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# GREENCHIP

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**GreenTouch3™ GT308L**  
**Capacitive Touch Sensor**

**DATASHEET**  
**VER2.70**

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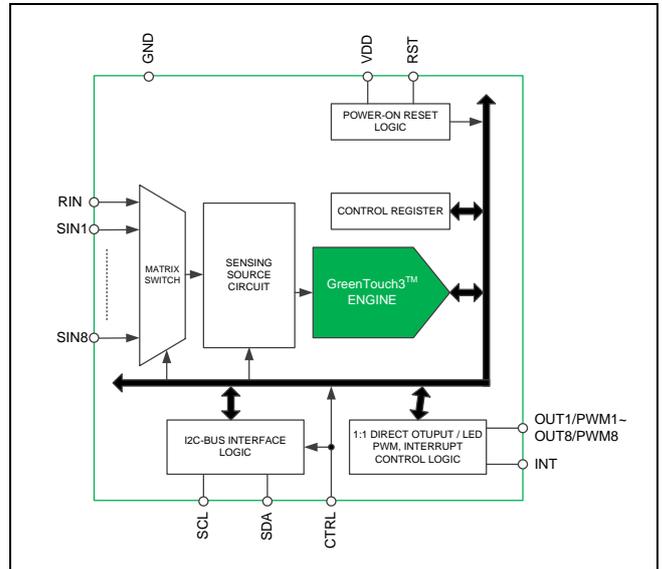
# 1. INTRODUCTION

The GT308L is one of the new GreenTouch3™ capacitive touch sensor series. Especially the GT308L can do capacitance sensing with 8 channels under above GreenTouch3™ engine operation. Thanks to this epochal GreenTouch3™ engine, the applications will be more robust and problem free against EMC, EMI, H/W variations, voltage disturbance, temperature drift, humidity drift and so on. Especially, it doesn't make any issue against CS and EFT noise environments occurred in any touch applications. The GT308L offers 8 LED drivers with 16 steps dimming controller. The OUT1~8 pins can be used for PWM output for LED dimming control. It's very economical solution when the LED feedbacks are required because there is no additional material cost for LED control. For the touch output result, the I2C or 1:1 direct output interface can be used. I2C interface might be useful when the MCU IO or connector resource is not enough in the application. The GT308L can be applied under wide supply voltage range from 2.5V to 5.5V. And it has CTRL pin to select sensitivity options and I2C-bus slave address by making the pin connection to VDD, GND and OPEN.

# 2. FEATURES

- 8 channels cap. Sensing input
- Embedded GreenTouch3™ Engine
  - Analog compensation circuit
  - Embedded digital noise filter
  - Intelligent sensitivity calibration
  - Embedded CS, EFT enhancer core
- Two types of interface support
  - 1:1 direct Output mode.
  - I2C interface mode
- Provide interrupt function
- LED driver (16 steps dimming control)
- Sensitivity control by CTRL pin connection
- Incredibly low power consumption
  - Standby mode : 140uA (@3.3V)
  - Standby mode : 160uA (@5.0V)
- Wide supply voltage range: 2.5V to 5.5V
  - Single supply operation
- Package type
  - QFN-24L, 4x4
  - SSOP-24L, e0.635
- RoHS compliant

# 3. BLOCK DIAGRAM



# 4. APPLICATIONS

- Multi key application - Door lock, Remote controller and Etc.
- Portable Electronics - Mobile phone, MP3, PMP, PDA, Navigation, Digital Camera, Video Camera and Etc.
- Multimedia Devices - TV, DVD player, Blue ray player, Digital photo frame, Home theater system and Etc.
- Home Appliance - Refrigerator, Air cleaner, Air conditioner, Washing machine, Micro wave oven and Etc.
- PC, OA and Others - PC, LCD monitor Fax, Copy machine, Lighting controls, Toys, Gaming devices and Etc.

# 5. ORDERING INFORMATION

Part No.	Package
GT308L-QN	QFN-24L, 4x4
GT308L-SO	SSOP-24L, e0.635

# 6. MARKING INFORMATION

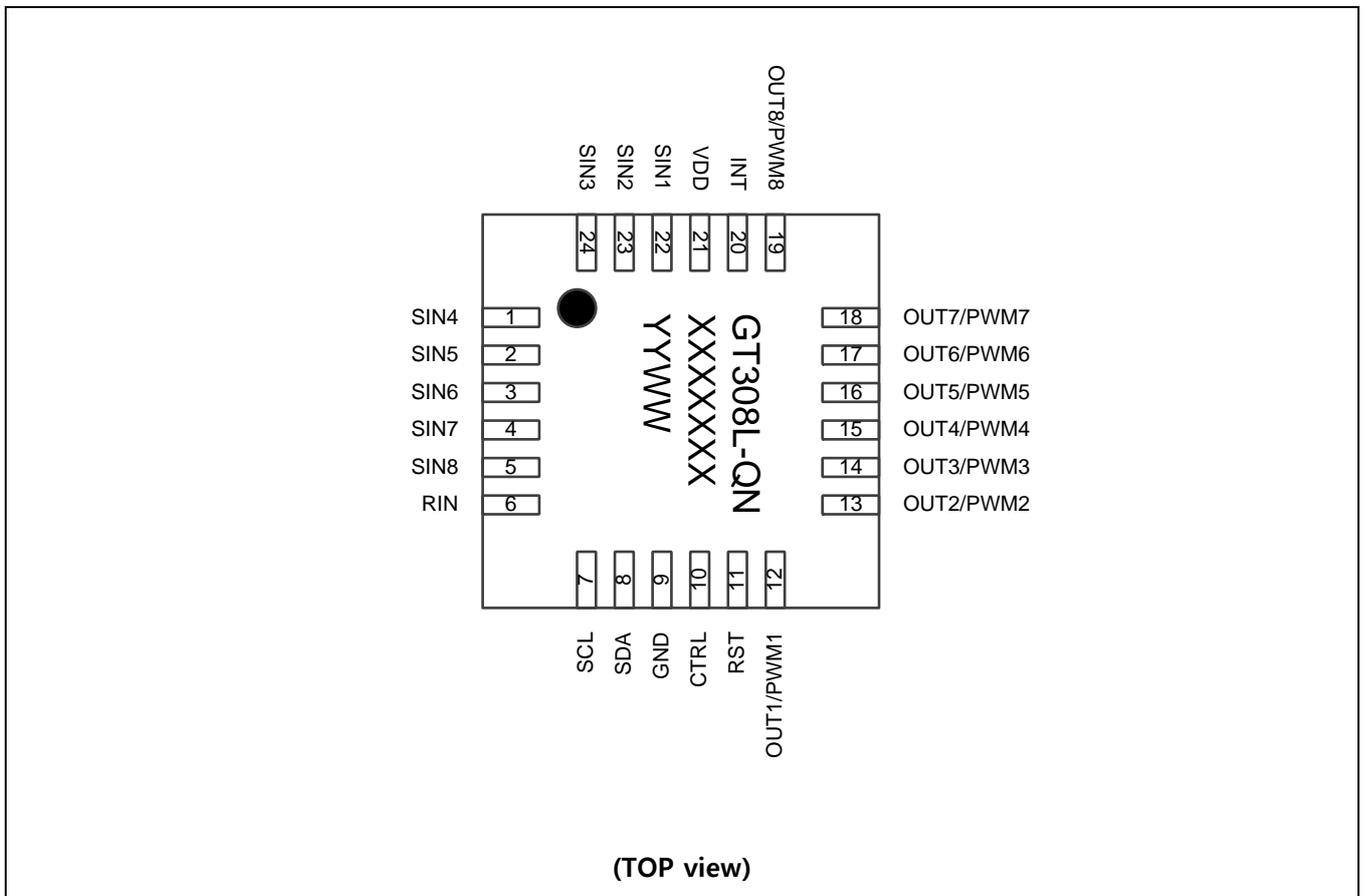


## 7. PIN DESCRIPTION

This section describes the lists and illustrates the GT308L of GreenTouch3™ family pins as well as pin configuration. The GT308L device is available in the following package

