F75385M

±1°C Accuracy Temperature Sensor IC Datasheet

Release Date: July, 2006
Revision: V0.21P

F75385 Datasheet Revision History

Version	Date	Page	Revision History
0.20P	March, 2006	-	Original Release Version
0.21P	July, 2006	10	Modify VT1/VT2 High Limit and VT1 THERM Limit Default Value. Original (64h) → New (55h)

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Table of Contents

1. General Description

The F75385 is a temperature sensor IC with alert signal which is specific designed for notebook, graphic cards etc. An 11-bit analog-to-digital converter (ADC) was built inside F75385. The F75385 can monitor two set of temperature which is very important for the system to work stably and properly. This chip provides 1 remote temperature sensor and 1 local temperature sensor. The remote temperature sensor can be performed by CPU thermal diode or transistor 2N3906. The users can set up the upper and lower limits (alarm thresholds) of all monitored parameters and this chip can also issue warning messages for system protection when there is something wrong with monitored items.

Through the BIOS or application software, the users can read all the monitored parameters of system all the time. And a pop-up warning can be also activated when the monitored item was out of the proper/pre-setting range. The application software could be Fintek's application utility, or other management application software. The F75385 is in the package of 8-pin MSOP and powered by 3.3V.

2. Features

◆ Provide 1 on-chip local and 1 remote temperature sensing
◆ $\pm 1\ ^oC$ accuarcy on remote channel and $\pm 3\ ^oC$ accuarcy on local channel
  ■ $\pm 1\ ^oC$ (+60 ^oC to +100 ^oC, remote)
  ■ $\pm 3\ ^oC$ (+60 ^oC to +100 ^oC, local)
◆ ALERT# output for SMBus alert
◆ THERM# output for over temperature alert or for system shut down
◆ Programmable THERM# limits and THERM# hysteresis
◆ Programmable alert queue
◆ Programmable limited and setting points(alert threshold) for all monitored items
◆ 2 wire SMBus interface
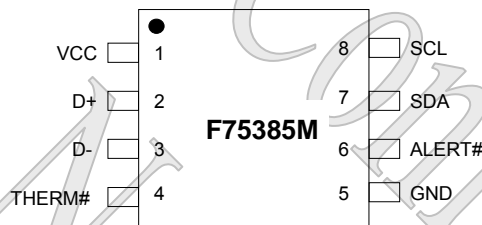◆ 3VCC operation and in 8-MSOP package
◆ The SMBus slave address:

	A6	A5	A4	A3	A2	A1	A0
F75385	1	0	0	1	1	0	0

--Patented: TW 235231--

3. Key Specifications

◆ Supply Voltage   3.0~3.6V

◆ Supply Current   180 uA (typ)

◆ Measured Range   0 ~ 145 ^{o}C

◆ Remote Diode Temperature Accuracy   ±1°C from +60°C to +100°C

◆ Local Temperature Accuracy   ±3°C from +60°C to +100°C

4. Pin Configuration

```
          ●
  VCC  □  1        8  □  SCL
  D+   □  2        7  □  SDA
            F75385M
  D-   □  3        6  □  ALERT#
 THERM# □ 4        5  □  GND
```

5. Pin Descriptions

OD$_{12}$ - Open-drain output pin with 12 mA sink capability
PWR   - Power pin
IN$_{ts}$ - TTL level input pin and schmitt trigger
AIN   - Input pin(Analog)

PIN NO	PIN NAME	TYPE	PWR	DESCRIPTION
1	VCC	PWR	3VCC	Power Pin
2	D+	AIN	3VCC	Positive connection to remote temperature sensor (ex: thermal diode anode)
3	D-	AIN	3VCC	Negative connection to remote temperature sensor(ex: thermal diode cathode)
4	THERM#	OD$_{12}$	3VCC	Active **LOW** output. This pin will be logic low when the temperature exceeds its limit. (Default 108 ^{o}C enable)
5	GND	PWR	3VCC	Ground
6	ALERT#	OD$_{12}$	3VCC	Active **LOW** output. Used as SMBus alert or Interrupt
7	SDA	IN$_{ts}$/OD$_{12}$	3VCC	Serial bus data
8	SCL	IN$_{ts}$	3VCC	Serial bus clock

6. Functional Description

6.1 General Description

The F75385 is a simple temperature sensor with warning signal output. It includes a local and a remote temperature sensor. Both measured temperature are compared with its high, low and THERM limits which are stored in the registers. When one or more out-of-limit events occur, the flags in Status Register will be set and that may cause ALERT output to low. Also, measured temperature exceeding THERM limit may cause THERM output to low.

