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**W83L771W/W83L771G**

**Winbond**

**H/W Monitoring IC**



## W83L771W

## Data Sheet Revision History

	PAGES	DATES	VERSION	VERSION ON WEB	MAIN CONTENTS
1	n.a.	12/10/04	0.5	NA	First Release
2	n.a.	01/31/05	0.6	NA	Add lead-free package version
3	n.a.	03/31/06	0.7	NA	Correct section 8.6 conversion rate; correct section 9.1 operating temperature; add application circuit
4					
5					

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## 1. GENERAL DESCRIPTION

W83L771W/G, a 2-channel temperature sensor with a 2-wire System Management Bus (SMBus™) serial interface, is Winbond hardware monitoring IC specifically designed for notebook applications. W83L771W/G has an on-chip thermal sensor and a remote temperature sensor input with high accuracy. The remote temperature sensor input could be connected to thermal diode or transistor such as 2N3904. A 10-bit plus sign ADC (Analog to Digital Converter) with 0.125°C resolutions is built inside W83L771W/G to convert the monitored temperature value.

W83L771W/G is a high temperature accuracy, low-power consumption, SMBus™ serial interface IC, which is available in 8-pin, TSSOP package, and the working voltage is 3.3 V ±10%.

## 2. FEATURES

### 2.1 Monitoring Items - Temperature

- Measure the temperature with high accuracy, up to +/- 1°C accuracy.
- One on-chip thermal sensor
- One remote temperature sensor input

### 2.2 General

- Interface: SMBus™ serial interface
- 3.3V±10% V<sub>CC</sub> operation
- 10 bit plus sign remote temperature data format, 0.125°C resolution
- Programmable offset register for various thermal diodes
- ALERT Output supports SMBus™ 2.0 protocol
- Programmable Temperature High/Low limit and hysteresis for ALERT and T\_CRIT\_A output
- SMBus™ 2.0 compatible interface, supports TIMEOUT

### 2.3 Package

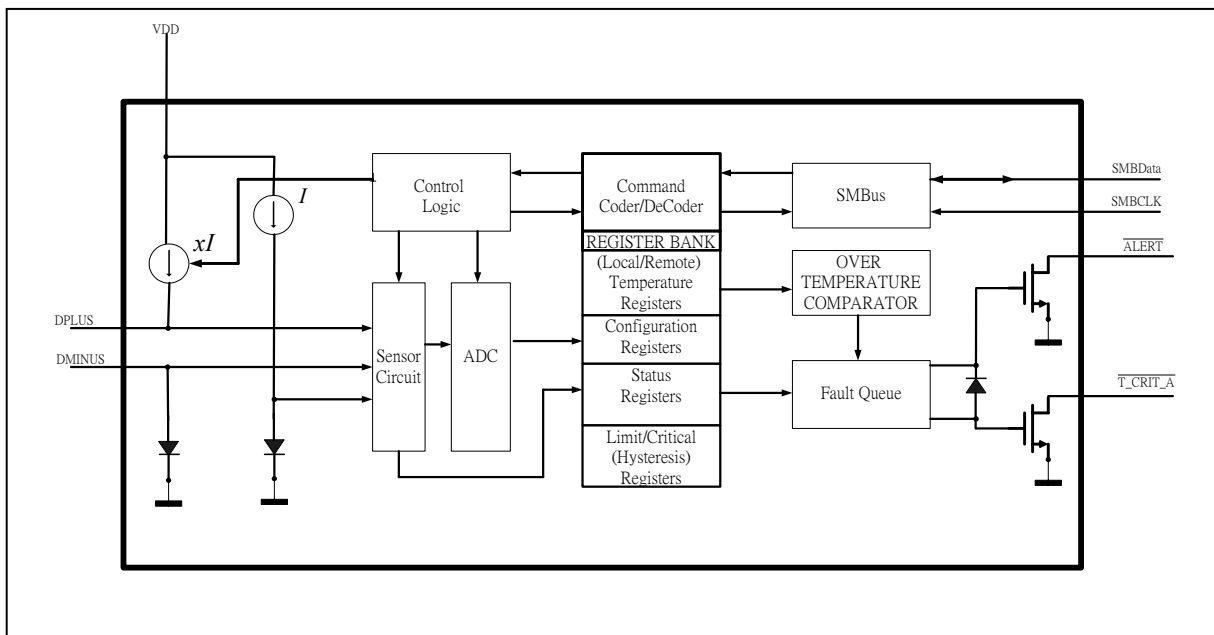
- 8-pin TSSOP



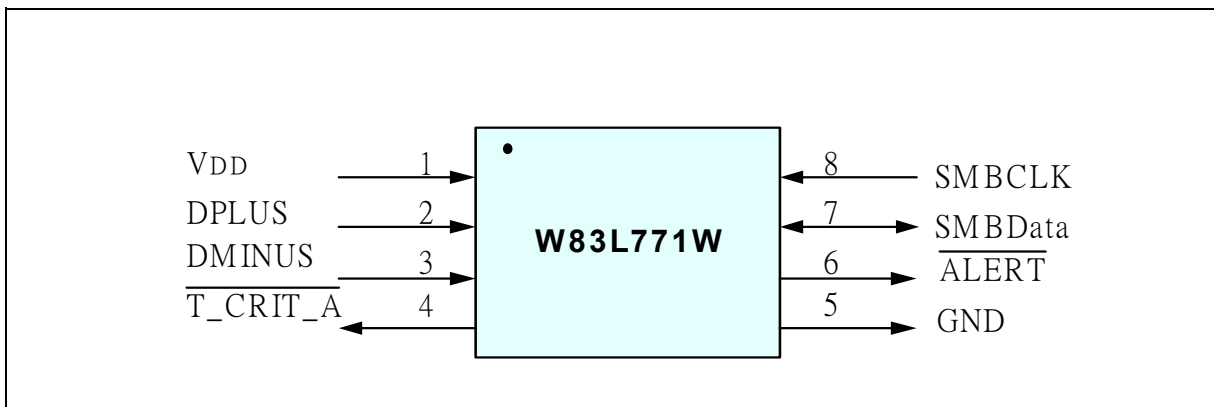
### 3. KEY SPECIFICATIONS

- |   |                                 |
|---|---------------------------------|
| ■ Local temperature range and accuracy  | 0°C to +80°C                    |
| ■ Remote temperature range and accuracy | ± 3°C(@70°C)<br>-30°C to +127°C |
| ■ Supply voltage                        | ± 1°C(@70°C)                    |
| ■ Operating supply current              | 3.3V ±10%                       |
| ■ ADC resolution                        | 1 mA typ.<br>11 Bits            |

