

TOSHIBA CMOS Type Integrated Circuit Silicon Monolithic

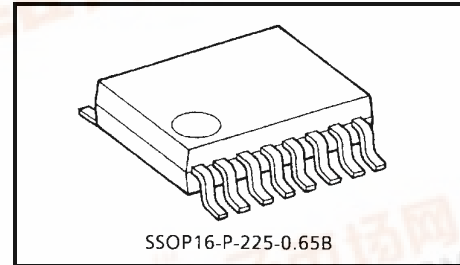
TC9350BFN-T00, TC9350BFN-T01

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-μm CMOS monolithic IC
- Small package: SSOP16: SSOP16-P-225-0.65B

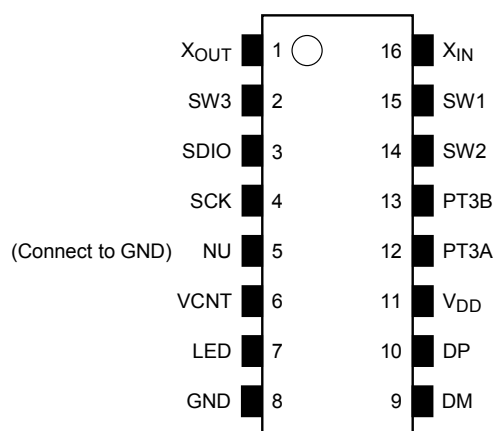


Weight: 0.07 g (typ.)

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 _{DD} (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 _{DD} | — | 11 | Power supply pin. |
| GND | — | 8 | Ground pin. |
| X _{OUT} | O | 1 | Ceramic resonator output pin. |
| X _{IN} | I | 16 | Ceramic resonator input pin. |

Pin Assignment (top view)



Pin Explanation

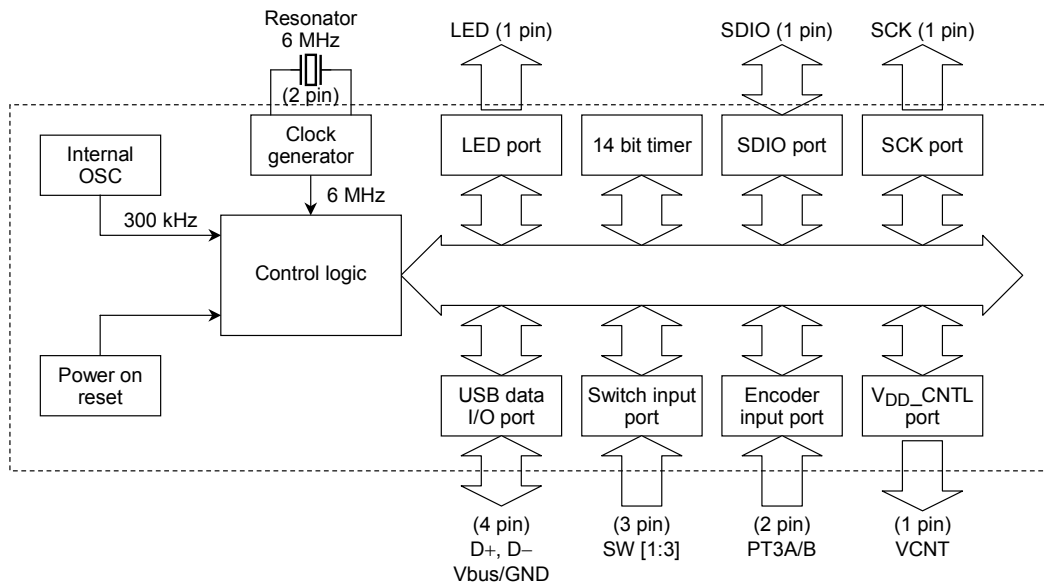
| Symbol | Description |
|------------------|---|
| V _{DD} | 5 V power supply. Guaranteed 4.35 to 5.25 V. |
| GND | Ground. |
| X _{IN} | Connected to a 6-MHz ceramic resonator (ceramic resonator input pin). |
| X _{OUT} | Connected to a 6-MHz ceramic resonator (ceramic resonator output pin). |
| LED | 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 _{DD} 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 _{DD} 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_{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.

