TriTech Microelectronics

TR88L811

Touch Pad Mouse Controller

Features

- Selectable pen input or pen mouse modes
- 10-bit A/D for high resolution
- Microsoft Mouse compatible mode
- Absolute coordinates in Pen mode
- Supports object selection through 2 Buttons
- Supports object selection through Pen Tap
- Pin selectable Auto Cursor Motion in Mouse mode
- Pen detection circuitry with auto Power Save
- 3.3V operation, Low Power

Applications

- Personal digital assistants
- Touch screens
- Mouse replacement for computers
- Electronic organizers/terminals
- Feature phones
- Digitizer tablets

General Description

The dual mode TR88L811 contains all the circuitry required to easily interface low-cost resistive digitizers to applications and provide pen and mouse capability. It supports the Microsoft Mouse protocol at 1200 bits per second when in Pen Mouse mode and provides absolute co-ordinate data at 19.2 Kbits per second in Pen mode over the same serial interface. The TR88L811 is fully self-contained and requires no user programming or use of any driver software for mouse function. Mode selection is controlled by the MS_SEL pin.

TR88L811 supports both standard button selection and pen tap selection of objects in Pen Mouse mode. The TR88L811 interprets the user's pen click, move, point and drag actions, translates these information into the Microsoft Mouse format and sends these out to the host computer via the serial pin. Its low power consumption makes the TR88L811 suitable for use with hand-held or battery-operated devices.

BLOCK DIAGRAM

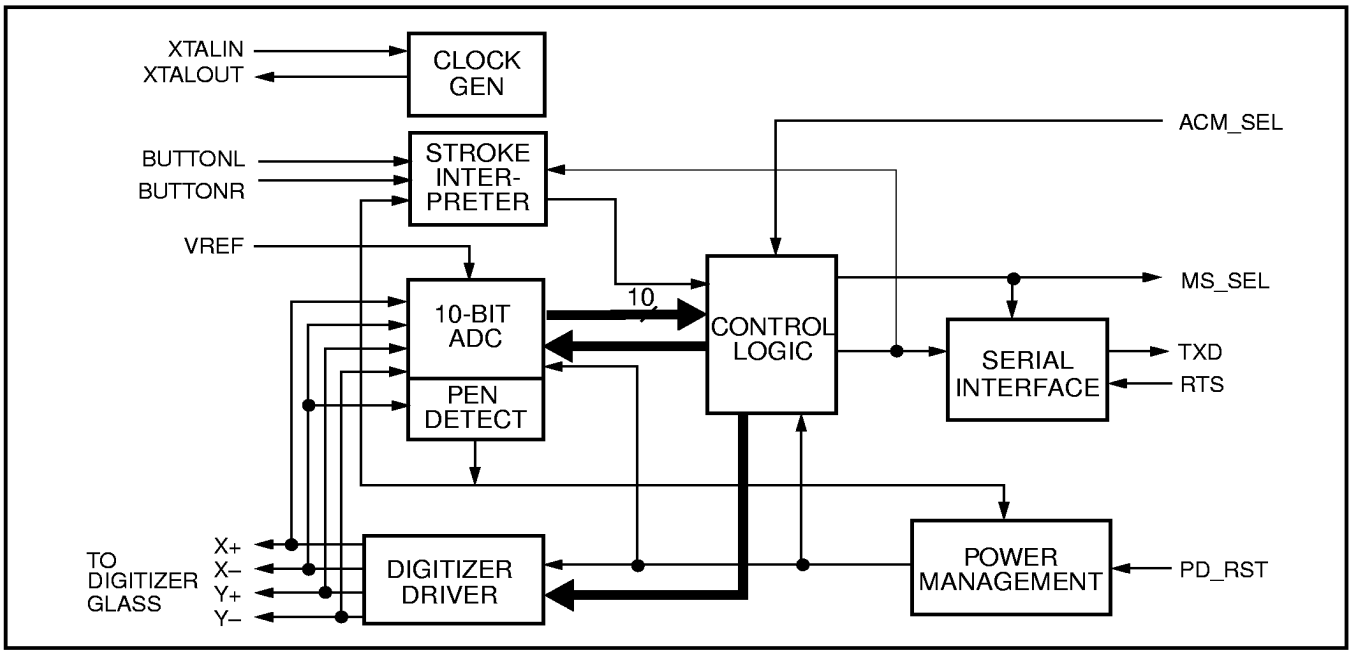
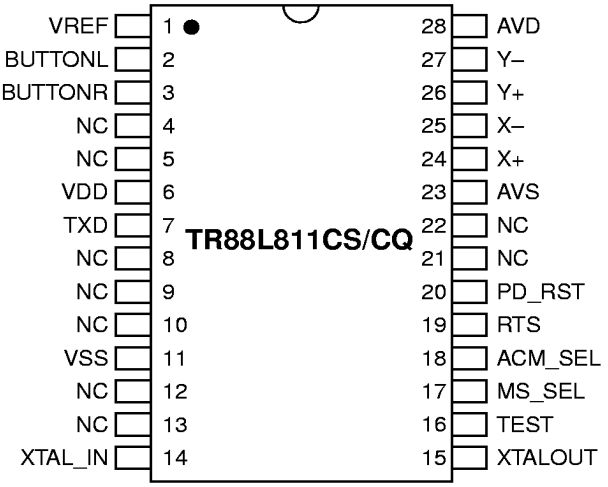


