MIC384

Three-Zone Thermal Supervisor

Features

- Measures Local and Two Remote Temperatures
- 2-Wire SMBus-Compatible Interface
- Programmable Thermostat Settings for All Three Zones
- Open-Drain Interrupt Output Pin
- Interrupt Mask and Status Bits
- Fault Queues to Prevent Nuisance Tripping
- Low Power Shutdown Mode
- Failsafe Response to Diode Faults
- 2.7V to 5.5V Power Supply Range
- 8-Lead SOIC and MSOP Packages

Applications

- Desktop, Server, and Notebook Computers
- Power Supplies
- Test and Measurement Equipment
- Wireless Systems
- Networking/Datacom Hardware

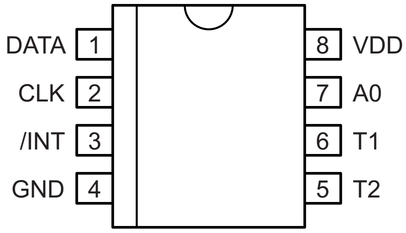
General Description

The MIC384 is a versatile digital thermal supervisor capable of measuring temperature using its own internal sensor and two inexpensive external sensors or embedded silicon diodes such as those found in the Intel Pentium III CPU. A 2-wire serial interface is provided to allow communication with either I^2C or SMBus hosts. The open-drain interrupt output pin can be used as either an overtemperature alarm or a thermostatic control signal.

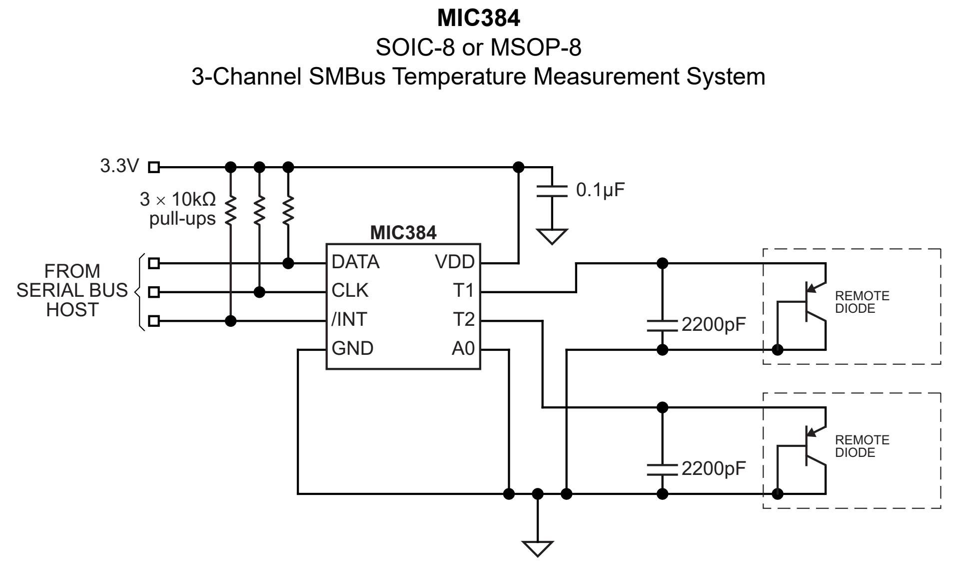
Interrupt mask and status bits are provided for reduced software overhead. Fault queues prevent nuisance tripping due to thermal or electrical noise. A programmable address pin permits two devices to share the bus. Alternate base addresses are available by contacting Microchip. Superior performance, low power, and small size makes the MIC384 an excellent choice for the most demanding thermal management applications.

Package Type

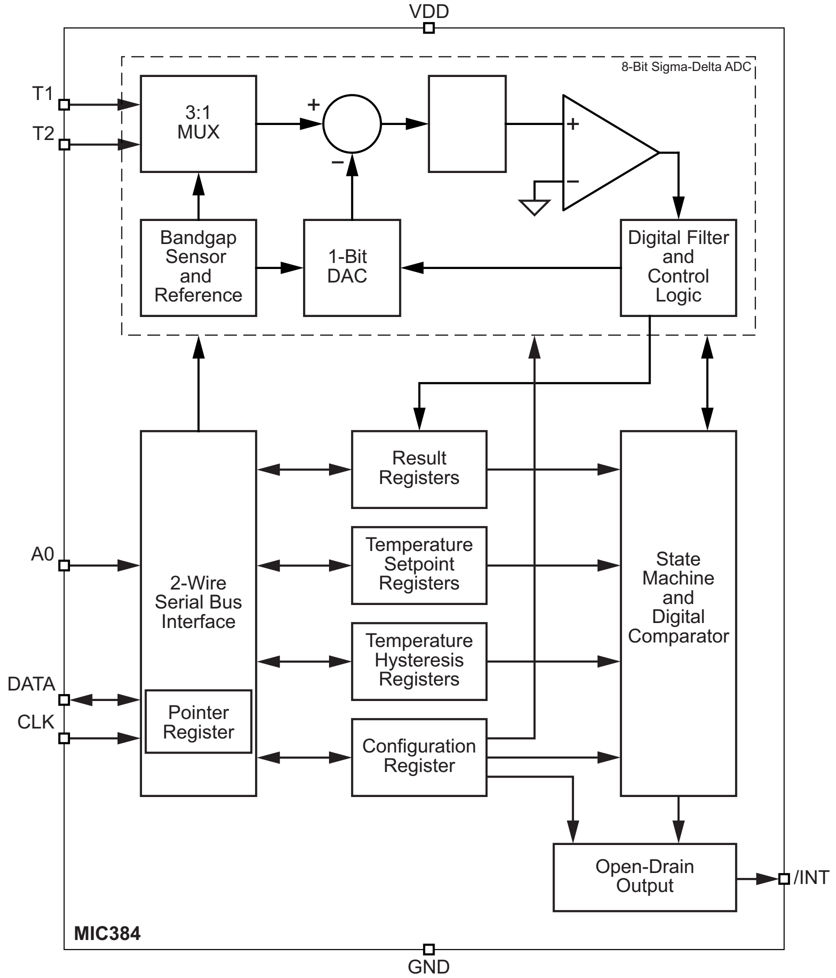
MIC384
8-Lead SOIC (M) or MSOP (MM)
(Top View)



Typical Application Circuit



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Power Supply Voltage (V_{DD})	+6.0V
Voltage on Any Pin	–0.3V to V_{DD} + 0.3V
Current into Any Pin	±10 mA
Power Dissipation (T_A = +125°C)	30 mW
ESD Rating (HBM, Note 1)	TBD kV
ESD Rating (MM, Note 1)	TBDV

Operating Ratings ‡

Power Supply Voltage (V_{DD})	+2.7V to +5.5V

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

‡ Notice: The device is not guaranteed to function outside its operating ratings. Final test on outgoing product is performed at T_A = +25°C.

Note 1: Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: 2.7V ≤ V_{DD} ≤ 5.5V; T_A = +25°C, unless noted. **Bold** values indicate –55°C ≤ T_A ≤ +125°C, unless noted. Note 1

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Power Supply						
Supply Current	I_{DD}	—	350	**750**	µA	/INT, open, A0 = V_{DD} or GND, CLK = DATA = high, normal mode
		—	3	—		/INT, open, A0 = V_{DD} or GND, shutdown mode, CLK = 100 kHz
		—	1	**10**		/INT, open, A0 = V_{DD} or GND, shutdown mode, CLK = DATA = high
Power-on Reset Time, Note 2	t_{POR}	—	—	**200**	µs	V_{DD} > V_{POR}
Power-on Reset Voltage	V_{POR}	—	2.0	2.7	V	All registers reset to default values; A/D conversions initiated
Power-on Reset Hysteresis Voltage	V_{HYST}	—	250	—	mV	—
Temperature-to-Digital Converter Characteristics						
Local Temperature Accuracy, Note 1, Note 3	—	—	±1	**±2**	°C	0°C ≤ T_A ≤ +100°C, /INT open, 3V ≤ V_{DD} ≤ 3.6V
		—	±2	**±3**		–55°C ≤ T_A ≤ +125°C, /INT open, 3V ≤ V_{DD} ≤ 3.6V
Remote Temperature Accuracy, Note 1, Note 3, Note 4	—	—	±1	**±3**	°C	0°C ≤ T_D ≤ +100°C, /INT open, 3V ≤ V_{DD} ≤ 3.6V, 0°C ≤ T_A ≤ +85°C
		—	±2	**±5**		–55°C ≤ T_D ≤ +125°C, /INT open, 3V ≤ V_{DD} ≤ 3.6V, 0°C ≤ T_A ≤ +85°C
Local Zone Conversion Time	t_{CONV0}	—	50	**80**	ms	Note 2, Note 5
Remote Zone Conversion Time	t_{CONV1}	—	100	**160**	ms	Note 2, Note 5
Remote Temperature Input, T1						
Current into External Diode, Note 2	I_F	—	224	**400**	µA	T1 or T2 forced to 1.5V, high level
		7.5	14	—		Low level
Address Input (A0)						
Low Input Voltage	V_{IL}	—	—	**0.6**	V	2.7V ≤ V_{DD} ≤ 5.5V
High Input Voltage	V_{IH}	**2.0**	—	—	V	2.7V ≤ V_{DD} ≤ 5.5V
Input Capacitance	C_{IN}	—	10	—	pF	—
Input Current	I_{LEAK}	—	±0.01	±1	µA	—

