ON Semiconductor®

*dB*Cool™ Remote Thermal Controller and Voltage Monitor

ADT7476A

FEATURES

Monitors up to five voltages
Improved TACH and PWM performance
Controls and monitors up to four fans
High and low frequency fan drive signal
One on-chip and two remote temperature sensors
Extended temperature measurement range up to 191°C
Automatic fan speed control mode controls system cooling based on measured temperature
Enhanced acoustic mode dramatically reduces user perception of changing fan speeds
Thermal protection feature via $\overline{\text{THERM}}$ output
Monitors performance impact of Intel® Pentium® 4 processor
Thermal control circuit via $\overline{\text{THERM}}$ input
3-wire and 4-wire fan speed measurement
Limit comparison of all monitored values
5 V support on all TACH and PWM channels
Meets SMBus 2.0 electrical specifications

GENERAL DESCRIPTION

The ADT7476A *dB*COOL controller is a thermal monitor and multiple PWM fan controller for noise-sensitive or power-sensitive applications requiring active system cooling. The ADT7476A can drive a fan using either a low or high frequency drive signal and can monitor the temperature of up to two remote sensor diodes plus its own internal temperature. The part also measures and controls the speed of up to four fans, so the fans operate at the lowest possible speed for minimum acoustic noise.

The automatic fan speed control loop optimizes fan speed for a given temperature. The effectiveness of the system's thermal solution can be monitored using the $\overline{\text{THERM}}$ input. The ADT7476A also provides critical thermal protection to the system using the bidirectional $\overline{\text{THERM}}$ pin as an output to prevent system or component overheating.

FUNCTIONAL BLOCK DIAGRAM

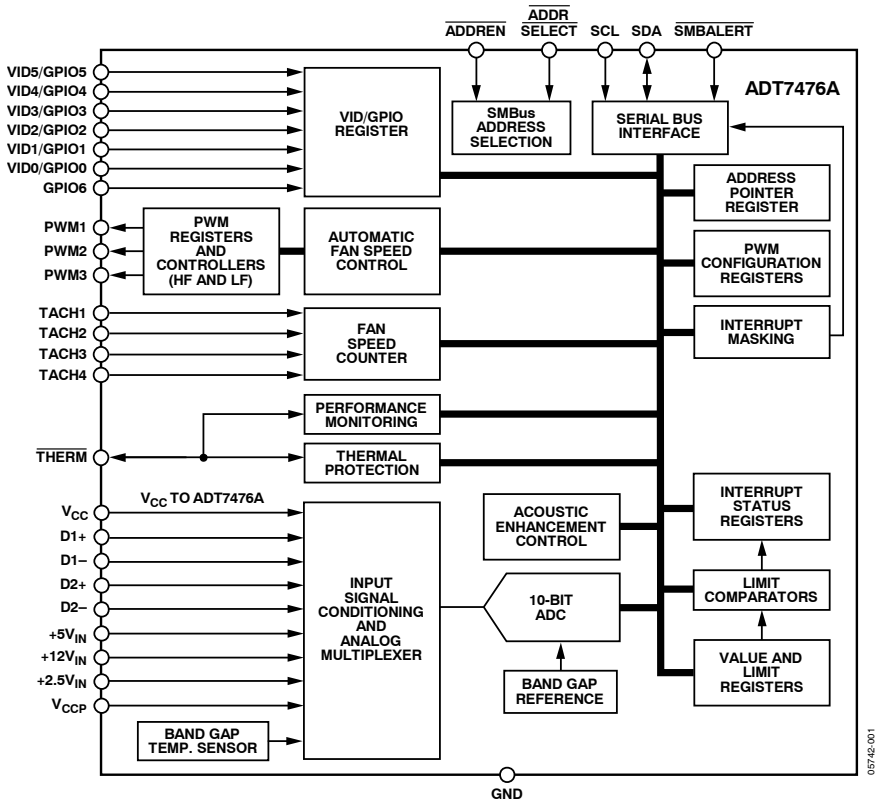

Figure 1.

