FLEXIBLE CAPACITIVE TOUCH SENSOR

A NEW CHANGE TO THE WORLD

CAPACITIVE TOUCH SENSING BASICS

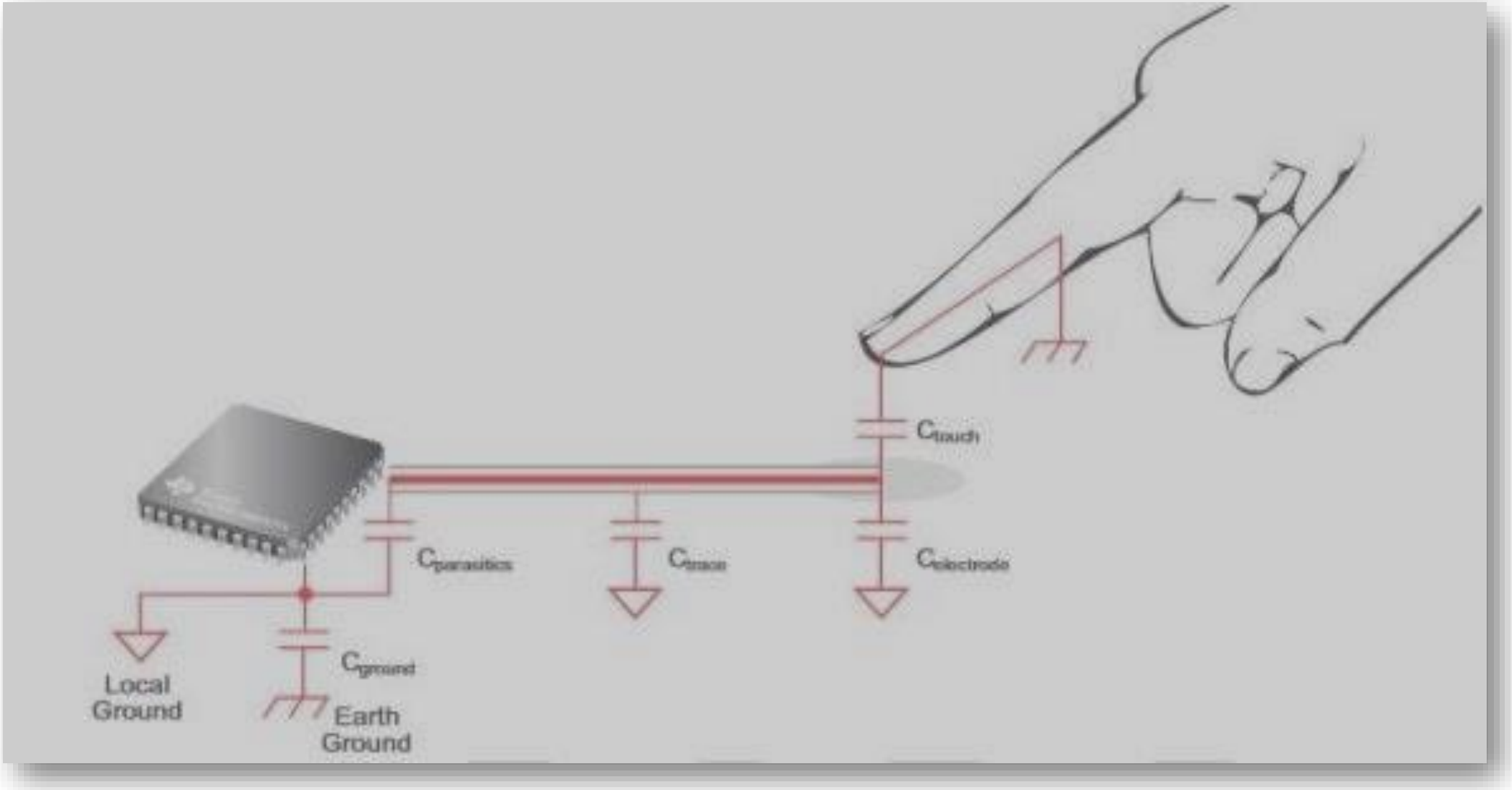
Capacitors are the basic building blocks of the electronics world.

During interaction with physical objects, pets and human beings, touch (physical contact) constitutes an extremely significant event.

The technology used to respond to such a physical touch by capacitance change method is termed as capacitive touch sensing.

We have done an innovative research in this and found a new concept that may define the new age capacitive sensing technology. A capacitive touch sensor device uses the human body capacitance as their input and according to the sensory feedback they provide output.

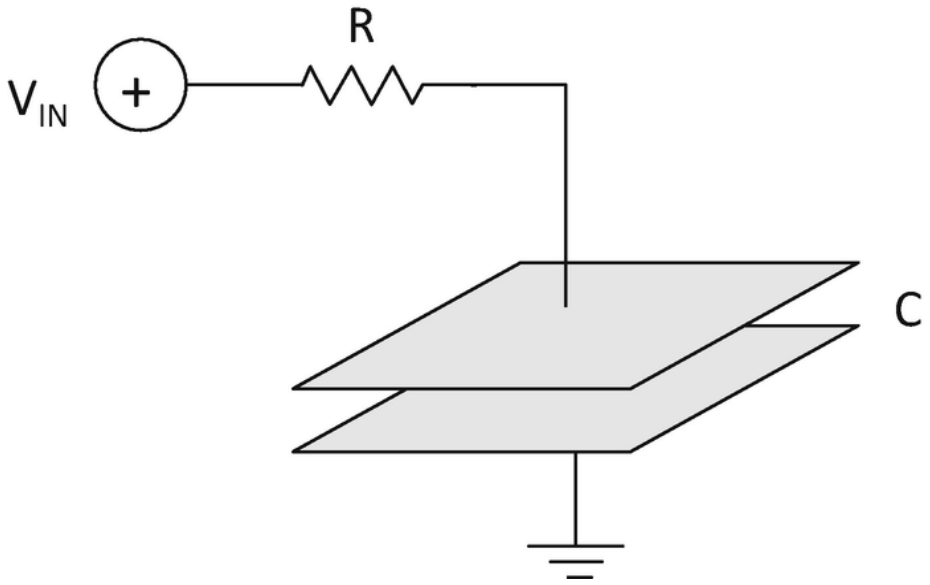
CIRCUIT DIAGRAM



WORKING OF A CAPACITIVE TOUCH SENSOR

A self capacitive touch sensor forms a capacitance with the ground. When the human finger touches the sensor, it forms another capacitance, which gets added up. So, this increase in the capacitance is detected and reported by a hardware component called PTC (Peripheral Touch Sensor).

