LM75 溫度感測器

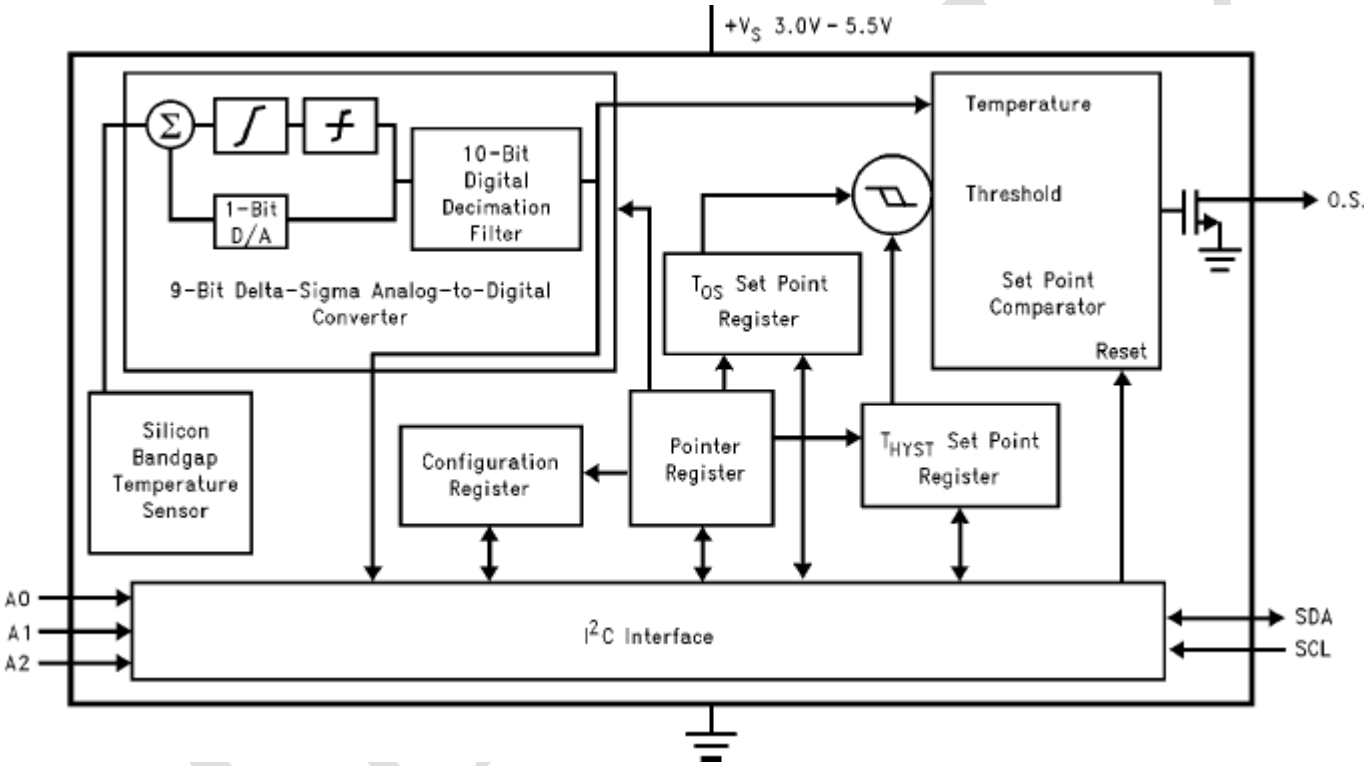
工作電壓:DC 3.0 ~ 5.5V

溝通介面:I2C

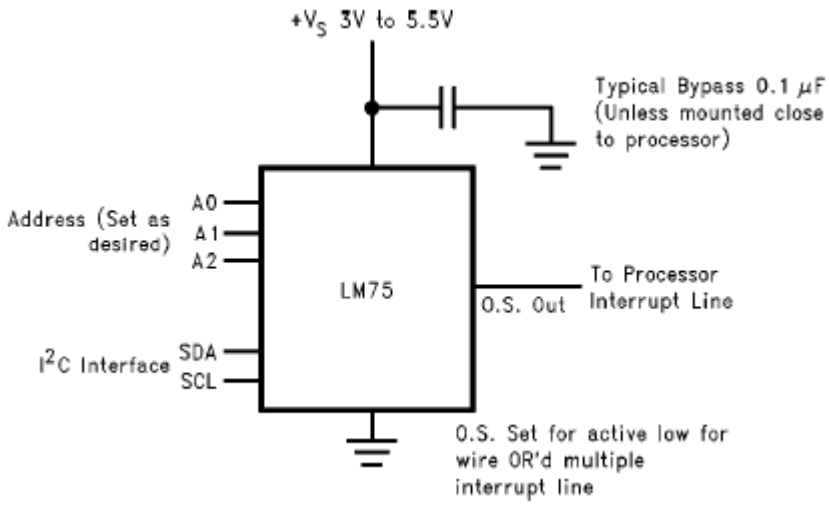
溫度準確度: -25 度~100 度 ±2 度(max)；-55 度~125 度 ±3 度(max)