SPECIFICATIONS

$T_A = T_{MIN}$ to T_{MAX}, $V_{CC} = V_{MIN}$ to V_{MAX}, unless otherwise noted.[1]

Table 1.

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
POWER SUPPLY					
Supply Voltage	3.0	3.3	3.6	V	
Supply Current, I_{CC}		1.5	3	mA	Interface inactive, ADC active
TEMP-TO-DIGITAL CONVERTER					
Local Sensor Accuracy		±0.5	±1.5	°C	0°C ≤ T_A ≤ 85°C
			±2.5	°C	−40°C ≤ T_A ≤ 125°C
Resolution		0.25		°C	
Remote Diode Sensor Accuracy		±0.5	±1.5	°C	0°C ≤ T_A ≤ 85°C
			±2.5	°C	−40°C ≤ T_A ≤ 125°C
Resolution		0.25		°C	
Remote Sensor Source Current		180		µA	High level
		11		µA	Low level
ANALOG-TO-DIGITAL CONVERTER (INCLUDING MUX AND ATTENUATORS)					
Total Unadjusted Error (TUE)			±2	%	For 12 V channel
			±1.5	%	For all other channels
Differential Nonlinearity (DNL)			±1	LSB	8 bits
Power Supply Sensitivity		±0.1		%/V	
Conversion Time (Voltage Input)		11		ms	Averaging enabled
Conversion Time (Local Temperature)		12		ms	Averaging enabled
Conversion Time (Remote Temperature)		38		ms	Averaging enabled
Total Monitoring Cycle Time		145		ms	Averaging enabled
Total Monitoring Cycle Time		19		ms	Averaging disabled
Input Resistance	70	120		kΩ	For V_{CCP} channel
	70	114		kΩ	For all other channels
FAN RPM-TO-DIGITAL CONVERTER					
Accuracy			±6	%	0°C ≤ T_A ≤ 70°C
			±10	%	−40°C ≤ T_A ≤ +120°C
Full-Scale Count			65,535		
Nominal Input RPM		109		RPM	Fan count = 0xBFFF
		329		RPM	Fan count = 0x3FFF
		5,000		RPM	Fan count = 0x0438
		10,000		RPM	Fan count = 0x021C
OPEN-DRAIN DIGITAL OUTPUTS, PWM1 TO PWM3, XTO					
Current Sink, I_{OL}			8.0	mA	
Output Low Voltage, V_{OL}			0.4	V	I_{OUT} = −8.0 mA
High Level Output Current, I_{OH}		0.1	20	µA	$V_{OUT} = V_{CC}$
OPEN-DRAIN SERIAL DATA BUS OUTPUT (SDA)					
Output Low Voltage, V_{OL}			0.4	V	I_{OUT} = −4.0 mA
High Level Output Current, I_{OH}		0.1	1.0	µA	$V_{OUT} = V_{CC}$
SMBus DIGITAL INPUTS (SCL, SDA)[2]					
Input High Voltage, V_{IH}	2.0			V	
Input Low Voltage, V_{IL}			0.4	V	
Hysteresis		500		mV	