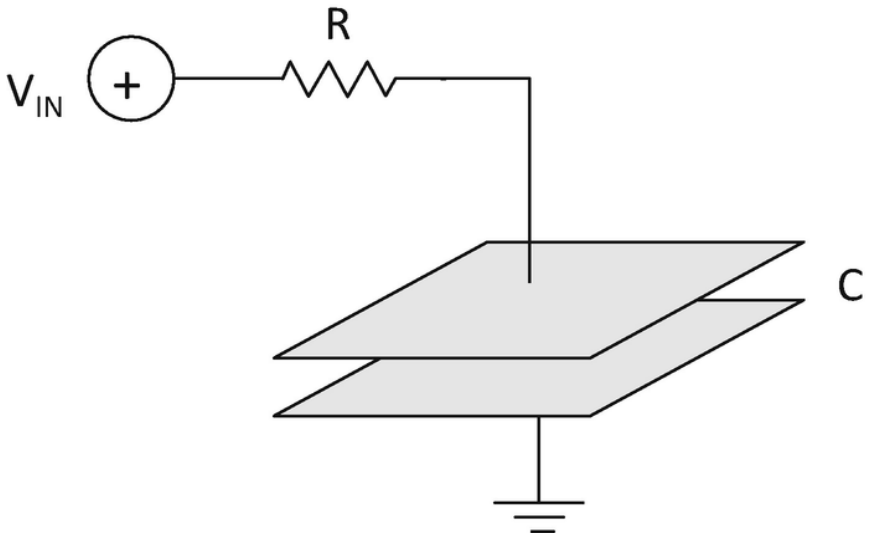
A mutual capacitive touch sensor forms a capacitance with the ground and another capacitance with itself. When the human finger touches the sensor, it interferes with the electric field lines and thus creates a minute decrease in the capacitance. This is detected and reported by PTC.



COMPARISON

SELF CAPACITANCE

Self capacitance is the coupling of one plate of a capacitor to virtual ground. Just as with mutual capacitance, the self capacitance of the plate changes when a finger is near the plate. This change in self capacitance can be used to determine the distance to the finger.



MUTUAL CAPACITANCE

The mutual capacitance, C, between two conductors is defined as the amount of charge that can be stored on each plane, per unit of voltage difference between the planes. The classical calculation of this capacitance is generally done by applying Gauss's and Poisson's equation for a given system.

OUR CONCEPT

Our concept is to construct an extremely low-cost, thin, flexible capacitive touch sensor using simple construction methods.
Graphite is used as the electrode which is made by grinding it and making it into a powder.

The substrate is a plastic cover/a sheet of paper on which the graphite powder is applied and forms as capacitor.

It should be applied in the form grills or fins with 1 mm gap for forming a mutual capacitance sensor.

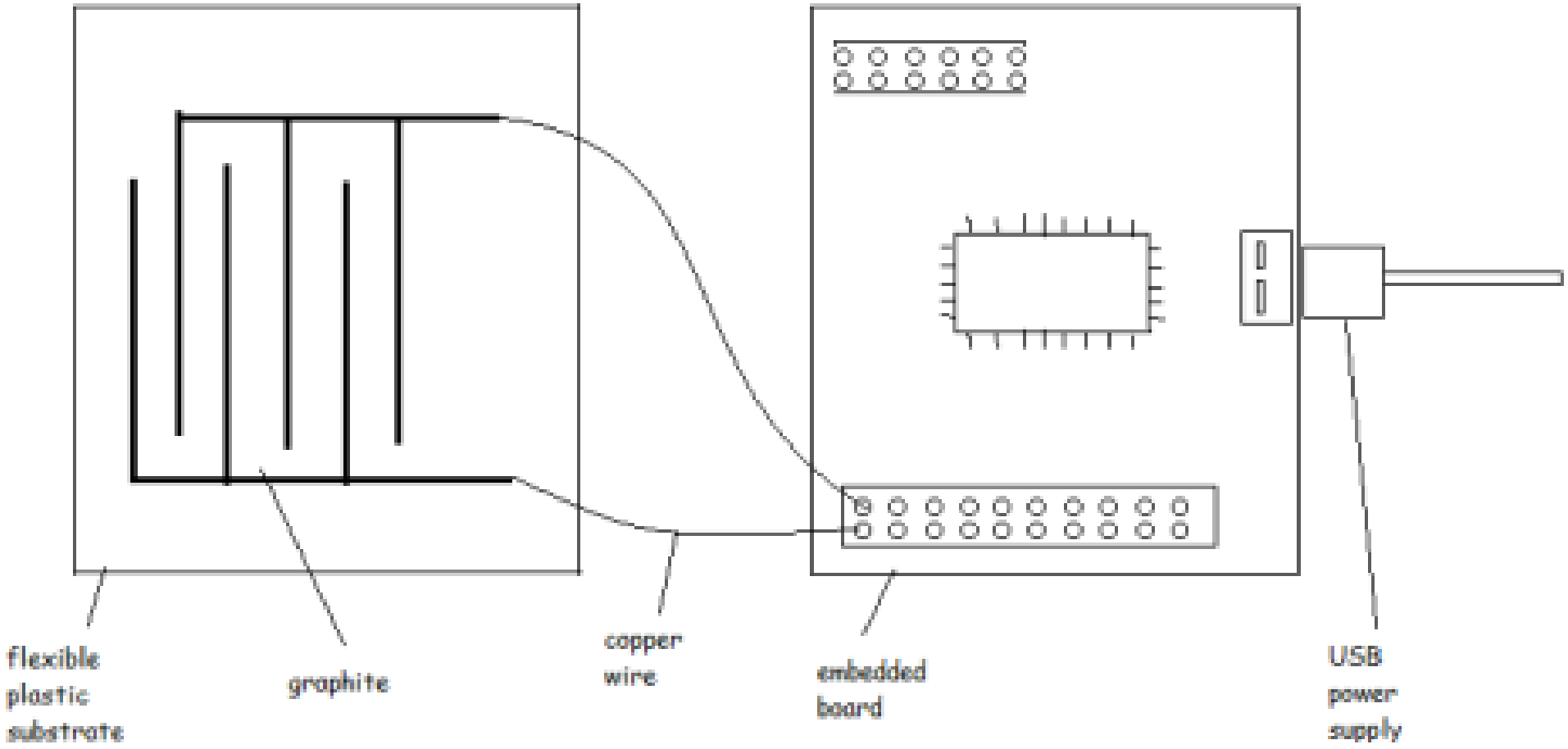
The capacitor is connected with a micro-controller which is programmed.

The capacitor is laminated with a plastic cover.

When the finger touches the sensor, the program reports the connected device (LED in our implementation).