### 7.1 QFN-24L PACKAGE

#### 7.1.1 PACKAGE INFORMATION



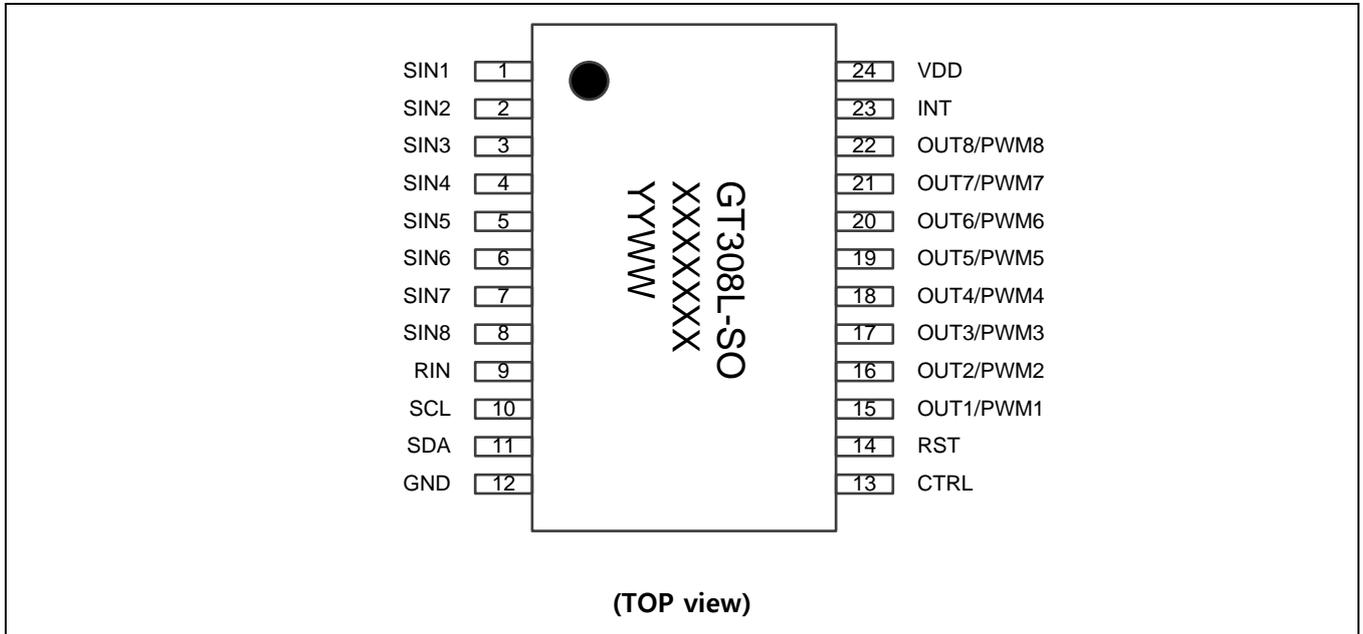
## 7.1.2 PIN CONFIGURATION

No.	Name	Type	Description
1	SIN4	AI	Channel 4: Touch sensing input
2	SIN5	AI	Channel 5: Touch sensing input
3	SIN6	AI	Channel 6: Touch sensing input
4	SIN7	AI	Channel 7: Touch sensing input
5	SIN8	AI	Channel 8: Touch sensing input
6	RIN	AI	Capacitance reference input
7	SCL	DI	I2C serial clock input
8	SDA	DIO	I2C serial data communication pin
9	GND	GND	Ground connection
10	CTRL	AO/DI	Sensitivity / I2C interface address / Multi key control input
11	RST	DI	Reset control pin (Active HIGH)
12	OUT1/PWM1	DO	1:1 Direct output pin for SIN1 / LED PWM1 drive output
13	OUT2/PWM2	DO	1:1 Direct output pin for SIN2 / LED PWM2 drive output
14	OUT3/PWM3	DO	1:1 Direct output pin for SIN3 / LED PWM3 drive output
15	OUT4/PWM4	DO	1:1 Direct output pin for SIN4 / LED PWM4 drive output
16	OUT5/PWM5	DO	1:1 Direct output pin for SIN5 / LED PWM5 drive output
17	OUT6/PWM6	DO	1:1 Direct output pin for SIN6 / LED PWM6 drive output
18	OUT7/PWM7	DO	1:1 Direct output pin for SIN7 / LED PWM7 drive output
19	OUT8/PWM8	DO	1:1 Direct output pin for SIN8 / LED PWM8 drive output
20	INT	DO	Interrupt output pin
21	VDD	PWR	Supply Voltage
22	SIN1	AI	Channel 1: Touch sensing input
23	SIN2	AI	Channel 2: Touch sensing input
24	SIN3	AI	Channel 3: Touch sensing input

**NOTE:** DI: Digital Input, DO: Digital Output, DIO: Digital Input and Output, AI: Analog Input, AO: Analog Output, PWR: POWER

## 7.2 SSOP-24L PACKAGE

### 7.2.1 PACKAGE INFORMATION



## 7.2.2 PIN CONFIGURATION

No.	Name	Type	Description
1	SIN1	AI	Channel 1: Touch sensing input
2	SIN2	AI	Channel 2: Touch sensing input
3	SIN3	AI	Channel 3: Touch sensing input
4	SIN4	AI	Channel 4: Touch sensing input
5	SIN5	AI	Channel 5: Touch sensing input
6	SIN6	AI	Channel 6: Touch sensing input
7	SIN7	AI	Channel 7: Touch sensing input
8	SIN8	AI	Channel 8: Touch sensing input
9	RIN	AI	Capacitance reference input
10	SCL	DI	I2C serial clock input
11	SDA	DIO	I2C serial data communication pin
12	GND	GND	Ground connection
13	CTRL	AO/DI	Sensitivity / I2C interface address / Multi key control input
14	RST	DI	Reset control pin (Active HIGH)
15	OUT1/PWM1	DO	1:1 Direct output pin for SIN1 / LED PWM1 drive output
16	OUT2/PWM2	DO	1:1 Direct output pin for SIN2 / LED PWM2 drive output
17	OUT3/PWM3	DO	1:1 Direct output pin for SIN3 / LED PWM3 drive output
18	OUT4/PWM4	DO	1:1 Direct output pin for SIN4 / LED PWM4 drive output
19	OUT5/PWM5	DO	1:1 Direct output pin for SIN5 / LED PWM5 drive output
20	OUT6/PWM6	DO	1:1 Direct output pin for SIN6 / LED PWM6 drive output
21	OUT7/PWM7	DO	1:1 Direct output pin for SIN7 / LED PWM7 drive output
22	OUT8/PWM8	DO	1:1 Direct output pin for SIN8 / LED PWM8 drive output
23	INT	DO	Interrupt output pin (Active LOW)
24	VDD	PWR	Supply Voltage

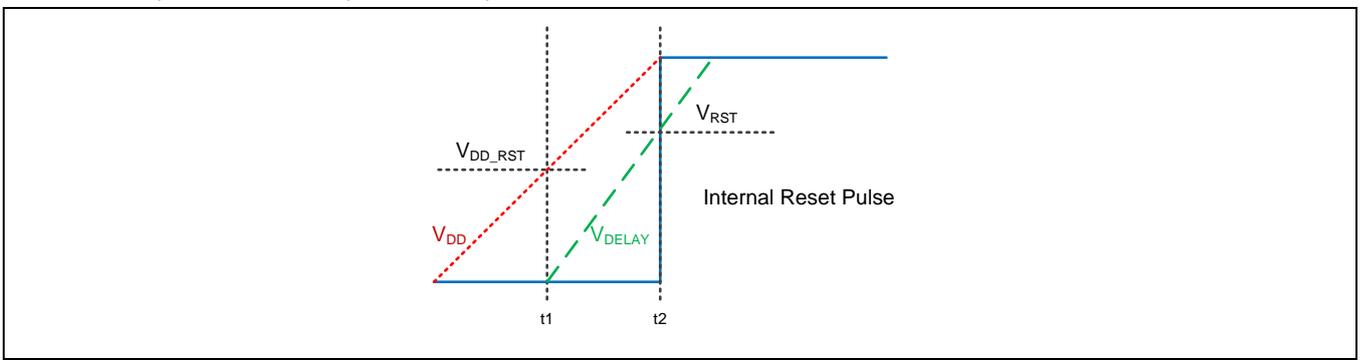
**NOTE:** DI: Digital Input, DO: Digital Output, DIO: Digital Input and Output, AI: Analog Input, AO: Analog Output, PWR: POWER

## 8. FUNCTION DESCRIPTION

### 8.1 INTERNAL AND EXTERNAL RESET (RST)

The GT308L has both internal power reset and external reset functions. The internal reset operation is used for initial power reset and the external reset operation is done by RST pin. High pulse signal by RST pin is for an abrupt reset which is required for intensive system reset. The RST pin might be floating and no external reset components are required when the external reset is not in use.

The internal power reset sequence is represented as below.



The internal  $V_{\text{DELAY}}$  voltage starts to rise when  $V_{\text{DD}}$  come up to  $V_{\text{DD\_RST}}$  level. The internal reset pulse is maintained as low between  $t_1$  and  $t_2$ . During this low pulse period, the internal power reset operation is finished. Every time when  $V_{\text{DD}}$  drops under  $V_{\text{DD\_RST}}$  internal reset block makes  $V_{\text{DELAY}}$  signal low and then internal reset pulse drops to low. By above internal reset operation sequence GT308L gets more certain and more correct power reset function than any others.

The external reset by RST pin is activated during high input pulse period. The intensive system reset can be easily obtained by this high pulse input to the RST pin. More than 10 $\mu\text{s}$  high pulse period is required for proper reset. Because RST pin has an internal pull-down resistor (typical value is 45k $\Omega$ ), the RST pin might be floating.