有 O.S 中斷通知主控或控制其他開關風扇，此 O.S pin 為 oepn-drain **O**vertemperature **S**hut doww(O.S) 輸出。是 Active-low。相關參數為 T_{OS} 和 T_{HYST} 後面等等會介紹。

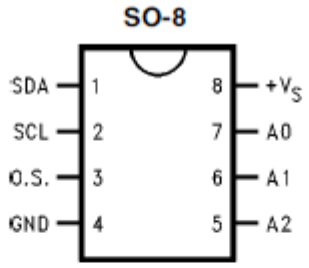
工作方塊圖



基本應用電路



接腳介紹



TL/H/12658–2

Order Number LM75CIM-3, LM75CIMX-3, LM75CIM-5 or LM75CIMX-5
See NS Package Number M08A

Ordering Information

Order Number	Supply Voltage	Supplied As
LM75CIM-3	3.3V	
LM75CIMX-3	3.3V	2500 Units on Tape and Reel
LM75CIM-5	5V	
LM75CIMX-5	5V	2500 Units on Tape and Reel

Pin Description

Label	Pin #	Function	Typical Connection
SDA	1	I²C Serial Bi-Directional Data Line	From Controller
SCL	2	I²C Clock Input	From Controller
O.S.	3	Overtemperature Shutdown Open Collector Output	Pull Up Resistor, Controller Interrupt Line
GND	4	Power Supply Ground	Ground
$+V_S$	8	Positive Supply Voltage Input	DC Voltage from 3V to 5.5V
A0–A2	7,6,5	User-Set I²C Address Inputs	Ground (Low, "0") or $+V_S$ (High, "1")

其中 A0~A2 設定 I2C Slave Address 如下：

Therefore, the complete slave address is:

1	0	0	1	A2	A1	A0

MSB LSB

設定 A0~A2 為 HIGH 或 LOW 來建立 LM75 Slave address，假設 A0=0 ; A1=0 ; A2=0 ; 則 Slave address 為 0x48(7bit)，0x90(8bit,write)，0x91(8bit,read)。

相關電性特性介紹

Parameter	Conditions	Typical	Limits (Note 7)	Units (Limit)
Accuracy	T_A = −25°C to +100°C T_A = −55°C to +125°C		**±2.0** **±3.0**	°C (max)
Resolution		9		Bits
Temperature Conversion Time	(Note 8)	100		ms
Quiescent Current	I²C Inactive I²C Active Shutdown Mode	0.25 1	 **1.0** 	mA mA (max) mA
O.S. Output Saturation Voltage	I_{OUT} = 4.0 mA (Note 9)		**0.8**	V (max)
O.S. Delay	(Note 10)		**1** **6**	Conversions (min) Conversions (max)
T_{OS} Default Temperature	(Note 11)	80		°C
T_{HYST} Default Temperature	(Note 11)	75		°C

- 準確度(Accuracy)如上表，
- 解析度(Resoultion)，為 9bit，

溫度轉換所需時間：100mS，主控讀取時須注意地方。一般來說主控 300mS~1000 mS 讀取一次就好。

值得注意的是(NOTE 8 的這句話)，如下，在 SPEC 的第 4 頁

Note 8: This specification is **provided only to indicate how often temperature data is updated**. **The LM75 can be read at any time without regard to conversion state** (and will yield last conversion result). If a conversion is in process it will be interrupted and restarted after the end of the read.