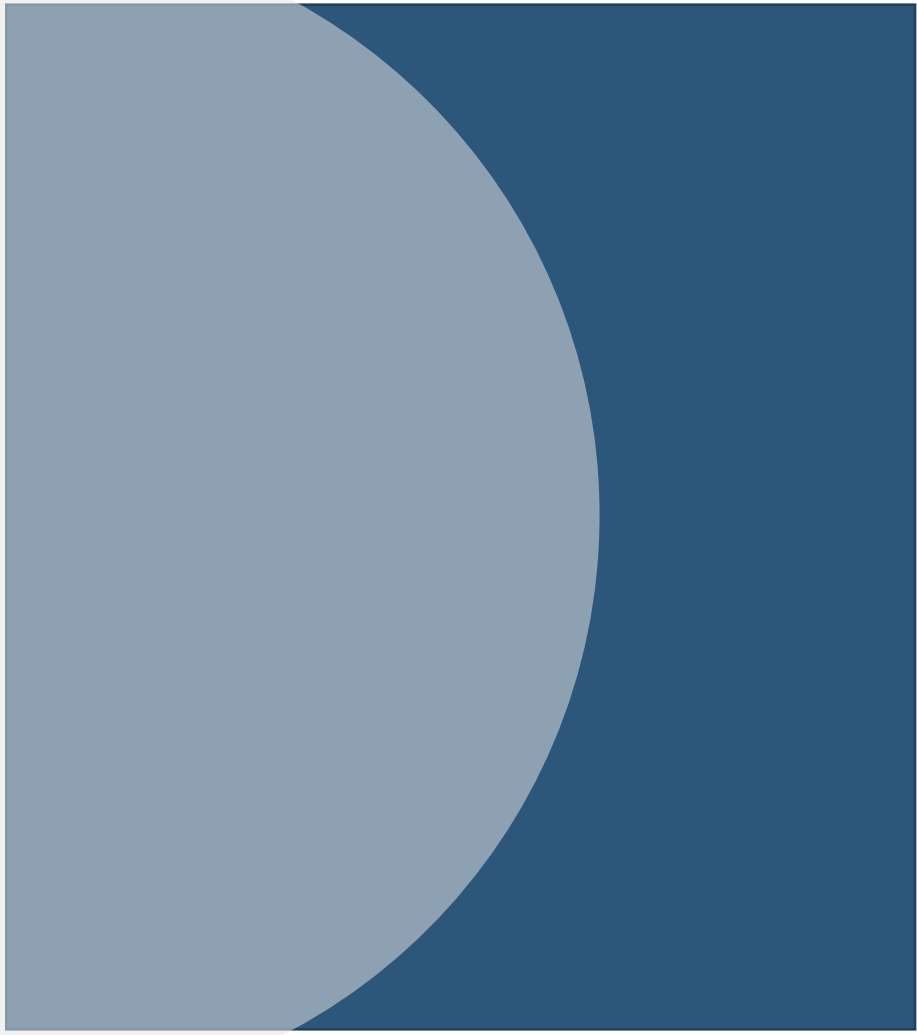
Overall, the a working capacitive touch sensor is made flexible.

SCHEMATIC DIAGRAM

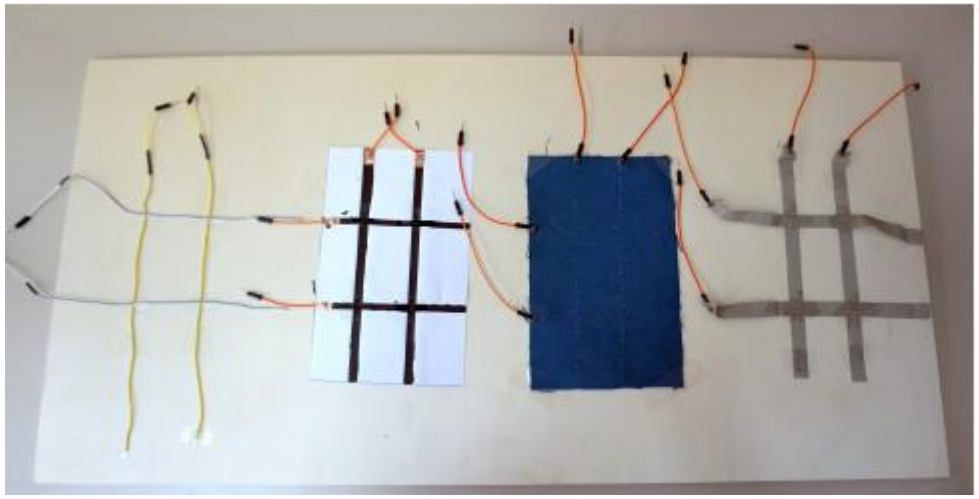


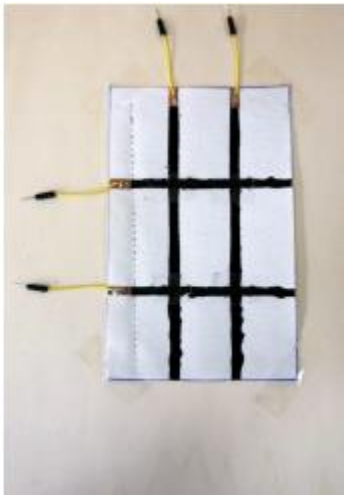
ADVANTAGES

- Flexible.
- High tensile strength.
- Construction of the sensor is cheap.
- Moisture proof.
- Very thin (less than 0.1 mm).
- Eco-friendly (Except the plastic lamination, everything is bio-degradable).
- Low operational power.



APPLICATIONS

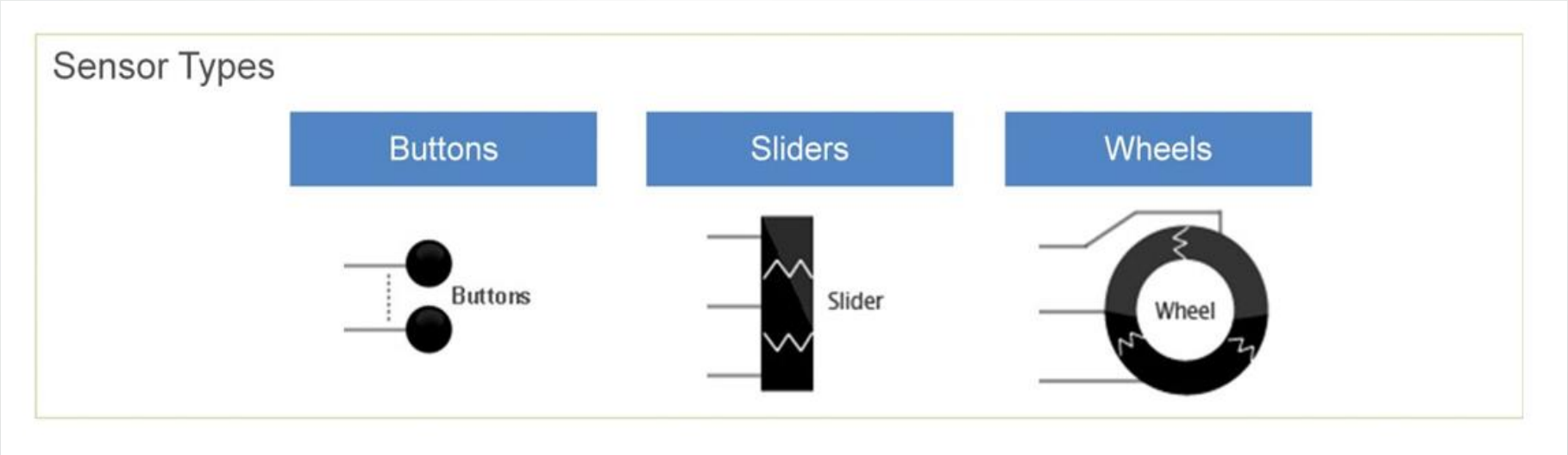




- Can be embedded in clothes.
- Can be used in wrist bands.
- Can be used in flexible ASCII keyboards (in rolling computers).
- Can be used in surface computers.
- Can be used in obtaining electrocardiographic potential (ECG – monitor).