Figure 1 • *TR88L811 Block Diagram*

Pin Configuration



28-pin SOW/TSSOP

Package Top View

Pin Descriptions

TR88L811CS/CQ

TSSOP/ SOW Pin	Pin Name	I/O	Description
1	VREF	Analog Input	Smoothing point for internal 1.65V reference. Connect a 1μF ceramic capacitor between this pin and analog ground pin (AVS).
2	BUTTONL	CMOS Input	Mouse Left Button. Connect to logic **0** to activate. Internal switch debounce circuitry. Used only in Microsoft Mouse mode.
3	BUTTONR	CMOS Input	Mouse Right Button. Connect to logic **0** to activate. Internal switch debounce circuitry. Used only in Microsoft Mouse mode.
6	VDD	Power	Digital Positive Supply. Nominally 3.3V
7	TXD	TTL Output	Serial data out. Pen Input Mode: With a 1.8432 MHz input clock, data is 19.2 kbps NRZ format (1 start bit; 8 data bits; 1 stop bit). Pen Mouse Mode: Data is in Microsoft Mouse format at 1200 baud.
11	VSS	Power	Digital Ground.
14	XTALIN	CMOS Input	Crystal oscillator input pin. Normally connected to 1.8432MHz Crystal. Can also be driven by a CMOS input clock.
15	XTALOUT	CMOS Output	Used when connected to crystal as shown in Figure 8. Should be left floating if clock input is applied at XTALIN.
16	TEST	CMOS Input	Connect to logic **0** for normal operation
17	MS_SEL	TTL Schmitt Input	Pen Mouse mode select. Logic **1** selects Pen Mouse mode (Microsoft Mouse data format). Logic **0** selects Pen Input mode (absolute coordinate data).
18	ACM_SEL	TTL Schmitt Input	Auto Cursor Motion Select. Logic **1** sets ACM ON for both Move and Drag actions. Logic **0** sets ACM OFF for both Move and Drag actions. Always keep this pin at logic **0** when in Pen Input mode.

Pin Descriptions

TR88L811CS/CQ (continued)

TSSOP/ SOW Pin	Pin Name	I/O	Description
19	RTS	TTL Schmitt Input	System Request-to-Send. When in the Pen Mouse mode (MS_SEL at Logic **1**), the TR88L811 will send out 0x4D via the TXD pin on receipt of the RTS signal (rising edge of RTS) from the host computer. TR88L811 ignores RTS when in Pen Input mode (MS_SEL at Logic **0**).
20	PD_RST	TTL Schmitt Input	Active-Hi Power down/ Reset input. Assert logic **1** for ≥ 10ns to reset. Hold at Logic **1** for power-down mode.
23	AVS	Power	Analog Ground.
24	X+	Analog I/O	Resistive tablet X-plane driver. Connect across X-plane of resistive tablet.
25	X–	Analog I/O	Resistive tablet X-plane driver. Connect across X-plane of resistive tablet.
26	Y+	Analog I/O	Resistive tablet Y-plane driver. Connect across Y-plane of resistive tablet.
27	Y–	Analog I/O	Resistive tablet Y-plane driver. Connect across Y-plane of resistive tablet.
28	AVD	Power	Analog Positive Supply. May be connected to digital positive supply (VDD) via a ferrite bead or an inductor.
4, 5, 8–10, 12, 13, 21, 22	NC	—	No Connect

Background Information

Digitizer Technologies

Pen-input appliances usually employ some form of digitizer tablet as a designated writing surface for capturing the position of the pen. In desktop digitizer tablets, the captured pen position is fed via a serial link to the host computer where it is displayed as “ink” on the computer monitor.

Resistive Digitizers

A resistive digitizer is made up of a multi-layer sandwich of resistive films and protective coatings. Figure 2 shows a simplified blown-up picture of a typical resistive digitizer and its connections in a serial pen-input or touchpad mouse appliance.

The resistive digitizer works by direct contact of the pen flexing a pair of resistive films, hence any blunt pointing instrument or finger may be used as the “pen”. A protective hard coating is often added at the top of the resistive tablet to ensure durability of the resistive films and to prevent subsequent digitizing errors arising from the non-uniform wear and tear of an unprotected resistive film surface.

The simplicity of a resistive digitizer design and the use of a passive pen makes it an energy-efficient, lightweight and cost-effective solution to meet the needs of most pen-input appliances.

Digitizer Resolution

The resolution of a digitizer is typically measured in dots per inch (dpi) and is a function of the physical size of the digitizer tablet and the resolution of the ADC used in the conversion circuitry.

For example a 10-bit ADC is capable of resolving 2^{10} (or 1024) levels. When used in a 5 inch by 8 inch digitizer system, this results in a digitizer resolution of 128 dpi. When used in a smaller 3 inch by 5 inch system, the theoretical resolution becomes 204 dpi.

The effective digitizer resolution will be affected by things like the choice of digitizer technology, the choice of pen architecture (particularly the shape of the tip) and also by system noise.

In the case of resistive digitizers, the direct-contact nature of its operation and the pen thickness often imposes an upper limit on the effective system resolution that may be achieved, regardless of the resolution of the ADC itself.

