TP8833-35-15-25

USB+PS/2 3D 3/5Key Mouse Controller

DataSheet

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General Specification

The TP88x5/x3 is to provide a reliable and low-cost solution of transferring mouse data to the host system through a USB environment and accept a report information from host system to indicate e-mail coming. This USB e-mail Mouse controller has been developed for applications requiring a low speed interface to the USB. It completely conforms to the USB 1.5 Mbps specification, version 1.1 and USB HID specification, version 1.1. TP88x5/x3 build in a RC Oscillator,so it doesn't need any external crystal for whole system. This e-mail mouse controller can interface five key-switches and six photo-couplers direct to USB and up to three indicator ELED to turn on/off an LED in order to indicate e-mail received by your mail server. Key de-bouncing circuit is provided to prevent false entry and improve the accuracy, and the noise immunity circuits to eliminate this noise.

Selector Guide

Part Number	Interface	No. of Keys	No. of LEDs	Support Buzzer	Pin/Package
TP8833 (a)AP/BP	USB+PS/2	3	0	NONE	18/DIP,SOP
TP8835 (a)AP/BP	USB+PS/2	5	0	NONE	20/DIP,SOP
*TP8815 (a)AP/BP	USB+PS/2	5	1	NONE	20/DIP,SOP
*TP8825 (a)AP/BP	USB+PS/2	5	3	YES	22/DIP 24/SOP

Note: 1."A"=>resolution in z direction=1/2.

2."B"=>resolution in z direction=1/4.

3.In USB mode,the "a" indicates Button-Wakeup only,if not,that indicates Button with Motion Wakeup.

4.A LED could instead of a Buzzer.

5. ' *' = development

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Features

- Built-in 6MHz RC oscillator or 6MHz external oscillator.
- Fully compliant with the USB 1.1 specification, supports control and interrupt transactions.
- Fully compliant with the HID 1.1 specification, supports remote wakeup and USB mouse boot protocol feature.
- Data transfer at USB low speed, Supports 1 device address and 2 endpoints.
- Integrated USB Transceiver & 1.5Mbps USB serial interface engine.
- Improved output drivers to reduce EMI.
- Single 5V power supply with DC supply voltage from 4.4v to 5.25v.
- Internal power-on-reset (POR).
- Built-in noise immunity circuit.
- Five key-switches and six photo-couples inputs.
- Both key-press and key release de-bounce intervals are 11ms.
- Support USB suspend mode and remote wakeup feature.
- Operating temperature range from 0 to 70 degree Celsius.
- Built-in auto-reference function.
- Auto speed with dynamic resolutions.
- Set on/off time for ELED1 and ELED2. When e-mail coming it can flashlight.
- Change frequency for buzzer when e-mail coming it will sing a song.
- PS/2 Support with compatible 2D & 3D & 5-button Wheel mode.
- PIN to PIN compatible with TP8301/02, TP88X5.
- Improved ESD protection.
- 5-button & 3D Wheel mode.
- Low power dissipation. Support USB suspend power management to lower suspend current
. the LEDs and internal Clocks are turned off before the device goes into suspend and are turned on right after the device gets out of suspend.

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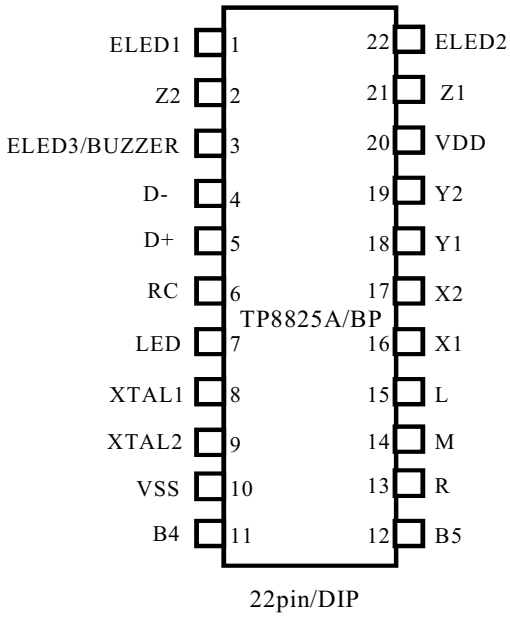
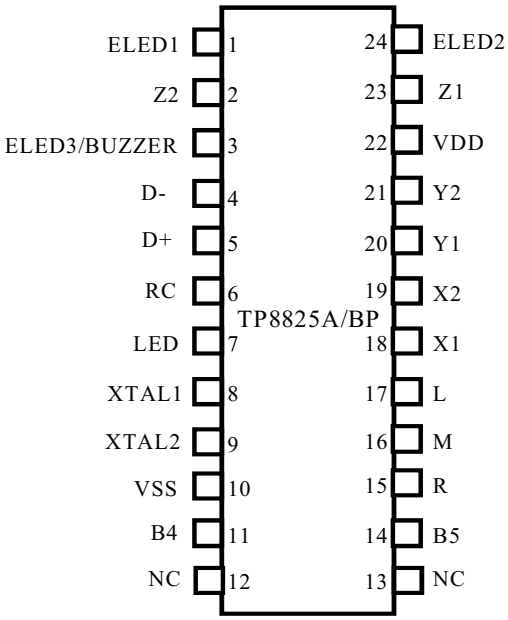
Pin Configurations and Package Type

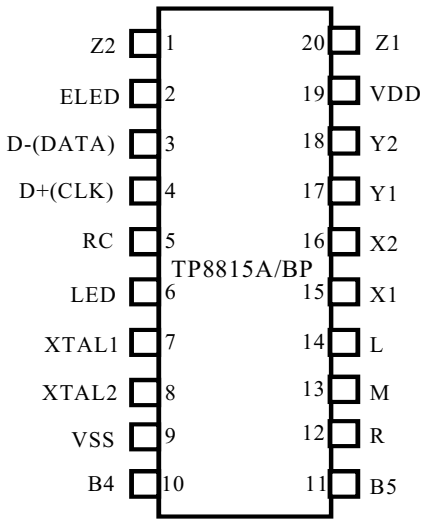
1. 5Key Series(TOP VIEW)



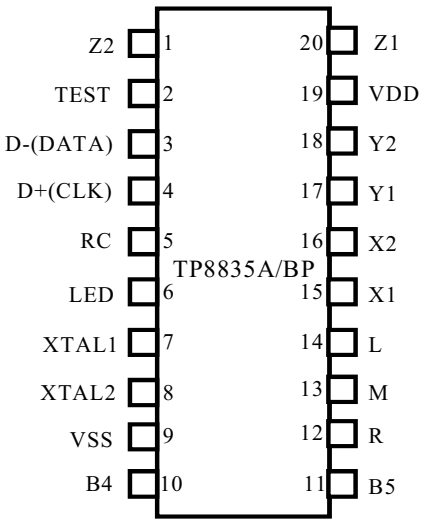
22pin/DIP



24pin/SOP



20pin/DIP
20pin/SOP



20pin/DIP
20pin/SOP

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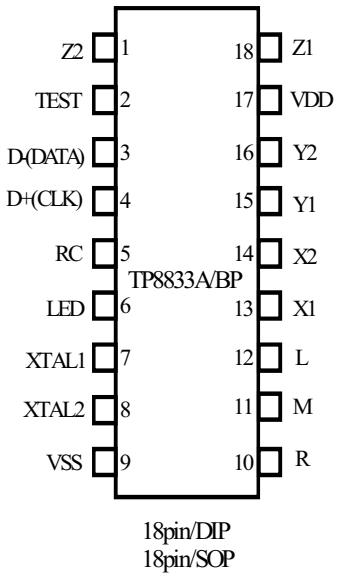
2. 3Key Series(TOP VIEW)



