6~10 Keys Touch Detector IC

TTP123-AOBN

Verion:1.0 Date:2022/10/17

Content

Outline

TTP123-AOBN is a touch pad detector IC which offers 6~10 Keys Touch. Stable sensing method can cover diversity conditions, which can widely meet the needs of different applications and can realize the touch function under the condition of medium isolation protection. It has high security (such as Glass, acrylic and other materials).The touching detection IC is designed for replacing traditional direct button key with diverse pad size. Low power consumption and wide operating voltage are the contact key features for DC or AC application.

Characteristic

- Operating voltage 2.4~5.5V
- Standby mode Current (no load)

		VDD=3.3V		VDD=5.0V	
Mode	Keys	Typ.	Max.	Typ.	Max.
Direct	6	7uA	14uA	14uA	28uA
I2C	10	9uA	18uA	16uA	32uA

- Built-in power on initial(POR) and low voltage reset (LVR) function
- Output Response Time (minimum) @VDD=5.0V

  @ Detective mode 48ms.

  @ Standby mode 160ms.
- There are two ways to adjust channel sensitivity

  (1) Can be adjusted uniformly by an external capacitor (C_{S0}) (C_{S0}:1~33nF).

  (2) Each channel has an independent external capacitor (C_{TX}) for adjustment (C_{TX}:1~50pF).
- Provide Direct Mode、CMOS output、Active Low
- Provide the maximum on time 10 seconds
- Auto calibration

  The re-calibration period is about 62.5 milliseconds within 4 seconds after power-on. Power on after 4 seconds then it returns to standby mode, then the re-calibration period change to about 1 second.

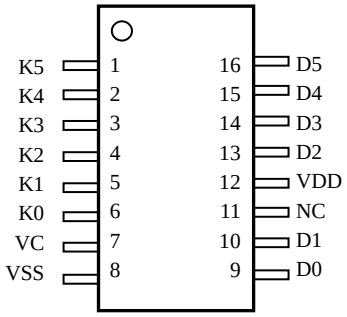
Applications

- Wide consumer products and all kinds of home applications.
- Button key replacement.

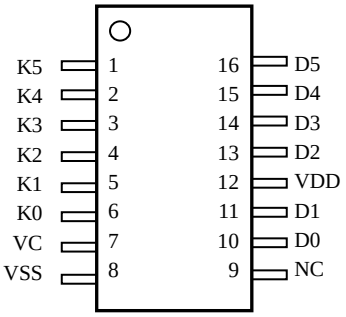
Mode Function Selection Table

Item	Keys	Output Description			Maximum Output Time	備註
		Mode	Active	O/T		
TTP123-AOBN-F001	6	Single/Direct	Low	CMOS	10sec	
TTP123-AOBN-F002	6	Single/Direct	Low	OD		
TTP123-AOBN-F003	10	Single/I2C	INT Low	OD		
TTP123-AOBN-F004	10	Single/I2C	INT Low	OD		
TTP123-AOBN-F005	6	Multiple/Direct	Low	CMOS		
TTP123-AOBN-F007	10	Multiple /I2C	INT Low	OD		