## 8.2 IMPLEMENTATION FOR TOUCH SENSING (SIN1~SIN8, RIN)

SIN inputs (SIN1~SIN8) and RIN input are used for touch detection of capacitance variation sensing. The SIN input pins are connected to touch sensing pad and catches capacitance variation caused by direct touch or approach. And RIN input for the reference capacitance is connected only to a capacitor to compensate capacitance difference between SIN inputs and RIN input. The GT308L compares each capacitance of SIN input and that of RIN input and determines touch detection of each channel when capacitance of each SIN input increases. So, for correct capacitance comparison between SIN inputs and RIN input, approximately equal initial-steady state capacitance between SIN inputs and RIN input are recommended. User can compensate initial-steady state capacitance difference between SIN inputs and RIN input by adding capacitor to RIN pin. Experimentally, proper  $C_{RIN}$  capacitor value is about the average value of SIN inputs capacitors.

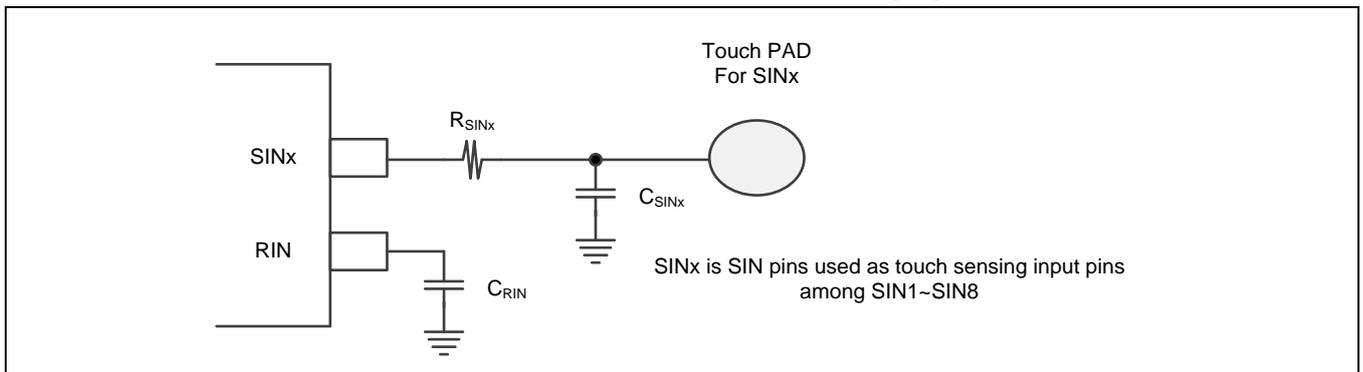
The GT308L also has various intelligent sensing functions to determine valid touch from error or sensitivity problems caused by various environmental noise effects. These advanced sensing methods will help making faultless touch key systems under the worst conditions.

With sensitivity options by CTRL pin and  $C_{SIN1-8}$  capacitors, there will be no difficulties to satisfy system's required sensitivity. The internal intelligent sensitivity adjustment algorithm removes sensitivity rolling caused by system noise, circuit deviation, and circumstantial drift. The GT308L has a special noise elimination filter for more powerful noise rejection and it will be very helpful for proper touch operation even if the system operates under deteriorative environment conditions.

Implementation circuit for SIN inputs and RIN input is shown in figure below. The GT308L SIN inputs have an internal series resistor for ESD protection. The additional external series resistors are profitable for prevention of abnormal actions caused by radiation noise or electrical surge pulse. In any case, if the additional external series resistor ( $R_{SIN1-8}$ ) of each SIN input is required, then it should be less than 1k $\Omega$  and the location of resistor is recommended as closer to the SIN pins. For  $C_{SIN1-8}$ ,  $C_{RIN}$  capacitor, less than 100pF capacitor can be used. Both  $R_{SIN1-8}$  and  $C_{SIN1-8}$  are not obligatory components.

The SIN input routing lines are desirable to be routed as short as possible and the width of routing lines should be as narrow as possible and should be placed on bottom metal. In other words, a touch PAD and other parts should be placed on different metal each other. The additional extension line pattern of RIN input on application PCB can help prevention of abnormal actions caused by radiation noise, but excessive long RIN input line can be a reason for failure of touch detect. The SIN inputs and RIN input lines are desirable to be routed as far as possible from impedance varying path such as LED drive current path. All touch sensing pads are recommended to be surrounded by GND pattern in order to reduce noise influence.

Implementation circuit for SIN pins and RIN pin is shown in the following figure.

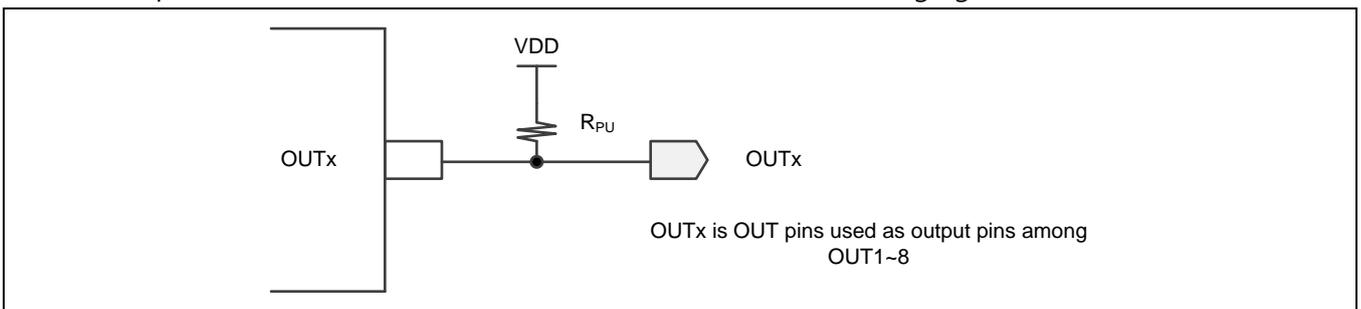


### 8.3 IMPLEMENTATION FOR OUTPUT (OUT1/PWM1~OUT8/PWM8)

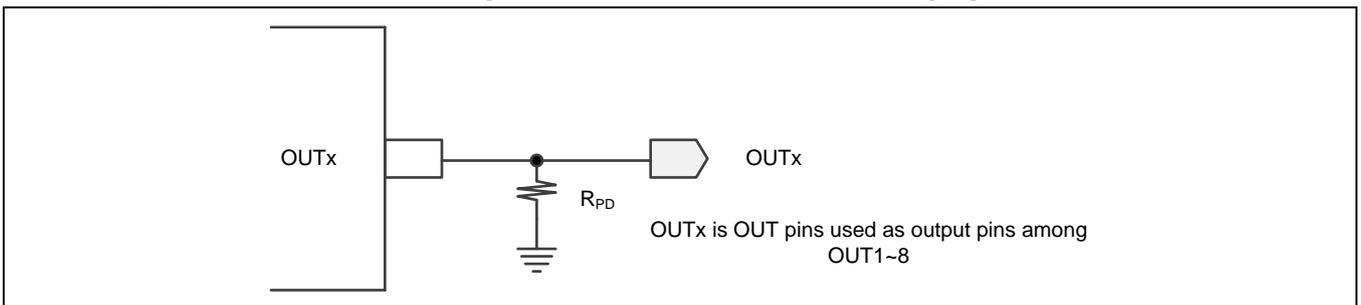
#### 8.3.1 1:1 DIRECT OUTPUT (OUT1~OUT8)

The GT308L has two types of output data interface methods. The first method is 1:1 direct output using from the OUT1 to OUT8 pins which are corresponding to SIN1 to SIN8 respectively. (Output pins OUTx corresponds to sensing channel of SINx) The other one is I2C interface using SCL and SDA pins. This two interface methods can be used simultaneously. These 1:1 direct output pins can operate in active low or active high mode. Its polarity of output can be changed with register address "3Ah = OUT\_POL" bit and all OUTx pins will have the same active polarity. The OUTx pins have open drain NMOS structure so therefore it needs pull-up resistors when the OUTx pins are used in active low mode. They also have open drain PMOS structure and they need pull-down resistors in active high mode. A couple of kΩ can be used for these pull-up or pull-down resistors.

The basic implementations for active low modes are shown in the following figure.



The basic implementations for active high modes are shown in the following figure.



