OH}	V_{CC}>V_{TH} max, I_{SOURCE} =5.0mA	V_{CC}-1.5	---	---	V

Note 1: Guaranteed but not 100% tested.

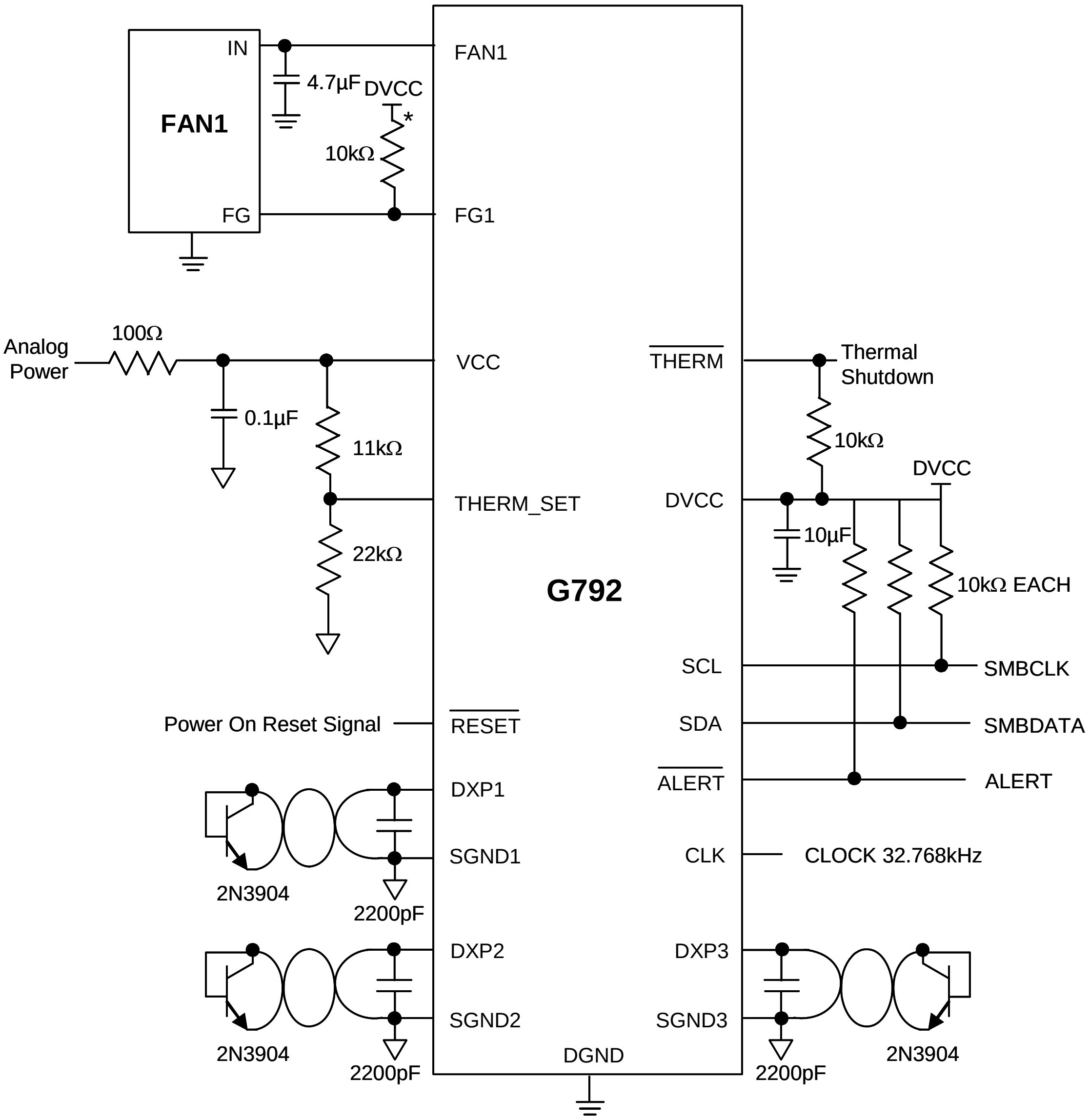
Note 2: Quantization error is not included in specifications for temperature accuracy.

Note 3: A remote diode is any diode-connected transistor from Table1. TR is the junction temperature of the remote diode. See Remote Diode Selection for remote diode forward voltage requirements.

