

TOSHIBA CMOS Type Integrated Circuit Silicon Monolithic

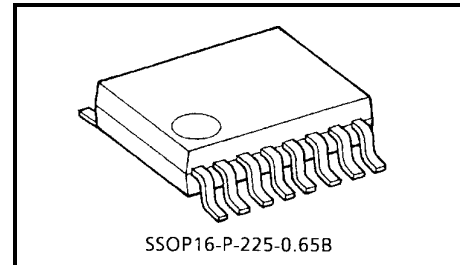
# TC9350BFN-T00,TC9350BFN-T01

## USB Mouse Controller IC

The TC9350BFN is a USB 1.1 mouse controller IC.  
It can communicate with Agilent's ADNS-2610 optical mouse sensor.

### Features

- Conforms to USB HID specification version 1.1
- Supports Agilent's ADNS-2610 optical mouse sensor.
- The TC9350BFN-T00 enables the built-in pull-up resistors of the encoder input pins (PT3A, PT3B) when the mouse is operating. It is suitable for a mechanical encoder. (The pull-up resistors are disabled in suspend mode.)
- The TC9350BFN-T01 maintains the encoder input pins (PT3A, PT3B) always in high-impedance state. It is suitable for an optical encoder (phototransistor and LED).
- Input/output ports  
USB input/output driver: 2 pins (DP/DM)  
Switch input: 3 pins (SW1, SW2, SW3)  
Serial port clock output: 1 pin (SCK)  
Serial data input/output: 1 pin (SDIO)  
VDD control (for controlling the power supply for the ADNS-2610 optical mouse sensor): 1 pin (VCNT)  
Encoder input: 2 pins (PT3A, PT3B)  
LED driver: 1 pin (LED)
- Operating voltage: 4.35 to 5.25 V
- Operating temperature: 0 to 70°C
- Operating frequency: 6 MHz
- 0.6- $\mu$ m CMOS monolithic IC
- Small package: SSOP16: SSOP16-P-225-0.65B

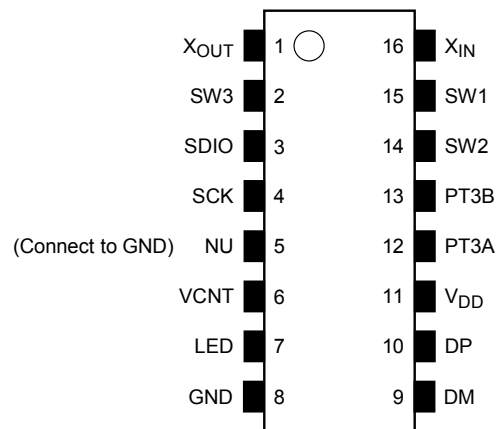


Weight: 0.07 g (typ.)

## Pin Description

Symbol	I/O	Pin No.	Description
SW1	I	15	Switch input pin 1 (left switch signal input pin).
SW2	I	14	Switch input pin 2 (middle switch signal input pin).
SW3	I	2	Switch input pin 3 (right switch signal input pin).
SCK	O	4	Serial port clock (output) pin.
SDIO	I/O	3	Serial data input and output pin.
VCNT	O	6	V <sub>DD</sub> (Optical Sensor) Control pin (for controlling the power supply for the ADNS-2610 optical mouse sensor).
NU	I	5	No use (please connect to GND).
PT3A	I	12	Encoder input pin A.
PT3B	I	13	Encoder input pin B.
LED	O	7	LED driver output.
DM	I/O	9	USB DM pin.
DP	I/O	10	USB DP pin.
V <sub>DD</sub>	—	11	Power supply pin.
GND	—	8	Ground pin.
X <sub>OUT</sub>	O	1	Ceramic resonator output pin.
X <sub>IN</sub>	I	16	Ceramic resonator input pin.