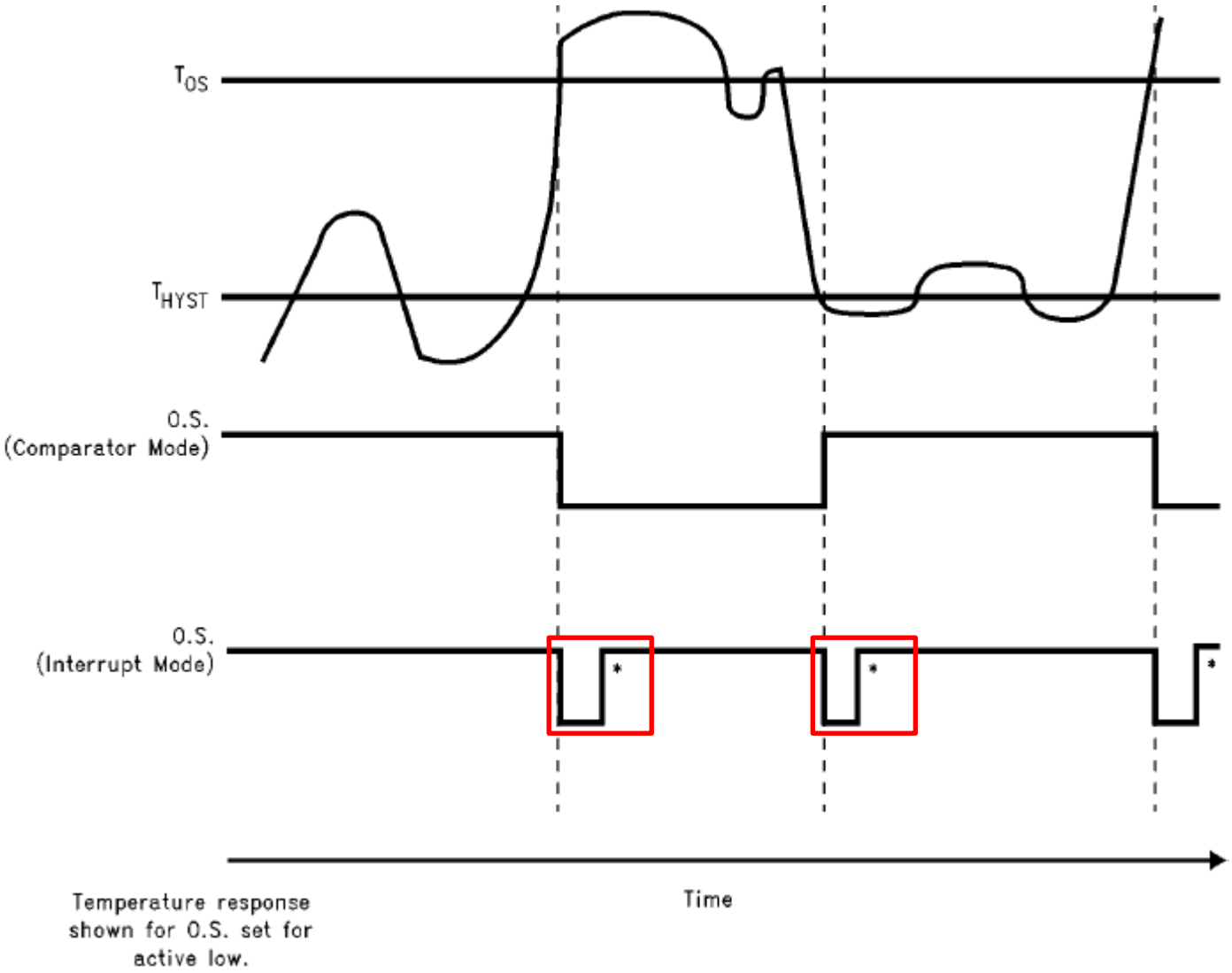
也就是說，只是說此顆 LM75 的轉換時間需要 100mS，且 LM75 可以在任何時候讀取，不用去理會 conversion state。且若有更新會在讀取完之後再更新(I2C read 完畢)。

- T_{OS} 和 T_{HYST}

預設值(default value)，分別為 T_{OS}=80 度；T_{HYST}=75 度。(NOTE11)為如下，

Note 11: Default values set at power up.

T_{OS} 和 T_{HYST} 關係圖 O.S. Output Temperature Response



1. 當 LM75 測量溫度超過 T_{OS}，**O.S pin 為設定為 Comparator Mode**，則會持續 Active Low，直到測量到溫度低於 T_{HYST}
2. 當 LM75 測量溫度超過 T_{OS}，**O.S pin 為設定為 Interrupt Mode**，則會拉 Active Low，直到 I2C 有來讀取 LM75，O.S pin 則會放開，回到 High。如紅框所示，其中*表示這一段話：

   *Note: These interrupt mode resets of O.S. occur only when LM75 is read. Otherwise, O.S. would remain active indefinitely for any event.

