CORERIVER
Total Solution of MCU

TC304M

Capacitive Touch Sensor Controller

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1 TC304M Overview

1.1 General Description

TC304M is a high-performance Controller for capacitive touch keys. Its engine is an 8-bit 80C51 compatible Processor.

TC304M has two timer/counters, maximum 4-channel of touch sensors, maximum 12 programmable I/O pins, 4-channel 8-bit PWMs, 1 Watchdog timer, POR (Power-On Reset), I^2C and LVD (Low Voltage Detector) as peripherals. In addition, it contains an internal ring oscillator, which can generate the 25 MHz system clock signal.

TC304M 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, ***TC304M*** enables low power consumption by using scan interval and clock control methods after last touch.

TC304M operates over the extended -40℃ to +85℃ temperature range, and is available in the 16-pin QFN and 16-pin SOP package.

1.2 Features

- Capacitive touch key controller
  - Supports up to 4 single-type touch keys
  - Supports scroll bar-type touch keys
  - Supports wheel-type touch keys
- Key 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: +2.2V to +5.5V
- Operating Frequency: Max. 25MHz
- 12 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
- 8 Internal Interrupt Sources and 3 External Interrupt Sources
- 3 Reset Sources
- Power Down Wake-up Sources
  - Reset Sources + 3 External Interrupt (Both Levels)
  - Sleep Timer Interrupt
- 4 operating modes: Active, IDLE, Sleep, Deep Sleep
- E.S.D. Protection up to
  - 8,000V
- Latch-up Protection Up to ±200mA
- Package
  - 16-pin QFN (0.55T)
  - 16-pin SOP

1.3 Applications

- TV, Monitor, Home Theater
- Refrigerator, Washer, Air conditioner
- Mobile Phones
- Battery power applications

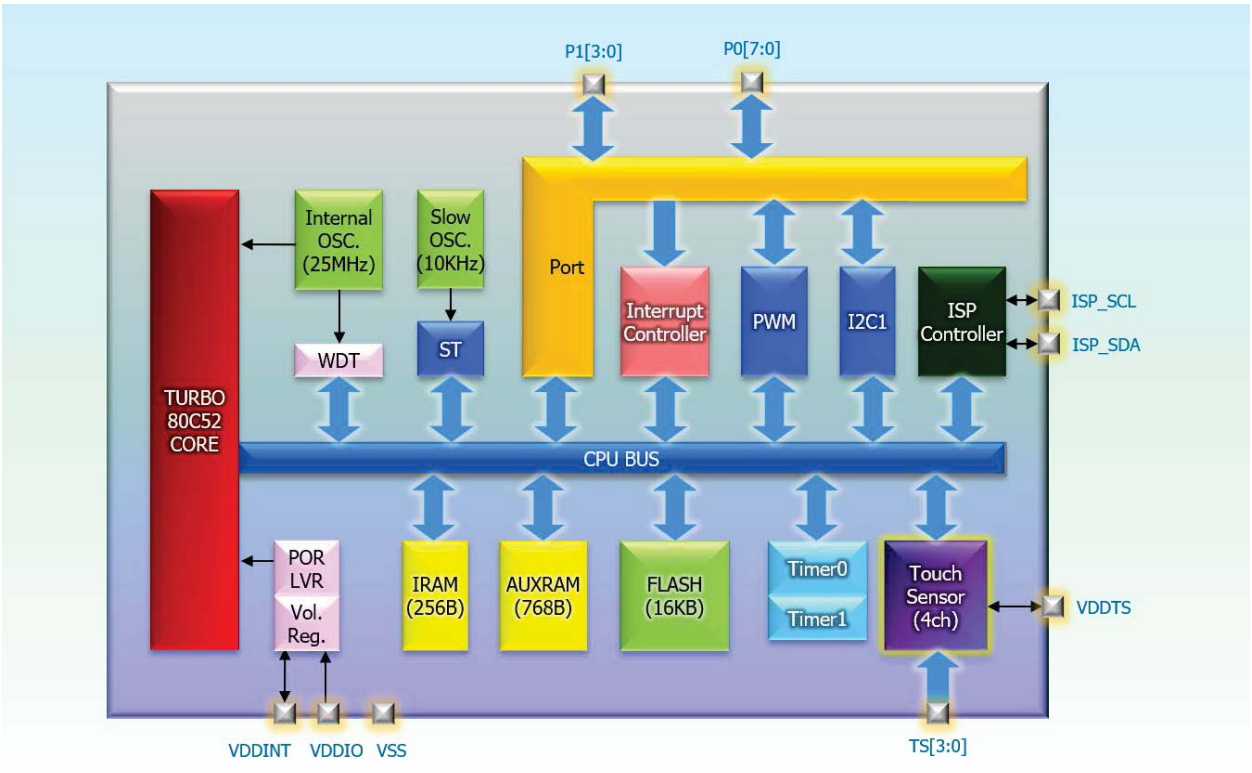
1.4 Product Family Guide

Product	FLASH, [Byte]	RAM [Byte]	Volt [V]	COM I/O	PWM (bit X ch)	I/O Pins	Touch Channel, Res.	Package	Others
TC304M-QF16IP	16K	768 + 256	2.2 ~ 5.5	1 I2C	8 X 4	12	4, 65,536	16-QFN	IAP ISP LVR POR RING
TC304M-SO16IP			VDDIO (2.2 ~ 5.5) VDDHOST (1.8 ~ 5.5)			10	4, 65,536	16-SOP	