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

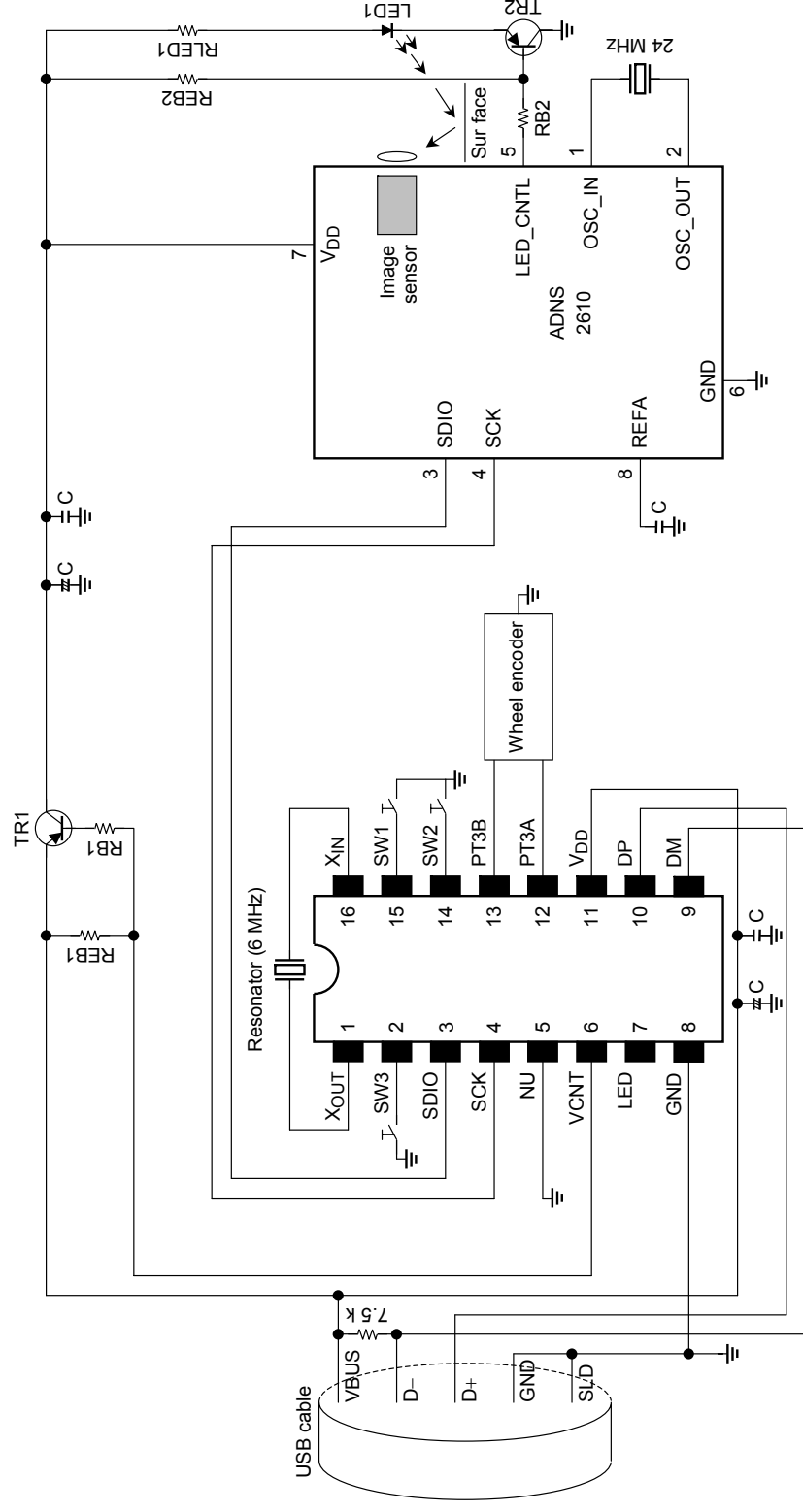
| Symbol | I/O | Pin No. | Description | Circuit |
|------------------|-----|---------|------------------------|---------|
| DM | I/O | 9 | USB DM pin. | |
| DP | I/O | 10 | USB DP pin. | |
| V _{DD} | — | 11 | Power supply. | |
| GND | — | 8 | Ground. | |
| X _{OUT} | O | 1 | Ceramic resonator out.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