Parameter	Min	Typ	Max	Unit	Test Conditions/Comments
DIGITAL INPUT LOGIC LEVELS (TACH INPUTS)					
Input High Voltage, V_{IH}	2.0			V	
			5.5	V	Maximum input voltage
Input Low Voltage, V_{IL}			0.8	V	
	−0.3			V	Minimum input voltage
Hysteresis		0.5		V p-p	
DIGITAL INPUT LOGIC LEVELS ($\overline{THERM}$) ADTL+					
Input High Voltage, V_{IH}			$0.75 \times V_{CC}$	V	
Input Low Voltage, V_{IL}			0.4	V	
DIGITAL INPUT CURRENT					
Input High Current, I_{IH}		±1		µA	$V_{IN} = V_{CC}$
Input Low Current, I_{IL}		±1		µA	$V_{IN} = 0$
Input Capacitance, C_{IN}		5		pF	
SERIAL BUS TIMING					See Figure 2
Clock Frequency, f_{SCLK}	10		400	kHz	
Glitch Immunity, t_{SW}			50	ns	
Bus Free Time, t_{BUF}	4.7			µs	
SCL Low Time, t_{LOW}	4.7			µs	
SCL High Time, t_{HIGH}	4.0		50	µs	
SCL, SDA Rise Time, t_r			1,000	ns	
SCL, SDA Fall Time, t_f			300	µs	
Data Setup Time, $t_{SU;DAT}$	250			ns	
Detect Clock Low Timeout, $t_{TIMEOUT}$	15		35	ms	Can be optionally disabled

[1] All voltages are measured with respect to GND, unless otherwise specified. Typical voltages are T_A = 25°C and probably represent a parametric norm. Logic inputs accept input high voltages up to V_{MAX}, even when the device is operating down to V_{MIN}. Timing specifications are tested at logic levels of V_{IL} = 0.8 V for a falling edge, and V_{IH} = 2.0 V for a rising edge.

[2] SMBus timing specifications are guaranteed by design and are not production tested.

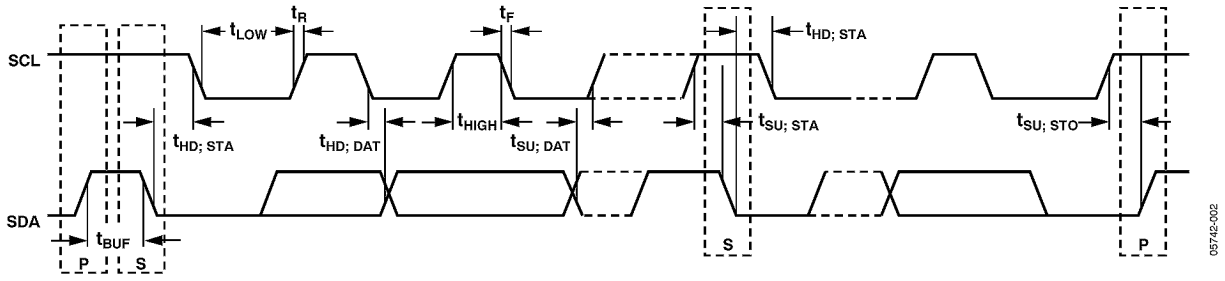

Figure 2. Serial Bus Timing Diagram

ABSOLUTE MAXIMUM RATINGS

Table 2.

Parameter	Rating
Positive Supply Voltage (V_{CC})	3.6 V
Maximum Voltage on +12 V_{IN} Pin	16 V
Maximum Voltage on +5 V_{IN} Pin	6.25 V
Maximum Voltage on All Open-Drain Outputs	3.6 V
Max Voltage on TACH/PWM Pins	+5.5 V
Voltage on Remaining Input or Output Pins	−0.3 V to +4.2 V
Input Current at Any Pin	±5 mA
Package Input Current	±20 mA
Maximum Junction Temperature (T_{JMAX})	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature, Soldering	
IR Reflow Peak Temperature	220°C
Pb-Free Peak Temperature	260°C
Lead Temperature (Soldering, 10 sec)	300°C
ESD Rating	1500 V

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

THERMAL CHARACTERISTICS

JA is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 3. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit
24-lead QSOP	122	31.25	°C/W

ESD CAUTION

ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although this product features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

PRODUCT DESCRIPTION

The ADT7476A is a complete thermal monitor and multiple fan controller for any system requiring thermal monitoring and cooling. The device communicates with the system via a serial system management bus. The serial bus controller has a serial data line for reading and writing addresses and data (Pin 1), and an input line for the serial clock (Pin 2). All control and programming functions for the ADT7476A are performed over the serial bus. In addition, a pin can be reconfigured as an $\overline{\text{SMBALERT}}$ output to signal out-of-limit conditions.

