W83773G /

W83773SG

Nuvoton

H/W Monitoring IC

DATE: OCTOBER 21TH, 2009

REVISION: 1.2

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1. GENERAL DESCRIPTION

The W83773G/SG, which integrates two remote and one local temperature sensors and a 2-wire System Management Bus (SMBus™) serial interface, is Nuvoton's hardware monitoring IC specifically designed for PC, notebook and any embedded environments. Ideality factor configuration is also added in the W83L773G to eliminate temperature measurement error. The remote temperature sensor input can be connected to the thermal diode or transistor like 2N3904. With the two remote temperature sensors, the W83773G/SG can report the temperatures of both diodes in the Dual-core CPU. A 10-bit plus sign ADC (Analog to Digital Converter) with 0.125°C resolution is built inside the W83773G/SG to convert the monitored temperature value. Programmable conversion rates and standby mode support low-power operation.

The W83773G/SG is high temperature accuracy, low-power consumption, SMBus™ serial interface IC available in 8-pin, TSSOP (MSOP) and SOP packages. The working voltage is 3.3 V ±10%.

1.1 Product Selection Guide

PART NUMBER	SMBUS ADDRESS	FUNCTIONALITY		PACKAGE
		REMOTE	LOCAL	
W83773G	1001_100xb	2	1	TSSOP-8 (MSOP-8)
W83773G-2	1001_101xb			
W83773SG	1001_100xb			SOP-8
W83773SG-2	1001_101xb			

2. FEATURES

2.1 Monitoring Items - Temperature

- Measure the temperature with high accuracy
- One on-chip thermal sensor
- Two remote temperature sensor inputs
- Ideality Factor Configuration on two External Diodes.
- Remote Diode Fault Detection.

2.2 General Features

- Support SMBus™ serial interface
- 3.3V±10% V_{CC} operation
- 10 bit plus sign remote temperature data format, 0.125°C resolution
- Programmable offset register for various thermal diodes
- SMBus™ 2.0 compatible interface, supports TIMEOUT
- Programmable conversion rates allow user to optimize the power consumption.
- Report the temperatures of both diodes in the Dual-core CPU.

2.3 Package Type

- W83773G in 8-pin TSSOP (MSOP)
- W83773SG in 8-pin SOP

2.4 Applications

- Desktop and Notebook computers, support down to 45nm processes and below. (Please refer to application notice for details)
- Hardware Management
- Servers
- Embedded Applications

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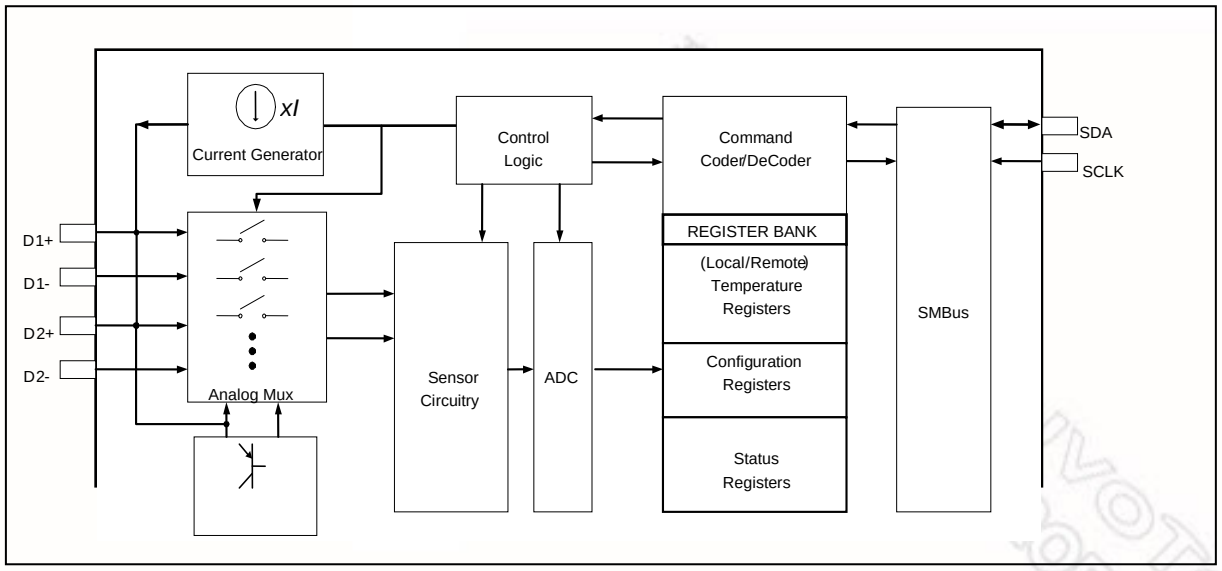
3. KEY SPECIFICATIONS