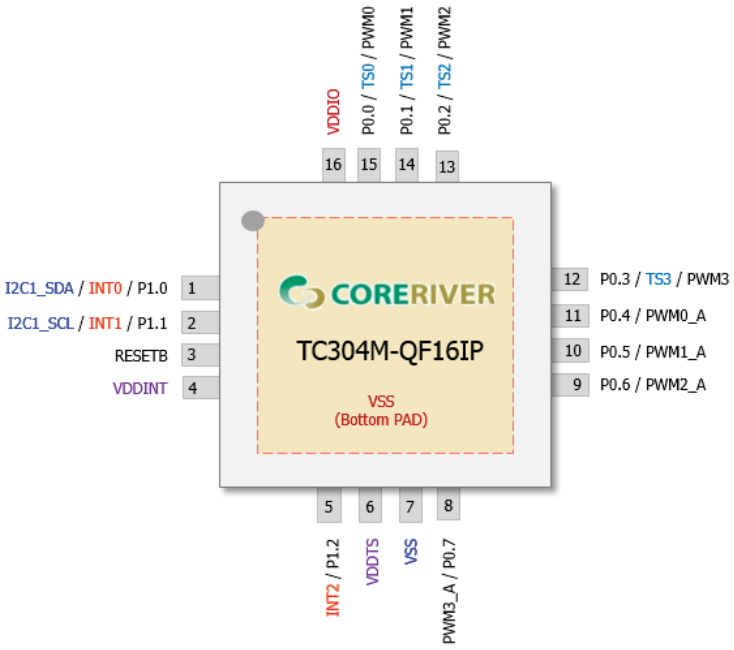
2 Block Diagram

Figure shows the block diagram of ***TC304M***. 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 ***TC304M*** are configured as part of the on-chip RAM: therefore each register has an address. This is reasonable for ***TC304M***, since it has so many registers.


P1[3:0]
P0[7:0]
Internal OSC. (25MHz)
Slow OSC. (10KHz)
Port
Interrupt Controller
PWM
I2C1
ISP Controller
ISP_SCL
ISP_SDA
WDT
ST
TURBO 80C52 CORE
CPU BUS
POR LVR
Vol. Reg.
IRAM (256B)
AUXRAM (768B)
FLASH (16KB)
Timer0
Timer1
Touch Sensor (4ch)
VDDTS
VDDINT
VDDIO
VSS
TS[3:0]

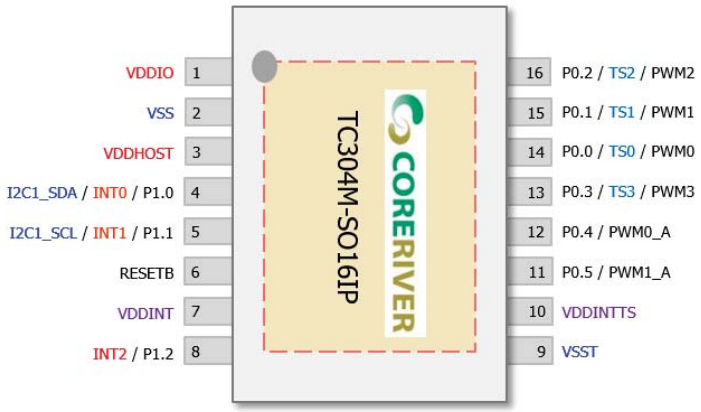
3 Pin Configuration



TC304M-QF16IP Package Diagram

Pin No. 16-QFN	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	RESETB	I/O	Reset Pin	INT3 / GPIO
4	VDDINT	O	Digital Power Filter	
5	P1.2	I/O	General I/O Port 1.2	INT2
6	VDDTS	O	Touch Sensor Power Filter	

7	VSS	GND	Ground	
8	P0.7	I/O	General I/O Port 0.7	PWM3_A
9	P0.6	I/O	General I/O Port 0.6	PWM2_A
10	P0.5	I/O	General I/O Port 0.5	PWM1_A
11	P0.4	I/O	General I/O Port 0.4	PWM0_A
12	P0.3	I/O	General I/O Port 0.3	Touch Sensing Channel 3 PWM3
13	P0.2	I/O	General I/O Port 0.2	Touch Sensing Channel 2 PWM2
14	P0.1	I/O	General I/O Port 0.1	Touch Sensing Channel 1 PWM1
15	P0.0	I/O	General I/O Port 0.0	Touch Sensing Channel 0 PWM0
16	VDDIO	PWR	Power Supply	