### 4. BLOCK DIAGRAM



### 5. PIN CONFIGURATION





## 6. PIN DESCRIPTION

PIN TYPE	PIN ATTRIBUTE
I/OD <sub>12ts</sub>	TTL level and schmitt trigger open drain output with 12 mA sink capability
OD <sub>12</sub>	Open-drain output pin with 12 mA sink capability
IN <sub>ts</sub>	TTL level input pin and schmitt trigger
AIN	Input pin (Analog)

PIN NAME	NO	PIN TYPE	DESCRIPTION
V <sub>DD</sub>	1	POWER	DC power supply, voltage input 3.3V±10%.
DPLUS	2	<b>AIN</b>	<b>Connect to Thermal Diode Anode.</b>
DMINUS	3	<b>AIN</b>	<b>Connect to Thermal Diode Cathode.</b>
$\overline{T\_CRIT\_A}$	4	OD <sub>12</sub>	T_CRIT alarm output, for interrupt or shutdown control.
GND	5	GROUND	Power supply ground
$\overline{ALERT}$	6	OD <sub>12</sub>	Alarm output, for interrupt control.
SDA	7	I/OD <sub>12</sub>	Digital I/O (Open drain). SMBus bidirectional serial data. Requires SMBus pull-up.
SCL	8	IN <sub>ts</sub>	Digital Input (Open drain). SMBus serial clock input. Requires SMBus pull-up.





7. FUNCTIONAL DESCRIPTION

7.1 General Description

The W83L771W/G provides one remote temperature sensor input which could be connected to remote thermistors, 2N3904 transistors, or CPU/GPU thermal diode, and one local on die thermal sensor to detect ambient temperature. The measured temperature is digitally compared with the value stored in the programmable High/Low limit Registers and T\_CRIT registers. Any out-of-limit value could be detected by monitoring Status Register (SR). W83L771W/G also supports SMBus™ 2.0 ALARM protocol and TIMEOUT.

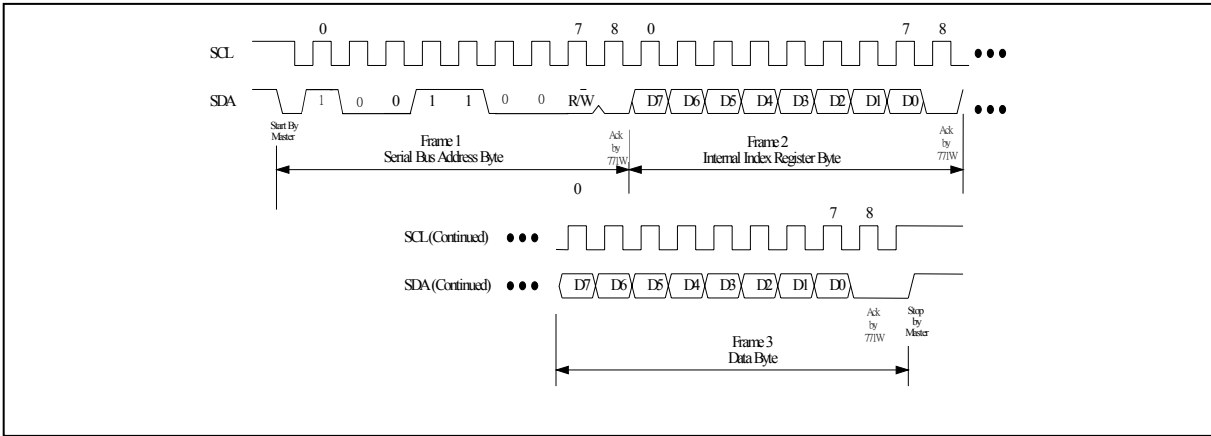
The data format of remote temperature is 10 bit plus sign combined with two 8 bits wide SMBus™ access interface. The real temperature equals the measured temperature plus or minus offset value. Offset value could be set in offset registers. The date format of the offset registers is also the same as the data format of remote temperature.

7.2 Access Interface

W83L771W/G provides SMBus serial interface to read/write internal registers, and the SMBus address for read and write is 10011001b and 10011000b, respectively.

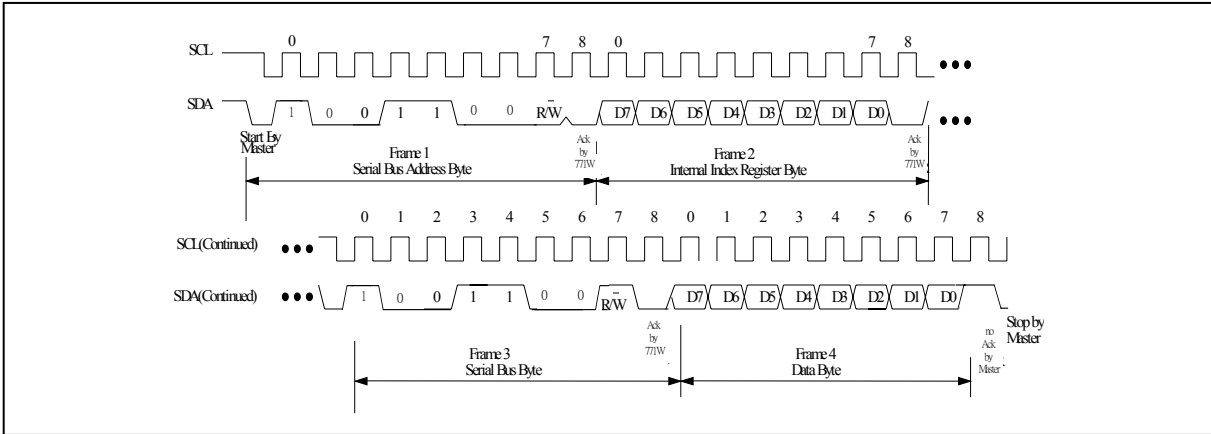
The first serial bus access timing is shown as follows:

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





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



### 7.3 ALERT Output Mode

W83L771W/G  $\overline{ALERT}$  pin is an active-low open-drain output pin which is triggered when measured temperature exceeds the limitation defined in limit registers. There are three types of  $\overline{ALERT}$  output mode:  $\overline{ALERT}$  output comparator mode,  $\overline{ALERT}$  output interrupt mode, and  $\overline{ALERT}$  output SMBus ALERT mode. Each kind of  $\overline{ALERT}$  output mode could best serve the system designer.

