

TC303M

Capacitive Touch Sensor Controller

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1 TC303M Overview

1.1 General Description

TC303M is a high-performance Controller for capacitive touch. Its engine is an 8-bit 80C51 compatible Processor.

TC303M has two timer/counters, maximum 2-channel of touch sensors, maximum 5 programmable I/O pins, 1 Watchdog timer, POR (Power-On Reset), I²C and LVD (Low Voltage Detector) as peripherals. In addition, it contains an internal ring oscillator, which can generate the 27 MHz system clock signal.

TC303M 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, **TC303M** enables low power consumption by using scan interval and clock control methods after last touch.

TC303M operates over the extended -40°C to +85°C temperature range, and is available in the 10-pin DFN package.

1.2 Features

- ◆ Capacitive Touch Controller
- ◆ Touch 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 (V_{DDIO}) : +2.3V to +5.5V
 - Operating Voltage (V_{DDHOST}) : +1.8V to VDDIO
(* V_{DDHOST} : P1 I/O Power)
- ◆ Operating Frequency: Typ. 27MHz
- ◆ Max. 5 Programmable I/O Pins
- ◆ Communication interfaces
 - 1-channel I2C Communication (Slave)
- ◆ Internal Ring OSC with Calibration function
- ◆ Supporting ISP/IAP
- ◆ 7 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
 - I2C Interrupt

- ◆ 4 operating modes:
 - Active : Typ. 1mA
 - IDLE : Typ. 400uA
 - Sleep (ST on) : Typ. 1.4uA
 - Deep Sleep (ST off): Typ. 1.0uA
- ◆ E.S.D. Protection up to
 - 8,000V
- ◆ Latch-up Protection Up to $\pm 200\text{mA}$
- ◆ Package
 - 10-pin DFN (0.50T)