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: 2.7V ≤ V_{DD} ≤ 5.5V; T_A = +25°C, unless noted. **Bold** values indicate –55°C ≤ T_A ≤ +125°C, unless noted. Note 1

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Serial Data I/O Pin, DATA						
Low Output Voltage, Note 6	V_{OL}	—	—	**0.4**	V	I_{OL} = 3 mA
		—	—	**0.8**		I_{OL} = 6 mA
Low Input Voltage	V_{IL}	—	—	**0.3V**$_{DD}$	V	2.7V ≤ V_{DD} ≤ 5.5V
High Input Voltage	V_{IH}	**0.7V**$_{DD}$	—	—	V	2.7V ≤ V_{DD} ≤ 5.5V
Input Capacitance	C_{IN}	—	10	—	pF	—
Input Current	I_{LEAK}	—	±0.01	±1	µA	—
Serial Clock Input, CLK						
Low Input Voltage	V_{IL}	—	—	**0.3V**$_{DD}$	V	2.7V ≤ V_{DD} ≤ 5.5V
High Input Voltage	V_{IH}	**0.7V**$_{DD}$	—	—	V	2.7V ≤ V_{DD} ≤ 5.5V
Input Capacitance	C_{IN}	—	10	—	pF	—
Input Current	I_{LEAK}	—	±0.01	±1	µA	—
Status Output (/INT)						
Low Output Voltage, Note 6	V_{OL}	—	—	**0.4**	V	I_{OL} = 3 mA
		—	—	**0.8**	V	I_{OL} = 6 mA
Interrupt Propagation Delay, Note 2, Note 5	t_{INT}	—	—	**t_{CONV} + 1**	µs	From TEMP > T_SET or TEMPx < T_HYSTx to INT < V_{OL}, FQ = 00, R_{PULLUP} = 10 kΩ
Interrupt Reset Propagation Delay, Note 2	t_{nINT}	—	—	**1**	µs	From any register read to /INT > V_{OH}, FQ = 00, R_{PULLUP} = 10 kΩ
Default T_SET0 Value	T_SET0	81	81	81	°C	t_{POR} after V_{DD} > V_{POR}
Default T_HYST0 Value	T_HYST0	76	76	76	°C	t_{POR} after V_{DD} > V_{POR}
Default T_SET1 Value	T_SET1	97	97	97	°C	t_{POR} after V_{DD} > V_{POR}
Default T_HYST1 Value	T_HYST1	92	92	92	°C	t_{POR} after V_{DD} > V_{POR}
Default T_SET2 Value	T_SET2	97	97	97	°C	t_{POR} after V_{DD} > V_{POR}
Default T_HYST2 Value	T_HYST2	92	92	92	°C	t_{POR} after V_{DD} > V_{POR}

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Characteristics: 2.7V ≤ V_{DD} ≤ 5.5V; T_A = +25°C, unless noted. **Bold** values indicate –55°C ≤ T_A ≤ +125°C, unless noted. Note 1

Parameters	Symbol	Min.	Typ.	Max.	Units	Conditions
Serial Interface Timing (Note 2)						
CLK (Clock) Period	t_1	**2.5**	—	—	µs	—
Data-In Set-Up Time to CLK High	t_2	**100**	—	—	ns	—
Data-Out Stable after CLK Low	t_3	**0**	—	—	ns	—
Data-Low Set-Up Time to CLK Low	t_4	**100**	—	—	ns	Start Condition
Data-High Hold Time after CLK High	t_5	**100**	—	—	ns	Stop Condition

Note 1: Final test on outgoing product is performed at T_A = +TBD°C.

2: Guaranteed by design over the operating temperature range. Not 100% production tested.

3: Accuracy specification does not include quantization noise, which may be up to ±1/2 LSB (±0.5°C).

4: T_D is the temperature of the remote diode junction. Testing is performed using a single unit of one of the transistors listed in Table 5-1.

5: $t_{CONV} = t_{CONV0} + (2 \text{ x } t_{CONV1}) \text{ x } t_{CONV0}$ is the conversion time for the local zone; t_{CONV1} is the conversion time for the remote zone.

6: Current into this pin will result in self-heating of the MIC384. Sink current should be minimized for best accuracy.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Storage Temperature	T_S	–65	—	+150	°C	—
Ambient Temperature Range	T_A	–55	—	+125	°C	—
Lead Temperature Soldering	—	—	—	+220 ±5	°C	Vapor Phase, 60 sec.
		—	—	+235 ±5	°C	Infrared, 15 sec.
Package Thermal Resistances						
SOIC-8	θ_{JA}	—	152	—	°C/W	—
MSOP-8	θ_{JA}	—	206	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +150°C rating. Sustained junction temperatures above +150°C can impact the device reliability.

2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Symbol	Description
1	DATA	Digital I/O: Open-drain. Serial data input/output.
2	CLK	Digital Input: The host provides the serial bit clock on this input.
3	/INT	Digital Output: Open-drain. Interrupt or thermostat output.
4	GND	Ground: Power and signal return for all IC functions.
5	T2	Analog Input: Connection to remote temperature sensor (diode junction).
6	T1	Analog Input: Connection to remote temperature sensor (diode junction).
7	A0	Digital Input: Client address selection input. See Table 3-1.
8	VDD	Analog Input: Power supply input to the IC.

Timing Diagram

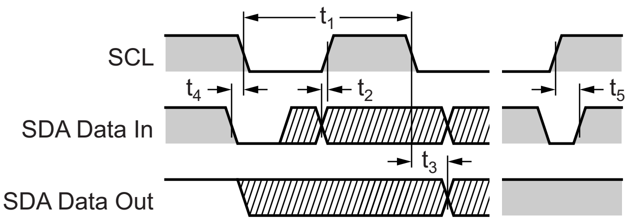


FIGURE 2-1: Serial Interface Timing.

3.0 FUNCTIONAL DESCRIPTION

3.1 Pin Descriptions

3.1.1 VDD

Power supply input. See Table 2-1.

3.1.2 GND

Ground return for all MIC384 functions.

3.1.3 CLK

Clock input to the MIC384 from the two-wire serial bus. The clock signal is provided by the host and is shared by all devices on the bus.

3.1.4 DATA

Serial data I/O pin that connects to the two-wire serial bus. DATA is bi-directional and has an open-drain output driver. An external pull-up resistor or current source somewhere in the system is necessary on this line. This line is shared by all devices on the bus.

3.1.5 A0

This input sets the least significant bit of the MIC384's 7-bit client address. The six most-significant bits are fixed and are determined by the part number ordered. Each MIC384 will only respond to its own unique client address, allowing up to eight MIC384s to share a single bus. A match between the MIC384's address and the address specified in the serial bit stream must be made to initiate communication. A0 should be tied directly to VDD or ground. See Temperature Measurement and Power-On for more information. A0 determines the client address as shown in Table 3-1.

TABLE 3-1: MIC384 CLIENT ADDRESS SETTINGS

Part Number	A0 Inputs	Binary Address	Hex Address
MIC384-0	0	100 1000_b	48_h
	1	100 1001_b	49_h
MIC384-1	0	100 1010_b	$4A_h$
	1	100 1011_b	$4B_h$
MIC384-2	0	100 1100_b	$4C_h$
	1	100 1101_b	$4D_h$
MIC384-3	0	100 1110_b	$4E_h$
	1	100 1111_b	$4F_h$

3.1.6 /INT

Temperature events are indicated to external circuitry via this output. Operation of the /INT output is controlled by the MODE and IM bits in the MIC384's configuration register. See Comparator and Interrupt Modes. This output is open-drain and may be wire-OR'ed with other open-drain signals. Most systems will require a pull-up resistor or current source on this pin. If the IM bit in the configuration register is set, it prevents the /INT output from sinking current. In I^2C and SMBus systems, the IM bit is therefore an interrupt mask bit.

