# NCT7717U

# Nuvoton

# Thermal Sensor IC

Date: Jan./11/2011 Revision: 1.11

新唐科技 NUVOTON INTELLECTUAL PROPERTY

# NCT7717U Datasheet Revision History

| | PAGES | DATES | VERSION | MAIN CONTENTS |
|---|---|---|---|---|
| 1 | | 05/25/09 | 0.2 | Preliminary version. |
| 2 | | 10/29/09 | 0.3 | The ALERT# point hardware power-on setting table and register detail is TBD. |
| 3 | | 12/25/09 | 0.4 | Modified the registers default value and the hardware strapping resistor value. |
| 4 | | 05/06/10 | 0.5 | Modified the hardware strapping resistor value. |
| 5 | | 09/15/10 | 1.0 | Add the top marking specification, key specification and AC/DC specification<br>All versions before 1.0 are preliminary versions |
| 6 | | 12/23/10 | 1.1 | Add taping specification |
| 7 | 9 | 1/11/11 | 1.11 | Modified the Alert mod setting register description, correct some typo |

新唐科技 NUVOTON INTELLECTUAL PROPERTY

## *Table of Content-*


1. GENERAL DESCRIPTION ..... 1
2. FEATURES ..... 1
   - 2.1 Monitoring Items - Temperature ..... 1
   - 2.2 General ..... 1
   - 2.3 Package ..... 1
3. KEY SPECIFICATIONS ..... 1
4. PIN CONFIGURATION ..... 2
5. PIN DESCRIPTION ..... 2
6. FUNCTION DESCRIPTION ..... 3
   - 6.1 General Description ..... 3
   - 6.2 Access Interface ..... 3
     - 6.2.1 Data write to the internal register ..... 3
     - 6.2.2 Data read from the internal register ..... 3
   - 6.3 Address Setting ..... 3
   - 6.4 Temperature Measurement Data Format ..... 4
   - 6.5 ALERT# Output ..... 4
     - 6.5.1 ALERT# Output Comparator Mode ..... 4
     - 6.5.2 ALERT# Output Interrupt Mode ..... 5
     - 6.5.3 ALERT# Output SMBus™ alert Mode ..... 5
   - 6.6 ALERT# point hardware power-on setting ..... 6
7. REGISTER SUMMARY ..... 6
   - 7.1 Register Map ..... 6
   - 7.2 Register Detail ..... 7
     - 7.2.1 Register：Local Diode Temperature Readout ..... 7
     - 7.2.2 Register：Alert Status ..... 7
     - 7.2.3 Register：Configuration ..... 7
     - 7.2.4 Register：Conversion Rate ..... 8
     - 7.2.5 Register：Local Diode Temperature Alert Temperature ..... 9
     - 7.2.6 Register：One Shot Conversion ..... 9
     - 7.2.7 Register：Customer Data Log Registers ..... 9
     - 7.2.8 Register：Alert Mode Setting ..... 9
     - Register：Chip ID ..... 10
     - 7.2.9 Register：Vendor ID ..... 10
     - 7.2.10 Register：Device ID ..... 10
8. ELECTRICAL CHARACTERISTICS ..... 11
   - 8.1 Absolute Maximum Ratings ..... 11
   - 8.2 DC Characteristics ..... 11

8.3 AC Characteristics ..... 12
9. ORDER INSTRUCTION ..... 13
10. TOP MARKING SPECIFICATION ..... 13
11. TAPING SPECIFICATION ..... 13
12. PACKAGE DRAWING AND DIMENSIONS ..... 14

新唐科技 NUVOTON INTELLECTUAL PROPERTY

# 1. GENERAL DESCRIPTION

NCT7717U is an one on-chip local thermal sensor with high accuracy, a 8-bit ADC (Analog-to-Digital Converter) is built inside NCT7717U to convert the monitored temperature value with 1°C resolution. The NCT7717U supports an independent over temperature protection signal to activate system protection and hardware thermal shutdown via the ALERT# pin.

The NCT7717U is a high precision, low-power consumption IC supporting SMBus ™ interface, which is specifically designed for the PC, Notebook applications, and any embedded environments. Its available package is 5-pin SOT23, with the working voltage of 3.3V.