Coordinate Data Report Rate

The coordinate data report rate is quantified in coordinate pairs per second (cpps) and refers to how many (x,y) coordinate positions of the pen were obtained from the tablet, digitzed, and reported to the CPU every second. A higher coor-

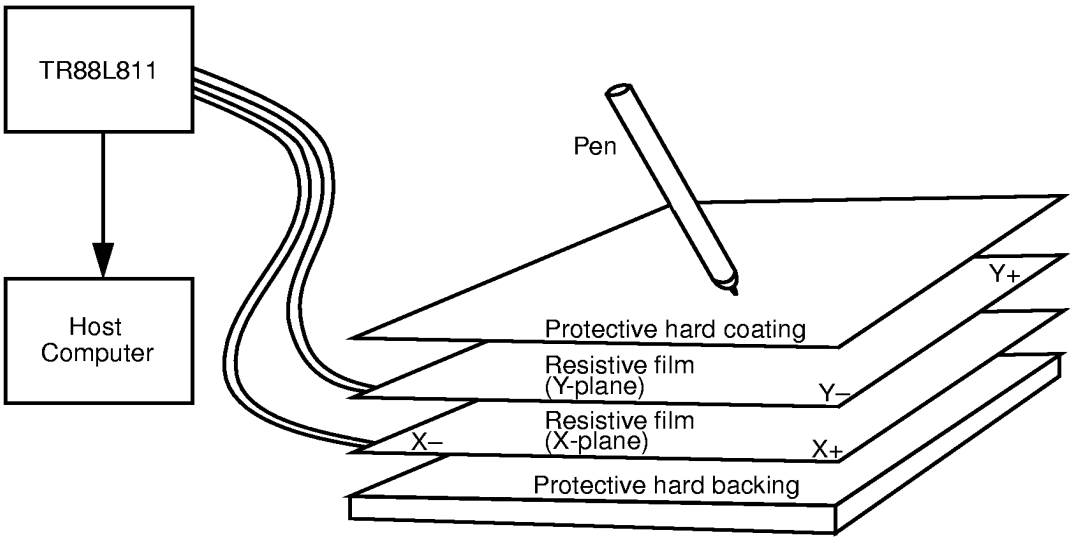


***Figure 2** • Typical Resistive Tablet/Digitizer*

dinate rate enables closer tracking of the pen movement over the digitzer tablet surface and prevents distortion of quick doodles or missed pen strokes in the entry of complex characters (e.g. Chinese or Japanese script).

Functional Description

The TR88L811 when used in a serial pen-input or touchpad appliance interfaces to a resistive digitizer and the host computer.

Resistive Digitizer Interface

The device interface to a typical resistive digitizer consists of four bi-directional (input/output) pins. These four pins (X+, X–, Y+, Y–) are connected across the X-plane resistive film and Y-plane resistive film of the digitizer respectively. On-chip buffers provide the necessary current drive to the resistive digitizer via these same four pins.

When a pen (or finger) is in contact with the digitizer tablet, the pressure forces the X-plane and Y-plane resistive films to come into contact at the exact position where the pen is located (see Figure 3).

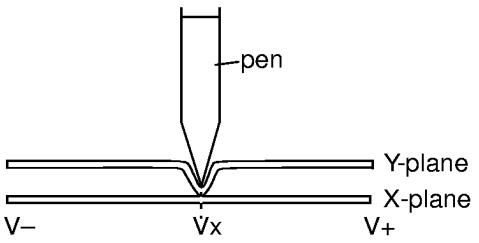


***Figure 3** • Locating the Pen Position*

To get the x-coordinate position, the TR88L811 will apply current drive to the X-plane resistive film (via X+, X–) and sense the voltages picked up by the Y-plane resistive film (via Y–). The current drive to the X-plane sets up a voltage gradient (V+, V–) across the resistive film. At the point of pen contact, the voltage at that point along the X-plane voltage gradient may be some value Vx, where $V- \leq Vx \leq V+$. Through direct contact, the Y-plane resistive film picks up the voltage Vx at the point of contact with the X-plane resistive film. This voltage is sensed by the TR88L811 and used to calculate the X-coordinate of the pen position.

Next, to get the y-coordinate position, the TR88L811 will apply the current drive at the Y-plane resistive film and sense the voltage picked up by the X-plane resistive film.

Pen Detection

On-chip circuitry detects if the pen is in contact with the digitizer tablet. If no pen is detected, no coordinate data will be made available.

Power Management

The TR88L811 is designed in advanced sub-micron CMOS process and consumes minimal power under normal operation. To further conserve power, a power save mode is built into the TR88L811. When the TR88L811 senses that the pen/ finger is out of contact with the resitive digitizer for more than three seconds, it automatically enters the power save mode. In this power save mode, the TR88L811 is powered down and will power up only under any of the following events: 1)

when the pen next comes back into contact with the resistive digitizer; 2) either button is activated or 3) if the host computer sends an RTS signal to the mouse.

This automatic power save feature is built into both the pen input mode (MS_SEL at Logic **0**) and the pen mouse (MS_SEL at Logic **1**) modes.

Coordinate Calculation

The voltages picked up by the digitizer interface are first passed to a 10-bit Analog-to-Digital Converter (ADC) where they are digitized before further processing. The conversion speed of the ADC permits a data rate of 200 coordinate pairs per second at a crystal frequency (Fclk) of 1.8432 MHz. The Control Logic block calculates the (x,y) coordinate location of the pen and formats the data for output via the serial (TXD) interfaces. The x-coordinate and y-coordinate information are each 10-bits wide.

Serial Interface: TR88L811

With the TR88L811 device, serial data is available at the TXD pin. With an input clock of 1.8432 MHz, the serial baud rate is 19200 bits per second. Table 1 shows the serial interface data format.