- Local temperature range and accuracy
  -40°C to +125°C (T_A)
  Typ. ± 2°C (20°C~40°C)
  Max. ± 3°C (-40°C~125°C) *1
- Remote temperature range and accuracy
  -40°C to +127°C (T_D)
  Typ. ± 1°C (25°C ~70°C)
  Typ. ± 2°C (-40°C ~127°C)
  Max. ± 3°C (-40°C~127°C) *2
- Supply voltage — 3.3V ± 10%
- Operating supply current — 900 uA typ.
- Low Power Operation — 15 μA Standby Current
- ADC resolution include sign bit — 10 Bits

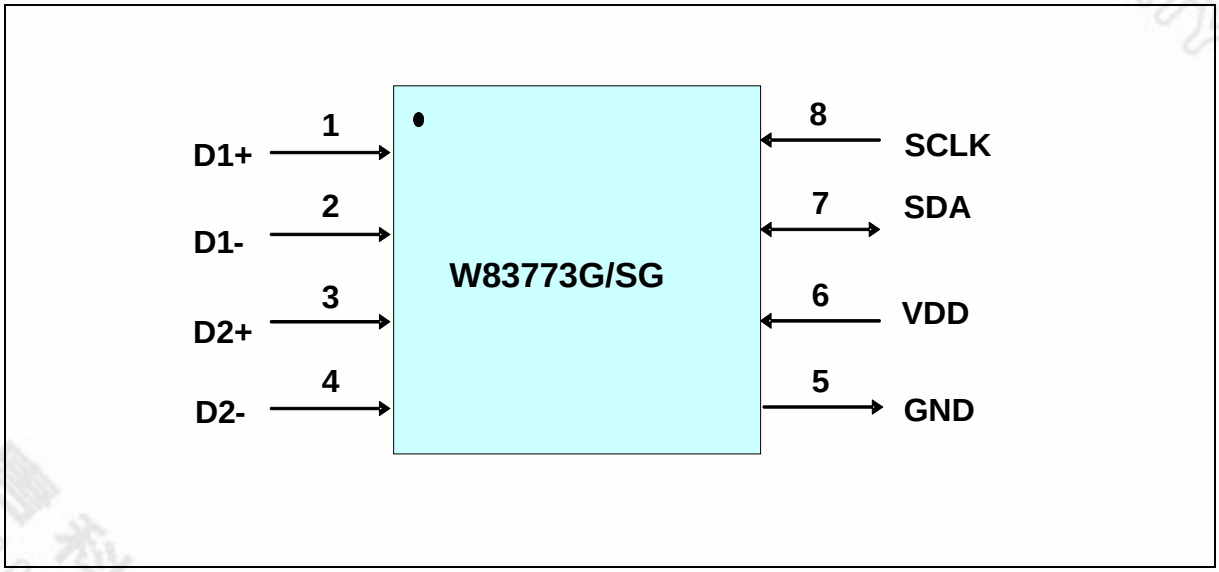
*1 Guaranteed by design from -40~125 degree C, 100% tested at 85 degree C.
*2 Guaranteed by design from -40~127 degree C, 100% tested at 85 degree C.

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4. BLOCK DIAGRAM



5. PIN CONFIGURATION



6. PIN DESCRIPTION

PIN TYPE	PIN Attribute
I/OD_{12ts}	TTL level and schmitt trigger open drain output with 12 mA sink capability
IN_{ts}	TTL level input pin and schmitt trigger
AIN	Input pin (Analog)
POWER	Positive power supply input
GROUND	Power supply ground

PIN NAME	NO	PIN TYPE	DESCRIPTION
D1+	1	**AIN**	**Connect to Thermal Diode Anode.**
D1-	2	**AIN**	**Connect to Thermal Diode Cathode.**
D2+	3	**AIN**	**Connect to Thermal Diode Anode.**
D2-	4	**AIN**	**Connect to Thermal Diode Cathode.**
GND	5	GROUND	Power supply ground
VDD	6	POWER	DC power supply, voltage input of 3.3V± 10%.
SDA	7	I/OD_{12}	Digital I/O (Open drain). SMBus bidirectional serial data. Requires a pull-up resistor.
SCLK	8	IN_{ts}	Digital Input (Open drain). SMBus serial clock input. Requires a pull-up resistor.

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7. FUNCTIONAL DESCRIPTION

7.1 General Description

The W83773G/SG provides two remote temperature sensor inputs which can be connected to the remote 2N3904 transistor, or CPU/GPU thermal diode, and one local on-die thermal sensor to detect the ambient temperature.

The W83773G/SG supplies Ideality Factor Configuration on one External Diode to eliminate the temperature measurement error. In addition, the W83773G/SG also reports both temperatures of the external temperature zones and supports selectable conversion rates and modes for low power operation.