# 2. FEATURES

## 2.1 Monitoring Items - Temperature

- One on-chip thermal sensor
- Measure temperature with high accuracy
- Two's complement data format, 1°C resolution

## 2.2 General

- Alert point supports Hardware Power-on Setting
- $I^2C$® Compatible System Management bus (SMBus™)
- 3.3V±5% $V_{DD}$ operation

## 2.3 Package

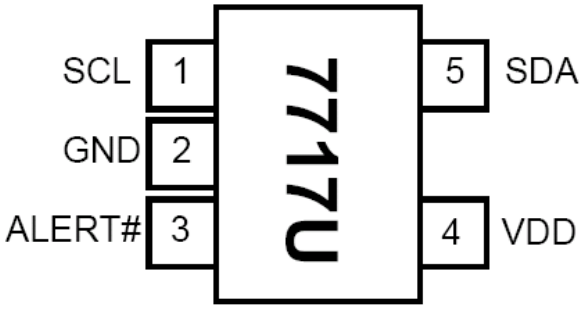
- SOT-23-5 Lead Free (ROHS Compliant) and Halogen Free Package

# 3. KEY SPECIFICATIONS

| PARAMETER | RATING |
|---|---|
| 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 |
| Supply voltage | 3.3V ± 5% |
| Operating supply current | 700 uA typ. |
| ADC resolution include sign bit | 8 Bits |

*1 Guaranteed by design from -40~125 degreeC.

## 4. PIN CONFIGURATION




## 5. PIN DESCRIPTION

| PIN TYPE | PIN ATTRIBUTE |
|---|---|
| $OD_{12}$ | Open-drain output pin with 12 mA sink capability |
| $IN_{ts}$ | TTL level input pin and schmitt trigger |
| P | Power or Ground Pin |

| PIN NO. | PIN NAME | I/O | FUNCTION |
|---|---|---|---|
| **1** | **SCL** | $IN_{ts}$ | SMBus ™ Clock |
| **2** | **GND** | P | Power supply ground |
| **3** | **ALERT#** | $OD_{12}$ | Alarm output, for interrupt control or shutdown control |
| **4** | **VDD** | P | DC Power supply, Voltage input 3.3V±10% |
| **5** | **SDA** | $IN_{ts}$/ $OD_{12}$ | SMBus ™ bi-directional data |

# 6. FUNCTION DESCRIPTION

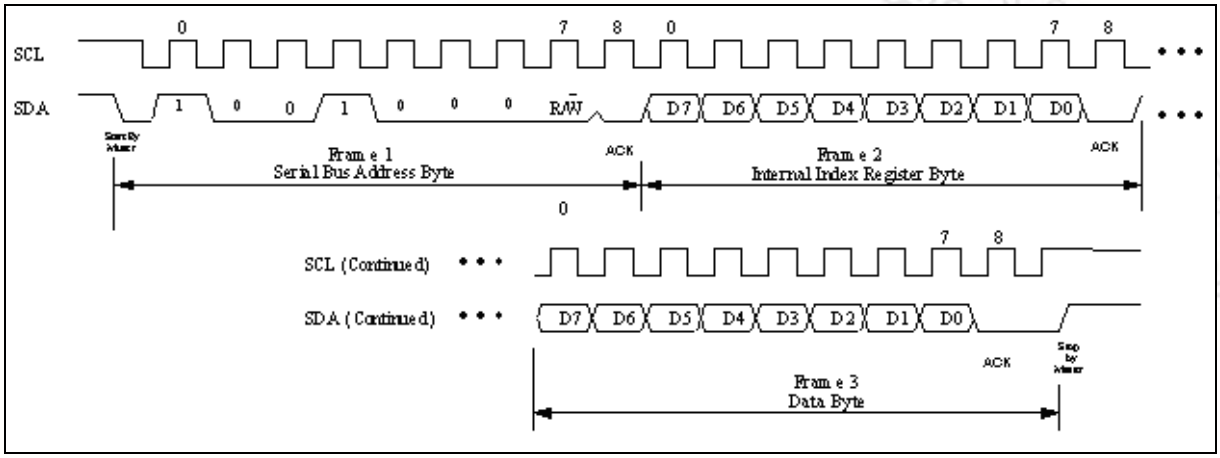
## 6.1 General Description

NCT7717U is SMBus™ interface device to provide on-die temperature sensor, 1 wire alert signal for event notification or system shutdown.