6.2 The warning message

Pin4 and pin6 act as warning message when the temperature exceeds it threshold point.

6.3 Access Interface

The F75385 can be connected to a compatible 2-wire serial system management bus as a slave device under the control of the master device, using two device terminals SCL and SDA. The F75385 supports SMBus protocol of, "Write Byte", "Read Byte", both with or without Packet Error checking(PEC) which is calculated using CRC-8. For detail information about PEC, please check SMBus 1.1 specification. F75385 supports 25ms timeout for no activity on the SMBus. This timeout function is programmed at 22h bit7 and default is disabled. F75385 also supports Alert Response Address (ARA) protocol.

The operation of the protocol is described with details in the following sections.

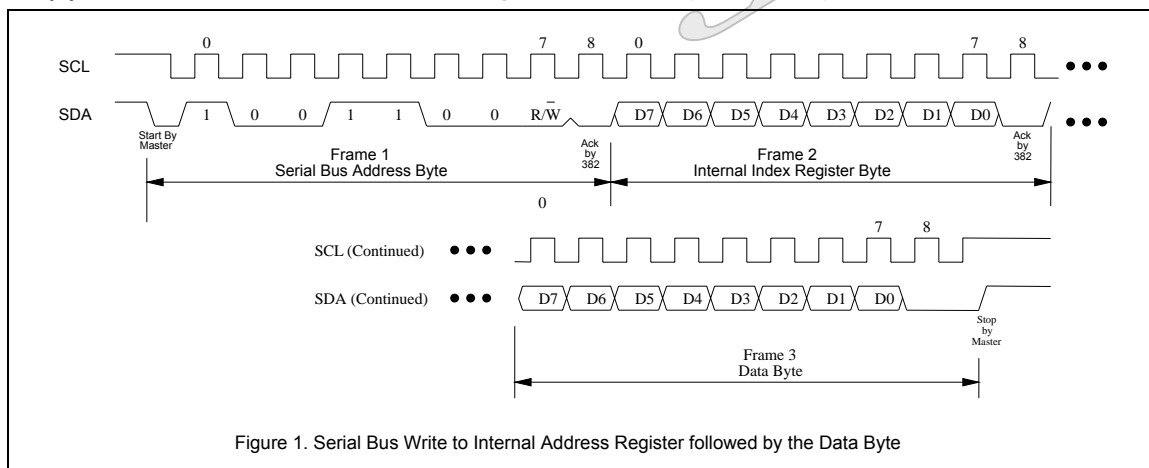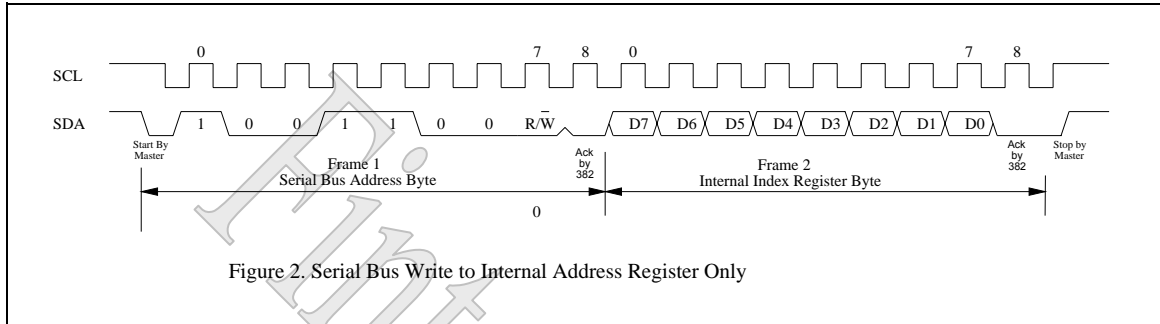*(a)   SMBus write to internal address register followed by the data byte*

