MM50201 Data Sheet

Version 1.0

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Preface

This data sheet specifies the board layout, interface, power supply and other information for CapTouCon MM50201. Some of the CapTouCon MM50201 features are explained using other CapTouCon devices.

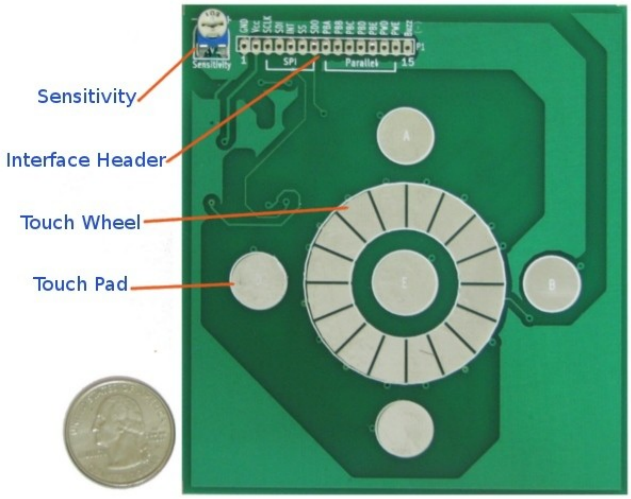
In this document all numbers are decimal notation except for those preceded by ‘0x’, such numbers are in hexadecimal notation.

Note and Caution

NOTE : Notes are attention to important information.
CAUTION : Cautions are included to avoid damaging hardware.

Table of Contents

1 CapTouCon Board MM50201



2 Specification

Features	Specification
Board	CapTouCon
Model	MM50201
Operating Voltage	5V DC
Touch Interface	5 Touch Buttons + Touch Wheel
Sensitivity Control	Yes
Parallel Interface	Yes (on Header)
Serial SPI Interface	Yes
Buzzer Interface	Yes
TP Extension	No
Toggle Mode	No
Multi Touch	Yes (up-to 5 buttons)
Weight	35 gm (without packaging)
Dimension	109x98x1.6 mm

3 Interface Header

Pin No	Pin Name	Description
1	GND	Ground Pin
2	Vcc	5V DC power supply
3	SCLK	SPI Clock
4	SDI	SPI Data input
5	INT	Interrupt, active low interrupt indicating change in touch state (status register). To be used with SPI.
6	SS	SPI chip select
7	SDO	SPI Data out
8	PBA	Pin on header interface for Touch Pad A, reflects status register bit[2]. Active low.
9	PBB	Pin on header interface for Touch Pad B, reflects status register bit[3]. Active low.
10	PBC	Pin on header interface for Touch Pad C, reflects status register bit[4]. Active low.
11	PBD	Pin on header interface for Touch Pad D, reflects status register bit[5]. Active low.
12	PBE	Pin on header interface for Touch Pad E, reflects status register bit[6]. Active low.
13	PWD	Pin on header interface. Indicates wheel direction, Clock-wise is indicated by ‘1’, and Anti-Clockwise by ‘0’. This changes before PWE so that correct direction can be sampled with PWE event. Reflects status register bit[1].
14	PWE	Pin on header interface. This pin toggles on any rotational touch-movement over the touch wheel (clockwise or anti-clockwise). Reflects status register bit[0].
15	Buzz	For Buzzer

4 Functionality

MM50201 provides two types of touch gestures. Touch-pads and Touch-Wheel. It has 5 touch pads marked with “A”, “B”, “C”, “D” and “E” respectively and a “Touch-Wheel”. When finger is placed on “touch-pad” or moved over “touch-wheel”, CapTouCon board detects touch event and updates its internal status register. In case of “touch-wheel” WD(Wheel-Direction) and WE (Wheel-Event) status bits are updated. Touch wheel consists of 16 touch-elements, when finger moves from one element to another WE toggles, and corresponding WD (direction) status is updated. The WD (direction) status indicates if wheel motion was clock-wise or anti-clock-wise. For clock-wise WD gets set to 1, and for anti-clock-wise, WD gets set to 0.

CapTouCon provides two independent ways to access internal-status register.

Option 1: Option 1 is to use header interface. Status register bits 0 to 6 directly reflects on pins [PWE, PWD, PBA, PBB, PBC, PBD, PBE]. Note [PBA, PBB, PBC, PBD, PBE] are active low. PWD and PWE reflects Direction and Wheel-Event (toggle) on header interface respectively.

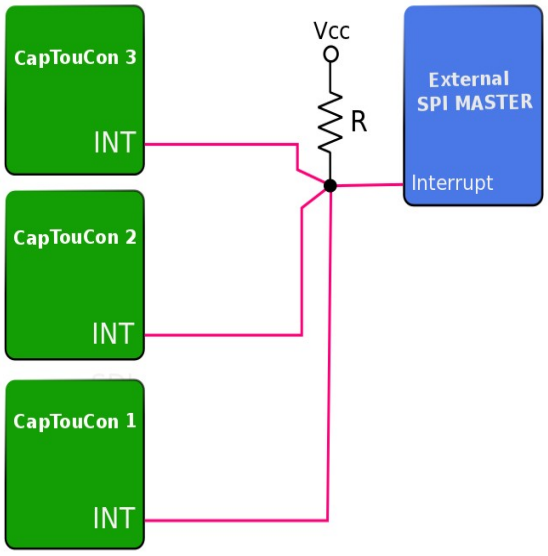
Option 2: Option 2 is to use SPI interface. Additional interrupt (INT) pin along with standard SPI interface (SS/Dout/Din/Clk) is provided. Interrupt (INT) pin is expected to be used with SPI interface. CapTouCon asserts interrupt (INT) pin when a touch-even is detected, so that any external SPI master can read status-register through SPI interface when it receives an interrupt. Interrupt (INT) is asserted for both touch-pads and touch-wheel.