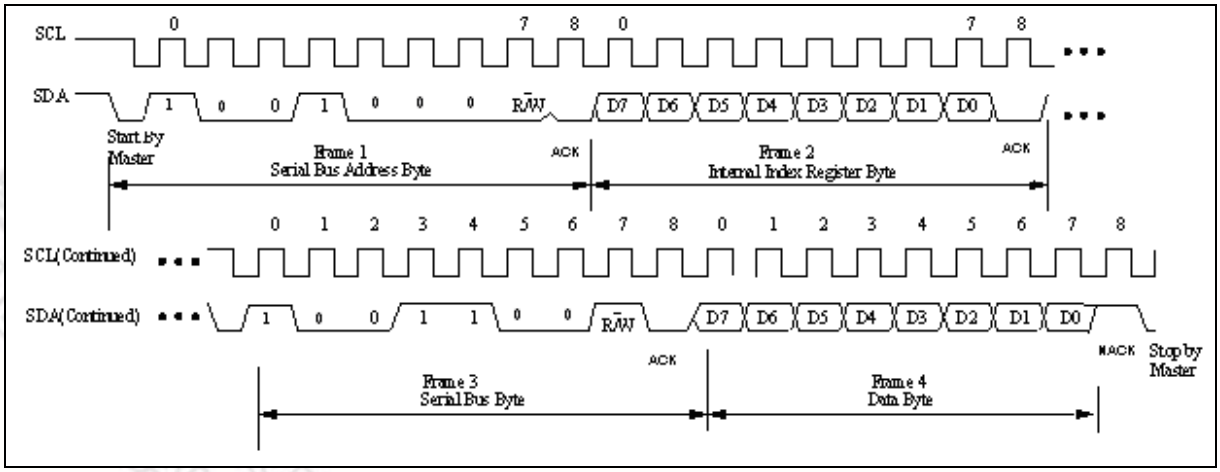
## 6.2 Access Interface

NCT7717U provides SMBus™ to access the internal register, supports SMBus™ byte write and byte read protocols.

### 6.2.1 Data write to the internal register




### 6.2.2 Data read from the internal register




## 6.3 Address Setting

NCT7717U I²C/ SMBus™ address is 1001000xb (x is R/W bit).

## 6.4 Temperature Measurement Data Format

The local temperature (on-die) data with 8-bit 2`s complement 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 |

## 6.5 ALERT# Output

The NCT7717U ALERT# pin is an active-low open-drain output pin which is triggered when measured temperature exceeds the limitation defined in the limit registers. There are three types of ALERT# output mode: the ALERT# output comparator mode, the ALERT# output interrupt mode, and the ALERT# output SMBus™ ALERT# mode.

### 6.5.1 ALERT# Output Comparator Mode

Figure 1 shows the mechanism of the ALERT# output comparator mode. In this mode, the ALERT# pin will be alerted if the monitored temperature is out-of-limit and the ALERT# pin keeps low until the temperature goes back to the target range.