3.1.7 T1 AND T2

The T1 and T2 pins connect to off-chip PN diode junctions for monitoring the junction temperature at remote locations. The remote diodes may be embedded thermal sensing junctions in integrated circuits so equipped (such as Intel's Pentium III), or discrete 2N3906-type bipolar transistors with base and collector tied together.

3.2 Temperature Measurement

The temperature-to-digital converter is built around a switched current source and an eight-bit analog-to-digital converter. Each diode's temperature is calculated by measuring its forward voltage drop at two different current levels. An internal multiplexer directs the current source's output to either the internal or one of the external diode junctions. The MIC384 uses two's-complement data to represent temperatures. If the MSB of a temperature value is zero, the temperature is zero or positive. If the MSB is one, the temperature is negative. More detail on this is given in the Temperature Data Format section. A temperature event results if the value in either of the temperature result registers (TEMPx) becomes greater than the value in the corresponding temperature setpoint register (T_SETx). Another temperature event occurs if and when the measured temperature subsequently falls below the temperature hysteresis setting in T_HYSTx.

During normal operation the MIC384 continuously performs temperature-to-digital conversions, compares the results against the setpoint and hysteresis registers, and updates the states of /INT and the status bits accordingly. The remote zones are converted first, followed by the local zone (T1 > T2 > LOCAL). The states of /INT and the status bits are updated after each measurement is taken.

3.3 Diode Faults

The MIC384 is designed to respond in a failsafe manner to hardware faults in the external sensing circuitry. If the connection to the external diode is lost or the sense line (T1 or T2) is shorted to VDD or ground, the temperature data reported by the A/D converter will be forced to its full-scale value (+127°C). This will cause a temperature event to occur if the setpoint register for the corresponding zone is set to any value less than 127°C ($7F_h = 0111\ 1111_b$). An interrupt will be generated on /INT if so enabled. The temperature reported for the external zone will remain +127°C until the fault condition is cleared. This fault detection mechanism requires that the MIC384 complete the number of conversion cycles specified by Fault_Queue. The part will therefore require one or more conversion cycles following power-on or a transition from shutdown to normal operation before reporting an external diode fault.

3.4 Serial Port Operation

The MIC384 uses standard SMBus Write_Byte and Read_Byte operations for communication with its host. The SMBus Write_Byte operation involves sending the device’s client address, with the R/W bit low to signal a write operation, followed by a command byte and a data byte. The SMBus Read_Byte operation is similar, but is a composite write and read operation: the host first sends the device’s client address followed by the command byte, as in a write operation. A new start bit must then be sent to the MIC384, followed by a repeat of the client address with the R/W bit (LSB) set to the high (read) state. The data to be read from the part may then be clocked out.

The command byte is eight bits wide. This byte carries the address of the MIC384 register to be operated upon, and is stored in the part’s pointer register. The pointer register is an internal write-only register. The command byte (pointer register) values corresponding to the various MIC384 register addresses are shown in Table 3-2. Command byte values other than those explicitly shown are reserved, and should not be used. Any command byte sent to the MIC384 will persist in the pointer register indefinitely until it is overwritten by another command byte. If the location latched in the pointer register from the last operation is known to be correct (i.e., points to the desired register), then the Receive_Byte procedure may be used. To perform a Receive_Byte, the host sends an address byte to select the MIC384, and then retrieves the data byte. Figure 3-1 through Figure 3-3 show the formats for these procedures.

TABLE 3-2: MIC384 REGISTER ADDRESSES

Command Byte		Target Register	
Binary	**Hex**	**Label**	**Description**
$0000\ 0000_b$	00_h	TEMP0	Local temperature
$0000\ 0001_b$	01_h	CONFIG	Configuration register
$0000\ 0010_b$	02_h	T_HYST0	Local temperature hysteresis
$0000\ 0011_b$	03_h	T_SET0	Local temperature setpoint
$0001\ 0000_b$	10_h	TEMP1	Remote zone 1 temperature
$0001\ 0010_b$	12_h	T_HYST1	Remote zone 1 temperature hysteresis
$0001\ 0011_b$	13_h	T_SET1	Remote zone 1 temperature setpoint
$0010\ 0000_b$	20_h	TEMP2	Remote zone 2 temperature
$0010\ 0010_b$	22_h	T_HYST2	Remote zone 2 temperature hysteresis
$0010\ 0011_b$	23_h	T_SET2	Remote zone 2 temperature setpoint