Figure 1. Serial Bus Write to Internal Address Register followed by the Data Byte

(b) *Serial bus write to internal address register only*

Figure 2. Serial Bus Write to Internal Address Register Only

(c) Serial bus read from a register with the internal address register prefer to desired location

Figure 3. Serial Bus Read from Internal Address Register

(d) Alert Response Address
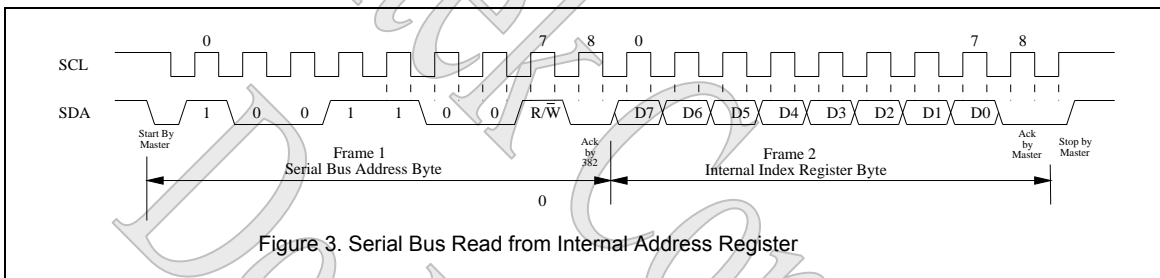
Figure 4. Alert Response Address
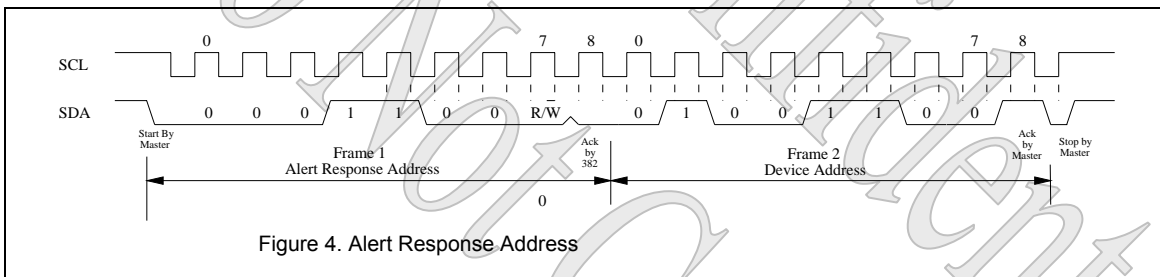
6.4 Temperature Monitoring

The F75385 monitors a local and a remote temperature sensor. Both can be measured from 0°C to 145°C.

The temperature format is as the following table:

Temperature (High Byte)	Digital Output	Temperature (Low Byte)	Digital Output
0°C	0000 0000	0°C	000 0 0000
1°C	0000 0001	0.125°C	001 0 0000
25°C	0001 1001	0.250°C	010 0 0000
50°C	0011 0010	0.375°C	011 0 0000
75°C	0100 1011	0.500°C	100 0 0000
90°C	0101 1010	0.625°C	101 0 0000

| 100°C | 0110 0100 | 0.750°C | 110 0 0000 |
| 145°C | 1001 0001 | 0.875°C | 111 0 0000 |

Remote-sensor transistor manufacturers

Manufacturer	Model Number
Panasonic	2SB0709 2N3906
Philips	PMBT3906

6.5 Alert#

Five events can trigger ALERT# to low:

    (1). VT1(Local) temperature exceeds High Limit

    (2). VT1(Local) temperature goes below Low Limit

    (3). VT2(Remote) temperature exceeds High Limit

    (4). VT2(Remote) temperature goes below Low Limit

    (5). VT2(Remote) temperature is Open-circuit.