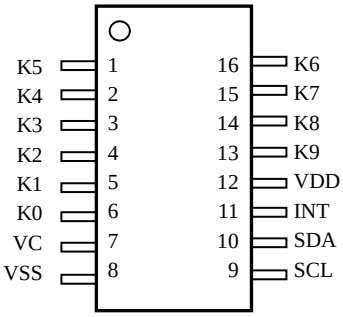
Pin Assignment



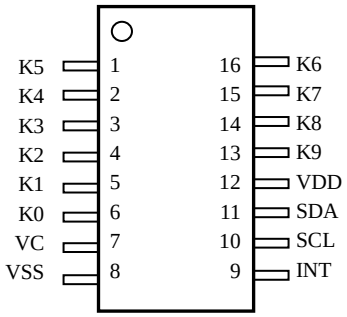
TTP123-AOBN-F001
TTP123-AOBN-F005



TTP123-AOBN-F002

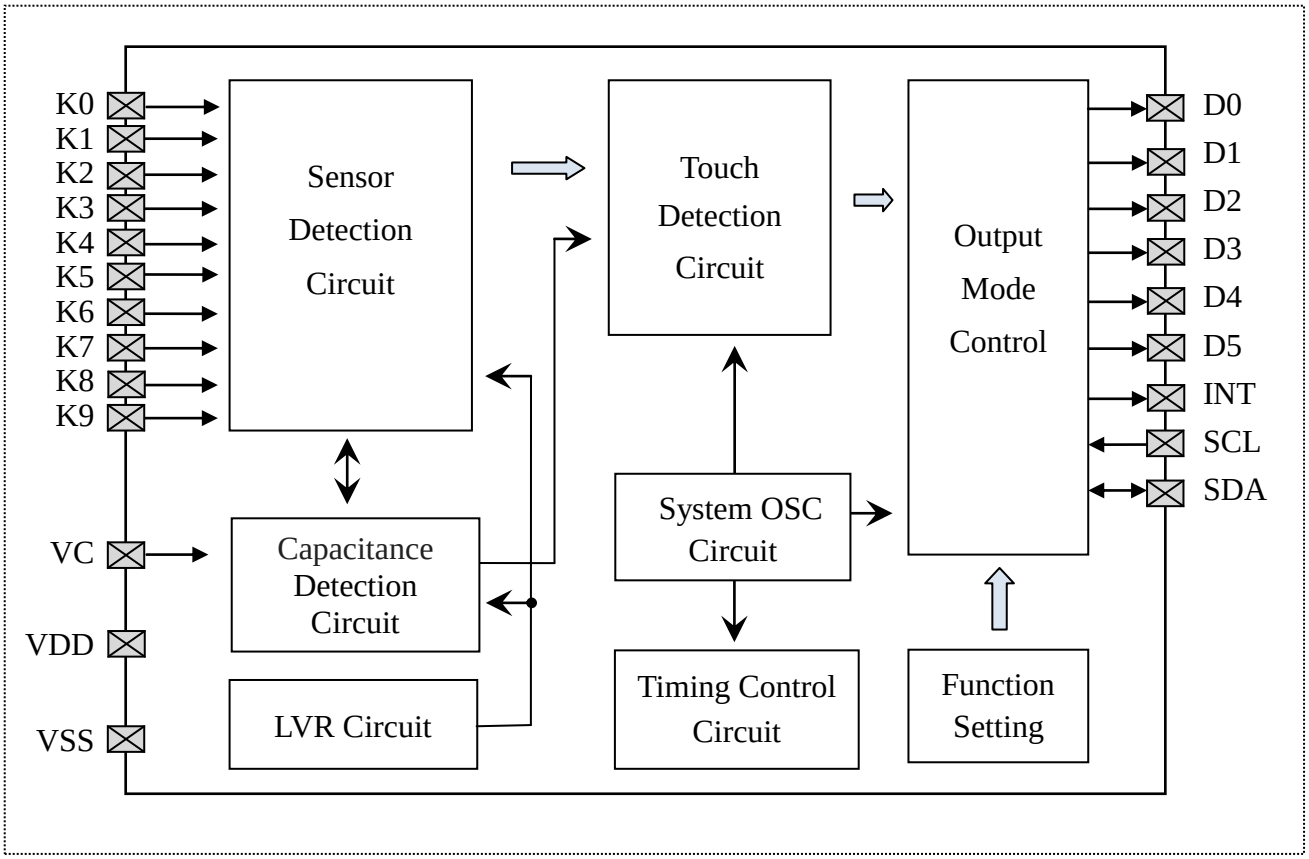


TTP123-AOBN-F003



TTP123-AOBN-F004
TTP123-AOBN-F007

Block diagram



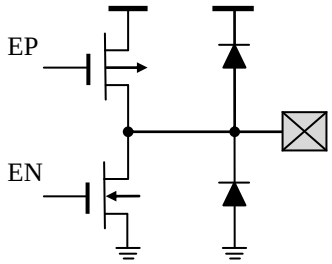
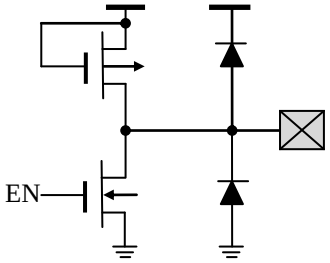
Pin Description

Pin Name	I/O Type	Assignment
K9	I/O	K9 Touch input sensor port
K8		K8 Touch input sensor port
K7		K7 Touch input sensor port
K6		K6 Touch input sensor port
K5		K5 Touch input sensor port
K4		K4 Touch input sensor port
K3		K3 Touch input sensor port
K2		K2 Touch input sensor port
K1		K1 Touch input sensor port
K0		K0 Touch input sensor port
D5	O/OD	D5 output port, correspond K5 touch input sensor port
D4		D4 output port, correspond K4 touch input sensor port
D3		D3 output port, correspond K3 touch input sensor port
D2		D2 output port, correspond K2 touch input sensor port
D1		D1 output port, correspond K1 touch input sensor port
D0		D0 output port, correspond K0 touch input sensor port
VC	I/O	Capacitance detection
VDD	P	Positive power supply
VSS	P	Negative power supply, ground
INT	OD	K0~K9 PADs Touched notification output pin (Active Low)
SCL	I	I^2C Clock Input
SDA	OD	I^2C Data Output
NC	I-PL	Not care. Do not use.

Pin Type

- I CMOS input only
- O CMOS output
- I/O CMOS input/output
- P Power/Ground
- I-PL CMOS input and pull-low resister
- OD Open drain output, it has a diode
- I/OD CMOS input／Open drain output, it has a diode protection circuit

COMS output and Open drain output illustrate

CMOS output (O)	Open drain output (OD)
	

Electrical Characteristics

- **Absolute maximum ratings**

Parameter	Symbol	Conditions	Rating	Unit
Operating Temperature	TOP	—	-40～+85	℃
Storage Temperature	TSTG	—	-50～+125	℃
Supply Voltage	VDD	Ta=25°C	VSS-0.3～VSS+5.5	V
Input Voltage	VIN	Ta=25°C	VSS-0.3～VDD+0.3	V
Human Body Mode	ESD	—	≧4	KV
Note：VSS symbolizes for system ground				

- **DC / AC characteristics：（Test condition at room temperature = 25℃）**

Parameter	Symbol	Test Condition		Min.	Typ.	Max.	Unit
Operating Voltage	VDD			2.4	3.3	5.5	V
Standby mode current (no load)	I_{st}	6 Keys	VDD=3.3V, VC=10nF	-	7	14	uA
			VDD=5.0V, VC=10nF	-	14	28	
		10 Keys	VDD=3.3V, VC=10nF	-	9	18	
			VDD=5.0V, VC=10nF	-	16	32	
Detective mode current (no load)	I_{OP}	6 Keys	VDD=3.3V, VC=10nF	-	0.3	0.6	mA
			VDD=5.0V, VC=10nF	-	0.5	1.0	
		10 Keys	VDD=3.3V, VC=10nF	-	0.3	0.6	
			VDD=5.0V, VC=10nF	-	0.5	1.0	
System oscillator	F_{OSC}	VDD =3.3V		-	15K	-	Hz
		VDD =5.0V		-	16K	-	
Input ports	V_{IL}	Input low voltage		-	-	0.2	VDD
	V_{IH}	Input high voltage		0.8	-	1.0	
D0~5、INT、SDA Sink Current	I_{OL}	VDD=3.3V, VOL=0.5V		-	8	-	mA
		VDD=5.0V, VOL=0.5V			12		
D0~5 Source Current	I_{OH}	VDD=3.3V, VOH=2.8V		-	-5.5	-	
		VDD=5.0V, VOH=4.5V			-8.0		
D0~5 Output response time	T_R	VDD=3.3V, standby mode		-	170	-	ms
		VDD=3.3V, detective mode			50		
		VDD=5.0V, standby mode		-	160	-	ms
		VDD=5.0V, detective mode			48		
SCL	SCL_H			0.04		10	ms
	SCLL			0.04	-	10	
Time Of Data interval				30	-	-	

