# HT6515
# Mouse Controller

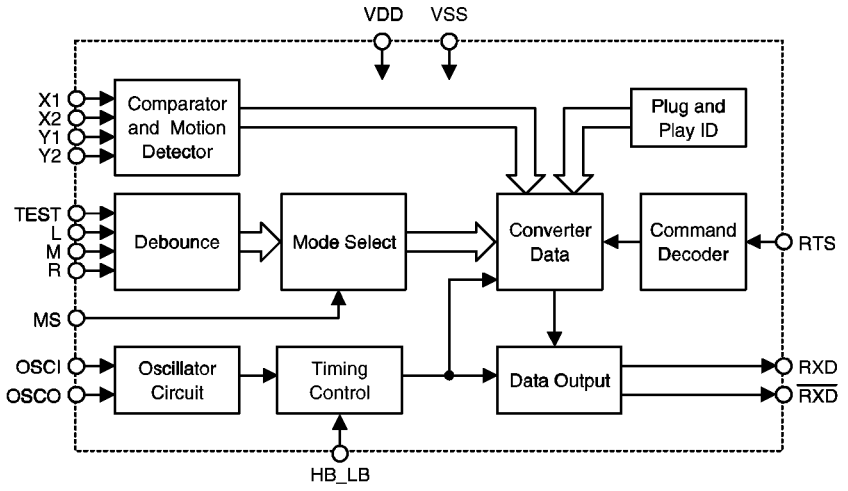
## Features

- Supports optomechanical mouse
- Plug and Play compatible
- Fits a defined Windows 95 class name
- Uses 32.768kHz crystal
- On chip crystal oscillator circuits
- 1200/9600 baud rate serial output
- Power directly from RS-232C without external power supply
- Three key-switches and four photo-coupler inputs
- Compatible with both Microsoft and Mouse systems
- Mouse mode (MS/PC) changeable during power-on reset
- $\overline{\text{RXD}}$ with heavy NMOS open drain or CMOS output

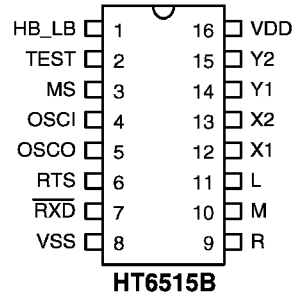
## General Description

The HT6515 is specially designed for PnP compatible mouse controller. It is capable of driving up to three key-switches and four photo-couplers (optomechanical mouse) directly into a standard RS-232C line. It can be operated without external power supply. It is compatible with both Microsoft and Mouse systems. False entries are prevented by internal debounce circuits.