18pin/DIP
18pin/SOP

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Pin Descriptions

Symbol	Type	Function
D+(CLK) D-(DATA)	I/O I/O	Bi-directional data line. For USB environment, An external 7.5kΩ resistor must be connected between the D- and Vdd to select low-speed operation. For PS2 environment, D+, D- are functioned as PS/2 CLK, DATA line
XTAL1	I	6 MHz ceramic resonator or external clock input
XTAL2	O	6 MHz ceramic resonator
R M L B4 B5	I I I I I	Five key-switches exert seven different combinations totally. Both key-pressed and key-released signals will be sent accompanied with horizontal and vertical state. The de-bounce interval for both key-press and key-release is 11ms.
VSS VDD	G P	Ground Power
X1 X2 Y1 Y2 Z1 Z2	I I I I I I	Six photo-couple signals denote UP, DOWN, LEFT, RIGHT, Scrolling UP and Scrolling DOWN state. During the scanning period, as long as the photo-couples change their state, the value of vertical or horizontal counter will accordingly increase or decrease.
BUZZER	O	Open Drain & can set on/off time.
RC	I	Connect to external RC circuit for USB suspend mode power management
LED	O	Open Drain & Control for the sink of photo diodes.
ELED1 ELED2 ELED3	O O O	Open Drain output pin. A LED indicator, When e-mail coming, the host can control this pin state by send SET REPORT(see HID-Class Request or Functional Descriptions) , and also can set ON / OFF time.

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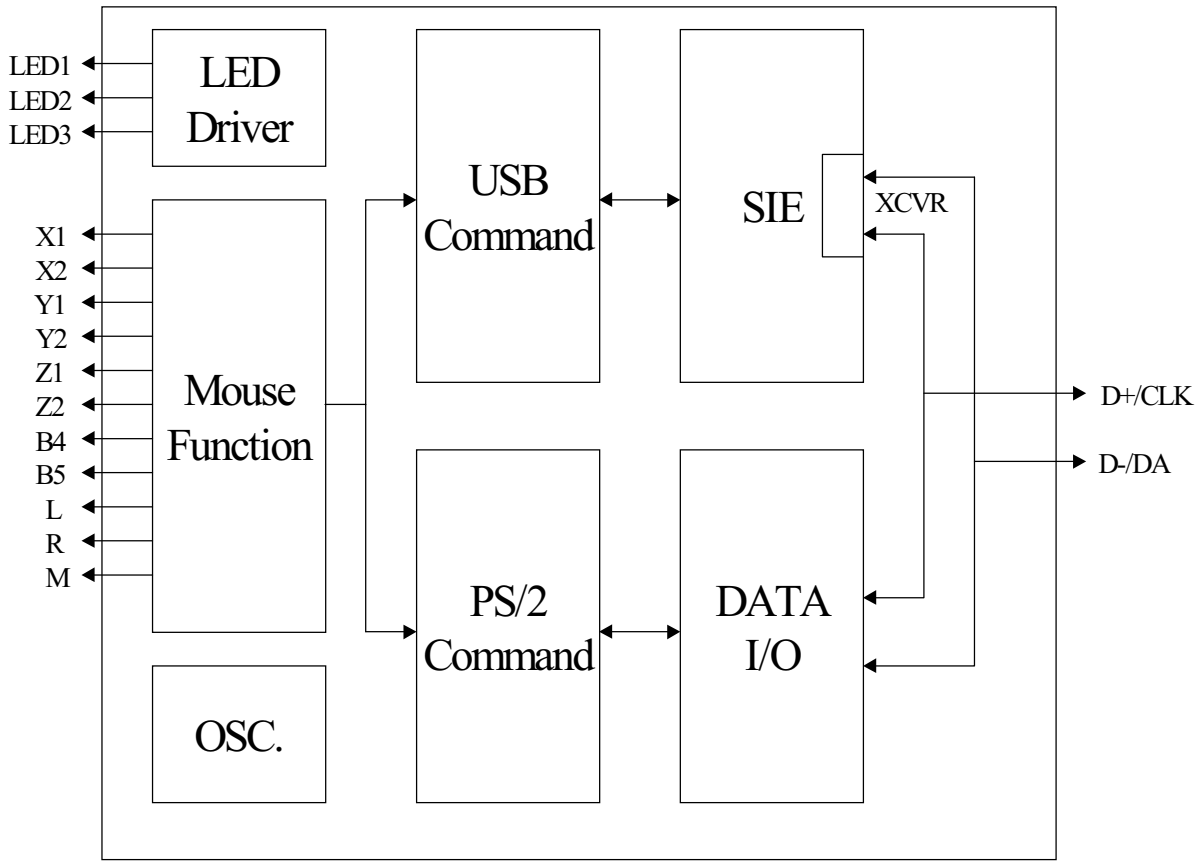
Functional Block Diagram



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Functional Descriptions

The TP88X5/X3 supports the USB Specification 1.1 data model. Data from the USB host to the device is transmitted serially. The data are NRZI coded to increase transmission reliability; bit stuffing (inserting an extra 0 bit after any 6 consecutive 1 bits) is performed and a CRC check carried out. Bit stuffing, NRZI coding/decoding and CRC checks or generation are performed within the TP88X5/X3.

The data is transmitted in packets. Three types of packets are defined for the USB: token, data and handshake. The token is always passed on by the host. It contains a PID (packet identifier) which defines the direction of the following data transmission and the address of the device and endpoints to be addressed. Depending on the previous token command, data is transferred from the USB host to the TP88X5/X3 (OUT transfer) or transferred from the TP88X5/X3 to the USB host (IN transfer). In the process the respective FIFOs are written (OUT) or read (IN).

The data transfer is concluded with a handshake. If the data has been received successfully, an ACK is sent to the data source. If no data is ready for an IN transfer out of the TP88X5/X3, it sends an NAK handshake instead of the data (If endpoint is enabled).