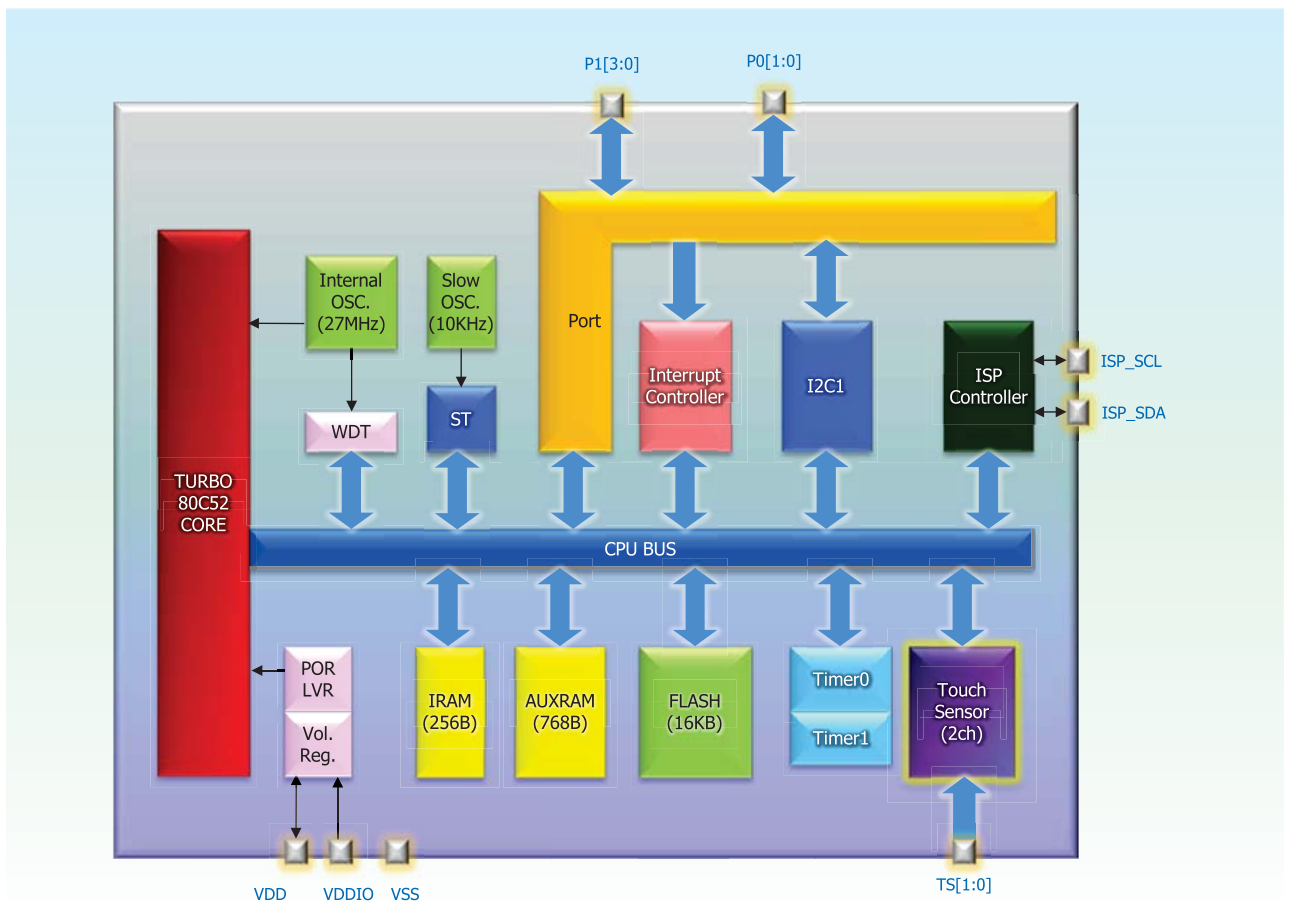
1.3 Product Family Guide

Product	FLASH, [Byte]	RAM [Byte]	Volt [V]	COM I/O	I/O Pins	Touch Channel, Res.	Package	Others
TC303M-DF10IP	16K	768 + 256	VDDIO (2.3~5.5) VDDHOST (1.8~VDDIO)	I2C	5	2, 65,536	1.25mm	Timer/ Counter WDT POR LVD ROSC
TC303A-DF10IP	12k						x	
TC303B-DF10IP	8k						1.5mm	
TC303C-DF10IP	4k	0.5T						
							10-DFN	

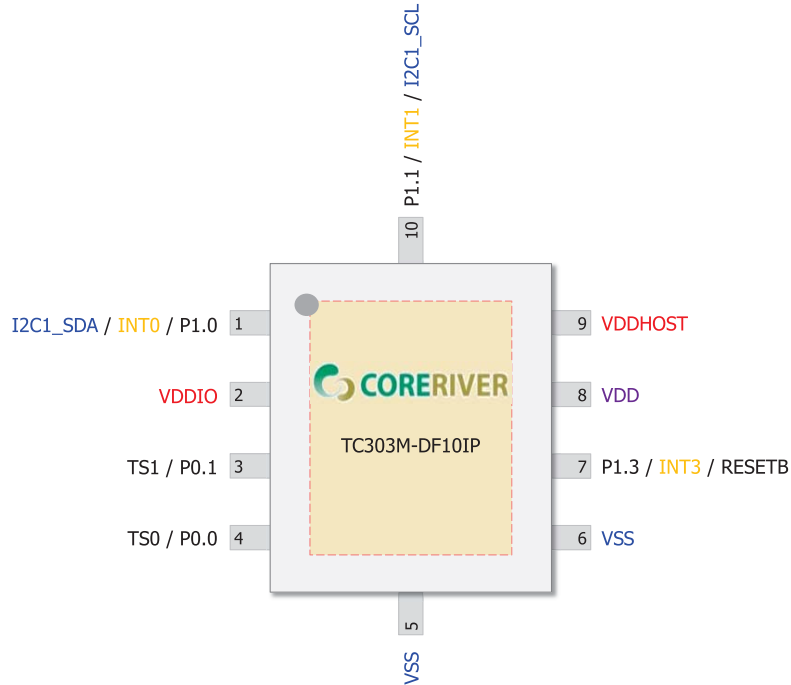
2 Block Diagram

Figure shows the block diagram of **TC303M**. 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 **TC303M** are configured as part of the on-chip RAM: therefore each register has an address. This is reasonable for **TC303M**, since it has so many registers.