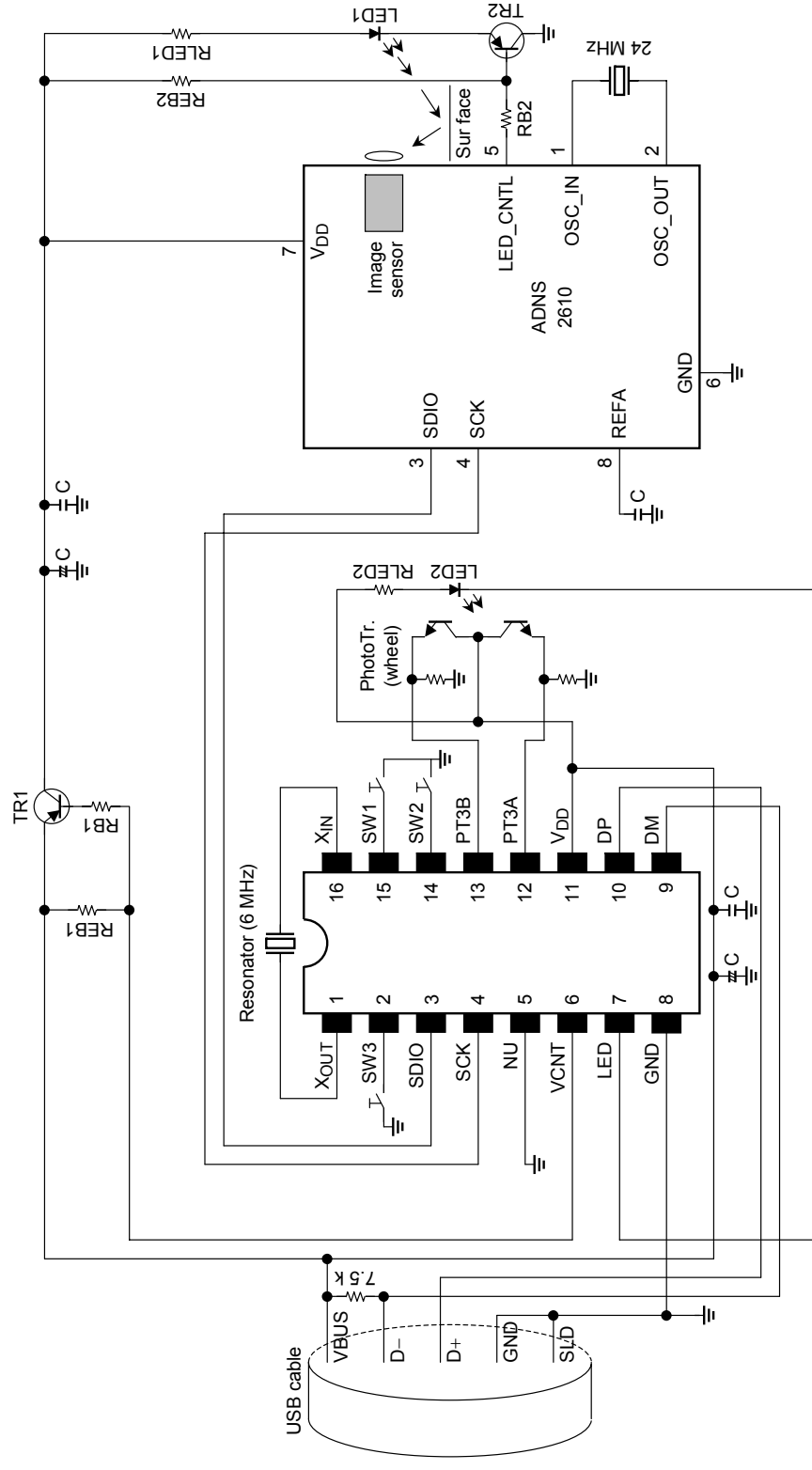
Block Diagram



Example of Circuit

TC9350BFN-T00





Maximum Ratings (Ta = 25°C)

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

Electrical Characteristics (Ta = 25°C)
(1) General

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|-----------------|----------------|------|------|------|------|
| Power supply voltage 2 | V _{DD} | | 4.35 | 5.0 | 5.25 | V |
| Power supply current (normal operation) | I _{DD} | IC only. | — | — | 5 | mA |
| Power supply current (suspend mode) | I _{SB} | IC only. | — | — | 250 | μA |

