

# TC305K

## *Capacitive Touch Sensor Controller*

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# 1 TC305K Overview

## 1.1 General Description

**TC305K** is a high-performance Controller for capacitive touch keys. Its engine is an 8-bit 80C51 compatible Processor.

**TC305K** has two timer/counters, maximum 8-channel of fine turned touch sensors, maximum 11 programmable I/O pins, 4-channel 8-bit PWMs, 1 Watchdog timer, POR (Power-On Reset), I<sup>2</sup>C and LVD (Low Voltage Detector) as peripherals. In addition, it contains an internal ring oscillator, which can generate the 25 MHz system clock signal.

**TC305K** has its own architecture for fast sensing. With the hardware filter, it provides noise immunity and excellent sensitivity. The firmware algorithm supports smart sensitivity and compensates for changes in the sensitivity due to environmental factors such as temperature and humidity.

To effectively manage power, **TC305K** enables low power consumption by using scan interval and clock control methods after last touch.

**TC305K** operates over the extended -25°C to +85°C temperature range, and is available in the 16-pin QFN package.

## 1.2 Features

- ◆ Capacitive touch key controller
  - Supports up to 8 single-type fine turned touch keys
  - Supports scroll bar-type touch keys
  - Supports wheel-type touch keys
  - Supports Grip Sensor
- ◆ Response Time
  - The latency of < 20ms for touch, subject to configuration
  - Programmable sensing rate for power saving.

- ◆ CPU
  - 8-bit Turbo 80C52 Architecture
  - 4 Cycles / 1 Machine Cycle
  - Instruction Level Compatible with Intel 80C52
- ◆ Memory
  - 16KB Flash
  - 768B Internal Aux. RAM
  - 256B Internal RAM
- ◆ Power Supply
  - Operating Voltage : +1.75V to +3.60V
- ◆ Operating Frequency: Max. 25MHz
- ◆ 11 Programmable I/O Pins
- ◆ 4-channel 8-bit PWMs
- ◆ Communication interfaces
  - 1-channel I2C Communication (Slave)
- ◆ Internal Ring OSC with Calibration function
- ◆ Supporting ISP/IAP/MDS
- ◆ 7 Internal Interrupt Sources and 3 External Interrupt Sources
- ◆ 3 Reset Sources
- ◆ Power Down Wake-up Sources
  - Reset Sources + 3 External Interrupt (Both Levels)
  - Watchdog Timer Interrupt
- ◆ Power Consumption
  - Active Current : Max. 1mA @+3.3V, 2MHz
  - Sleep Current : Typ. 15uA @+3.3V(ST on)
  - Deep Sleep Current: Typ. 3uA @+3.3V
- ◆ E.S.D. Protection up to
  - 8,000V
- ◆ Latch-up Protection Up to  $\pm 200\text{mA}$
- ◆ Package
  - 16-pin QFN (0.50T)

### 1.3 Applications

- ◆ Home appliance: TV, Monitor, Home Theater
- ◆ Mobile Phones
- ◆ Portable MP3, MP4
- ◆ Digital Cameras
- ◆ Battery power applications