Note: $K=10^3$

Function Description

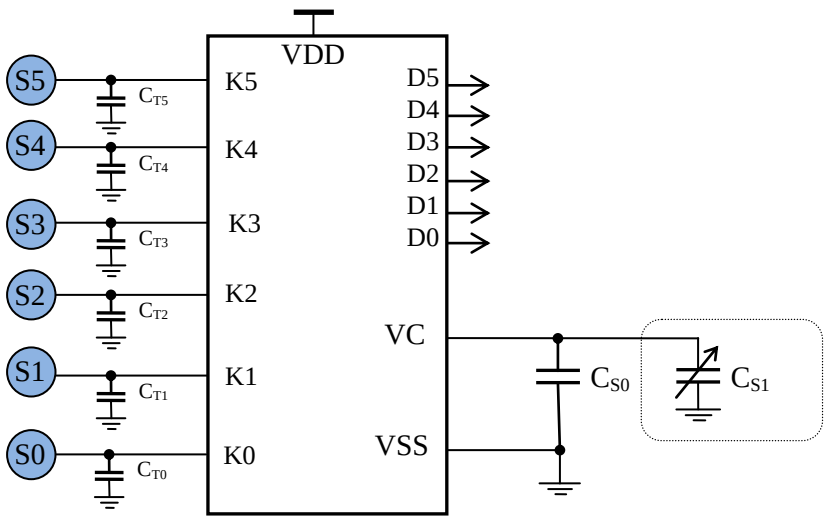
Ⅰ. Power-On and Reset instruction

The reference value is refreshed every 62.5 milliseconds within 4.0 seconds after power-on. If the touch button is not touched after 4.0 seconds of power-on, the recalibration cycle switching time is about 1.0 second. The output port returns to its initial state when rest.

Ⅱ. Sensitivity adjustment

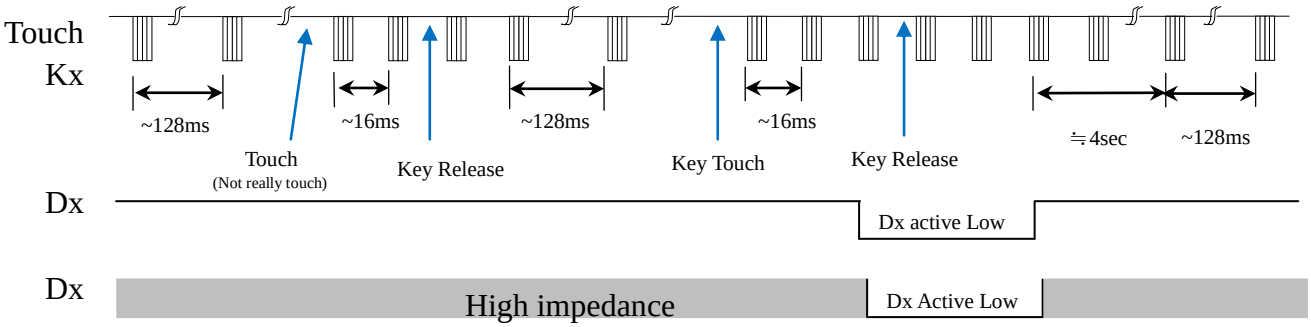
The total loading of electrode size and capacitance of connecting line on PCB can affect the sensitivity. The sensitivity adjustment must according to the practical application on PCB. The chip offers some methods for adjusting the sensitivity outside.

1. By the electrode size
   Under other conditions are fixed. Using a larger electrode size can increase sensitivity. Otherwise it can decrease sensitivity. But the electrode size must use in the effective scope.
2. By the panel thickness
   Under other conditions are fixed. Using a thinner panel can increase sensitivity. Otherwise it can decrease sensitivity. But the panel thickness must be below the maximum value.
3. By the value of C_{T0}～C_{T5} capacitor（please see the down figure）
   Under other conditions are fixed. Add the capacitor C_{T0}～C_{T5}, can fine tune the sensitivity for single key, that lets all key's sensitivity identical. When do not use any capacitor to VSS, the sensitivity is most sensitive. C_{TX} will reduce the sensitivity of the corresponding button. The adjustment range of C_{TX} capacitance is 1~50pF.
4. By the value of C_{S0} capacitor（please see the down figure）
   Under other conditions are fixed. PAD VC to VSS capacitance C_{S0} adjustable sensitivity, C_{S0} capacitance is within the usable range (1~33nF) and the larger the value of C_{S0} capacitance, the higher the sensitivity. C_{S1} is used for fine-tuning.



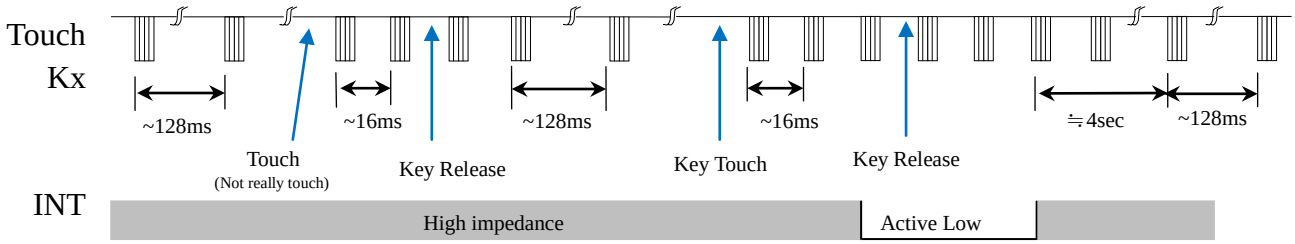
Ⅲ. Standby mode Touch and Dx output

IC will save power in standby mode. When detecting key touch, it will switch to detective mode. Until the key touch is released and will keep a time about 4 sec. Then it returns to standby mode. At VDD=5V, the standby mode Dx output response time about 160ms, the detective mode Dx output response time about 48 milliseconds.