## Pin Assignment (top view)



## Pin Explanation

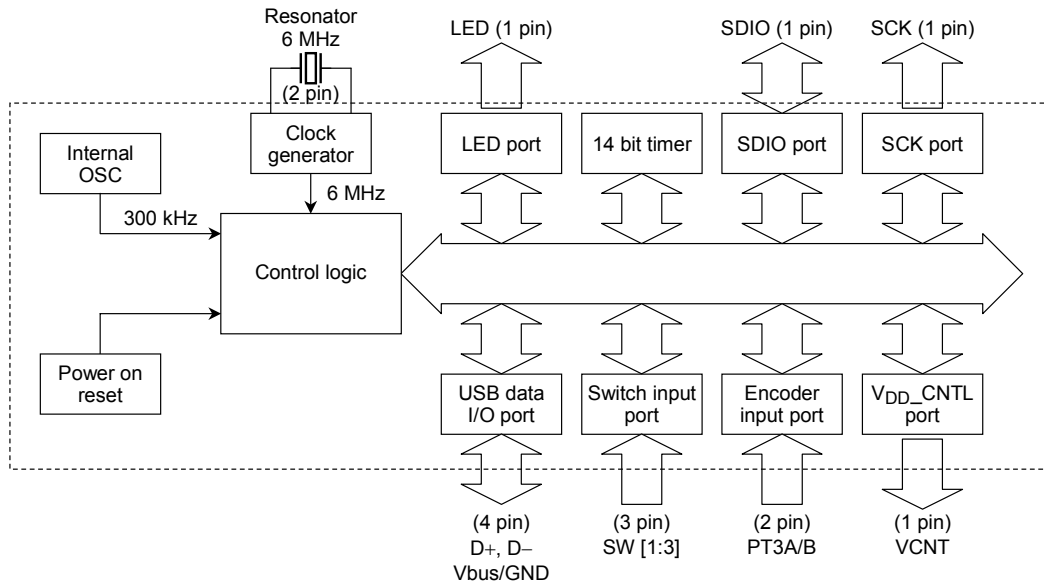
Symbol	Description
V <sub>DD</sub>	5 V power supply. Guaranteed 4.35 to 5.25 V.
GND	Ground.
X <sub>IN</sub>	Connected to a 6-MHz ceramic resonator (ceramic resonator input pin).
X <sub>OUT</sub>	Connected to a 6-MHz ceramic resonator (ceramic resonator output pin).
LED	When the mouse is operating, the LED is always turned on by current drive with N-MOS turned on. The sink current is 50 mA maximum. Current drive is turned off in suspend mode.
SW [1:3]	Connected to the buttons (left, middle, and right) of the mouse. Pulled up to V <sub>DD</sub> by built-in resistors. To prevent chattering noise, the SW signals are not recognized until 15 ms after the first change in their state, allowing the signals to be sufficiently stabilized before entering the internal circuit. The pins are assigned to the mouse switches as follows: SW1: Left switch SW2: Middle switch SW3: Right switch
SCK	Serial port clock (output) pin.
SDIO	Serial data input and output pin.
VCNT	V <sub>DD</sub> control pin (for controlling the power supply for the ADNS-2610 optical mouse sensor) When the mouse is operating, the TC9350BFN supplies power to the optical mouse sensor via an external transistor by current drive with N-MOS turned on. In suspend mode, N-MOS is turned off, stopping power supply to the optical mouse sensor.
NU	No use pin. Please connect to GND.
PT3A/B	Encoder input pins. PT3A and PT3B are used as scroll pins. Data is sampled at intervals of 100 μs. The TC9350BFN-T00 enables the built-in pull-up resistors of the encoder input pins (PT3A, PT3B) when the mouse is operating. It is suitable for a mechanical encoder. (The pull-up resistors are disabled in suspend mode.) When using a mechanical encoder, it is recommended to use an external capacitor to reduce chattering and bouncing. In stable state, PT3A = PT3B. The TC9350BFN-T01 maintains the encoder input pins (PT3A, PT3B) always in high-impedance state. It is suitable for an optical encoder (phototransistor and LED).
DP, DM	It connects with the both-directions data bus line of USB.

Note: Any short circuit (between adjacent pins or between a pin and V<sub>CC</sub> or ground) or misinsertion of pins may damage the IC chip.  
When designing an application and mounting the chip, be careful not to apply overvoltage or overcurrent to peripheral components.