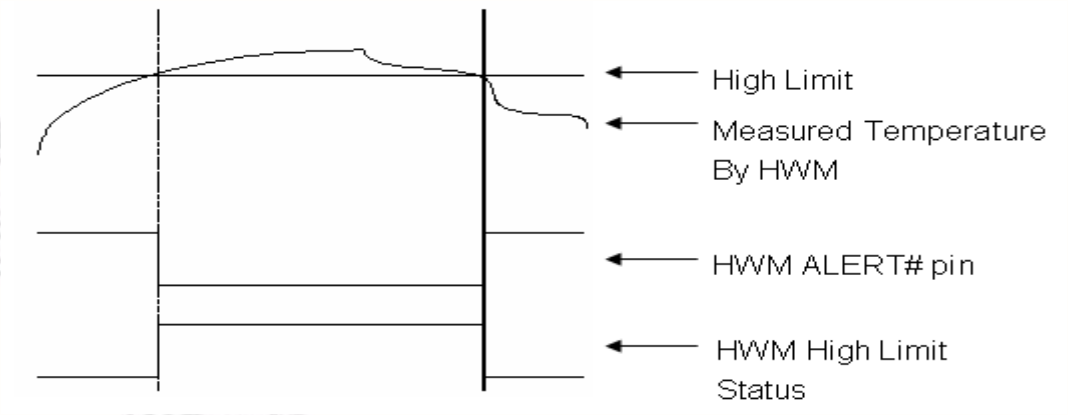



Figure 1

### 6.5.2 ALERT# Output Interrupt Mode

Figure 2 shows the mechanism of the ALERT# output interrupt mode. In this mode, the NCT7717U will set the ALERT mask bit of Configuration Register during a read of the Status Register if any flag in Status Register, except the ADC_Busy flag is set. This prevents further ALERT# triggering until the master has reset the ALERT mask bit (write 0 to Alert_MSK), at the end of the interrupt service routine. The Status Register flags are cleared only upon a read Status Register command from the master and will be re-alerted at the end of the next temperature conversion if the measured temperature still falls outside of the allowed range.

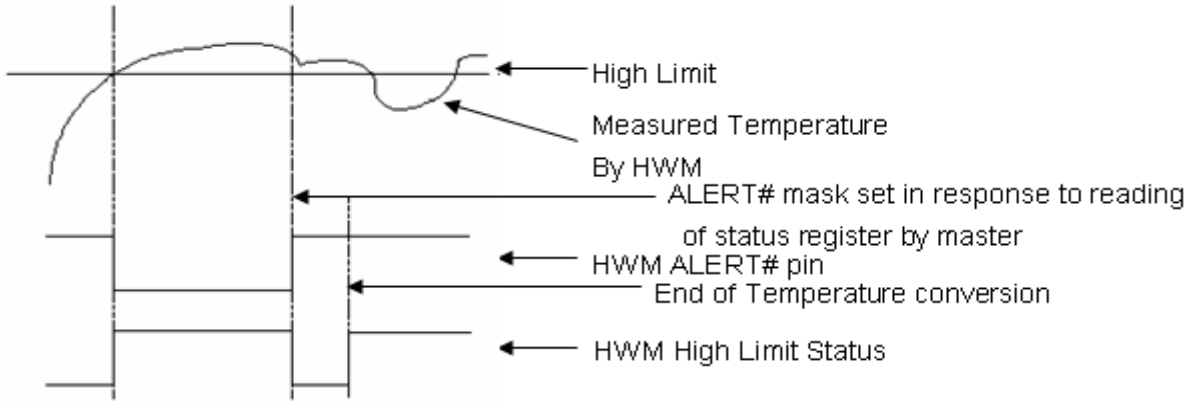



Figure 2

### 6.5.3 ALERT# Output SMBus™ alert Mode

Figure 3 shows the mechanism of the ALERT# output SMBus™ alert mode. In this mode, the ALERT# output of the NCT7717U is connected to the SMBus™ alert line which has more than one device connected to it. Through such and implementation, SMBus™ alert mode can assist the master in resolving which salve generates an interrupt. When the measured temperature falls outside of the allowed range, the ALERT# pin will be pulled low and the corresponding alert flags in Status Register will be set to 1. The ALERT mask bit will just be set if there is a read command for Status Register or when SMBus™ ALERT Response Address (ARA) occurs from master (Alert Response Address is 0001100x). Meanwhile, the NCT7717U will generate and return its own address to the master. If the temperature never falls outside of the allowed range, the latched ALERT# pin can release by the reset ALERT mask bit and the latched corresponding alert flags in Status Register can release by reading command for Status Register.