Pin Description

PIN	NAME	FUNCTION
1	FAN1	Output connected to Power of fan1.
2	$\overline{\text{RESET}}$	$\overline{\text{RESET}}$ Output remains low while V_{CC} is below the reset threshold, and for 220ms after V_{CC} rises above the reset threshold.
3	THERM_SET	Hardware thermal shutdown setting for sensor 2. The trigger point is set by external resisters
4	FG1	Fan1 pulse input.
5	DGND	Digital Ground.
6	VCC	Supply Voltage Input for Thermal Sensors. Add series 100Ω resistor and Bypass to SGND with a 0.1µF capacitor.
7	DXP1	Combined Current Source and A/D Positive Input for remote-diode channel 1. Do not leave DXP1 floating; tie DXP1 to SGND1 if no remote diode on channel 1 is used. Place a 2200pF capacitor between DXP1 and SGND1 for noise filtering.
8	SGND1	Combined Current Sink, A/D Negative Input and analog ground. The SGND1 should be connected together as close as possible to the IC and connected to a clear ground.
9	DXP2	Combined Current Source and A/D Positive Input for remote-diode channel 2. Do not leave DXP2 floating; tie DXP2 to SGND2 if no remote diode on channel 1 is used. Place a 2200pF capacitor between DXP2 and SGND2 for noise filtering.
10	SGND2	Combined Current Sink, A/D Negative Input and analog ground. The SGND2 should be connected together as close as possible to the IC and connected to a clear ground.
11	DXP3	Combined Current Source and A/D Positive Input for remote-diode channel 3. Do not leave DXP3 floating; tie DXP3 to SGND3 if no remote diode on channel 1 is used. Place a 2200pF capacitor between DXP3 and SGND3 for noise filtering.
12	SGND3	Combined Current Sink, A/D Negative Input and analog ground. The SGND3 should be connected together as close as possible to the IC and connected to a clear ground.
13	$\overline{\text{THERM}}$	Thermal Shutdown Output, open drain.
14	CLK	32.768KHz clock input for fan controller.
15	$\overline{\text{ALERT}}$	SMBus Alert (interrupt) Output, open drain.
16	SDA	SMBus Serial-Data Input / Output, open drain.
17	DGND	This Pin should be Connected to DGND.
18	SCL	SMBus Serial-Clock Input.
19	N.C.	Do Not Connect.
20	DVCC	Supply Voltage Input for Digital Part. Bypass to DGND with a 10µF capacitor.

Typical Operating Circuit



* Note: If FG is open-drain/open-collector output,add 10kΩ pull-high resistor.

Detailed Description

The G792 consists of 3 remote temperature sensors, 1 fan controllers, and power-monitor reset circuit with SMBus serial interface (Figure 1).