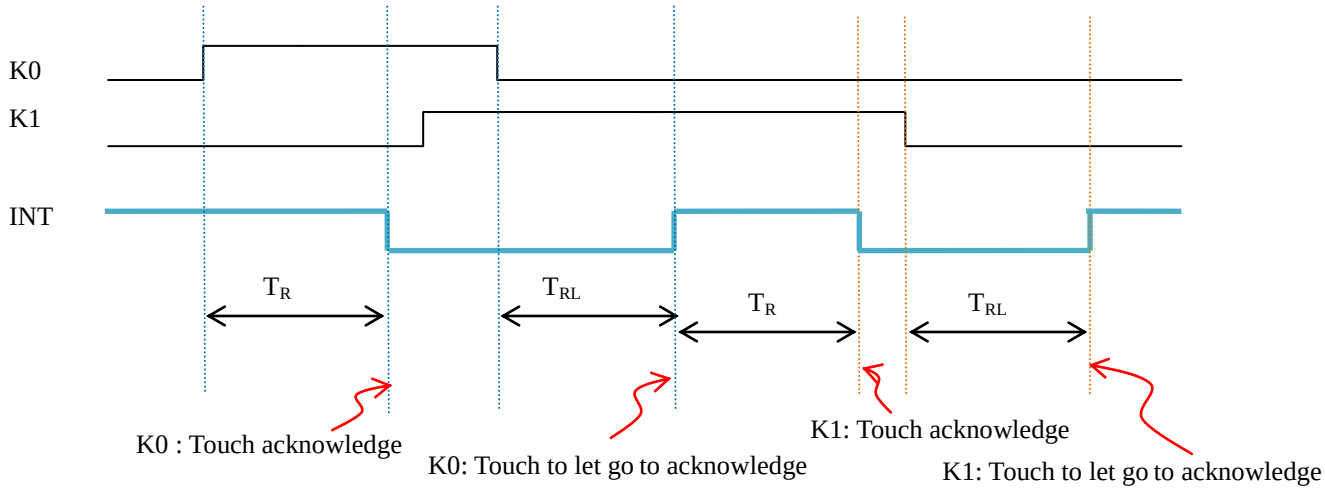


Ⅳ. Standby mode Touch and INT wake up the host and I2C output

IC will save power in standby mode. When detecting key touch, it will switch to detective mode. Until the key touch is released and will keep a time about 4 sec. Then it returns to standby mode. At VDD=5V, the standby mode INT output response time about 160ms, the detective mode INT output response time about 48 milliseconds.



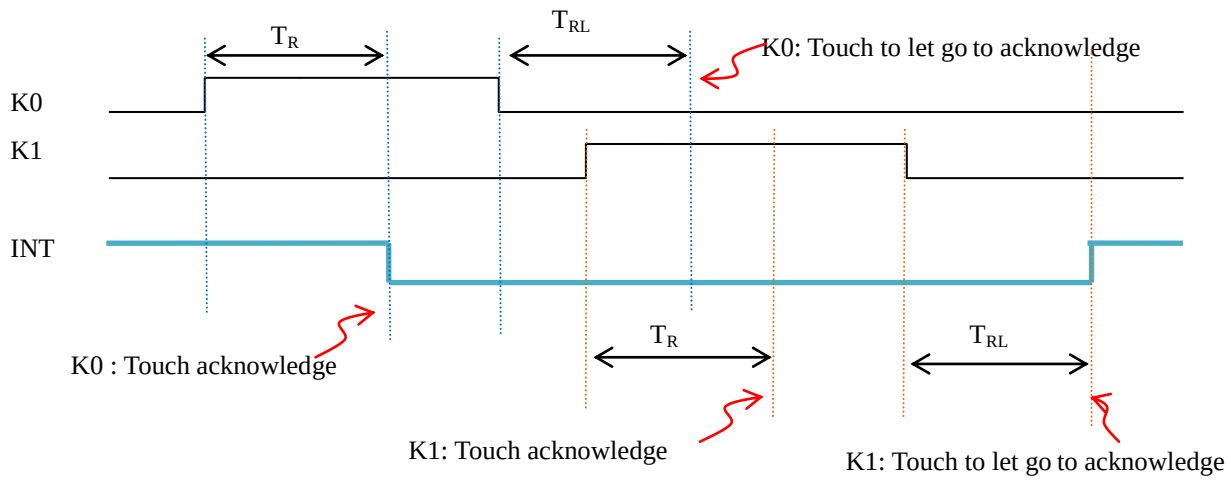
Example: Single Mode K0, K1 touch and INT timing diagram



Note: (1) T_R: Touch active acknowledge time

(2) T_{RL}: Touch release acknowledge time

Example: Multiple Mode K0, K1 touch and INT timing diagram

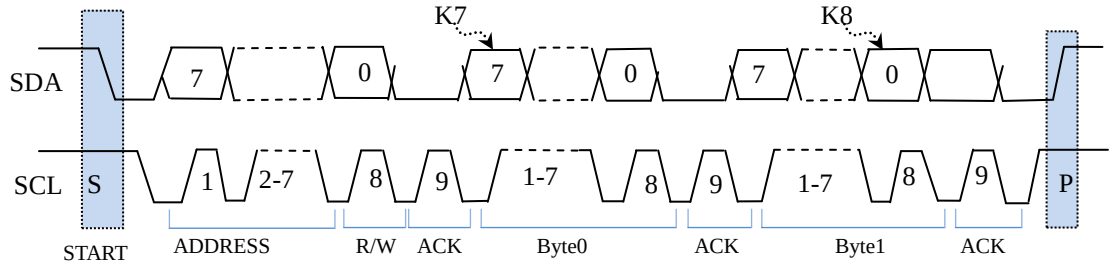


Note: (1) T_R: Touch active acknowledge time

(2) T_{RL}: Touch release acknowledge time

V. I2C Transmission timing description

1. Transmission timing



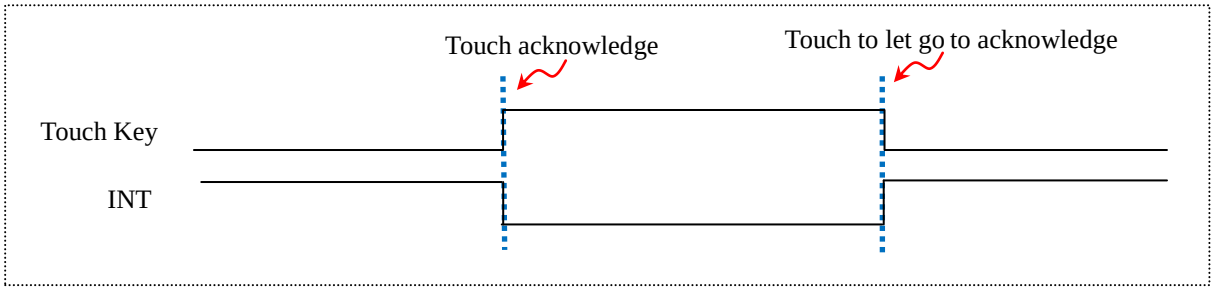
2. Slave Address

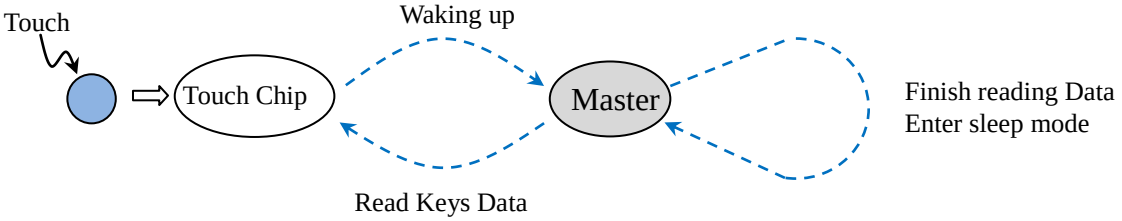
Slave address (A7-A1)	Read (A7-A1,R)
53H	A7H