### 8.3.2 LED PWM OUTPUT (PWM1~PWM8)

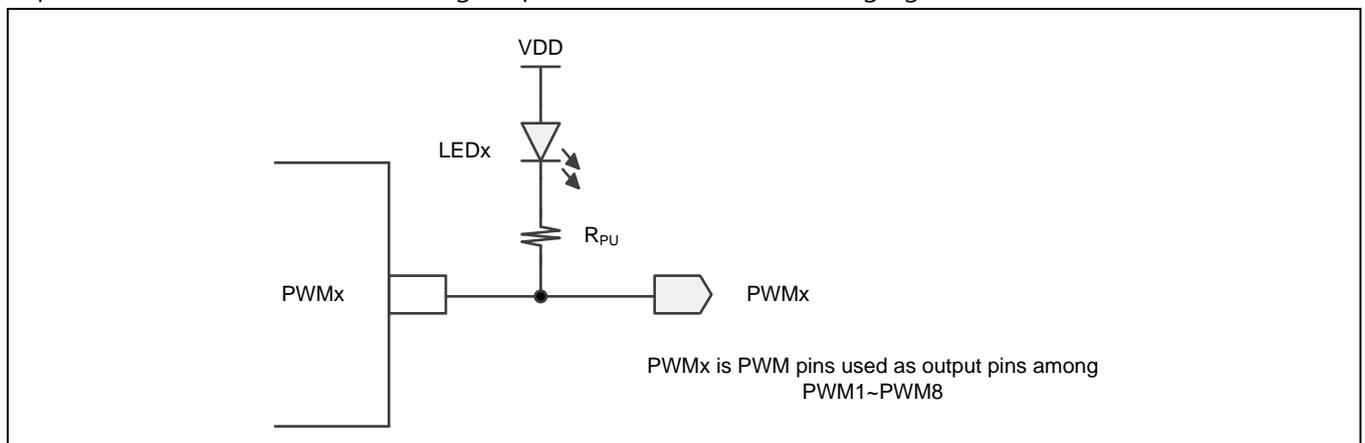
The LED PWM drive is available by using output pins from PWM1 to PWM8. There are 16 steps for the LED brightness and it is controlled by PWM control register. The maximum LED brightness is on 100% duty and the minimum is on 0% duty. The maximum sink current is 10mA on each pin under typical condition. The OUTx pins can't be used for 1:1 direct touch sensing output simultaneously when it is used for driving LED. The  $R_{PU}$  are LED current limiting resistors.

(See register address 05h = PWM\_CH\_EN)

(See register address 3Bh = PWM\_EN)

(See register address 48h~4Bh = PWM\_DATA1~8)

Implementation circuit for LED driving output is shown in the following figure.

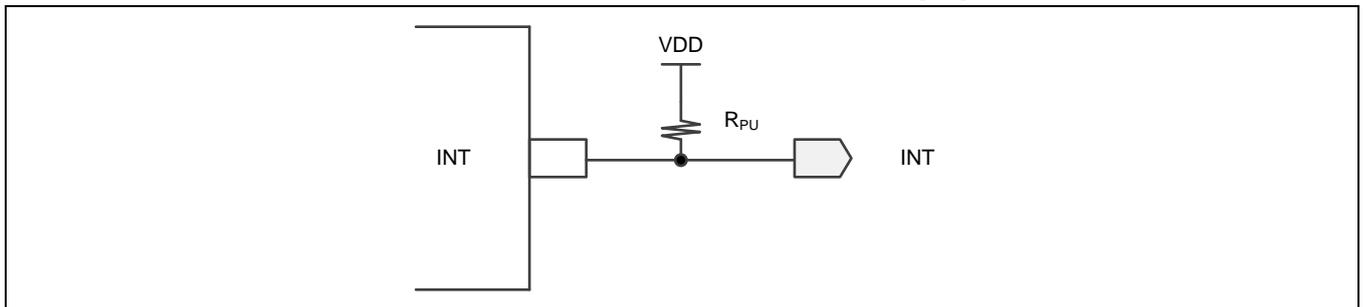


## 8.4 IMPLEMENTATION FOR INTERRUPT (INT)

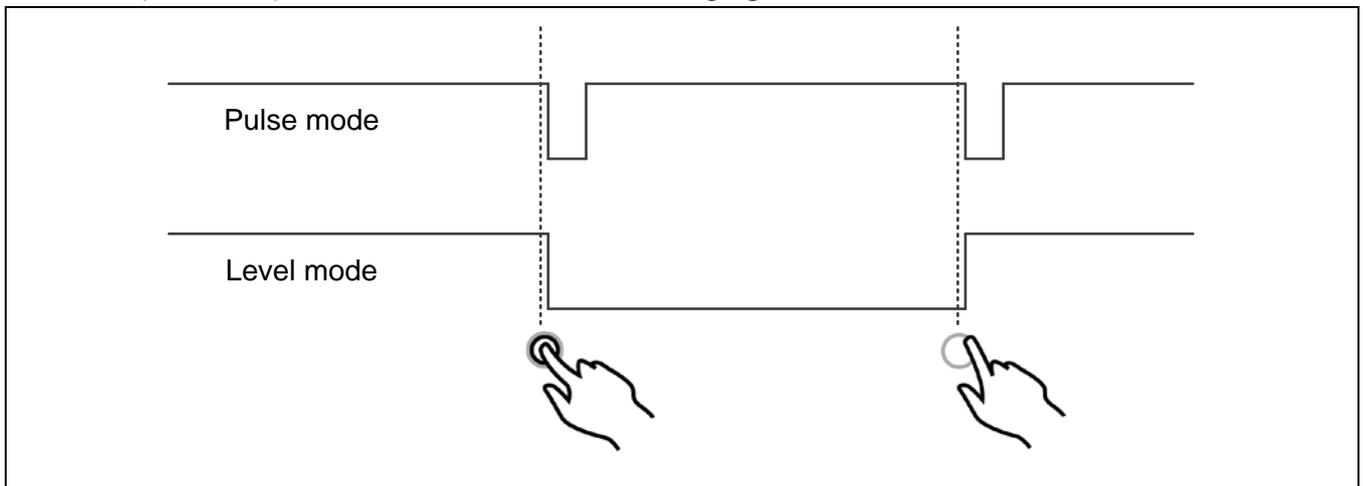
The GT308L provides an interrupt (INT) function to reduce a communication load between MCU and GT308L. The INT will indicate a point of time that the output status registers at the address 2Ah changes and MCU needs to read it. The INT pin has an open drain NMOS structure hence a couple of k $\Omega$  pull-up resistor must be required.

(See register address 3Ah = INT\_MODE)

The basic implementations for active low modes are shown in the following figure.



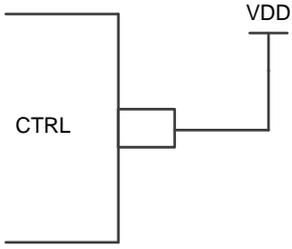
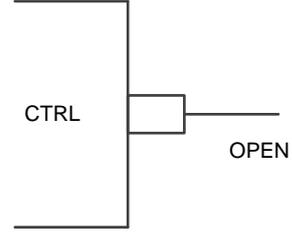
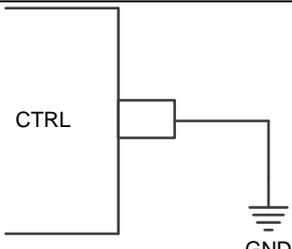
Two interrupt mode operations are shown in the following figure.



## 8.5 CTRL OPTION SELECTION (CTRL)

In the GT308L, three options are available by CTRL pin connection. Each option and its connections are shown in the table and figures below. This CTRL pulse signal starts at internal power reset time and finishes after a few operation period and options setting. For more detail sensitivity adjustment,  $C_{SIN}$  capacitors should be used.

Each options and respective connection are shown in the following table.

CTRL Option	I2C Address	Touch Mode	Sensitivity
 <p>Option 1 (Connect to VDD)</p>	B8h	Multi Touch	Low Sensitivity (18h)
 <p>Option 2 (OPEN)</p>	B8h	Multi Touch	Middle Sensitivity (0Fh)
 <p>Option 3 (Connect to GND)</p>	B4h	Single Touch	High Sensitivity (0Ch)

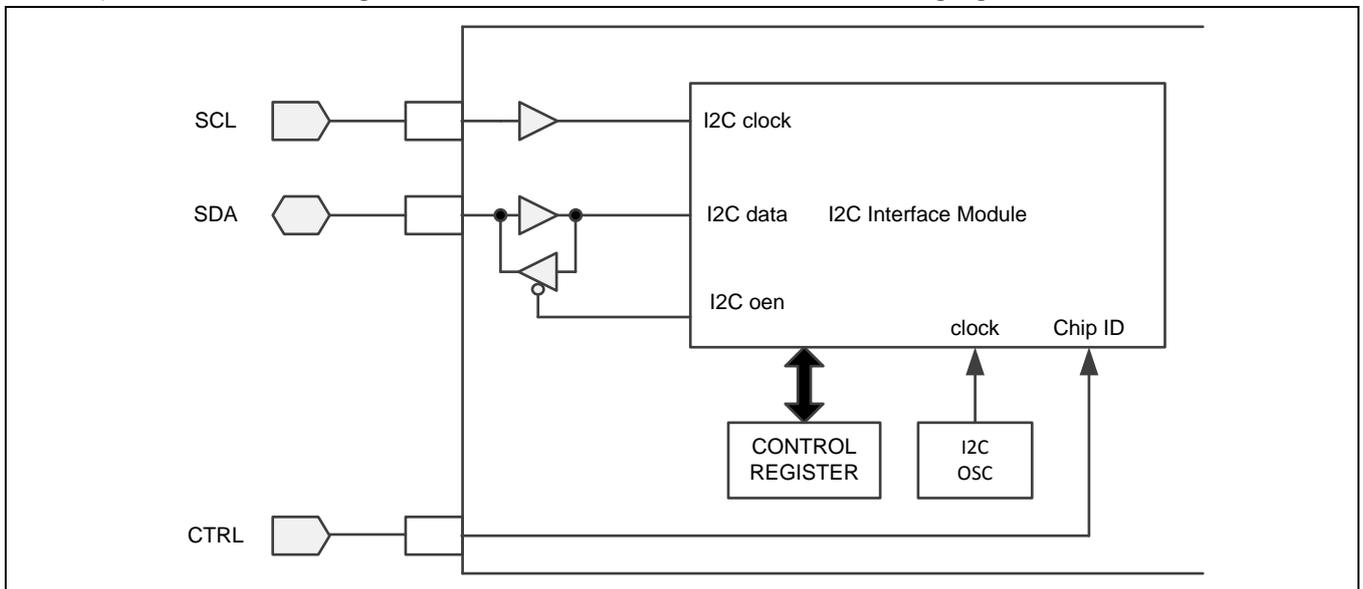
## 8.6 I2C INTERFACE (SCL, SDA, CTRL)

The I2C-bus is for 2-way, 2-line communication between different ICs or modules. The serial bus consists of two bidirectional lines; one for data signals (SDA), and one for clock signals (SCL).