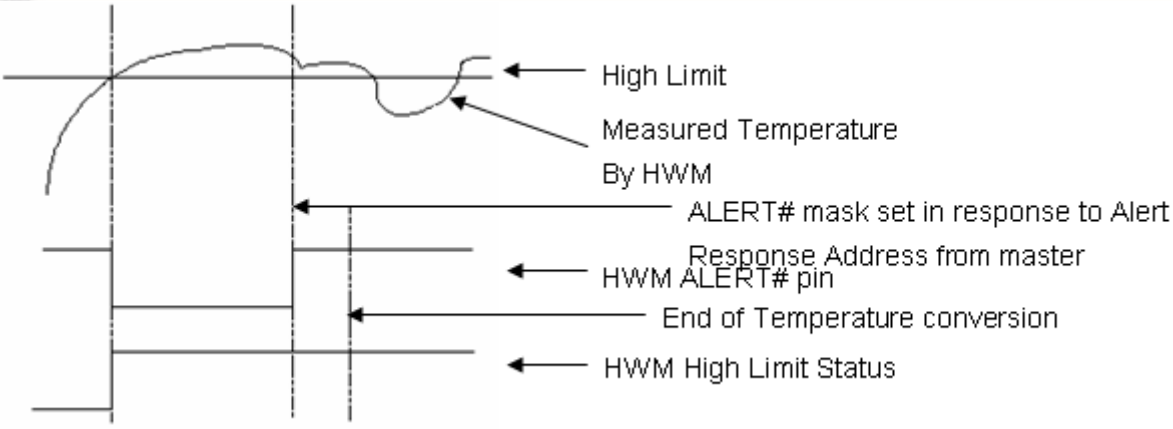



Figure 3

## 6.6 ALERT# point hardware power-on setting

The default value could be set after power up 100ms by different pull-up resistor of ALERT# pin:

| PULL-UP RESISTOR | | TEMPERATURE (℃) |
|---|---|---|
| ALERT | 2KΩ | 75 |
| | 7.5KΩ | 90 |
| | 10.5KΩ | 100 |
| | 14KΩ | 105 |
| | 18.7KΩ | 110 |

# 7. REGISTER SUMMARY

## 7.1 Register Map

| Idx | Register Name | Attr | Dft | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | LDT Readout | RO | 00 | MNTREG_LT[7:0] | | | | | | | |
| 2 | Alert Status | RO | 00 | ADC_Busy | STS_LTHA | Reserved | | | | | |
| 3 | Configuration [R] | RW | 21 | ALERT_MSK | STOP_Mnt | Reserved | | | | | EN_FaultQueue |
| 4 | Conversion Rate [R] | RW | 08 | Reserved | | | | ConvRate[3:0] | | | |
| 5 | LT High Alert Temp [R] | RW | - | LT_HAT[7:0] | | | | | | | |
| 9 | Configuration [W] | RW | 21 | ALERT_MSK | STOP_Mnt | Reserved | | | | | EN_FaultQueue |
| A | Conversion Rate [W] | RW | 08 | Reserved | | | | ConvRate[3:0] | | | |
| B | LT High Alert Temp [W] | RW | - | LT_HAT[7:0] | | | | | | | |
| F | One Shot Conversion | WO | FF | | | | | | | | |
| 2D | Customer Data Log Register 1 | RW | 00 | CustomerLogReg1[7:0] | | | | | | | |
| 2E | Customer Data Log Register 2 | RW | 00 | CustomerLogReg2[7:0] | | | | | | | |
| 2F | Customer Data Log Register 3 | RW | 00 | CustomerLogReg3[7:0] | | | | | | | |
| BF | Alert mode | RW | 01 | Reserved | | | | | | | Alert_MD |
| FD | CID (Chip ID) | RO | 50 | 50h | | | | | | | |
| FE | VID (Vendor ID) | RO | 50 | 50h | | | | | | | |
| FF | DID (Device ID) | RO | 90 | 90H | | | | | | | |

## 7.2 Register Detail

### 7.2.1 Register：Local Diode Temperature Readout

Location : Address 00h

Type : Read Only

Power on default value : 00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | **Local Diode Temperature Readout Value.** The real temperature value calculation is referred to TEMPERATURE MEASUREMENT DATA FORMAT. | | | | | | | |
| VALUE | SIGN | 64 | 32 | 16 | 8 | 4 | 2 | 1 |

### 7.2.2 Register：Alert Status

Location : Address 02h

Type : Read Only

Power on default value : 00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | ADC_Busy | STS_LTHA | Reserved | | | | | |
| DEFAULT | 0 | 0 | | | | | | |

| BIT | FLAG NAME | DESCRIPTION |
|---|---|---|
| 7 | ADC_Busy | If set to ‘1’ indicates ADC is busy converting. |
| 6 | STS_LTHA | If set to ‘1’ indicates a measured Local Diode Temperature Higher than Local High set point (High Limit). |