TC304M-SO16IP Package Diagram

Pin No. 16-SOP	Name	Type	Description	Share Pins
1	VDDIO	PWR	Power Supply	
2	VSS	GND	Ground	
3	VDDHOST	PWR	Power Supply	
4	P1.0	I/O	General I/O Port 1.0	I2C1_SDA / INT0
5	P1.1	I/O	General I/O Port 1.1	I2C1_SCL / INT1
6	RESETB	I/O	Reset Pin	INT3 / GPIO
7	VDDINT	O	Digital Power Filter	
8	P1.2	I/O	General I/O Port 1.2	INT2
9	VSST	GND	Ground	
10	VDDINTTS	O	Touch Sensor Power Filter	
11	P0.5	I/O	General I/O Port 0.5	PWM1_A
12	P0.4	I/O	General I/O Port 0.4	PWM0_A
13	P0.3	I/O	General I/O Port 0.3	Touch Sensing Channel 3 PWM3
14	P0.0	I/O	General I/O Port 0.0	Touch Sensing Channel 0 PWM0
15	P0.1	I/O	General I/O Port 0.1	Touch Sensing Channel 1 PWM1
16	P0.2	I/O	General I/O Port 0.2	Touch Sensing Channel 2 PWM2

4 Absolute Maximum Ratings

. Absolute Maximum Ratings (TA = 25 °C)

Item	Conditions	Range
DC Voltage in V_{DDIO} relative to Ground	-	-0.5 V to +6V
DC Input Voltage	-	-0.5V to (V_{DDIO}+0.5V)
DC Output Voltage	-	-0.5 V to (V_{DDIO}+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	-	+2.2V to +5.5V
Operating Temperature	-	-40℃ to + 85℃

5 DC Characteristics

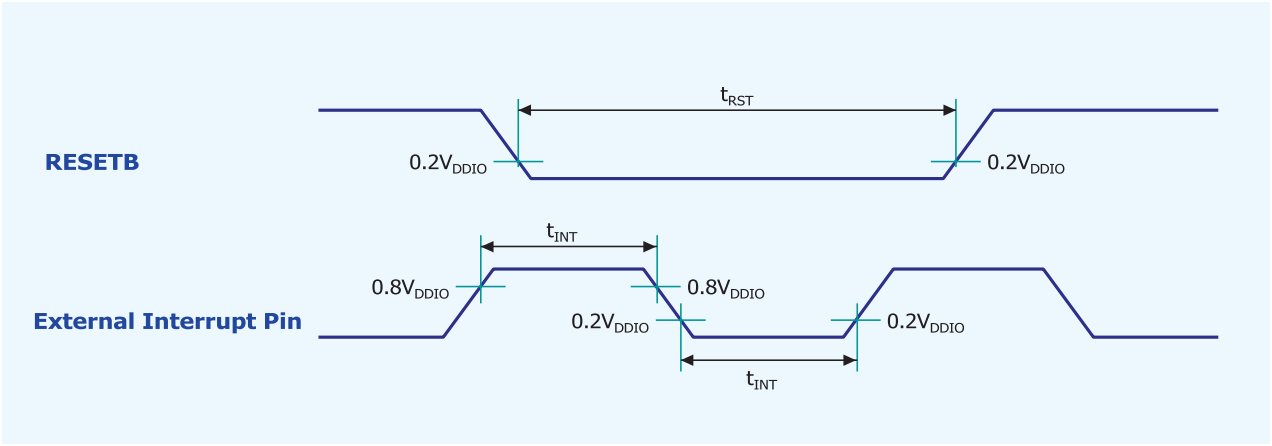
* T_A= -40°C ~ +85°C, V_{DD}=2.2V ~ 5.5V unless otherwise specified