USB Engine

The USB engine includes the Serial Interface Engine (SIE) and the low-speed USB I/O transceiver. The SIE block performs most of the USB Interface functions. Two endpoints are supported. Endpoint 0 is used to receive and transmit control (including setup) packet while Endpoint 1 is only used to transmit data packets. The USB SIE processes USB bus activity at the transaction level independently. It does all the NRZI encoding/decoding and bit stuffing/unstuffing. It also determines token type, checks address and endpoint values, generates and checks CRC values and controls the flow of data byte between the bus and Endpoint FIFOs. The SIU handles higher level and function specific tasks. During control transfers the SIU must interpret device requests and respond correctly. It also must coordinate Suspend/Resume, verify and select DATA toggle value, and perform function specific tasks.

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Attached

A USB device may be attached or detached from the USB. The state of a USB device when it is detached from the USB is not defined by this specification. The specification only addresses required operations and attributions once the device is attached.

Powered

USB devices may obtain power from USB through the hub to which they are attached. A hub port must be powered in order to detect port status changes, including attach and detach. Hubs do not provide any downstream power until they are configured, at which point they will provide power as allowed by their configuration and power source.

Default

After the device has been powered, it must not respond to any bus transactions until it has received a reset from the bus. After receiving a reset, the device is then addressable at the default address.

Address assigned

All USB devices use the default address when initially powered or after the device has been reset. Each USB device is assigned a unique address by the host after attachment or after reset. A USB device maintains its assigned address while suspended. A USB device responds to requests on its default pipe whether the device is currently assigned a unique address or is using the default address.

Configured

Before the USB device's function may be used, the device must be configured. From the device's perspective, configuration involves writing a non-zero value to the device configuration register. Configuring a device or changing an alternate setting causes all of the status and configuration values associated with endpoints in the affected interfaces to be set to their default values. This includes setting the data toggle of any endpoint using data toggle to the value DATA0.

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Suspended

In Order to conserve power, USB devices automatically enter the suspended state when the devicehas observed no bus traffic for a specified period. When suspended, the USB device maintains any internal status including its address and configuration.

Bus Enumeration

When a USB device is attached to or removed from the USB, the host uses a process known as bus enumeration to identify and manage the device state changes necessary.

Dynamic Attachment and Removal

USB devices may be attached and removed at any time. The hub that provides the attachment point or port is responsible for reporting any change in the state of the port.

Address Assignment

When a USB device is attached, the host is responsible for assigning a unique address to the device after the device has been reset by the host and the hub port where the device is attached has been enabled.

Configuration

A USB device must be configured before its function may be used. The host is responsible for configuring a USB device. The host typically requests configuration information from the USB device to determine the device's capabilities.

Data Transfer

Data may be transferred between a USB device endpoint and the host in one of four ways. Some endpoints may be capable of different types of data transfer. However once configured, a USB device endpoint uses only one data transfer method.

Power Budgeting

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For bus-powered devices, power is limited resource. When a host detects the attachment of a bus-powered USB device, the host needs to evaluate the power requirements of the device. If USB

device power requirements exceed available power, the device is not configured.

Remote Wakeup

Remote wakeup allows a suspended USB device to signal a host that may be suspended. This notifies the host that it should resume from its suspended mode, if necessary, and service the external event that triggered the suspended USB device to signal the host.

USB Request

The TP88X5/X3 supports the following USB standard request : (ref to USB spec. for detailed description)

a. clear_feature :
   This request is used to clear endpoint_stall or disable device_remote_wakeup
b. get_configuration:
   This request returns the current device configuration. If the returned value is zero, the device is not configured.
c. get_descriptor :
   This request returns the specified descriptor if the descriptor exists.
d. get_status :
   This request returns status for the specified recipient.
e. set_address :
   This request sets the device address for all future device accesses.
f. set_configuration :
   This request sets the device configuration.
g. set_feature :
   This request is used to enable device_remote_wakeup feature.

HID-Class Request

The TP88X5/X3 supports the following HID class-specific requests : (ref to HID spec. for detailed description)

a. get_class_descriptor :
   This request returns a class descriptor for the device.

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b. get_report :

This request allows the host to receive a report via the control pipe.

c. get_idle :

This request reads the current idle rate for the input report.

d. get_protocol :

This request reads which protocol is currently active, either the boot protocol or the report protocol. This request is supported by devices in the boot subclass.

e. set_report :

This request allows the host to send a report to device, possibly setting the state of input, output, or feature controls.

f. set_idle :

This request silences a particular report on the interrupt pipe until new event or the specified amount of time passes. The default idle rate is infinity.

g. set_protocol :

This request switches between the boot protocol and the report protocol.

USB Descriptors

The TP88X5/X3 supports the following USB standard descriptors : (ref to USB spec. for detailed descriptor)

a. device descriptor :

A device descriptor describes general information about a USB device. It includes information that applies globally to device and all of the device's configurations. A USB device has only one device descriptor.

b. configuration descriptor :

The configuration descriptor describes information about a specific device configuration.

c. interface descriptor :

This descriptor describes a specific interface provided by associated configuration.

d. endpoint descriptor :

This descriptor contains the information required by the host to determine the bandwidth requirement of each endpoint.

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e. string descriptor :

String descriptors are optional. If a device does not support string descriptors, all references to string descriptors within device, configuration, and interface descriptors must be reset to zero.

HID Descriptors

The TP88X5/X3 supports the following HID class-specific descriptors : (ref to HID spec. for detailed description)

a. HID descriptor :
The HID descriptor identifies the length and type of subordinate descriptors for a device.

b. report descriptor :
The report descriptor is made up of item, which provide information about the device. The length and content of a report descriptor vary depending on the number of data fields required for the device's reports.

c. physical descriptor :
The physical descriptor is a data structure that provides information about the specific parts of the human body that are activating controls.

Mouse Report Format

	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Byte0	3 bit padding			5thbutton	4thbutton	Mbutton	Rbutton	Lbutton
Byte1	X displacement							
Byte2	Y displacement							
Byte3	Z displacement							

Host Request Report Format

	Bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Byte0	Select LED		X	Select LED flash cycle				ELED ON/OFF
Byte1	ON Time(Unit = 0.1Second)							
Byte2	OFF Time (Unit = 0.1Second)							

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Contents of descriptors

a. device descriptor

Offset	Field	size	value	Description
0	Blength	1	0x12	size of this descriptor in bytes
1	BdescriptorType	1	0x01	DEVICE descriptor type
2	BcdUSB	2	0x0110	USB specification release 1.10
4	BdeviceClass	1	0x00	class code
5	BdeviceSubClass	1	0x00	subclass code
6	BdeviceProtocol	1	0x00	protocol code
7	BmaxPacketSize0	1	0x08	Maximum packet size for endpoint zero
8	IdVendor	2	0x06A2	Topro vender ID
10	IdProduct	2	0x0001	product ID
12	BdcDevice	2	0x0100	device release number in bcd
14	IManufacturer	1	0x01	string index for iManufacturer
15	IProduct	1	0x02	string index for iProduct
16	ISerialNumber	1	0x00	no string index
17	BNumConfigurations	1	0x01	number of possible configuration

b. configuration

Offset	Field	size	Value	description
0	BLength	1	0x09	size of this descriptor in bytes
1	BDescriptorType	1	0x02	CONFIGURATION descriptor type
2	WTotalLength	2	0x0022	configuration+interface+endpoint+HID
4	BNumInterfaces	1	0x01	number of interface
5	BConfigurationValue	1	0x01	configuration argument
6	IConfiguration	1	0x04	string index for iConfiguration
7	BmAttributes	1	0xa0	bus powered + remote wakeup feature
8	MaxPower	1	0x32	max. power consumption in 2mA unit

c. interface descriptor

Offset	Field	size	Value	description
0	BLength	1	0x09	size of this descriptor in bytes
1	BDescriptorType	1	0x04	INTERFACE descriptor type
2	BInterfaceNumber	1	0x00	interface argument
3	BAlternateSetting	1	0x00	value used to select alternate setting
4	BNumEndpoint	1	0x01	number of endpoints(excluding ep0)
5	BInterfaceClass	1	0x03	HID class code