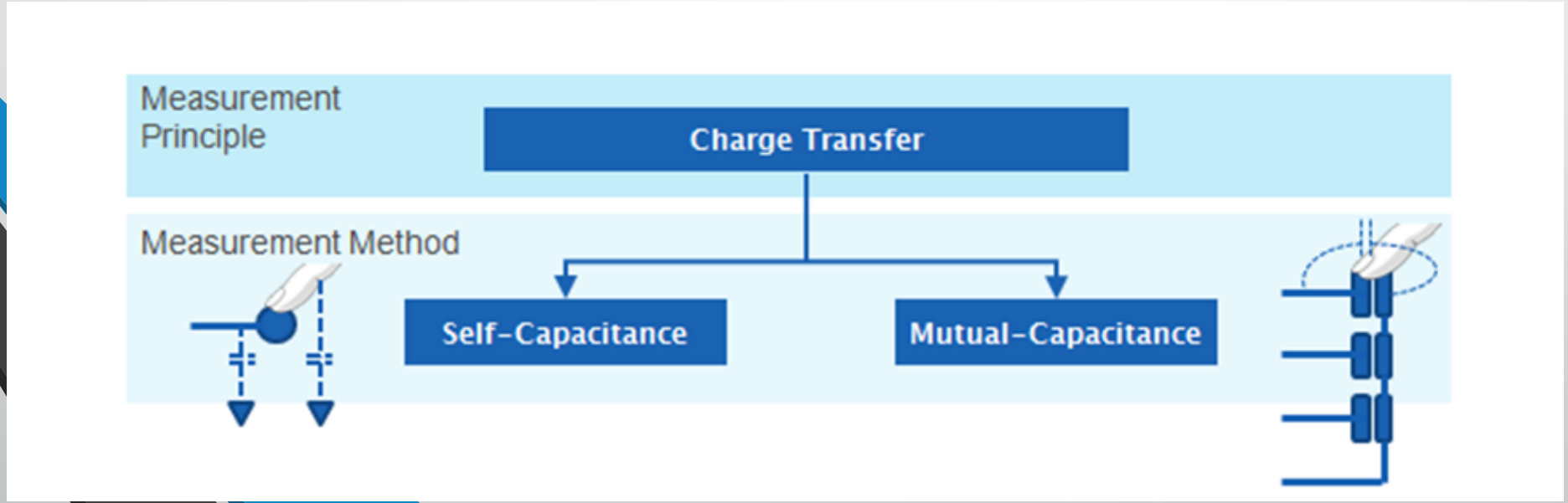
Capacitive Touch Sensor

There are three types of sensors:



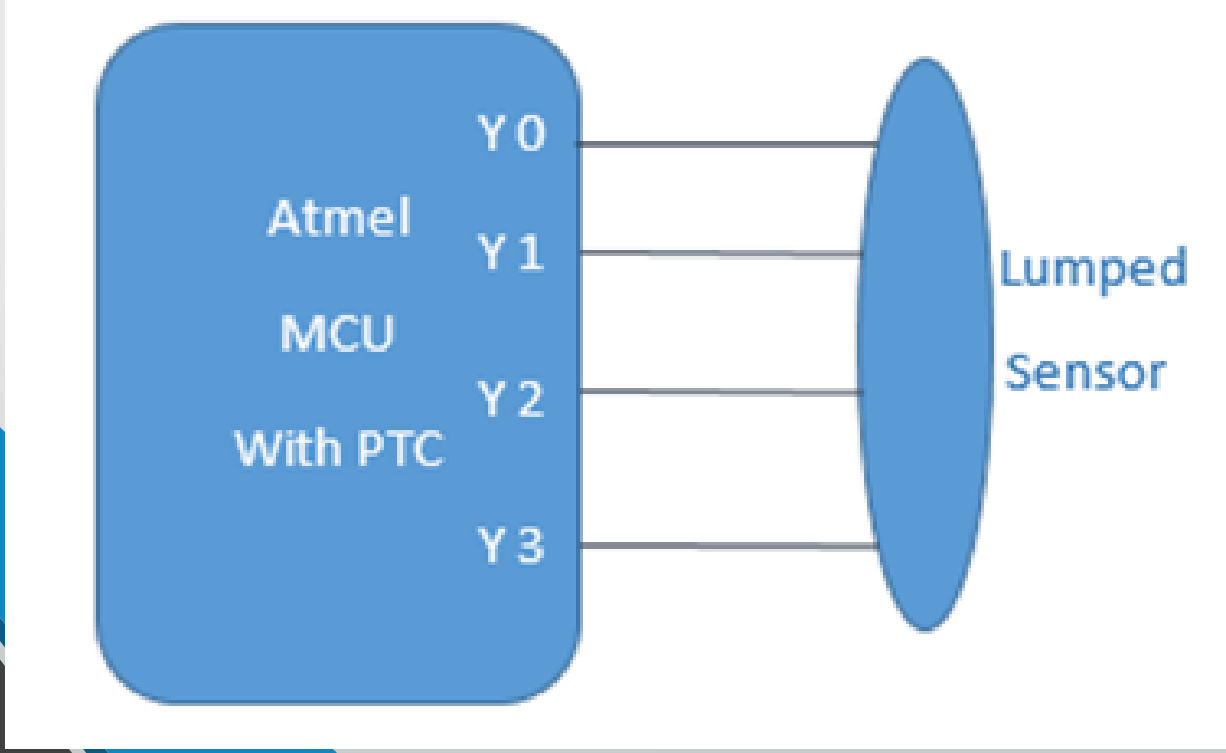
Capacitance Measurement Methods

Self-capacitance measurement method involves charging a sense electrode of unknown capacitance to a known potential. The resulting charge is transferred into a measurement circuit. By measuring the charge with one or more charge-and transfer cycles, the capacitance of the sense plate can be determined.