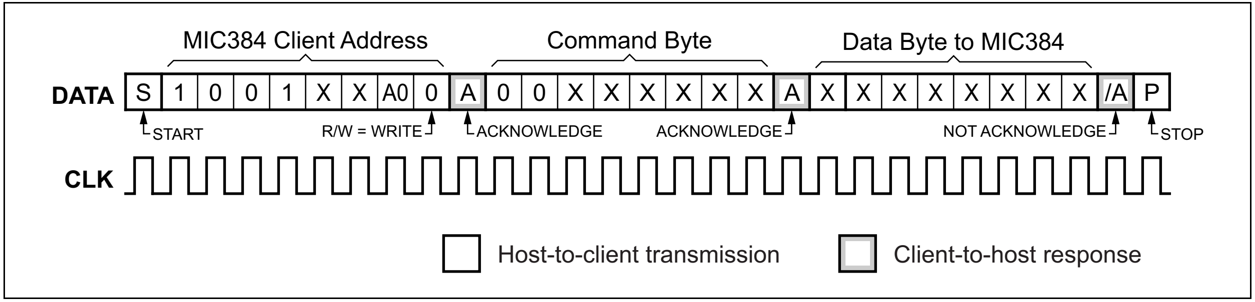


FIGURE 3-1: *WRITE_BYTE Protocol.*

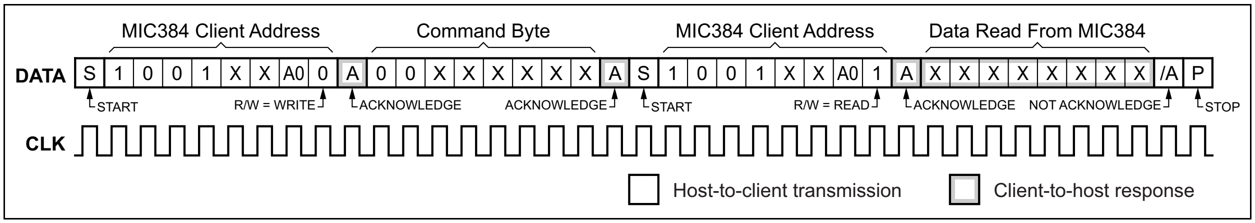


FIGURE 3-2: *READ_BYTE Protocol.*

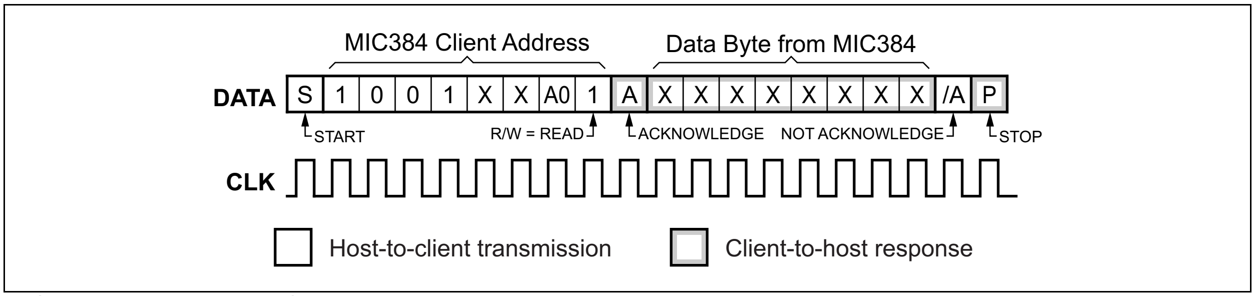


FIGURE 3-3: *RECEIVE_BYTE Protocol.*

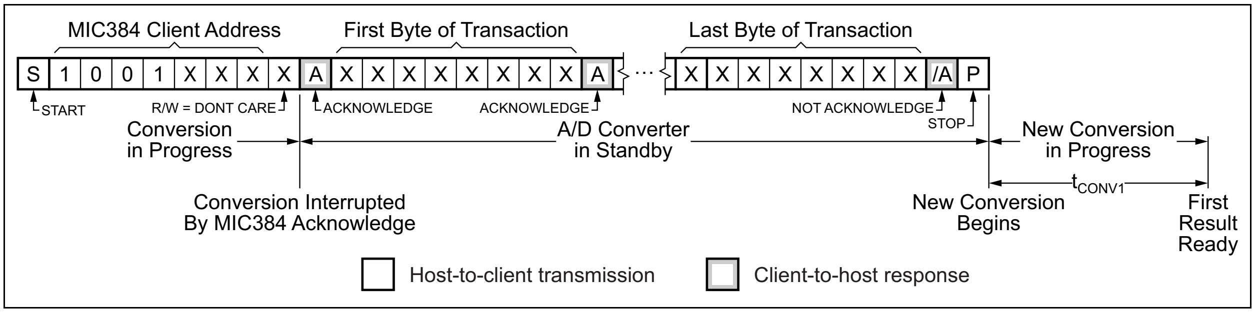


FIGURE 3-4: *A/D Converter Timing.*

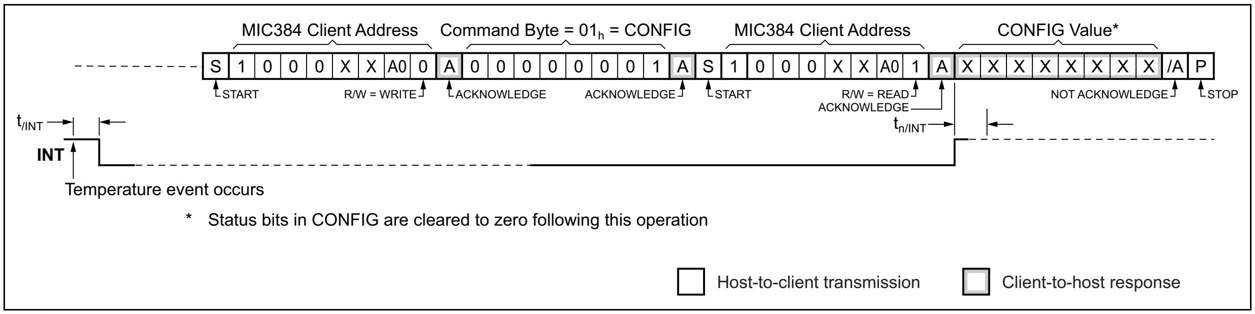


FIGURE 3-5: *Responding to Interrupts.*

3.5 Temperature Data Format

The LSB of each register represents one degree Centigrade. The values are in a two's complement format, wherein the most significant bit (D7), represents the sign: zero for positive temperatures and one for negative temperatures. Table 3-3 shows examples of the data format used by the MIC384 for temperatures.

TABLE 3-3: DIGITAL TEMPERATURE FORMAT

Temperature	Binary	Hex
+125°C	$0111\ 1101_b$	$7D_h$
+100°C	$0110\ 0100_b$	64_h
+25°C	$0001\ 1001_b$	19_h
+1.0°C	$0000\ 0001_b$	01_h
0°C	$0000\ 0000_b$	00_h
–1.0°C	$1111\ 1111_b$	FF_h
–25°C	$1110\ 0111_b$	$E7_h$
–40°C	$1101\ 1000_b$	$D8_h$
–55°C	$1100\ 1001_b$	$C9_h$

3.6 A/D Converter Timing

Whenever the MIC384 is not in its low power shutdown mode, the internal A/D converter (ADC) attempts to make continuous conversions unless interrupted by a bus transaction accessing the MIC384.

Upon powering up or coming out of shutdown mode, the ADC will begin acquiring temperature data starting with the first external zone (zone 1), then the second external zone (zone 2), and finally the internal zone (zone 0). Results for zone 1 will be valid after t_{CONV1}, results for zone two will be ready after another t_{CONV1}, and for the local zone t_{CONV0} later. Figure 3-4 shows this behavior. The conversion time is twice as long for external conversions as it is for internal conversions. This allows the use of a filter capacitor on T1 and/or T2 without a loss of accuracy due to the resulting longer settling times.

Upon powering up, coming out of shutdown mode, or resuming operation following a serial bus transaction, the ADC will begin acquiring temperature data with the first external zone (zone 1), followed by the second external zone (zone 2), and then the internal zone (zone 0). If the ADC in interrupted by a serial bus transaction, it will restart the conversion that was interrupted and then continue in the normal sequence. This sequence will repeat indefinitely until the MIC384 is shut down, powered off, or is interrupted by a serial bus transaction as described above.

3.7 Power-On

When power is initially applied, the MIC384's internal registers are set to their default states. Also at this time, the level on the address input, A0, is read to establish the device's client address. The MIC384's power-up default state can be summarized as follows:

- Normal Mode operation (i.e., part is not in shutdown)
- /INT function is set to Comparator Mode
- Fault Queue depth = 1 (FQ = 00)
- Interrupts are enabled (IM = 0)
- T_SET0 = 81°C; T_HYST0 = 76°C
- T_SET1 = 97°C; T_HYST1 = 92°C
- T_SET2 = 97°C; TT_HYST2 = 92°C
- Initialized to recognize overtemperature faults

3.8 Comparator and Interrupt Modes

Depending on the setting of the MODE bit in the configuration register, the /INT output will behave either as an interrupt request signal or a thermostatic control signal. Thermostatic operation is known as comparator mode. The /INT output is asserted when the measured temperature, as reported in any of the TEMPx registers, exceeds the threshold programmed into the corresponding T_SETx register for the number of conversions specified by Fault_Queue. In comparator mode, /INT will remain asserted and the status bit(s) will remain high unless and until the measured temperature falls below the value in the T_HYSTx register for Fault_Queue conversions. No action on the part of the host is required for operation in comparator mode. Note that entering shutdown mode will not affect the state of /INT when the device is in comparator mode.

In interrupt mode, once a temperature event has caused a status bit to be set and the /INT output to be asserted, they will not be automatically de-asserted when the measured temperature falls below T_HYSTx. They can only be de-asserted by reading any of the MIC384's internal registers or by putting the device into shutdown mode. If the most recent temperature event was an overtemperature condition, Sx will not be set again, and /INT cannot be reasserted, until the device has detected that TEMPx is less than T_HYSTx. Similarly, if the most recent temperature event was an undertemperature condition, Sx will not be set again, and /INT cannot be reasserted, until the device has detected that TEMPx is greater than T_SETx. This keeps the internal logic of the MIC384 backward compatible with that of the LM75 and similar devices. In both modes, the MIC384 will be responsive to overtemperature events at power-up. See Interrupt Generation below.

3.9 Shutdown Mode

Setting the SHDN bit in the configuration register halts the otherwise continuous conversions by the A/D converter. The MIC384's power consumption drops to 1 µA typical in shutdown mode. All registers may be read from or written to while in shutdown mode. Serial bus activity will slightly increase the part's power consumption.

Entering shutdown mode will not affect the state of /INT when the device is in comparator mode (MODE = 0). It will retain its state until after the device exits shutdown mode and resumes A/D conversions.

However, if the device is shut down while in interrupt mode, the /INT pin will be unconditionally de-asserted and the internal latches holding the interrupt status will be cleared. Therefore, no interrupts will be generated while the MIC384 is in shutdown mode, and the interrupt status will not be retained. Because entering shutdown mode stops A/D conversions, the MIC384 is incapable of detecting or reporting temperature events of any kind while in shutdown. Diode faults require one or more A/D conversion cycles to be recognized, and therefore will not be reported either while the device is in shutdown (see Diode Faults for more information).

3.10 Fault_Queue

Fault queues (programmable digital filters) are provided in the MIC384 to prevent false tripping due to thermal or electrical noise. The two bits in CONFIG[4:3] set the depth of Fault_Queue. Fault_Queue then determines the number of consecutive temperature events (TEMPx > T_SETx, or TEMPx < T_HYSTx) that must occur in order for the condition to be considered valid. There are separate fault queues for each zone. As an example, assume the part is in comparator mode, and CONFIG[4:3] is programmed with 10_b. The measured temperature in zone one would have to exceed T_SET1 for four consecutive A/D conversions before /INT would be asserted or the S1 status bit set. Similarly, TEMP1 would then have to be less than T_HYST1 for four consecutive conversions before /INT would be reset. Like any filter, the fault queue function also has the effect of delaying the detection of temperature events. In this example, it would take 4 x t_{CONV} to detect a temperature event. The depth of Fault_Queue vs. D[4:3] of the configuration register is shown in Table 3-4.