In a typical setup, where SPI is used, an external SPI master is connected to CapTouCon board with SPI interface and below sequence of events are expected. Finger placed over touch-pad -> CapTouCon detects touch event and asserts interrupt (INT) pin. External master acts on the interrupt and reads the CapTouCon’s status register over SPI. CapTouCon detects SPI read and de-asserts its interrupt (INT).

As both the header-interface and serial options are totally independent, it provides great flexibility for user to chose any or both of them.

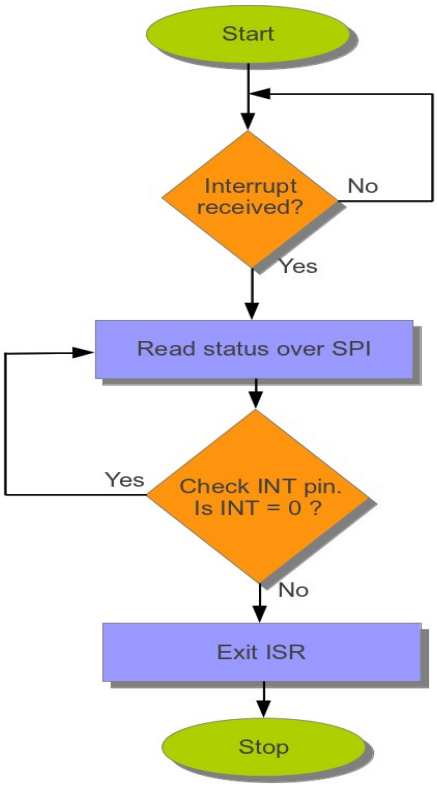
5 Interrupt

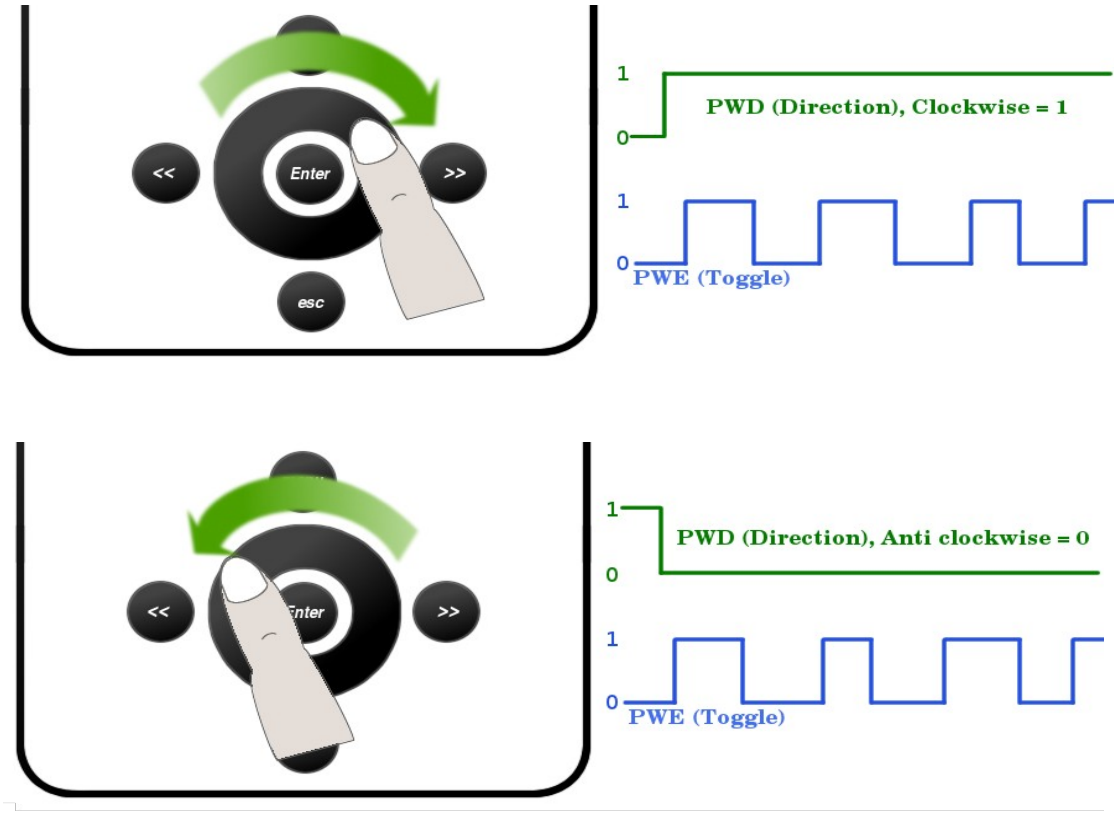
Interrupt pin INT is active low and it gets tri-stated when not active. This property enables interrupt from different CapTouCon to be combined and given as a single interrupt signal to External-SPI-Master. One external pull-up register (10K) will be needed to combine them as shown (side image). With this wired ORing of interrupt, when any of CapTouCon asserts interrupt, interrupt to External-SPI-Master gets asserted. External-SPI-Master reads status register of all CapTouCon devices over SPI to figure-out which status has changed.