3. Package Data: Touch Kx=1(high level). Non-touch Kx=0(low level)

Read Byte	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	K7	K6	K5	K4	K3	K2	K1	K0
1							K9	K8

4. The INT pin sequence diagram of the INT for forcibly waking up the MCU during communication during sleep:



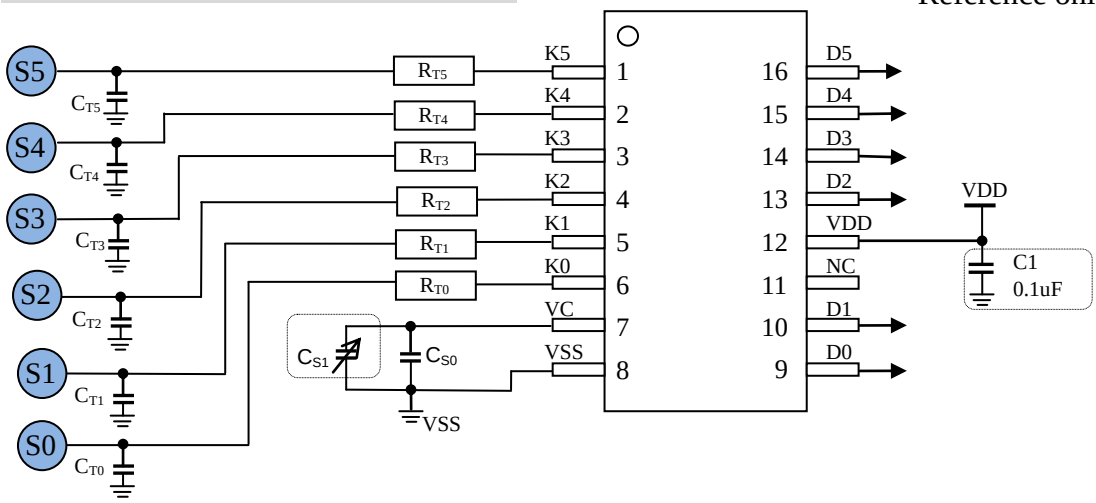


Application circuit

I．TTP123-AOBN-F001/F005 Application circuit

D0~5: CMOS out， Direct Active Low

Reference only



Note:

(1) $C_{T0\sim5}$ depending on the application. The capacitance value is inversely proportional to the sensitivity.

(2) C_{S0} = 1~33nF depending on the application. The capacitance value is proportional to the sensitivity.

(3) C1, C_{S1} depending on the application.

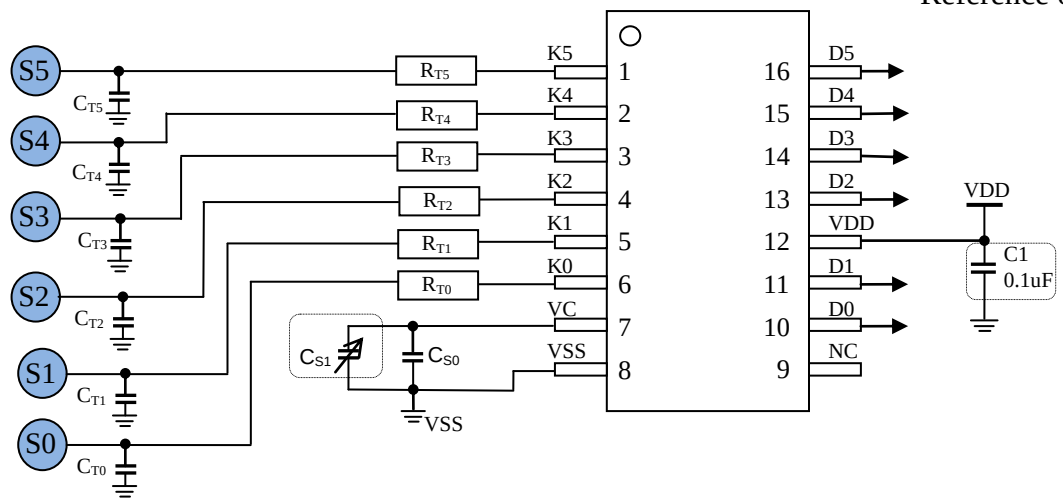
(4) R_{T0}~R_{T5} typical value 1KΩ , depending on the application.

(5) The line length from S0~S5 touch board to IC pins should be as equal as possible, so that the sensitivity of each touch board can be consistent.

Ⅱ.TTP123-AOBN-F002 Application circuit

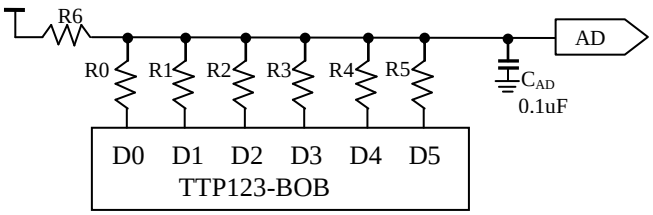
D0~5: Open Drain(OD)，Direct Mode Active Low

Reference only



AD KEY Application Example:

Reference only



Note:

(1) $C_{T0\sim5}$ depending on the application. The capacitance value is inversely proportional to the sensitivity.

(2) C_{S0} = 1~33nF depending on the application. The capacitance value is proportional to the sensitivity.

(3) C1, C_{S1} depending on the application.