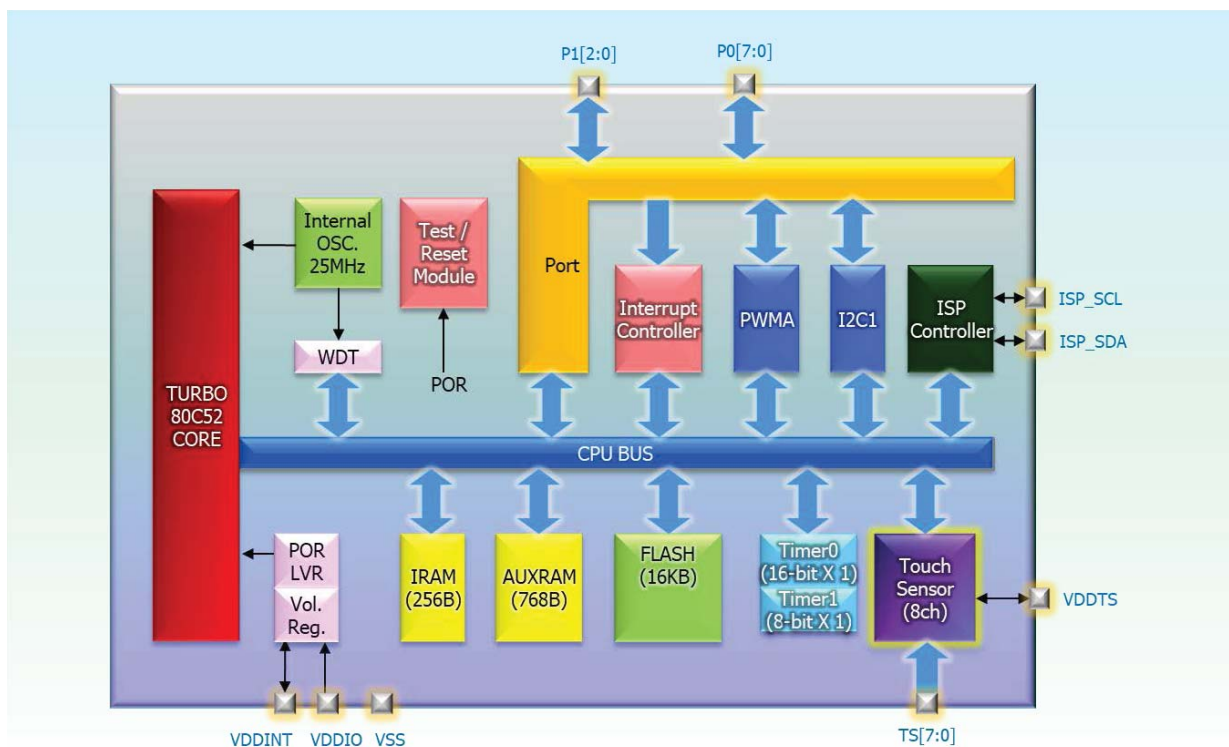
### 1.4 Product Family Guide

Product	Res.	FLASH [Byte]	RAM [Byte]	Volt [V]	Freq [MHz]	T/C [16/8bit]	COM I/O	PWM [bit x ch]	WDT	I/O Pins	Touch Channel	Package	Others
TC305K- QF16IP	65,536	16K	768 + 256	1.75 ~ 3.60	25	2	1 I2C	8 x 4	1	11	8	16-QFN (e-PAD) 3 x 3 mm 0.55T	IAP ISP LVR POR RING

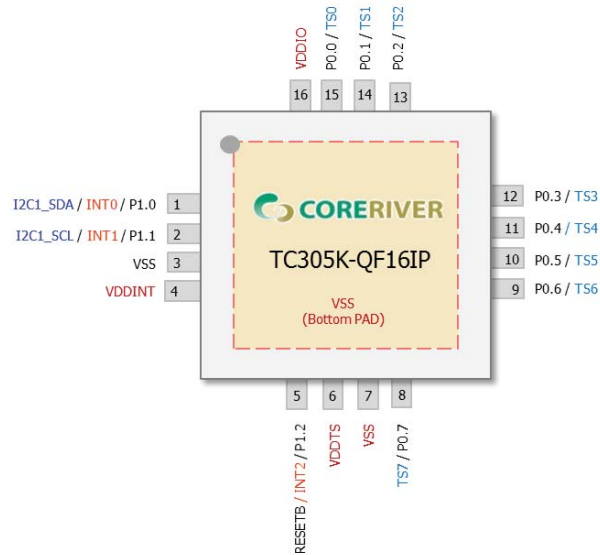
## 2 Block Diagram

Figure shows the block diagram of **TC305K**. Programs reside in the internal program memory (Embedded Flash Memory). Data are read from or written to data memory (SRAM) or special function registers (SFRs).

The internal registers of **TC305K** are configured as part of the on-chip RAM: therefore each register has an address. This is reasonable for **TC305K**, since it has so many registers.



