8-bit Microcontroller

Nuvoton Touch Key Series
NT1080
Datasheet

For additional information or questions, please contact: Nuvoton Technology Corporation.

www.nuvoton.com

Table of Contents

1 GENERAL DESCRIPTION

The Nuvoton touch key series, NT1080, supports 8 capacitive touch keys and 8 corresponding output channels with excellent anti-impulse noise and anti-electromagnetic noise ability. The NT1080 supports many functions, such as single key, multi-key and toggle mode. Meanwhile, an external host MCU can control the NT1080 through the I²C bus easily.

2 FEATURES

- Support 8 capacitive touch keys and 8 corresponding output channels
- Output modes:
  - GPIO
  - I^2C
- Water resistant or water-droplet operation
  - Operating at water resistant without error operation
  - Key lock function
- Resist electromagnetic immunity
  - Resist mobile phone electromagnetic immunity
  - Resist 5W walky-talky electromagnetic immunity (> 2 cm)
- Multiple touch key output selection
  - Single touch key/ multi-keys function selectable
  - Toggle function
  - Low active/high active output
  - Key lock function
- I^2C parameter settings
  - Touch key trigger level for each key
  - Touch key de-bounce for each key
  - Auto calibration interval
- Operating voltage: 2.4V~5.5V
- Operating current: 1.8mA~2.3mA
- Operating temperature: -40℃~85℃
- Touch key response time: 32 ms

3 PIN DIAGRAM

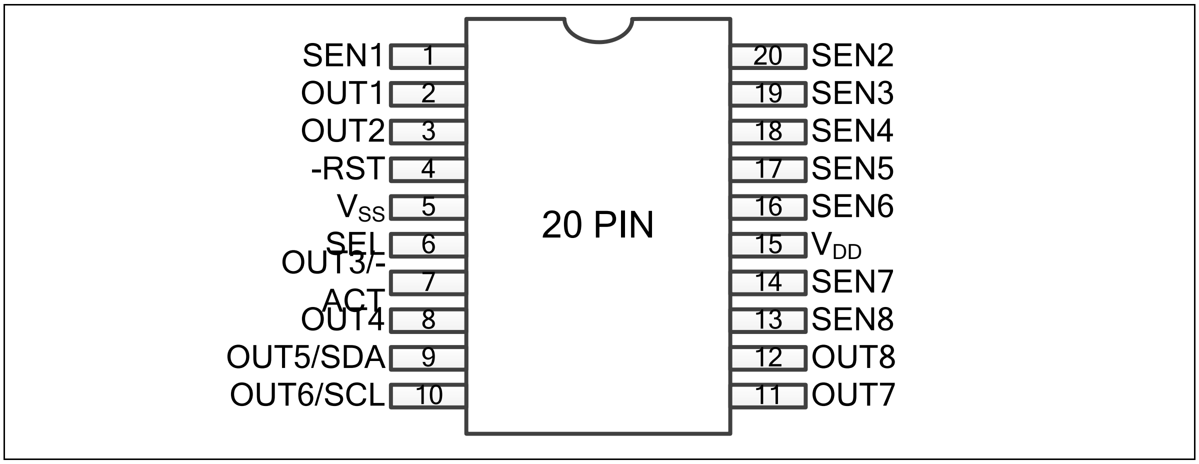


Figure 3-1 TSSOP20 Pin Diagram

No.	Pin Name	Description
1	SEN1	Touch key-1 input pin.
2	OUT1	Touch key-1 output pin.
3	OUT2	Touch key-2 output pin.
4	-RST	IC reset pin.
5	V_{SS}	Ground pin.
6	SEL	Output mode selection pin. (Connected to V_{SS}: GPIO output, Connected to V_{DD}: I^2C output)
7	OUT3/-ACT	Touch key-3 output pin / Touch key active indicator when selecting I^2C output
8	OUT4	Touch key-4 output pin.
9	OUT5/SDA	Touch key-5 output pin / Data pin of I²C bus when selecting I²C output. (I²C : write touch key parameter only)
10	OUT6/SCL	Touch key-6 output pin/ Clock pin of I²C bus when selecting I²C output. (I²C : write touch key parameter only)
11	OUT7	Touch key-7 output pin.
12	OUT8	Touch key-8 output pin.
13	SEN8	Touch key-8 input pin.
14	SEN7	Touch key-7 input pin.
15	V_{DD}	Power supply pin.
16	SEN6	Touch key-6 input pin.
17	SEN5	Touch key-5 input pin.
18	SEN4	Touch key-4 input pin.
19	SEN3	Touch key-3 input pin.
20	SEN2	Touch key-2 input pin.

Table 3-1 Pin Description

4 CAPACITIVE TOUCH KEY

4.1 Input Circuit

Each capacitive touch key needs to connected with one resistor as shown in Figure 4-1. It is strongly recommended that the resistor value is 100 kΩ. At the same time, all the resistors need to be kept as close to sensor pad as possible during PCB layout.