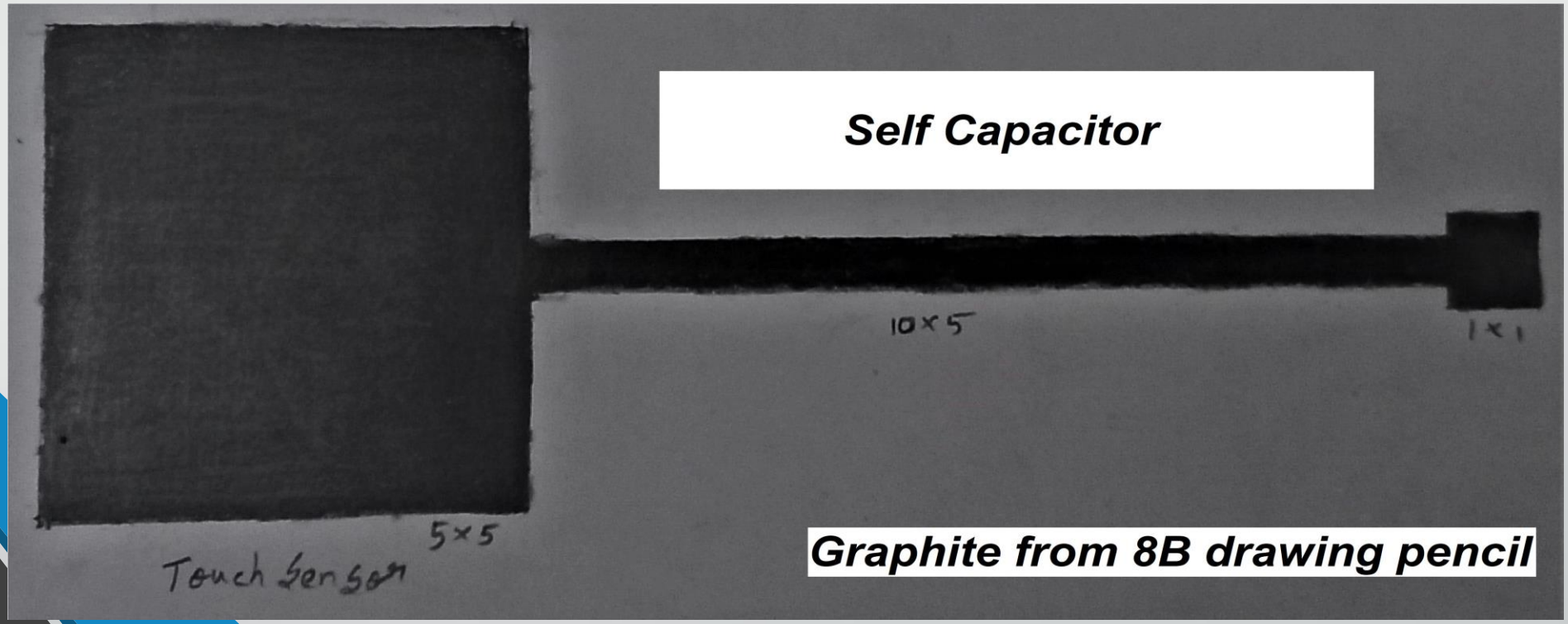


Capacitive Touch Lumped Sensors

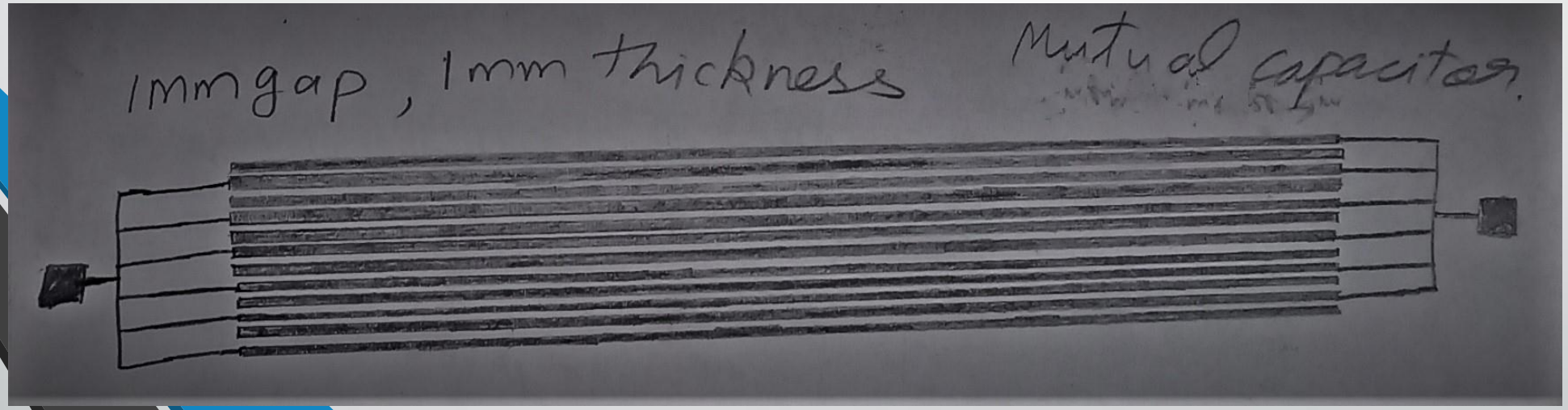
Lumped sensor configuration is a combination of multiple sense lines (Self-capacitance measurement) or multiple drive and sense lines (Mutual capacitance measurement) to act as one single sensor. Lumped mode acts as a tool for application developers to improve overall system performance.



In this project we are using a self capacitance sensor,



This concept can also be implemented with a mutual capacitor by making some minor changes in the program in the micro-controller.



In this self capacitor,

1] Substrate used is an ordinary paper
The Thickness of the paper is 0.10mm.
2] The touch sensor is made up of graphite from an 8B pencil
Which contains nearly 90% of graphite in it.
3] Protective layer or lamination is given using an ordinary transparent cello tape.

Advantages

The main advantage of this kind of sensor is that, it can be constructed with the easily available materials like a ordinary paper, 8B pencil, and cello tape.