### 3 Pin Configuration



**TC305K-QF16IP Package Diagram**

Pin No.	Name	Type	Description	Share Pins
1	P1.0	I/O	General I/O Port 1.0	I2C1_SDA / INT0
2	P1.1	I/O	General I/O Port 1.1	I2C1_SCL / INT1
3	VSS	GND	Ground	
4	VDDINT	O	Digital Power Filter( +1.8V )	
5	P1.2	I/O	General I/O Port 1.2	INT2 / RESETB
6	VDDINTS	O	Touch Sensor Power Filter	
7	VSS	GND	Ground	
8	TS7	I/O	Touch Sensing Channel 7	P0.7 / PWM3_A
9	TS6	I/O	Touch Sensing Channel 6	P0.6 / PWM2_A
10	TS5	I/O	Touch Sensing Channel 5	P0.5 / PWM1_A
11	TS4	I/O	Touch Sensing Channel 4	P0.4 / PWM0_A
12	TS3	I/O	Touch Sensing Channel 3	P0.3 / PWM3
13	TS2	I/O	Touch Sensing Channel 2	P0.2 / PWM2
14	TS1	I/O	Touch Sensing Channel 1	P0.1 / PWM1
15	TS0	I/O	Touch Sensing Channel 0	P0.0 / PWM0
16	VDDIO	PWR	Power Supply	

## 4 Absolute Maximum Ratings

.Absolute Maximum Ratings ( TA = 25 °C )

Item	Conditions	Range
DC Voltage in V <sub>DDIO</sub> relative to Ground	-	-0.5 V to +4.6V
DC Input Voltage	-	-0.5V to (V <sub>DDIO</sub> +0.5V)
DC Output Voltage	-	-0.5 V to (V <sub>DDIO</sub> +0.5V)
DC Output Current High	One I/O pin active	-25mA
	All I/O pin active	-100mA
DC Output Current Low	One I/O pin active	+30mA
	All I/O pin active	+150mA
Storage Temperature	-	-65 °C to +150 °C
Soldering Temperature	-	260 °C for 10 seconds

.Recommended Operating Conditions

Item	Conditions	Range
Operating Voltage	-	+1.75V to +3.60V
Operating Temperature	-	-25°C to + 85°C

## 5 DC Characteristics

\*  $T_A = -25^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  $V_{DD} = 1.75\text{V} \sim 3.60\text{V}$  unless otherwise specified