Once External-SPI-Master receives an interrupt, it should read SPI interface till interrupt is LOW, master may need to do multiple reads on SPI to do this. This is required as another touch-event might have occurred after first interrupt assertion while externa-SPI-Master still servicing the first interrupt. In this case INT pin won't get chance to assert again as it is already asserted and being serviced. Hence, after servicing the interrupt event, External-SPI-Master should check the INT pin to see if INT pins is still LOW (indicating pending touch-events to be read) and should put additional reads on SPI to read them out. This is shown as a flow diagram.

Caution : If External-SPI-Master doens't check the INT pin again after servicing the interrupt and there is a pending touch-event yet to be read out, a dead-lock might happen.





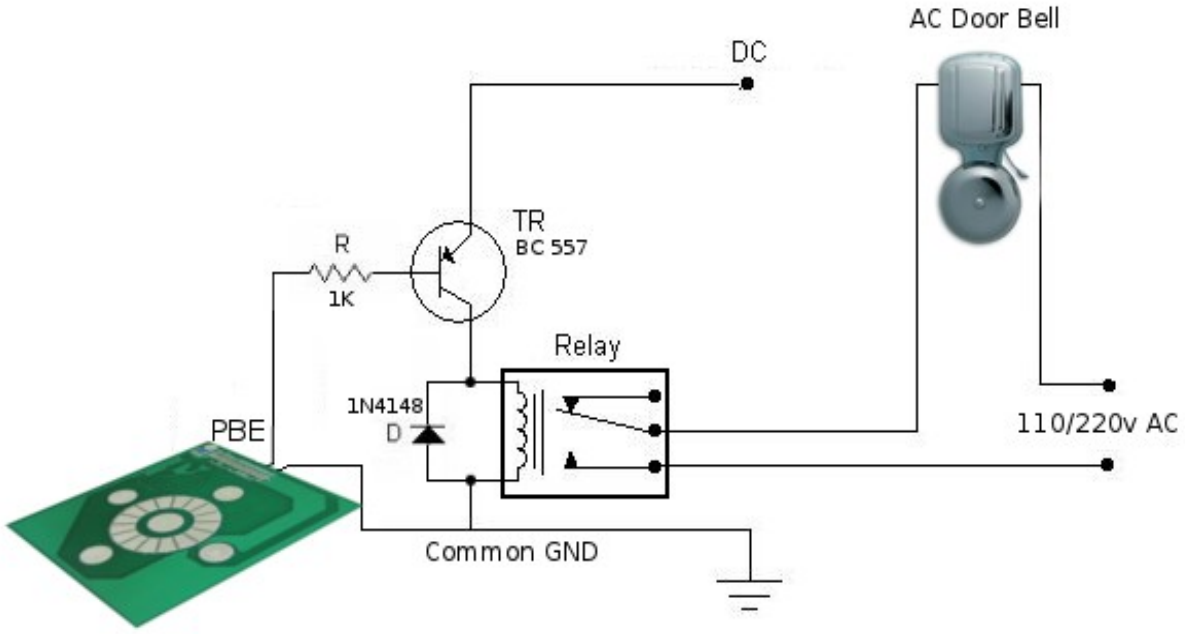
Above image shows waveform of PWD and PWE signal to explain their behavior on clockwise and anti-clockwise wheel motion.

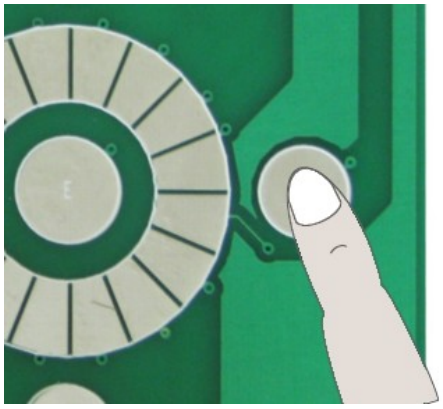
Below are some practical use-case where Header-interface and Serial (SPI) access method can be used.

6 Header Interface

Header interface can be used directly as a switch to control suitable devices. One of the use case shown below, where a electro-magnetic door bell is being operated using header interface. As user puts finger on touch pad the bell starts ringing and stops as he removes his finger from the touch pad.

NOTE : MM50201 doesn't support Toggle-Mode.



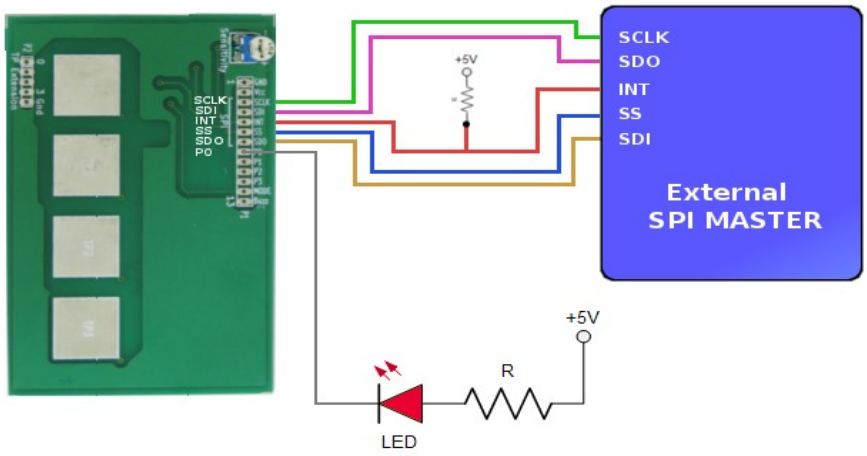


7 SPI and Header Interface

Both SPI and Header interfaces can be used together to achieve great user interaction. In a use-case shown below, CapTouCon is connected with External-SPI-Master on SPI interface and an LED is put on the header interface to give visual indication. CapTouCon always acts as SPI Slave and need be always connected with SPI-mode 0.