The data format of the remote temperature is represented by a 10-bit plus sign, two's complement word and 11-bit unsigned binary word with an LSB equal to 0.125°C. The real temperature equals the measured temperature plus or minus the offset value. The offset value can be set in the offset registers. The date format of the offset registers is the same as the data format of the remote temperature. Local Temperature data is represented by an 8-bit plus sign, two's complement format, with an LSB equal to 1°C.

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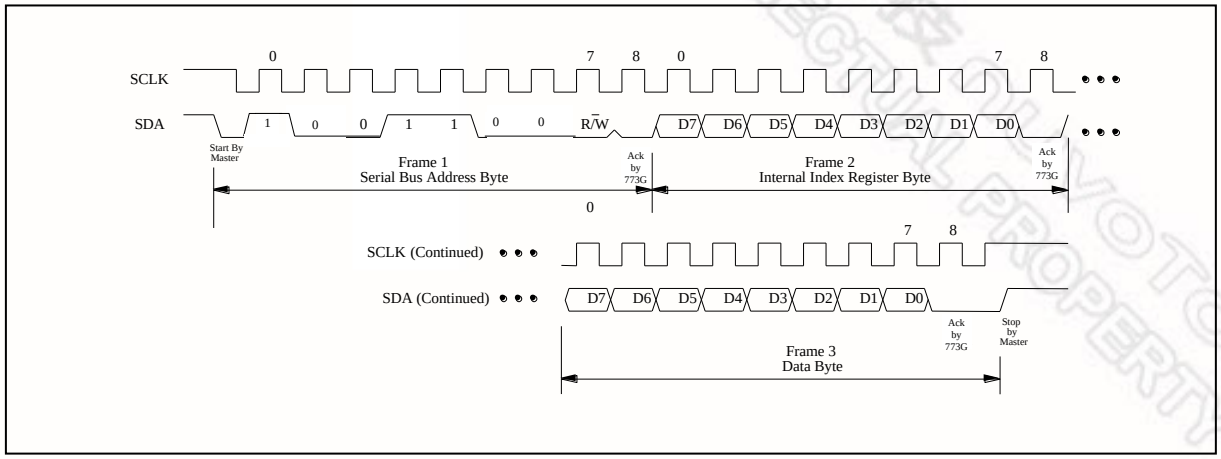
7.2 Access Interface

The W83773G/SG/AG provides SMBus serial interface to read/write internal registers, and the SMBus address for read and write is 10011001b and 10011000b, respectively.

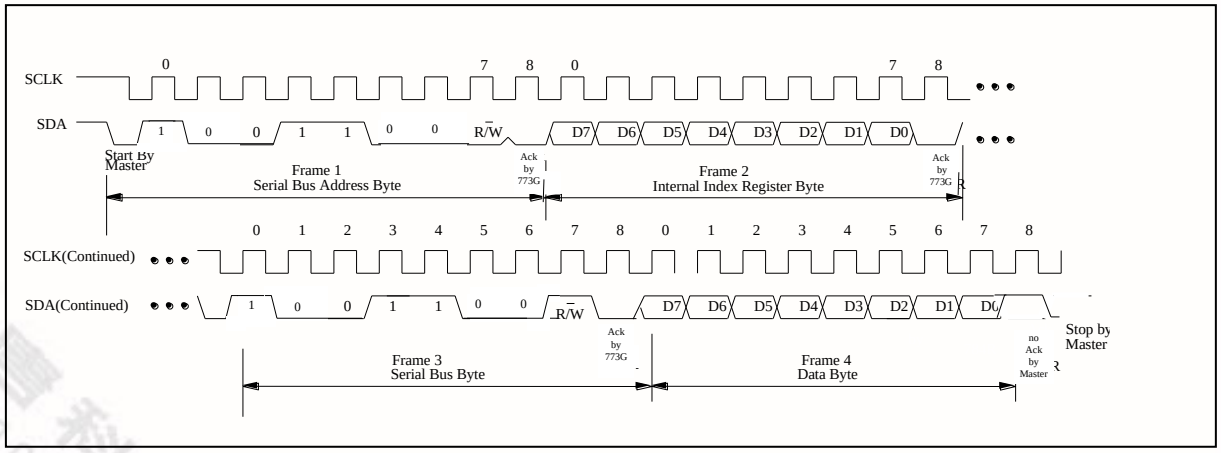
The W83773G-2 and W83773SG-2 respond to hard-wire SMBus slave address as shown in Table 1.1

The first serial bus access timing is shown as followed:

(a) Serial bus write to the internal address register followed by the data byte



(b) Serial bus read form the internal address register followed by the data byte



7.3 Measured Temperature Data Format

The W83773G/SG can measure the remote temperature with the resolution of 11-bit two's complement format, as well as the local temperature with the resolution of 8-bit two's complement format.