Symbol	I/O	Pin No.	Description	Circuit
SW1	I	15	Switch input 1 (left).	<p>(SW [1-3])</p>
SW2	I	14	Switch input 2 (middle).	
SW3	I	2	Switch input 3 (right).	
PT3A	I	12	Encoder input pins A.	<p>(PT3A/B)</p>
PT3B	I	13	Encoder input pins B.	
SDIO	I/O	3	Serial data input and output.	<p>(SDIO)</p>
SCK	O	4	Serial port clock (output).	<p>(SCK)</p>
LED	O	7	LED driver output.	<p>(LED)</p>
VCNT	O	6	V <sub>DD</sub> Control pin. (Controlling the power supply for the Optical Mouse Sensor).	<p>(VCNT)</p>

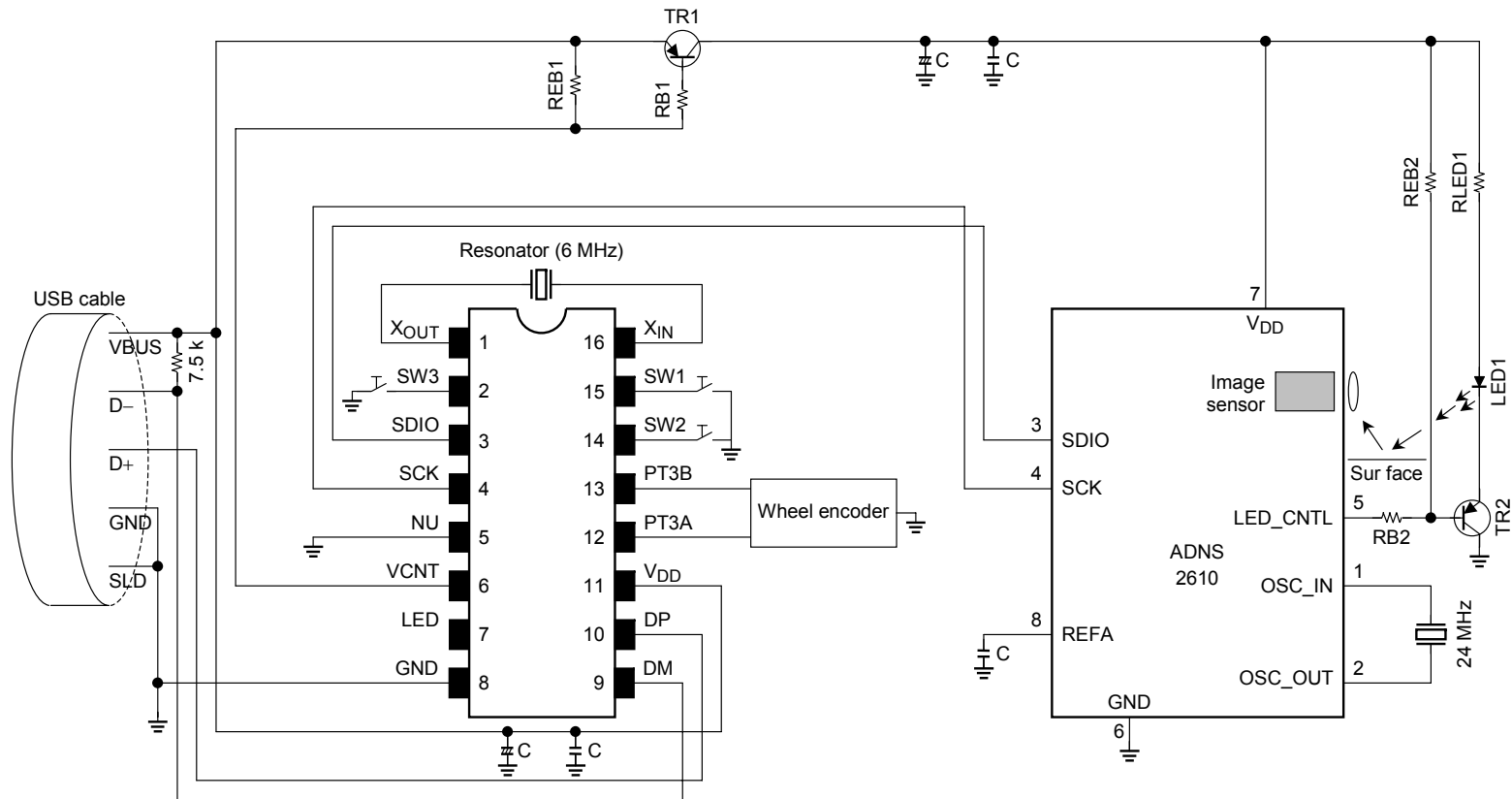
Symbol	I/O	Pin No.	Description	Circuit
DM	I/O	9	USB DM pin.	
DP	I/O	10	USB DP pin.	
V <sub>DD</sub>	—	11	Power supply.	
GND	—	8	Ground.	
X <sub>OUT</sub>	O	1	Ceramic resonator out.	
X <sub>IN</sub>	I	16	Ceramic resonator in.	