#### 7.3.1 $\overline{ALERT}$ Output Comparator Mode

Fig. 7.3.1 shows the mechanism of  $\overline{ALERT}$  output comparator mode. Setting Filter and Alert Configure Register, or register address BFh, D0 to 1 could enable  $\overline{ALERT}$  output comparator mode. Under this mode, the  $\overline{ALERT}$  pin will be alerted if the monitored temperature is out-of-limit and the  $\overline{ALERT}$  pin keeps low until the temperature goes back to the target range. This mode is not power on default setting.

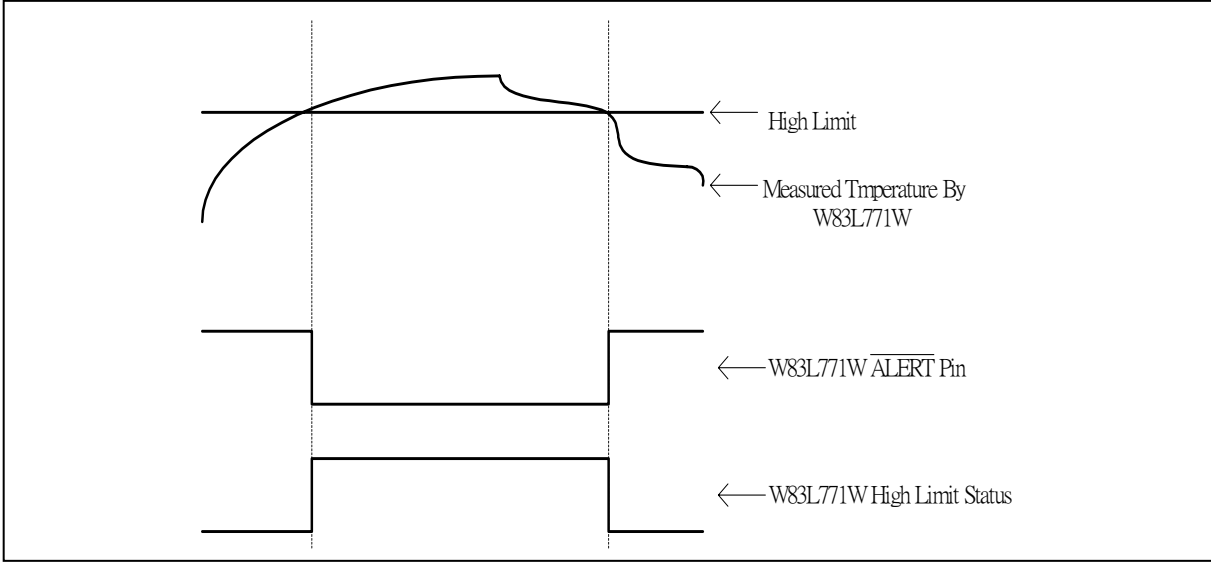


Fig. 7.3.1 Response of  $\overline{ALERT}$  output comparator mode

**7.3.2  $\overline{ALERT}$  Output Interrupt Mode**

Fig. 7.3.2 shows the mechanism of  $\overline{ALERT}$  output interrupt mode. Under this mode, W83L771W/G will set the ALERT mask bit D7 of Configuration Register during a read of the Status Register if any flag in Status Register is set, with the exception of Busy flag D7 and OPEN flag D2. This prevents further  $\overline{ALERT}$  triggering until the master has reset the ALERT mask bit, at the end of the interrupt service routine. The Status Register flags are cleared only upon a read command from the master and will be re-alerted at the end of the next conversation if the measured temperature still exceeds limitation. The flags in Status Register will be cleared again waiting for next read command.