## Block Diagram



## Pin Assignment

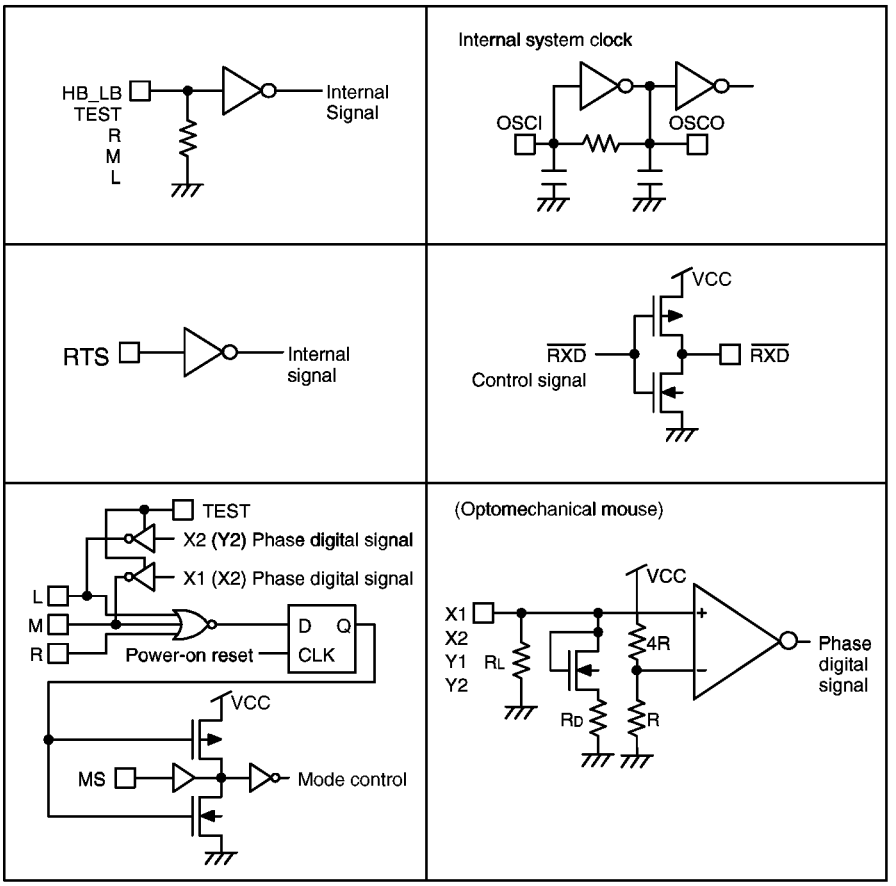



## Pin Description

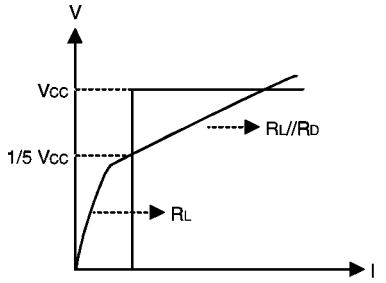
| Pin Name | I/O | Internal Connection | Description |
|---|---|---|---|
| MS | I | | When this pin is connected to $V_{DD}$, operates under the Microsoft mode only. If the pin is connected to $V_{SS}$, operates under the mouse system mode. If MS pin is "floating", the product is on the power-on initiation mode. |
| OSCO | O | | Oscillator output pin |
| OSCI | I | | Oscillator input pin |
| RTS | I | | When a rising edge signal is sent to RTS then the mouse will return a series of ID code to identify the mouse mode. The RTS must be kept high while the mouse is in normal operation. |
| $\overline{RXD}$ | O | | NMOS, serial data output (HT6515B) |
| VSS | I | | Negative power supply |
| HB_LB | I | Pull-low | If this pin is connected to high level, the RXD can transmit data at 9600 baud rate. The RXD is transmit at 1200 baud rate while it is connected to low level or floating. |
| R<br>M<br>L | I | | Three key-switches have a total of seven different combinations. Both key-pressed and key-released signals will be sent accompanied with horizontal and vertical state. The status of the key-switches, the values of horizontal or vertical counter will be present at $\overline{RXD}$. |

| Pin Name | I/O | Internal Connection | Description |
|---|---|---|---|
| X1<br>X2<br>Y1<br>Y2 | I | | Four photo-coupler signals denote UP, DOWN, LEFT and RIGHT state. During the scanning period, as long as the photo-couplers change their states, the value of vertical or horizontal counter will increase or decrease accordingly. |
| TEST | I | | For IC test only. The test pin must be connected to $V_{SS}$, while the chip is under normal usage. |
| VDD | I | | Positive power supply |

**Approximate internal connections**



**X1/X2/Y1/Y2 Input pin I/V curve (optomechanical mouse)**




## Absolute Maximum Ratings*

Supply Voltage.....–0.3V to 6.5V
Input Voltage..... $V_{SS}$–0.3V to $V_{DD}$+0.3V
Storage Temperature.. .....–50°C to 125°C
Operating Temperature.....–25°C to 70°C

*Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

## D.C. Characteristics

Ta=25°C

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_{DD}$ | Conditions | | | | |
| $V_{DD}$ | Operating Voltage | — | — | 2.5 | 5.1 | 6 | V |
| $I_{DD}$ | Operating Current | 5.6V | No load | — | 400 | 800 | μA |
| $V_{IL}$ | X1, X2, Y1, Y2 Input Low Voltage | 5.6V | — | 0 | — | 1 | V |
| $V_{IH}$ | X1, X2, Y1, Y2 Input High Voltage | 5.6V | — | 1.5 | — | 5.6 | V |
| $V_{IL1}$ | Input Low Voltage, Other Pin | 5.1V | — | 0 | — | 1 | V |
| $V_{IH1}$ | Input High Voltage, Other Pin | 5.1V | — | 3.5 | — | 5.1 | V |
| $I_{OL1}$ | $\overline{RXD}$ Output Sink Current | 5.6V | $V_{OL}$=0.56V | 3.5 | 6 | — | mA |
| $V_{OH}$ | $\overline{RXD}$ High-level Output Voltage | — | — | — | — | 16 | V |
| $R_{PL}$ | Pull-low Resistance | 5.6V | L, M, R key-switches | 65 | — | 200 | kΩ |