**Block Diagram**

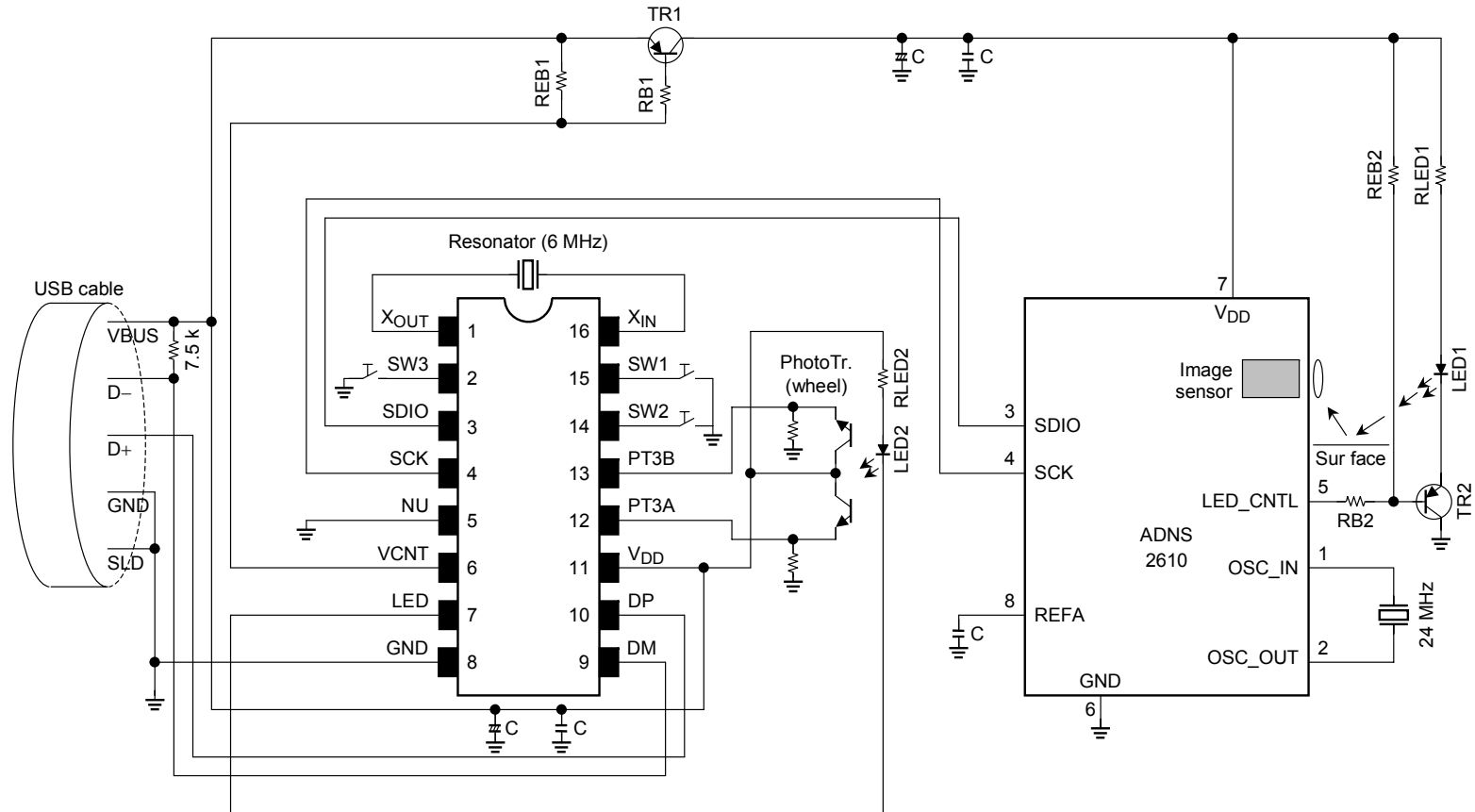


Example of Circuit

TC9350BFN-T00



TC9350BFN-T01





## Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Storage temperature range	T <sub>stg</sub>	-40~ + 150	°C
Operating ambient temperature range	T <sub>A</sub>	0~ + 70	°C
Power supply voltage	V <sub>DD</sub>	-0.5~ + 5.5	V
DC input voltage	V <sub>IN</sub>	-0.5~ V <sub>DD</sub> + 0.25	V
DC output voltage at high impedance	V <sub>OUT</sub>	-0.5~ V <sub>DD</sub> + 0.25	V
LED output pin current	I <sub>LED</sub>	70	mA
VCNT output pin current	I <sub>VCNT</sub>	7	mA
SDIO output pin current	I <sub>SDIO</sub>	5	mA
SCK output pin current	I <sub>SCK</sub>	5	mA
Power consumption	P <sub>D</sub>	100	mW
Electrostatic destruction	V <sub>ESD</sub>	MIL: -2 k~ + 2 k	V
Latch up current	I <sub>LATCH</sub>	200	mA

## Electrical Characteristics (Ta = 25°C)

### (1) General

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Power supply voltage 2	V <sub>DD</sub>		4.35	5.0	5.25	V
Power supply current (normal operation)	I <sub>DD</sub>	IC only.	—	—	5	mA
Power supply current (suspend mode)	I <sub>SB</sub>	IC only.	—	—	250	μA

### (2) USB interface

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output High voltage	V <sub>OH</sub>		2.8	—	3.6	V
Output Low voltage	V <sub>OL</sub>		—	—	0.3	V