Both the SDA and SCL lines be connected to a positive supply voltage via a internal pull-up resistor (typical 31k $\Omega$ ) to prevent open gate leakage current in input mode. But the lines must be connected to a positive supply voltage via a pull-up additional external resistor.

The internal oscillator is disabled when all of both the SDA and SCL lines are high for saving current consumption.

The simple internal block diagram for SCL and SDA is shown in the following figure.

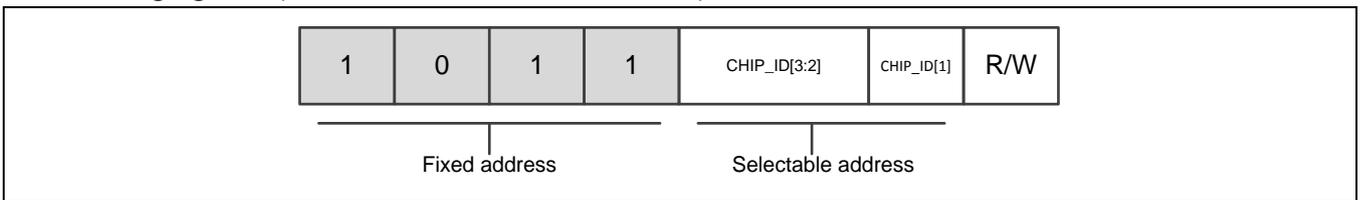


### 8.6.1 DEVICE ADDRESSING

Following a START condition, the bus master must output the address of the slave it is accessing. To conserve power, no internal pull-up resistors are incorporated on the hardware selectable pins(CTRL) and it must be connected to VDD, GND or OPEN.

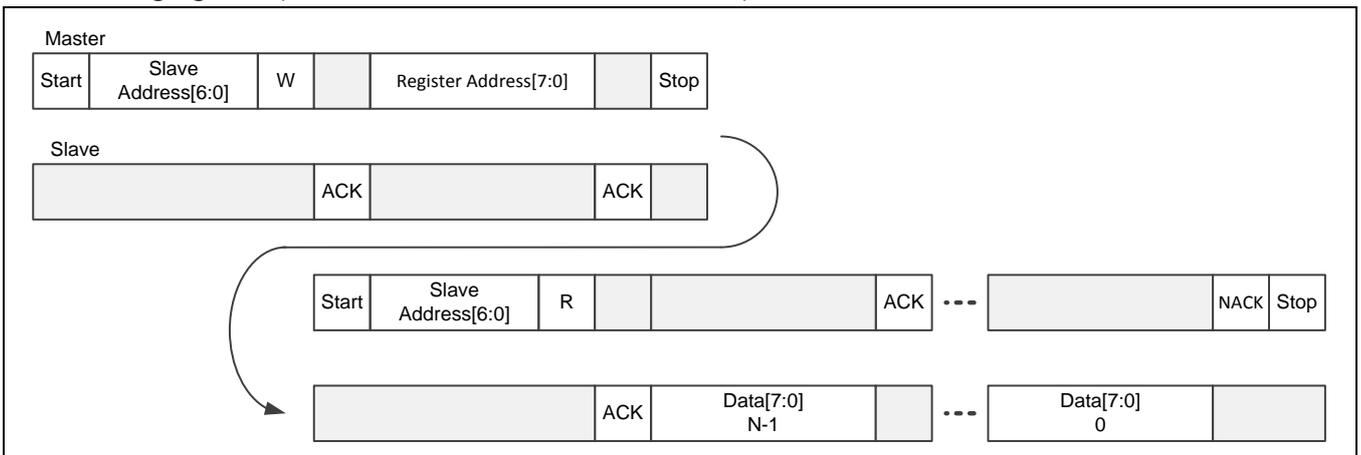
The last bit of the slave address defines the operation to be performed. When set to logic 1, a read operation is selected, while a logic 0 selects a write operation.

The following figure represents the I2C slave address map.



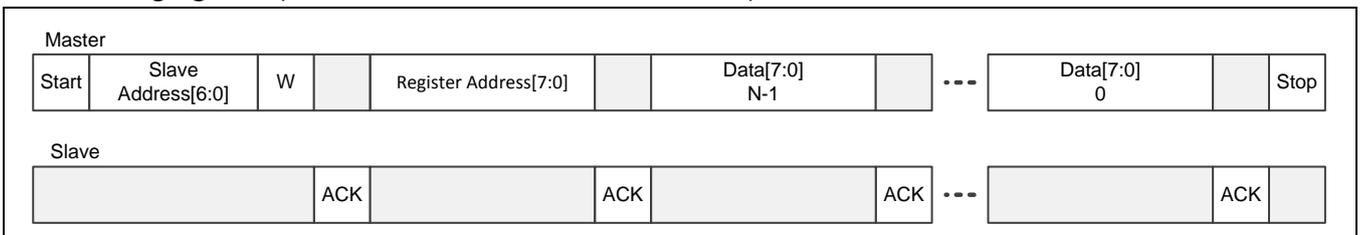
### 8.6.2 READ OPERATION

The following figure represents the I2C normal mode read operation.



### 8.6.3 WRITE OPERATION

The following figure represents the I2C normal mode write operation.



## 9. REGISTER DESCRIPTION

### 9.1 QUICK REGISTER MAP

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
02h	R/W	B8h B4h	1	0	1	1	CHIP_ID[3:2]		CHIP_ID[1]	0
03h	R/W	FFh	TOUCH_CH_EN							
04h	R/W	55h 51h	0	1	0	1	0	MULTI_MODE	0	1
05h	R/W	00h	PWM_CH_EN							
07h	R/W	27h	0	TOUCH_PERIOD			CAL_TIME			
2Ah	R	-	TOUCH_OUTPUT							
3Ah	R/W	05h	0	0	0	INT_MODE	0	1	OUT_POL	1
3Bh	R/W	20h	0	SEN_IDLE_TIME		PWM_EN	0	0	0	SOFT_RST

40h	R/W	18h 0Fh 0Ch	0	0	SENSITIVITY1						
41h	R/W		0	0	SENSITIVITY2						
42h	R/W		0	0	SENSITIVITY3						
43h	R/W		0	0	SENSITIVITY4						
44h	R/W		0	0	SENSITIVITY5						
45h	R/W		0	0	SENSITIVITY6						
46h	R/W		0	0	SENSITIVITY7						
47h	R/W		0	0	SENSITIVITY8						
48h	R/W	00h	PWM_DATA2				PWM_DATA1				
49h	R/W	00h	PWM_DATA4				PWM_DATA3				
4Ah	R/W	00h	PWM_DATA6				PWM_DATA5				
4Bh	R/W	00h	PWM_DATA8				PWM_DATA7				
4Fh	R/W	20h	0	0	MON_RST	0	0	0	0	0	

## 9.2 REGISTER CONFIGURATION

### 9.2.1 02H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
02h	R/W,		1	0	1	1	CHIP_ID[3:2]		CHIP_ID[1]	0
		B8h <sup>(1)</sup>	1	0	1	1	1	0	0	0
		B4h <sup>(2)</sup>	1	0	1	1	0	1	0	0

<b>CHIP_ID[3:2]</b>	Hardware selectable chip ID bit
	CTRL pin = VDD,      CHIP_ID[3:2] = 10
	CTRL pin = OPEN,    CHIP_ID[3:2] = 10
	CTRL pin = GND,     CHIP_ID[3:2] = 01
	<b>NOTE:</b> This bit might be controlled by CTRL pin.
<b>CHIP_ID[1]</b>	Software selectable chip ID bit

**NOTE:** (1) CTRL pin = VDD or OPEN, (2) CTRL pin = GND

### 9.2.2 03H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
03h	R/W		TOUCH_CH_EN							
		FFh	1	1	1	1	1	1	1	1

<b>TOUCH_CH_EN</b>	Each of channel(SIN1~8) enable/disable bits <sup>(1)</sup> 0 = disable 1 = enable
--------------------	---

**NOTE:** (1) bit7 = SIN8 ~ bit0 = SIN1

## 9.2.3 04H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
04h	R/W		0	1	0	1	0	MULTI_ MODE	0	1
		55h <sup>(1)</sup>	0	1	0	1	0	1	0	1
		51h <sup>(2)</sup>	0	1	0	1	0	0	0	1

<b>MULTI_MODE</b>	Touch engine mode selection bit 0 = Single touch mode 1 = Multi touch mode.
	<b>NOTE:</b> This bit might be controlled by CTRL pin.