7.3.1 Measure Remote Temperature Data Format

Table 7.3.1 shows the remote temperature data with 11-bit two's complement format.

Table 7.3.1 Measured Remote Temperature Data Format

TEMPERATURE	8-BIT DIGITAL OUTPUT HIGH BYTE	8-BIT DIGITAL OUTPUT LOW BYTE
+127.875°C	0111,1111	111X,XXXX
+25.750°C	0001,1001	110X,XXXX
+2.250°C	0000,0010	010X,XXXX
+1.125°C	0000,0001	001X,XXXX
+0.000°C	0000,0000	000X,XXXX
- 1.125°C	1111,1110	111X,XXXX
- 2.250°C	1111,1101	110X,XXXX
- 25.750°C	1110,0110	010X,XXXX
- 127.875°C	1000,0000	001X,XXXX

7.3.2 Measure Local Temperature Data Format

Table 7.3.2 shows the local temperature data with 8-bit two's complement format.

Table 7.3.2 Measured Local Temperature Data Format

TEMPERATURE	8-BIT DIGITAL OUTPUT
+127°C	0111,1111
+25°C	0001,1001
+2°C	0000,0010
+1°C	0000,0001
+0°C	0000,0000
- 1°C	1111,1111
- 2°C	1111,1110
- 25°C	1110,0111
- 128°C	1000,0000

7.4 Digital Filter

The W83773G/SG provides three Digital Filter levels to suppress erroneous remote temperature readings due to noise. The register address to set the digital filter is at Filter Configure Resister. If set bits <D2, D1> = <0, 0>, then no filter is selected. If set bits <D2, D1> = <0, 1> or <1, 0>, then filter level 1 is selected. If set bits <D2, D1> = <1, 1>, then level 2 is selected. Figure 7.4.1 shows the step response of reading remote temperature with different filter level, and Figure 7.4.2 shows the impulse response.

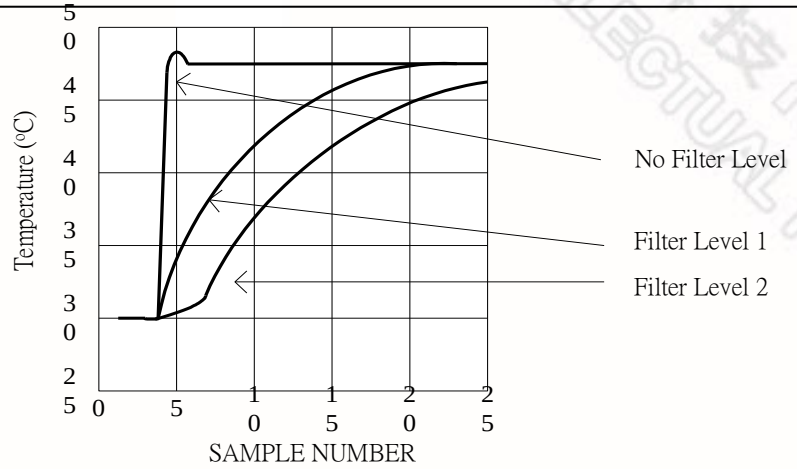


Figure 7.4.1 Step Response of reading remote temperature

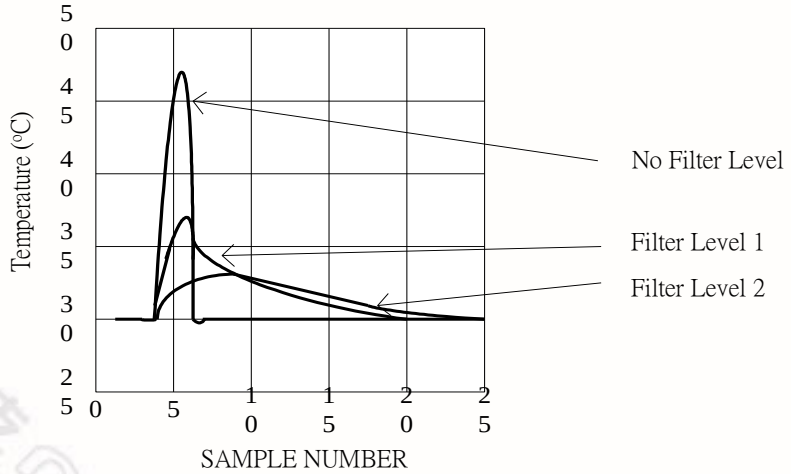


Figure 7.4.2 Impulse Response of reading remote temperature

7.5 Fault Detect

Table 7.5 shows the response of Fault Detection if the false connection of D+ and D- occurs after power-up. Please also refer to the W83L771AWG_773G_775G Application Note 2.pdf for implementation.