(2) USB interface

| Characteristics | Symbol | Test Condition | Min | Typ. | Max | Unit |
|---|-------------------|-------------------------|-----|------|-----|------|
| Output High voltage | V _{OH} | | 2.8 | — | 3.6 | V |
| Output Low voltage | V _{OL} | | — | — | 0.3 | V |
| Differential signal input common mode range | V _{CM} | | 0.8 | — | 2.5 | V |
| A receiving part single end input threshold voltage | V _{SE} | | 0.8 | — | 2.0 | V |
| Data rising time | T _R | C = 350 pF (10% to 90%) | 75 | — | 300 | ns |
| Data falling time | T _F | C = 350 pF (10% to 90%) | 75 | — | 300 | ns |
| Rising/Falling matching | T _{LRFM} | | 80 | — | 125 | % |
| Output cross voltage | V _{CRS} | | 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_{OLLED} | $I_{LED} = 50 \text{ mA}$ | — | — | 0.8 | V |
| Output low voltage of VCNT | V_{OLVCNT} | $I_{VCNT} = 5 \text{ mA}$ | — | — | 0.8 | V |
| Output high voltage of SDIO | V_{OHSDIO} | $I_{SDIO} = -1 \text{ mA}$ | $V_{DD} - 0.8$ | — | — | V |
| Output low voltage of SDIO | V_{OLSDIO} | $I_{SDIO} = 1 \text{ mA}$ | — | — | 0.4 | V |
| Output high voltage of SCK | V_{OHSCK} | $I_{SCK} = -1 \text{ mA}$ | $V_{DD} - 0.8$ | — | — | V |
| Output low voltage of SCK | V_{OLSCK} | $I_{SCK} = 1 \text{ mA}$ | — | — | 0.4 | V |
| Input threshold voltage (SW) | V_{ITH1} | | 25% | — | 75% | V_{DD} |
| Input threshold voltage (PT) | V_{ITH2} | | 30% | — | 70% | V_{DD} |
| Input threshold voltage (SDIO) | V_{ITH3} | | 30% | — | 70% | V_{DD} |
| Leak current | I_{IN} | | -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:

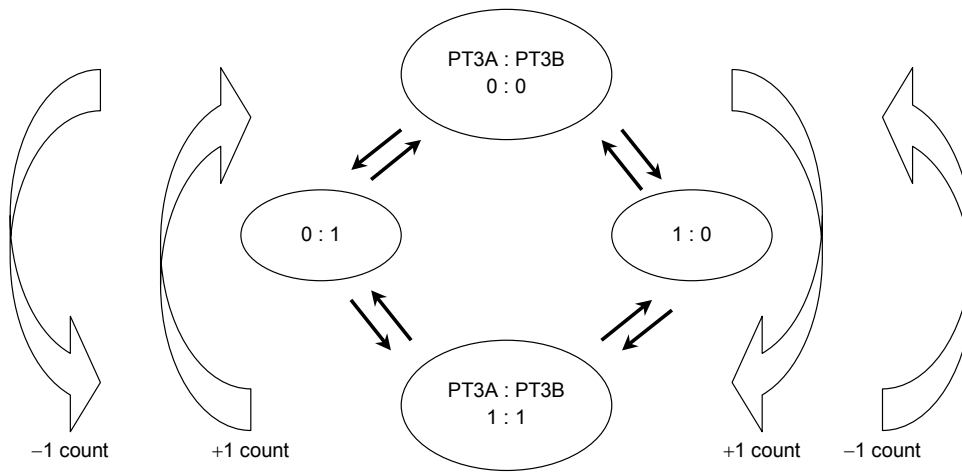
<< Scroll signal processing >>

“+1 count” (If the transition of PT3A precedes that of PT3B)

(PT3A, PT3B) = (0,0) → (1,0) → (1,1) or (PT3A, PT3B) = (1,1) → (0,1) → (0,0)

“−1 count” (If the transition of PT3B precedes that of PT3A)