Power on 後，

1. 是 Comparator Mode
2. T_{OS}=80 度
3. T_{HYST}=75 度
4. O.S 是 Active Low，建議接一個上拉電阻約 10K。

溫度與數位轉換圖表

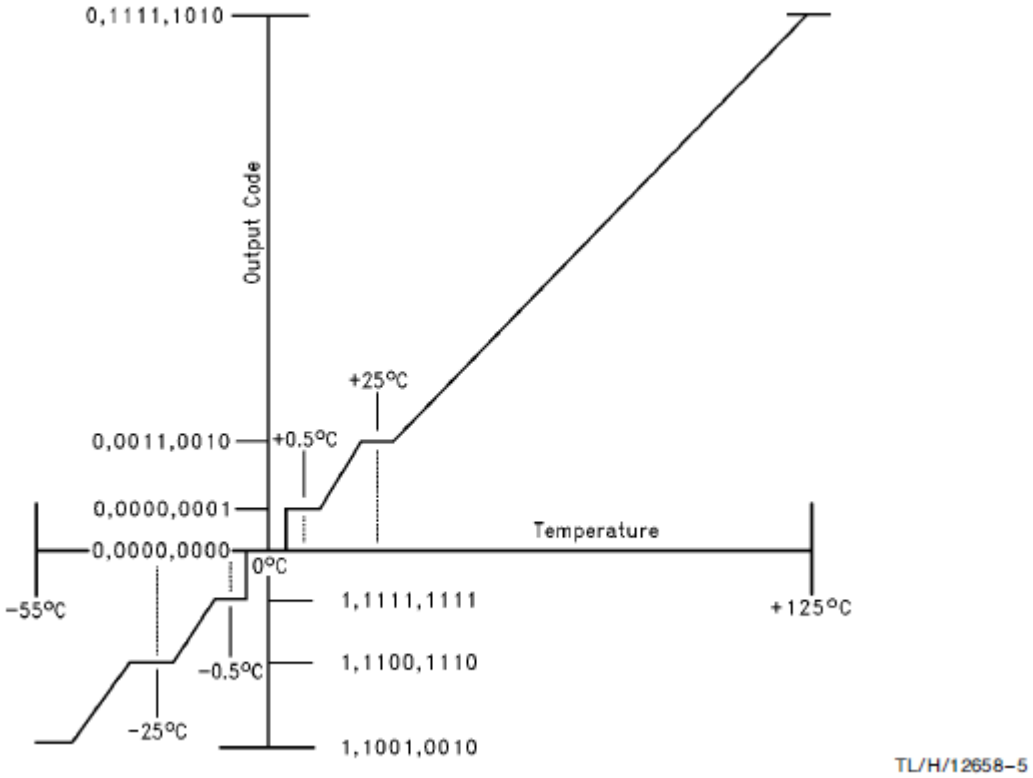


FIGURE 2. Temperature-to-Digital Transfer Function (Non-linear scale for clarity)

第 9 個 bit 代表正負號，也就是讀取到量測數值，**請做 2's 補數**

如下表，SPEC page 7 的表，

Temperature	Digital Output	
	Binary	Hex
+125°C	0 1111 1010	0FAh
+25°C	0 0011 0010	032h
+0.5°C	0 0000 0001	001h
0°C	0 0000 0000	000h
−0.5°C	1 1111 1111	1FFh
−25°C	1 1100 1110	1CEh
−55°C	1 10010010	192h

SHUTDOWN MODE

此模式為**低功耗模式，耗流僅 1uA**，設定方式，**設置 Configuration register 的 bit 0 為"1"**。

等等會介紹 LM75 的暫存器。

暫存器介紹

有四個暫存器，分別為

1. Temperature (Register address = 0x00) , Read Only
2. Configuration (Register address = 0x01) , Read/Write
3. T_{OS} Set(Register address = 0x11) , Read/Write
4. T_{HYST} Set(Register address = 0x10) , Read/Write

P7	P6	P5	P4	P3	P2	P1	P0
0	0	0	0	0	0	Register Select	

P0-P1: Register Select

P1	P0	Register
0	0	Temperature (Read only)(Power-up default)
0	1	Configuration (Read/Write)
1	0	T_{HYST} (Read/Write)
1	1	T_{OS} (Read/Write)

P2–P7: Must be kept zero.

Temperature Register

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB	X	X	X	X	X	X	X

D0–D6: Undefined

D7–D15: Temperature Data. One LSB = 0.5°C. Two's complement format.