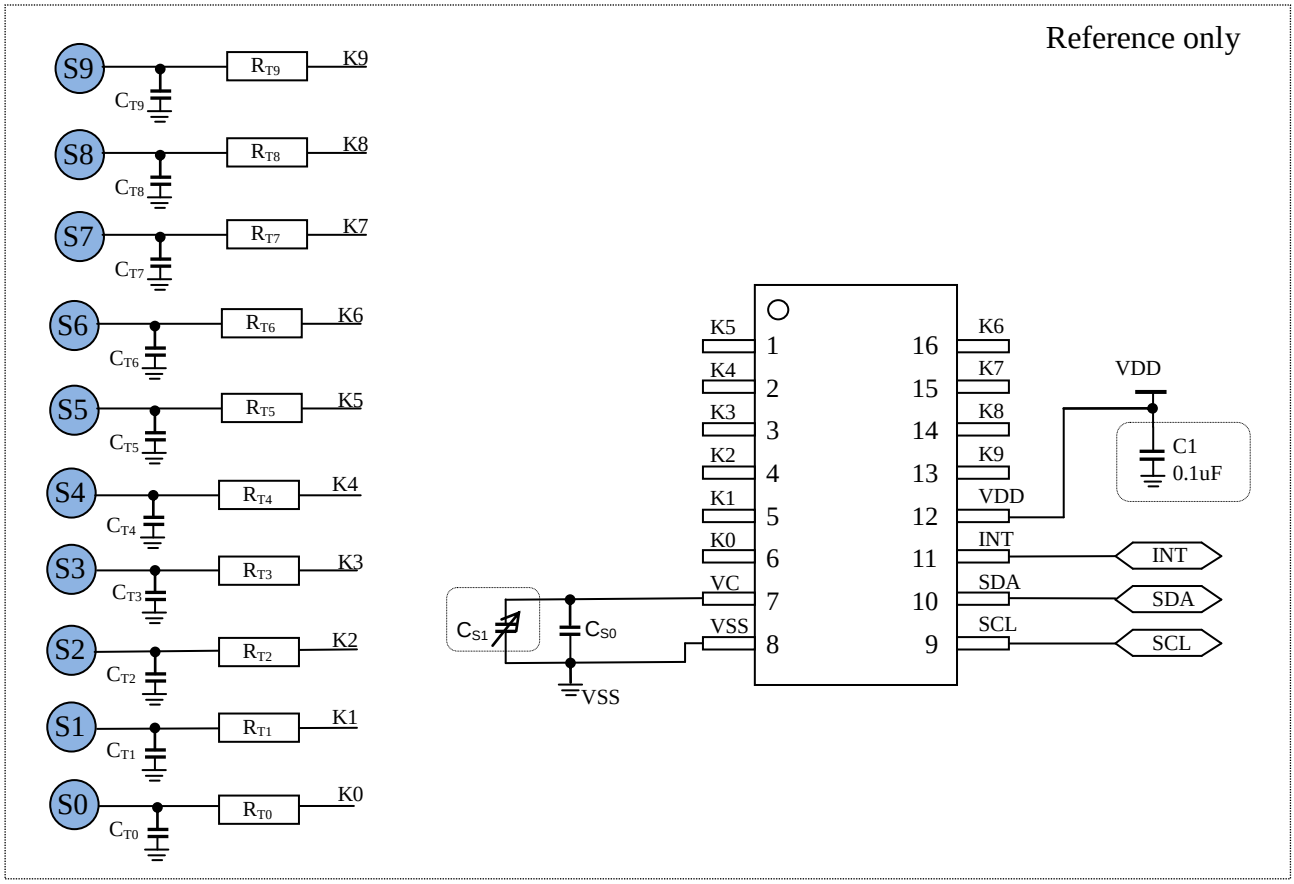
(4) R_{T0}~R_{T5} typical value 1KΩ, depending on the application.

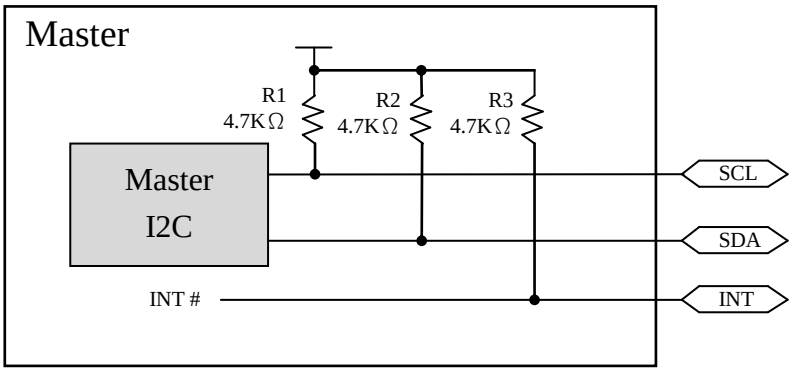
(5) Please float the unused input sensor port (for example, if K5 is not used, please float K5)

(6) When applied to AD KEY, please add CAD = 0.1uF capacitor to the input terminal of AD.

(7) The line length from S0~S5 touch board to IC pins should be as equal as possible, so that the sensitivity of each touch board can be consistent.

Ⅲ. TTP123-AOBN-F003 Application circuit





Note:

(1) $C_{T0\sim9}$ depending on the application. The capacitance value is inversely proportional to the sensitivity.