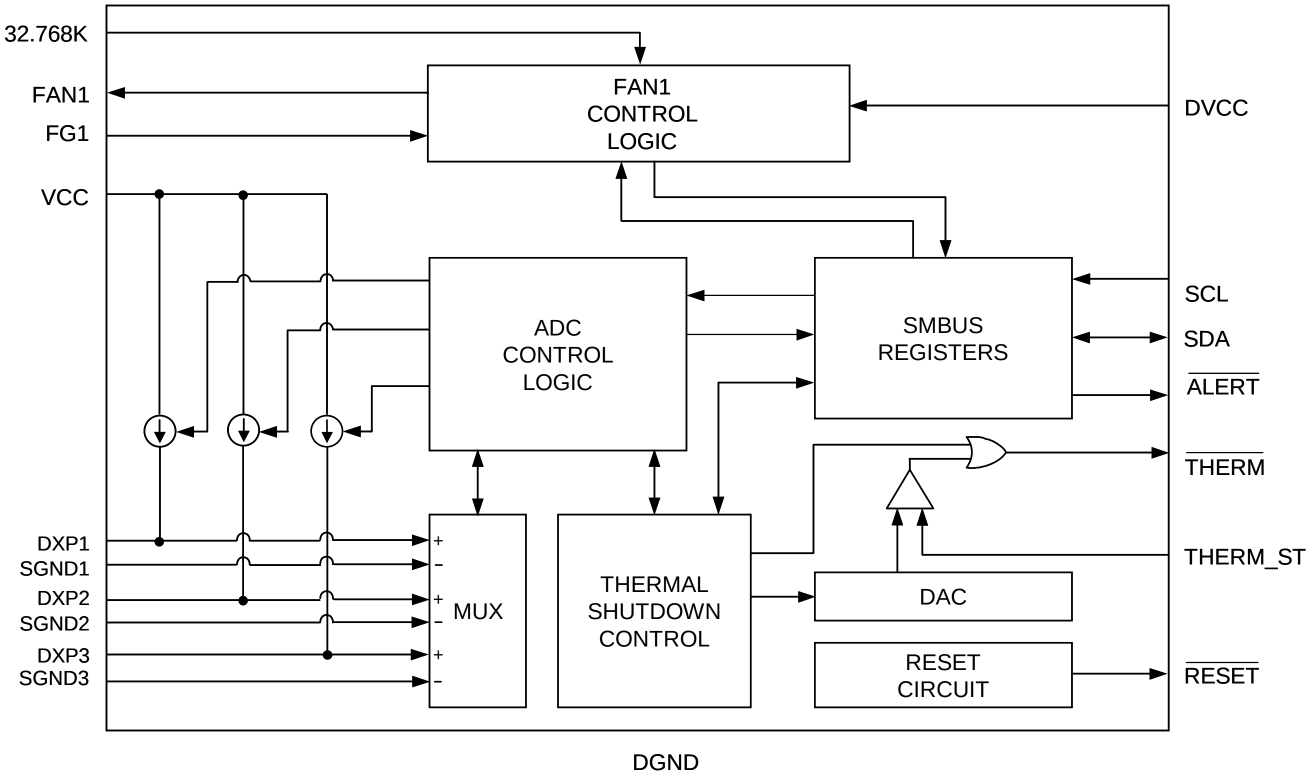


Figure 1. Functional Diagram

Thermal Sensors

Thermal diodes can be a 2N3904 NPN type or the diode built-in in CPU. Connect a thermal diode from DXP to SGND, and tie SGND to a clear ground. A multiplexer automatically steers bias currents through the 3 remote diodes, measures their forward voltage, and computes their temperatures. If one of the three channels is not used, the device still performs three measurements, and the users can simply ignore the result of the unused channel. Tie the DXP to SGND rather than leaving the pin floating if the corresponding channel is not used. The diode selection and PCB layout guides are stated in application notes.

The accuracies of thermal sensors is ±1°C (+60°C to 100°C). Excess resistance in series with the remote diode cause about +0.6°C error per ohm. Namely, 240µV of offset voltage forces on DXP-SGND, then causes about 1°C error.

Data Format of Temperature Outputs

The format of temperature data format is 11 bits plus sign in two's-complement form, with each data bit representing 0.125°C (Tabl1, Table2). The MSB 8 bits can be read via SMBus by commands 00h (sensor 2), 01h (sensor 1), and 05h (sensor 3). The extended bits for sensor 1 are data bit 7~bit 5 read by command 06h, and for sensor 2, sensor 3 are data bit 7~bit 5, bit 4~bit 2 of command 07h respectively.

Table 1. Temperature Data Format (Two's-Complements)

TEMP. (°C)	DIGITAL OUTPUT DATA BITS			
	SIGN	MSB	LSB	EXT
+127.875	0	111	1111	111
+126.375	0	111	1110	011
+25.5	0	001	1001	100
+1.75	0	000	0001	110
+0.5	0	000	0000	100
+0.125	0	000	0000	001
-0.125	1	111	1111	111
-1.125	1	111	1110	111
-25.5	1	110	0110	100
-55.25	1	100	1000	110
-65.000	1	011	1111	000

Table 2. Extended Temperature Data Format

EXTENDED RESOLUTION	DATA BITS
0.000°C	000
0.125°C	001
0.250°C	010
0.375°C	011
0.500°C	100
0.625°C	101
0.750°C	110
0.875°C	111

Thermal Sensors Conversion Sequence

If a Start command is written (or generated automatically in the free-running auto-convert mode), 3 channels are converted, and the 3 results are available after the end of conversion. A BUSY status in the bit 7 of status byte read by command 02h shows that the device is actually performing a new conversion; however, even if the ADC is busy, the results of the previous conversion are always available.

Free-running conversion rate is from 0.0625Hz to 8Hz controlled by data bits 2 ~ bits 0 of command 0Ah (Table3). Default is set to 1Hz. To reduces supply current, set the conversion rate to 0.0625Hz.

One-shot command 0Fh initiates a single conversion during the stop conversion period.

Table 3. Conversion-Rate Control Byte

DATA	CONVERSION RATE (Hz)
000	0.0625
001	0.125
010	0.25
011	0.5
100	1
101	2
110	4
111	8

Temperature Offset Adjustment

Data bit 3~bit 0 of command 16h, 17h, 18h are for fixing the temperature offsets from parasitic resisters or diode variation of the three sensors. The data format is twos-complement form. (Table 4)

Table 4. Code Offset Data Format

OFFSET	DATA BITS
+3.5°C	0111
+3°C	0110
+2.5°C	0101
+2.0°C	0100
+1.5°C	0011
+1.0°C	0010
+0.5°C	0001
0°C	0000
-0.5°C	1111
-1.0°C	1110
-1.5°C	1101
-2.0°C	1100
-2.5°C	1011
-3.0°C	1010
-3.5°C	1001
-4°C	1000

Diode Fault and Diode Short Detection

At the beginning of each conversion, diode fault detector at DXP detects whether the remote diodes are in open condition or not. If DXP rises above VCC-1V (typical) due to the diode current source, diode fault condition occurs. ALERT pin outputs low and remote temperature reading doesn't update if the corresponding diode is open. Note that the diode fault isn't checked until a conversion is initiated, so immediately after power-on reset no fault is present even if the diode path is broken. The diode fault condition can be read by status read (command 02h). Bit 3~bit1 are corresponding to the diode fault events of sensor 1, sensor 2, sensor 3.

G792 contains a diode short detector. If DXP falls below 0.1V at the beginning of the conversion, the temperature reading of the channel is -128°C.