解析度為 0.5 度，一共 9 個 bit，資料，I2C 讀取格式等等會說明。

且讀取出來先做 **2'S 的補數**。

Configuration Register

D7	D6	D5	D4	D3	D2	D1	D0
0	0	0	Fault Queue		O.S. Polarity	Cmp/Int	Shutdown

Power up default is with all bits "0" (zero).
D0: Shutdown: When set to 1 the LM75 goes to low power shutdown mode.
D1: Comparator/Interrupt mode: 0 is Comparator mode, 1 is Interrupt mode.
D2: O.S. Polarity: 0 is active low, 1 is active high. O.S. is an open-drain output under all conditions.
D3–D4: Fault Queue: Number of faults necessary to detect before setting O.S. output to avoid false tripping due to noise:

D4	D3	Number of Faults
0	0	1 (Power-up default)
0	1	2
1	0	4
1	1	6

D5–D7: These bits are used for production testing and must be kept zero for normal operation.

D0:是否進入 Shutdown 模式，如果要設"1"

D1:設定 O.S pin 的模式

D2:設定 O.S pin 極性，預設值是 Active low。

D3~D4:設定 O.S 的錯誤跳動次數，抗雜訊。預設值為 1 次。

D5~D7:當寫入任何值，D5~D7 請保持 0。

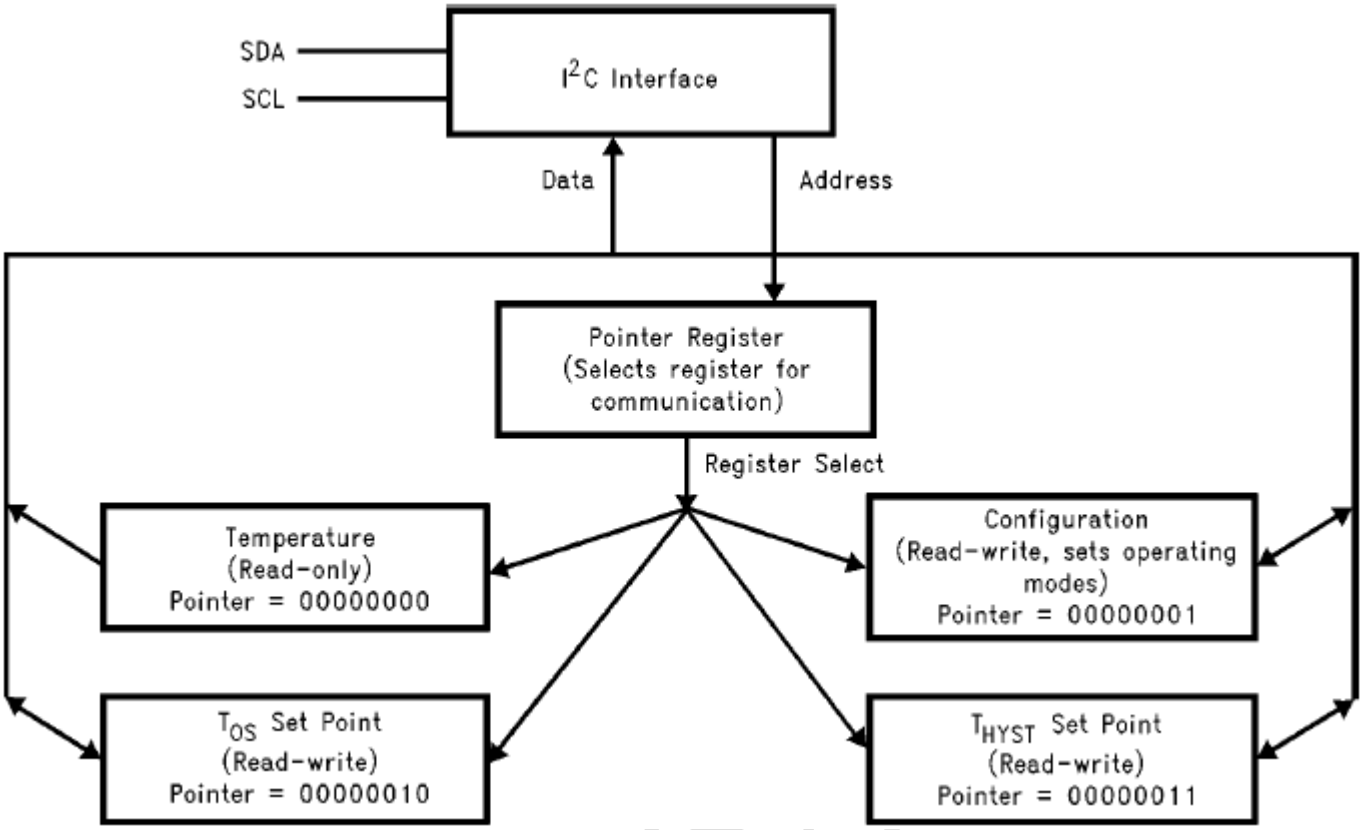
T_{OS} Set(Register address = 0x11) , Read/Write

T_{HYST} Set(Register address = 0x10) , Read/Write

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
MSB	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LSB	X	X	X	X	X	X	X

D0–D6: Undefined
D7–D15: T_{HYST} Or T_{OS} Trip Temperature Data. Power up default is T_{OS} = 80°C, T_{HYST} = 75°C.