Table 1 • Serial Interface Data Format, Pen Input Mode

Parameter	Description
Data Output Voltage Levels	TTL
Serial output	1 start bit, 8 data bits, 1 stop bit, Non-return-to-zero (NRZ); No parity
Normal Frame[1] (5 bytes)	byte 1 = 0xFF byte 2 = Low byte of X byte 3 = High byte of X byte 4 = Low byte of Y byte 5 = High byte of Y
Pen off frame[2] (3 bytes)	byte 1 = 0xFF byte 2 = 0xFE byte 3 = 0xFE
Stream Format	Normal Frame Normal Frame . . . Normal Frame Pen-Off Frame
Transmission Rate	200 frames/sec at 19200 bps

Notes

1. *Normal frames sent when pen is detected on Digitizer. Refer to Figure 4 for bit pattern of these bytes.*
2. *TxD line goes idle after a Pen Off frame.*

	MSB							LSB
High byte	D9	D8	D7	D6	D5	D4	D3	D2
Low byte	D1	D0	0	0	0	0	0	0

***Figure 4** • Bit pattern of transmitted bytes*

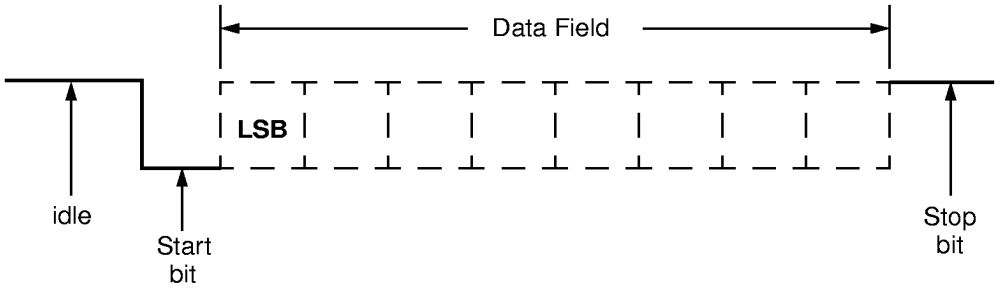


***Figure 5** • Serial data format, Pen Input Mode*

Pen Mouse Operations

Mouse Interface

In the Pen Mouse mode (MS_SEL at Logic **1**), the TR88L811 interfaces with the host computer via pins RTS and TXD. Upon receipt of a signal (logic **1**) on the RTS pin from the host computer, the TR88L811 responds with a hex "4D" output on the TXD pin. In Mouse mode, the distance moved by the pen mouse (or finger) and the button status are sent to the host via the TXD pin. The data is in the Microsoft Mouse format as shown in Table 2. The ACM_SEL pin is used to enable/ disableAuto cursor motion.

Table 2 • Microsoft Mouse Data Format (Pen Mouse mode—Relative Data)

Parameter	Description
Data Output Voltage Levels	CMOS (VSS to VDD)
Data Format	7 data bits, No parity
Word Format	1 start bit 7 data bits 2 stop bits
Packet Format (3 words)	1 L R y7 y6 x7 x6 0 x5 x4 x3 x2 x1 x0 0 y5 y4 y3 y2 y1 y0
Transmission Rate	1200 bps

Notes

1. *"L" is Left button status; "R" is Right button status*
2. *y7 is MSB of vertical counter; y0 is LSB*
3. *x7 is MSB of horizontal counter; x0 is LSB*
4. *Vertical and horizontal data are in 2's complement format*
5. *Serial data is always shifted out starting with the LSB*

In the Pen Mouse mode, 3 words are transmitted in each data packet. Each word consists of 1 start bit, 7 data bits and 2 stop bits. The switch status and the 2 most significant bits of both vertical and horizontal counters are given in the first word of the data packet. The most significant bit of the second and third words are always zero.

For a mousepad digitzer size of 2.5 inch by 1.8 inch, the achievable mouse resolution is 409 dpi. This exceeds the requirement for a "high resolution" (400 dpi) Microsoft Mouse.

Mouse Actions

The TR88L811 when used in Pen Mouse mode, can recognize either the two mouse buttons or pen taps to perform various mouse functions. This is achieved through user-intuitive pen action and does not require user programming.

With the TR88L811, the user can slide the pen across the digitizer tablet to move the mouse pointer and tap on the digitizer tablet to activate button functions. The TR88L811 Pen Mouse Controller will interpret the user inputs, translate the information to Microsoft mouse format and send the data out via the TXD pin.

Move or Point Action

To move the pointer on the computer screen, the user just needs to slide the pen across the digitizer tablet in the direction that he wishes the pointer to go. When the pen is lifted from the digitizer surface and set down in a different spot, the on-screen pointer stays in its original position. When the user slides the pen across the surface, the pointer or cursor follows the pen.

Single-Click Action

A single-click is made by moving the pointer to the object and tapping once lightly on the digitizer tablet. This single tap is equivalent to a single click of the left button on a standard desk-bound mouse.

Double-Click Action

A double-click is made by tapping twice quickly on the digitizer tablet. This double-tap is equivalent to a double-click of the left button on a standard mouse.

Drag Action

A drag action is made by double-tapping on the digitizer tablet, holding the pen down after the second tap and then sliding the pen across the digitizer surface.

Auto Cursor Motion*

Auto Cursor Motion (or ACM), allows users to extend a move or drag operation for long distances. It is activated by sliding the pen across an imaginary boundary close to the edge of the tablet and not lifting the pen. The TR88L811 ACM keeps the pointer moving on-screen in one of the predefined directions and speed depending on original movement. The pointer stops moving when the user lifts the pen from the digitizer tablet. Keeping ACM_SEL at Logic **1** enables the ACM feature. ACM always works for both Move and Drag operations. Keeping ACM_SEL at Logic **0** disables ACM.

The ACM feature has been designed for use with a 2 inch x 2.5 inch resistive touch pad. The coordinates (219,219) and (804,804) which are used to detect the edge zone are pre-determined. Referring to Figure 6, when a user moves from the normal working area to the left edge and enters the edge zone, ACM is activated if certain speed constraints are met. TR88L811 activates ACM if the X coordinate of the first sample in the edge zone is 215 or lower and the X coordinate of the second sample in the edge zone is at least two counts lesser than the earlier sample.