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6	BInterfaceSubClass	1	0x01	boot interface subclass code
7	BInterfaceProtocol	1	0x02	mouse protocol
8	IInterface	1	0x05	Interface string index

d. endpoint descriptor

Offset	Field	size	Value	description
0	Blength	1	0x07	size of this descriptor in bytes
1	BdescriptorType	1	0x05	ENDPOINT descriptor type
2	BendpointAddress	1	0x81	IN endpoint address
3	BmAttributes	1	0x03	interrupt pipe attribute
4	WmaxPacketSize	2	0x0008	maximum packet size
6	Binterval	1	0x0a	interval for polling EP for data transfer

e. HID descriptor

Offset	Field	size	Value	description
0	Blength	1	0x09	size of this descriptor in bytes
1	BdescriptorType	1	0x21	HID descriptor type
2	BcdHID	2	0x0100	HID class specification release number
4	BcountryCode	1	0x00	Hardware target country
5	BnumberDescriptors	1	0x01	number of HID class descriptors to follow
6	BdescriptorType	1	0x22	report descriptor type
7	WreportLength	2	0x0055	total length of report descriptor

f. report descriptor

Item	**Value(3D)**
Usage page (generic desktop)	05 01
Usage (mouse)	09 02
Collection (application)	a1 01
Usage (pointer)	09 01
Collection (Physical)	a1 00
Usage page (buttons)	05 09
Usage minimum (button 1)	19 01
Usage maximum (button 5)	29 05
Logical minimum (0)	15 00
Logical maximum (1)	25 01
Report count (5)	95 05

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Report size (1)	75 01
Input(data, variable, absolute)	81 02
Report count (1)	95 01
Report size (3)	75 03
Input (constant)	81 03
Usage page (generic desktop)	05 01
Usage (x)	09 30
Usage (y)	09 31
Usage (wheel)	09 38
Logical minimum (-127)	15 81
Logical maximum (127)	25 7f
Report size(8)	75 08
Report count (3)	95 03
Input (data, variable, relative)	81 06
End collection	c0
Usage page(LEDs)	05,08
Usage (Usage Selected Indicator)	09,3a
Collection (Logical)	a1, 02
Usage (Num Lock)	09,01
Logical Minimum(0)	15,00
Logical Maximum(1)	25,01
Reprot count (1)	95,01
Report size (1)	75,01
Output (Data,Var,Abs)	91,02
End collection	C0
Report count (1)	95,01
Report size (7)	75,07
Output (Cnst,Ary,Abs)	91,01
Usage (Flash On Time)	09,42
Report count (2)	95,02
Report size (8)	75,08
Output (Data,Var,Abs)	91,02
End collection	C0

g. string descriptor

Offset	Field	size	Value	Description
0	Blength	1	0x04	size of this descriptor in bytes
1	BdescriptorType	1	0x03	String descriptor type

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2	Bstring	2	0x0409	LangID code for English

String index 1 for manufacturer

Offset	Field	size	Value	Description
0	Blength	1	0x0c	size of this string in bytes
1	BdescriptorType	1	0x03	String descriptor type
2	Bstring		“TOPRO “	

String index 2 for product

Offset	Field	Size	Value	Description
0	Blength	1	0x14	size of this string in bytes
1	BdescriptorType	1	0x03	String descriptor type
2	Bstring		“USB Mouse”	

String index 4 for configuration

Offset	Field	size	Value	Description
0	Blength	1	0x14	size of this string in bytes
1	BdescriptorType	1	0x03	String descriptor type
2	Bstring		“HID Mouse”	

String index 5 for interface

Offset	Field	Size	Value	Description
0	Blength	1	0x1e	Size of this string in bytes
1	BdescriptorType	1	0x03	String descriptor type
2	Bstring		“Interrupt Pipe”	

PS/2 Functional Descriptions

(A) Operating mode

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There are four operating modes in PS/2 mouse :

a. Reset Mode :

In this mode a self-test is initiated during power-on or by a Reset command. After reset signal, PS/2 mouse will send:

(a) Completion code AA & ID code 00.

(b) Set default:

sampling rate: 100 reports/s

non-autospeed

stream mode

4 counts/mm

disable

b. Stream Mode:

The maximum rate of transfer is the programmed sampling rate.

Data report is transmitted if

(a) switch is pressed

(b) movement has been detected

c. Remote Mode:

Data is transmitted only in response to a Read Data command.

d. Wrap Mode:

Any byte of data sent by the system, except hex EC (Reset wrap mode) or hex FF (Reset), is returned by TP88X5/X3.

(B) PS/2 Mouse Data Report:

a. In stream mode: A data report is sent at the end of a sample interval.

b. In remote mode: A data report is sent in response to Read Data command.

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c. Data report format:

Byte	Bit	Description
1	0	Left button status; 1 = pressed
	1	Right button status; 1 = pressed
	2	Middle button status; 1 = pressed
	3	Reserved
	4	X data sign; 1 = negative
	5	Y data sign; 1 = negative
	6	X data overflow; 1 = overflow
	7	Y data overflow; 1 = overflow
2	0-7	X data (D0 - D7)
3	0-7	Y data (D0 - D7)
4	0-7	Z data :
		D0 – D6,sign bit (3D mode)
		D0 – D3,4^{th-},5th button (5-button 3D mode)

(C) PS/2 mouse Data Transmission:

a. TP88X5/X3 generates the clocking signal when sending data to and receiving data from the system.

b. The system requests TP88X5/X3 to receive system data output by forcing the DATA line to an inactive level then allowing CLK line to go to an active level.

c. Data transmission frame:

Bit	Function
1	Start bit (always 0)
2-9	Data bits (D0 - D7)
10	Parity bit (odd parity)
11	Stop bit (always 1)

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d. Data Output (data from TP88X5/X3 to system):

If CLK keep low (inhibit status), data will not transmit.
If CLK raised to high and DATA is low(request-to-send),data is updated.
After receiving data from system, TP88X5/X3 will not start transmitting until CLK and DATA are both high.