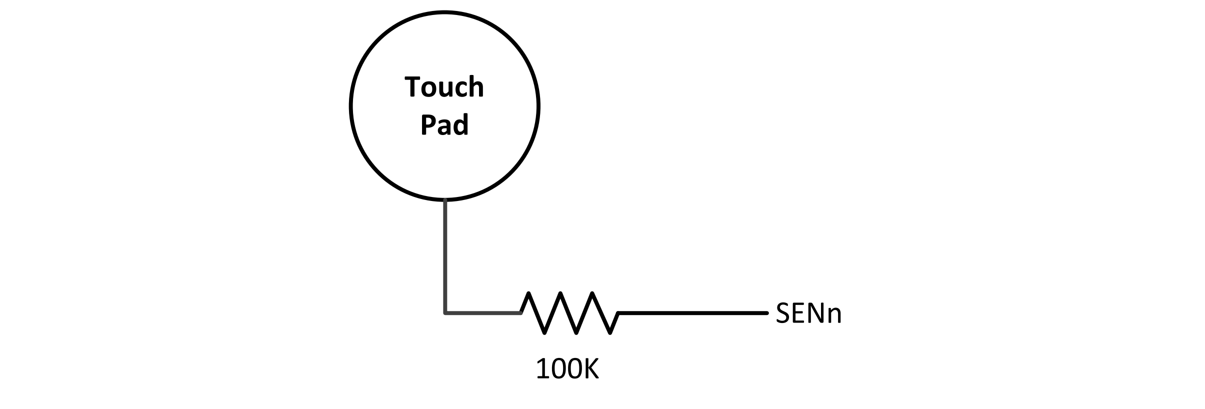


Figure 4-1 Touch Key Reference Circuit

4.2 Sensor Pad and Ground for PCB Layout

The size of sensor pad, using circular shape with diameter equal or greater than 8mm is recommended. Actually, sensor pad could be any kinds of shape, but fulfilling finger size is suitable. Extra ground-net around sensor pads is not needed for PCB artwork. However, ground-net along sensor pad to chip is alternative. Figure 4-2 shows that the PCB line width of sensor pad to chip should be 0.254mm (10mil) or less and to keep distance with ground at least 1mm. The other layer of PCB could implement ground-net for PCB artwork to block noise interfering with signal line. All the subsidiary components need to be kept as close to sensor pad as possible at PCB layout. Meanwhile, touch key chip (NT1080) and touch pad located in the PCB board would be better.

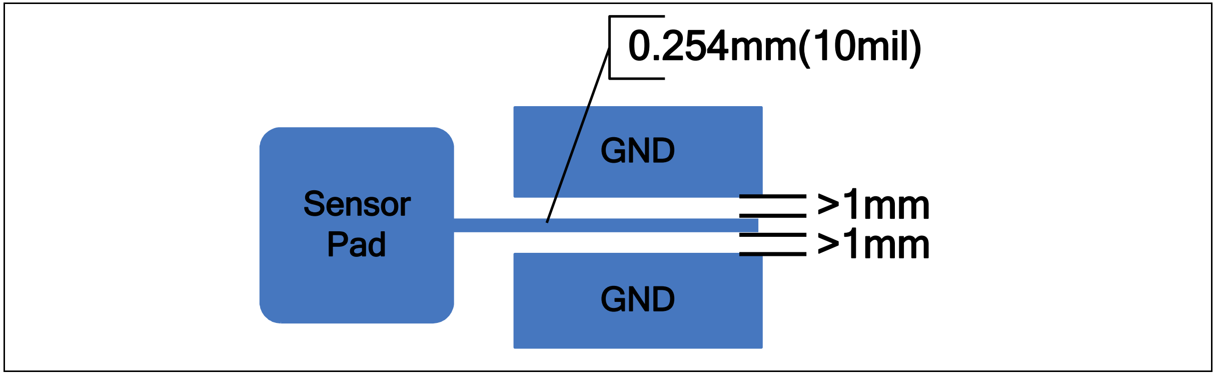


Figure 4-2 Sensor Pad and Ground-Net

As shown in Figure 4-3, a spring attached with metal-panel can be used to act as sensor pads. It is recommended that metal-panel (ring) should be adhered to the inside of cover to be an effective sensing area. If user wants to add a LED in the middle of sensor pad, the measure of sensor area should be increased to compensate the hollowing part and keeping the same sensitivity.