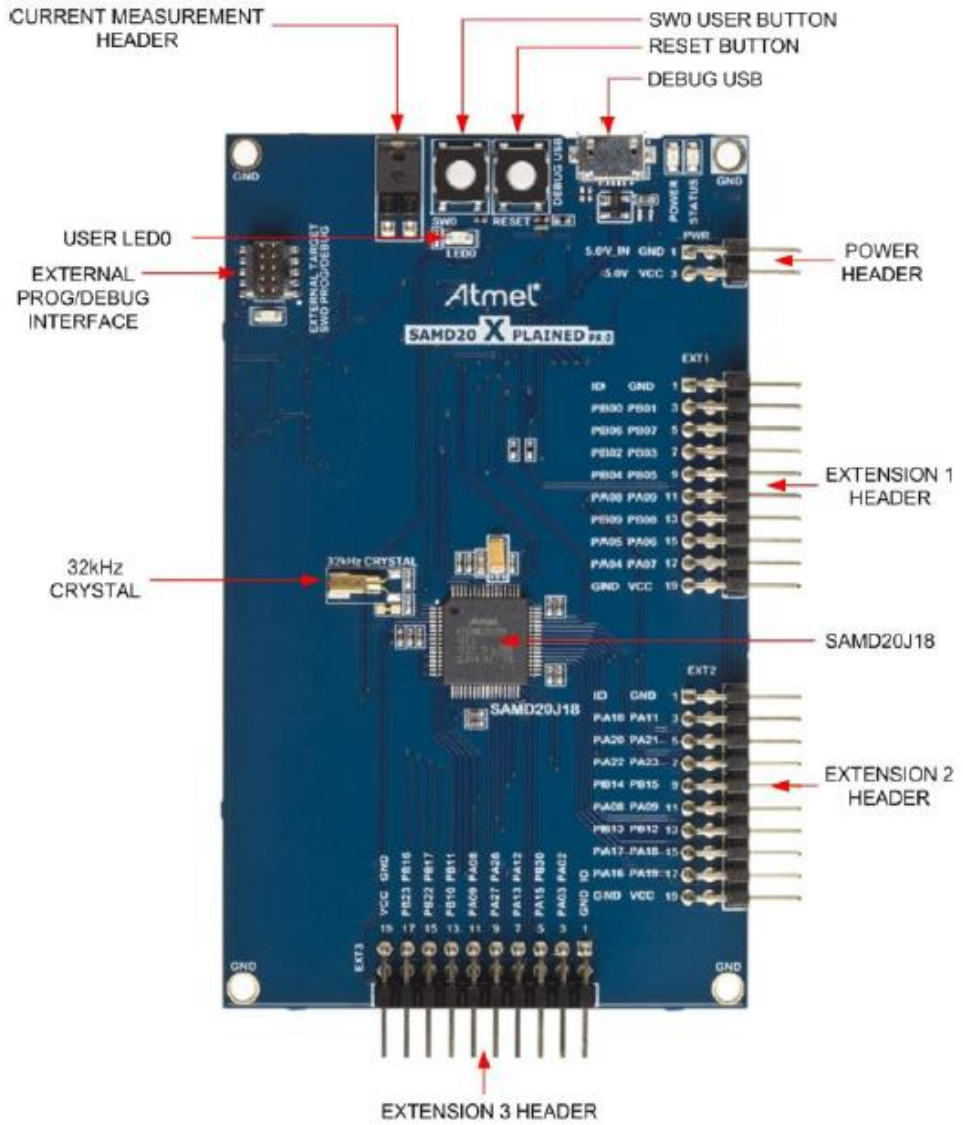
PROGRAMMING AND IMPLEMENTATION

Hardware Specification

Entity	Description
Microcontroller	ATSAMD20J18 (with PTC integrated)
Evaluation Kit	SAMD20 Xplained Pro
Voltage requirements	4.4V to 5.25V (according to USB spec)
Current requirements	500 mA to 2 A (according to USB spec)
I/O components	One LED and one user button (with extension headers for connecting the touch sensor)

SAMD20 Xplained Pro

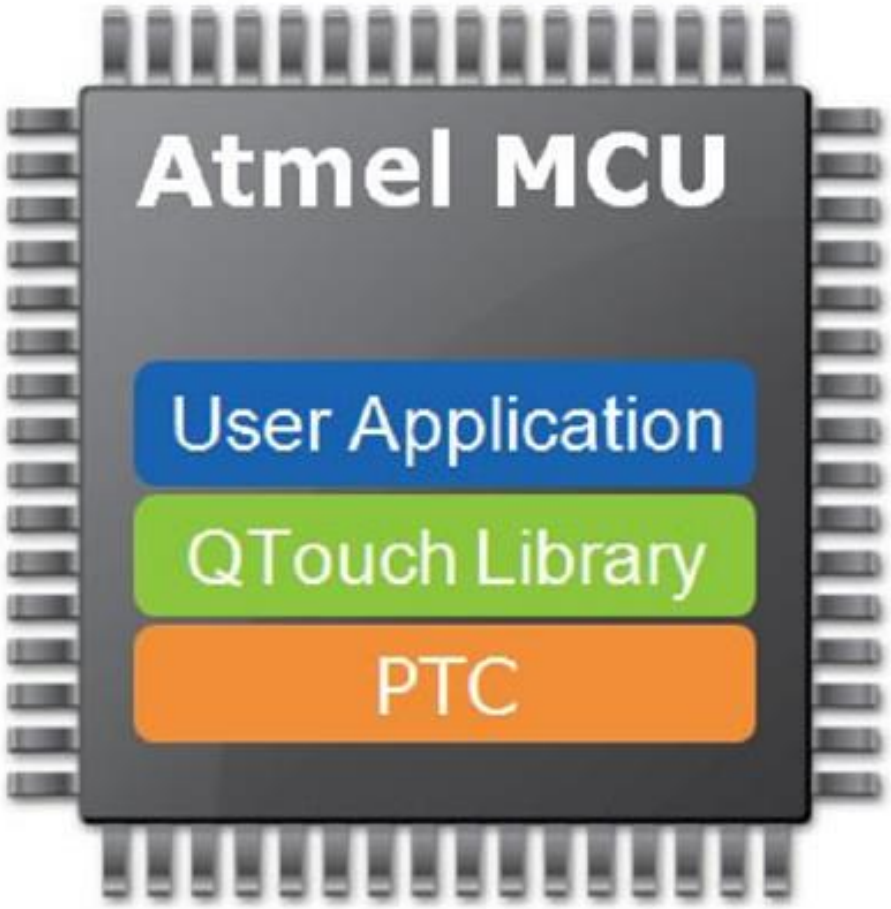
Figure 1-1. SAM D20 Xplained Pro evaluation kit overview