### 7.2.3 Register：Configuration

Location : Read = Address 03h  Write = Address 09h

Type : Read/Write

Power on default value : 21

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | ALERT_MSK | STOP_Mnt | Reserved | | | | | EN_FaultQueue |
| DEFAULT | 0 | 0 | | | | | | 1 |

| BIT | DESCRIPTION |
|---|---|
| 7 | **ALERT_MSK** – ALERT# function is enable |

| BIT | DESCRIPTION |
|---|---|
| | 0 = Enable<br>1 = Disable |
| 6 | **STOP_Mnt** – Stop Monitor and entry Standby<br>0 = Monitor<br>1 = Stop Monitor |
| 0 | **EN_FaultQueue**–Enable Fault Queue function.<br>0 = Disable. ALERT# will be generated if monitor result of any channel is above or below high/low set point.<br>1 = Enable. ALERT# will be generated if monitor result of any channel is three successive times above or below high/low set point. |

### 7.2.4 Register：Conversion Rate

Location : Read = Address 04h  Write = Address 0Ah

Type : Read/Write

Power on default value : 08

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | Reserved | | | | ConvRate | | | |
| DEFAULT | Reserved | | | | 1 | 0 | 0 | 0 |

| BIT<D7:D0> | FREQUENCY/TIME |
|---|---|
| 00h | 0.0625Hz / 16sec |
| 01h | 0.125Hz / 8sec |
| 02h | 0.25Hz / 4sec |
| 03h | 0.5Hz / 2sec |
| 04h | 1Hz / 1sec |
| 05h | 2Hz / 0.5sec |
| 06h | 4Hz / 0.25sec |
| 07h | 8Hz / 0.125sec |
| 08h | 16Hz / 0.0625sec |
| 09h-FFh | Reserved |

### 7.2.5 Register：Local Diode Temperature Alert Temperature

Location : Read = Address 05h  Write = Address 0Bh

Type : Read/Write

Power on default value : Hardware strapping.

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | LDT Alert Temperature | | | | | | | |
| VALUE | SIGN | 64 | 32 | 16 | 8 | 4 | 2 | 1 |
| DEFAULT | Hardware strapping | | | | | | | |

### 7.2.6 Register：One Shot Conversion

Location : Address 0Fh

Type : Write Only

| BIT | DESCRIPTION |
|---|---|
| 7-0 | One Shot Conversion – When enter Stop Monitor state, to fill any value into this register will trigger one temperature conversion cycle. |

### 7.2.7 Register：Customer Data Log Registers

Location : Address 2Dh, 2Eh, 2Fh

Type : Read/Write

Power on default value : 00

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | Customer Data Log Register | | | | | | | |
| DEFAULT | 00h | | | | | | | |

### 7.2.8 Register：Alert Mode Setting

Location : Address BFh

Type : Read/Write

Power on default value : 01

| BIT | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| NAME | Reserved | | | | | | | ALERT_MD |
| DEFAULT | 01h | | | | | | | |

| BIT | DESCRIPTION |
|---|---|
| 0 | ALERT_MD – ALERT mode configuration<br>0 = Interrupt or SMBus ™ alert mode ,  1 = Comparator mode |

* Note: To enable Interrupt or SMBus ™ alert mode, the address[21h] must be written 0x00 at the same time.

**Register：Chip ID**

Location : Address FDh

Type : Read Only

Power on default value : 50

| BIT | DESCRIPTION |
|---|---|
| 7-0 | **Chip ID.**<br>Chip ID of NCT7717U is 50h |

### 7.2.9 Register：Vendor ID

Location : Address FEh

Type : Read Only

Power on default value : 50

| BIT | DESCRIPTION |
|---|---|
| 7-0 | **Vendor ID.**<br>Vendor ID of NCT7717U is 50h |

### 7.2.10 Register：Device ID

Location : Address FFh

Type : Read Only

Power on default value: 9x

| BIT | DESCRIPTION |
|---|---|
| 7-0 | **Device ID.**<br>Device ID of NCT7717U is 9xh (x=0,1,2…) |

新唐科技 NUVOTON INTELLECTUAL PROPERTY

# 8. ELECTRICAL CHARACTERISTICS

## 8.1 Absolute Maximum Ratings

| PARAMETER | RATING | UNIT |
|---|---|---|
| Power Supply Voltage | 3.3V ± 5% | V |
| Input Voltage | -0.3 to +3.6 | V |
| Operating Temperature | -40 to +125 | ° 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.