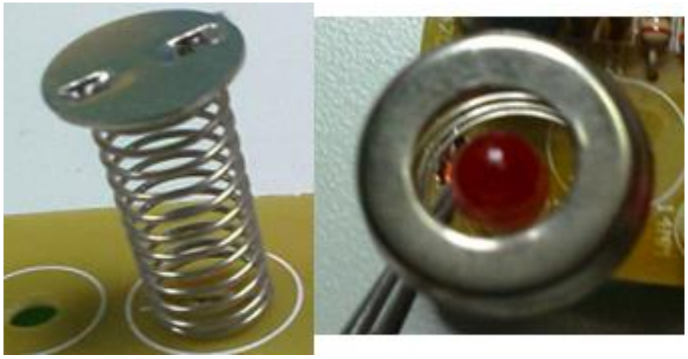


Figure 4-3 Spring with Solid Metal Plane/Ring

4.3 Sensor Pad Size

The size of sensor pad plays a great role in determining thickness of panel. The greater area of sensor pad is, and the deeper touch signal could be detected. Table 4-1 shows the relation with thickness and panel thickness.

Size of Sensor Pad	**Panel Thickness (Recommended Value)**
8 mm X 8 mm	2.0 mm
10 mm X 10 mm	3.0 mm
15 mm X 15 mm	4.5 mm
20 mm X 20 mm	6.0 mm

Table 4-1 Sensor Pas and Corresponding Panel Thickness

5 I^2C INTERFACE

The maximum speed of I^2C serial interface could be up to 400Kbps and it will not send any signal in an active way to main controller since it is I^2C slave. The I^2C interface is not working in normal operation time. To enter I^2C serial mode, user must connect V_{DD} to SEL pin and then make chip power-on. User could easily set the touch related parameter and adjust the sensitivity by using the I^2C interface.

The I^2C transmission provides three modes: byte-write, random-read and continual-read.

5.1 Byte-Write

The data protocol includes 3 bytes from master writing data to salve. The first byte for Device address, the second byte for Memory address and the third byte is for the write data. Figure 5-1 shows the detail about byte-write action.

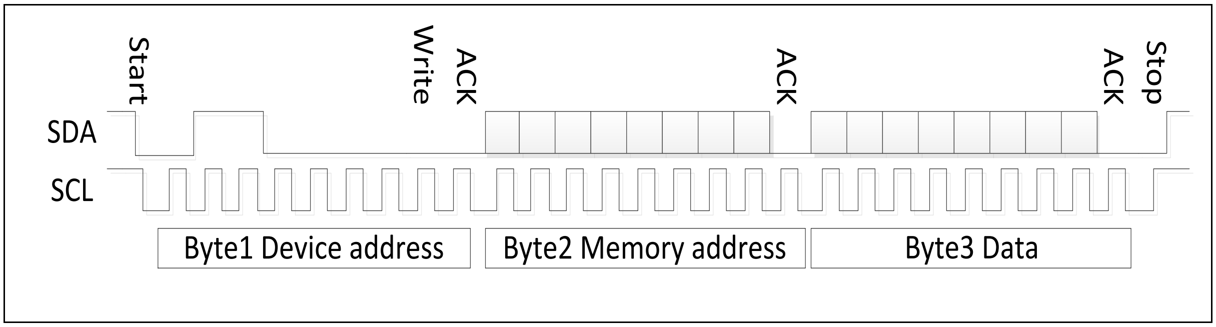


Figure 5-1 Byte-write Mode

In normal times, SDA and SCL will be kept as logic 1. For the start signal, SDA will change to logic 0 first then SCL to logic 0 as well. When transmitting, data is prepared on SDA signal and then SCL will change to logic 1. Slave reads the byte data based on the rising edge of SCL signal. Slave will send logic 0 on the 9th clock signal to indicate receiving the byte data. For the stop signal, master device will change SCL to logic 1 and then SDA to 1, when the transmission of 3 bytes of information are finished.

5.2 Random-Read

This is a 4-byte data combination when Master reads Slave. Figure 5-2 shows that the first byte is used as device address and write-status; the second byte is used as memory address; the third byte is used as device address and read-status and the fourth byte is used as Slave output data with Master keeping sending the SCL clock signal.

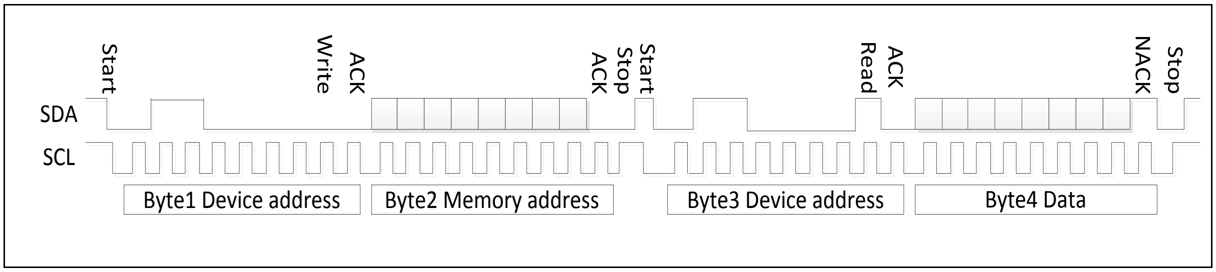


Figure 5-2 Random-Read Mode

After finishing 2nd byte data transmission, Start signal is needed before sending next 3rd byte data. SCL signal will change to logic 0 when 3rd byte data transmission is done. SCL signal will be released till 4th output data is ready. The first host could send logic 1 on SCL and monitor SCL changing to logic 1 to receive 1st bit. Note that Master should send a logic 1, NACK signal, on the 9th clock signal of the 4th byte.