工作流程

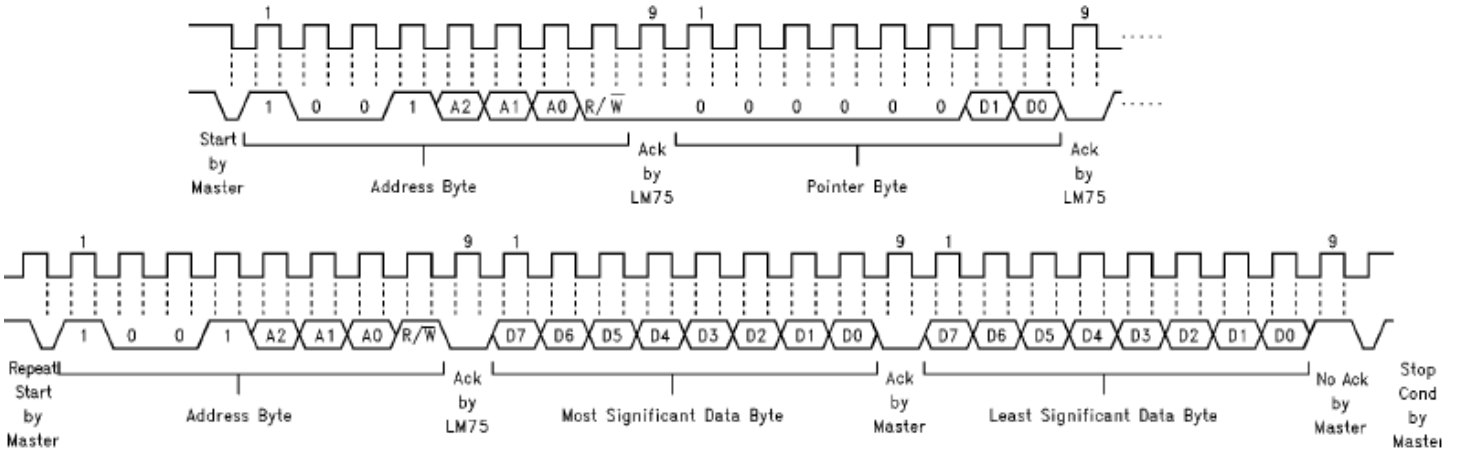

SDA
SCL
I2C Interface
Data
Address
Pointer Register
(Selects register for
communication)
Register Select
Temperature
(Read-only)
Pointer = 00000000
Configuration
(Read-write, sets operating
modes)
Pointer = 00000001
TOS Set Point
(Read-write)
Pointer = 00000010
THYST Set Point
(Read-write)
Pointer = 00000011