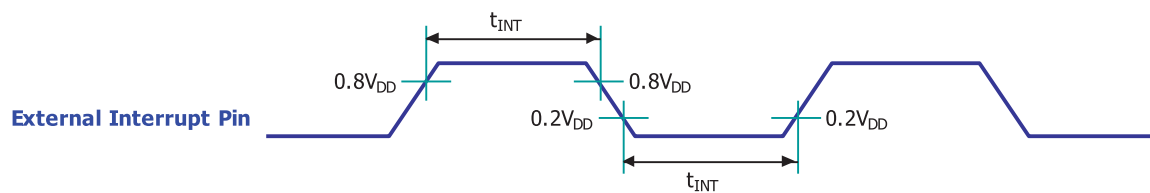
Parameter	Symbol	Pin	Conditions	Value			Unit
				Min.	Typ.	Max.	
Input Low Voltage	$V_{IL}$	P0, P1	$V_{DDIO} = +1.75\text{V to } +3.60\text{V}$	-0.5	-	$0.2V_{DDIO} + 0.1$	V
Input high Voltage	$V_{IH}$	P0, P1	$V_{DDIO} = +1.75\text{V to } +3.60\text{V}$	$0.2V_{DDIO} + 1.0$	-	$V_{DDIO} + 0.5$	V
Output Low Voltage	$V_{OL}$	P0, P1	$V_{DDIO} = +3.3\text{V} (I_{OL} = 4.20\text{mA})$ $V_{DDIO} = +1.8\text{V} (I_{OL} = 2.00\text{mA})$	-	-	$0.3V_{DDIO}$	V
		P0, P1 (High Drive)	$V_{DDIO} = +3.3\text{V} (I_{OL} = 34.14\text{mA})$ $V_{DDIO} = +1.8\text{V} (I_{OL} = 8.17\text{mA})$	-	-	$0.3V_{DDIO}$	V
Output High Voltage	$V_{OH}$	P0, P1	$V_{DDIO} = +3.3\text{V} (I_{OH} = -7.80\text{mA})$ $V_{DDIO} = +1.8\text{V} (I_{OH} = -2.22\text{mA})$	$0.7V_{DDIO}$	-	-	V
Pull-up Resistor	$R_{Pu}$	P0	$V_{DDIO} = +3.3\text{V}$		52		K $\Omega$
	$R_{Pu1}$	P1	$V_{DDIO} = +3.3\text{V}$		5.6		K $\Omega$
	$R_{Pu2}$		$V_{DDIO} = +2.2\text{V}$ (Internal 1.8V Pull-up)		2.2		K $\Omega$
Logical 1 to 0 Transition Current	$I_{TL}$	P0, P1	$V_{DDIO} = 3.0\text{V} \pm 10\%$ ( $V_{IN} = +2.0\text{V}$ )	-	-	-650	$\mu\text{A}$
Input Leakage Current	$I_{IL}$	P0, P1	$V_{IN} = V_{IH}$ or $V_{IL}$	-	-	$\pm 1$	$\mu\text{A}$
Pin Capacitance	$C_{IO}$	All	$V_{DDIO} = +3.0\text{V}$	-	10	-	pF
Active Current	$I_{DD}$	$V_{SS}$	$V_{DDIO} = +1.8\text{V}$ , $T_A = 25^{\circ}\text{C}$ , $F_{SYS} = 12.5\text{MHz}$ , Touch Sampling rate = 100Hz(4 Channels), no I/O sourcing current	-	1.31	2.1	mA
Sleep Current	$I_{SB}$	$V_{SS}$	$V_{DDIO} = +3.0\text{V}$ , $T_A = 25^{\circ}\text{C}$ , no I/O sourcing current	-	3	7	$\mu\text{A}$



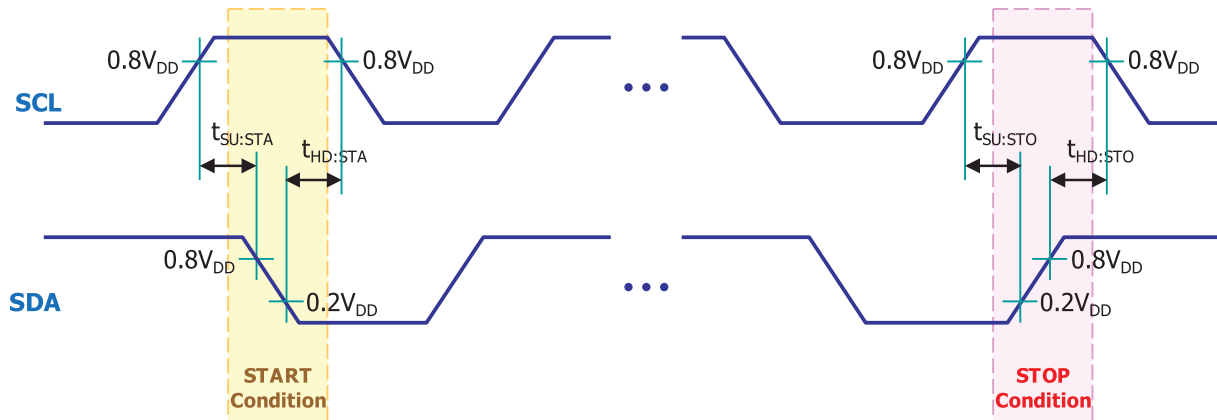
## 6 AC Characteristics

\*  $T_A = -25^{\circ}\text{C} \sim +85^{\circ}\text{C}$ ,  $V_{DD} = 1.75\text{V} \sim 3.60\text{V}$  unless otherwise specified