3 Pin Configuration



TC303M-DF10IP Package Diagram

Pin No. 10-DFN	Name	Type	Description	Share Pins
2	VDDIO	PWR	Power Supply	
9	VDDHOST	PWR	Power Supply for host interface (Port 1 IO Power)	
5, 6	VSS	GND	Ground	
8	VDD	O	Digital Power Filter	
7	RESETB	RESETB	External Reset Input Signal General I/O Port 1.3	P1.3
10	P1.1	I/O	General I/O Port 1.1	I2C1_SCL / INT1
1	P1.0	I/O	General I/O Port 1.0	I2C1_SDA / INT0
3	P0.1	I/O	General I/O Port 0.1	Touch Sensing Channel 1
4	P0.0	I/O	General I/O Port 0.0	Touch Sensing Channel 0

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	Range
Operating Voltage (V _{DDIO})	+2.3V to +5.5V
Operating Voltage (V _{DDHOST})	+1.8V to +V _{DDIO}
Operating Temperature	-40°C to + 85°C

5 DC Characteristics

* $T_A = -40^{\circ}\text{C} \sim +85^{\circ}\text{C}$, $V_{DDIO} = 2.3\text{V} \sim 5.5\text{V}$ unless otherwise specified

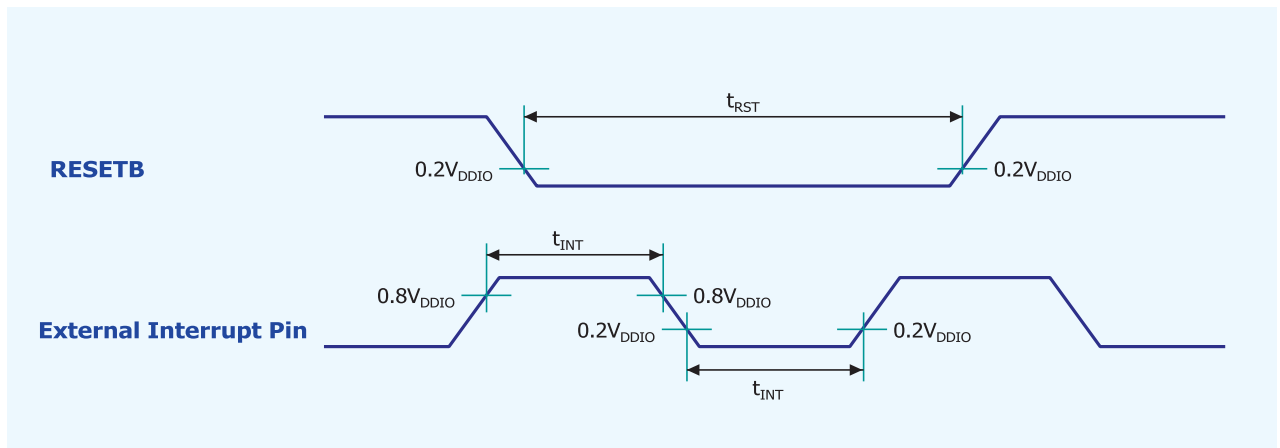
Parameter	Symbol	Pin	Conditions	Value			Unit
				Min.	Typ.	Max.	
Power Source	PWR	V_{DDIO}	-	+2.3	-	5.5	V
Power Source	PWR	V_{DDHOST}	$V_{DDIO} = +2.3\text{V to } +5.5\text{V}$	+1.8	-	V_{DDIO}	V
Input Low Voltage	V_{IL}	P0	$V_{DDIO} = +2.3\text{V to } +5.5\text{V}$	-0.5	-	$0.2V_{DDIO} + 0.1$	V
		P1	$V_{DDIO} = +2.3\text{V to } +5.5\text{V}$ $V_{HOST} = +1.8\text{V to } +V_{DDIO}$	-0.5	-	$0.2V_{DDHOST} + 0.1$	V
Input high Voltage	V_{IH}	P0	$V_{DDIO} = +2.3\text{V to } +5.5\text{V}$	$0.2V_{DDIO} + 1.0$	-	$V_{DDIO} + 0.5$	V
		P1	$V_{DDIO} = +2.3\text{V to } +5.5\text{V}$ $V_{HOST} = +1.8\text{V to } +V_{DDIO}$	$0.2V_{DDHOST} + 1.0$	-	$V_{DDHOST} + 0.5$	V
Output Low Voltage	V_{OL}	P0	$V_{DDIO} = +5.0\text{V}$ ($I_{OL} = 8\text{mA}$) $V_{DDIO} = +3.3\text{V}$ ($I_{OL} = 4\text{mA}$)	-	-	$0.3V_{DDIO}$	V
		P1	$V_{DDHOST} = +5.0\text{V}$ ($I_{OL} = 8\text{mA}$) $V_{DDHOST} = +3.3\text{V}$ ($I_{OL} = 4\text{mA}$)	-	-	$0.3V_{DDHOST}$	V
		P0 (High Drive)	$V_{DDIO} = +3.3\text{V}$ ($I_{OL} = 35\text{mA}$)	-	-	$0.3V_{DDIO}$	V
		P1 (High Drive)	$V_{DDHOST} = +3.3\text{V}$ ($I_{OL} = 35\text{mA}$)	-	-	$0.3V_{DDHOST}$	V