用 I2C Bus 操作 LM75

幾個重要的 I2C 時序要注意。LM75 有提供幾個非標準 I2C 讀取方式，這邊不考慮使用，例如。

如果太小看不清楚，請看 LM75 SPEC

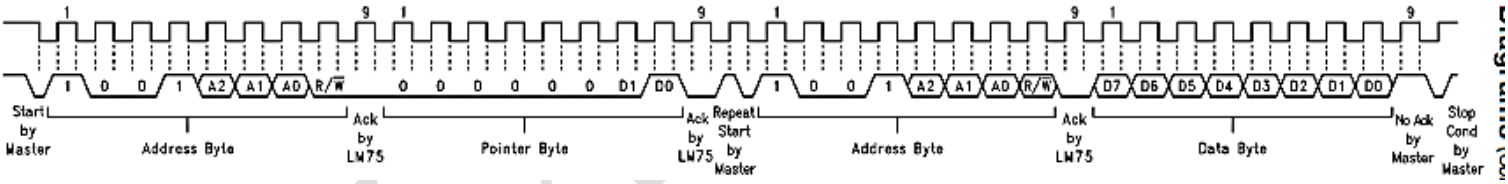
連續讀取 2BYTE



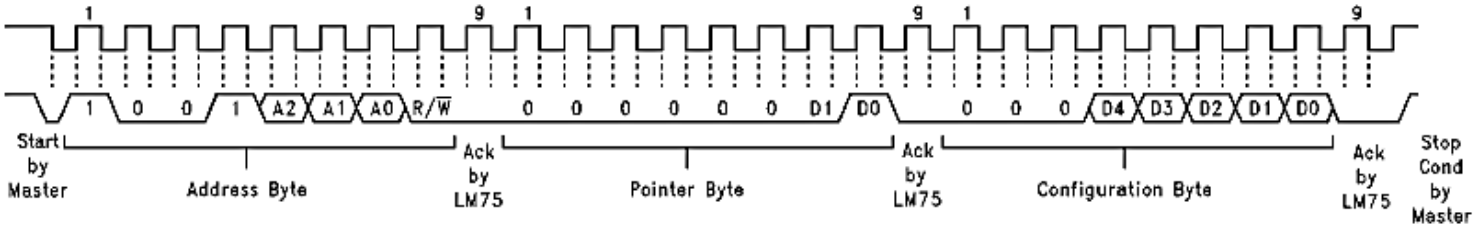
(b) Typical Pointer Set Followed by Immediate Read for 2−Byte Register such as Temp, T_{OS}, T_{HYST}

如上圖時序圖 Pointer Byte 就是設定 Register Adress，下方時序就是讀取資料。

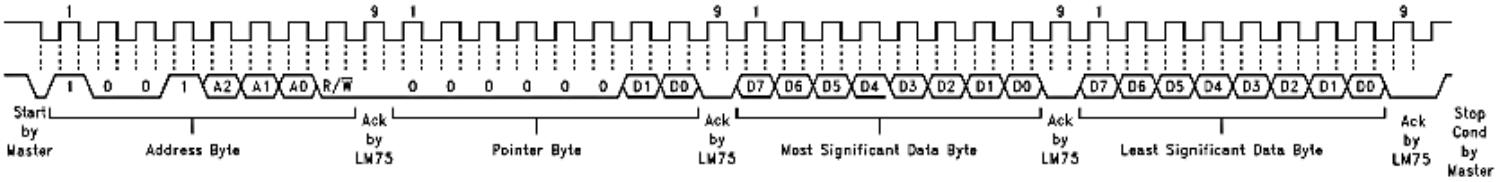
讀取 1BYTE



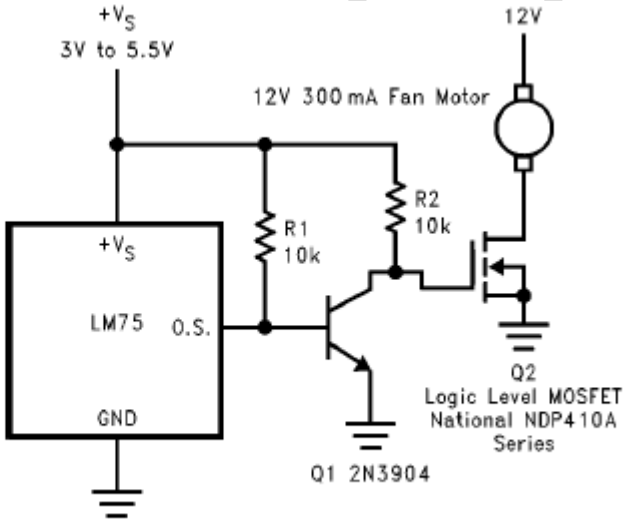
寫 1BIYE



寫 T_{OS} 或 T_{HYST} 的連續 2BYTE



其他應用電路



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When using I²C interface: program O.S. for active high and connect O.S. directly to Q2's gate.