Table 7.5 response of Fault Detect

Connection (D+, D-)	Status Register bit (OPENA or OPENB)	Measured Remote A or B Temperature
(VDD, Floating)	1	+127.875 ℃
(GND, Floating)	1	+127.875 ℃
(Floating, Floating)	1	+127.875 ℃
Short	1	+127.875 ℃

7.6 Conversion Rate and Moving Average

The W83773G/SG provides an embedded moving average into conversion rate selection. Each conversion rate can set a couple of proper noise rejection and average supply current.

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8. CONTROL AND STATUS REGISTER

8.1 W83773G/SG Registers

REGISTER NAME (HEX)	READ ADDRESS (HEX)	WRITE ADDRESS (HEX)	POWER ON DEFAULT STATES	
			<D7:D0> BINARY / HEX	DECIMAL
Local Temperature (LT)	00h	Read Only	0000,0000b / 00h	0
Remote Temperature A High Byte (RTAHB)	01h	Read Only	0000,0000b / 00h	0
Status Register 1 (SR1)	02h	Read Only	0000,0000b / 00h	0
Configuration (C)	03h	09h	0000,0001b / 01h	1
Conversion Rate (CR)	04h	0Ah	0000,1000b / 08h	8
Remote Temperature A Low Byte (RTALB)	10h	Read Only	0000,0000b / 00h	0
Remote Temperature A Offset High Byte (RTAOHB)	11h	11h	0000,0000b / 00h	0
Remote Temperature A Offset Low Byte (RTAOLB)	12h	12h	0000,0000b / 00h	0
Remote Temperature B Offset High Byte (RTBOHB)	15h	15h	0000,0000b / 00h	0
Remote Temperature B Offset Low Byte (RTBOLB)	16h	16h	0000,0000b / 00h	0
Status Register 2 (SR2)	17h	Read Only	0000,0000b / 00h	0
Remote Temperature B High Byte (RTBHB)	24h	Read Only	0000,0000b / 00h	0
Remote Temperature B Low Byte (RTBLB)	25h	Read Only	0000,0000b / 00h	0
Remote Diode Temperature Filter (RDTFA, RDTFB)	BFh	BFh	0000,0000b / 00h	0
Remote Diode A ideality (IDEAA)	E3h	E3h	1000,0100b / 84h	132
Remote Diode B ideality (IDEAB)	E4h	E4h	1000,0100b / 84h	132
Remote Temperature B Enable (RTBE) *For W83773G-2/SG-2 only.	Write Only	E8h	0101,0101b / 55h	85
Read Manufacturer's ID (RMID)	FEh	Read Only	0101,1100b / 5Ch	92
Read Die Revision (RDR)	FFh	Read Only	0001,0000b /10h 0001,0001b /11h 0001,0011b /13h	16 17 19

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8.2 Data Format of Temperature Registers

(LT, RTAHB, RTALB, RTBHB, RTBLB, RTAOHB, RTAOLB, RTBOHB, RTBOLB)

REGISTER: LT, RTHB, LHS, RHSHB, LLS, RLSHB,RTAOHB, RTBOHB								
DATA FORMAT: TWO'S COMPLEMENT FORMAT								
BIT	D7	D6	D5	D4	D3	D2	D1	D0
VALUE	Sign	64	32	16	8	4	2	1
Unit: ℃								
REGISTER: RTLB, RHSLB, RTAOLB, RTBOLB								
DATA FORMAT: TWO'S COMPLEMENT FORMAT								
BIT	D7	D6	D5	D4	D3	D2	D1	D0
VALUE	0.5	0.25	0.125	0	0	0	0	0

8.3 Status Register 1 (SR1)

BIT	FLAG NAME	DESCRIPTION
D7	Busy	'1' indicates ADC is busy converting.
D6	Reserve	
D5	Reserve	
D4	Reserve	
D3	Reserve	
D2	OPENA	'1' indicates Remote Diode 1 is disconnected.
D1	Reserve	
D0	Reserve	

8.3.1 Status Register 2 (SR2)

BIT	FLAG NAME	DESCRIPTION
D7	Reserve	
D6	Reserve	
D5	Reserve	
D4	Reserve	
D3	Reserve	
D2	OPENB	'1' indicates a Remote Diode 2 is disconnected.
D1	Reserve	
D0	Reserve	

8.4 Configuration Register (C)

BIT	FLAG NAME	DESCRIPTION
D7	Reserved	
D6	STOP/ $\overline{RUN}$	If this bit is set to '1', Device enters standby mode.
D5	0	No definition and can be read as 0.
D4	Reserved	
D3	0	No definition and can be read as 0.
D2	Reserved	
D1	0	No definition and can be read as 0.
D0	Reserved	Reserved