TABLE 3-4: FAULT_QUEUE DEPTH SETTINGS

CONFIG[4:3]	Fault_Queue Depth
00	1 Conversion (default)
01	2 Conversions
10	4 Conversions
11	6 Conversions

3.11 Interrupt Generation

Assuming the MIC384 is in interrupt mode and interrupts are enabled, there are seven different conditions that will cause the MIC384 to set one of the status bits (S0, S1, or S2) in CONFIG and assert its /INT output. These conditions are listed in Table 3-5. When a temperature event occurs, the corresponding status bit will be set in CONFIG. This action cannot be masked. However, a temperature event will only generate an interrupt signal on /INT if it is specifically enabled by the interrupt mask bit (IM = 0 in CONFIG). Following an interrupt, the host should read the contents of the configuration register to confirm that the MIC384 was the source of the interrupt. A read operation on any register will cause /INT to be de-asserted. This is shown in Figure 3-5. The status bits will only be cleared once CONFIG has been read.

Because temperature-to-digital conversions continue while /INT is asserted, the measured temperature could change between the MIC384's assertion of /INT and the host's response. It is good practice for the interrupt service routine to read the value in TEMPx, to verify that the overtemperature or undertemperature condition still exists. In addition, more than one temperature event may have occurred simultaneously or in rapid succession between the assertion of /INT and servicing of the MIC384 by the host. The interrupt service routine should allow for this eventuality. Keep in mind that clearing the status bits and de-asserting /INT is not sufficient to allow further interrupts to occur. TEMPx must become less than T_HYSTx if the last event was an overtemperature condition, or greater than T_SETx if the last event was an undertemperature condition, before /INT can be asserted again.

Putting the device into shutdown mode will de-assert /INT and clear the status bits (S0, S1, and S2). This should not be done before completing the appropriate interrupt service routine(s).

TABLE 3-5: MIC384 TEMPERATURE EVENTS

Event	Condition (Note 1)	MIC384 Response (Note 2)
High temperature, local	TEMP0 > T_SET0	Set S0 in CONFIG, assert /INT
High temperature, remote zone 1	TEMP1 > T_SET1	Set S1 in CONFIG, assert /INT
High temperature, remote zone 2	TEMP2 > T_SET2	Set S2 in CONFIG, assert /INT
Low temperature, local	TEMP0 < T_HYST0	Set S0 in CONFIG, assert /INT
Low temperature, remote zone 1	TEMP1 < T_HYST1	Set S1 in CONFIG, assert /INT
Low temperature, remote zone 2	TEMP2 < T_HYST2	Set S2 in CONFIG, assert /INT
Diode fault	T1 or T2 open or shorted to VDD or GND	Set S1 and/or S2 in CONFIG, assert /INT, Note 3

Note 1: Condition must be true for FAULT_QUEUE conversion to be recognized.

2: Assumes interrupts enabled.

3: Assumes the T_SET1 and T_SET2 are set to any value less than +127°C = $7F_h$ = $0111\ 1111_b$.

3.12 Polling

The MIC384 may either be polled by the host, or request the host's attention via the /INT pin. In the case of polled operation, the host periodically reads the contents of CONFIG to check the state of the status bits. The act of reading CONFIG clears the status bits. If more than one event that sets a given status bit occurs before the host polls the MIC384, only the fact that at least one such event has occurred will be apparent to the host. For polled systems, the interrupt mask bit should be set (IM = 1). This will disable interrupts from the MIC384 and prevent the /INT pin from sinking current.

4.0 REGISTER SET AND PROGRAMMER’S MODEL

TABLE 4-1: INTERNAL REGISTER SET

Name	Description	Command Byte	Operation	Power-Up Default
TEMP0	Measured temperature, local zone	00_h	8-bit read only	00_h (0°C), Note 1
CONFIG	Configuration register	01_h	8-bit read/write	00_h, Note 2
T_HYST0	Hysteresis setting, local zone	02_h	8-bit read/write	$4C_h$ (+76°C)
T_SET0	Temperature setpoint, local zone	03_h	8-bit read/write	51_h (+81°C)
TEMP1	Measured temperature, zone 1	10_h	8-bit read/write	00_h (0°C), Note 1
T_HYST1	Hysteresis setting, zone 1	12_h	8-bit read/write	$5C_h$ (+92°C)
T_SET1	Temperature setpoint, zone 1	13_h	8-bit read/write	61_h (+97°C)
TEMP2	Measured temperature, zone 2	20_h	8-bit read/write	00_h (0°C), Note 1
T_HYST2	Hysteresis setting, zone 2	22_h	8-bit read/write	$5C_h$ (+92°C)
T_SET2	Temperature setpoint, zone 2	23_h	8-bit read/write	61_h (+97°C)

Note 1: TEMPx will contain measured temperature data after the completion of one conversion cycle.

2: After the first Fault_Queue conversions are complete, status bits will be set if TEMPx > T_SETx.

4.1 Detailed Register Descriptions

TABLE 4-2: CONFIGURATION REGISTER (CONFIG) 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
Read Only	Read Only	Read Only	Read/Write		Read/Write	Read/Write	Read/Write
Local Status (S0)	Remote Status (S1)	/CRIT Status (CRIT1)	Fault Queue Depth (FQ[1:0])		Interrupt Mask (IM)	CMP/INT Mode (MODE)	Shutdown (SHDN)

Bits	Function	Operation
S0	Local interrupt status (read only)	1 = event occurred, 0 = no event.
S1	Remote interrupt status (read only)	1 = event occurred, 0 = no event.
CRIT1	Remote overtemperature status (read only)	1 = overtemperature, 0 = no event.
FQ[1:0]	Fault_Queue depth	00 = 1 conversion, 01 = 2 conversions, 10 = 4 conversions, 11 = 6 conversions
IM	Interrupt mask	1 = disabled, 0 = interrupts enabled.
MODE	Comparator/interrupt mode selection for /INT pin	1 = interrupt mode, 0 = comparator mode.
SHDN	Normal/shutdown operating mode selection	1 = shutdown, 0 = normal.

CONFIG Power-Up Value: $0000\ 0000_b = 00_h$

- Not in shutdown mode
- Comparator mode
- /INT = active low
- Fault_Queue depth = 1
- Interrupts enabled.
- No temperature events pending

CONFIG Command Byte Value: $0000\ 0001_b = 01_h$

Note that following the first Fault_Queue conversions, one or more of the status bits may be set.

TABLE 4-3: LOCAL TEMPERATURE RESULT (TEMP0), 8-BIT READ ONLY

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Temperature Data from ADC							
Bits	**Function**			**Operation**			
D[7:0]	Measured temperature data for the local zone, Note 1			Read only			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

TEMP0 Power-Up Value: $0000\ 0000_b = 00_h$ (0°C)

TEMP0 Command Byte Value: $0000\ 0000_b = 00_h$

Please note that TEMP0 will contain measured temperature data after the completion of one conversion.

TABLE 4-4: LOCAL TEMPERATURE HYSTERESIS (T_HYST0), 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Local Temperature Hysteresis Setting							
Bits	**Function**			**Operation**			
D[7:0]	Local temperature hysteresis setting, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

T_HYST0 Power-Up Value: $0100\ 1100_b = 4C_h$ (+76°C)

T_HYST0 Command Byte Value: $0000\ 0010_b = 02_h$

TABLE 4-5: LOCAL TEMPERATURE SETPOINT (T_SET0), 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Local temperature setpoint							
Bits	**Function**			**Operation**			
D[7:0]	Local temperature setpoint, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

T_SET0 Power-Up Value: $0101\ 0001_b = 51_h$ (+81°C)

T_SET0 Command Byte Value: $0000\ 0011_b = 03_h$

TABLE 4-6: REMOTE ZONE 1 TEMPERATURE RESULT (TEMP1), 8-BIT READ ONLY

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 1 temperature data from ADC, Note 1							
Bits	**Function**			**Operation**			
D[7:0]	Measured temperature data for remote zone 1, Note 1			Read Only			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

TEMP1 Power-Up Value: $0000\ 0000_b = 00_h$ (0°C)

TEMP1 Command Byte Value: $0001\ 0000_b = 10_h$

Please note that TEMP1 will contain measured temperature data for the selected zone after the completion of one conversion.