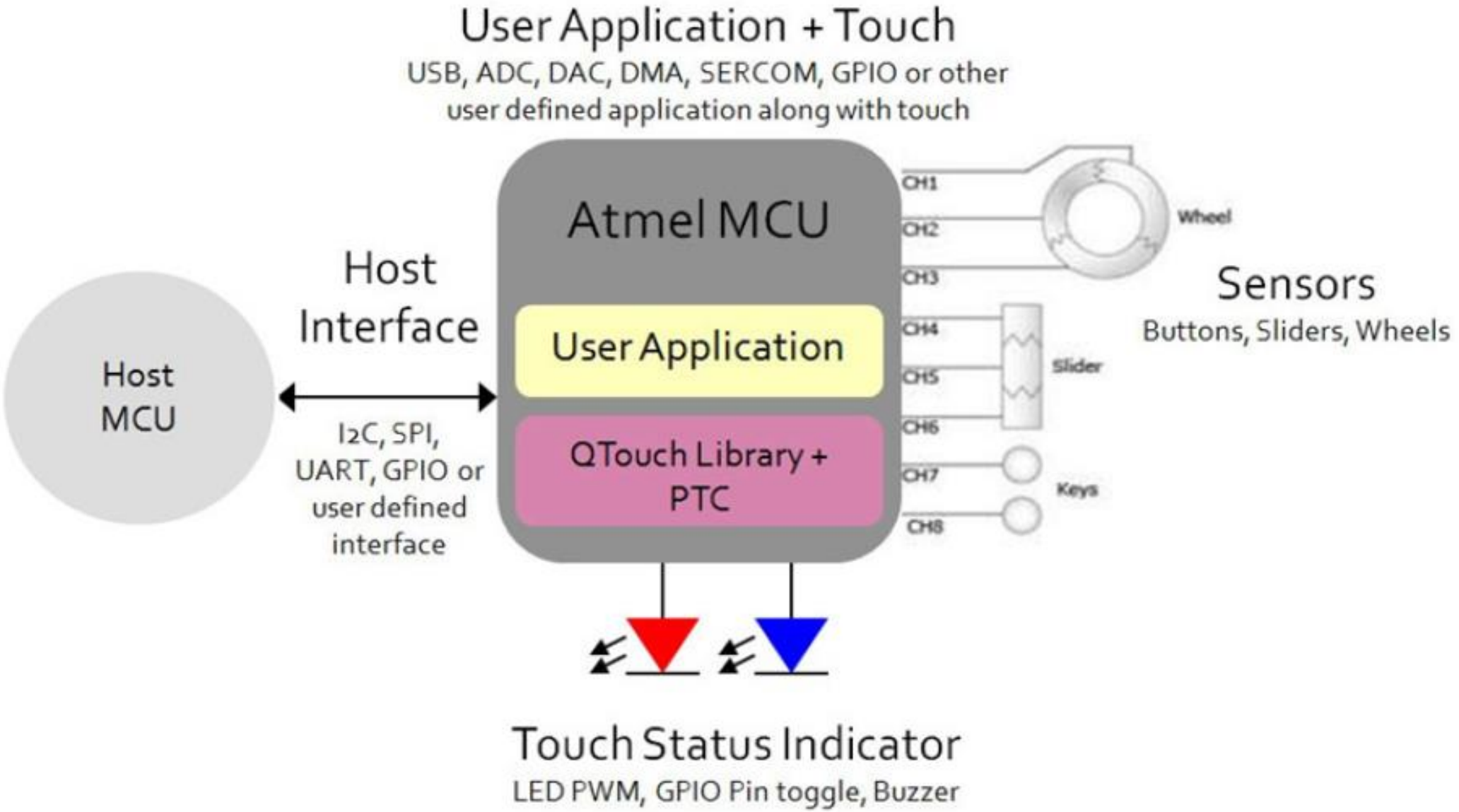
Software Specification

Entity	Description
Language	C
Method used	Self Cap.
Compiler	GNU ARM GCC Compiler
IDE	Atmel Studio 7
Libraries	• ATMEL QTouch Library 5.0.1 • ASF
Software Tools	• QTouch Analyzer

PTC (Peripheral Touch Controller) Overview



Application Design Approach

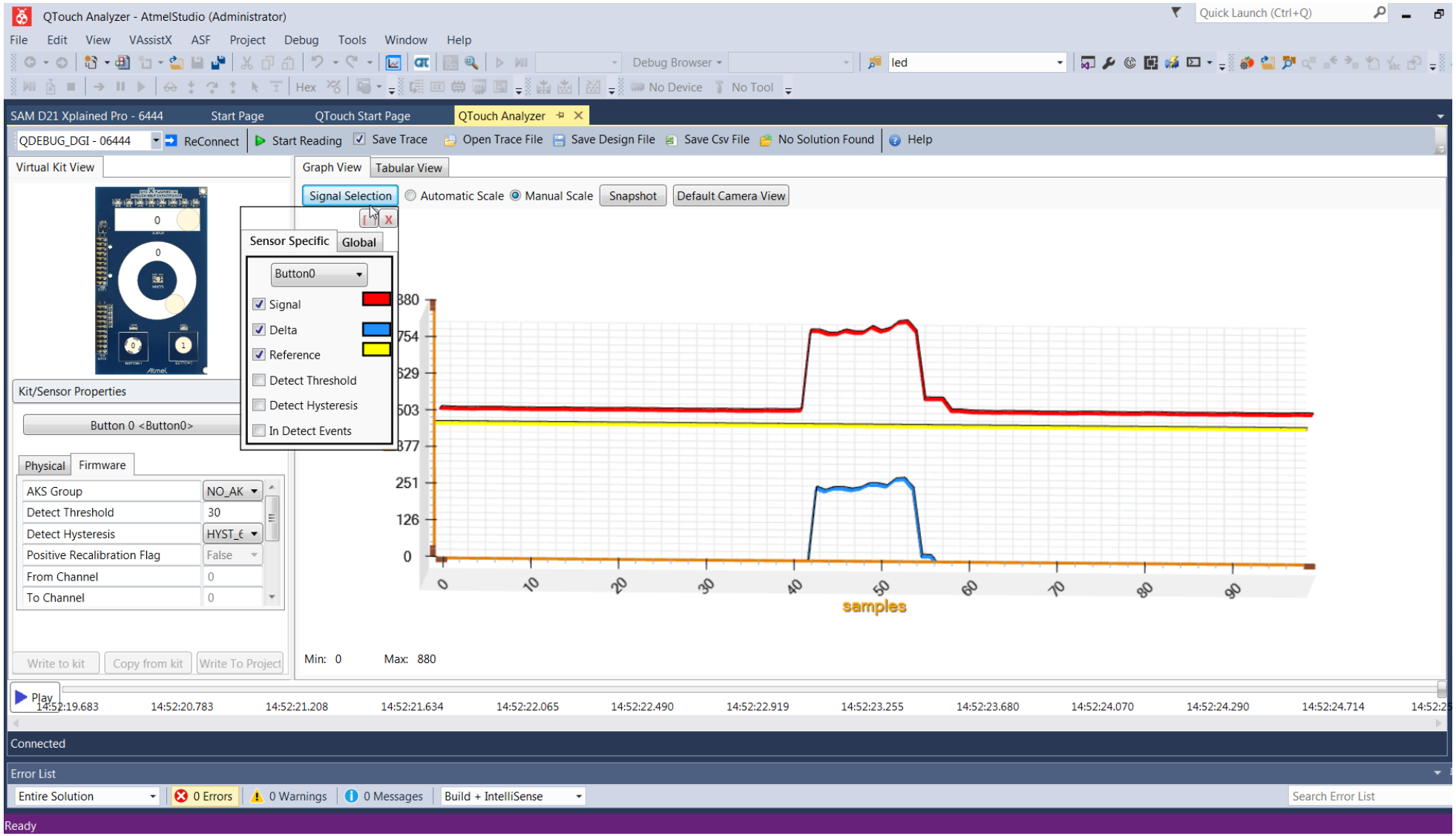


Signal, Reference, Delta, Gain, Noise and Threshold

- Signal is the raw signal/capacitance value obtained from the sensor by the PTC. Got during runtime
- Reference is the ideal state capacitance of the sensor (without touch). Configured during the starting of the program.
- Delta is the difference/change in capacitance between the signal and the reference. Calculated during runtime.

  Delta = (Signal - Reference)
- Gain is the multiplicative factor of the delta used to increase the delta value, if very low. Gain can be from 1 (no scaling) to 32 (scale-up by 32).
- Noise is the slight, varying increase in the delta, due to external factors like magnetic field, electric field, moisture.
- Threshold is the minimum delta value to confirm the user touch. If delta value is below the threshold value, it is considered as noise.