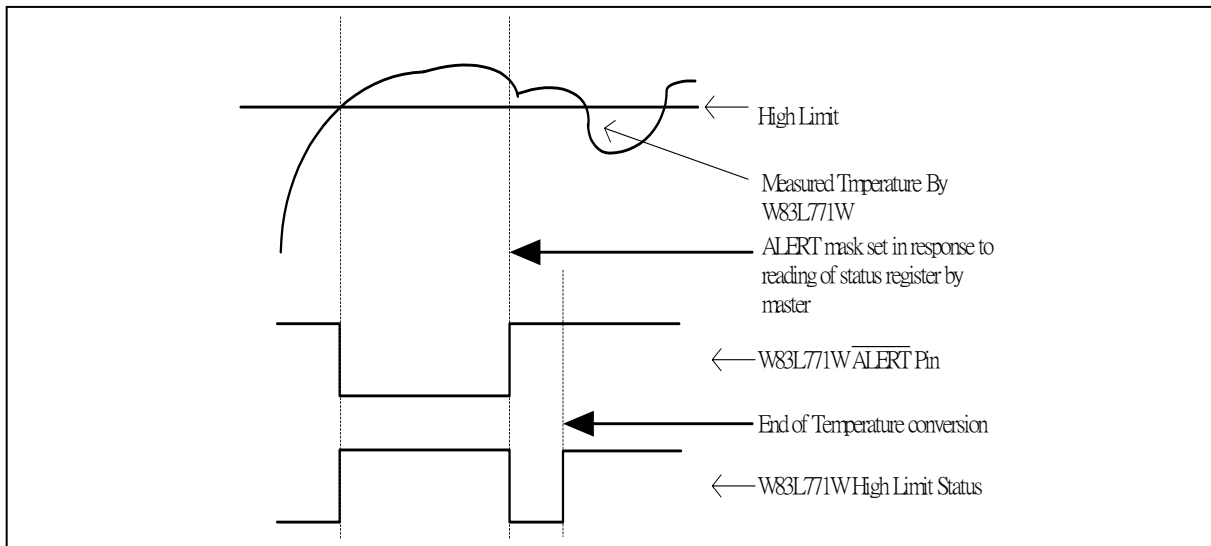


Fig. 7.3.2 Response of  $\overline{ALERT}$  output interrupt mode

### 7.3.3 $\overline{ALERT}$ Output SMBus ALERT Mode

Fig. 7.3.3 shows the mechanism of  $\overline{ALERT}$  output SMBus ALERT mode. Under this mode, the  $\overline{ALERT}$  output of W83L771W/G is connected to SMBus alert line which has more than one device connected to it. By using such implementation, SMBus ALERT protocol can assist the master in resolving which slave generates an interrupt. When measured temperature exceeds the limitation, the  $\overline{ALERT}$  pin is pulled low and the corresponding alert flags in Status Register high. If there is no read command for Status Register and the ALERT mask bit will just be set when SMBus ALERT Response Address (ARA) occurs from master (Alert Response Address is 0001100) and W83L771W/G will generate itself address to master. If the temperature never exceeds the limitation, the latched  $\overline{ALERT}$  pin can release by reset ALERT mask bit and the latched corresponding alert flags in Status Register can release by reading command for Status Register.

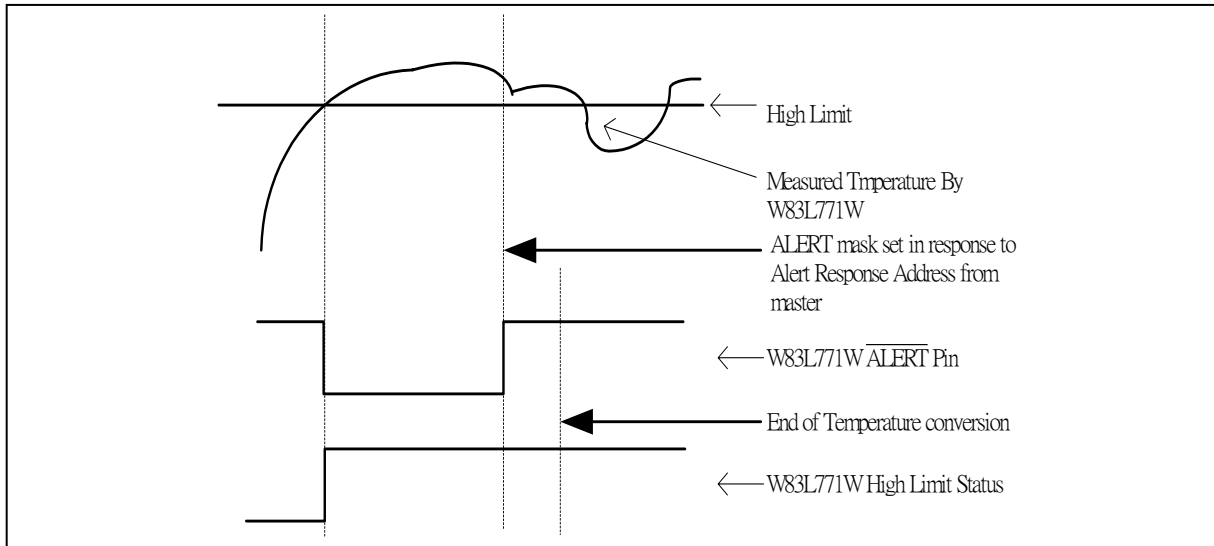


Fig. 7.3.3 Response of  $\overline{ALERT}$  output interrupt mode

#### 7.4 $\overline{T\_CRIT\_A}$ Output and T\_CRIT flags

$\overline{T\_CRIT\_A}$  Output pulls low when the measured temperature exceeds the critical temperature (T\_CRIT) defined in 19h, and 20h for Remote, and Local T\_CRIT set point, respectively. Once the  $\overline{T\_CRIT\_A}$  Output pulls high, it will not be reset until measured temperature is lower than (T\_CRIT - TH), where TH is Temperature Hysteresis. The Status Register will not be reset until it is read and the temperature conversion falls below the T\_CRIT set point. Figure 7.4 shows this mechanism.

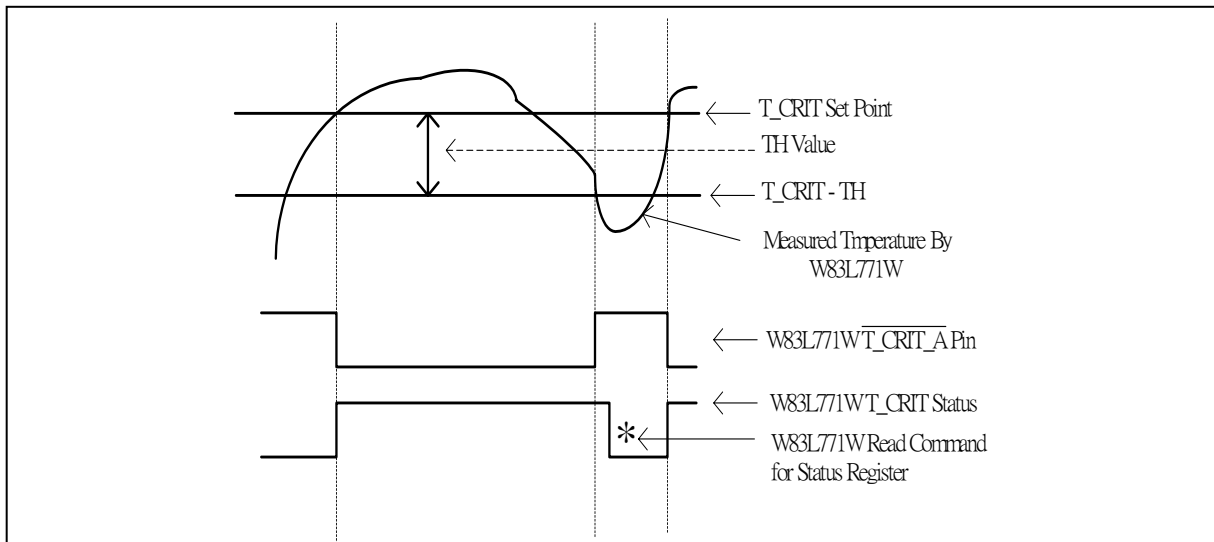


Fig. 7.4 Response of  $\overline{T\_CRIT\_A}$  output



## 7.5 Measured Temperature Data Format

W83L771W/G can measure remote temperature with the resolution of 11-bit two's complement format and local temperature with the resolution of 8-bit two's complement format.