Parameter	Symbol	Pin	Conditions	Value			Unit
				Min.	Typ.	Max.	
Input Low Voltage	V_{IL}	P0, P1	V_{DDIO} = +2.2V to +5.5V	-0.5	-	0.2V_{DDIO} +0.1	V
Input high Voltage	V_{IH}	P0, P1	V_{DDIO} = +2.2V to +5.5V	0.2V_{DDIO} +1.0	-	V_{DDIO} +0.5	V
Output Low Voltage	V_{OL}	P0, P1	V_{DDIO} = +5.0V (I_{OL} = 8mA) V_{DDIO} = +3.3V (I_{OL} = 4mA)	-	-	0.3V_{DDIO}	V
		P0, P1 (High Drive)	V_{DDIO} = +3.3V (I_{OL} = 35mA)	-	-	0.3V_{DDIO}	V
Output High Voltage	V_{OH}	P0, P1	V_{DDIO} = +5.0V (I_{OH} = -12mA) V_{DDIO} = +3.3V (I_{OH} = -6mA)	0.7V_{DDIO}	-	-	V
Pull-up Resistor	R_{Pu}	P0	V_{DDIO} = +5.0V V_{DDIO} = + 3.3V		37.5 45		KΩ
Pull-up Resistor	R_{Pu1}	P1	V_{DDIO} = +5.0V V_{DDIO} = + 3.3V		37.5 45		KΩ
Logical 1 to 0 Transition Current	I_{TL}	P0, P1	V_{DDIO} = 5.0V±10% (V_{IN} = +1.5V)	-	548	-	μA
Input Leakage Current	I_{IL}	P0, P1	V_{IN} = V_{IH} or V_{IL}	-	-	±1	μA
Pin Capacitance	C_{IO}	All	V_{DDIO} = +5.0V	-	10	-	pF
Active Current	I_{DD}	V_{SS}	V_{DDIO} = +2.2V, T_A=25°C, F_{SYS} =12.5MHz, Touch Sampling rate = 100Hz(4Channels), no I/O sourcing current	-	1.3	2.1	mA
Sleep Current	I_{SB}	V_{SS}	V_{DDIO} = +2.2V, T_A=25°C, no I/O sourcing current	1	2	5	μA

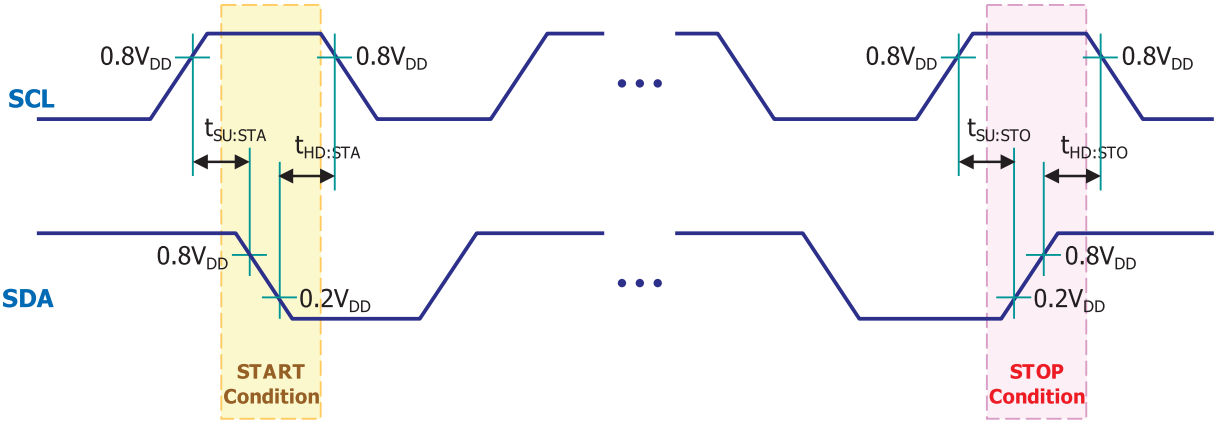
6 AC Characteristics

* T_A = -40 °C ~ +85 °C, V_{DDIO} = 2.2V ~ 5.5V unless otherwise specified

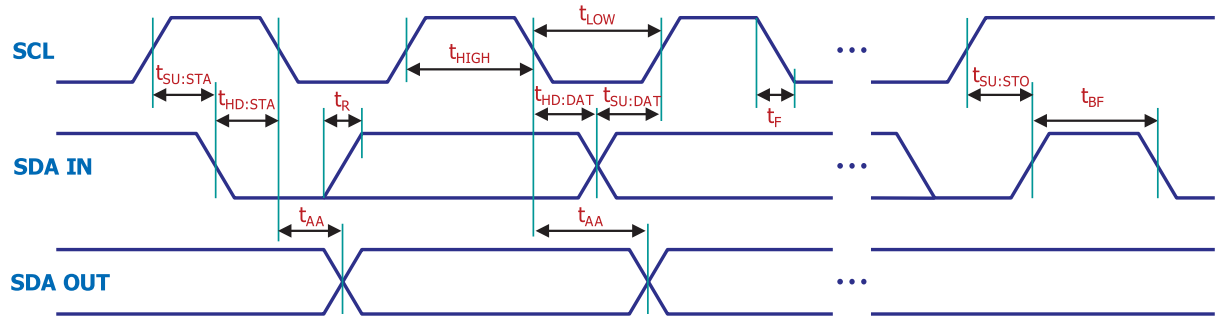
Parameter	Symbol	Pin	Conditions	Value			Unit
				Min	Typ	Max	
RESETB Input Width	t_{RST}	RESETB	V_{DDIO} = 3V ± 10%	24	-	-	F_{SYS}
External Interrupt Input Width	t_{INT}	External Interrupt	V_{DDIO} = 3V ± 10%	4	-	-	F_{SYS}