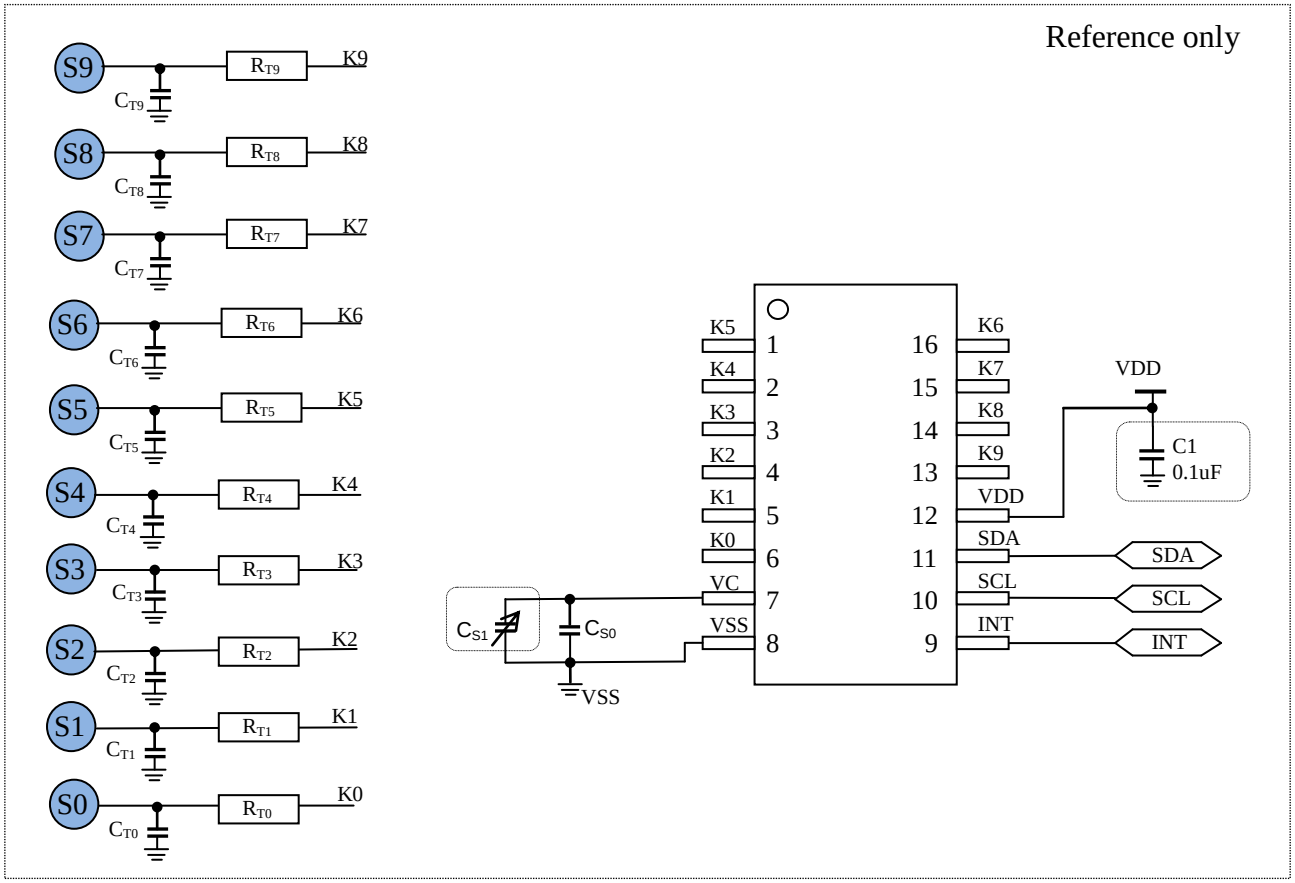
(2) C_{S0} = 1~33nF depending on the application. The capacitance value is proportional to the sensitivity.

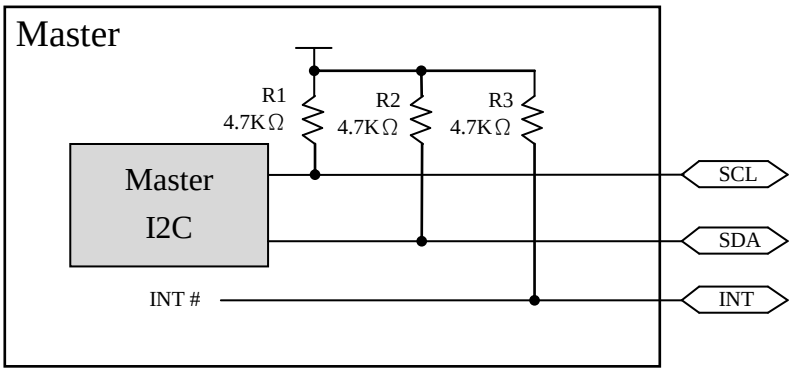
(3) C1, C_{S1} depending on the application.

(4) R_{T0}~R_{T5} typical value 1KΩ , R1~R3 typical value 4.7KΩ , depending on the application.

(5) The line length from S0~S9 touch board to IC pins should be as equal as possible, so that the sensitivity of each touch board can be consistent.

Ⅳ. TTP123-AOBN-F004 / F007 Application circuit





Note:

(1) $C_{T0\sim9}$ depending on the application. The capacitance value is inversely proportional to the sensitivity.

(2) C_{S0} = 1~33nF depending on the application. The capacitance value is proportional to the sensitivity.

(3) C1, C_{S1} depending on the application.

(4) R_{T0}~R_{T5} typical value 1KΩ , R1~R3 typical value 4.7KΩ , depending on the application.

(5) The line length from S0~S9 touch board to IC pins should be as equal as possible, so that the sensitivity of each touch board can be consistent.

PCB layout note

1. On PCB, the length of lines from touch pad to IC pin shorter is better.
   And the lines do not parallel and cross with other lines.
2. The power supply must be stable. If the supply voltage drift or shift quickly, maybe causing sensitivity anomalies or false detections.
3. The material of panel covering on the PCB can not include the metal or the electric element. The paints on the surfaces are the same.
4. The C1 capacitor must be used between VDD and VSS; and should be routed with very short tracks to the device's VDD and VSS pins.
5. The capacitance C_{T0}~C_{T9} can be used to adjust the sensitivity. The value of C_{T0}~C_{T9} use smaller, then the sensitivity will be better. The sensitivity adjustment must according to the practical application on PCB. The range of C_{T0}~C_{T9} value are 1~50pF.
6. The capacitance C_{S0} can be used to adjust the sensitivity. The value of C_{S0} use larger, then the sensitivity will be better. The sensitivity adjustment must according to the practical application on PCB. The range of C_{S0} value are 1~33nF.
7. The sensitivity adjustment capacitors（C_{T0}~C_{T9}, C_{S0}）must use smaller temperature coefficient and more stable capacitors such as X7R and NPO. So for touch application, recommend to use NPO capacitor, for reducing that the temperature varies to affect sensitivity.
8. Medium type for adjustment capacitors（C_{S0}）
9. Please float the unused touch button sensor (for example, if K5 is not used, please float K5), or connect a 50pF capacitor to the ground to avoid being too sensitive and causing misoperation.