Thermal Shutdown

There are hardware and software thermal shutdown functions in G792. The hardware thermal shutdown function is for sensor 2. It is set by two resistors (error $\leq \pm1\%$) in series from 0.35 V_{CC} to 0.95 V_{CC} as a voltage divider to determine the voltage on THERM_SET pin. The trigger point setting ranges from 72°C to 102°C, 2°C a step. The formula as below is

$$THERM\_SET = [(Tset-72) \times 0.02+0.34] \times V_{CC}$$

The software thermal shutdown is for sensor 1, sensor 3. Set the 8 bits critical point registers TCRIT1, TCRIT3 by command 35h, 36h respectively.

If one of the channels triggers thermal shutdown (DXP1 and DXP3 integer part are larger than their trigger point TCRIT1 and TCRIT3. DXP2 is integer part is equal or larger than THERM_SET trigger point) THERM pin goes low. User can read the TS_STATUS registers (command 08h) to detect which sensor triggers thermal shutdown. Bit 2~bit 0 of TS_STATUS registers are corresponding to sensor 3, sensor 2, sensor 1, and the bit is high if the corresponding channel triggers thermal shutdown.

Fault queue registers are set by data bit 2 to bit 0 of command 33h (Table 5). The THERM won't assert until consecutive out of limit measurements have reached the queue number.

Table 5. Thermal Shutdown Fault Queue

THERM FQ VALUE	FAULT QUEUE NUMBER
000	1
001	2
010	3
011	4
100	5
101	6
110	7
111	8

The THERM pin is an open-drain output. Connect a 10kΩ resister from the pin to V_{CC}.

FAN Controller

The FAN1 controller performs both open-loop or closed-loop control mode. The control mode is selected by setting bit 1 of configuration registers. Default is close-loop mode.

In open-loop control mode, FAN1 outputs a fixed voltage. 8 bits SET_FAN1 registers (command 12h) set the output voltage. The formula of voltage output is

$$\frac{V_{CC}}{4} + (SET\_FAN1+1) \times \frac{1}{256} \times \frac{3}{4} V_{CC}$$

In closed-loop control mode, FAN1 controller performs fan revolution speed control. Users set 8 bits SET_CNT1 registers (command 10h) and CPR registers (data bit 1, bit 0 of command 19, Table 7) to change the target fan RPM. CPR is the pulse counts per revolution, the input FG1. SET_CNT1 set the counting number of CLK pin 32.768KHz clock input between the two falling edges of FG1. Read 8 bits ACT_CNT1 registers (command 11h) to get the actual FAN1 RPM. The formula of RPM versus CPR and SET_CNT1 (ACT_CNT1) is

SET_CNT1 (ACT_CNT1)=N: Count Number

CPR: FG pulses number per revolution

CPR =1 => N = 983040 / rpm

CPR =2 => N = 491520 / rpm

CPR =4 => N = 245762 / rpm

Some selected count number for P=2 are listed below. (Table 6.)

Table 6. RPM vs. Count Number

RPM	N
3000	164
4000	123
5000	98
6000	82
7000	70
8000	61
9000	55
10000	49
20000	25
30000	16

To stop the fan, program the fan speed register to 255. This RPM control accuracy is within 2%, when SET_CNT1 > 50.

Table 7. Pulse Counts per Revolution

PULSE COUNTS	DATA BITS
2	00
4	01
8	10
16	11

Controlling Fan at Lower Speed

For stably controlling fans at lower rotation speed, three schemes are recommended as below:

1. Use larger decoupling capacitors between FAN1 and GND.
2. Shunt a capacitor of 1µF-2µF on FG pin to GND.
3. Use fans with open-collector FG outputs.

When controlling fans under lower rotation speed, the output voltage of FAN1 would be too low for fan to generate recognizable FG signals.

Using decouple capacitors on FAN1 and FG is to increase the SNR on FG pins. While using fans with open-collector FG outputs can thoroughly solve the problem, because the logic high level of FG would be fixed to 5V.

Fan Protection and Fan Fail Detections

There are over-current and over-temperature protections for both fan drivers. The over-temperature trigger point is 160°C (typical). The over-current limit is 800mA (typical) for FAN1 driver. See the application note for the power consumption ratings of fan drivers.

There are fan fail detection circuits for the FAN1. Setting bit 5 of configuration register high to activate the detection of fan failure. G792 defines fan failure as no transition on FG pin for about 0.7sec if SET_FAN1 is not set to 00h in open-loop control mode (or ACT_FAN1=FFh in closed- loop control mode). Bit 6 of status registers records the fan fail event of FAN1. If fan failure events occur, ALERT pin goes low. To disable the fan-failure detection, set bit 5 of configuration register low.

In closed-loop control mode, after setting SET_CNT1 (a fan speed consist value) then to the configuration bit 4 DET_FAN1_FCON active, if FAN1 actual RPM is 25% out of the programmed value for over 6 seconds (typical), bit 5 in status register is set high to indicate FAN1 out of control event. ALERT pin also goes low if this condition occurs. To disable the out of control detection, set bit 4 in configuration registers low.