7 I2C Timing Characteristics



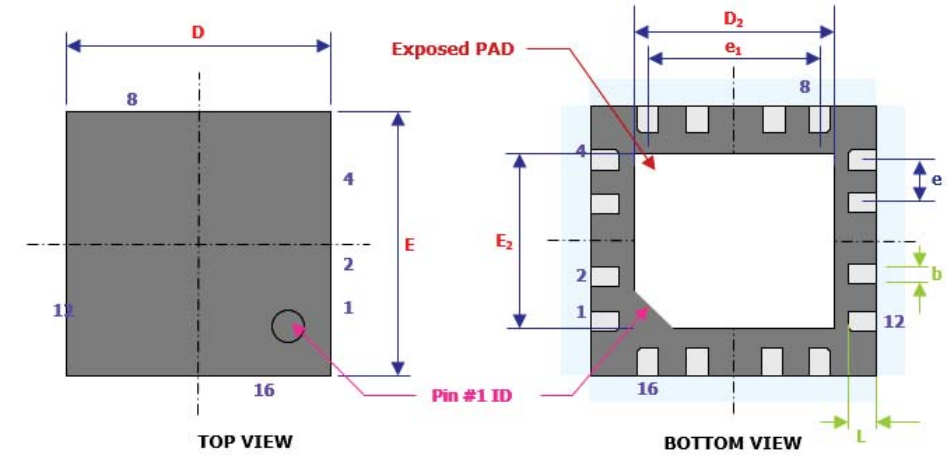
Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
$t_{SU:STA}$	START Condition Setup Time	100kHz Mode	4,700	-	Only relevant for repeated START condition
		400kHz Mode	600	-	
$t_{HD:STA}$	START Condition Hold Time	100kHz Mode	4,700	-	After this period, the first clock pulse is generated
		400kHz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

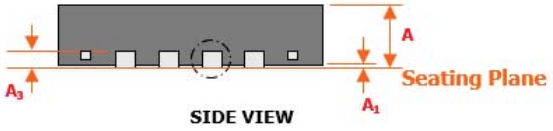


Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
t_{HIGH}	Clock High Time	100kHz Mode	4,000	-	Minimum Frequency : 1MHz
		400kHz Mode	600	-	Minimum Frequency : 5MHz
t_{LOW}	Clock Low Time	100kHz Mode	4,700	-	Minimum Frequency : 1MHz
		400kHz Mode	1,300	-	Minimum Frequency : 5MHz
$t_{SU:DAT}$	Data 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 + 0.1Cb	300	
t_F	SDA & SCL Falling Time	100kHz Mode	-	300	The Range of Cb is from 10pF to 400pF
		400kHz Mode	2.0 + 0.1Cb	300	