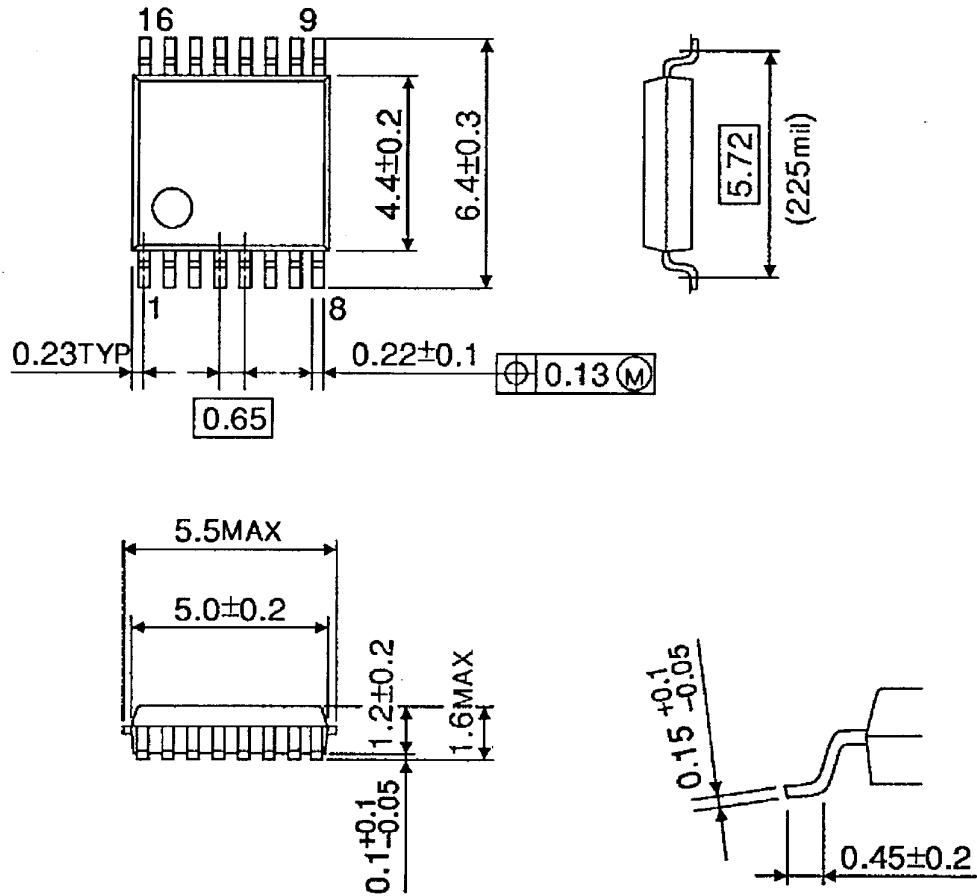
(PT3A, PT3B) = (0,0) → (0,1) → (1,1) or (PT3A, PT3B) = (1,1) → (1,0) → (0,0)



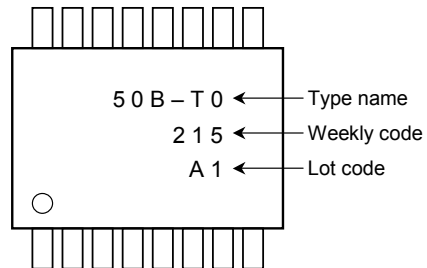
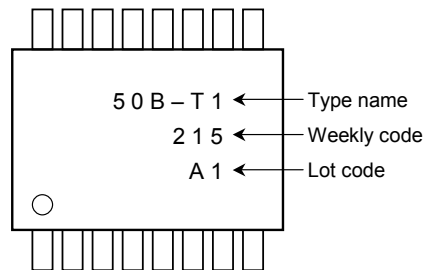
Package Dimensions

SSOP16-P-225-0.65B

Unit : mm



Weight: 0.07 g (typ.)

Marking (example)**TC9350BFN-T00****TC9350BFN-T01**

Appendix A. Recommended mounting of TC9350BFN

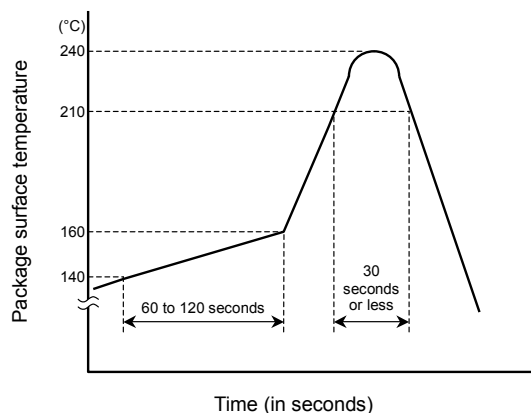
Infrared or hot air reflow

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

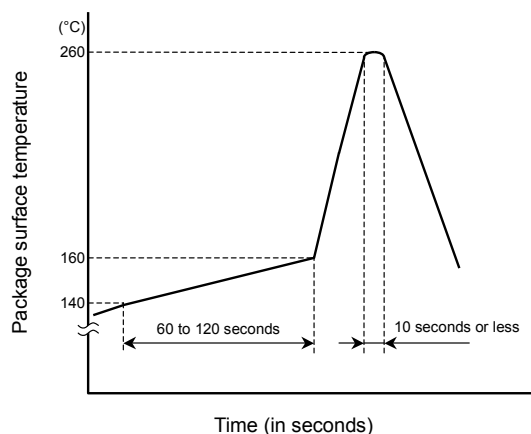
(For double-wave, the total time for primary wave and secondary wave must not exceed 10 seconds.)

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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