### 7.5.1 Measure Remote Temperature Data Format

Table 7.5.1 shows remote temperature data with 11-bit two's complement format.

**Table 7.5.1 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	1111,1111	111X,XXXX
- 2.250°C	1111,1110	110X,XXXX
- 25.750°C	1110,0111	010X,XXXX
- 128.875°C	1000,0000	001X,XXXX

### 7.5.2 Measure Local Temperature Data Format

Table 7.5.2 shows local temperature data with 8-bit two's complement format.

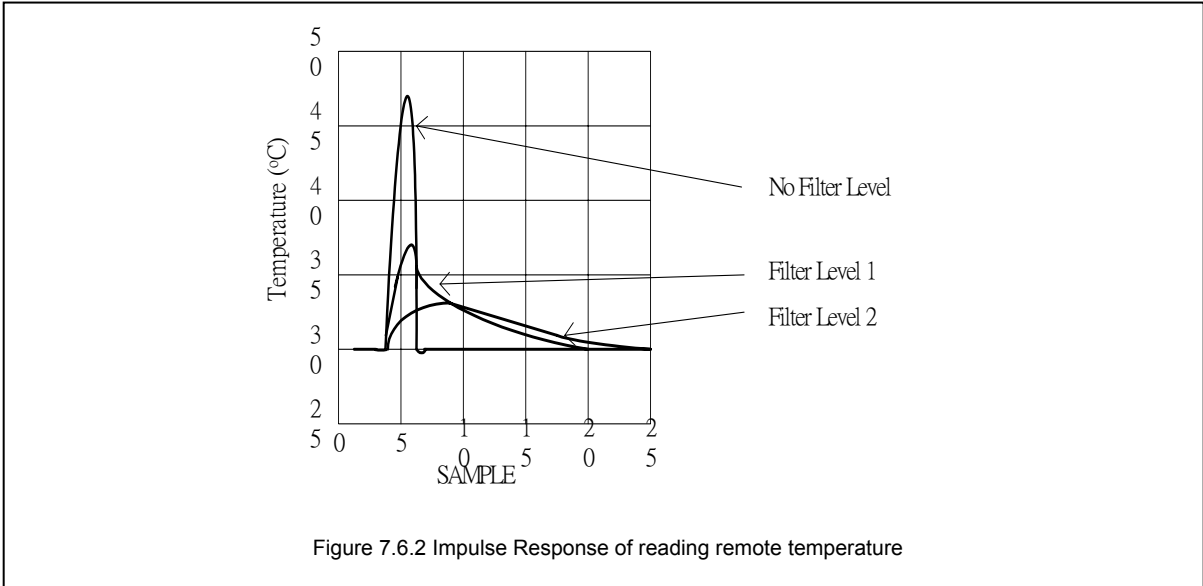
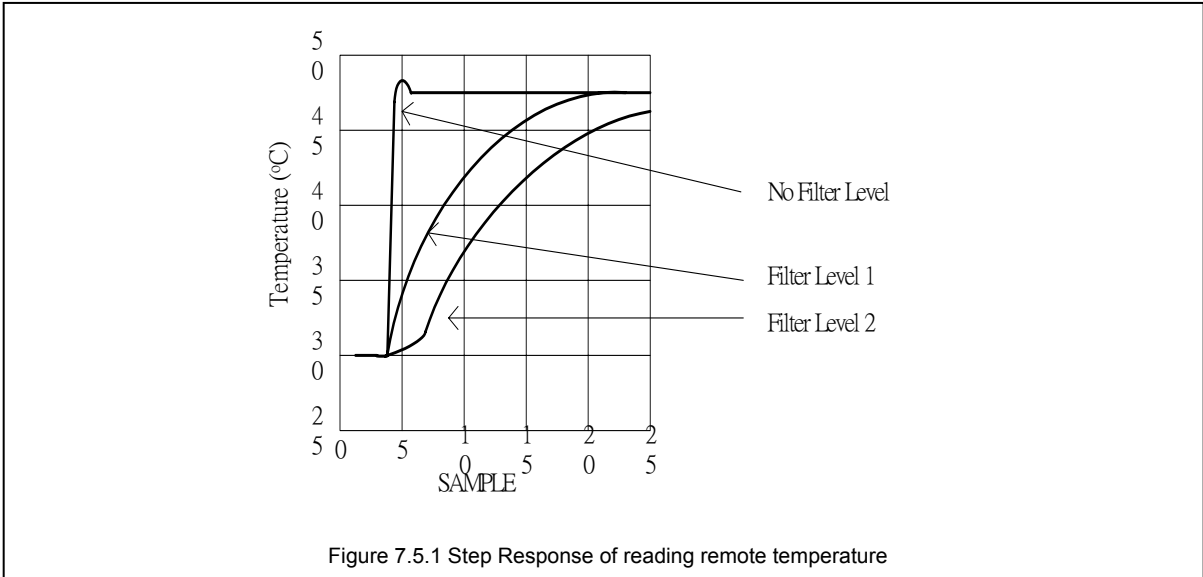
**Table 7.5.2 Measured Local Temperature Data Format**

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



**7.6 Digital Filter**

W83L771W/G provides three levels Digital Filter to suppress erroneous remote temperature readings due to noise. The register address to set digital filter is at Filter and Alert Configure Register. 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 7.5.1 shows the step response of reading remote temperature with different filter level, and Figure 7.5.2 shows the impulse response.





## 7.7 Fault Detect

Table 7.7 shows the response of Fault Detection if false connection of DPLUS and DMINUS occurs after power up. Except response of Table 7.7, if false connection takes place after power up Fault Detect, the OPEN flag will remain low and get a remote temperature  $-30^{\circ}\text{C}$ , the lowest temperature W83L771W/G could measure.