Output High Voltage	V _{OH}	P0	V _{DDIO} = +5.0V (I _{OH} = -12mA) V _{DDIO} = +3.3V (I _{OH} = -6mA)	0.7V _{DDIO}	-	-	V
		P1	V _{DDHOST} = +5.0V (I _{OH} = -12mA) V _{DDHOST} = +3.3V (I _{OH} = -6mA)	0.7V _{DDHOST}	-	-	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 _{DDHOST} = +5.0V V _{DDHOST} = + 3.3V		37.5 45		KΩ
Logical 1 to 0 Transition Current	I _{TL}	P0	V _{DDIO} = 5.0V ± 10% (V _{IN} = +1.5V)	-	548	-	μA
		P1	V _{DDHOST} = 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} = +2.3V, T _A =25°C, F _{sys} =12.5MHz, Touch Sampling rate = 100Hz(4 Channels), no I/O sourcing current	-	1	2.1	mA
Deep Sleep Current	I _{SB}	V _{SS}	V _{DDIO} = +2.3V, T _A =25°C, no I/O sourcing current	-	1	5	μA

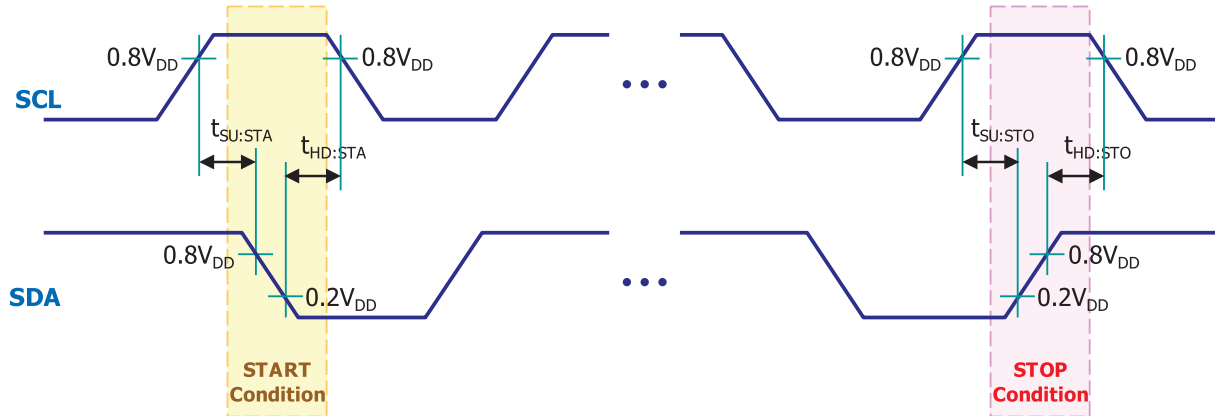
6 AC Characteristics

* $T_A = -40\text{ }^{\circ}\text{C} \sim +85\text{ }^{\circ}\text{C}$, $V_{DDIO} = 2.3\text{V} \sim 5.5\text{V}$ unless otherwise specified