If CLK and DATA are both high, the transmission is ready.
DATA is valid prior to the falling edge of CLK and beyond the rising edge of CLK. During transmission, TP88X5/X3 check for line contention by checking for an inactive level on CLK lasting for no more than 100m sec.

Contention occurs when the system lowers CLK to inhibit TP88X5/X3 output after TP88X5/X3 has started a transmission. If this occurs before the rising edge of the tenth clock, TP88X5/X3 internal store its data in its buffer and returns DATA and CLK to an active level. If the contention does not occur by the tenth clock, the transmission is completed.

Following a transmission, the system inhibits TP88X5/X3 by holding CLK low until it can service the input or until the system receives a request to send a response from TP88X5/X3.

e. Data Input (from system to TP88X5/X3):

System first check if TP88X5/X3 is transmitting data. If TP88X5/X3 is transmitting, the system can override the output by forcing CLK to an inactive level prior to the tenth clock. If the transmission of TP88X5/X3 beyond the tenth clock ,the system must receive the data.

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If TP88X5/X3 is not transmitting or if the system choose to override the output, the

system force CLK to an inactive level for a period of not less than 100u sec while preparing for output. When the system is ready to output start bit (0), it allows CLK to go to active level.

If request-to-send is detected, TP88X5/X3 clocks in 11 bits. Following the tenth clock, TP88X5/X3 checks for an active level on the DATA line, and if found, force DATA low, and clock once more.

If framing error occurs, TP88X5/X3 continue to clock until DATA is high, then clocks the line control bit and request a Re-send.

When the system sends out a command or a data that requires a response, the system must wait for TP88X5/X3 to response before sending its next output.

(D) PS/2 Mouse Error Handling:

a. A Re-send command (FE) following receipt of an invalid input or any input with incorrect polarity.

b. If two invalid input are received in succession, an error code of hex FC will be sent to the system.

c. The counter accumulators are cleared after receiving any command except “Re-send”.

d. As TP88X5/X3 receives a Re-send command (FE), it transmits its last packet of data.

e. In the stream mode ”Re-send” is received by TP88X5/X3 following a 4-byte data packet transmission to the system. TP88X5/X3 re-send the 4-byte data packet prior to clearing the counter.

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f. A response is sent within 25 ms if

(a) The system requires a response

(b) An error is detected during transmission

g. When a command requiring a response is issued by the system, another command should not be issued until either the response is received or 25ms has passed.

(E) PS/2 Mouse Commands Description:

There are 16 valid commands that transmit between the system and TP88X5/X3. The "EA" code is always the first response to any valid input received from the system other than a Set Wrap Mode or Re-send command.

The following table lists the commands:

Hex Code	Command	TP88X5/X3 echo code
FF	Reset	FA,AA,00
FE	Re-send	XX,(XX,XX)
F6	Set Default	FA
F5	Disable	FA
F4	Enable	FA
F3,XX	Set Sampling	Rate FA,FA
F2	Read Device Type	FA,00(2D mode)/03(3D mode)/04(5-button 3D mode)
F0	Set Remote Mode	FA
EE	Set Wrap Mode	FA
EC	Reset Wrap Mode	FA
EB	Read Data	FA,XX,XX,XX,XX(3 XX in 2D mode)
EA	Set Stream Mode	FA
E9	Status Request	FA,XX,XX,XX,XX(3 XX in 2D mode)
E8,XX	Set Resolution	FA,FA
E7	Set Autospeed	FA
E6	Reset Autospeed	FA

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The continuance command sequence below will activate 3-button 3D mode.

F3,XX
F3,XX
F3,XX

The continuance command sequence below will activate 5-button 3D mode.

F3,C8
F3,64
F3,50
F3,C8
F3,C8
F3,50

The following describes valid commands:

a. Reset (FF)

TP88X5/X3 operation:

(a) Complete the reset.
(b) Transmit FA,AA,00 to the system.
(c) Set default:
sampling rate: 100 reports/s
non-autospeed
stream mode
4 counts/mm
disable

b. Re-send (FE)

(a) Any time TP88X5/X3 receives an invalid command, it returns a Re-send command to the system.

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(b) When TP88X5/X3 receives a Re-send command, it retransmits its last output. If the

last
packet was a Re-send command, it transmits the packet just prior to the Re-send command.

(c) In stream mode, if a Re-send command is received by TP88X5/X3 immediately following
a 4-byte data packet transmission to the system, TP88X5/X3 will re-send the 4-byte data
packet prior to cleaning the count accumulators.

c. Set Default (F6)
The command reinitializes all conditions to the power-on defaults.

d. Disable (F5)
This command is used in the stream mode to disable transmissions from TP88X5/X3.

e. Enable (F4)
Enable transmissions, if in stream mode.

f. Set Sampling Rate (F3,XX)
In the stream mode, this command sets the sampling rate to the value indicated by byte hex XX, shown as follows:

Second byte XX	Sample Rate
0A	10/sec
14	20/sec
28	40/sec
3C	60/sec
50	80/sec
64	100/sec
C8	200/sec

g. Read Device Type (F2)
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TP88X5/X3 always echoes " FA,00 " in 2D mode, "FA 03" in 3D mode. "FA,04" in 5-

button 3D mode.

h. Set Remote Mode (F0)

Data value are reported only in response to a Read Data command.

i. Set Wrap Mode (EE)

Wrap mode remains until Reset (FF) or Reset Wrap Mode(EC) is received.

j. Reset Wrap Mode (EC)

TP88X5/X3 returns to the previous mode of operation after receiving this command.

k. Read Data (EB)

This command is executed in either remote or stream mode. The data is transmitted even if there has been no movement or the button status is unchanged since the last report. Following a Read Data command, the registers are cleared after a data transmission.

l. Set Stream Mode (EA)

This command sets TP88X5/X3 in stream mode.

m. Status Request (E9)

When this command is issued by the system, TP88X5/X3 responds with a 3-byte status report as follows:

Byte	Bit	Description
1	0	1 = Right button pressed
	1	1 = Middle button pressed
	2	1 = Left button pressed
	3	Reserved
	4	0 = Normal speed, 1 = Autospeed
	5	0 = Disabled, 1 = Enabled

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	6	0 = Stream mode, 1 = Remote mode
	7	Reserved
2	0-7	Current resolution setting (D0 - D7)
3	0-7	Current sampling rate (D0 - D7)

n. Set Resolution (E8,XX)

TP88X5/X3 provides four resolutions selected by the second byte of this command as follows:

Second Byte XX	Resolution
00	1 counts/mm
01	2 counts/mm
02	4 counts/mm
03	8 counts/mm
> 4 & <64	Set Eled or Buzzer on time counter
< 125 & > 64	Set Eled or Buzzer off time counter
7C	Select buzzer high byte
7D	Select buzzer low byte
7E	Select Eled1
7F	Select Eled2

o. Set Autospeed (E7)

At the end of a sample interval in the stream mode, the current X and Y data values are converted new values. The sign bits are not involved in this conversion. The conversion is only in stream mode. The relationship between the input and output count is as follows:

Input	Output
0	0
1	1
2	1
3	3

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4	6
5	9
N(>=6)	2.0*N

p. Reset Autospeed (E6)

This command restore normal speed.