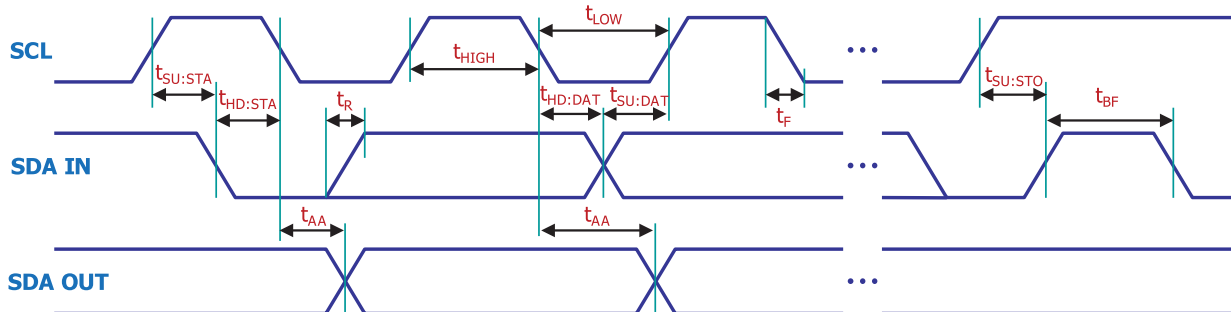
Parameter	Symbol	Pin	Conditions	Value			Unit
				Min	Typ	Max	
External Interrupt Input Width	$t_{INT}$	External Interrupt	$V_{DD} = 3\text{V} \pm 10\%$	4	-	-	$F_{SYS}$



## 7 I2C Timing Characteristics

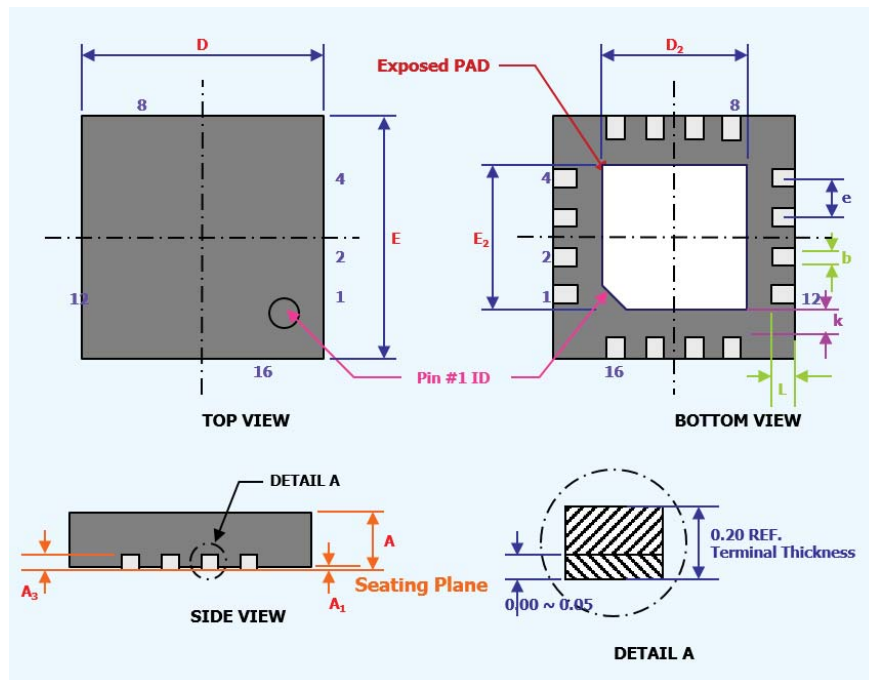


Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
$t_{SU:STA}$	START Condition Setup Time	100kHz Mode	4,700	-	Only relevant for repeated START condition
		400kHz Mode	600	-	
$t_{HD:STA}$	START Condition Hold Time	100kHz Mode	4,700	-	After this period, the first clock pulse is generated
		400kHz Mode	600	-	
$t_{SU:STO}$	STOP Condition Setup Time	100kHz Mode	4,700	-	
		400kHz Mode	600	-	
$t_{HD:STO}$	STOP Condition Hold Time	100kHz Mode	4,700	-	
		400kHz Mode	600	-	



Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
$t_{HIGH}$	Clock High Time	100kHz Mode	4,000	-	Minimum Frequency : 1MHz
		400kHz Mode	600	-	Minimum Frequency : 5MHz
$t_{LOW}$	Clock Low Time	100kHz Mode	4,700	-	Minimum Frequency : 1MHz
		400kHz Mode	1,300	-	Minimum Frequency : 5MHz
$t_{SU:DAT}$	Data Input Setup Time	100kHz Mode	250	-	
		400kHz Mode	100	-	
$t_{HD:DAT}$	Data Input Hold Time	100kHz Mode	0	-	
		400kHz Mode	0	900	
$t_{AA}$	Data Valid from Clock	100kHz Mode	-	3,500	
		400kHz Mode	-	-	
$t_{BF}$	BUS Free Time	100kHz Mode	4,700	-	
		400kHz Mode	1,300	-	
$t_R$	SDA & SCL Rising Time	100kHz Mode	-	1,000	The Range of Cb is from 10pF to 400pF
		400kHz Mode	$2.0 + 0.1C_b$	300	
$t_F$	SDA & SCL Falling Time	100kHz Mode	-	300	The Range of Cb is from 10pF to 400pF
		400kHz Mode	$2.0 + 0.1C_b$	300	

## 8 16-pin QFN Package Dimension



Symbol	Dimensions [mm]		
	Min.	Nom.	Max.
A	0.45	0.50	0.55
A <sub>1</sub>	0.00	-	0.05
A <sub>3</sub>	0.127 REF		
D	2.95	3.00	3.05
E	2.95	3.00	3.05
D <sub>2</sub>	1.70	1.80	1.90
E <sub>2</sub>	1.70	1.80	1.90
b	0.20	0.25	0.30
e	0.50 BSC		
L	0.30	0.35	0.40
k	0.25 REF		

### Notes:

1. All Dimension are in mm. Angles in Degrees.
2. Dimension b applies to Plated Terminal & is measured.
3. BSC : Basic Dimension. Theoretically exact value shown without tolerances.  
REF : Reference Dimension, Usually without tolerance, for information purpose only.

## 9 Revision History

Date	Revision	History
Nov.-2013	0.4	Preliminary release
Oct-2014	1.1	Updated "Operating Conditions (Voltage and Temperature)" and "PKG Dimension"
Nov-2014	1.2	Updated "DC Characteristics"
Nov-2015	1.4	Added Supports Grip Sensor
Jan-2017	1.5	Updated "1.8V Pull-up Resistor Characteristics"
Aug-2017	1.6	Added "Power Consumption"
Aug-2017	1.7	Modified "DC Characteristics"
Nov-2018	1.8	Modified Reference circuit
Mar-2021	1.9	Notation error corrected.
May-2021	2.0	Updated "Operating Conditions Temperature" -20°C to -25°C