SMBus Digital Interface

A standard SMBus 2-wire serial interface is used to read data or control the chip. The G792 employs four standard SMBus protocols: Write Byte, Read Byte, Send Byte, and Receive Byte (Figure2). The SMBus address of G792 is 7ah for write and 7bh for read. There is a built-in writing protection circuit for Write or Send Byte functions. Users must setting writing enable bit to 1 (data bit 0 of command 20h) to enable the Write or Send Byte function. Set the protection bit 0 after completing all the settings to prevent error behavior of µP. All the SMBus commands are listed in table 11.

The G792 supports SMBus clock timeout function. When SMBCLK are held low for more than 30ms (typical) during an SMBus communication the G792 will reinitiate its bus interface and be ready for a new transmission.

Alert Function and Status Registers

Besides the BUSY bit, if any of one bit in status registers is high, ALERT pin outputs low. The ALERT interrupt signal is latched and can only be cleared by reading the Alert Response address (Table 8). ALERT function can be disable by setting MASK bit in configuration registers. The ALERT pin is open-drain output. Connect a 10kΩ resister from ALERT pin to V_{CC}.

Table 8. Read Format for Alert Response Address (0001 100)

BIT	NAME
7(MSB)	ADD7
6	ADD6
5	ADD5
4	ADD4
3	ADD3
2	ADD2
1	ADD1
0(LSB)	1

Write Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	DATA	ACK	P
	7 bits			8 bits		8 bits		1

Slave Address: equivalent to chip- select line of a 3-wire interface
Command Byte: selects which register you are writing to
Data byte: data goes into the register set by the command byte (to set thresholds, configuration masks, and sampling rate)

Read Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	S	ADDRESS	RD	ACK	DATA	///	P
	7 bits			8bits			7bits			8 bits		

Slave Address: equivalent to chip- select line
Command Byte: selects which register you are reading from
Slave Address: repeated due to change in data-flow direction
Data byte: reads from the register set by the command byte

Send Byte Format

S	ADDRESS	WR	ACK	COMMAND	ACK	P
	7 bits			8 bits		

Command Byte: sends command with no data , usually used for one-shot command

Receive Byte Format

S	ADDRESS	RD	ACK	DATA	///	P
	7 bits			8 bits		

Data Byte: reads data from the register commanded by the last Read Byte or Write Byte transmission; also used for SMBus Alert Response return address

S = Start condition Shaded = Slave transmission P = Stop condition /// = Not acknowledged

Figure 2. SMBus Protocols

The status registers show the busy state of thermal sensors, fan abnormal conditions, and diode fault events (Table 9). The status byte is cleared by any successful read of status, unless the fault conditions persist.

Table 9. Status-Byte Bit Assignments

BIT	NAME	FUNCTION
7 (MSB)	BUSY	A high indicates that the ADC is busy converting.
6	FAN1_FAIL*	A high indicates that the FAN1 fail alarm has activated.
5	FAN1_FCON*	A high indicates that the FAN1 out of control alarm has activated.
4	RFU	Reserved for future use.
3	OPEN3*	A high indicates a remote-diode 3 continuity (open-circuit) fault.
2	OPEN2*	A high indicates a remote-diode 2 continuity (open-circuit) fault.
1	OPEN1	A high indicates a remote-diode 1 continuity (open-circuit) fault.
0 (LSB)	RFU	Reserved for future use.

*These flags stay high until cleared by POR, or until the status byte register is read.

Configuration Registers

Configuration registers control the ALERT mask, thermal sensors operating mode, FAN1 control mode and fan abnormal detections (Table 10). The Read command of configuration registers is 03h, and the Write command is 09h.

Table 10. Configuration-Byte Bit Assignments

BIT	NAME	POR STATE	FUNCTION
7	MASK	0	Masks all $\overline{\text{ALERT}}$ interrupts when high.
6	RFU	0	This bit should be kept to 0.
5	DET_FAN1	0	Validation of the FAN1 failure detection. Set high to enable
4	DET_FAN1FCON	0	Validation of the FAN1 out of control detection. Set high to enable
3	RFU	0	This bit should be kept to 0.
2	RFU	0	This bit should be kept to 0.
1	FAN1_MODE	1	0—FAN1 in open loop-control mode, 1—FAN1 closed-loop control mode.
0	RFU	0	This bit should be kept to 0.

Reset Function

The G792 also provides a µP power monitoring circuit. If V_{CC} is rising higher than 4.38V (typical), RESET pin goes high after 240ms (typical), or RESET pin remains low.

Application Information

Thermal Sensor Noise Filtering and PC Board Layout

Careful PC board layout and proper external noise filtering are required for high-frequency remote measurements in electrically noisy environments.

High-frequency EMI is best filtering at DXP and SGND with an external 2200pF capacitor. This value can be increased to about 3300pF (max), including cable capacitance. Higher capacitance than 3300pF introduces errors due to the rise time of the switched current source.

Place the G792 as close as practical to the remote diode and route the DXP and SGND traces in parallel and in close proximity to each other, away from any high-voltage traces such as +12V power. For remote diodes distances longer than 8 inches, or in particularly noisy environments, a twist pair is recommended. Nearly all noise sources tested cause the measurements higher than the actual temperature, typically +1°C to 10°C, depending on the frequency and amplitude. Leackage currents from PC board contamination must also be dealt with carefully, since a 10MΩ leakage path from DXP to ground causes about +1°C error.