5.3 Continual-Read

This is a 4-byte data combination when Master continually reads Slave. Figure 5-3 shows that the first byte as device address and write-status; the second byte as memory address; the third byte as device address and read-status. From the fourth byte, Slave will keep output data with Master keeping sending ACK and SCL clock signal. The memory address will be automatically increased.

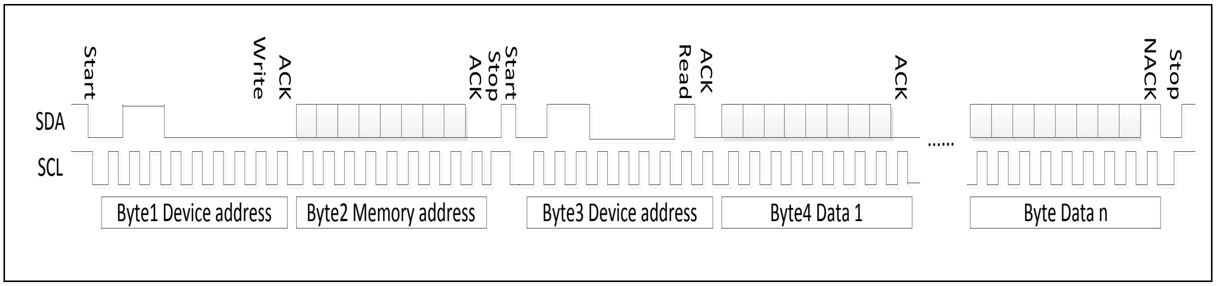


Figure 5-3 Continual-Read Mode

5.4 I²C Circuit

The pins of I²C are SDA and SCL with Open-Drain mode which requires pull-high resistor on the I²C bus.

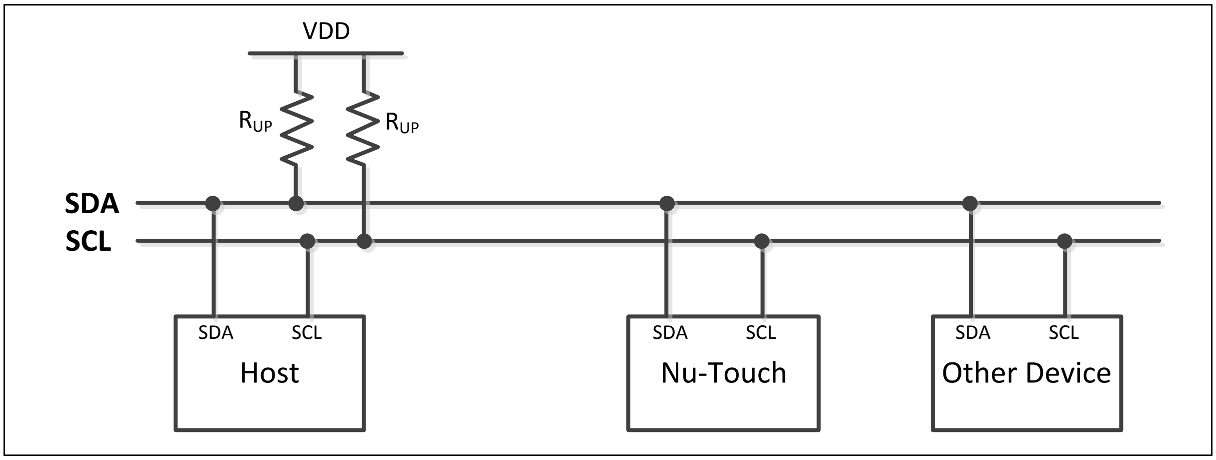


Figure 5-4 I²C Bus Connection

6 I²C DATA DEFINITION

6.1 Memory Address

Table 6-1 shows the memory address of I²C starting from 0x00~0x4F with specific function on each address.

R: Read only, **R/W:** Read / Write, **(B)R:** Must be set "Build" bit, and user can read only.

(B)R/W: Must be set to "Build" bit, and user can read and write.