Table 7.7 response of Fault Detect

CONNECTION (DPLUS, DMINUS)	STATUS REGISTER BIT (OPEN)	MEASURED REMOTE TEMPERATURE	$\overline{ALERT}$ & $\overline{T\_CRIT\_A}$ PIN
(VDD, Floating)	1	+128 $^{\circ}\text{C}$	Pull Low
(GND, Floating)	0	- 128 $^{\circ}\text{C}$	Pull Low
(Floating, Floating)	1	+128 $^{\circ}\text{C}$	Pull Low
Shot	0	- 128 $^{\circ}\text{C}$	Pull Low

## 7.8 Conversion Rate and Moving Average

W83L771W/G provides an embedded moving average into conversion rate selection. The lower conversation rate can get more average times of measured remote temperature. Using an averaging temperature attains excellent noise rejection.





## 8. CONTROL AND STATUS REGISTER

### 8.1 W83L771W/G 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 High Byte (RTHB)	01h	Read Only	0000,0000b / 00h	0
Status Register (SR)	02h	Read Only	0000,0000b / 00h	0
Configuration (C)	03h	09h	0000,0000b / 00h	0
Conversion Rate (CR)	04h	0Ah	0000,1000b / 08h	8
Local High Set point (LHS)	05h	0Bh	0100,0110b / 46h	70
Local Low Set point (LLS)	06h	0Ch	0000,0000b / 00h	0
Remote High Set point High Byte (RHSB)	07h	0Dh	0100,0110b / 46h	70
Remote Low Set point High Byte (RLSHB)	08h	0Eh	0000,0000b / 00h	0
Remote Temperature Low Byte (RTLb)	10h	Read Only	0000,0000b / 00h	0
Remote Temperature Offset High Byte (RTOHB)	11h	11h	0000,0000b / 00h	0
Remote Temperature Offset Low Byte (RTOLB)	12h	12h	0000,0000b / 00h	0
Remote High Set point Low Byte (RHSLB)	13h	13h	0000,0000b / 00h	0
Remote Low Set point Low Byte (RLSLB)	14h	14h	0000,0000b / 00h	0
Remote T_CRIT Set point (RCS)	19h	19h	0110,1110b / 6Eh	110
Local T_CRIT Set point (LCS)	20h	20h	0101,0101b / 55h	85
T_CRIT Set point (TH)	21h	21h	0000,1010b / 0Ah	10
Remote Diode Temperature Filter (RDTF)	BFh	BFh	0000,0000b / 00h	0
Read Manufacturer's ID (RMID)	FEh	Read Only	0101,1100b / 5Ch	92
Read Die Revision (RDR)	FFh	Read Only	0000,0000b / 00h	0



## 8.2 Data Format of Temperature Registers (LT, RTHB, RTLB, LHS, RSHB, RSLB, LLS, RLSB, RLSLB)

REGISTER: LT, RTHB, LHS, RSHB, LLS, RLSB					DATA FORMAT: TWO'S COMPLEMENT FORMAT			
<b>BIT</b>	D7	D6	D5	D4	D3	D2	D1	D0
<b>VALUE</b>	Sign	64	32	16	8	4	2	1
Unit: °C								
REGISTER: RTLB, RSLB					DATA FORMAT: TWO'S COMPLEMENT FORMAT			
<b>BIT</b>	D7	D6	D5	D4	D3	D2	D1	D0
<b>VALUE</b>	0.5	0.25	0.125	0	0	0	0	0

## 8.3 Status Register (SR)

BIT	FLAG NAME	DESCRIPTION
D7	Busy	If set to '1' indicates ADC is busy converting.
D6	LHIGH	If set to '1' indicates a measured Local Temperature Higher than Local High set point (High Limit).
D5	LLOW	If set to '1' indicates a measured Local Temperature lower than Local Low set point (Low Limit).
D4	RHIGH	If set to '1' indicates a measured Remote Temperature higher than Remote High set point (High Limit).
D3	RLOW	If set to '1' indicates a measured Remote Temperature lower than Remote Low set point (Low Limit).
D2	OPEN	If set to '1' indicates a Remote Diode disconnect.
D1	RCRIT	If set to '1' indicates a Remote Critical Temperature alarm.
D0	LCRIT	If set to '1' indicates a Local Critical Temperature alarm.



#### 8.4 Configuration Register (C)

BIT	FLAG NAME	DESCRIPTION
D7	$\overline{ALERT}$ mask	If set to '1' $\overline{ALERT}$ interrupts are masked.
D6	Reserved	Reserved
D5	0	No definition and can be read out to 0.
D4	Remote $\overline{T\_CRIT\_A}$ mask	If set to '1' Remote $\overline{T\_CRIT\_A}$ interrupts are masked.
D3	0	No definition and can be read out to 0.
D2	Local $\overline{T\_CRIT\_A}$ mask	If set to '1' Local $\overline{T\_CRIT\_A}$ interrupts are masked.
D1	0	No definition and can be read out to 0.
D0	Reserved	Reserved

#### 8.5 T\_CRIT Hysteresis Register (TH)

REGISTER: TH					MAXIMUM VALUE: 31			
BIT	D7	D6	D5	D4	D3	D2	D1	D0
VALUE	0	0	0	16	8	4	2	1
Unit: °C								

#### 8.6 Conversion Rate Register (CR)

REGISTER: CR				DEFAULT CONVERSION RATE: 16HZ				
BIT<D7:D0> (DECIMAL)	0	1	2	3	4	5	6	7
CONVERSION RATE	31.25 mHz (32 Sec)	62.5 mHz (16 Sec)	125 mHz (8 Sec)	250 mHz (4 Sec)	500 Hz (2 Sec)	1 Hz (1 Sec)	2 Hz (0.5 Sec)	4 Hz (0.25 Sec)
BIT<D7:D0> (DECIMAL)	8	9	10-255					
CONVERSION RATE	8 Hz (125 mSec)	16 Hz (62.5 mSec)	Reserve					



### 8.7 Filter and Alert Configure Register (RDTF)

BIT	COMMAND	DESCRIPTION
<D7:D3>	0	No definition and can be read out to 0.
<D2:D1>	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	$\overline{ALERT}$ Configure	If set to '1' $\overline{ALERT}$ Output Comparator mode is enabled.