**NOTE:** (1) CTRL pin = VDD or OPEN, (2) CTRL pin = GND

## 9.2.4 05H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
05h	R/W		PWM_CH_EN							
		00h	0	0	0	0	0	0	0	0

<b>PWM_CH_EN</b>	Each of output pins(OUT1~8) control bit <sup>(1)</sup> 0 = Channel ON/OFF output enable (PWM pulse output disable) 1 = PWM pulse output enable (Channel ON/OFF output disable)
------------------	--

**NOTE:** (1) bit7 = OUT8/PWM8 ~ bit0 = OUT1/PWM1

## 9.2.5 07H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
07h	R/W		0	TOUCH_PERIOD			CAL_TIME			
		27h	0	0	1	0	0	1	1	1

<b>TOUCH_PERIOD</b>	Touch period selection bit	
	000 = 1 period 001 = 2 period 010 = 3 period 011 = 4 period	100 = 5 period 101 = 6 period 110 = 7 period 111 = 8 period
	<p><b>NOTE:</b> The continuous period for touch detection. If the TOUCH_PERIOD is increased, it will be stronger to electrical noise. But, the response time is slower.</p>	
<b>CAL_TIME</b>	Calibration time selection bit	
	0000 = 0ms + 1 period 0001 = 100ms + 1 period 0010 = 200ms + 1 period 0011 = 300ms + 1 period 0100 = 400ms + 1 period 0101 = 500ms + 1 period 0110 = 600ms + 1 period 0111 = 700ms + 1 period	1000 = 800ms + 1 period 1001 = 900ms + 1 period 1010 = 1000ms + 1 period 1011 = 1100ms + 1 period 1100 = 1200ms + 1 period 1101 = 1300ms + 1 period 1110 = 1400ms + 1 period 1111 = No Calibration
	<p><b>NOTE:</b> (1) The calibration time to protect from environmental change (2) Deviation : ±30% (@5.0V)</p>	

## 9.2.6 2AH REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
2Ah	R	-	TOUCH_OUTPUT							

<b>TOUCH_OUTPUT</b>	Touch ON/OFF detection bit <sup>(1)</sup> 0 = No detection 1 = Detection
---------------------	--

**NOTE:** (1) bit7 = SIN8 pin detection bit ~ bit0 = SIN1 pin detection bit

## 9.2.7 3AH REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
3Ah	R/W		0	0	0	INT_ MODE	0	1	OUT_ POL	1
		05h	0	0	0	0	0	1	0	1

<b>INT_MODE</b>	Interrupt operation mode selection bit 0 = Pulse mode. 1 = Level mode.
<b>OUT_POL</b>	Output pins(OUT1~8) polarity control bit 0 = Active low 1 = Active High

## 9.2.8 3BH REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
3Bh	R/W		0	SEN_IDLE_TIME		PWM_EN	0	0	0	SOFT_RST
		20h	0	0	1	0	0	0	0	0

<b>SEN_IDLE_TIME</b>	Idle time section bit
	00 = 4ms 01 = 30ms 10 = 80ms 11 = 420ms
	<b>NOTE:</b> Deviation : $\pm 30\%$ (@5.0V)
<b>PWM_EN</b>	PWM Generation enable/disable bit 0 = disable 1 = enable
<b>SOFT_RST</b>	Soft reset bit 0 = Operation mode 1 = Sleep mode.
	<b>NOTE:</b> Current consumption can be saved and Touch engine is not work in sleep mode.

## 9.2.9 40H~47H REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
40h ~ 47h	R/W		0	0	SENSITIVITY1					
			0	0	SENSITIVITY2					
			0	0	SENSITIVITY3					
			0	0	SENSITIVITY4					
			0	0	SENSITIVITY5					
			0	0	SENSITIVITY6					
			0	0	SENSITIVITY7					
			0	0	SENSITIVITY8					
		18h <sup>(1)</sup>	0	0	0	1	1	0	0	0
		0Fh <sup>(2)</sup>	0	0	0	0	1	1	1	1
0Ch <sup>(3)</sup>	0	0	0	0	1	1	0	0		

<b>SENSITIVITY<sub>n</sub></b> <sup>(4)</sup>	Touch sensitivity control bit 00h = Very high sensitive 3Fh = Very high insensitive
	CTRL pin= VDD,      SENSITIVITY1~8 = 18h CTRL pin= OPEN,      SENSITIVITY1~8 = 0Fh CTRL pin= GND,      SENSITIVITY1~8 = 0Ch
	<b>NOTE:</b> This bit might be controlled by CTRL pin.

**NOTE:** (1) CTRL pin = VDD, (2) CTRL pin = OPEN, (3) CTRL pin = GND

(4) n = 1~8 pin

## 9.2.10 48H~4BH REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
48h ~ 4Bh	R/W		PWM_DATA2				PWM_DATA1			
			PWM_DATA4				PWM_DATA3			
			PWM_DATA6				PWM_DATA5			
			PWM_DATA8				PWM_DATA7			
		00h	0	0	0	0	0	0	0	0

<b>PWM_DATA<sup>n</sup></b> ( <sup>1</sup> )	LED PWM brightness control bit 0h = 0% (LED off.) 1h~Eh = PWM duty rate control Fh = 100% (LED on)
	<b>NOTE:</b> LED PWM Brightness is controlled within 16 steps.

**NOTE:** (1) n = 1~8 pin

## 9.2.11 4FH REGISTER

Address	R/W	Reset Value	Data							
			Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
4Fh	R/W		0	0	MON_ RST	0	0	0	0	0
		20h	0	0	1	0	0	0	0	0

<b>MON_RST</b>	Internal and external reset monitoring bit 0 = not active and clear bit by user 1 = active and set bit by GT308L
	<b>NOTE:</b> It's set '1' when GT308L is reset.

## 10. ELECTRICAL CHARACTERISTICS

### 10.1 ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Min	Typ.	Max	Units
Maximum supply voltage	$V_{DD\_MAX}$		-0.3		6.0	V
Supply voltage range <sup>(1)</sup>	$V_{DD\_RNG}$		-0.3		6.0	V
Voltage on any input pin	$V_{IN\_MAX}$		-0.3		VDD +0.3	V
Maximum current into any pin	$I_{MIO}$		-100		100	mA
Power dissipation	$P_{MAX}$		-		800	mW
Storage temperature	$T_{STG}$		-65		150	°C
Operating humidity	$H_{OP}$	8 hours	5		95	%
Operating temperature	$T_{OPR}$		-40		85	°C
Junction temperature	$T_J$		-40		125	°C

**NOTE:** (1) This is the real valid power supply voltage range considering allowable supply tolerance. It cannot be used as target supply voltage range which is separately presented at below I/O ELECTRICAL CHARACTERISTICS.

## 10.2 I/O ELECTRICAL CHARACTERISTICS

This section includes information about power supply requirements and I/O pin characteristics.

(TA = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Target supply voltage	V <sub>DD</sub>		2.5	3.3 / 5.0	5.5	V
Current consumption	I <sub>DD</sub>	Standby mode (VDD = 3.3V)	-	140	-	µA
		Standby mode (VDD = 5.0V)	-	160	-	µA
Input high voltage	V <sub>IH</sub>	All input pins	0.7VDD	-	VDD + 0.3	V
Input low voltage	V <sub>IL</sub>	All input pins	-0.3	-	0.3VDD	V
Output high voltage	V <sub>OH</sub>	All output pins (I <sub>OH</sub> = -4mA, VDD = 5.0V)	VDD - 0.4	-	-	V
Output low voltage	V <sub>OL</sub>	All output pins (I <sub>OL</sub> = 10mA, VDD = 5.0V)	-	-	0.4	V
Output sink current <sup>(1)</sup>	I <sub>SINK</sub>	All output pins <sup>(2)</sup> (Active low)	-	-	10	mA
Output source current <sup>(1)</sup>	I <sub>SRC</sub>	All output pins <sup>(2)</sup> (Active high)	-	-	-4	mA
Output high leakage current	I <sub>LOH</sub>		-	-	1	µA
Output low leakage current	I <sub>LOL</sub>		-	-	-1	µA

RST internal pull-down resistor <sup>(1)</sup>	R <sub>PD_RST</sub>	-	45	-	kΩ
SDA Internal Pull-up Resistor <sup>(1)</sup>	R <sub>PU_SDA</sub>	-	31	-	kΩ
SCL Internal Pull-up Resistor <sup>(1)</sup>	R <sub>PU_SCL</sub>	-	31	-	kΩ

**NOTE:**

(1) Test condition: V<sub>DD</sub> = 5V, T<sub>A</sub> = 25°C and normal operation mode under default control register value. (Unless otherwise noted)

(2) The OUT1~8 pins can be selected as open-drain NMOS structure (Active Low) or as open drain PMOS structure (Active High). And the INT pin is open-drain NMOS structure (Active Low).