TABLE 4-7: REMOTE ZONE 1 TEMPERATURE HYSTERESIS (T_HYST1), 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 1 temperature hysteresis							
Bits	**Function**			**Operation**			
D[7:0]	Remote zone 1 temperature hysteresis s, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

T_HYST1 Power-Up Value: $0101\ 1100_b = 5C_h$ (+92°C)

T_HYST1 Command Byte Value: $0001\ 0010_b = 12_h$

TABLE 4-8: REMOTE ZONE 1 TEMPERATURE SETPOINT (T_SET1), 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 1 temperature setpoint							
Bits	**Function**			**Operation**			
D[7:0]	Remote zone 1 temperature setpoint, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as $0000\ 0000_b$. See Temperature Data Format for more details.

T_SET1 Power-Up Value: $0110\ 0001_b = 61_h$ (+97°C)

T_SET1 Command Byte Value: $0001\ 0011_b = 13_h$

TABLE 4-9: REMOTE ZONE 2 TEMPERATURE RESULT (TEMP2), 8-BIT READ ONLY

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 2 temperature data from ADC							
Bits	**Function**			**Operation**			
D[7:0]	Measured temperature data for remote zone 2, Note 1			Read only			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as 0000 0000_b. See Temperature Data Format for more details.

TEMP2 Power-Up Value: 0000 0000_b = 00_h (0°C)

TEMP2 Command Byte Value: 0010 0000_b = 20_h

Please note that TEMP2 will contain measured temperature data for the selected zone after the completion of one conversion.

TABLE 4-10: REMOTE ZONE 2 HYSTERESIS (T_HYST2), 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 2 temperature hysteresis setting							
Bits	**Function**			**Operation**			
D[7:0]	Remote zone 2 temperature hysteresis setting, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as 0000 0000_b. See Temperature Data Format for more details.

T_HYST2 Power-Up Value: 0101 1100_b = $5C_h$ (+92°C)

T_HYST2 Command Byte Value: 0010 0010_b = 22_h

TABLE 4-11: REMOTE ZONE 2 TEMPERATURE SETPOINT, 8-BIT READ/WRITE

D[7]	D[6]	D[5]	D[4]	D[3]	D[2]	D[1]	D[0]
MSB	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB
Remote zone 2 temperature setpoint							
Bits	**Function**			**Operation**			
D[7:0]	Remote zone 2 temperature setpoint, Note 1			Read/Write			

Note 1: Each LSB represents one degree Centigrade. The values are in a two's complement format such that 0°C is reported as 0000 0000_b. See Temperature Data Format for more details.

T_SET2 Power-Up Value: 0110 0001_b = 61_h (+97°C)

T_SET2 Command Byte Value: 0010 0011_b = 23_h

5.0 APPLICATIONS

5.1 Remote Diode Selection

Most small-signal PNP transistors with characteristics similar to the JEDEC 2N3906 will perform well as remote temperature sensors. Table 5-1 lists several examples of such parts that Microchip has tested for use with the MIC384. Other transistors equivalent to these should also work well.

TABLE 5-1: SUITABLE TRANSISTORS

Vendor	Part Number	Package
Fairchild	MMBT3906	SOT-23
On Semiconductor	MMBT3906L	SOT-23
Phillips Semiconductor	PMBT3906	SOT-23
Samsung	KST3906-TF	SOT-23

5.2 Minimizing Errors

5.2.1 SELF-HEATING

One concern when using a part with the temperature accuracy and resolution of the MIC384 is to avoid errors induced by self-heating (V_{DD} × I_{DD}) + (V_{OL} × I_{OL}). In order to understand what level of error this might represent, and how to reduce that error, the dissipation in the MIC384 must be calculated and its effects reduced to a temperature offset.

The worst-case operating condition for the MIC384 is when V_{DD} = 5.5V, MSOP-08 package. The maximum power dissipated in the part is given in Equation 5-1.

EQUATION 5-1: WORST CASE SELF-HEATING

$$P_D = (I_{DD} \times V_{DD}) + (I_{OL(DATA)} \times V_{OL(DATA)}) + (I_{OL(/\mathrm{INT})} \times V_{OL(/\mathrm{INT})})$$

$$P_D = (0.75mA \times 5.5V) + (6mA \times 0.8V) + (6mA \times 0.8V)$$

$$P_D = 13.73mW$$

$R_{\theta JA}$ of the MSOP-8 package is 206°C/W. The maximum ΔT_J relative to T_A due to self-heating is 13.73 mW x 206°C/W = 2.83°C.

In most applications, the /INT output will be low for at most a few milliseconds before the host resets it back to the high state, making its duty cycle low enough that its contribution to self-heating of the MIC384 is negligible. Similarly, the DATA pin will in all likelihood have a duty cycle of substantially below 25% in the low state. These considerations, combined with more typical device and application parameters, give a better system-level view of device self-heating in interrupt-mode usage. This is illustrated by Equation 5-2.

EQUATION 5-2: REAL WORLD SELF-HEATING EXAMPLE

$$[(0.35mAI_{DD(TYP)} \times 3.3V) + (25\% \times 1.5mAI_{OL(DATA)}) \times 0.3V] + (1\% \times 1.5mAI_{OL(/\mathrm{INT})} \times 0.3V) = 1.27mW$$

$$\Delta T_J = (1.27mW \times 206°C/\mathrm{W}) = 0.262°C$$

If the part is to be used in comparator mode, calculations similar to those shown in Equation 5-2 (accounting for the expected value and duty cycle of $I_{OL(/INT)}$) will give a good estimate of the device's self-heating error.

In any application, the best test is to verify performance against calculation in the final application environment. This is especially true when dealing with systems for which some of the thermal data (e.g., PC board thermal conductivity and ambient temperature) may be poorly defined or unobtainable except by empirical means.

5.3 Series Resistance

The operation of the MIC384 depends upon sensing the $\Delta V_{CB\text{-}E}$ of a diode-connected PNP transistor ("diode") at two different current levels. For remote temperature measurements, this is done using an external diode connected between T1, T2, and ground.

Because this technique relies upon measuring the relatively small voltage difference resulting from two levels of current through the external diode, any resistance in series with the external diode will cause an error in the temperature reading from the MIC384. A good rule of thumb is that for each ohm in series with the external transistor, there will be a 0.9°C error in the MIC384's temperature measurement. It isn't difficult to keep the series resistance well below an ohm (typically less than 0.1Ω), so this will rarely be an issue.

5.4 Filter Capacitor Selection

It is sometimes desirable to use a filter capacitor between the T1 and/or T2 pins and the GND pin of the MIC384. The use of this capacitor is recommended in environments with a lot of high frequency noise (such as digital switching noise), or if long wires are used to attach to the remote diode. The maximum recommended total capacitance from the T1 or T2 pin to GND is 2700 pF. This typically suggests the use of a 2200 pF NP0 or C0G ceramic capacitor with a 10% tolerance.

If the remote diode is to be at a distance of more than about 6" to 12" from the MIC384, using twisted pair wiring or shielded microphone cable for the connections to the diode can significantly help reduce noise pickup. If using a long run of shielded cable, remember to subtract the cable's conductor-to-shield capacitance from the 2700 pF maximum total capacitance.

5.5 Layout Considerations

The following guidelines should be kept in mind when designing and laying out circuits using the MIC384:

1. Place the MIC384 as close to the remote diode as possible, while taking care to avoid severe noise sources such as high frequency power transformers, CRTs, memory and data busses, and the like.
2. Because any conductance from the various voltages on the PC Board to the T1 or T2 line can induce serious errors, it is good practice to guard the remote diode's emitter trace with a pair of ground traces. These ground traces should be returned to the MIC384's own ground pin. They should not be grounded at any other part of their run. However, it is highly desirable to use these guard traces to carry the diode's own ground return back to the ground pin of the MIC384, thereby providing a Kelvin connection for the base of the diode. See Figure 5-1.
3. When using the MIC384 to sense the temperature of a processor or other device which has an integral thermal diode, e.g., Intel's Pentium III, connect the emitter and base of the remote sensor to the MIC384 using the guard traces and Kelvin return shown in Figure 5-1. The collector of the remote diode is typically inaccessible to the user on these devices. To allow for this, the MIC384 has superb rejection of noise appearing from collector to GND, as long as the base to ground connection is relatively quiet.
4. Due to the small currents involved in the measurement of the remote diode's ΔV_{BE}, it is important to adequately clean the PC board after soldering to prevent current leakage. This is most likely to show up as an issue in situations where water-soluble soldering fluxes are used.
5. In general, wider traces for the ground and T1/T2 lines will help reduce susceptibility to radiated noise (wider traces are less inductive). Use trace widths and spacing of 10 mm wherever possible and provide a ground plane under the MIC384 and under the connections from the MIC384 to the remote diode. This will help guard against stray noise pickup.
6. Always place a good quality power supply bypass capacitor directly adjacent to, or underneath, the MIC384. This should be a 0.1 µF ceramic capacitor. Surface-mount parts provide the best bypassing because of their low inductance.
7. When the MIC384 is being powered from particularly noisy power supplies, or from supplies that may have sudden high-amplitude spikes appearing on them, it can be helpful to add additional power supply filtering. This should be implemented as a 100Ω resistor in series with the part's VDD pin, and a 4.7 µF, 6.3V electrolytic capacitor from VDD to GND. See Figure 5-2.