It is strongly recommended use transistor based driver circuit to drive LED, to simplify conceptual explanation, direct connection of LDE is shown (R = 330 Ohms).

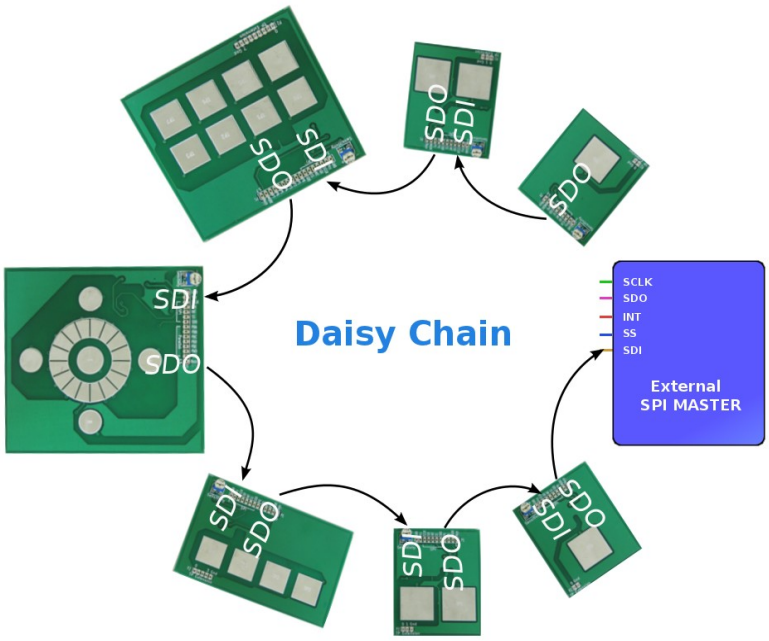
INFO : SPI standard defines various clock-polarity and phases combination, and these combinations are called SPI-MODES. For any SPI-MASTER and Slave to connect properly both should use same SPI-MODE. CapTouCon uses SPI-MODE 0. For SPI-MODE = 0, clock-polarity (CPOL/CPK) = 0 , clock-edge (CKE/NCPHA) = 1.



1. Illustration: Serial and Header-Interface example using TP40201

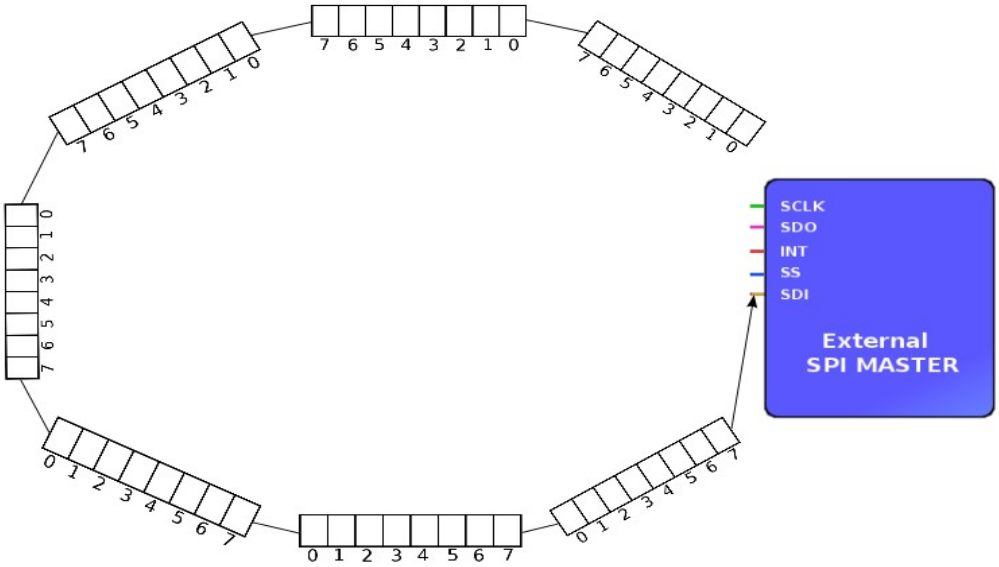
8 SPI Daisy Chain

Single SPI bus can be used to connect to number of CapTouCon devices in series, image below shows 7 CapTouCon board are connected in daisy-chain on one SPI interface. Connecting CapTouCon boards in dasiy-chain provides immense expandability. Below image primarily shows data-flow between various CapTouCon devices when they are connected in daisy-chain, other SPI connections are not shown for simplicity. Note how data moves from one CapTouCon to another serially and finally reaches the External-SPI-Master.