8.5 Conversion Rate Register (CR)

REGISTER: CR ***(DEFAULT CONVERSION RATE: 16HZ)***						
(OPENA, OPENB)	(01,10)		00		11	
Temp. sensor	1 local + 1remote(A or B)		2 remote + 1 local		1 local	
BIT<D7:D0>	Frequency/Time(Sec)	Average I_{VDD}	Frequency/Time(Sec)	Average I_{VDD}	Frequency/Time(Sec)	Average I_{VDD}
00h	0.0625Hz/16	==	0.0625Hz/16	==	0.0625Hz/16	==
01h	0.125Hz/8	==	0.125Hz/8	==	0.125Hz/8	==
02h	0.25Hz/4	==	0.25Hz/4	==	0.25Hz/4	==
03h	0.5Hz/2	211uA	0.5Hz/2	211uA	0.5Hz/2	211uA
04h	1Hz/1	232uA	1Hz/1	232uA	1Hz/1	232uA
05h	2Hz/0.5	331uA	2Hz/0.5	331uA	2Hz/0.5	331uA
06h	4Hz/0.25	393uA	4Hz/0.25	393uA	4Hz/0.25	393uA
07h	8Hz/0.125	589uA	8Hz/0.125	589uA	8Hz/0.125	589uA
08h	16Hz/0.0625	833uA	16Hz/0.0625	833uA	16Hz/0.0625	833uA
09h-FFh	Reserve		Reserve		Reserve	

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8.6 Filter Configure Register (RDTF)

BIT	COMMAND	DESCRIPTION
<D7:D5>	0	No definition and can be read as 0.
<D4:D3>	RDTFB Filter Level	<D2, D1>=<0, 0>: No Filter Selected <D2, D1>=<0, 1> or <1, 0>: Filter Level 1 Selected <D2, D1>=<1, 1>: Filter Level 2 Selected
<D2:D1>	RDTFA Filter Level	<D2, D1>=<0, 0>: No Filter Selected <D2, D1>=<0, 1> or <1, 0>: Filter Level 1 Selected <D2, D1>=<1, 1>: Filter Level 2 Selected
D0	Reserve	

8.7 Ideality (IDEAA, IDEAB)

The Ideality factor is dependant upon the process that was used in the fabrication of the particular diode.

REGISTER: IDEAA, IDEAB ***(DEFAULT IDEALITY: 1.003(MMBT3904))***	
BIT<D7:D0>	Range
86h	0.9851~0.9924
85h	0.9925~1.0000
84h	1.0001~1.0076
83h	1.0077~1.0153
82h	1.0154~1.0232
81h	1.0233~1.0312
80h	1.0313~1.0393
7Fh	1.0394~1.0476
7Eh	1.0477~1.0560
7Dh	1.0561~1.0645
7Ch	1.0646~1.0731
7Bh	1.0732~1.0819
00h-7Ah, 87h-FFh	Reserved

8.8 Remote Temperature B Enable (RTBE) *for W83773G-2/SG-2 only.

The remote temperature B channel of **W83773G-2/W83773SG-2** is default disabled, it is used to make the design convenience for dual core CPU and single core CPU optional on a platform.

Write **0Eh** into **CR[E8h]** to **enable** the Remote Temperature B channel.

Write **0Fh** into **CR[E8h]** to **disable** the Remote Temperature B channel.

9. ELECTRICAL CHARACTERISTIC

9.1 Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Power Supply Voltage	3.3V ± 10%	V
Input Voltage	-0.3 to +3.6	V
Operating Temperature*	-40 to +125	° C
Storage Temperature	-50 to +150	° C

*Guaranteed by design, 100% test at 85 degreeC.

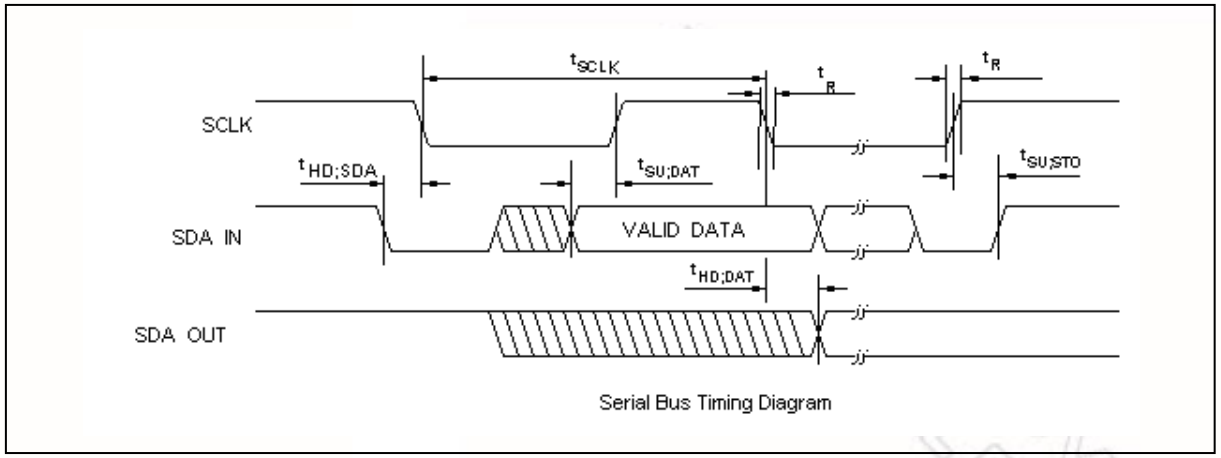
Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings may adversely affect the life and reliability of the device.