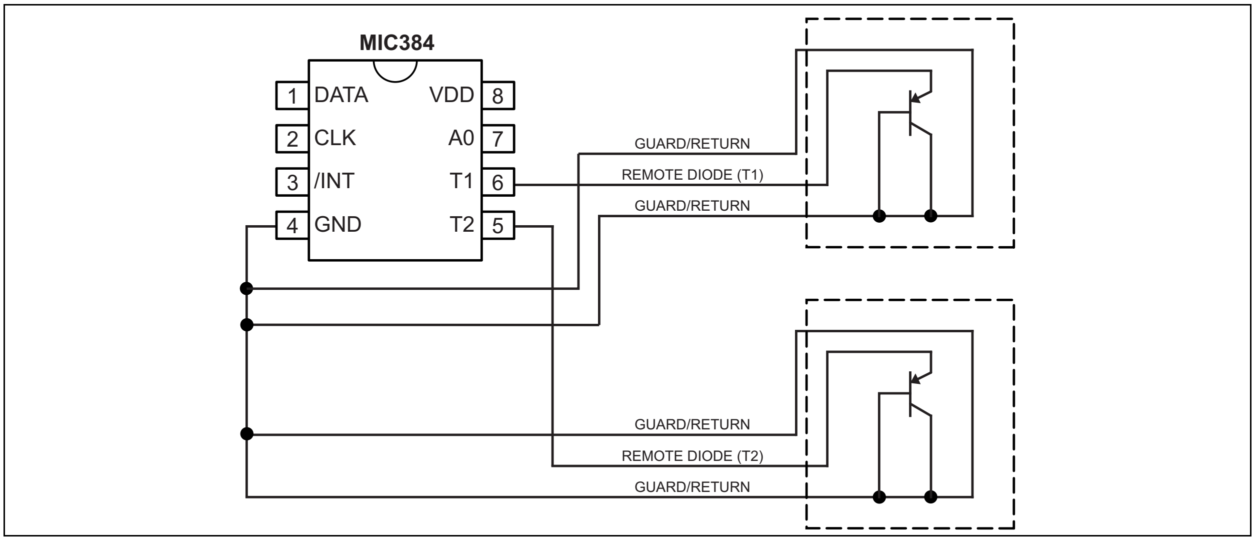


FIGURE 5-1: *Guard Traces/Kelvin Ground Returns.*

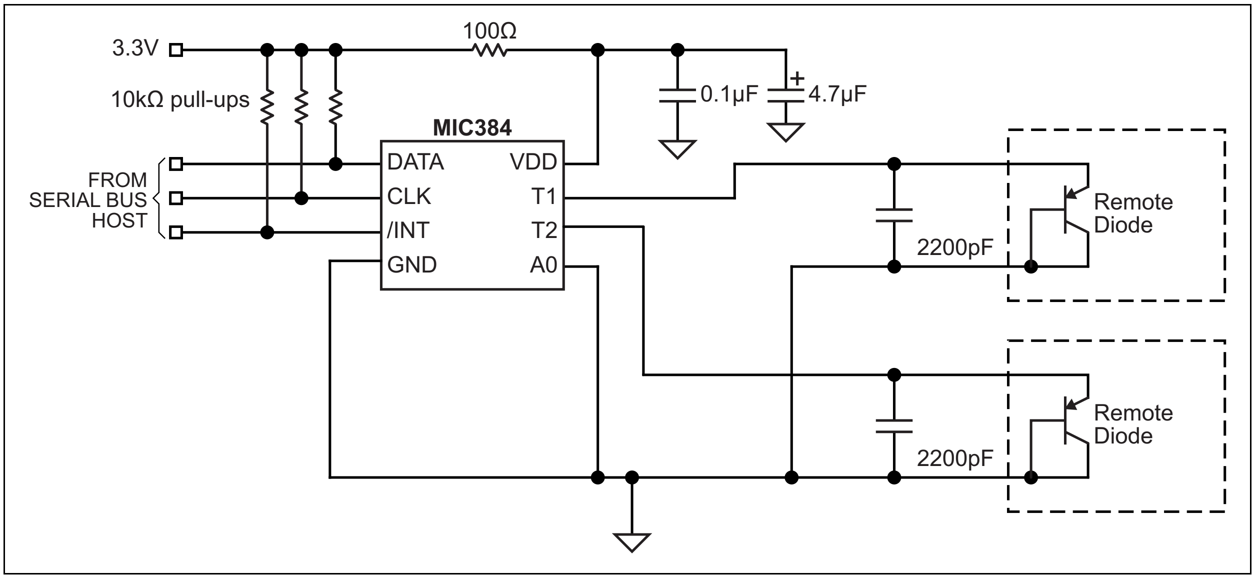
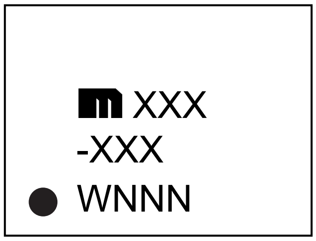


FIGURE 5-2: *VDD Decoupling for very Noisy Supplies.*

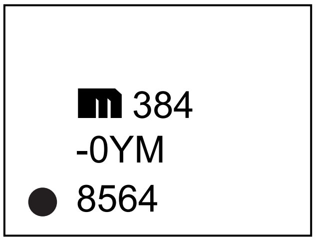
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

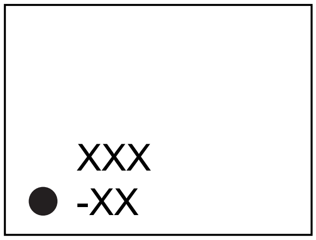
8-Lead SOIC*



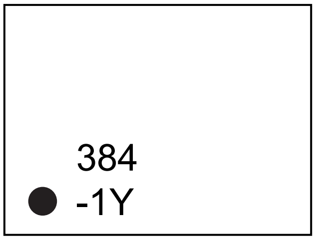
Example



8-Lead MSOP*



Example



Part Number	Base Address (Note 1)
MIC384-0YM and MIC384-0YMM	100 100x
MIC384-1YM and MIC384-1YMM	100 101x
MIC384-2YM and MIC384-2YMM	100 110x
MIC384-3YM and MIC384-3YMM	100 111x

Note 1: The least significant bit of the client address is determined by the state of the A0 pin.

Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	ⓔ3	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (ⓔ3) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