DVCC and DGND are noisy power for fan and digital part, while VCC and SGND are clear ground for thermal sensors. Separates the two groups of power rails near the chip, and connects them as near the source as possible. Place a 100Ω resister and 0.1µF capacitor as the low pass filter for V_{CC}.

Power Rating for Fan Drivers

The recommended maximal current for FAN1 is 550mA.

Table 11. SMBus Command Byte

REGISTORS	COMMAND	POR	FUNCTION	USED BITS R/W
TDXP2	00h	00000000	Read DXP2 high byte	[7:0]R
TDXP1	01h	00000000	Read DXP1 high byte	[7:0]R
STATUS	02h	N/A	Read status registers. bit 7: BUSY, ADC is busy. bit 6: FAN1_FAIL: FAN1 fail status. Bit 5: FAN1_FCON: FAN1 out of control status. bit 4: RFU bit 3: OPEN3: diode 3 open. bit 2: OPEN2: diode 2 open. bit 1: OPEN1: diode 1 open. bit 0: RFU	[7:1]R
RCONFIG	03h	00000010	Read configuration registers. bit 7: MASK, this bit mask ALERT_N output. bit 6: RFU. keep this bit 0 bit 5: DET_FAN1, set 1 to activate FAN1 fail detection. bit 4: DET_FAN1FCON, set 1 to activate FAN1 fail control. bit 3: RFU, keep this bit 0. bit 2: RFU keep this bit 0 bit 1: FAN1MODE, 0—open loop, 1—close loop bit 0: RFU. keep this bit 0	[7:0]R
RCRATE	04h	00000100	Read conversion rate. bit 2,1,0; 000:1/16Hz 001:1/8Hz 010:1/4Hz 011:1/2Hz 100:1Hz 101:2Hz 110:4Hz 111:8Hz	[2:0]R
TDXP3	05h	00000000	Read DXP3 high byte	[7:0]R
TDXP1_EXT	06h	00000000	Read DXP1 extended byte bit 7, 6, 5 000:0C 001:0.125C 010:0.25C 011:0.375C 100:0.5C 101:0.625C 110:0.75C 111:0.875C	[7:5]R

Table 11. SMBus Command Byte (continued)

REGISTORS	COMMAND	POR	FUNCTION	USED BITS R/W
TDXP23_EXT	07h	00000000	Read DXP2,3 extended byte bit 7,6,5:DXP2 bit 4,3,2:DXP3 Format is the same as TDXP1_EXT	[7:2]R
TS_STATUS	08h	00000000	Read thermal shutdown status of 3 sensors. bit2: DXP3 thermal shutdown if 1 bit1: DXP2 thermal shutdown if 1 bit0: DXP1 thermal shutdown if 1	[2:0]R
WCONFIG	09h	00000010	Write configuration registers. See Command 03h.	[7:0]W
WCRATE	0Ah	00000010	Write conversion rate registers. See Command 04h.	[2:0]W
ONESHOT	0Fh	N/A	One-shot command	W
SET_CNT1	10h	11111111	Set fan1 RPM in close loop control.	[7:0]R/W
ACT_CNT1	11h	11111111	Read fan1 RPM.	[7:0]R
SET_FAN1	12h	00000000	Set fan1 output voltage in open loop control.	[7:0]R/W
CODEOS1	16h	00000000	Set DXP1 default offset, 2's complement from -4°C~3.5°C, 0.5°C a step.	[3:0]R/W
CODEOS2	17h	00000000	Set DXP2 default offset	[3:0]R/W
CODEOS3	18h	00000000	Set DXP3 default offset	[3:0]R/W
CPR	19h	00000000	Set FG1 pulse count per revolution 00: 2 01: 4 10: 8 11: 16	[1:0]R/W
SMWRITABLE	20h	00000000	Set SMbus Write enable, bit 0 set to 1 to enable Write Function of SMBUS.	[0:0]R/W
FQ	33h	00000010	Fault queue setting for thermal shutdown.	[2:0]R/W
TCRIT1	35h	01101100	Set DXP1 thermal shutdown threshold	[7:0]R/W
TCRIT3	36h	01011000	Set DXP3 thermal shutdown threshold	[7:0]R/W

Remote Diode Selection

Temperature accuracy depends on having a good-quality, diode-connected small-signal transistor. The G792 can also directly measure the die temperature of CPUs and other integrated circuits having on-board temperature-sensing diodes.

The transistor must be a small-signal type with a relatively high forward voltage; otherwise, the A/D input voltage range can be violated. The forward voltage must be greater than 0.25V at 10µA; check to ensure-this is true at the highest expected temperature. The forward voltage must be less than 0.95V at 300µA. check to ensure this is true at the lowest expected temperature. Large power transistors don't work at all. Tight specifications for forward-current gain (+50 to +150, for example) indicate that the manufacturer has good process controls and that the devices have consistent V_{be} characteristics.