Similar speed constraints apply to ACM activation in all four directions. As soon as ACM is activated, the cursor moves in one of the four directions. Cursor speed is fixed at this time to an increment (or decrement) of 3 counts per cycle.

It is possible to alter speed and direction of the cursor even after ACM has been activated. For this, the pen has to first stop on the pad in the edge zone. Once TR88L811 detects that the pen has stopped in the edge zone, ACM enters a different phase where it is possible to change cursor direction and speed.

Auto Cursor Motion can be reset any time by lifting the pen or by sliding the pen away from the touchpad edge. The user is able to move back and forth between Auto Cursor Motion and normal mouse motion without lifting his finger from the touchpad digitizer.

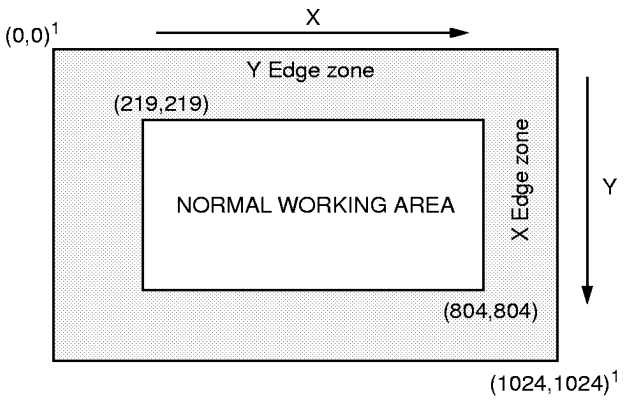


Figure 6 • *Edge zone on touch pad*

* Protected by international patents.

Absolute Maximum Ratings

Beyond these limits damage may occur to the device.

Symbol	Parameter	Min	Max	Units
V	Supply Voltage	-0.25	6.5	V
Ts	Storage Temperature	-40	125	°C

Recommended DC Operating Conditions

Symbol	Parameter	Min	Typ	Max	Units
Vdd	Supply Voltage	2.7	3.3	3.6	V
Avd	Analog Supply Voltage	2.7	3.3	3.6	V
Fclk	Crystal Frequency		1.8432	2	MHz
Topr	Operating Temperature Range	0		70	°C

General Specifications

Valid for 25°C ambient temperature and 3.3V supply

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{il}	TTL input LO	Vdd = 3.3V			0.4	V
V_{ih}	TTL input HI	Vdd = 3.3V	1.9			V
V_{-}	Schmitt input HI	Vdd = 3.3V		1.3		V
V_{+}	Schmitt input LO	Vdd = 3.3V		0.8		V
V_{hys}	Schmitt input Hysteresis	Vdd = 3.3V		0.5		V
I_{il}	Input leakage	V_i = Vdd or Vss	-10		10	µA
V_{ol}	Low Level Output	I_{ol} = 4mA, Vdd = 3.3V			0.4	V
V_{oh}	High Level Output	I_{oh} = -1mA, Vdd = 3.3V	2.4			V
I_{oz}	High Z leakage	V_o = Vdd or Vss	-10		10	µA

Electrical Specifications

Valid for 25°C ambient temperature and 3.3V supply

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{VDD}	Digital Supply Current (using CMOS-level clock)	Normal operation		300	600	µA
I_{AVD}	Analog Supply Current	Normal operation		1.7	3	mA
I_{VDDPD}	Digital Supply Current	Power Save Mode (no pen contact for > 3 sec)		0.1	1	µA
I_{AVDPD}	Analog Supply Current	Power Save Mode (no pen contact for > 3 sec)		0.1	1	µA
$C_{interplate}$	Parasitic capacitance between X and Y-plates of Digitizer			2.5	5	nF
R_{driver}	Parasitic Resistance of On-chip driver	Note 1		35	50	Ω
R_D	Resistance of Digitizer Film		300		10k	Ω
BR	Serial Baud Rate Pen Input Mode Pen Mouse Mode	Fclk=1.8432MHz MS_SEL=Logic **0** MS_SEL=Logic **1**		 19200 1200		 bps bps
CPPS	Coordinate Pairs Per Second (Pen Input Mode)	Fclk=1.8432MHz MS_SEL=Logic **0**		200		cpps
$C_{PPS(M)}$	Coordinate Pairs Per Second in Mouse Mode	MS_SEL = 1			40	cpps
RC_d	Time Constant of Digitizer Film				10	µs
T_{upd1}	PD_RST Deactivation to Data available	Pen on Digitizer, Pen input Mode		10		ms
T_{upd2}	PD_RST Deactivation to valid coordinates	Pen on Digitizer, Pen input Mode (Note 2)		40		ms
t_{db}	Button Debounce Time			50		ms

Notes

1. *Effect of parasitic resistance is to reduce the total count from 1024 by 6% to 8% on each of the four sides.*
2. *With 1µF Capacitor connected to VREF pin.*

Pen Mouse Operations

Single Click Timing

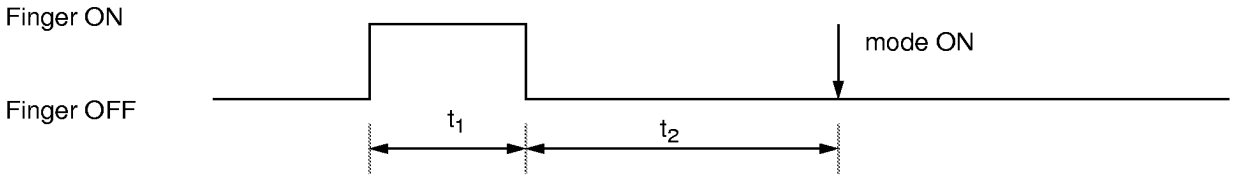


***Figure 7** • Single Click Timing Diagram*

Symbol [1]	Parameter	Min	Typ	Max	Units
t_1	Time from finger touches the pad to finger OFF	1		16	scan cycle [2]
t_2	Required finger OFF time	23			scan cycle