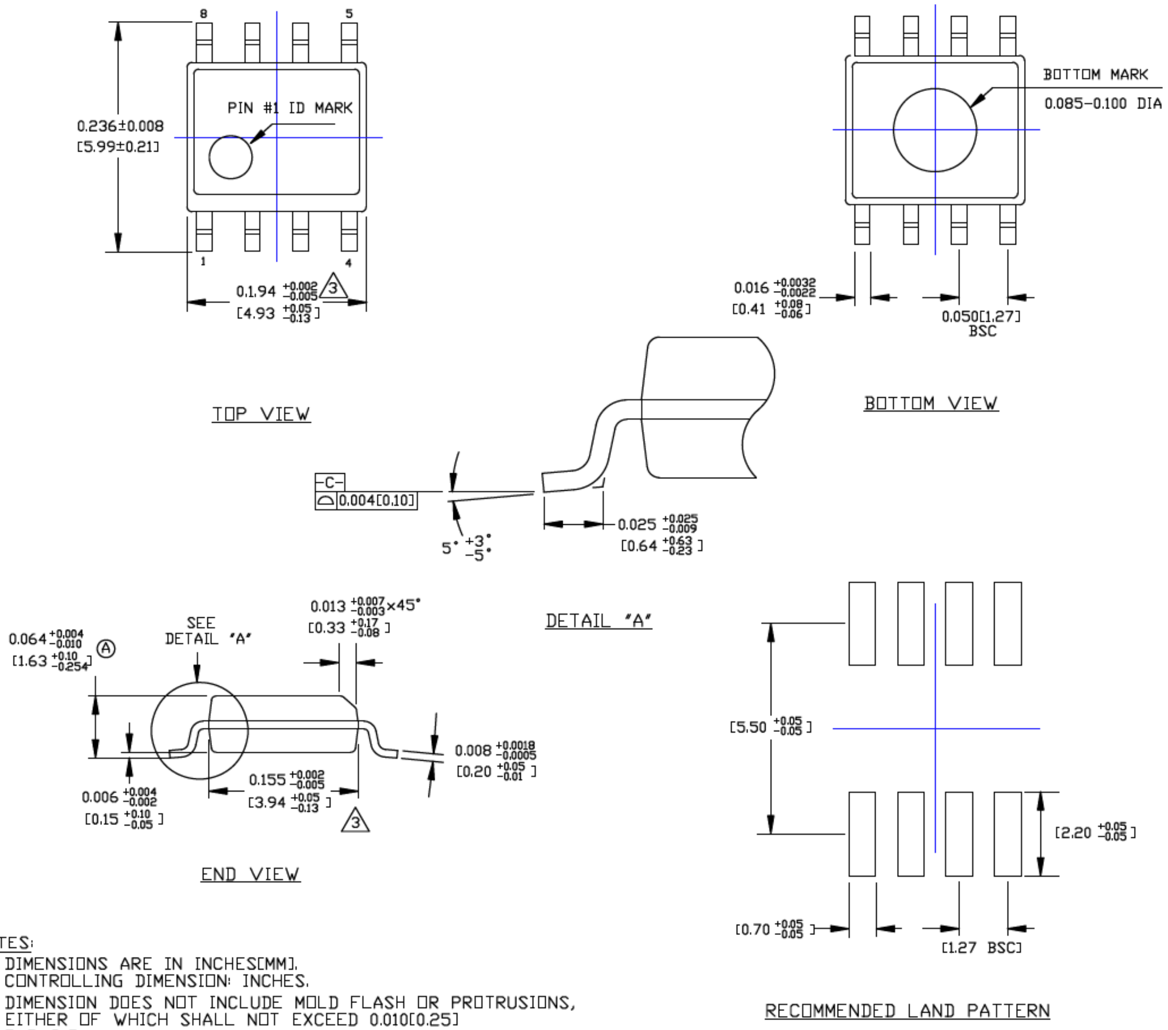
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

8-Lead SOIC Package Outline and Recommended Land Pattern

TITLE
8 LEAD SOICN PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	SOICN-8LD-PL-1	**UNIT**	INCH [MM]



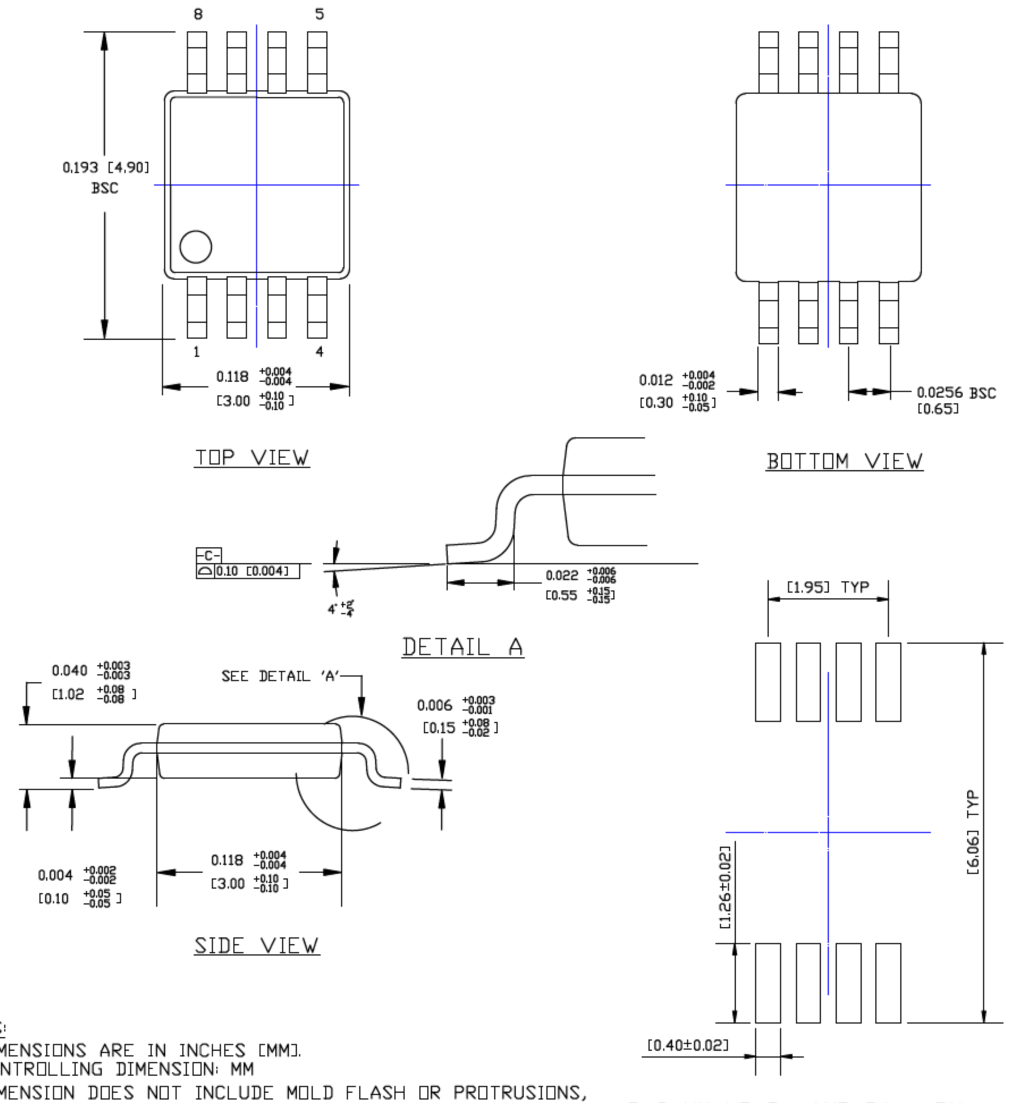
NOTES:
1. DIMENSIONS ARE IN INCHES[MM].
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.010[0.25] PER SIDE.

Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

8-Lead MSOP Package Outline and Recommended Land Pattern

TITLE
8 LEAD MSOP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	MSOP-8LD-PL-1	**UNIT**	INCH [MM]



NOTES:
1. DIMENSIONS ARE IN INCHES [MM].
2. CONTROLLING DIMENSION: MM
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.008 [0.20] PER SIDE.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

APPENDIX A: REVISION HISTORY

Revision A (December 2020)

- Converted Micrel data sheet MIC384 to Microchip data sheet DS20006469A.
- Minor grammatical corrections throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

PART NO.	**-X**	**X**	**XX**	**-XX**
Device	**Client Address**	**Junction Temp. Range**	**Package**	**Media Type**

Device:	MIC384:	Three-Zone Thermal Supervisor
Client Address:	0 = 1 = 2 = 3 =	100 100x 100 101x 100 110x 100 111x
Junction Temperature Range:	Y =	–55°C to +125°C
Package:	M = MM =	8-Lead SOIC 8-Lead MSOP
Media Type	<blank>= <blank>= TR =	95/Tube (SOIC Package only) 100/Tube (MSOP Package only) 2,500/Reel

Examples:

a) MIC384-0YM-TR:	3-Zone Thermal Supervisor, 100 100x Client Address, –55°C to +125°C Junction Temperature Range, 8-Lead SOIC, 2,500/Reel
b) MIC384-2YMM:	3-Zone Thermal Supervisor, 100 110x Client Address, –55°C to +125°C Junction Temperature Range, 8-Lead MSOP, 100/Tube
c) MIC384-1YM:	3-Zone Thermal Supervisor, 100 101x Client Address, –55°C to +125°C Junction Temperature Range, 8-Lead SOIC, 95/Tube
d) MIC384-3YMM-TR:	3-Zone Thermal Supervisor, 100 111x Client Address, –55°C to +125°C Junction Temperature Range, 8-Lead MSOP, 2,500/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner and under normal conditions.
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