2. Illustration: Daisy chain data flow

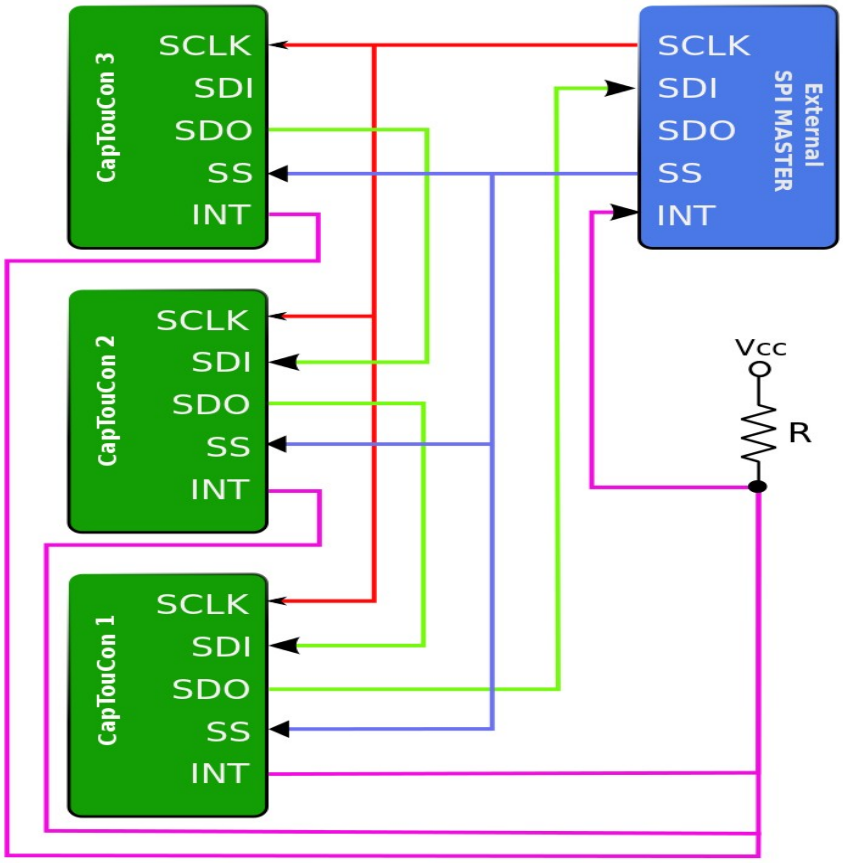
Each CapTouCon has 8-bit status register, when connected in daisy-chain (for above example), it is as equivalent as seven 8-bit shift registers connected serially. So in case of 7 devices in serial, Master would put 7 SPI read request to read complete chain. It is responsibility of External-SPI-Master to put appropriate reads based on number of SPI-slave (CapTouCon here) present on the chain. Conceptually, master will need 16 (8x2) clocks to serial-out two SPI-Slave serial chain and 56 clocks (8x7) to serial-out seven SPI-Slaves present on the chain.



3. Illustration: Pictorial representation of all daisy chain register in series

Image below shows 3 CapTouCon boards connected in daisy chain (with connection details). Clocks (SCLK) is fed to all CapTouCon, Data-out (SDO) is connected to another CapTouCon's Data-In (SDI) in the chain. Chip-Select (SS) is connected to all CapTouCon. Interrupt (INT) from all CapTouCon are connected to Master with a pull-up register. It is because, INT is active low and TRI-stated when not active. With this interrupts from all CapTouCon can be logically ORed and fed to SPI Master as a single interrupt signal. When any CapTouCon asserts interrupt, Master sees its INT input going low and it reads complete chain to check which device's status register has changed.

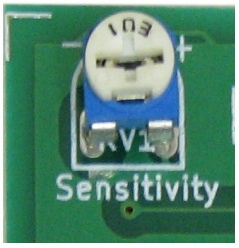
Note: Below is one of the implementation of daisy chain, but not the only implementation.



4. Illustration: Daisy chain connections

9 Sensitivity Control

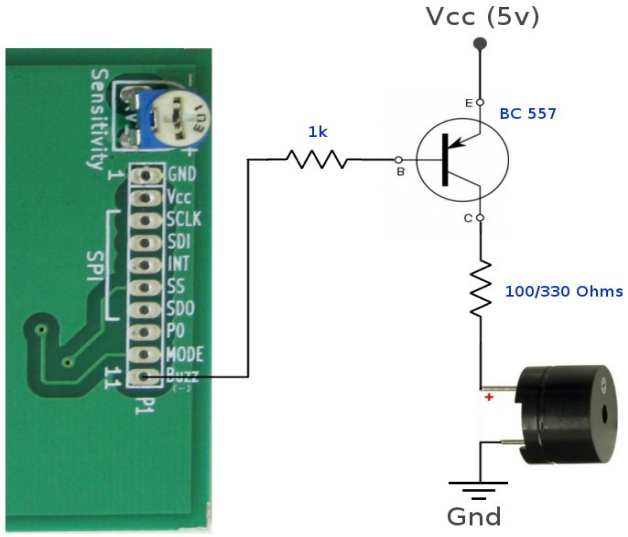
Sensitivity of touch-sensors can be controlled with sensitivity potentiometer present on the board. Turning + side increase, and – side decreases sensitivity. User may feel need to adjust sensitivity when a sticker is put over touch-panel. CapTouCon needs restart for any change in sensitivity to come to effect. Simple way to restart is power-off and power-on.



Caution : Sensitivity potentiometer is mechanical component and it is expected to be adjusted very few times over its lifetime. Frequent adjustment will result damage.