(G) BUZZER and ELED function:

There are three special function support difference application and can control On/off independently by command F1/EF,select and set on/off time by option byte of command E8.All legal command and option TP88X5 will answer “FA”.

Testing Mode Descriptions

Whenever “Test” pin is connected to logic 1, the chip will enter buyer's testing mode.
If RC = “0” (i.e. connect to GND)：The X direction output signals of comparators will present to “L” and “M” pin. Pressing "R" key can toggle the output from X direction to Y direction.
If RC = “1”(i.e. connect to VDD)：The TP88X5/X3 will enter engineer testing mode.

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Absolute Maximum Ratings

Parameter	Symbol	min	Max	unit
Temperature under bias	Top	0	50	℃
Storage temperature	Tst	-65	150	℃
Power dissipation	Pdis	---	500	mW
Supply voltage	Vcc	4.5	5.25	volt

DC Characteristics

Parameter	Symbol	Test condition	min	max	unit
Supply voltage	Vdd		4.4	5.25	V
Operating current	Iop			20	mA
USB characteristics: (Note)					
USB mode Suspended current	Isu			480	uA
D+,D- Hi-Z state data line leakage	Ilo	0v<Vin<3.3v	-10	10	uA
D+,D- Differential input sensitivity	Vdi	|(D+)-(D-)|	0.3		V
D+,D- Differential common mode rang	Vcm		0.8	2.0	V
D+,D- Single ended receiver threshold	Vse		0.8	2.0	V
D+,D- Static data line output low	Vol	RL of 1.5k to 3.6v		0.3	V
D+,D- Static data line output high	Voh	RL of 15k to Gnd	2.8	3.6	V
USB Transceiver capacitance	Cin	pin to Gnd		20	pF
PS/2 characteristics:					
CLK,DATA positive-going threshold Voltage	Vt+		3.2	3.8	V
CLK,DATA negative-going threshold Voltage	Vt-		1.2	1.9	V
DATA, CLK input current	Idc	pull up resistor Vin=0V	-0.6	1.8	mA
DATA, CLK low output voltage	Vprl	Iprl=4mA		0.4	V
Other characteristics:					
X1,X2,Y1,Y2,Z1,Z2 input reference Voltage (comparator mode)	Virh		1.5		V
X1,X2,Y1,Y2,Z1,Z2 input linkage Current	Iil	Vin = 0v	0	3	uA
L,M,R,4th ,5th input(pull-down) current	Imi	Vin=5v	18.6	56	uA

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L,M,R,4th ,5th input high voltage	Vih	Vdd=5v	3.5		V
L,M,R,4th ,5th input low voltage	Vil	Vdd=5v		1.5	V
Xtalin, L,M,R,4th ,5th input low Leakag Current	Iil	Vin=0v,Vdd=5v	0	2.5	uA
Xtalin input leakage current	Iih	Vin=5v,Vdd=5v	-2.5		uA

Note 1: All voltage measured from the local ground potential, unless otherwise specified.

Note 2: All timings use a capacitive load (CL) to ground of 50 pF, unless otherwise specified.

Note 3: Excludes external resistor. In order to comply with USB Specifications 1.0, external series resistors of 24Ω± 1% each on D+ and D- are recommended.

Note 4: Semi auto-reference circuit are used at X/Y/Z input to detect photo-coupled voltage and generate digital pulses for caculating the movement of mouse.

AC Characteristics

Parameter	Symbol	conditions	Min.	Typ.	Max.	unit
USB D+, D- Driver characteristics:						
Rise time	Tdr	Cl=50pf	75		-	ns
		Cl=300pf	-		300	ns
Fall time	Tdf	Cl=50pf	75		-	ns
		Cl=300pf	-		300	ns
Rise/fall time matching	Trfm	Tr/Tf	80		120	%
Output signal crossover voltage	Vcrs		1.3		2.0	v
USB D+, D- Data source timings:						
Low speed data rate	Tdrate		1.477		1.5225	Mbs
Source differential driver jitter						
To next transition	Tudj1	ref Fig 1	-95		95	ns
For paired transitions	Tudj2		-150		150	ns
Source EOP width	Teopt	ref Fig 2	1.25		1.50	us
Differential to EOP transition skew		ref Fig 2	-40		100	ns
Receiver data jitter tolerance						
To next transition	Tdjr1	ref Fig 3	-75		75	ns
For paired transitions	Tdjr2		-45		45	ns
EOP width at receiver			1.25		1.5	us

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Must reject as EOP Must accept						
Mouse timings:						
Rising Edge Crossed Width	Tmr		15			us
Falling Edge Crossed Width	Tmf		15			us
Mouse key debounce time	Tkd			12		ms
PS/2 CLK, DATA timings:						
Mouse CLK active time	Tmca			44.8		us
Mouse CLK inactive time	Tmci			44.8		us
System CLK active time	Tsca			44.8		us
System CLK inactive time	Tsci			44.8		us
Time that mouse sample DATA from CLK rising edge	Tmdc			14.9		us
Time from DATA transition to Falling Edge of CLK	Tsdc			14.9		us
Time from rising edge of CLK to DATA Transition	Tscd			28.6		us
Time to mouse inhibit after the 11th CLK to ensure mouse does not start another Transmission	Tpi		0		50	us
Oscillator timings:						
Oscillating frequency	Fosc		6-2%	6	6+2%	MHz

Note 1: All voltage measured from the local ground potential, unless otherwise specified.

Note 2: All timings use a capacitive load (CL) to ground of 50 pF, unless otherwise specified.

Note 3: Low Speed USB timings have a 1.5kΩ pull-up to 2.8V on the D- data line.

Note 4: The PS/2 AC timings are measured with 6 MHz system clock signal.