QTouch Analyzer



Custom Sensor Configuration

Parameter	Value
Gain	GAIN_1 (no scaling)
Threshold	100u (100 femto Farad)
Sensor measurement interval (INTERRUPT FREQUENCY)	50u (50 milli seconds)
Filter level setting	FILTER_LEVEL_64 (64 samples)

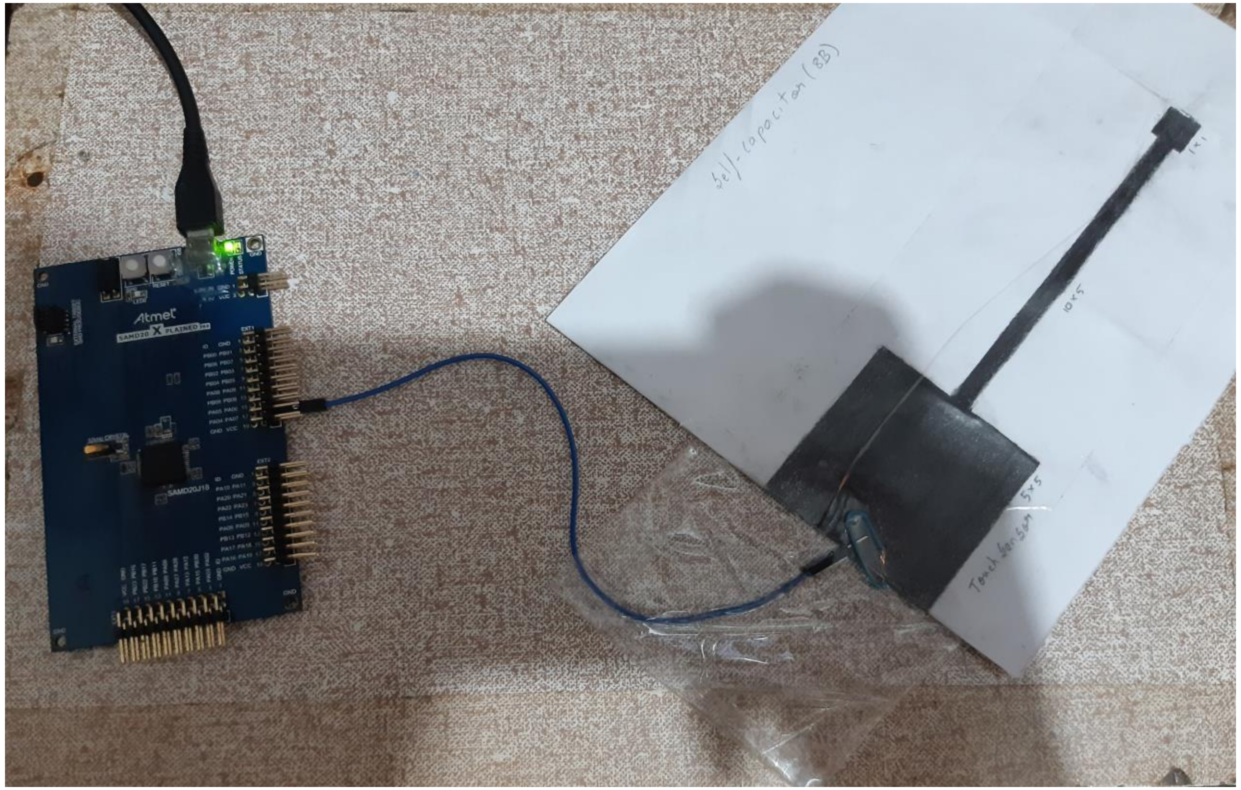
Core Algorithm/Pseudocode

```
init()       // initialisation and configuration
while(1)     // forever loop    "super loop"
{
        touch_sensors_measure ();    // if measurement done, it sets the flag measurement_done = 1
        if(measurement_done == 1)         // if flag is set,
        {
                measurement_done = 0;   // set the flag back to 0.
                sensor_state = get_sensor_state();        // get touch status
                if (sensor_state == 1)   // touch is done
                {
                        //LED on
                }
                else                     // touch not done
                {
                        //LED off
                }
        }
}
```

Algorithm Continued…

```
void touch_sensors_measure ()
{
        if(INTERRUPT_flag == 1)    // if hardware interrupt triggers the flag
        {
                INTERRUPT_flag = 0;    // flag is set back to ideal state
                /*
                 * MEASURE THE SENSORS
                 * --------------------
                 * checks the CONFIGURED pin (our sensor)
                 * calculates the delta => with the help of API functions of "QTouch Library”
                 */
                // set sensor_state to 0 or 1, based on the gain, i.e.,
                // if (delta > threshold) sensor_state = 1;
                // else sensor_state = 0;
                measurement_done = 1;   // sets the measurement_done flag to 1, since the sensor_state is updated
        }
}
```

PROJECT DEMO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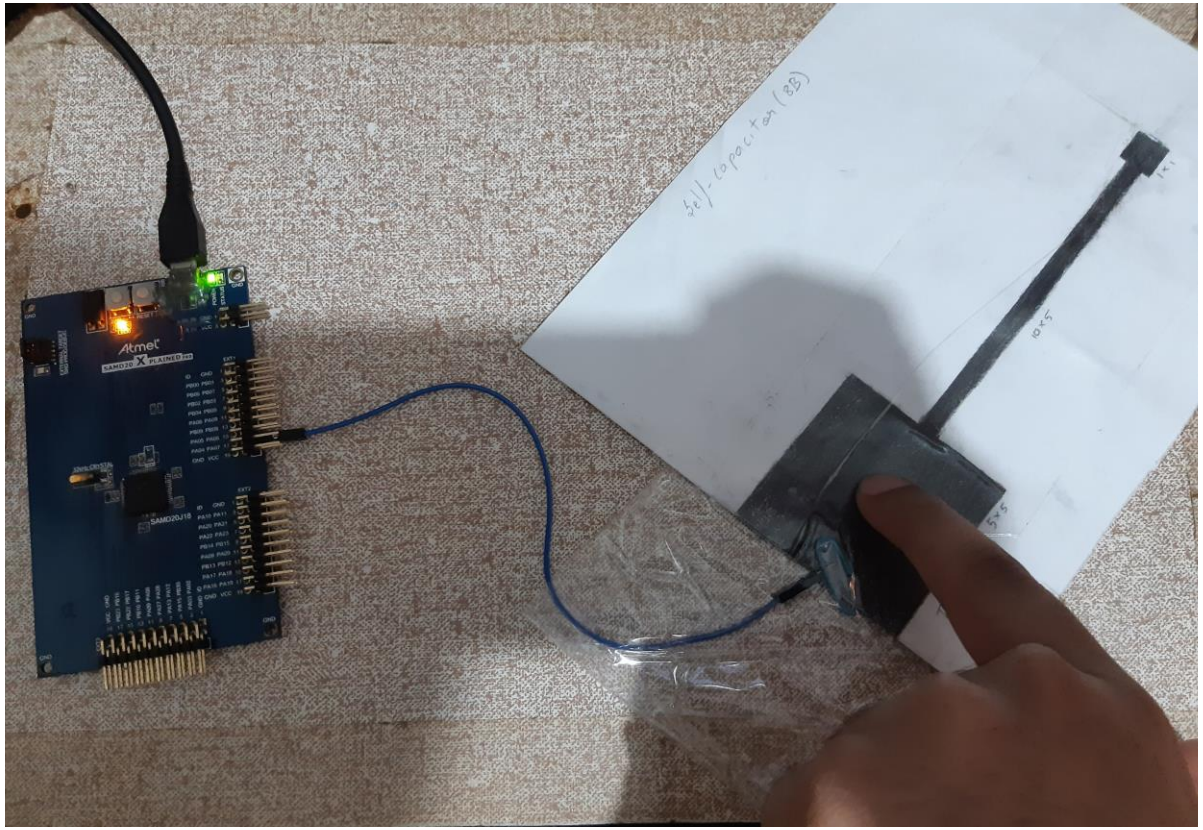
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< One demo video is been removed to reduce the ppt's file size and to avoid problems when taking print out. >

Thank you

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