These five events are wired-NOR together. This means that when one of out-of-limit event occurs, the ALERT# output goes low if the MASK control is disabled. ALERT# signal can be used as an IRQ-like interrupt or as an SMBALERT. When ALERT# acts as an IRQ-like interrupt, the ALERT# will be de-asserted until the following 2 conditions are matched:

    (1). The abnormal condition is gone

    (2). Reading the Status register to clear the status

When ALERT# acts as a SMBALERT, the ALERT# will be de-asserted until the following 3 conditions are matched:

    (1). The abnormal condition is gone

    (2). Reading the Status register to clear the status

    (3). The ALERT# has been serviced by the SMBus master reading the device address.

For more information about SMBALERT, please see SMBus 1.1 specification.

6.6 THERM#

Either VT1(Local) or VT2(Remote) temperature exceeds the corresponding THERM limit, the THERM# output will assert low. The asserted output will be de-asserted until the temperature goes below (THERM Limit – Hysteresis). The hysteresis default value is 10°C and it can be programmed. Both VT1 and VT2 have their own THERM limits and

Hysteresis values.

6.7 ADC Conversion Sequence

If a START command is written, both channels are converted and the results of both measurements are available after the end of conversion. A BUSY status bit in the status byte 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.

6.8 Thermal Mass and Self Heating

Thermal mass effect can seriously degrade effective accuracy of the F75385. The thermal time constant of the SOP package is about 140 in still air. For the F75385 junction temperature to settle to within +1°C after a sudden +100°C change requires about five time constants or 12 minutes. The use of smaller packages for remote sensors such as SOT23, improves the situation. Take care to account for thermal gradients between the heat source and the sensor package do not interfere with measurement accuracy. Sel-heating does not significantly affect measurement accuracy. Remote sensor self-heating due to the diode current source is negligible. For the local diode, the worst case error occurs when auto-converting at the fastest rate and simultaneously sinking maximum current at the ALERT# output. For instance, at an 64Hz rate and ALERT# sink around 0.7mA when pull up resistor 4.7K ohm to 3.3VCC, the typical power dissipation is VCC x 220 uA plus 0.4V x 0.7mA. Package θJA is about 120 °C/W, so with VCC = 3.3V and no copper PC board heat-sinking, the resulting temperature rise is:

$$dT = 1.01mW \times 120 \,°C/W = 0.12 \,°C$$

Even with these contrived circumstances, it is difficult to introduce significant self-heating errors.

6.9 ADC Noise Filtering

The ADC is integrating type with inherently good noise rejection. Micro-power operation places constraints on high-frequency noise rejection; therefore, careful PCB board layout and suitable external filtering are required for high-accuracy remote measurement in electronically noisy environment. High frequency EMI is best filtered at D+ and D- with an external 2200pF capacitor. Too high capacitance may introduce errors due to the rise time of the switched current source. Nearly all noise sources tested cause the ADC measurement to be higher than the actual temperature, depending on the frequency and amplitude.

6.10 PCB Layout Guide

PCB can be electrically noisy environments, and the F75385 is measuring very small voltage from the remote sensor, so care must be taken to minimize noise which is occurred at the sensor inputs. The following guideline should be taken to reduce the measurement error of the temperature sensors:

1. Place the F75385 as close as practical to the remote sensing diode. In noisy environments, such as a computer main-board, the distance can be 4 to 8 inches. (typ). This length can be increased if the worst noise sources are avoided. Noise sources generally include clock generators, power control circuit, CRTs, memory buses and PCI/ISA bus etc.

2. Route the D+ and D- tracks close together, in parallel, with grounded guard tracks on each side. Provide a ground plane under the tracks if possible. Do not route D+ & D- lines next to the deflection coil of the CRT. And also don't route the trace across fast digital signals which can easily induce bigger error.
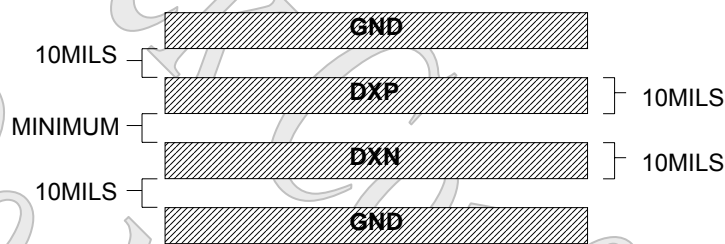
3. Use wide tracks to minimize inductance and reduce noise pickup. 10 mil track minimum width and spacing is recommended.