8 Package Dimension

8.1 QFN 16 Pin (UNISEM IPOH)



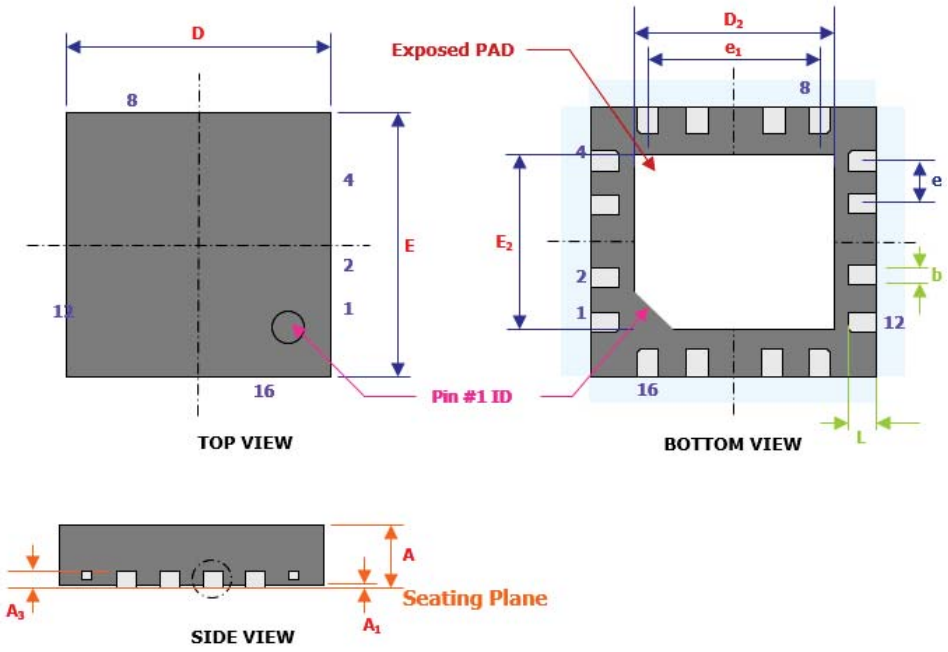


Symbol	Dimensions [mm]		
	Min.	Nom.	Max.
A	0.50	0.55	0.60
A_1	0.00	-	0.05
A_3		0.15 REF	
b	0.20	0.25	0.30
D	2.95	3.00	3.05
D_2	1.65	1.70	1.75
E	2.95	3.00	3.05
E_2	1.65	1.70	1.75
e		0.50 BSC	
e_1		1.50 REF	
L	0.30	0.35	0.40

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.

8.2 QFN 16 Pin (UNISEM Chengdu)

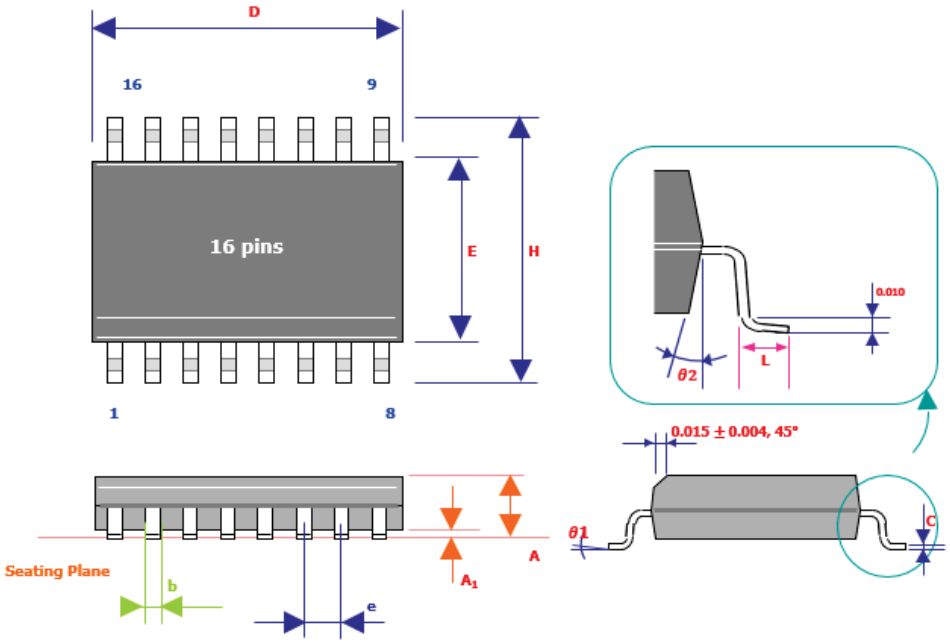


Symbol	Dimensions [mm]		
	Min.	Nom.	Max.
A	0.50	0.55	0.60
A_1	0.00	-	0.05
A_3		0.15 REF	
b	0.20	0.25	0.30
D	2.95	3.00	3.05
D_2	1.75	1.80	1.85
E	2.95	3.00	3.05
E_2	1.75	1.80	1.85
e		0.50 BSC	
e_1		1.50 REF	
L	0.30	0.35	0.40

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.

8.3 SOP 16 Pin



Symbol	Dimensions [mm]		
	Min.	Nom.	Max.
A	1.3716	-	1.7272
A_1	0.1016	-	0.24892
B	0.3556	-	0.4826
D	9.8044	-	9.9822
E	3.8100	-	3.9878
H	5.8166	-	6.1976
e	1.2700 BSC		
C	0.1905	-	0.24892
L	0.4064	-	0.8636
X	0.5080 REF		
Θ1	0°	-	8°
Θ2	7° BSC		

Notes:

1. Lead Coplanarity Should be 0 to 0.1016mm MAX.
2. Package surface finishing : VDI 24 ~ 27 (Dual)
   Package surface finishing : VDI 13 ~ 15 (16L SOIC(NB) Matrix)
3. All dimension excluding mold flashes.
4. the lead width, B to determined at 0.1905mm form the lead tip

9 Revision History

Date	Revision	History
Mar.-2017	1.0	Release
July - 2019	1.1	Added the TC304M-DF12IP package
Mar - 2021	1.2	Notation error corrected & deleted the TC304M-DF12IP package
Sep.-2021	1.3	On page 14 QFN16 Package Dimension description error e2 is corrected to e1.
Dec.-2021	1.4	On page 15 SOP16 Package Dimension description error is corrected.
Jan.-2022	1.5	Added Assembly Site of the UNISEM Ipoh