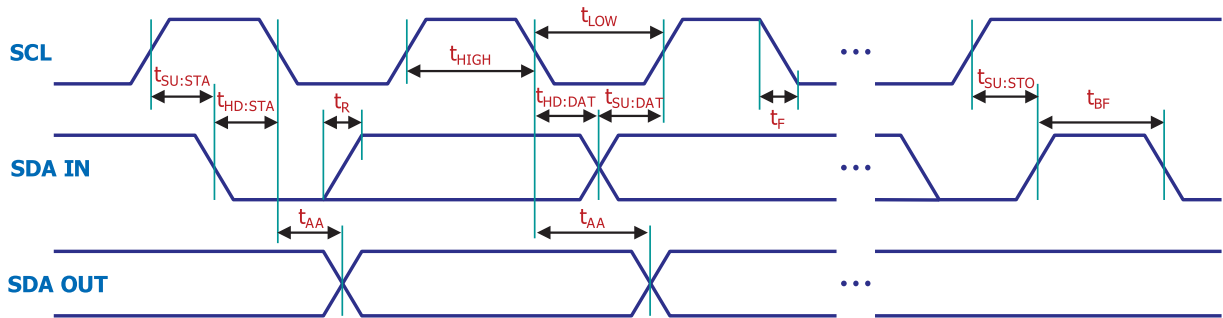
Parameter	Symbol	Pin	Conditions	Value			Unit
				Min	Typ	Max	
RESETB Input Width	t_{RST}	RESETB	$V_{DDIO} = 3\text{V} \pm 10\%$	24	-	-	F _{sys}
External Interrupt Input Width	t_{INT}	External Interrupt	$V_{DDIO} = 3\text{V} \pm 10\%$	4	-	-	F _{sys}



7 I2C Timing Characteristics

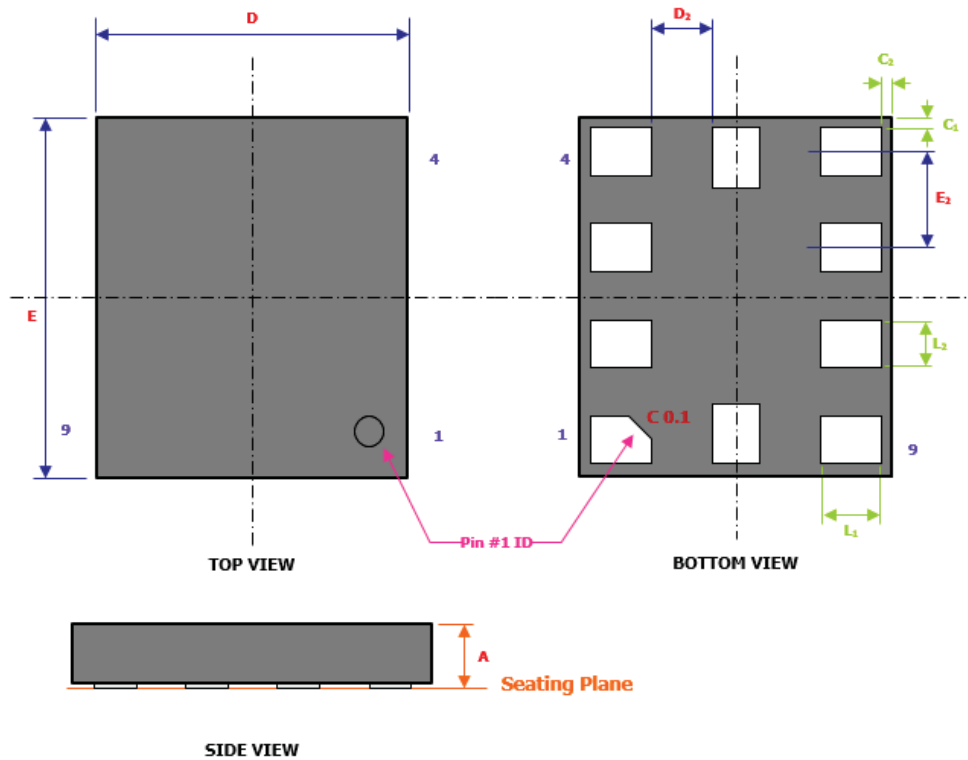


Symbol	Characteristics		Min. [ns]	Max. [ns]	Conditions
$t_{SU:STA}$	START Condition Setup Time	100kHz Mode	4,700	-	Only relevant for repeated START condition
		400kHz Mode	600	-	
$t_{HD:STA}$	START Condition Hold Time	100kHz Mode	4,700	-	After this period, the first clock pulse is generated
		400kHz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

10-pin DFN Package Dimension



Symbol	Dimensions [mm]		
	Min.	Nom.	Max.
A	0.45	0.50	0.55
C ₁	0.05 REF		
C ₂	0.05 REF		
D	1.20	1.25	1.30
D ₂	0.225 REF		
E	1.45	1.50	1.55
E ₂	0.40 BSC		
L ₁	0.20	0.25	0.30
L ₂	0.15	0.20	0.25

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

8 Revision History

Date	Revision	History
Oct. 2019	0.0	Preliminary version.
Mar. 2021	0.4	Notation error corrected.