Table 12. Remote-Sensor Transistor Manufacture

Table 12. Remote-Sensor Transistor Manufacturers

MANUFACTURER	MODEL NUMBER
Philips	PMBS3904
Motorola (USA)	MMBT3904
National Semiconductor (USA)	MMBT3904

Note:Transistors must be diode-connected (base shorted to collector)

PC Board Layout

Place the G792 as close as practical to the remote diode. In a noisy environment, such as a computer motherboard, this distance can be 4 in. to 8 in. (typical) or more as long as the worst noise sources (such as CRTs, clock generators, memory buses, and ISA/PCI buses) are avoided.

Do not route the DXP- SGND lines next to the deflectioncoils of a CRT. Also, do not route the traces across a fast memory bus, which can easily introduce +30°C error, even with good filtering, Otherwise, most noise sources are fairly benign.

Route the DXP and SGND traces in parallel and in close proximity to each other, away from any high-voltage traces such as $+12V_{DC}$. Leakage currents from PC board contamination must be dealt with carefully, since a 10MΩ leakage path from DXP to ground causes about +1°C error.

Connect guard traces to GND on either side of the DXP-SGND traces (Figure 3). With guard traces in place, routing near high-voltage traces is no longer an issue.

Route through as few vias and crossunders as possible to minimize copper/solder thermocouple effects. When introducing a thermocouple, make sure that both the DXP and the SGND paths have matching thermocouples. In general, PC board-induced thermocouples are not a serious problem, A copper-solder thermocouple exhibits 3µV/°C, and it takes about 240µV of voltage error at DXP- SGND to cause a +1°C measurement error. So, most parasitic thermocouple errors are swamped out.

Use wide traces. Narrow ones are more inductive and tend to pick up radiated noise. The 10mil widths and spacing recommended on Figure 3 aren't absolutely necessary (as they offer only a minor improvement in leakage and noise), but try to use them where practical. Keep in mind that copper can't be used as an EMI shield, and only ferrous materials such as steel work will. Placing a copper ground plane between the DXP-SGND traces and traces carrying high-frequency noise signals does not help reduce EMI.

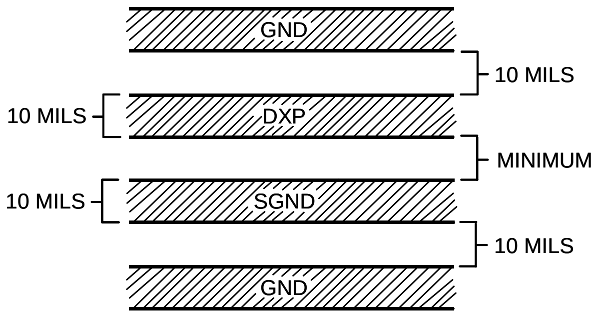
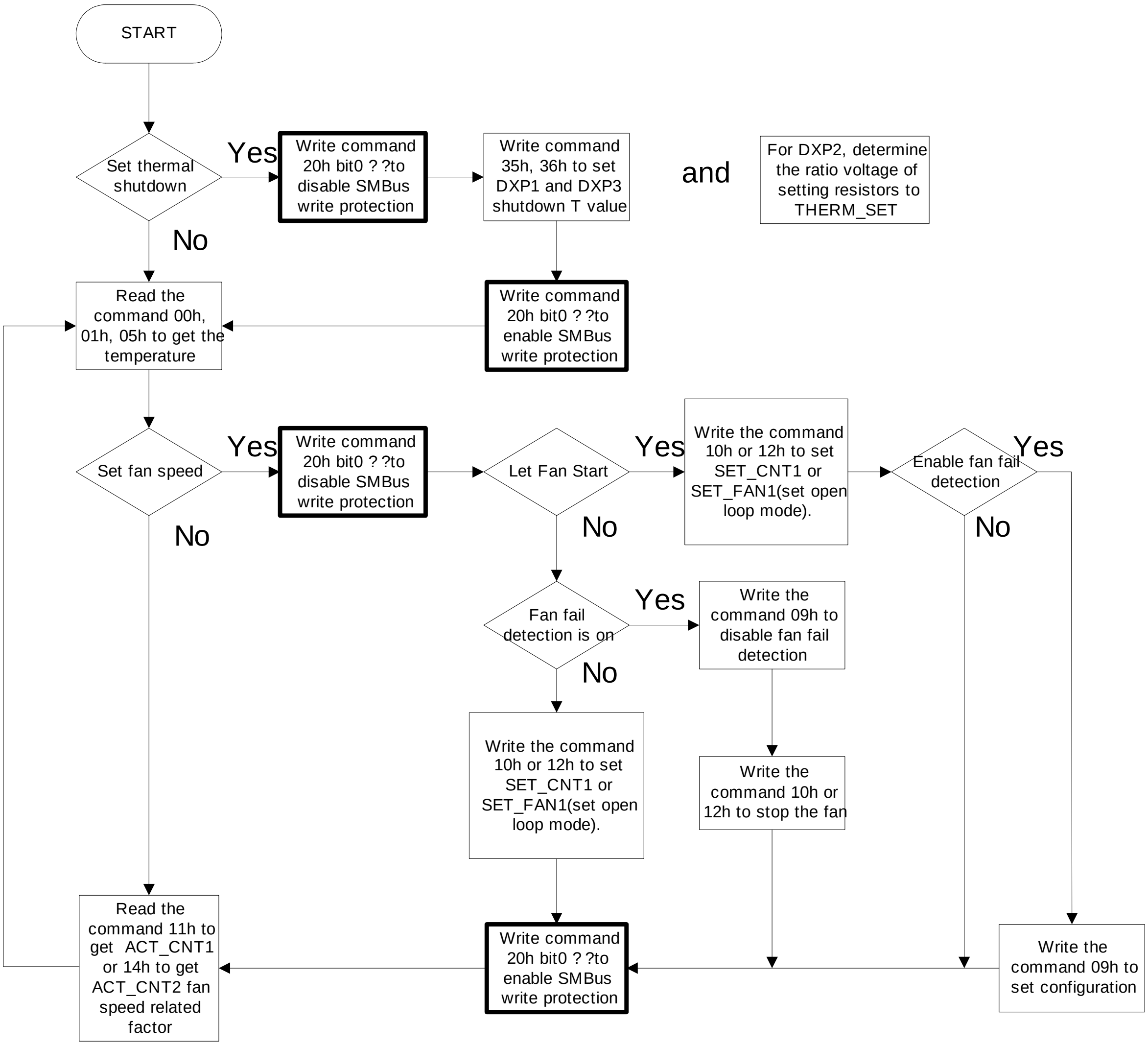