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Timing Waveforms

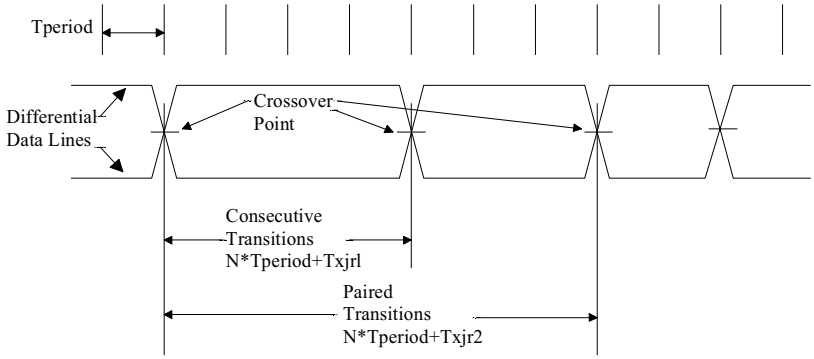

Figure 1 Differential Data Jitter

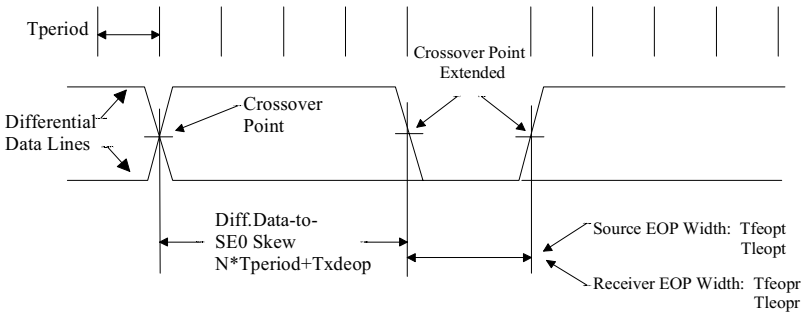

Figure 2 Differential to EOP Transition Skew and EOP Width

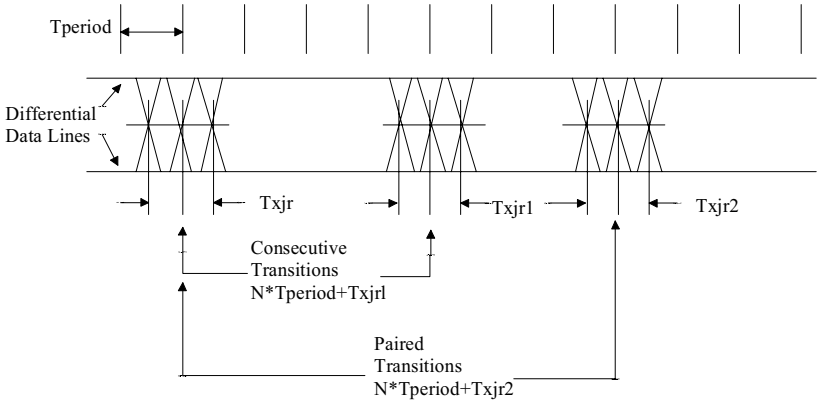

Figure 3 Receiver Jitter Tolerance

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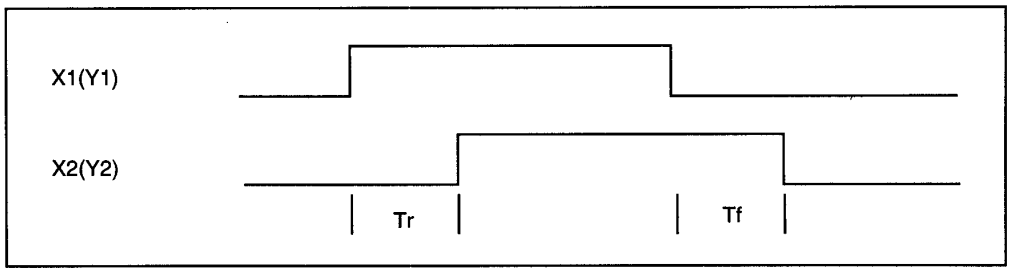
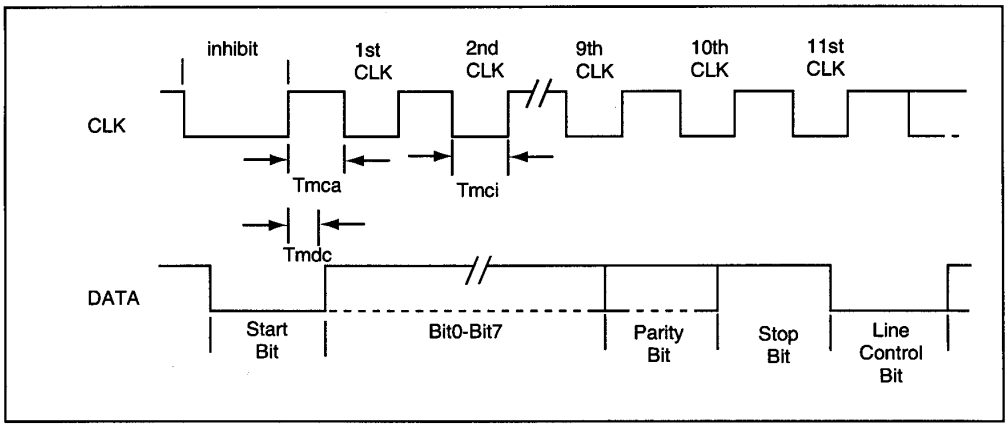
Timing Diagram