<table>
<tr><th>Address</th><th>R/W</th><th>Description</th><th>Default</th></tr>
<tr><td>0x00</td><td>R</td><td>Product no.</td><td>0x81</td></tr>
<tr><td>0x01</td><td>R</td><td>Shows how many buttons supported.</td><td>0x08</td></tr>
<tr><td>0x02</td><td>R</td><td>Version no.</td><td>0x31</td></tr>
<tr><td>0x03</td><td>R/W</td><td>I²C Device address<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>0</td></tr></table></td><td>0x60</td></tr>
<tr><td>0x04</td><td>R/W</td><td>System control<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>Reset</td><td>X</td><td>X</td><td>X</td><td>Auto</td><td>Calibrate</td><td>X</td><td>Build</td></tr></table></td><td>0x08</td></tr>
<tr><td>0x06</td><td>R/W</td><td>Output mode<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>Multi</td><td>Toggle</td><td>Act-High</td><td>0</td><td>Lock</td><td>En-Any</td><td>0</td><td>0</td></tr></table></td><td>0x00</td></tr>
<tr><td>0x07</td><td>(B)R/W</td><td>Sense pin Enable<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>Sen8</td><td>Sen7</td><td>Sen6</td><td>Sen5</td><td>Sen4</td><td>Sen3</td><td>Sen2</td><td>Sen1</td></tr></table></td><td>0xFF</td></tr>
<tr><td>0x0C</td><td>(B)R/W</td><td>De-Bounce (Range: 1~7)</td><td>0x03</td></tr>
<tr><td>0x0D</td><td>(B)R/W</td><td>Plus Times (Range: 15~127)</td><td>0x32</td></tr>
<tr><td>0x0E</td><td>(B)R/W</td><td>Sensor Cycle (Range: 3~15)</td><td>0x07</td></tr>
<tr><td>0x0F</td><td>(B)R/W</td><td>Calibration Delay (Range: 7~63)</td><td>0x32</td></tr>
<tr><td>0x10</td><td>R</td><td>Status<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>Any-Act</td><td>B-Change</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr></table></td><td>0x00</td></tr>
</table>

<table>
<tr><td>0x11</td><td>R</td><td>Key Status
<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>Sen8</td><td>Sen7</td><td>Sen6</td><td>Sen5</td><td>Sen4</td><td>Sen3</td><td>Sen2</td><td>Sen1</td></tr></table></td><td>0x00</td></tr>
<tr><td>0x15</td><td>R/W</td><td>LED Control
<table><tr><td>Bit7</td><td>Bit6</td><td>Bit5</td><td>Bit4</td><td>Bit3</td><td>Bit2</td><td>Bit1</td><td>Bit0</td></tr><tr><td>OUT8</td><td>OUT7</td><td>0</td><td>0</td><td>OUT4</td><td>0</td><td>OUT2</td><td>OUT1</td></tr></table></td><td>0x00</td></tr>
<tr><td>0x20~0x27</td><td>(B)R/W</td><td>Trigger Level (Range: 3~63)
<table><tr><td>0x20</td><td>0x21</td><td>0x22</td><td>0x23</td><td>0x24</td><td>0x25</td><td>0x26</td><td>0x27</td></tr><tr><td>Sen1</td><td>Sen2</td><td>Sen3</td><td>Sen4</td><td>Sen5</td><td>Sen6</td><td>Sen7</td><td>Sen8</td></tr></table></td><td>0x12</td></tr>
<tr><td>0x40~0x4F</td><td>(B)R</td><td>Sensor Value
<table><tr><td>0x40</td><td>0x41</td><td>0x42</td><td>0x43</td><td>0x44</td><td>0x45</td><td>0x46</td><td>0x47</td></tr><tr><td>Sen1-H</td><td>Sen1-L</td><td>Sen2-H</td><td>Sen2-L</td><td>Sen3-H</td><td>Sen3-L</td><td>Sen4-H</td><td>Sen4-L</td></tr><tr><td>0x48</td><td>0x49</td><td>0x4A</td><td>0x4B</td><td>0x4C</td><td>0x4D</td><td>0x4E</td><td>0x4F</td></tr><tr><td>Sen5-H</td><td>Sen5-L</td><td>Sen6-H</td><td>Sen6-L</td><td>Sen7-H</td><td>Sen7-L</td><td>Sen8-H</td><td>Sen8-L</td></tr></table></td><td>0x0000</td></tr>
</table>

Table 6-1 I^2C Memory Address Definition and Description

6.2 Address 0x00: Product No.

Product identification using

6.3 Address 0x01: Button No.

Product identification using

6.4 Address 0x02: Version No.

Product identification using

6.5 Address 0x03: I^2C Device Address

The default address is 0x60, including read/write 8-bit address. The device address could be changed by the I^2C interface. When changing the device address, the latest device address must be used in next read/write action.

6.6 Address 0x04: System Control Bits

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Reset	X	X	X	Auto	Calibrate	X	Build

Reset: **Software reset.**

Chip could be reset by writing “1” to become default value. This bit will be automatically changed back to “0” when chip reset is done.

Auto: **Auto Calibration.**

Write “1” to this bit and chip will automatically refer the value in address “0x0F” to execute new calibration delay time function.

Calibrate: **Calibration enabled.**

User could set this bit to enable calibration procedure and this bit will return to “0” when finishing the calibration. This bit is valid when “Auto” bit is “0”.