C_{S0} value table

Medium Types	C_{S0} Capacitance (Reference)
Acrylic sheet ≦3mm	6.8nF/25V
3≦Acrylic sheet ≦6mm	10nF/25V
3≦Acrylic sheet ≦10mm	22nF/25V

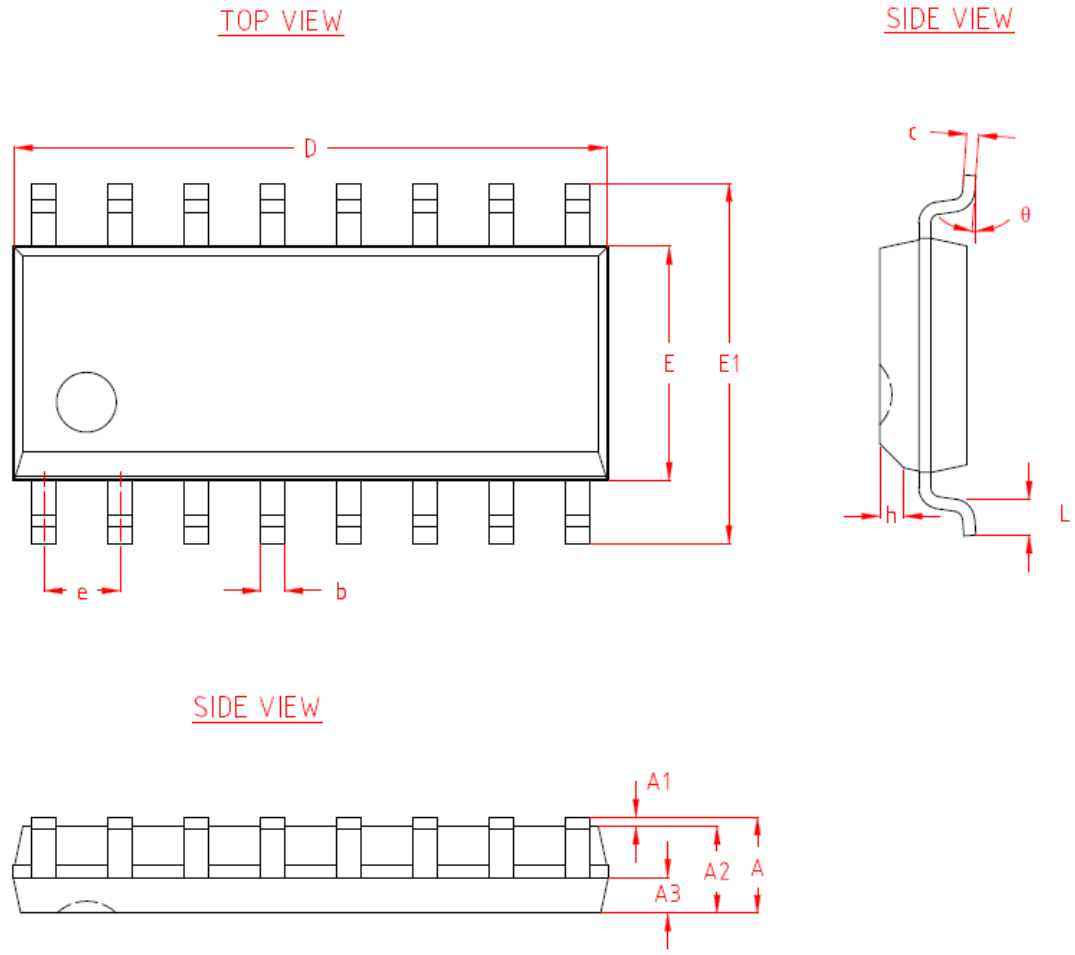
BOM table

Symbol	Type	Element parameter
C_{S0}	capacitor	As C_{S0} value Table
C_{S1}	capacitor	0pF*
C1	Electrolytic capacitor	104*
C_{T0}～C_{T9}	capacitor	1pF～ 50pF
R_{T0}～R_{T9}	Carbon film resister	1KΩ*

Note: * Resistance and Capacitance value depends on the application.

Package outline

Package Type: SOP-16



Symbol Parameter (Unit : mm)														
A			A1			A2			A3			b		
Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
		1.75	0.10		0.25	1.35	1.45	1.55	0.60	0.65	0.70	0.35		0.50

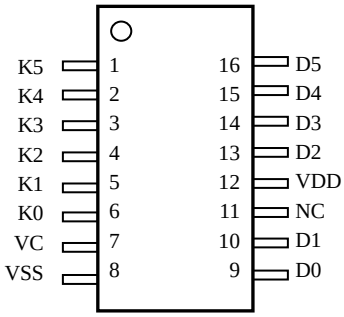
Symbol Parameter (Unit : mm)														
c			D			E			E1			e		
Min	Nom	Max	Min	Nom	Max	Min	Nom	Max	Min	Nom	Max		Typ	
0.19		0.25	9.80	10.00	10.20	3.80	3.90	4.00	5.80	6.00	6.20	1.27 BSC		

Symbol Parameter (Unit : mm)								
h			L			Θ		
Min	Nom	Max	Min	Nom	Max	Min	Nom	Max
0.30		0.50	0.40		0.80	0		8°

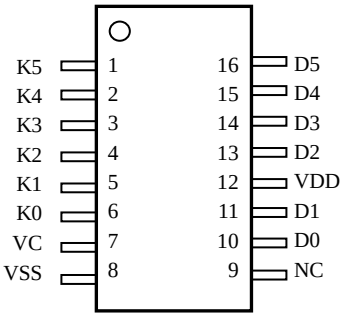
Package configuration

TTP123-AOBN

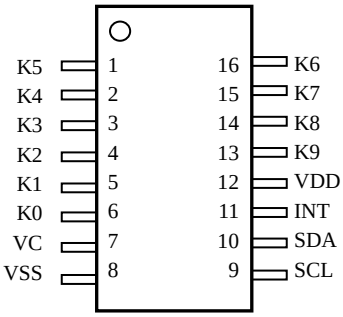
Package type: SOP-16



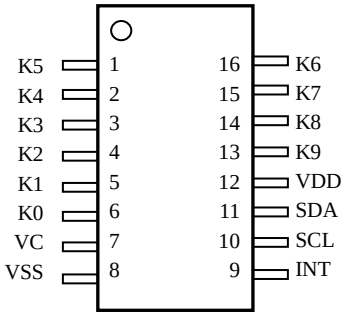
TTP123-AOBN-F001
TTP123-AOBN-F005



TTP123-AOBN-F002



TTP123-AOBN-F003



TTP123-AOBN-F004
TTP123-AOBN-F007

Ordering Information

TTP123			
Package Item	**Package Type**	**Chip Type**	**Wafer Type**
TTP123-AOBN-F001	SOP-16	No support	No support
TTP123-AOBN-F002			
TTP123-AOBN-F003			
TTP123-AOBN-F004			
TTP123-AOBN-F005			
TTP123-AOBN-F007			

Revision History:

1. 2022/10/17：Version: 1.0
   Original version.