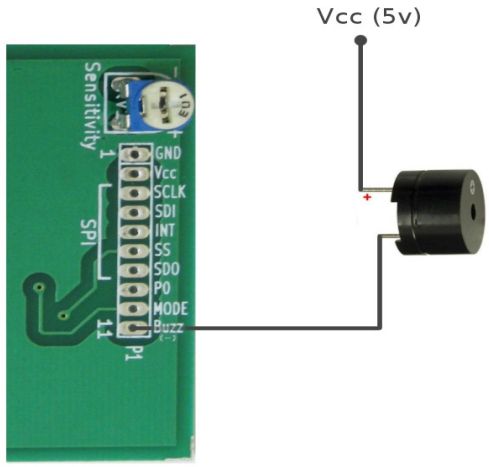
10 Buzzer

A Buzzer pin (Buzz) is provided to connect Buzzer as shown below. It generates beep on every touch.



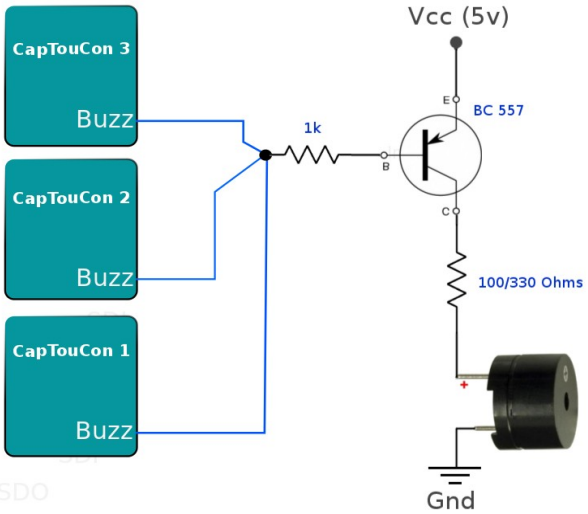
5. Illustration: Buzzer connection example using TP10201

TIP : It is strongly recommended to use transistor circuit to drive Buzzer, but for testing purpose one can connect Buzzer's + pin to Vcc and another pin to CapTouCon as shown below. User may observe non linear beep tones if buzzer is driven directly.

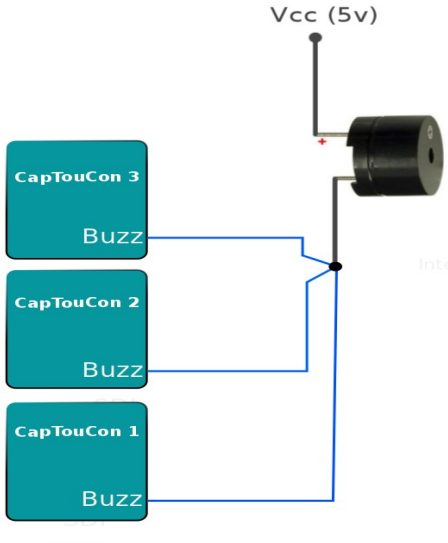


6. Illustration: Buzzer directly driven by CapTouCon, for testing purpose only.

Common Buzzer can be used for multiple CapTouCon boards, as shown below.

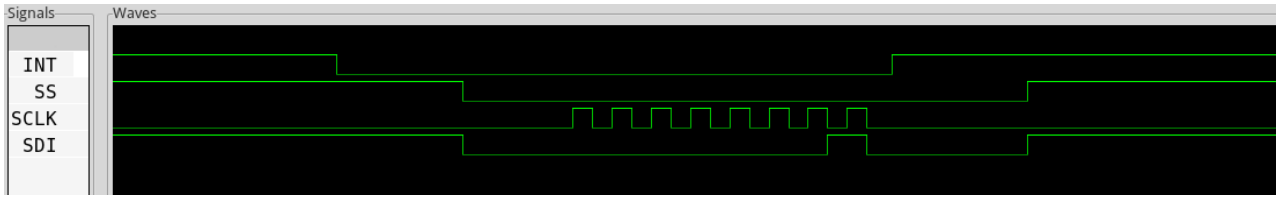


TIP : Again, It is strongly recommended to use transistor circuit to drive Buzzer, but for testing purpose one can connect common single Buzzer with multiple CapTouCon boards as shown below. User may observe non linear beep tones if buzzer is driven directly.