## 9. ELECTRICAL CHARACTERISTIC

### 9.1 Absolute Maximum Ratings

PARAMETER	RATING	UNIT
Power Supply Voltage	3.3	V
Input Voltage	3 to 5.5	V
Operating Temperature	0 to +70	°C
Storage Temperature	-50 to +150	°C

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

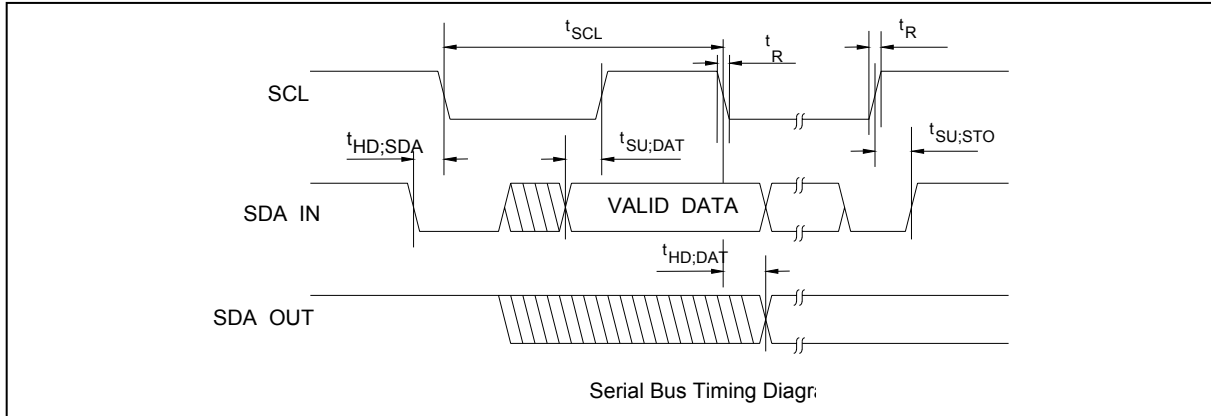
### 9.2 DC Characteristics

( $T_a = 0^\circ\text{C}$  to  $70^\circ\text{C}$ ,  $V_{DD} = 3.3\text{V} \pm 10\%$ ,  $V_{SS} = 0\text{V}$ )

PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
<b>I/O<sub>12ts</sub> - TTL level bi-directional pin with source-sink capability of 12 mA and schmitt-trigger level input</b>						
Input Low Threshold Voltage	V <sub>t-</sub>	0.5	0.8	1.1	V	V <sub>DD</sub> = 3.3 V
Input High Threshold Voltage	V <sub>t+</sub>	1.6	2.0	2.4	V	V <sub>DD</sub> = 3.3 V
Hysteresis	V <sub>TH</sub>	0.5	1.2		V	V <sub>DD</sub> = 3.3 V
Output Low Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 12 mA
Output High Voltage	V <sub>OH</sub>	2.4			V	I <sub>OH</sub> = -12 mA
Input High Leakage	I <sub>LIH</sub>			+10	μA	V <sub>IN</sub> = V <sub>DD</sub>
Input Low Leakage	I <sub>LIL</sub>			-10	μA	V <sub>IN</sub> = 0V
<b>OD<sub>12</sub> - Open-drain output pin with sink capability of 12 mA</b>						
Output Low Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 12 mA
<b>OD<sub>48</sub> - Open-drain output pin with sink capability of 48 mA</b>						
Output Low Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = 48 mA
<b>IN<sub>ts</sub> - TTL level Schmitt-triggered input pin</b>						
Input Low Threshold Voltage	V <sub>t-</sub>	0.5	0.8	1.1	V	V <sub>DD</sub> = 3.3 V
Input High Threshold Voltage	V <sub>t+</sub>	1.6	2.0	2.4	V	V <sub>DD</sub> = 3.3 V
Hysteresis	V <sub>TH</sub>	0.5	1.2		V	V <sub>DD</sub> = 3.3 V
Input High Leakage	I <sub>LIH</sub>			+10	μA	V <sub>IN</sub> = V <sub>DD</sub>
Input Low Leakage	I <sub>LIL</sub>			-10	μA	V <sub>IN</sub> = 0 V