Figure 3. Recommended DXP/SGND PC Traces

PC Board Layout Checklist

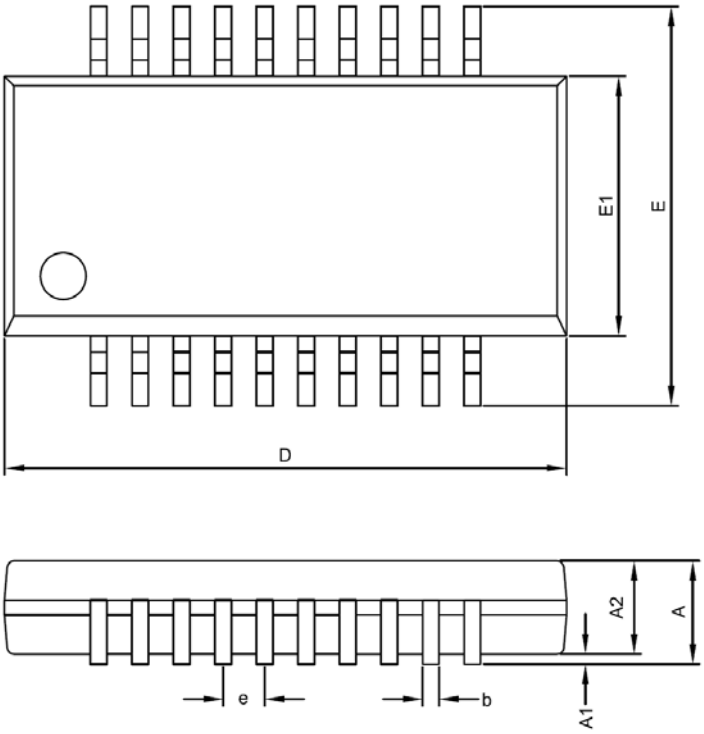
- Place the G792 close to a remote diode.
- Keep traces away from high voltages (+12V bus).
- Keep traces away from fast data buses and CRTs.
- Use recommended trace widths and spacing.
- Place a ground plane under the traces
- Use guard traces flanking DXP and SGND and connecting to GND.
- Place the noise filter and the 0.1µF VCC bypass capacitors close to the G792.



The bold frame items are necessary action to prevent SMBus malfunction in communication

OP_Flow

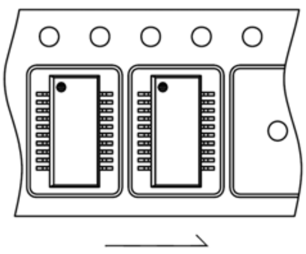
Package Information



SSOP-20 (SF) Package

Symble	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.35	1.55	1.75	0.053	0.061	0.069
A1	0.00	- - -	0.25	0.000	- - -	0.010
A2	1.15	1.35	1.50	0.045	0.053	0.059
D	8.56	8.66	8.74	0.337	0.341	0.344
E	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.153	0.157
c	0.19	0.23	0.27	0.007	0.009	0.011
b	0.20	0.25	0.33	0.008	0.010	0.013
e	0.635 BSC			0.025 BSC		
L	0.40	0.7	1.00	0.016	0.028	0.039

Taping Specification



PACKAGE	Q'TY/ REEL
SSOP-20	2,500 ea