9.2 DC Characteristics

(Ta = 0° C to 85° C, VDD = 3.3V ± 10%, VSS = 0V)

PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
I/OD_{12ts} - TTL level bi-directional pin with source-sink capability of 12 mA and schmitt-trigger level input						
Input Low Threshold Voltage	V_{t-}	0.5	0.8	1.1	V	V_{DD} = 3.3 V
Input High Threshold Voltage	V_{t+}	1.6	2.0	2.4	V	V_{DD} = 3.3 V
Hysteresis	V_{TH}	0.5	1.2		V	V_{DD} = 3.3 V
Output Low Voltage	V_{OL}			0.4	V	I_{OL} = 12 mA
Input High Leakage	I_{LIH}			+10	μA	V_{IN} = V_{DD}
Input Low Leakage	I_{LIL}			-10	μA	V_{IN} = 0V
OD_{12} - Open-drain output pin with sink capability of 12 mA						
Output Low Voltage	V_{OL}			0.4	V	I_{OL} = 12 mA
IN_{ts} - TTL level Schmitt-triggered input pin						
Input Low Threshold Voltage	V_{t-}	0.5	0.8	1.1	V	V_{DD} = 3.3 V
Input High Threshold Voltage	V_{t+}	1.6	2.0	2.4	V	V_{DD} = 3.3 V
Hysteresis	V_{TH}	0.5	1.2		V	V_{DD} = 3.3 V
Input High Leakage	I_{LIH}			+10	μA	V_{IN} = V_{DD}
Input Low Leakage	I_{LIL}			-10	μA	V_{IN} = 0 V

9.3 AC Characteristics



Serial Bus Timing Diagram

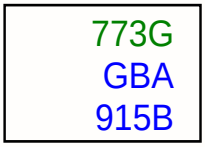
Timing for W83773G/SG :

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
SCL clock period	t_{SCL}	2.5		uS
Start condition hold time	$t_{HD;SDA}$	1.5		uS
Stop condition setup-up time	$t_{SU;STO}$	1		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

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10. TOP MARKING SPECIFICATIONS

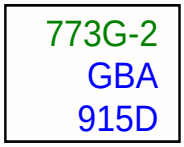
10.1 W83773G and W83773SG TOP MARKING

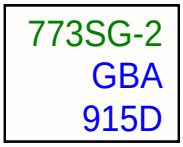




FIRST LINE	IC PART NUMBER: 773G (W83773G), 773SG (W83773SG)	
Second Line	Tracking Code 1	
	G	Assembly house code
	BA	Mask version
Third Line	Tracking Code 2	
	9	The package is made in 2009
	15	Week: 15
	B	IC version