## A.C. Characteristics

Ta=25°C

| Symbol | Parameter | Test Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| | | $V_{DD}$ | Conditions | | | | |
| $f_{SYS}$ | System Clock | 5.6V | Crystal oscillator | 30.8 | 32.768 | 34.2 | kHz |
| $f_P$ | Photo-couple Input Frequency | 5.6V | — | — | — | 8.2 | kHz |
| $f_N$ | Photo-couple Operation frequency | 5.6V | — | 0 | — | 8 | kHz |
| $t_{KD}$ | Key Debounce | 5.6V | — | — | 52 | — | ms |
| $t_{MS}$ | Transmission Time | 5.6V | Mouse system (1200) | — | 41.3 | — | ms |
| | | 5.6V | Mouse system (9600) | — | 5.3 | — | ms |
| $t_{MI}$ | Transmission Time | 5.6V | Microsoft (1200) | — | 24.8 | — | ms |
| | | 5.6V | Microsoft (9600) | — | 3.18 | — | ms |
| $t_S$ | Start Bit Time | 5.6V | (1200) | — | 0.85 | — | ms |
| | | | (9600) | — | 0.106 | — | ms |
| $t_D$ | Data Bit Time | 5.6V | (1200) | — | 0.82 | — | ms |
| | | | (9600) | — | 0.106 | — | ms |
| $t_P$ | Stop Bit Time | 5.6V | (1200) | — | 0.82 | — | ms |
| | | | (9600) | — | 0.106 | — | ms |
| $t_{RD}$ | Mode Code Delay Time ($f_{SYS}$= 32.768kHz) | 5.6V | (1200) | 11.9 | – | 14 | ms |
| | | | (9600) | 1.48 | – | 1.7 | ms |
| $t_R$ | Rising Edge Crossed Width | 5.6V | — | 31 | — | — | μs |
| $t_F$ | Falling Edge Crossed Width | 5.6V | — | 31 | — | — | μs |

## Functional Description

### Mouse system mode

Any change of state of the mouse key-switches or photo-couplers will be detected by the chip and transmitted over the RS-232C. The mouse system protocol will send five words at a 1200/9600 baud rate with each word containing 10 bits, one start bit, one stop bit and eight data bits. The first, second and third words correspond to key switch-status, horizontal counter and vertical counter respectively. The auto-speed sensing circuits ensure detection of higher mouse speeds resulting in the use of the 4th and 5th words for extra horizontal and vertical overflow counts respectively. For lower mouse speeds the 4th and 5th words remain at zero.

**Output word format**

| Bit No. | Mouse system word structures | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 1st word | 1 | 0 | 0 | 0 | 0 | L' | M' | R' |
| 2nd word | H7 | H6 | H5 | H4 | H3 | H2 | H1 | H0 |
| 3rd word | V7 | V6 | V5 | V4 | V3 | V2 | V1 | V0 |
| 4th word | EH7 | EH6 | EH5 | EH4 | EH3 | EH2 | EH1 | EH0 |
| 5th word | EV7 | EV6 | EV5 | EV4 | EV3 | EV2 | EV1 | EV0 |

': denotes complement
H0~H7: Horizontal counter values
V0~V7: Vertical counter values
EH0~EH7: Extra horizontal counter values
EV0~EV7: Extra vertical counter values

### Microsoft mode

In the microsoft mode only three words are transmitted with each word divided into one start bit, seven data bits and two stop bits. Note that only two switch operations are available with the "M" switch being redundant in this mode. The "L" and "R" switch status together with the two most significant bits of both vertical and horizontal counters are transferred in the first word. The second and third word represent the horizontal and vertical counters respectively. Note that this vertical data is recorded in 2's complement format.