**10.3 RESET CHARACTERISTICS**

(T<sub>A</sub> = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
RST input high width	t <sub>RST</sub>		10	-	-	usec
POR <sup>(1)</sup> Time	t <sub>POR</sub>		-	-	600	usec

**NOTE:** (1) POR = Internal Power-On Reset

**10.4 PWM OUTPUT CHARACTERISTICS**

(T<sub>A</sub> = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
PWM duty steps	N <sub>DUTY</sub>		-	16	-	Step
PWM maximum duty	D <sub>MAX</sub>		-	100	-	%
PWM minimum duty	D <sub>MIN</sub>		-	0	-	%
PWM frequency	f <sub>PWM</sub>		-	700	-	Hz

**10.5 INTERRUPT OUTPUT CHARACTERISTICS**

(T<sub>A</sub> = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
INT low pulse width	t <sub>INT</sub>		-	5	-	msec

## 10.6 SENSING INPUT CHARACTERISTICS

(TA = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Minimum detectable input capacitance variant	$\Delta C_{S\_MIN}$		0.1	-	-	pF
Maximum input external capacitance	$C_{EXT\_MAX}$		-	-	100	pF
Sensitivity selection steps	$N_{SEN}$		-	60	-	step
Sense OSC internal series resistor	$R_{INT}$		-	140	-	$\Omega$
external series resistor	$R_{EXT\_SIN}$		-	200	1,000	$\Omega$

## 10.7 SYSTEM CHARACTERISTICS

(TA = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Time for stable I2C communication after reset	$t_{I2C}$		1	-	-	msec
Time for stable Touch Operating after Reset	$t_{OP}$		300	-	-	msec
Touch On response time	$t_{ON}$	1 channel Touch at all of register default	-	80	-	msec

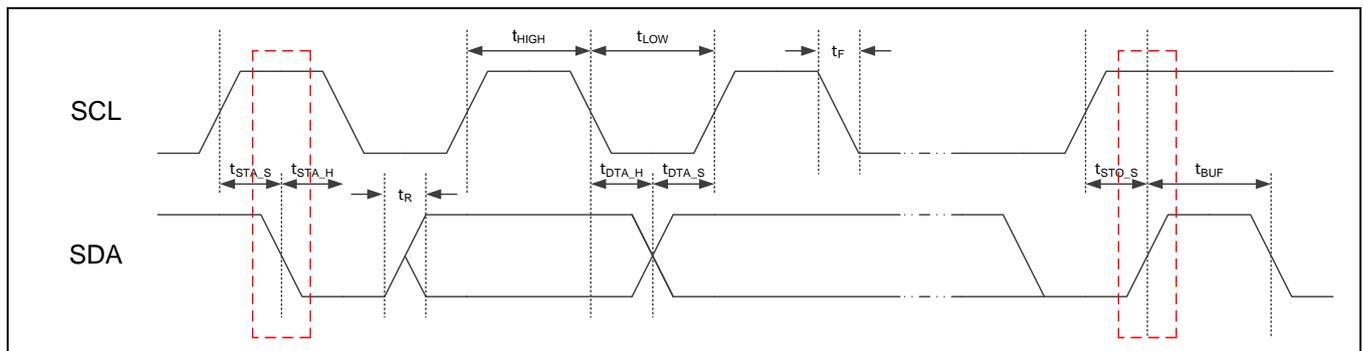
## 10.8 I2C INTERFACE TIMING CHARACTERISTICS

(TA = -25 to 85°C, V<sub>DD</sub> = 2.5V to 5.5V)

Parameter	Symbol	Standard-mode		Fast-mode		Unit
		Min.	Max.	Min.	Max.	
SCL clock frequency	f <sub>SCL</sub>	-	100	-	400	kHz
Hold time for START condition	t <sub>STA_H</sub>	4.0	-	0.6	-	us
LOW period of the SCL clock	t <sub>LOW</sub>	4.7	-	1.3	-	us
HIGH period of the SCL clock	t <sub>HIGH</sub>	4.0	-	0.7	-	us
Set-up time for START condition	t <sub>STA_S</sub>	4.7	-	0.6	-	us
Data hold time	t <sub>DAT_H</sub>	5	-	40	-	ns
Data set-up time	t <sub>DAT_S</sub>	250	-	100	-	ns
Rise time of both SDA and SCL signals	t <sub>R</sub>	-	1000	20 + 0.1 C <sub>b</sub> <sup>(2)</sup>	300	ns
Fall time of both SDA and SCL signals	t <sub>F</sub>	-	300	20 + 0.1 C <sub>b</sub> <sup>(2)</sup>	300	ns
Set-up time for STOP condition	t <sub>STO_S</sub>	4.0	-	0.6	-	us
Bus free time between a STOP and START condition	t <sub>BUF</sub>	4.7	-	1.3	-	us
Capacitive load for each bus line	C <sub>b</sub>	-	400		400	pF

### NOTE:

- (1) All values referred to V<sub>IH</sub> and V<sub>IL</sub> levels (please refer to I/O ELECTRICAL CHARACTERISTICS).
- (2) C<sub>b</sub> = total capacitance of one bus line in pF.



## 10.9 ESD CHARACTERISTICS

Qualification tests are performed to ensure that these devices can withstand exposure to reasonable levels of static without suffering any permanent damage. During the device qualification, ESD stresses were performed for the Human Body Model (HBM), the Machine Model (MM) and the Charge Device Model (CDM).

Rating	Symbol	Value	Unit
Human body model (HBM)	$V_{\text{HBM}}$	$\pm 8000$	V
Machine model (MM)	$V_{\text{MM}}$	$\pm 500$	V
Charge device model (CDM)	$V_{\text{CDM}}$	$\pm 2000$	V

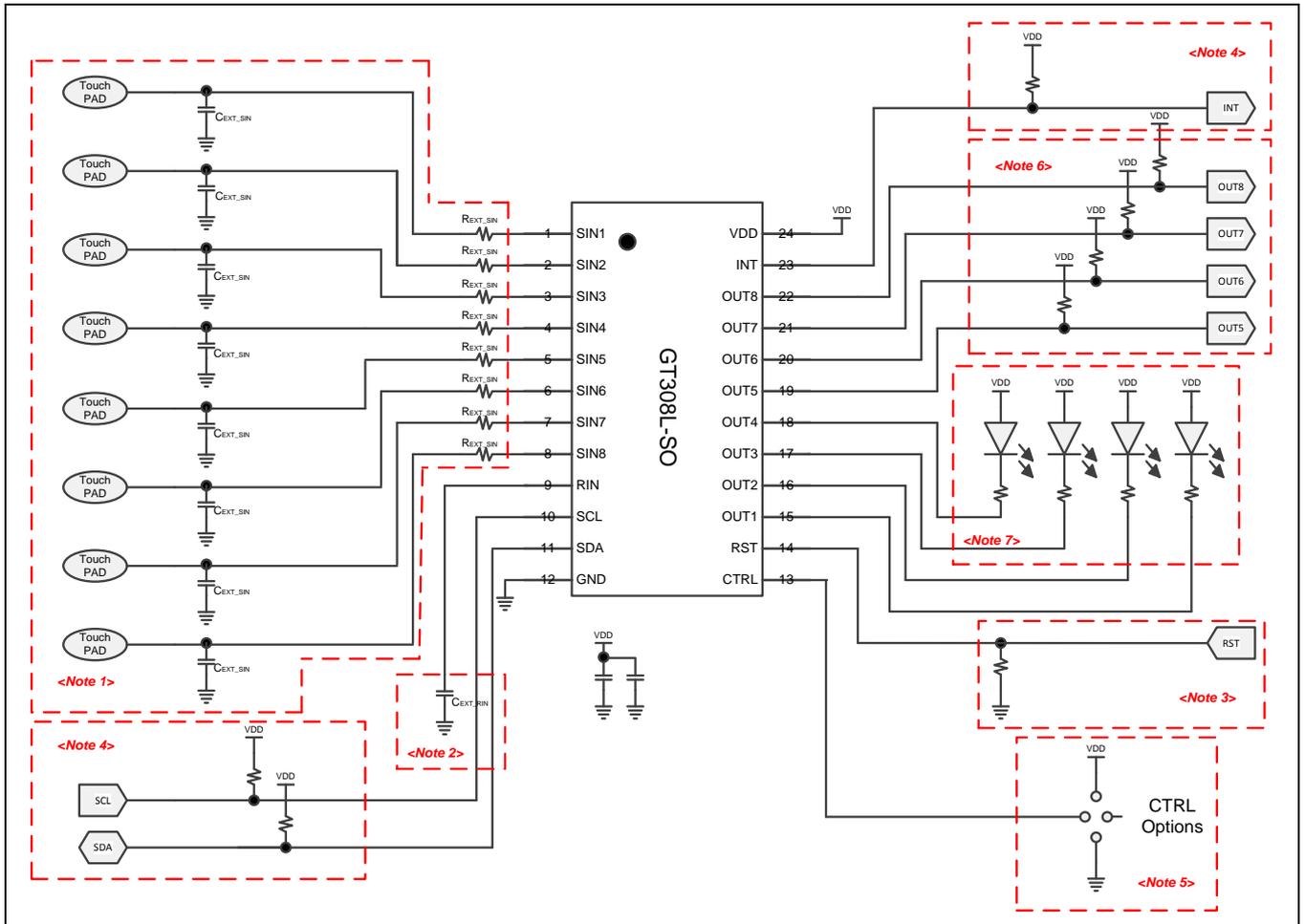
## 10.10 LATCH-UP CHARACTERISTICS

( $T_A = 85^\circ\text{C}$ )

Rating	Symbol	Value	Unit
Latch-up current	$I_{\text{LATCH}}$	$\pm 200$	mA

# 11. APPLICATION

## 11.1 EXAMPLE CIRCUIT (SSOP-24L PACKAGE)



**NOTE:**  $R_{EXT\_SIN} = 200 \Omega$ ,  $C_{EXT\_SIN} = 1pF$ ,  $C_{EXT\_RIN} = 1pF$  (recommend)

## 11.2 APPLICATION NOTES

Normally a touch sensing operation is ultimately impedance variation sensing. Hence a touch sensing system is recommended to be taken care of prevention of the external sensing disturbance. Although the GT308L has enough noise rejection algorithms and various protection circuits to prevent error touch detection caused by noise and incapable sensing, it is better to take care in noisy applications such as home appliances. There are many measurable or invisible noises in system that can affect the impedance sensing signal or distort that signal. The main principal design issues and required attentions are such as below.