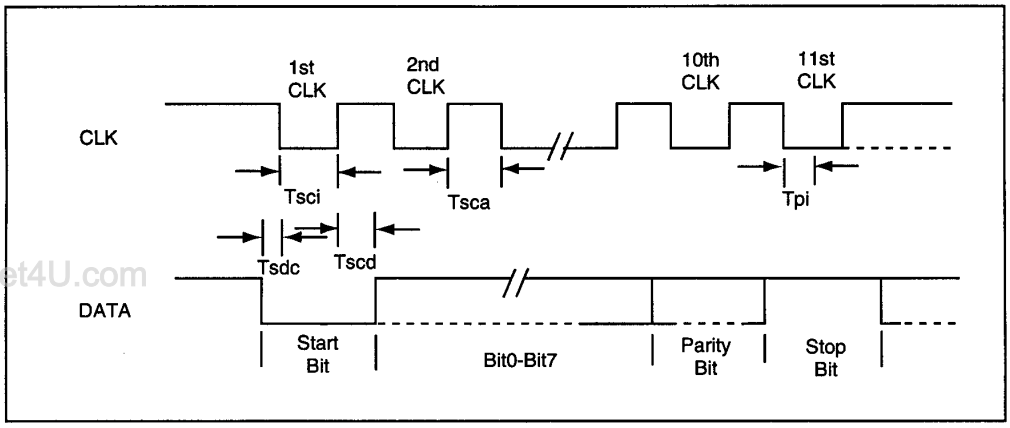
(A) Photo-couples pulse width



(B) Receiving Data



(C) Sending Data



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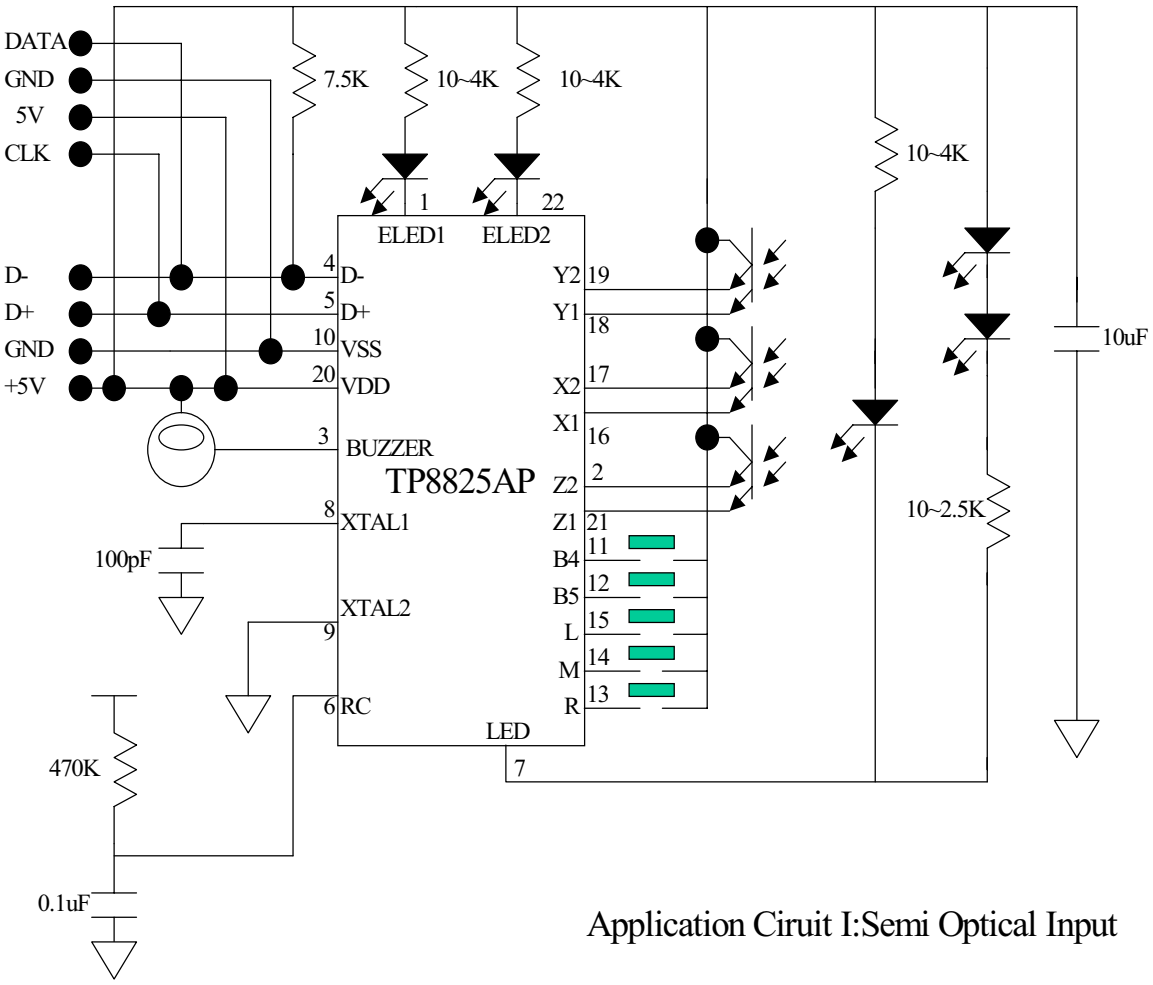
I. Typical Application Circuit



Application Ciruit I:Semi Optical Input

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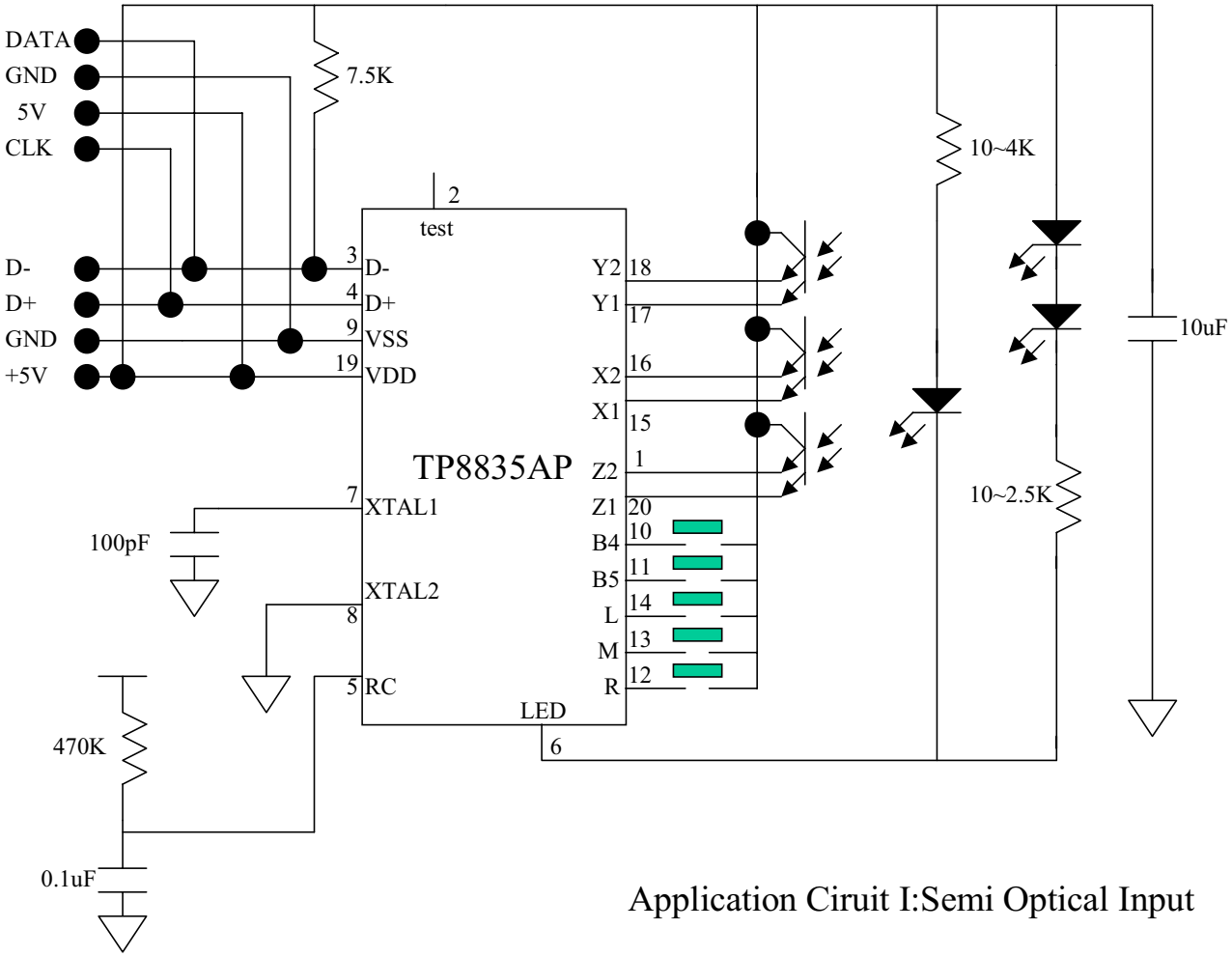
TP8833-35-15-25

USB+PS/2 3D 3/5Key Mouse Controller



Application Ciruit I:Semi Optical Input

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