This document introduces the operation mode of the touch wheel and LED tracking demo board, including the designs for the touch sensor and LED tracking.

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1 Hardware Block Diagram

Figure 1. Hardware Block Diagram
2 How to Program the Touch Wheel and LED-Tracking PCBA

2.1 Spy-Bi-Wire Programming Interface

Figure 2 illustrates that there is a 2-wire JTAG communication interface to debug or program the on-board MSP430G2955. Connect at least three signals on J1 to a MSP430USB-FET (TDO, TEST, or GND). Choose to power the PCBA from a 5-V USB or from the \textit{V}_{cc} tool, depending on which resistor you solder: R56 or R57.

2.2 MSP430 USB-FET JTAG Interface

Figure 3. Connect With MSP430 USB-FET JTAG
4 Touch Sensor Design

4.1 Touch Detect Method

MSP430 microcontrollers offer a number of peripherals that, when configured properly, can be used to perform a capacitance measurement. Because the platform has several different capacitive touch sensing algorithms, this design uses the PINRO method as shown in Figure 5. For other methods, visit the TI website at www.ti.com for more information.
The relaxation oscillator can be realized with the PinOsc feature. The frequency of the oscillation is the function of the resistance and the capacitance of the circuit. The capacitance is the intended variable and increases with a touch. In the time domain, the rise and fall times are increased, but in the frequency domain, the frequency is reduced. When the capacitance increases, the number of relaxation oscillator cycles decreases within the fixed gate time.

4.2 Touch Sensor Layout

The touch wheel is made up of four electrodes placed sequentially in a circular layout, represented by the four jagged shapes in Figure 6; the first electrode is placed adjacent to the last electrode. The inner circle is a single sensor for the touch key, which is just a reserved button and not used in the wheel function.

![Figure 6. Touch Wheel Sensor Layout](image)

Tuning a wheel is optimizing the software to provide the most linear representation of the wheel's hardware response to a touch. In certain instances, even after tuning the software parameters, the hardware does not provide due to its layout. In these cases, decide to change the PCB layout or to write custom algorithms to compensate for the hardware design. In this design, the four electrodes can be used in the 30 to 40-mm touch wheel; the number of electrodes can increase to six, eight, or more if the wheel is bigger.
5 LED Tracking

This design has 24 LEDs, and each LED is driven by one GPIO; every LED can have a different brightness with the software PWM settings and achieve a breathing effect.

The LEDs will light based on where you touch the wheel. When you move your finger on the wheel, the LEDs light one by one, following your finger's position with different lightness (see A and B in Figure 7); if you move fast enough, all of the LEDs will light at the same time (see C and D in Figure 7).

To get a good LED-tracking effect, this design also uses an interpolation algorithm.

Figure 7. Touch Wheel With LED Tracking
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