Differential signal input common mode range	V <sub>CM</sub>		0.8	—	2.5	V
A receiving part single end input threshold voltage	V <sub>SE</sub>		0.8	—	2.0	V
Data rising time	T <sub>R</sub>	C = 350 pF (10% to 90%)	75	—	300	ns
Data falling time	T <sub>F</sub>	C = 350 pF (10% to 90%)	75	—	300	ns
Rising/Falling matching	T <sub>LRFM</sub>		80	—	125	%
Output cross voltage	V <sub>CRS</sub>		1.3	—	2.0	V

Applied to pins DM, DP

**(3) I/O**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output low voltage of LED	V <sub>OLLED</sub>	I <sub>LED</sub> = 50 mA	—	—	0.8	V
Output low voltage of VCNT	V <sub>OLVCNT</sub>	I <sub>VCNT</sub> = 5 mA	—	—	0.8	V
Output high voltage of SDIO	V <sub>OHSDIO</sub>	I <sub>SDIO</sub> = -1 mA	V <sub>DD</sub> - 0.8	—	—	V
Output low voltage of SDIO	V <sub>OLSDIO</sub>	I <sub>SDIO</sub> = 1 mA	—	—	0.4	V
Output high voltage of SCK	V <sub>OH SCK</sub>	I <sub>SCK</sub> = -1 mA	V <sub>DD</sub> - 0.8	—	—	V
Output low voltage of SCK	V <sub>OL SCK</sub>	I <sub>SCK</sub> = 1 mA	—	—	0.4	V
Input threshold voltage (SW)	V <sub>I TH1</sub>		25%	—	75%	V <sub>DD</sub>
Input threshold voltage (PT)	V <sub>I TH2</sub>		30%	—	70%	V <sub>DD</sub>
Input threshold voltage (SDIO)	V <sub>I TH3</sub>		30%	—	70%	V <sub>DD</sub>
Leak current	I <sub>IN</sub>		-1	—	1	μA