4. Try to minimize the number of copper/solder joints, which can cause thermocouple effects. Where copper/solder joints are used, make sure that they are in both the D+ and D- path and at the same temperature. Thermocouple effects should not be a major problem as 1 corresponds to about 200μV. It means that a copper-solder thermocouple exhibits 3μV/ , and takes about 200μV of the voltage error at D+ & D- to cause a 1 measurement error. Adding a few thermocouples causes a negligible error.

5. Place a 0.1μF bypass capacitor close to the V_{DD} pin. In very noisy environments, place an external 2200pF input filter capacitors across D+, D- close to the F75385.

6. If the distance to the remote sensor is more than 8 inches, the use of twisted pair cable is recommended. It will work up to around 6 to 12 feet.

7. Because the measurement technique uses switched current sources, excessive cable and/or filter capacitance will affect the measurement accuracy. When using long cables, the filter capacitor may be reduced or removed. Cable resistance can also induce errors. 1 Ω series resistance introduces about 0.5 error.

7. *Registers Description*

7.1 Configuration Register — Index 03h(Read),   09h(Write)

Power on default <7:0> = 00h

Bit	Name	Attribute	Description
7	ALERT_MASK	R/W	Set to 1, mask ALERT# signal output.
6	RUN_STOP	R/W	Set to 0, monitor. Set to 1, stop to monitor(software power down).
5-0	Reserved		

7.2 Status Register — Index 02h

Power on default <7:0> = 00h

Bit	Name	Attribute	Description
7	ADC_BUSY	RO	Set to 1, ADC is converting.
6	VT1HIGH	RO	Set to 1, VT1 temperature exceeds high limit. Set to 0, VT1 temperature does not exceed high limit.
5	VT1LOW	RO	Set to 1, VT1 temperature goes below low limit. Set to 0, VT1 temperature does not goes below low limit.
4	VT2HIGH	RO	Set to 1, VT2 temperature exceeds high limit. Set to 0, VT2 temperature does not exceed high limit.
3	VT2LOW	RO	Set to 1, VT2 temperature goes below low limit. Set to 0, VT2 temperature does not goes below low limit.
2	OPEN	RO	Set to 1, VT2 is open-circuit.
1	VT2THERM	RO	Set to 1, VT2 temperature exceeds its THERM limit.
0	VT1THERM	RO	Set to 1, VT1 temperature exceeds its THERM limit.

VT1(Local) ; VT2(Remote)

7.3 Conversion Rate Register — Index 04h(Read), 0Ah(Write)

Power on default <7:0> = 08h

Bit	Name	Attribute	Description			
7-0	CONV_RATE	R/W	Set conversion times per second.			
			Value	Conversion/Sec	Value	Conversion/Sec

				00h	0.0625	06h	4
				01h	0.125	07h	8
				02h	0.25	08h	16
				03h	0.5	09h	32
				04h	1	0Ah	64
				05h	2	0Bh ~ FFh	Reserved

7.4 One-Shot Register ⎯ Index 0Fh

Power on default <7:0> = xxh

Bit	Name	Attribute	Description
7-0	ONE-SHOT	WO	When F75385 is at standby mode, writing any value to this register will initiate a single conversion and comparison cycle. After the single cycle, F75385 will returns to standby mode.

7.5 Alert Queue & Timeout Register ⎯ Index 22h

Power on default <7:0> = 01h

Bit	Name	Attribute	Description
7	EN_I2CTMOUT	R/W	Set to 1, enable serial interface timeout function. (Timeout time = 25ms) Set to 0, disable.
6-4	Reserved		
3-1	ALERT_QUEUE	R/W	This number determines how many abnormal measurements must occur before ALERT signal is generated. 000 : Once 001 : Twice 011 : 3 times 111 : 4 times
0	Reserved	RO	Always read 1.