**Output word format**

| Bit No. | Microsoft word structures | | | | | | |
|---|---|---|---|---|---|---|---|
| | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 1st word | 1 | L | R | V7' | V6' | H7 | H6 |
| 2nd word | 0 | H5 | H4 | H3 | H2 | H1 | H0 |
| 3rd word | 0 | V5' | V4' | V3' | V2' | V1' | V0' |

### Win 95 PnP ID fields

For compatibility with old serial mouse drivers, all mouse-compatible pointing devices must be restricted to a 6-bit character set, for all fields except the mouse ID. Therefore, all old-mouse-compatible strings are limited to values of 0x00 to 0x3f, character strings are ASCII codes from 0x20 to 0x5f, offset by subtracting 0x20.

### Microsoft mode

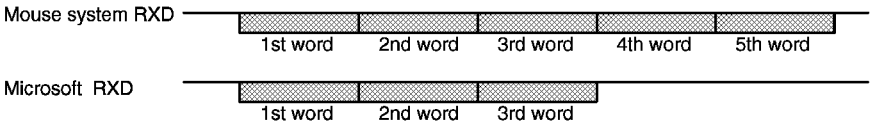
| Field Name | Size | Field Data | Description |
|---|---|---|---|
| Old Mouse ID | 1 | 4D | Identifies a mouse for old microsoft mode drivers |
| Begin Pnp | 1 | 08 | "(" indicates PnP IDs will follow |
| Pnp Rev | 2 | 01, 24 | Identifies PnP version 1.0 |
| EISA ID | 3 | 28, 34, 2B | "HTK" ( A mouse company ) |
| Product ID | 4 | 16, 15, 11, 21 | "651A" ( Unique product identifier ) |
| Extended | 1 | 3C | "\" |
| Class Name | 6 | 3C, 2D, 2F, 35, 33, 25 | "\MOUSE" fits a defined Windows 95 class name |
| Driver ID | 8 | 3C, 30, 2E, 30, 10, 26,10, 23 | "$\overline{\text{PNP0F0C}}$" fits a defined Windows 95 microsoft mouse compatible ID |
| Check sum | 2 | 21, 25 | Checksum of all characters from begin PnP to End PnP, exclusive of the checksum characters themselves. |
| End PnP | 1 | 09 | ")" indicates PnP IDs complete |

### Mouse system mode

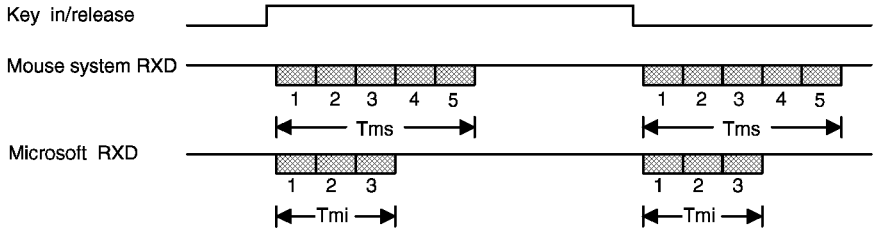
| Field Name | Size | Field Data | Description |
|---|---|---|---|
| Old Mouse ID | 1 | 6D | Identifies a mouse for old mouse system mode drivers |
| Begin Pnp | 1 | 08 | "(" indicates PnP IDs will follow |
| Pnp Rev | 2 | 01, 24 | Identifies PnP version 1.0 |
| EISA ID | 3 | 28, 34, 2B | "HTK" ( A mouse company ) |
| Product ID | 4 | 16, 15, 11, 21 | "651A" ( Unique product identifier ) |
| Extended | 1 | 3C | "\" |
| Class Name | 6 | 3C, 2D, 2F, 35, 33, 25 | "\MOUSE" fits a defined Windows 95 class name |
| Driver ID | 8 | 3C, 30, 2E, 30, 10, 26, 10, 14 | "$\overline{\text{PNP0F04}}$" fits a defined Windows 95 mouse system mouse compatible ID |
| Check sum | 2 | 19, 26 | Checksum of all characters from begin PnP to End PnP, exclusive of the checksum characters themselves. |
| End PnP | 1 | 09 | ")" indicates PnP IDs complete |