TC304M – QF16IP

Body Size : 3mm x 3mm

>>VDDIO [Operating Voltage] : +2.2V to +5.5V

* C1, C2 : Mandatory

Power Noise filter Cap

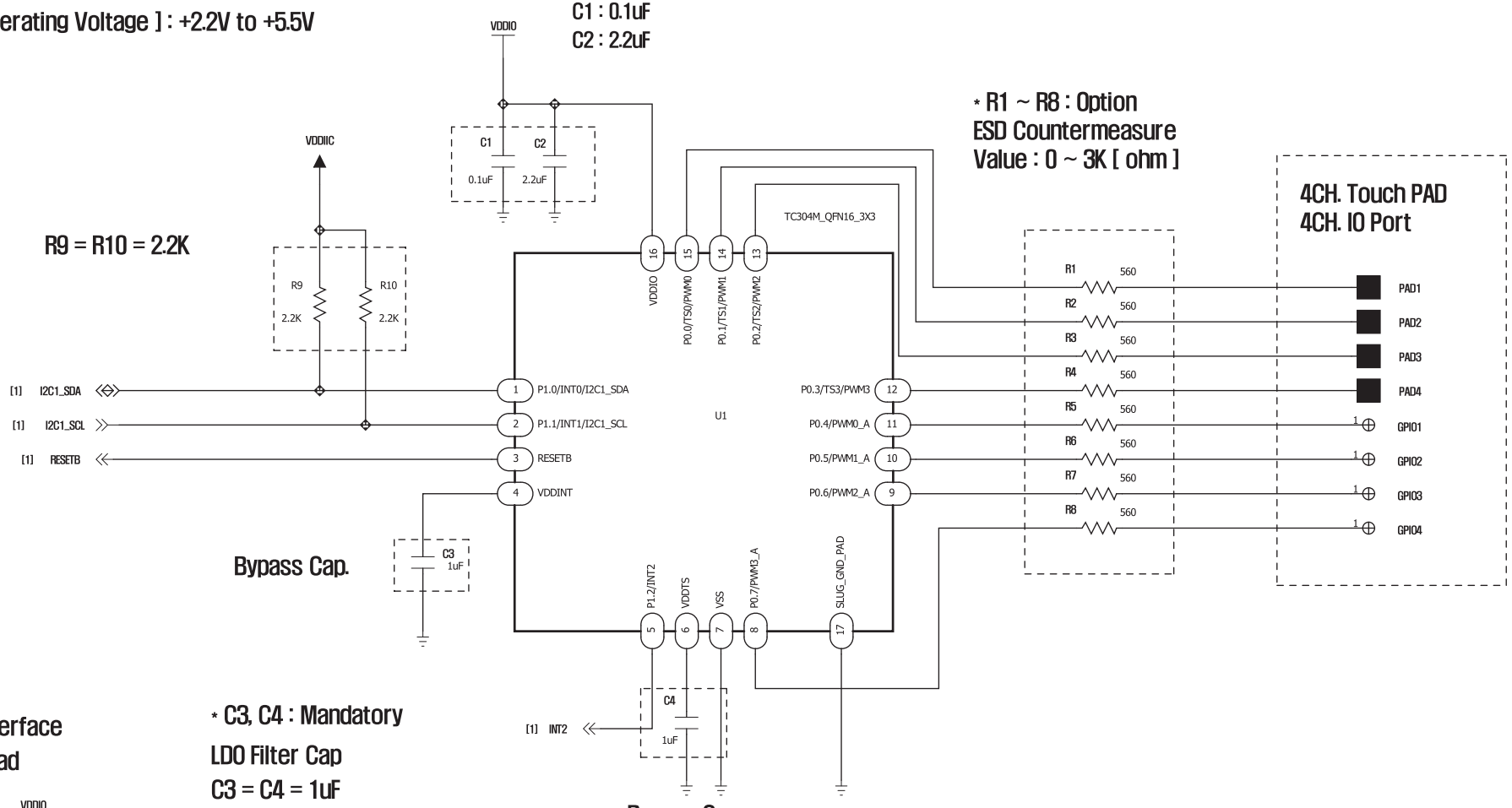
C1 : 0.1uF

C2 : 2.2uF

* R1 ~ R8 : Option

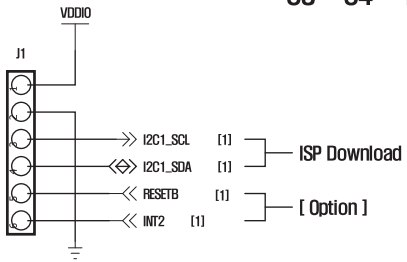
ESD Countermeasure

Value : 0 ~ 3K [ohm]