Notes

1. See Figure 4.

2. 1 scan cycle = 10 ms

Double Click Timing

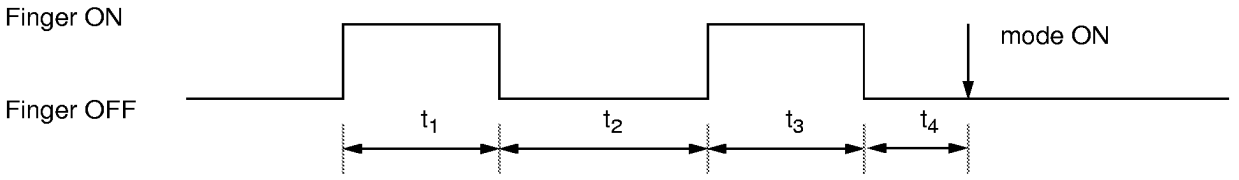


***Figure 8** • Double Click Timing Diagram*

Symbol [1]	Parameter	Min	Typ	Max	Units
t_1	Time from 1st finger touch to finger OFF	1		16	scan cycle
t_2	Waiting time from 1st finger OFF to 2nd finger touch	3		23	scan cycle
t_3	Time from 2nd finger touch to finger OFF	1		14	scan cycle
t_4	Required finger OFF time	3			scan cycle

Note

1. 1 scan cycle = 10 mS

Press/Drag Action Timing

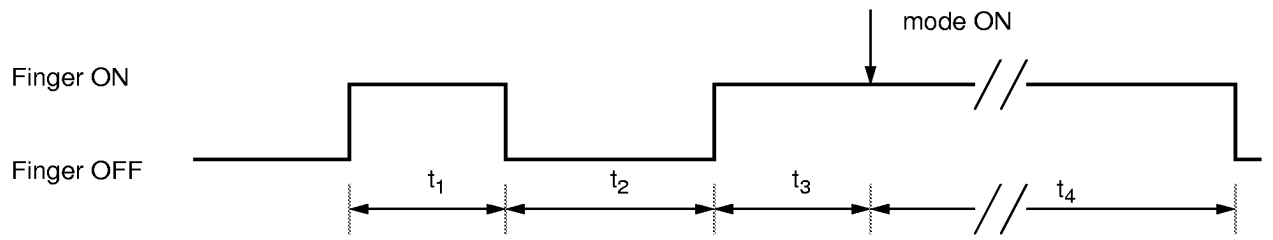


Figure 9 • *Press/Drag Action Timing Diagram*

Symbol [1]	Parameter	Min	Typ	Max	Units
t_1	Time from 1st finger touch to finger OFF	1		16	scan cycle
t_2	Waiting time from 1st finger OFF to 2nd finger touch	3		23	scan cycle
t_3	Required finger ON time	14			scan cycle

Note

1. 1 scan cycle = 10 mS.