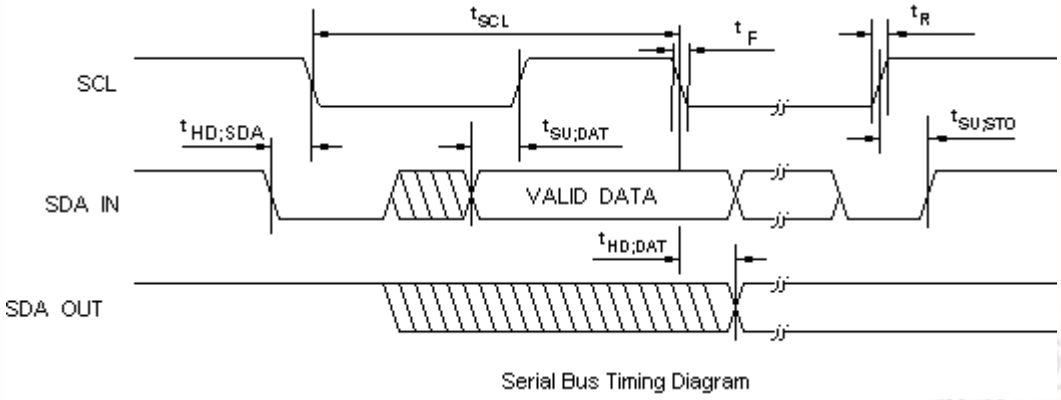
## 8.2 DC Characteristics

(Ta = 0° C to 70° C, VDD = 3.3V ± 5%, GND = 0V)

| PARAMETER | SYM. | MIN. | TYP. | MAX. | UNIT | CONDITIONS |
|---|---|---|---|---|---|---|
| $OD_{12}$ – Open-drain output pin with source-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 Voltage | $V_{IL}$ | | | 0.8 | V | VDD = 3.3V |
| Input High Voltage | $V_{IH}$ | 2.0 | | | V | VDD = 3.3V |
| Input High Leakage | $I_{LIH}$ | | | +10 | μA | VIN=3.3V |
| Input Low Leakage | $I_{LIL}$ | | | -10 | μA | VIN=0V |

## 8.3 AC Characteristics

SMBus ™ Interface



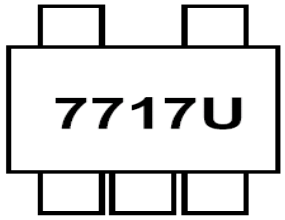

Serial Bus Timing Diagram

| 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 |

## 9. ORDER INSTRUCTION

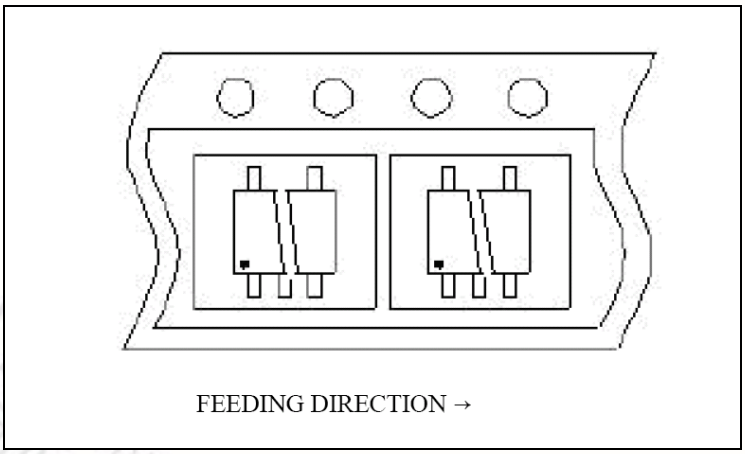
| PART NO. | PACKAGE | SUPPLIED AS | PRODUCTION FLOW |
|---|---|---|---|
| NCT7717U | SOT-23, 5pin<br>Green Package | T Shape:<br>3,000 units/T&R | Commercial, 0℃ to +70℃ |