10.2 W83773G-2 and W83773SG-2 TOP MARKING

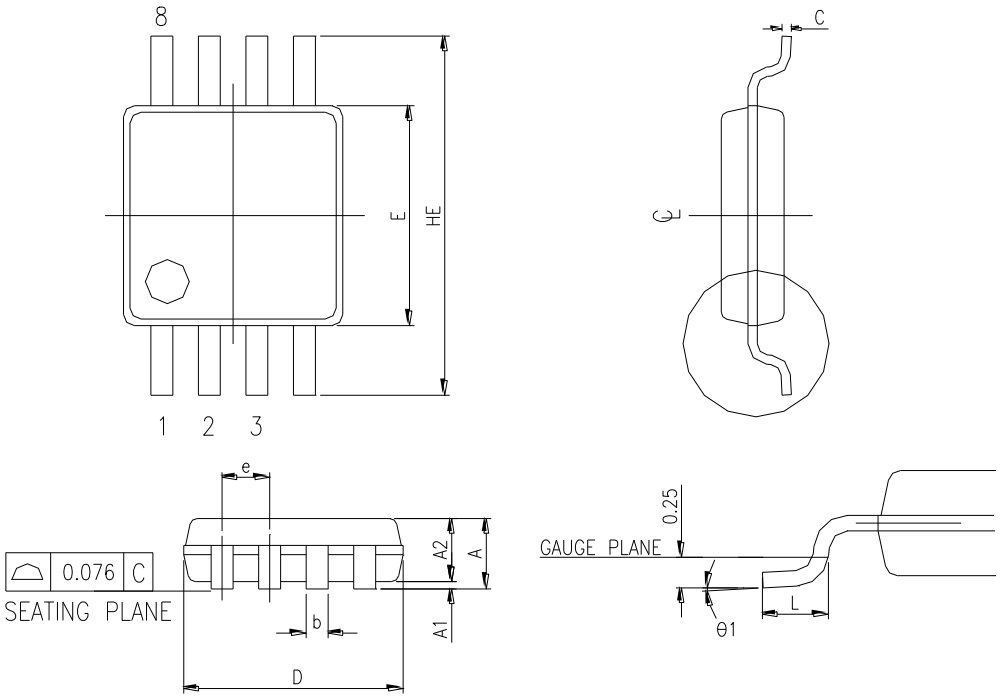




FIRST+ LINE	IC PART NUMBER: 773G-2 (W83773G-2), 773SG-2 (W83773SG-2)	
Second Line	Tracking Code 1	
	G	Assembly house code
	BA	Mask version
Third Line	Tracking Code 2	
	9	The package is made in 2009
	15	Week: 15
	D	IC version : A means version A; B means version B; D means version D

11. PACKAGE SPECIFICATION

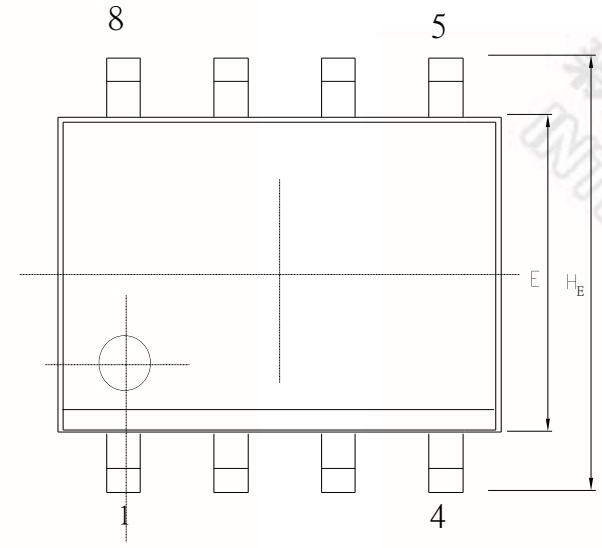
11.1 TSSOP (MSOP) 8L 3X3 MM^2

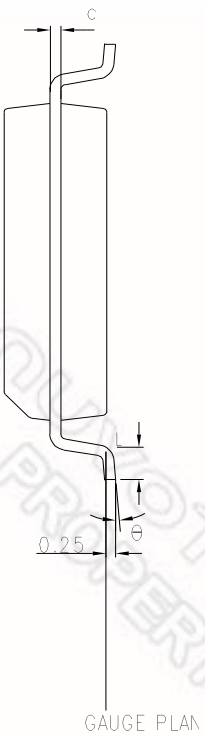


CONTROLLING DIMENSION : MILLIMETERS

SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	---	---	1.10	---	---	0.043
A1	0.05	---	0.15	0.002	---	0.006
A2	0.81	0.86	0.91	0.032	0.034	0.036
c	0.13	---	0.23	0.005	---	0.009
b	0.25	---	0.40	0.0098	---	0.0157
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
HE	4.90 BSC			0.193 BSC		
L	0.445	0.55	0.648	0.0175	0.0217	0.0255
θ1	0°		6°	0°		6°
e	0.65 BSC			0.026 BSC		

11.2 SOP8 150mil





Control demensions are in milmeters .

SYMBOL	DIMENSION IN MM		DIMENSION IN INCH	
	MIN.	MAX.	MIN.	MAX.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
b	0.33	0.51	0.013	0.020
c	0.19	0.25	0.008	0.010
E	3.80	4.00	0.150	0.157
D	4.80	5.00	0.188	0.196
e	1.27 BSC		0.050 BSC	
H_E	5.80	6.20	0.228	0.244
Y	—	0.10	—	0.004
L	0.40	1.27	0.016	0.050
θ	0	10	0	10

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12. REVISION HISTORY

VERSION	DATE	PAGE	DESCRIPTION
1.0	02/14/2008	N.A.	First published version.
1.1	01/15/2009	1,11,14,17	1. Added W83773G-2/SG-2 info. 2. Modified the typo of Ideality CR[E3~E4h] default value.
1.2	10/21/2009	All	1. Modified key specifications. 2. Modified AC specification. 3. Added application notices information. 4. Fixed the typo.

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