Mouse Data Timing

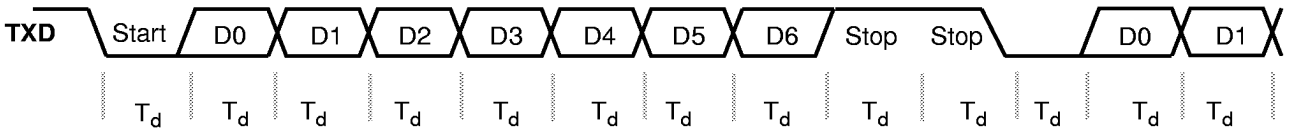


Figure 10 • *Mouse Data Timing Diagram*

Symbol [1]	Parameter	Min	Typ	Max	Units
T_d	Bit time		833		µs

RTS Signal Timing

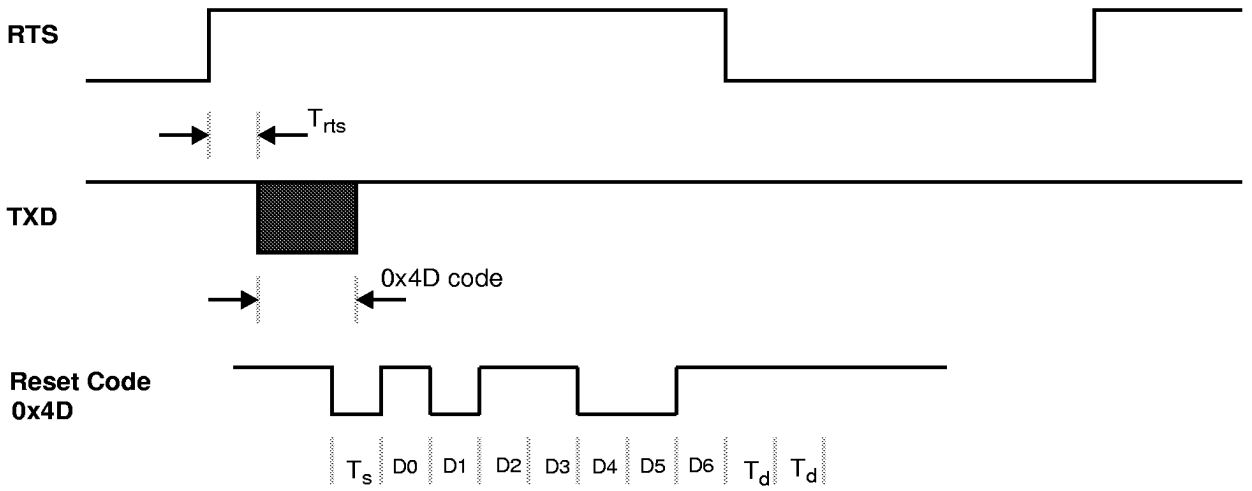


Figure 11 • *Mouse Data Timing Diagram*

Symbol [1]	Parameter	Condition	Min	Typ	Max	Units
T_{rts}	RTS delay	Normal operation		13.3		mS
T_{rd}	Power down to 0x4D transmission	Coming out of Power Save condition			40	mS
T_{xtal}	Crystal osc. start up time	Coming out of Power save condition			15	mS

Applications Information

Figure 12 shows TR88L811 used in a typical resistive touchpad application where it is powered from the RS232 port of a computer. This application takes advantage of the availability of -12V on the TXD pin and +12V on the DTR pin of a RS232 port. A 3.3V regulator is used in this application. Component values that are not directly related to TR88L811 are indicative and may be adjusted if required.

Clock frequency of 1.8432 MHz gives a data rate of 19.2 K bits per second. It is also possible to drive the XTALIN pin from an external clock. A jumper on the the MS_SEL pin allows the TR88L811 to enable either pen-input or pen-mouse operation. ACM feature can also be turned on or off through a jumper.

Analog traces connecting to X–, X+, Y–, Y+ should be kept short and routed away from clock and other high-activity lines. A ground plane directly behind the digitizer membrane can take care of shielding requirements. Traces from the TR88L811 to the decoupling capacitors should be short. The TR88L811 4-wire digitizer interface connects easily to most resistive digitizer tablets available from various manufacturers including MicroTouch, Dynapro, Panasonic and Samsung.

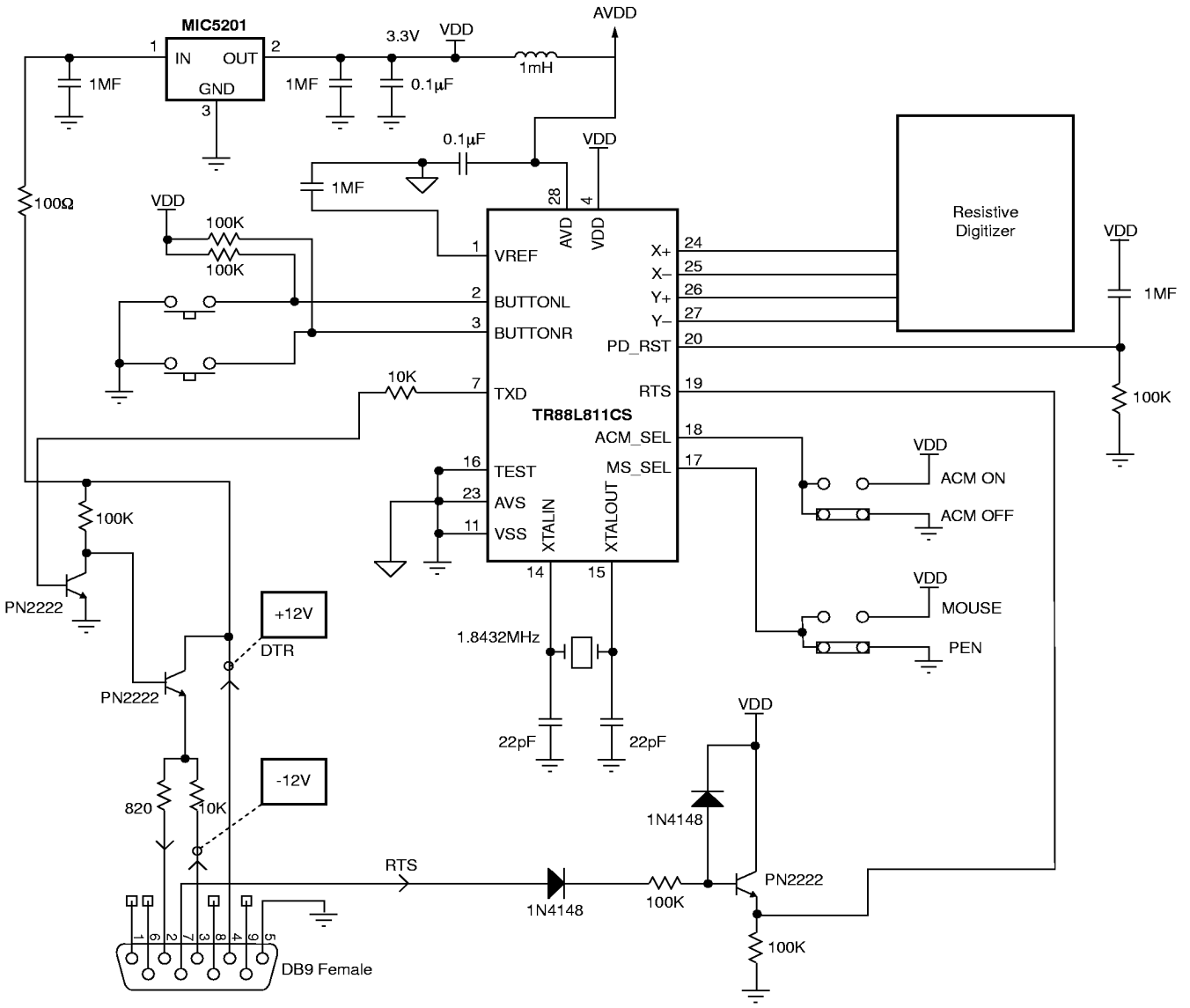
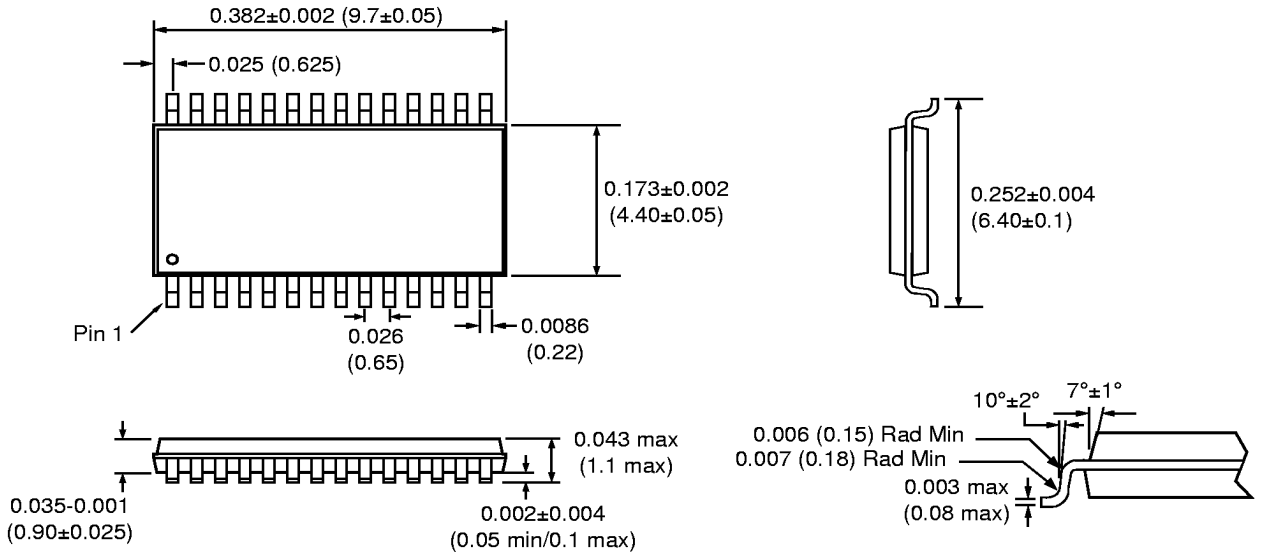