## 10. TOP MARKING SPECIFICATION



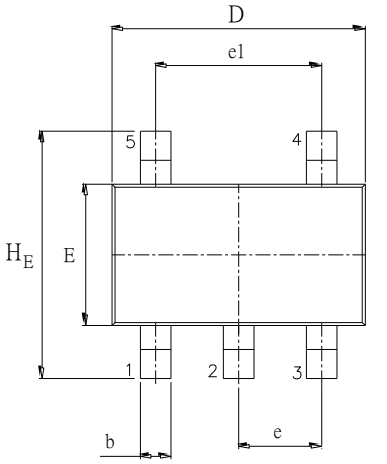

1st Line : **7717U** means part number NCT7717U

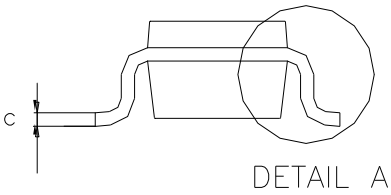
## 11. TAPING SPECIFICATION

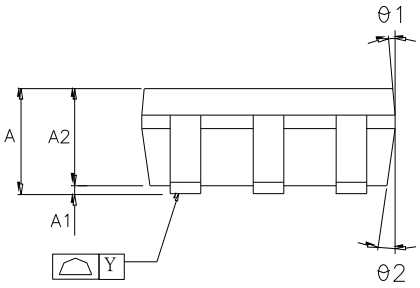


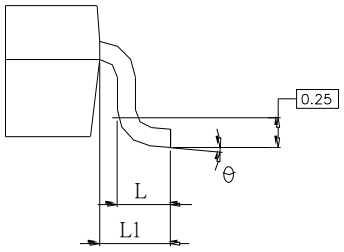
## 12. PACKAGE DRAWING AND DIMENSIONS

### SOT-23 (5L) 1.6X2.9 MM^2




DETAIL A

COTROL DIMENSIONS ARE IN MILLIMETERS

| SYMBOL | MILLIMETERS | | | INCH | | |
|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 1.05 | 1.20 | 1.35 | 0.041 | 0.047 | 0.053 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 1.00 | 1.10 | 1.2 | 0.039 | 0.043 | 0.047 |
| b | 0.25 | – | 0.50 | 0.010 | – | 0.020 |
| c | 0.08 | – | 0.20 | 0.003 | – | 0.008 |
| D | 2.70 | 2.90 | 3.00 | 0.106 | 0.114 | 0.118 |
| $H_E$ | 2.60 | 2.80 | 3.00 | 0.102 | 0.110 | 0.118 |
| E | 1.50 | 1.60 | 1.70 | 0.059 | 0.063 | 0.067 |
| e | 0.95 BSC | | | 0.037 BSC | | |
| e1 | 1.90 BSC. | | | 0.075 BSC. | | |
| L | 0.35 | 0.45 | 0.55 | 0.014 | 0.018 | 0.022 |
| L1 | 0.60 REF. | | | 0.024 REF. | | |
| θ | 0° | 5° | 10° | 0° | 5° | 10° |
| θ1 | 3° | 5° | 7° | 3° | 5° | 7° |
| θ2 | 6° | 8° | 10° | 6° | 8° | 10° |
| Y | – | – | 0.10 | – | – | 0.004 |

## Important Notice

**Nuvoton Products are neither intended nor warranted for usage in systems or equipment, any malfunction or failure of which may cause loss of human life, bodily injury or severe property damage. Such applications are deemed, "Insecure Usage".**

**Insecure usage includes, but is not limited to: equipment for surgical implementation, atomic energy control instruments, airplane or spaceship instruments, the control or operation of dynamic, brake or safety systems designed for vehicular use, traffic signal instruments, all types of safety devices, and other applications intended to support or sustain life.**

**All Insecure Usage shall be made at customer's risk, and in the event that third parties lay claims to Nuvoton as a result of customer's Insecure Usage, customer shall indemnify the damages and liabilities thus incurred by Nuvoton.**

*Please note that all data and specifications are subject to change without notice.*
*All the trademarks of products and companies mentioned in this datasheet belong to their respective owners.*