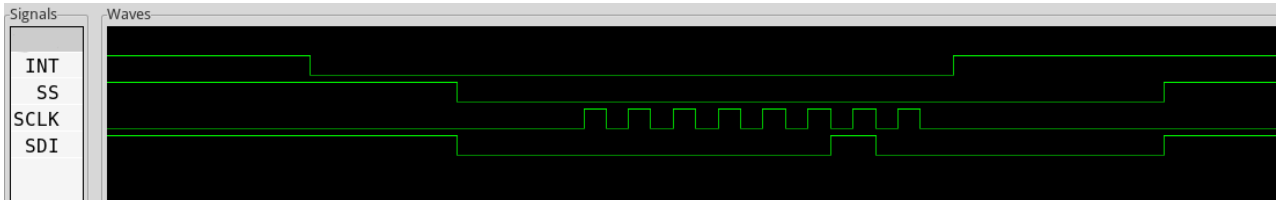


11 Timing Waveforms

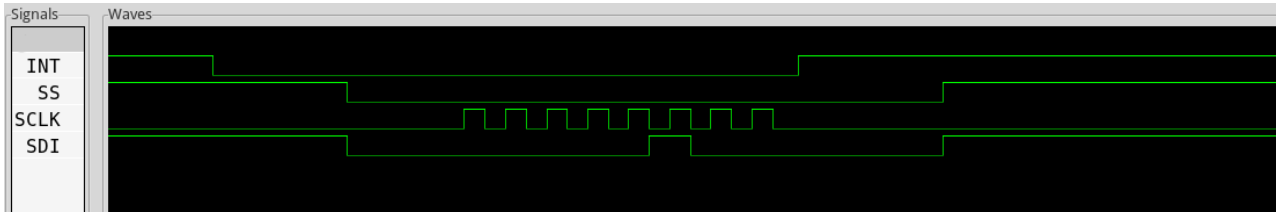
Below timing waveforms are captured with TP80201 device. It shows INT and SPI signals timing relationship for various touch events. Note TP80201 has eight touch pads.



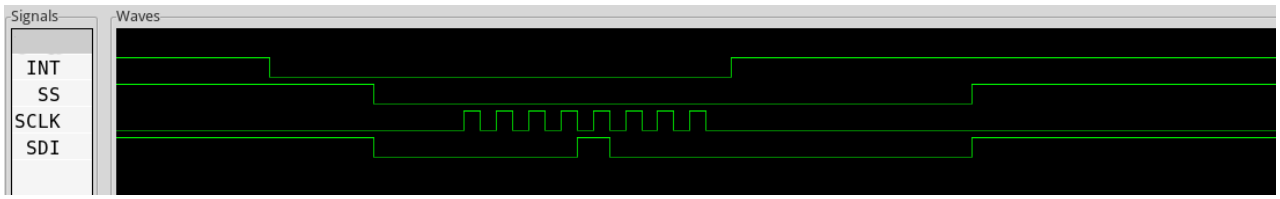
7. Illustration: TP0 Pressed, Status bit 0 gets set, status 0x1 is transfered over SPI



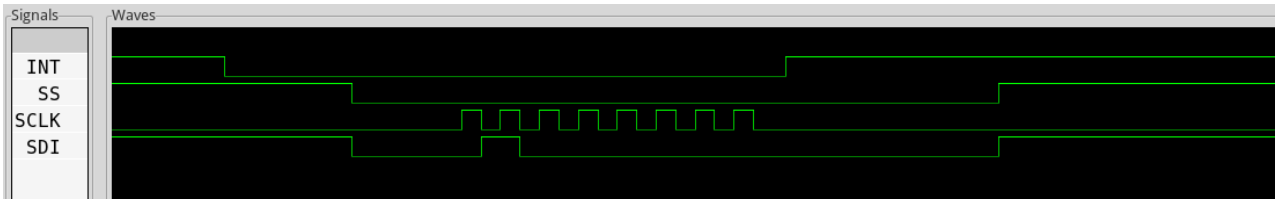
8. Illustration: TP1 Pressed, Status bit 1 gets set, status 0x2 is transfered over SPI



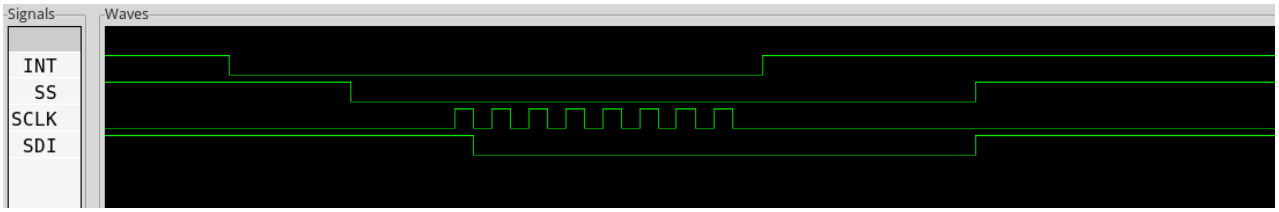
9. Illustration: TP2 Pressed, Status bit 2 gets set, status 0x4 is transfered over SPI



10. Illustration: TP3 Pressed, Status bit 3 gets set, status 0x8 is transfered over SPI



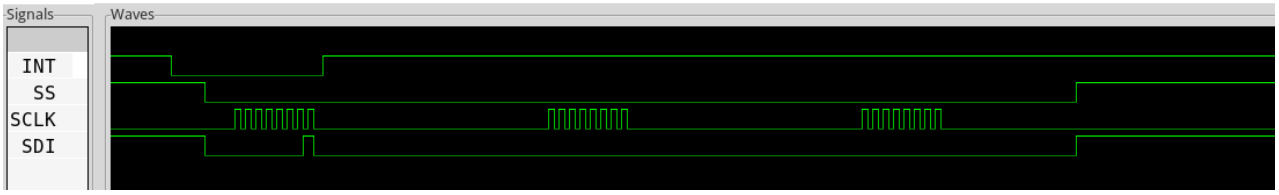
11. Illustration: TP6 Pressed, Status bit 6 gets set, status 0x40 is transfered over SPI