External interface

ISP Download



* C3, C4 : Mandatory

LDO Filter Cap

C3 = C4 = 1uF

NO.	REVISION NO.	NO.	REVISION NO.	C B A	NO	PART NO.	DESCRIPTION	METERIAL	COLOR FINISH	NOTE
1				QUANTITY						
2										

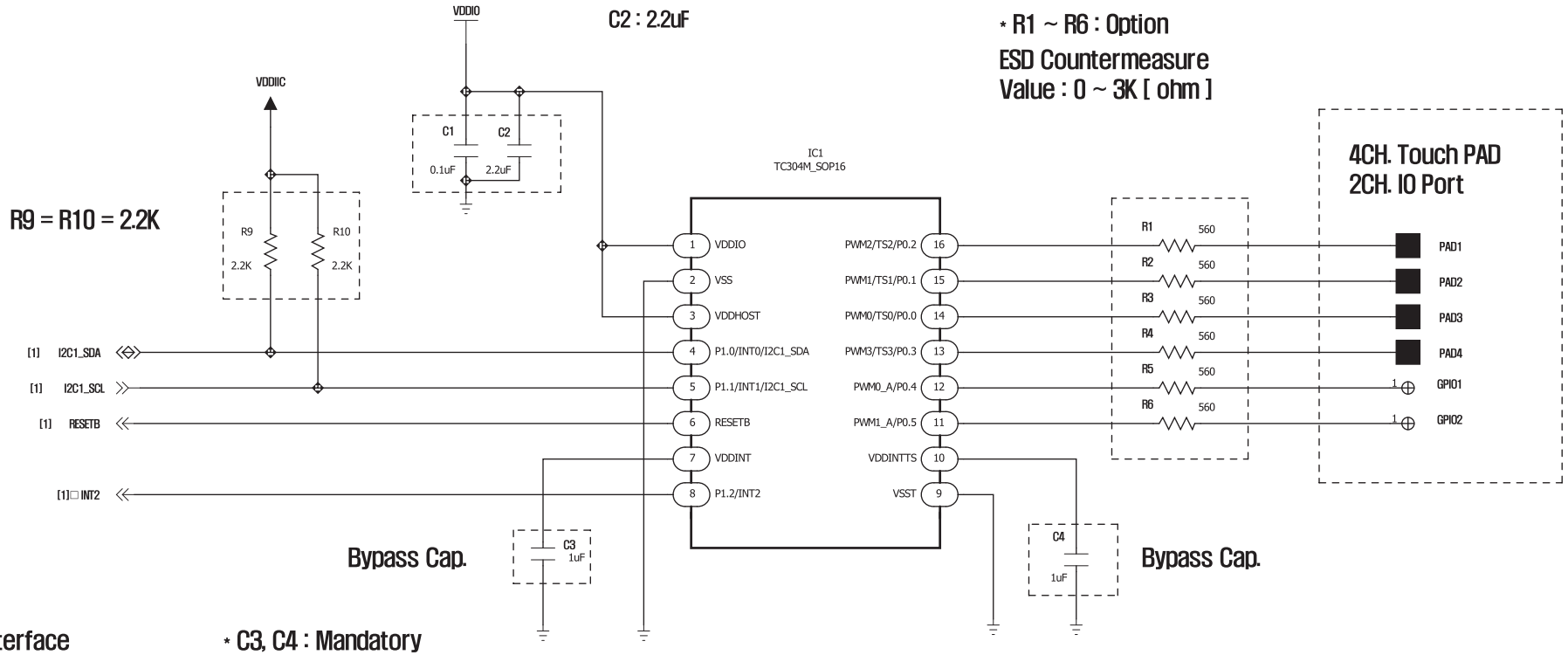
SCALE	UNIT	DRAWN.	AprilPark
A3	mm	2022-01-06	TC304M_QF16IP
SHEET	1 / 1	CORERIVER	

TC304M – SO16IP

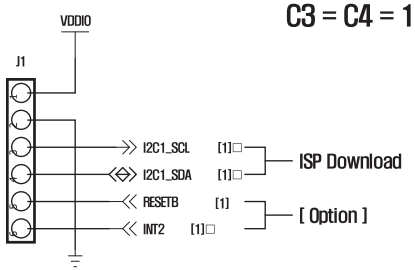
>>VDDIO [Operating Voltage] : +2.2V to +5.5V

* C1, C2 : Mandatory
Power Noise filter Cap
C1 : 0.1uF
C2 : 2.2uF

* R1 ~ R6 : Option
ESD Countermeasure
Value : 0 ~ 3K [ohm]



External interface
ISP Download



* C3, C4 : Mandatory
LDO Filter Cap
C3 = C4 = 1uF

NO.	REVISION NO.	NO.	REVISION NO.	C B A	NO	PART NO.	DESCRIPTION	METERIAL	COLOR FINISH	NOTE
1				QUANTITY						
2				SCALE A3	UNIT mm	DRAWN.	AprilPark			
						2017-03-14	TC304M_SO16IP			
				SHEET 1 / 1		CORERIVER				