7.6 Status-with-ARA Control Register ⎯ Index 24h

Power on default <7:0> = 01h

Bit	Name	Attribute	Description
7-6	Reserved		

0	EN_ARA_STS	R/W	Set to 1, ALERT de-asserted condition is related with ARA. Set to 0, ALERT de-asserted condition is not related with ARA(Alert Response Address).

7.7 Chip ID I Register — Index 5Ah

Power on default: 03h.

7.8 Chip ID II Register — Index 5Bh

Power on default: 03h.

7.9 Vendor ID I (Manufacturer ID) Register — Index 5Dh

Power on default: 19h.

7.10 Vendor ID I (Manufacturer ID) Register — Index 5Eh

Power on default: 34h.

7.11 Vendor ID II (Manufacturer ID) Register — Index FEh

Power on default: 23h. (programmable)

7.12 Value RAM — Index 10h- 2Fh

VT1 : Local Temperature

VT2 : Remote Temperature

The value in quota is its power-on default value.

Description	Attribute	Read Address (High Byte)	Read Address (Low Byte)	Write Address (High Byte)	Write Address (Low Byte)
VT1 reading	RO	00h	1Ah		
VT2 reading	RO	01h	10h		
VT1 High Limit	R/W	05h $_{(55h)}$	1Bh $_{(00h)}$	0Bh	1Bh
VT1 Low Limit	R/W	06h $_{(00h)}$	1Ch $_{(00h)}$	0Ch	1Ch
VT2 High Limit	R/W	07h $_{(55h)}$	13h $_{(00h)}$	0Dh	13h

VT2 Low Limit	R/W	08h (00h)	14h (00h)	0Eh	14h
VT1 THERM Limit	R/W	20h (55h)		20h	
VT1 THERM Hysteresis	R/W	21h (0Ah)		21h	
VT2 THERM Limit	R/W	19h (6Ch)		19h	
VT2 THERM Hysteresis	R/W	23h (0Ah)		23h	

8. Electrical characteristic

8.1 Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Power Supply Voltage	-0.5 to 3.3	V
Input Voltage	-0.5 to VDD+0.5	V
Operating Temperature	0 to +140	° C
Storage Temperature	-55 to 150	° C

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of

the device

8.2 DC Characteristics

(T_A = 0° C to 70° C, VDD = 3.3V $\pm$ 10%, VSS = 0V)

Parameter	Conditions	MIN	TYP	MAX	Unit
Temperature Error, Remote Diode	$60\,^oC < T_D < 100\,^oC$, VCC = 3.0V to 3.6V			± 1	^oC
	$0\,^oC < T_D < 60\,^oC$			± 3	
Temperature Error, Local Diode	$0\,^oC < T_A < 100\,^oC$, VCC = 3.0V to 3.6V		± 1	± 3	^oC
Supply Voltage range		3.0	3.3	3.6	V
Average operating supply current	16 Conversions / Sec Rate		180		uA
	0.0625 Conversions / Sec Rate		90		uA
Standby supply current			10		uA
Resolution			0.125		^oC
Under-voltage lockout threshold	VDD input, Disables ADC , Rising Edge		2.55		V
Power on reset threshold			2.2	2.4	V
Diode source current	High Level		95		uA
	Low Level		10		uA

(T_A = 0° C to 70° C, VDD = 3.3V $\pm$ 10%, VSS = 0V)

PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
OD$_{12}$ - Open-drain output pin with sink capability of 16 mA						
Output Low Current	IOL	9	12		mA	VOL = 0.4V
IN$_{ts}$ - TTL level Schmitt-triggered input pin						

Input Low Threshold Voltage	Vt-	0.5	0.8	1.1	V	VDD = 3.3V
Input High Threshold Voltage	Vt+	1.6	2.0	2.4	V	VDD = 3.3V
Input High Leakage	ILIH			+1	μA	VIN = VDD
Input Low Leakage	ILIL	-1			μA	VIN = 0 V