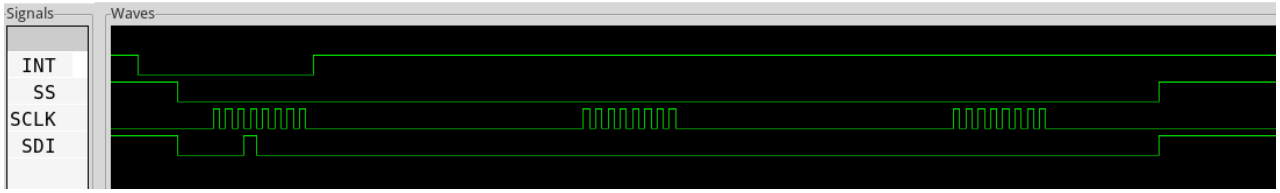
12. Illustration: TP7 Pressed, Status bit 7 gets set, status 0x80 is transfered over SPI

12 Timing Waveforms (Daisy Chain)

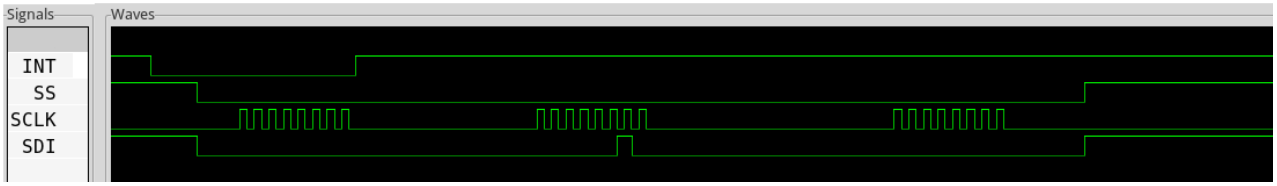
Below timing waveforms are captured with three devices connected in daisy chain over SPI. Device 1 is TP80201, Device 2 is TP20201 and Device 3 is MM50201. It shows INT and SPI signals timing relationship for various touch events on various devices. Note how on an interrupt, SPI Masters puts 3 SPI reads to get status data from all 3 devices present on daisy chain. Also note SS (Chip select) is asserted for all 3 reads.



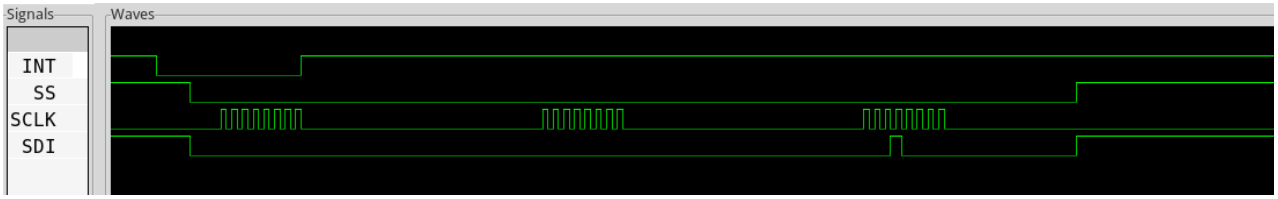
13. Illustration: TP0 of Device1 Pressed, Status bit 0 of Device 1 gets set, status 0x1 0x0 0x0 transfered over SPI



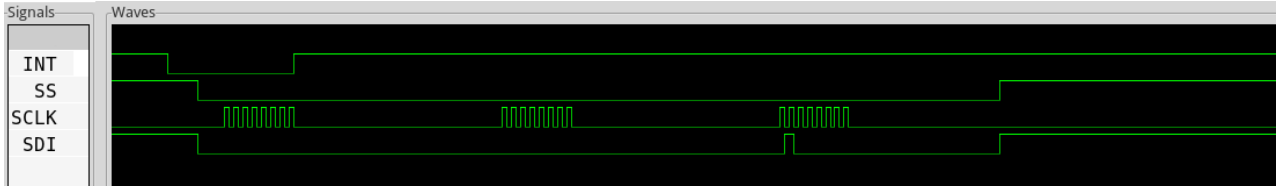
14. Illustration: TP4 of Device 1 Pressed, Status bit 4 of Device 1 gets set, status 0x10 0x0 0x0 transfered over SPI



15. Illustration: TP1 of Device 2 Pressed, Status bit 1 of Device 2 gets set, status 0x0 0x2 0x0 transfered over SPI



16. Illustration: Pad C of Device 3 Pressed, Status bit 5 of Device 3 gets set, status 0x0 0x0 0x10 transfered over SPI



17. Illustration: Pad E of Device 3 Pressed, Status bit 7 of Device 3 gets set, status 0x0 0x0 0x40 transfered over SPI

13 FAQ

Q : What SPI mode should be used by External-SPI master to connect to CapTouCon?
A: Use SPI MODE 0. For SPI-MODE = 0, clock-polarity (CPOL/CPK) = 0 , clock-edge (CKE/NCPHA) = 1. This is not configurable and not changeable.

Q : CapTouCon is Slave or Master on the SPI bus?
A: CapTouCon is always Slave.

Q: Can INT pin used along with Header interface.
A: INT is meant to be used with SPI interface.

Q: Can unused pins be left unconnected?
A: Yes.

Q: How many devices can be connected in daisy chain?
A: Theoretically there is no limitation and fairly large number of devices can be connected.

Q: I am driving buzzer directly, but the sound is not linear.
A: Direct driving buzzer is recommended only for testing purpose, buzzer should be driven by transistor circuit as shown in this document.

Q:Can I put a potentiometer in series with Buzzer to control its volume?
A: Yes.

Q: What is parallel interface?
A: Parallel interface is set of pins on header interface on which status register bits are directly mapped.

14 Support/Feedback

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