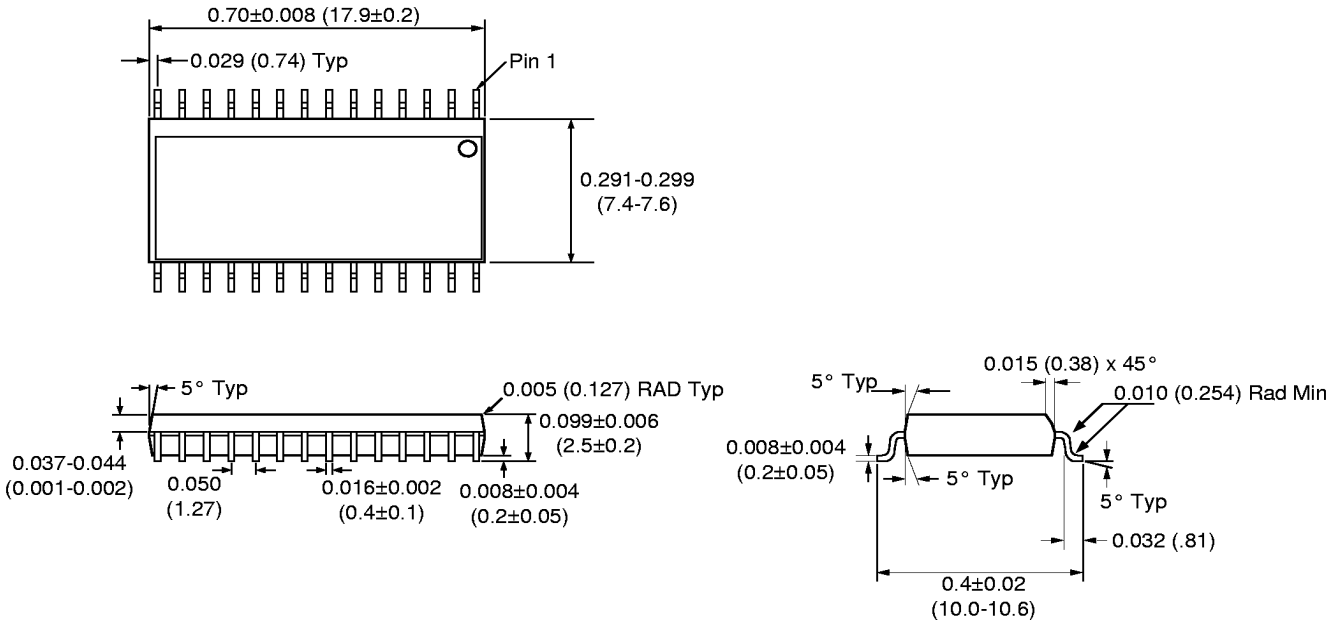
Figure 12 • *Typical Touchpad Mouse Controller Application*

Mechanical Dimensions

28-pin TSSOP
Dimensions in inches (mm)



28-pin SOW
Dimensions in inches (mm)



Ordering Information

Part Number	Package Type
TR88L811CQ	28-pin TSSOP
TR88L811CS	28-pin SOW