Build: **Test mode.**

1 = Read related sensor parameter and data to provide test and analysis function.

0 = Hide some parameter which has nothing to do with operation action to prevent parameter being changed accidentally.

6.7 Address 0x06: Output Mode Settings

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Multi	Toggle	Act-High	0	Lock	En-Any	0	0

Multi: **Multi-key output.**

1 = Output multi-key status simultaneously

0 = Output the key status with greatest signal

Toggle: **Switch mode.**

1 = GPIO is set to output signal in latch way to simulate like a switch. Press to active and then press to inactive.

This bit is active when “Display” is set as “0” and “Dout_0” as “1”. The high/low level will be decided by the “Act-High” setting.

Act-High: **High level action.**

1 = GPIO output high level.

0 = GPIO output low level.

This bit is active when “Display” is set as “0” and “Dout_0” as “1”.

Lock: **Lock.**

1 = If two or more keys are triggered, all output will be locked and no any output signal happened.

En-Any: **Enable -Act pin.**

1 = Enable -Act pin function. Any pressed key will make -Act pin output low level signal. -Act pin will return to high level when no key is pressed.

6.8 Address 0x07: Enable Sense Pin

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Sen8	Sen7	Sen6	Sen5	Sen4	Sen3	Sen2	Sen1

Sen8~Sen1: **Enable Sense Pin.**

1 = Enable corresponding key

0 = Disable corresponding key

6.9 Address 0x0C: De-Bounce

The value is from 1 to 7. Set this parameter to prevent key output bouncing. Key will react slower with less chance happening bouncing when set this value higher.

6.10 Address 0x0D: Plus Times

The value is from 15 to 127. The captures data will be more stable and key react slower if set this value higher.

6.11 Address 0x0E: Sensor Cycle

The value is from 3 to 15. The captures data will be more stable and key react slower if set this value higher.

6.12 Address 0x0F: Calibration Delay

The value is from 7 to 63. It defines how long chip will do re-calibration process again.

This bit is valid if “Auto” bit is set to “1”.

6.13 Address 0x10: Status.

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Any-Act	B-Change	0	0	0	0	0	0

Any-Act: This bit will be set to “1” if any key is pressed.

It will be cleared to “0” if all key are released.

B-Change: This bit will be set to “1” if any key status is changed.

It will be cleared to “0” if no key status is changed whether key is pressed or not.

6.14 Address 0x11: Key status

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
Sen8	Sen7	Sen6	Sen5	Sen4	Sen3	Sen2	Sen1

Sen8~Sen1: 1 = Corresponding key is pressed.

0 = Corresponding key is released.

Reading status here will ignore the setting in OUTPUT MODE

6.15 Address 0x15: LED Control

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
OUT8	OUT7	0	0	OUT4	0	OUT2	OUT1

OUT8~OUT1: Corresponding to pin OUT8~OUT1.

1 = Pin output high.

0 = Pin output low.

6.16 Address 0x20~0x27：Trigger Level

The value is from 3 to 63. This bit is to set trigger level individually to eliminate the sensitivity difference on each touch key sensor. The lower value user set will get higher sensitivity but lower stability.

Address	0x20	0x21	0x22	0x23	0x24	0x25	0x26	0x27
Sensor	Sen1	Sen2	Sen3	Sen4	Sen5	Sen6	Sen7	Sen8

6.17 Address 0x40~0x4F：Sensor Value

The value shows the reading sampling result which is from 0 to 1023. The data format is MSB first, then LSB.

Address	0x40	0x41	0x42	0x43	0x44	0x45	0x46	0x47
Sensor	Sen1-High	Sen1-Low	Sen2-High	Sen2-Low	Sen3-High	Sen3-Low	Sen4-High	Sen4-Low
Address	**0x48**	**0x49**	**0x4A**	**0x4B**	**0x4C**	**0x4D**	**0x4E**	**0x4F**
Sensor	Sen5-High	Sen5-Low	Sen6-High	Sen6-Low	Sen7-High	Sen7-Low	Sen8-High	Sen8-Low

7 GPIO

Each GPIO has the corresponding touch key output. For example, the OUTn pin corresponds to the SENn pin. Figure 7-1 shows all the output pins in Open-Drain mode. Figure 7-2 shows that it is easy to connect the system with the voltage lower than V_{DD} and it is convenient to achieve analog output mode via a resistor ladder. Add a pull-high resistor to perform active-high state. There are many kinds of output modes related to address 0x06 settings. Table 7-1 shows the detailed settings on relationship of each bit.