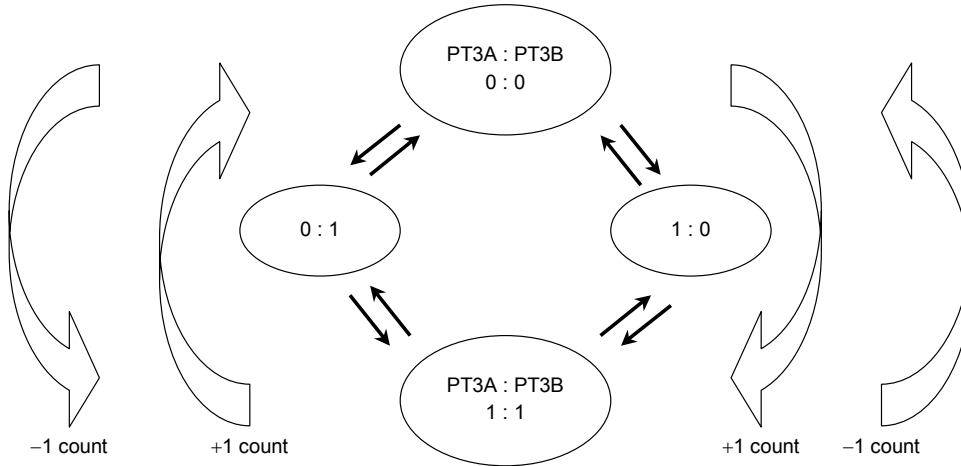
Applied to pins LED, VCNT, SDIO, SCK, SW1-3, PT3A/B

**Scrolling and the scroll count**

The following describes signal processing during scrolling:

**<< Scroll signal processing >>**

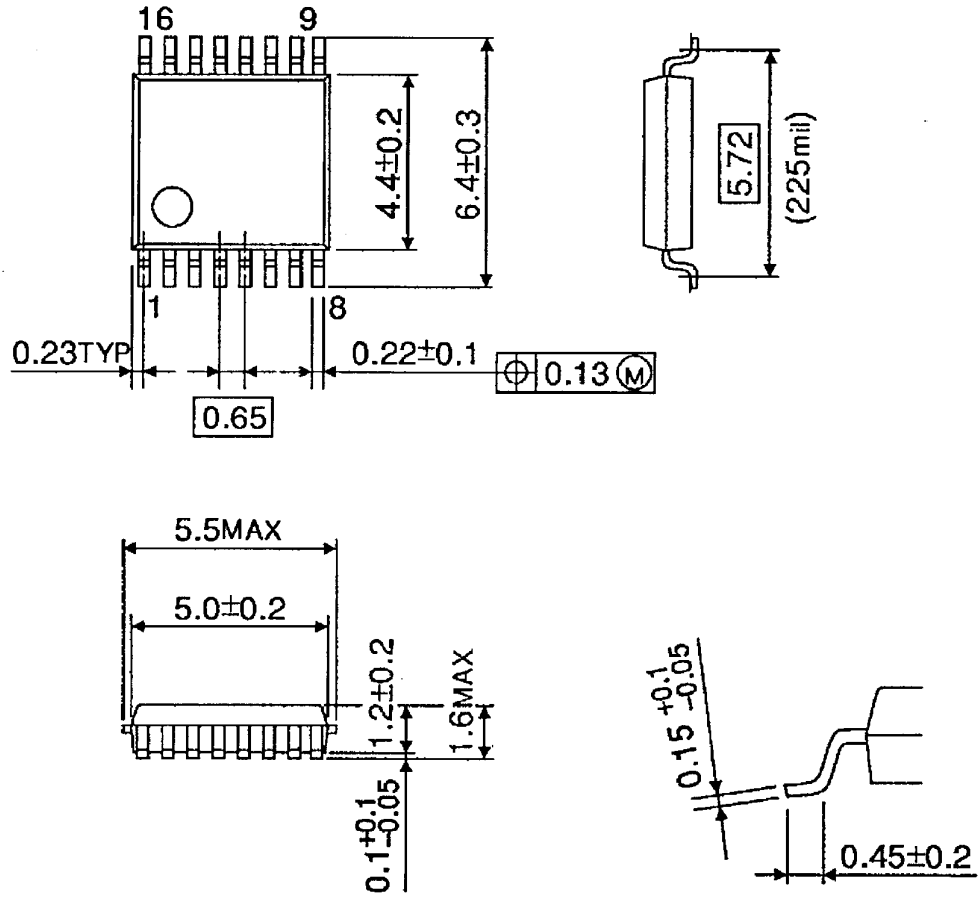
- “+1 count” (If the transition of PT3A precedes that of PT3B)  
 $(PT3A, PT3B) = (0,0) \rightarrow (1,0) \rightarrow (1,1)$  or  $(PT3A, PT3B) = (1,1) \rightarrow (0,1) \rightarrow (0,0)$
- “-1 count” (If the transition of PT3B precedes that of PT3A)  
 $(PT3A, PT3B) = (0,0) \rightarrow (0,1) \rightarrow (1,1)$  or  $(PT3A, PT3B) = (1,1) \rightarrow (1,0) \rightarrow (0,0)$