8.3 AC Characteristics

Serial Bus Timing Diagram
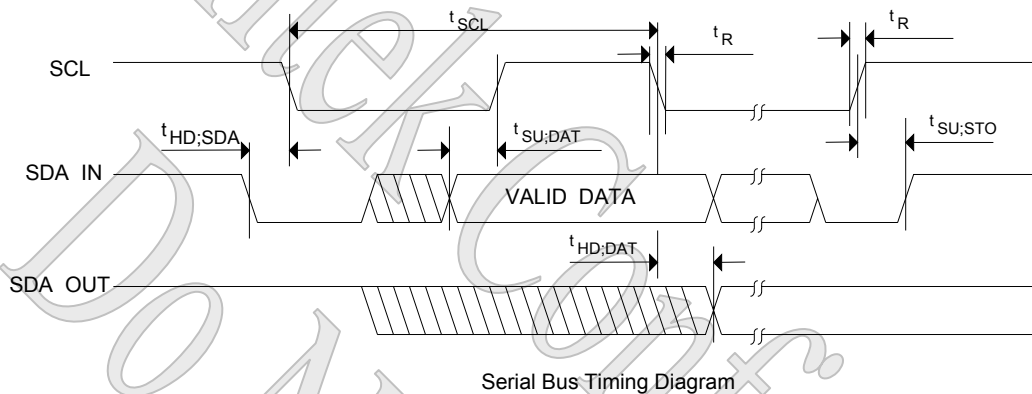
Serial Bus Timing

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
SCL clock period	t_{SCL}	10		uS
Start condition hold time	$t_{HD;SDA}$	4.7		uS
Stop condition setup-up time	$t_{SU;STO}$	4.7		uS
DATA to SCL setup time	$t_{SU;DAT}$	120		nS
DATA to SCL hold time	$t_{HD;DAT}$	5		nS
SCL and SDA rise time	t_R		1.0	uS
SCL and SDA fall time	t_F		300	nS

9. Ordering Information

Part Number	Package Type	Production Flow
F75385M	8 pin MSOP (Green Package)	Commercial, 0°C to +70°C

10. Package Dimensions (8 MSOP)
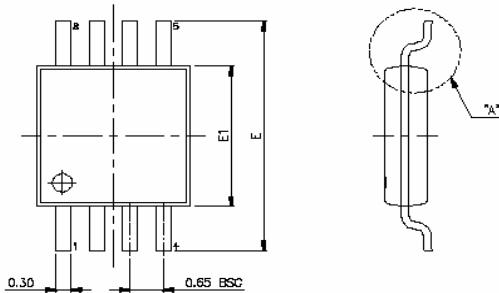
SYMBOLS	MIN.	NOM.	MAX.
A	–	–	1.10
A1	0.00	–	0.15
A2	0.75	0.85	0.95
D	3.00 BSC		
E	4.90 BSC		
E1	3.00 BSC		
L	0.40	0.60	0.80
L1	0.95 REF		
θ°	0	–	8

UNIT : MM
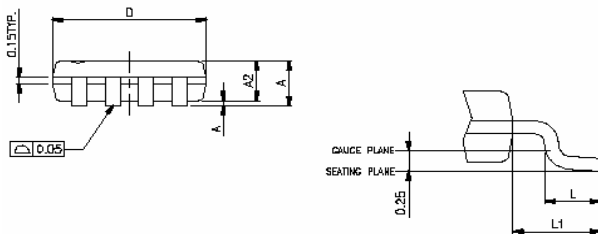
NOTES:
1. JEDEC OUTLINE : MO-187 AA
2. DIMENSION 'D' DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS SHALL NOT EXCEED 0.15 PER SIDE.
3. DIMENSION 'E1' DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.
4. DIMENSION '0.22' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 MM TOTAL IN EXCESS OF THE '0.22' DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OF THE FOOT. MINIMUM SPAC BETWEEN PROTRUSION AND ADJACENT LEAD IS 0.07 MM.
5. DIMENSIONS 'D' AND 'E1' TO BE DETERMINED AT DATUM PLANE H .

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