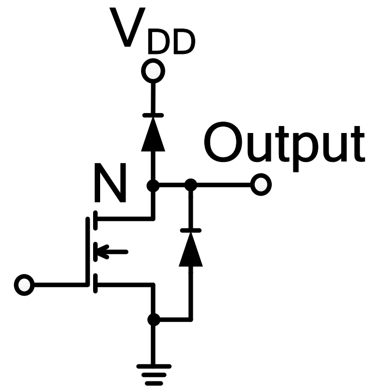


Figure 7-1 Open-Drain

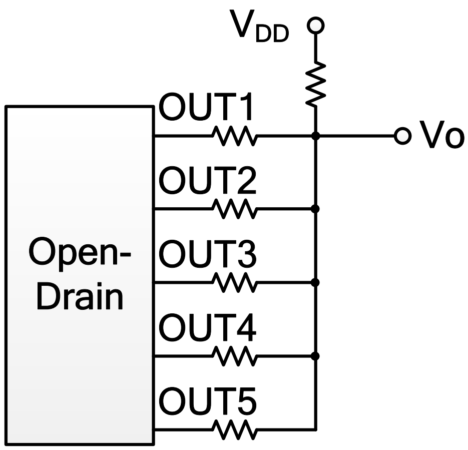


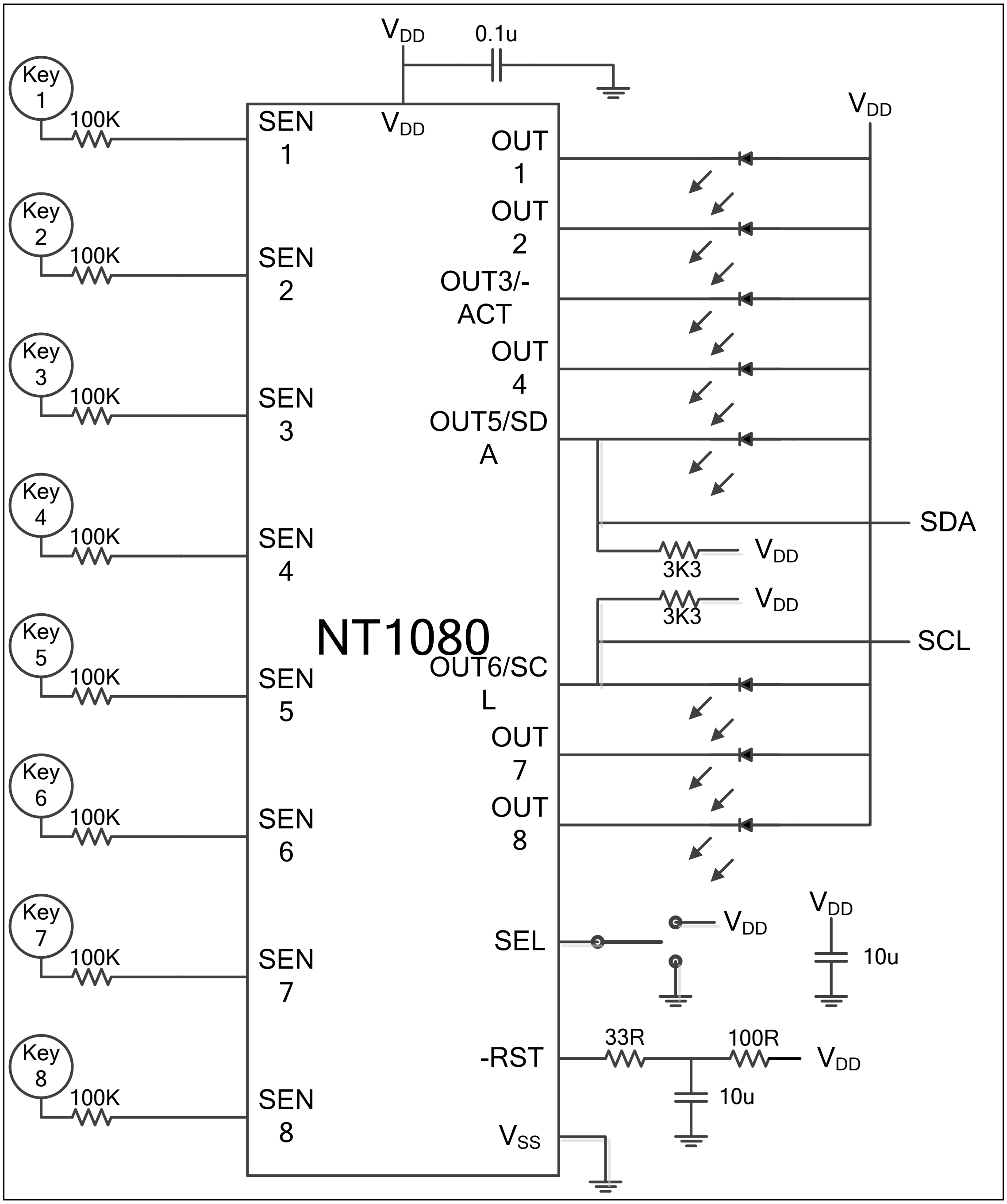
Figure 7-2 Resistor-voltage Divider Output