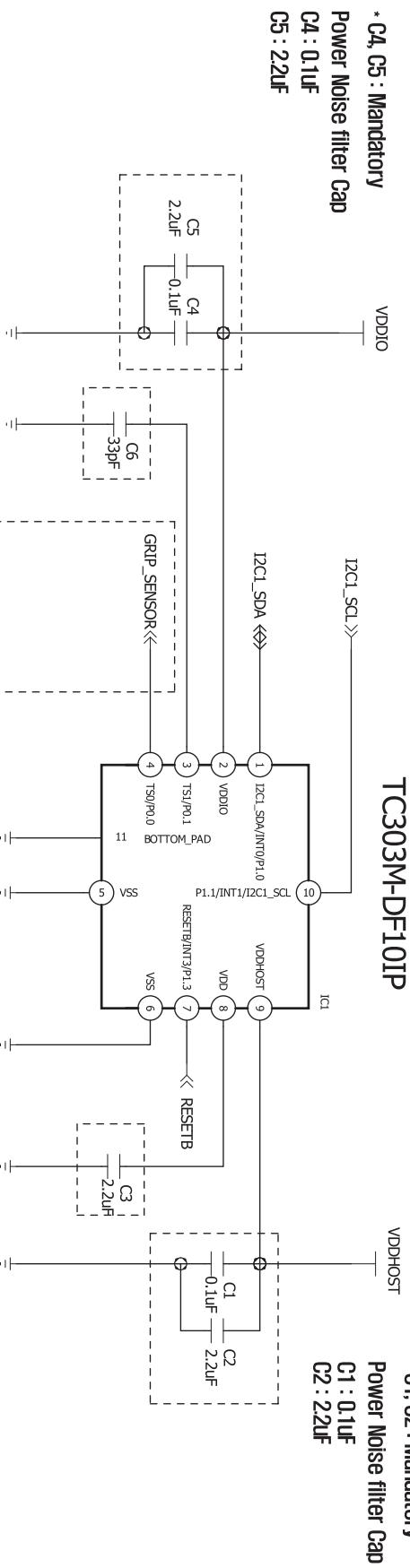
TC303M-DF10IP

Body Size : 1.25mm X 1.5mm

>>VDDIO [Operating Voltage] : +2.4V to +5.0V

>>VDDHOST [IIC Pull Up Voltage] : +1.8V to VDDIO

TC303M-DF10IP



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

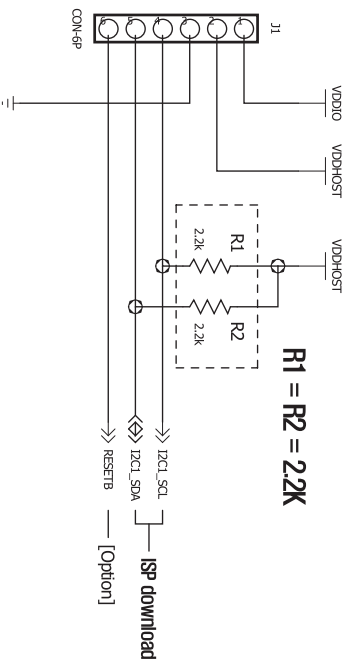
* C4, C5 : Mandatory
Power Noise filter Cap
C4 : 0.1uF
C5 : 2.2uF

Reference Cap.

* GRIP Sensor Parts should be designed according to the product.

Bypass Cap.
* C3 : Mandatory
LDO Filter Cap
C3 =2.2uF (or 4.7uF)

External interface ISP download



R1 = R2 = 2.2K

NO.	REVISION NO.	NO.	REVISION NO.	C	B	A	NO	PART NO.	DESCRIPTION	MATERIAL	COLOR FINISH	NOTE
1							SCALE	UNIT	DRAWN			
2							A3	mm	2019-10-08			

SHEET 1 / 1



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