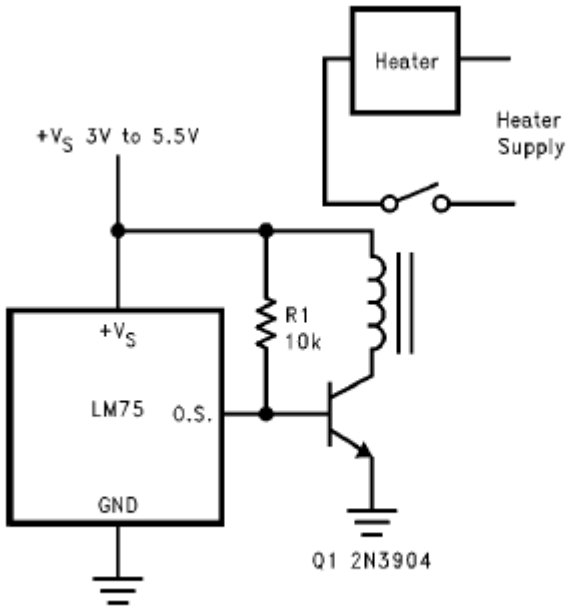

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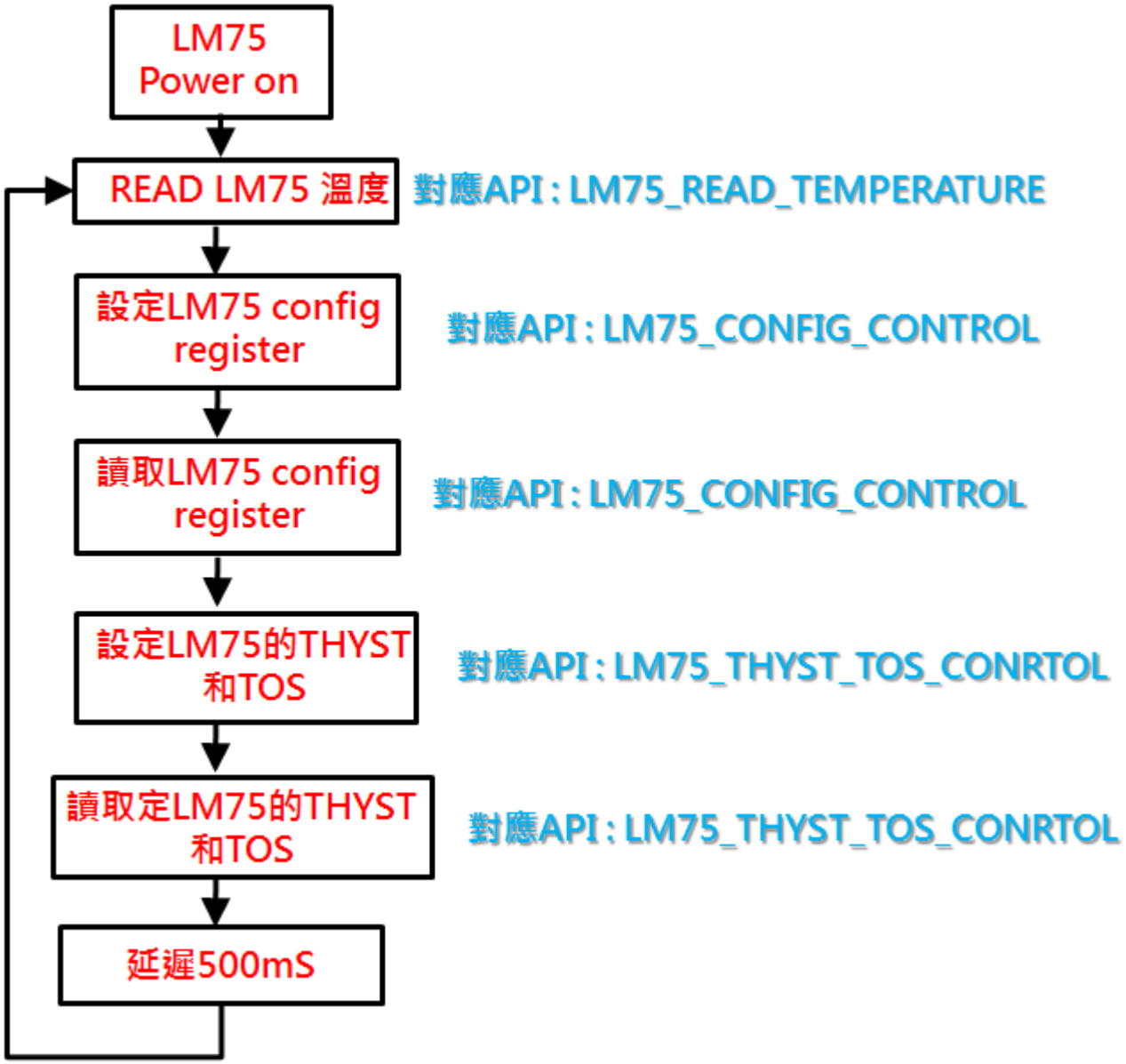
FIGURE 10. Simple Thermostat I²C Interface Optional

LM75 工作流程


LM75
Power on
READ LM75 溫度
對應API : LM75_READ_TEMPERATURE
設定LM75 config register
對應API : LM75_CONFIG_CONTROL
讀取LM75 config register
對應API : LM75_CONFIG_CONTROL
設定LM75的THYST和TOS
對應API : LM75_THYST_TOS_CONRTOL
讀取定LM75的THYST和TOS
對應API : LM75_THYST_TOS_CONRTOL
延遲500mS