FEATURE COMPARISONS BETWEEN ADT7476A AND ADT7468

- Dynamic T_{MIN}, dynamic operating point, and associated registers are no longer available in the ADT7476A. The following related registers are gone:
  - Calibration Control 1 (0x36)
  - Calibration Control 2 (0x37)
  - Operating Point (0x33, 0x34, and 0x35)
- Previously (in the ADT7468), T_{RANGE} defined the slope of the automatic fan control algorithm. T_{RANGE} now defines a true temperature range (in the ADT7476A).
- Acoustic filtering is now assigned to temperature zones, not to fans. Available smoothing times have been increased for better acoustic performance.
- Temperature measurements are now made with two switching currents instead of three. SRC is not available in the ADT7476A.
- High frequency PWM can now be enabled/disabled on each PWM output individually.
- $\overline{\text{THERM}}$ can now be enabled/disabled on each temperature channel individually.
- The ADT7476A does not support full shutdown mode.
- The ADT7476A offers increased temperature accuracy on all temperature channels.
- The ADT7476A defaults to twos complement temperature measurement mode.
- Some pins have swapped/added functions.
- The power-up routine for the ADT7476A is simplified.
- The ADT7476A has a higher maximum input voltage TACH/PWM spec, supporting a wider range of fans.
- $V_{CORE\_LOW\_ENABLE}$ has been reallocated to Bit 7 of Configuration Register 1 (0x40).

RECOMMENDED IMPLEMENTATION

Configuring the ADT7476A as shown in Figure 13 allows the system designer to use the following features:

- Two PWM outputs for fan control of up to three fans (the front and rear chassis fans are connected in parallel).
- Three TACH fan speed measurement inputs.
- V_{CC} measured internally through Pin 4.
- CPU temperature measured using Remote 1 temperature channel.
- Remote temperature zone measured through Remote 2 temperature channel.
- Local temperature zone measured through the internal temperature channel.
- Bidirectional $\overline{\text{THERM}}$ pin. This feature allows Intel Pentium 4 $\overline{\text{PROCHOT}}$ monitoring and can function as an overtemperature $\overline{\text{THERM}}$ output. It can alternatively be programmed as an $\overline{\text{SMBALERT}}$ system interrupt output.

OUTLINE DIMENSIONS

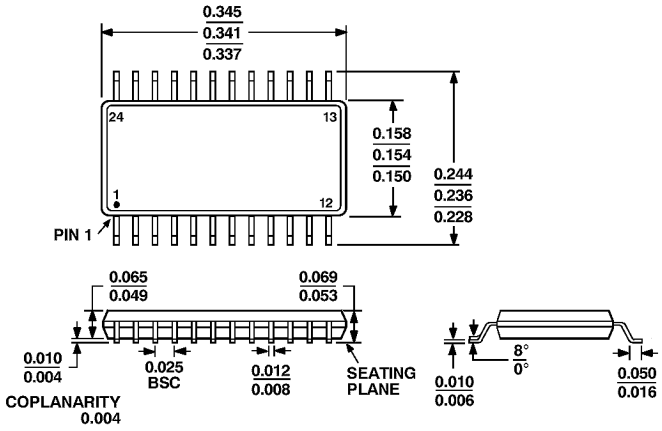

Figure 67. 24-Lead Shrink Small Outline Package [QSOP]
(RQ-24)
Dimensions shown in inches

ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADT7476AARQZ[1]	–40°C to +125°C	24-Lead Shrink Small Outline Package [QSOP]	RQ-24
ADT7476AARQZ-R[1]	–40°C to +125°C	24-Lead Shrink Small Outline Package [QSOP]	RQ-24
ADT7476AARQZ-RL7[1]	–40°C to +125°C	24-Lead Shrink Small Outline Package [QSOP]	RQ-24

[1] Z = Pb-free part.