- **Power Line**

- The touch sensor power line is recommended to be split from the other power lines such as relay circuits or LED power that can make pulsation noise on power lines.
- The big inductance that might exist in long power connection line can cause power fluctuation by other noise sources.
- The lower frequency periodic power noise such as a few Hz ~ kHz has more baneful influence on sensitivity calibration.
- An extra regulator for touch sensor is desirable for prevention above power line noises.
- The  $V_{DD}$  under shooting pulse less than internal reset voltage ( $V_{DD\_RST}$ ) can cause system reset.
- The capacitor connected between  $V_{DD}$  and GND is somehow obligation element for buffering above power line noises. This capacitor must be placed as near to IC as possible.

- **Sensing (Reference) Input Line for Touch Detect <Note1><Note2>**

- The sensing lines for touch detection are desirable to be routed as short as possible and the width of routing path should be as narrow as possible.
- The sensing line for touch detection should be formed by bottom metal, in other words, an opposite metal of a touch PAD.
- The additional extension line pattern of RIN input on application PCB can help prevention of abnormal actions caused by radiation noise, but excessive long RIN input line can be a reason for failure of touch detect.
- SIN capacitor is useful for sensitivity reduction adjust. A bigger capacitor of SIN makes sensitivity of corresponding channel to be lower.
- RIN capacitor value is about average value of total capacitance of each SIN touch sensing inputs.
- The sensing line for touch detection is desirable to be routed as far as possible from impedance varying path such as LED drive current path.

- An unused sensing channel is desirable to be turned off by control register. (Recommendation)
- Additional external series resistors are profitable for prevention of abnormal actions caused by radiation noise or electrical surge pulse. The series resistor value should be less than 1k $\Omega$  and the location of resistor is better as near as possible to the SIN pins for better stable operation.  
(Refer to IMPLEMENTATION FOR TOUCH SENSING)
- All touch sensing pads are recommended to be surrounded by GND pattern to reduce noise influence.

- **External Reset <Note3>**

- The RST pin is for the abrupt reset input signal. The high signal pulse can make system reset. This pin has also an internal pull-down resistor hence the RST pin can be floating.  
(Refer to INTERNAL AND EXTERNAL RESET)

- **I2C Interface and Interrupt Applications <Note4>**

- The SCL is I2C clock input pin and SDA is I2C data input/output pin. SCL and SDA have internal optional pull-up resistor. So, when I2C interface is not required, SCL and SDA pins can be floating. For high speed communication, SDA pin needs small pull-up resistor connected to V<sub>DD</sub> to reduce pulse rising delay.  
(Refer to I2C INTERFACE)
- INT is for the output signal that indicates changing of sensing output data. This pin is output only pin and has active low function. Because INT pin has open drain structure, pull-up resistor is required for valid output.  
(Refer to IMPLEMENTATION FOR INTERRUPT)

- **CTRL Option Selection <Note5>**

- Three optional sensitivities are available by CTRL pin connection. Open connection (e.g. N.C.) comes to normal sensitivity, VDD connection comes to low sensitivity, and GND connection comes to high sensitivity. This sensitivity selection is valid for all sensing channels.  
(Refer to CTRL OPTION SELECTION)

- **1:1 Direct Output Applications <Note6>**

- The pins that are used for 1:1 direct output have an active low and high output mode. Both output modes are all open drain type. Therefore a pull-up or a pull-down resistor is required for a valid output. The OUTx pin corresponds to SINx sense input respectively.

(Refer to 1:1 DIRECT OUTPUT)

- **LED PWM Drive Applications <Note7>**

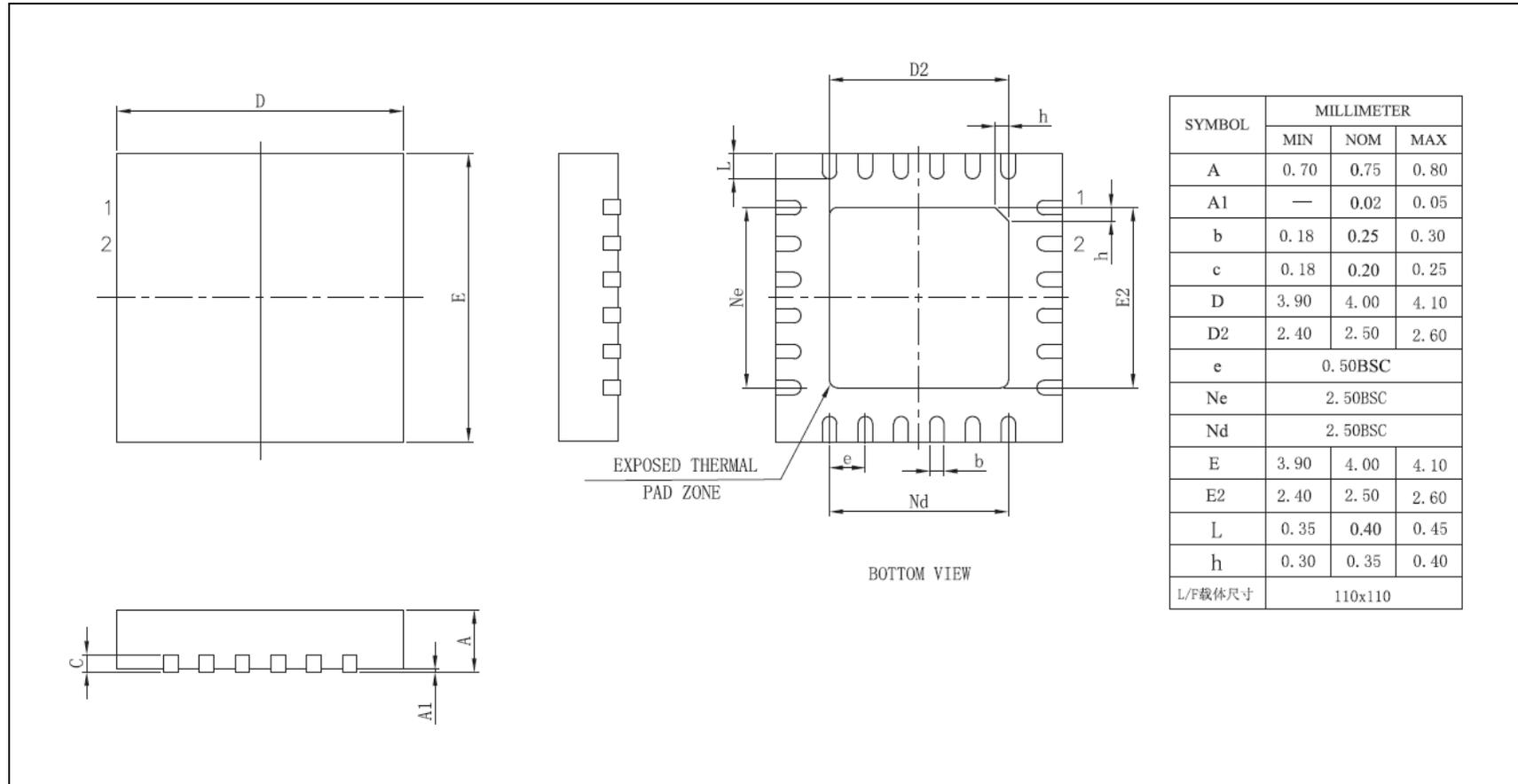
- The maximum 10mA LED drive current can be sunk by a single OUT pin on typical temperature condition. The OUT pins which are used as LED PWM drive pins cannot carry out the role of 1:1 direct out simultaneously. The 16 steps brightness control is possible.

(Refer to LED PWM OUTPUT)

- For LED dimming application, you must be configured power supply circuit to prevent power ripple.

## 12. PACKAGE DIMENSION

### 12.1 QFN-24L PACKAGE



## 12.2 SSOP-24L PACKAGE