## Timing Diagrams

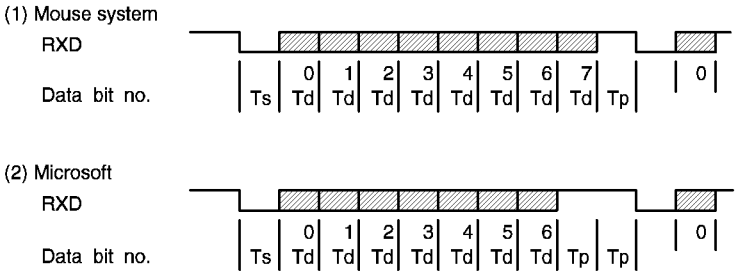
**Word structure**




**Key output**

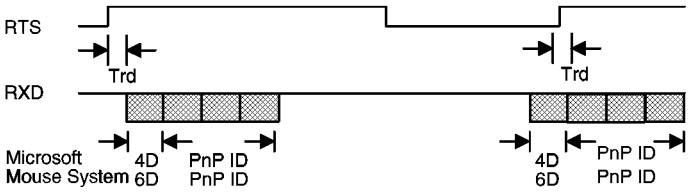



**Bit Structure**

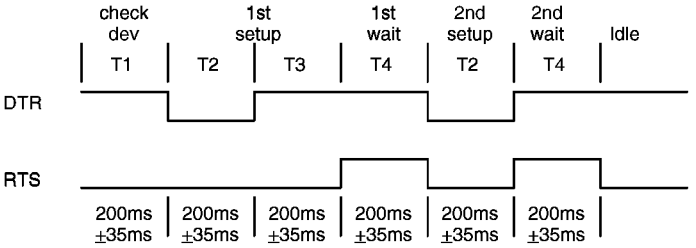


**Mode select timing**

Microsoft and Mouse system mode

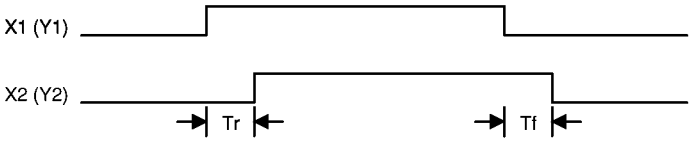



**PnP COM Enumerator timing**

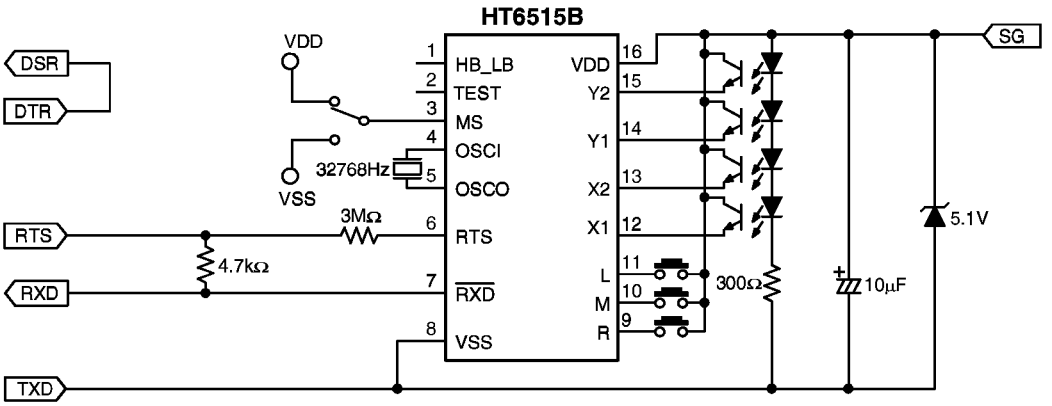



T1: interval to hold DTR high while waiting for DSR
T2: interval for external device to power down or detect the port state
T3: DTR-RTS enumerator signature delay
T4: maximum interval to wait for DSR and/or first received character
T5: PnP COM ID per/character timeout 200ms ( not shown )
**T6: PnP COM ID EndPnP timeout 2.2 seconds ( not shown )**
**T7:** disconnect **verification** timeout **5 seconds** ( not shown )

**Photo-coupler crossed width**



## Application Circuits




The $\overline{\text{RXD}}$ pin is NMOS open drain output.