Application	Multi	Toggle	Act-High	Lock
Single key, output low level (when active)	0	0	0	0
Single key, output high level	0	0	1	0
Multi key, output low level	1	0	0	0
Multi key, output high level	1	0	1	0
Single key, switch, output low level	0	1	0	0
Single key, switch, output high level	0	1	1	0

Multi key, switch, output low level	1	1	0	0
Multi key, switch, output high level	1	1	1	0
Single key, output low level, Lock	0	0	0	1
Single key, output high level, Lock	0	0	1	1
Single key, switch, output low level, Lock	0	1	0	1
Single key, switch, output high level, Lock	0	1	1	1

Table 7-1 GPIO Function Settings

8 REFERENCE SCHEMATIC



9 ELECTRICAL CHARACTERISTICS

9.1 Absolute Maximum Ratings

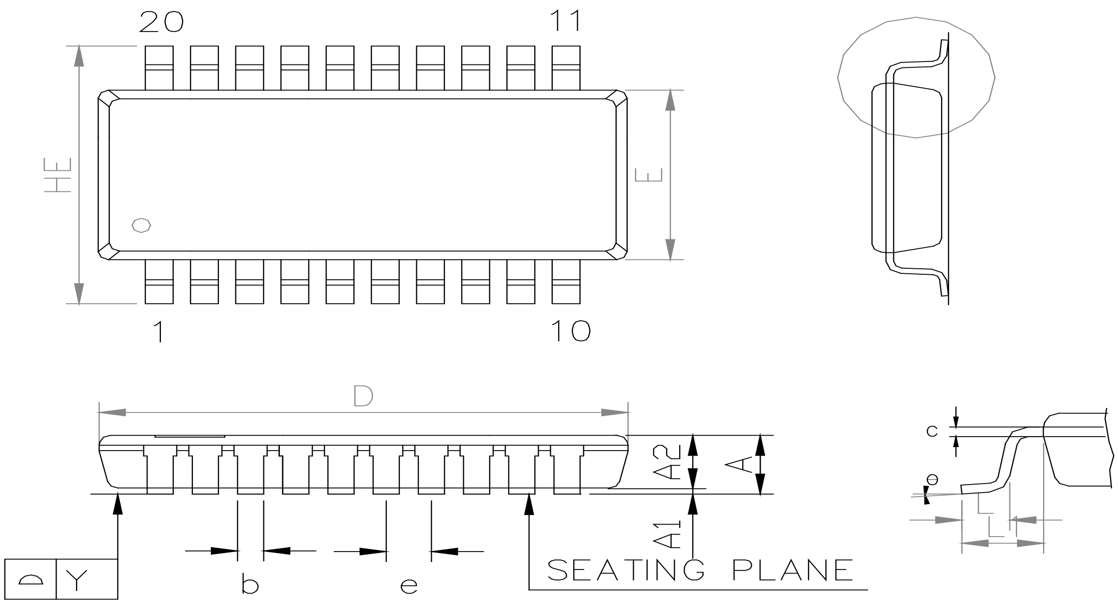
Parameter	Range	Unit
Operating Temperature	-40 to +85	°C
Storage Temperature	-55 to +150	°C
V_{DD} to V_{SS} voltage	-0.3 to +6.5	V
Other pin to V_{SS} voltage	-0.3 to (V_{DD}+0.3)	V

9.2 DC Electrical Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Voltage	V_{DD}	---	2.4	-	5.5	V
Operating Current	I_{DD}	V_{DD} = 5V	-	2.30	-	mA
		V_{DD} = 3V	-	1.93	-	mA
Input Low Voltage	V_{IL}	2.4V<V_{DD}<5.5	-0.5	-	0.3V_{DD}	V
Input High Voltage	V_{IH}	2.4V<V_{DD}<5.5	0.7V_{DD}	-	V_{DD}+0.5	V
Output Low Voltage (GPIO)	V_{OL1}	V_{DD} = 4.5V, I_{OL} = 20mA	-	-	0.45	V

10 PACKAGE DIMENSION

10.1 TSSOP20 – 4.4X6.5mm



SYMBOL	DIMENSION (MM)			DIMENSION (INCH)		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	–	–	1,20	–	–	0.047
A1	0,05	–	0,15	0.002	–	0.006
A2	0.80	0.90	1,05	0.031	0.035	0.041
E	4.30	4.40	4.50	0.169	0.173	0.177
HE	6.40 BSC			0.252 BSC		
D	6.40	6.50	6.60	0.252	0.256	0.260
L	0.50	0.60	0.75	0.020	0.024	0.030
L1	1.00 REF			0.039 REF		
b	0.19	–	0.30	0.007	–	0.012
e	0.65 BSC			0.026 BSC		
c	0.09	–	0.20	0.004	–	0.008
θ	0°	–	8°	0°	–	8°
Y	0.10 BASIC			0.004 BASIC		

11 REVISION HISTORY

Date	Revision	Description
2015.10.26	1.0	Preliminary version

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.