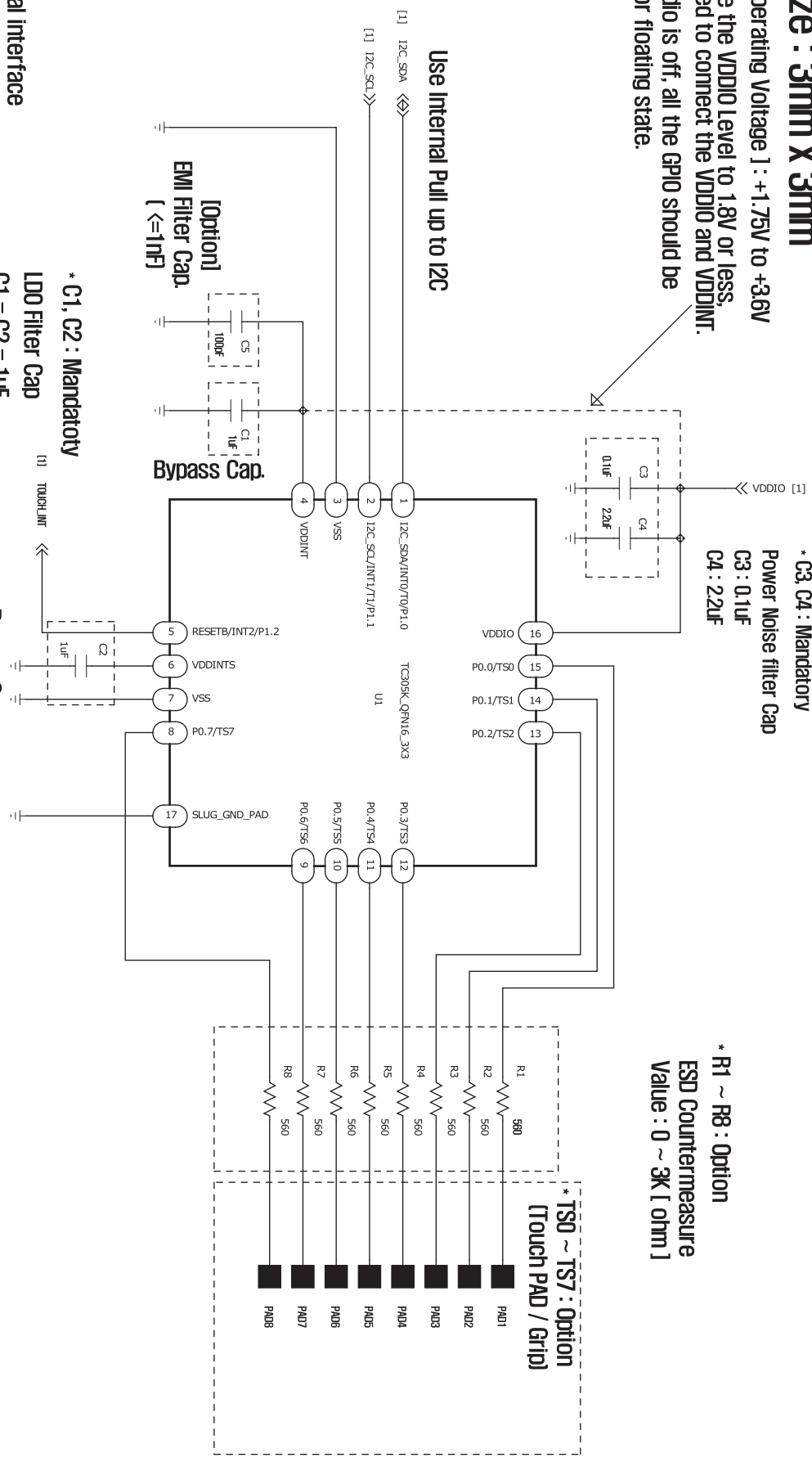
# TC305K – QF16IP

## Body Size : 3mm x 3mm

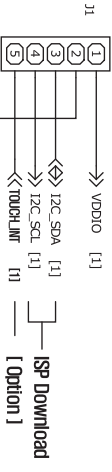
- 1) VDDIO [ Operating Voltage ] : +1.75V to +3.6V
- > If you use the VDDIO Level to 1.8V or less, you'll need to connect the VDDIO and VDDINT.
- 2) When vddio is off, all the GPIO should be 'LOWIO' or floating state.

\* C3, C4 : Mandatory  
 Power Noise filter Cap  
 C3 : 0.1uF  
 C4 : 22uF

\* R1 ~ R8 : Option  
 ESD Countermeasure  
 Value : 0 ~ 3K [ ohm ]



**External interface**  
 I2C\_SDA [1]  
 I2C\_SCL [1]  
 TOUCH\_INT [1]  
 ISP Download [Option]



\* C1, C2 : Mandatory  
 LDO Filter Cap  
 C1 = C2 = 1uF

Bypass Cap.

NO.	REVISION NO.	NO.	REVISION NO.	C	B	A	NO.	PART NO.	DESCRIPTION	MATERIAL	COLOR FINISH	NOTE
1				QUANTITY			SCALE	UNIT	DRAWN.	DSCHHEMATIC		
2				SCALE			A3	mm	2018-11-05	<undefined>		
				SHEET			1	1	CORERIVER			