### 9.3 AC Characteristics



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



## 10. THE TOP MARKING

The top marking of W83L771W



Left: Winbond logo

1st line: Winbond logo and the type number: W83L771W

2nd line: Tracking code 2 826978Y-61

3rd line: Tracking code 449 O B

449: packages made in '04, week 49

O: assembly house ID; A means ASE, S means SPIL, O means OSE

B: IC revision

The top marking of W83L771G



Left: Winbond logo

1st line: Winbond logo and the type number: W83L771G

2nd line: Tracking code 2 826978Y-61

3rd line: Tracking code 449 O B

449: packages made in '04, week 49

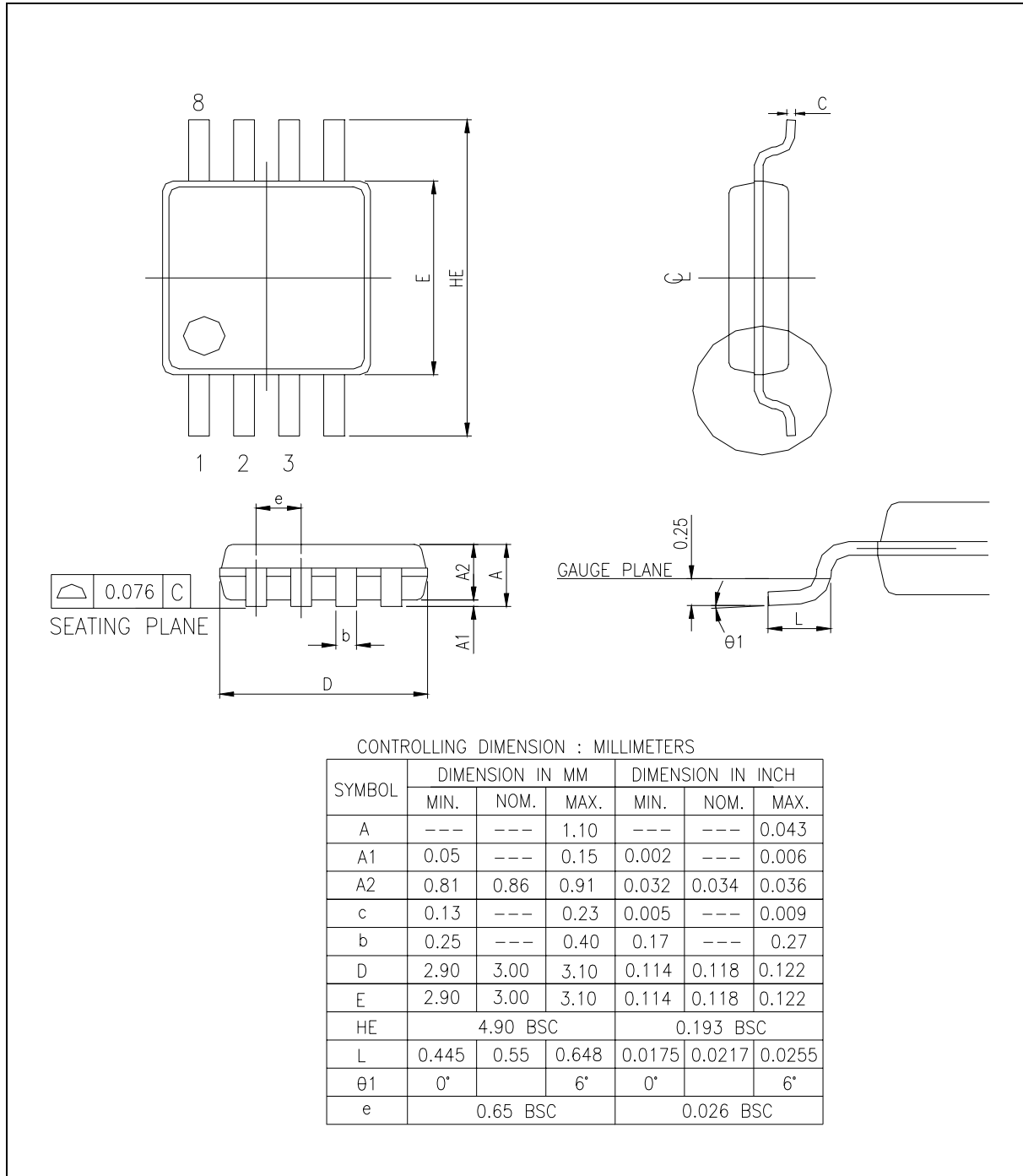
O: assembly house ID; A means ASE, S means SPIL, O means OSE

B: IC revision



## 11. PACKAGE SPECIFICATION

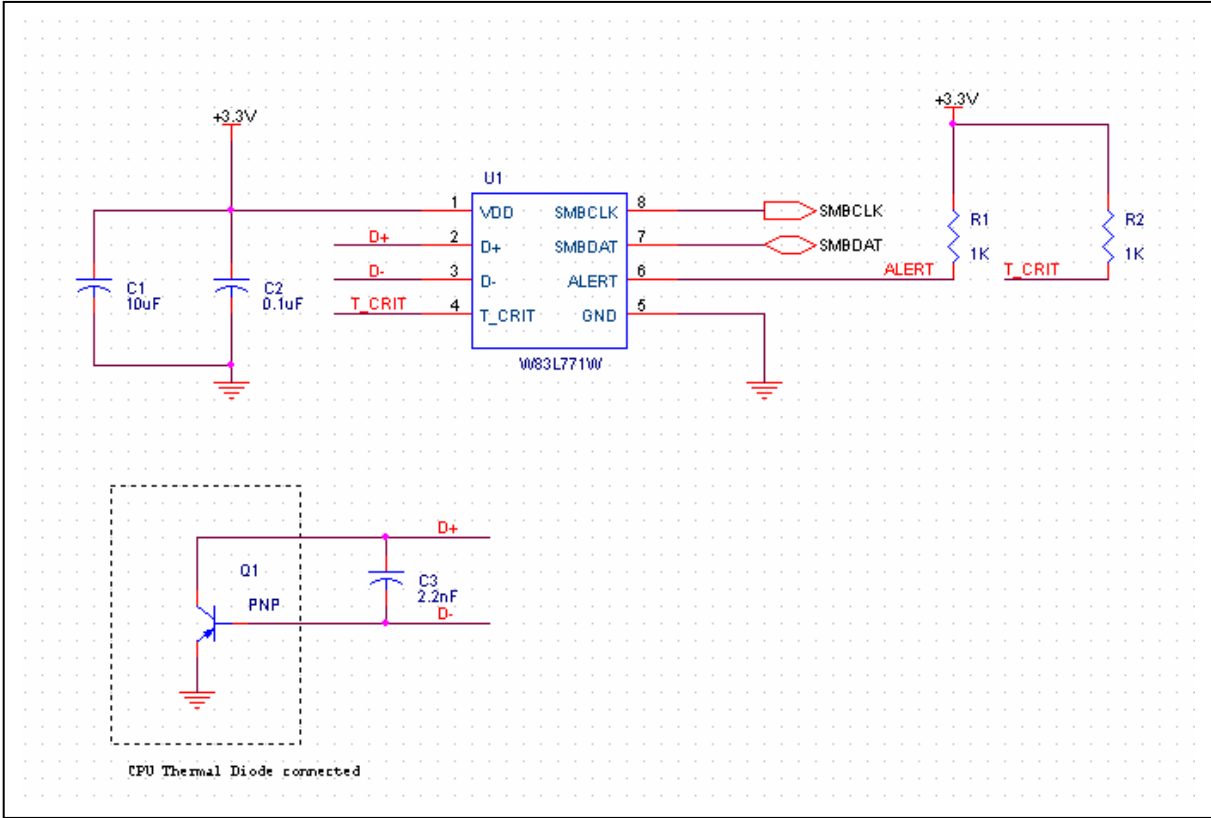
### TSSOP 8L 3X3 MM<sup>2</sup>







12. APPLICATION CIRCUITS



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