**Package Dimensions**

SSOP16-P-225-0.65B

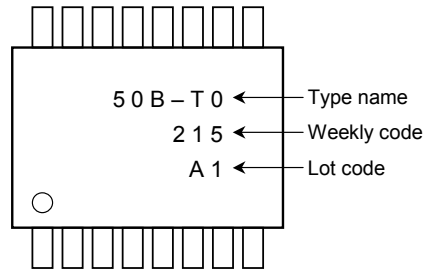
Unit : mm



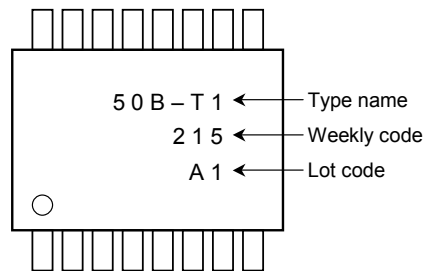
Weight: 0.07 g (typ.)

## Marking (example)

### TC9350BFN-T00



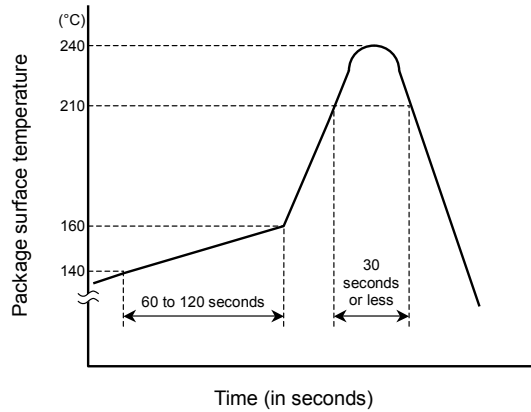
### TC9350BFN-T01



**Appendix A. Recommended mounting of TC9350BFN**

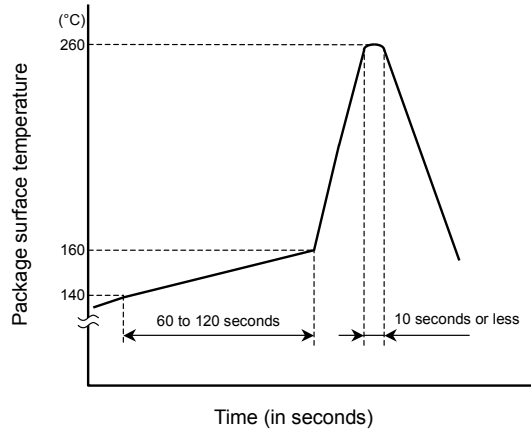
**Infrared or hot air reflow**

Preheat conditions: 140 to 160°C, 60 to 120 seconds  
 Reflow conditions: (a) 240°C max., (b) 210°C min., within 30 seconds  
 Soldering times: Maximum 2 times  
 Temperature profile:



**Solder flow (single-wave and double-wave)**

Preheat conditions: 140 to 160°C, 60 to 120 seconds  
 Reflow conditions: 260°C max., within 10 seconds  
 (For double-wave, the total time for primary wave and secondary wave must not exceed 10 seconds.)  
 Reflow cannot be performed more than once.  
 The following figure shows the recommended temperature profile.  
 Temperatures described in mounting requirements are based on the solder bath temperature.  
 The temperature profile indicates the maximum withstand temperature. The application must not cause the chip temperature to fall outside the profile range.



## Appendix B. USB Descriptors

### Device Descriptor

Offset	Field	Size	Value (Hex)	Description
0	bLength	1	12	Size of this descriptor in bytes.
1	bDescriptorType	1	01	Device descriptor type.
2	bcdUSB	2	0110	USB HID Specification Release 1.1.
4	bDeviceClass	1	00	Not supported.
5	bDeviceSubClass	1	00	Not supported.
6	bDeviceProtocol	1	00	Protocol depends on selected interface.
7	bMaxPacketSize0	1	08	Maximum packet size on endpoint zero.
8	idVendor	2	0930	Vendor ID
10	idProduct	2	6501	Product ID
12	bcdDevice	2	0000 (-T00) 0001 (-T01)	Device release number.
14	iManufacturer	1	01	Index of string descriptor describing manufacture.
15	iProduct	1	02	Index of string descriptor describing product.
16	iSerialNumber	1	00	Not supported.
17	bNumConfigurations	1	01	Number of possible configurations.

### Configuration Descriptor

Offset	Field	Size	Value (Hex)	Description
0	bLength	1	09	Size of this descriptor in bytes.
1	bDescriptorType	1	02	Configuration descriptor type.
2	wTotalLength	2	0022	Total length of data returned for this configuration including interface, HID, and endpoint.
4	bNumInterfaces	1	01	Number of interfaces supported by this configuration.
5	bConfigurationValue	1	01	Value to use as an argument to Set Configuration to select this configuration.
6	iConfiguration	1	00	Not supported.
7	bmAttributes	1	A0	Bus powered and able to perform remote wakeup.
8	MaxPower	1	32	Max power

### String Descriptor

Index	Size (Character)	Value (Hex)	Description
0	2	0409	Language ID
1	Max 8	TOSHIBA	ASCII Character
2	Max 32	USB Wheel Mouse	ASCII Character

## Interface Descriptor

Offset	Field	Size	Value (Hex)	Description
0	bLength	1	09	Size of this descriptor in bytes.
1	bDescriptorType	1	04	Interface descriptor type.
2	bInterfaceNumber	1	00	Number of interface.
3	bAlternateSetting	1	00	Value used to select alternate setting.
4	bNumEndpoints	1	01	Number of endpoints.
5	bInterfaceClass	1	03	Class code (HID code assigned by USB).
6	bInterfaceSubClass	1	01	Boot interface subclass.
7	bInterfaceProtocol	1	02	Mouse.
8	iInterface	1	00	Not supported.

## HID Descriptor

Offset	Field	Size	Value (Hex)	Description
0	bLength	1	09	Size of this descriptor in bytes.
1	bDescriptorType	1	21	HID descriptor type.
2	bcdHID	2	0110	HID class specification release number.
4	bCountryCode	1	00	Country Code USA
5	bNumDescriptors	1	01	Number of report descriptors
6	bDescriptorType	1	22	Descriptor Type
7	wDescriptorLength	2	0034	HID report Descriptor Length

## Endpoint Descriptor

Offset	Field	Size	Value (Hex)	Description
0	bLength	1	07	Size of this descriptor in bytes.
1	bDescriptorType	1	05	Endpoint descriptor type.
2	bEndpointAddress	1	81	The address of the endpoint.
3	bmAttributes	1	03	Interrupt endpoint.
4	wMaxPacketSize	2	0004	Maximum packet size.
6	bInterval	1	0A	Interval for polling endpoint for data transfers.



**HID Report Descriptor**

Offset	Field	Size	Value (Hex)	Description
0	Usage page	2	0501	Generic Desktop
2	Usage	2	0902	Mouse
4	Collection	2	A101	Application
6	Usage	2	0901	Pointer
8	Collection	2	A100	Linked
10	Usage page	2	0509	Buttons
12	Usage minimum	2	1901	Button 1
14	Usage maximum	2	2903	Button 3
16	Logical minimum	2	1500	Button open
18	Logical maximum	2	2501	Button close
20	Report count	2	9503	3 reports
22	Report size	2	7501	Each button report is 1bit. left = bit0, right = bit1, middle = bit2
24	Input	2	8102	Variable Data Bit Field with Absolute position
26	Report count	2	9501	1 report
28	Report size	2	7505	5 report bits for padding
30	Input	2	8101	Constant
32	Usage page	2	0501	Generic Desktop
34	Usage	2	0930	X
36	Usage	2	0931	Y
38	Usage	2	0938	Scroll
40	Logical minimum	2	1581	-127
42	Logical maximum	2	257F	127
44	Report size	2	7508	The x and y reports are 8bit
46	Report count	2	9503	3 reports
48	Input	2	8106	Variable, Relative
50	End collection	1	C0	
51	End collection	1	C0	

Note: Any short circuit (between adjacent pins or between a pin and  $V_{CC}$  or ground) or misinsertion of pins may damage the IC chip.  
When designing an application and mounting the chip, be careful not to apply overvoltage or overcurrent to peripheral components.

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