Application Report
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How to Use TI's 4-Wire TSC to Control an 8-Wire Resistive Touch Screen

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ABSTRACT

This application report implements a Texas Instruments 4-wire touch screen controller (TSC) to control an 8-wire touch screen and discusses features and performances for such applications.

Texas Instruments (TI) provides various TSC devices for the 4-wire or 5-wire resistive touch screens (TS). A TI 4-wire TSC device, such as the ADS7843, TSC2003, or TSC2046, is ideal for controlling a 4-wire TS, but It can also be used on an 8-wire TS.

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1 Using 4-Wire TS Technology

In a 4-wire resistive TS, the two transparent resistive layers, the X and the Y, are assembled one on top of the other and separated by insulating spacers, as shown in Figure 1.

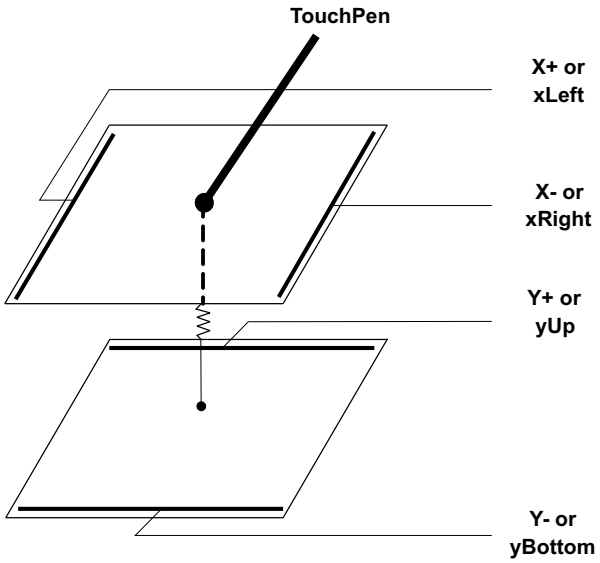

Figure 1. The 4-Wire Resistive TS Structure

Figure 1 shows the two conductor bars, each at one end of the X- or Y-layer, which lead to 4 wires, named X+, X–, Y+, and Y–, or Left, Right, Top, and Bottom, respectively. Each touch or press on the TS connects the two layers at one point.

When measuring the X-direction touch location, an *excite* or *force* voltage is applied crossing the X+ to X–, and the voltage gradient on the X resistive layer corresponds to the touch location. At this moment, no voltage is applied in the Y-layer, and the Y+ line is used as the voltage probe or the X touch location detect , from which the TSC obtains divided voltage on the X-layer, or the X touch data (see Figure 2).

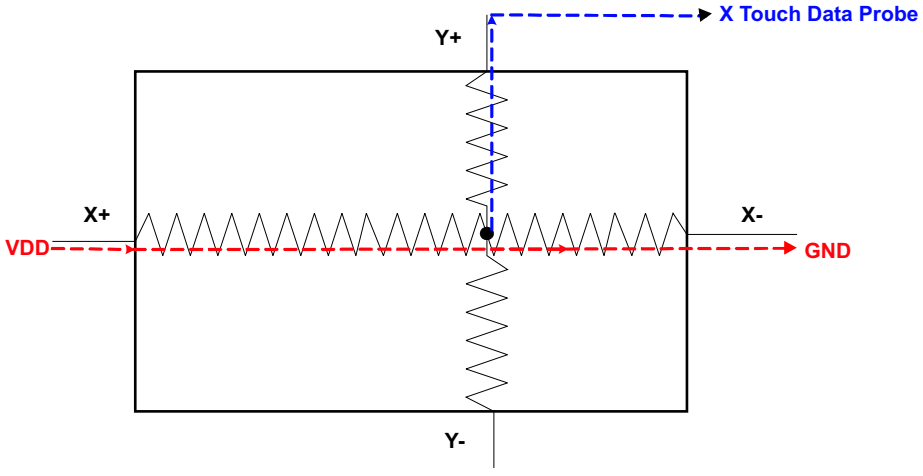

Figure 2. Measuring X Touch Location on a 4-Wire Resistive TS

Measuring the Y-direction touch location is similar to that on the X-direction, except that the excite voltage is applied to the Y-layer and the data is probed at X+.

Example 1: Using a 3-V VDD and 12-bit-resolution TSC, such as TSC2046, to control a 4-wire TS. A touch on the TS (1/3 on X-direction and ½ or center at Y-direction) can initialize the following actions:

1. Measure X-data:

– The TSC applies a voltage crossing X+ to X–.
– The measured voltage at Y+ is obtained (e.g., 1 V).
– The TSC samples, converts, and stores/transfers the X-data (= 1365 or 1/3 × 4095).

2. Measure Y-data:
   – Disconnect the voltage from the X-layer and apply it to the Y-layer.
   – A voltage at X+ (e.g., 1.5 V) is measured.
   – The TSC samples, converts, and stores/transfers the Y-data (= 2047 or 1.5/3 × 4095).

2 Using 8-Wire TS Technology

The 8-wire TS structure and technology is similar to the 4-wire one, previously discussed, but with each edge providing one more sensing or referencing line, as shown in Figure 3.

The four additional wires, located at each end of the X- or Y-layer, provides the additional *sense* or *reference* measurements directly off the screen, which can be used to perform a certain auto-calibration to compensate/reduce some errors, such as the resistance error on connecting or *pigtail* resistance.

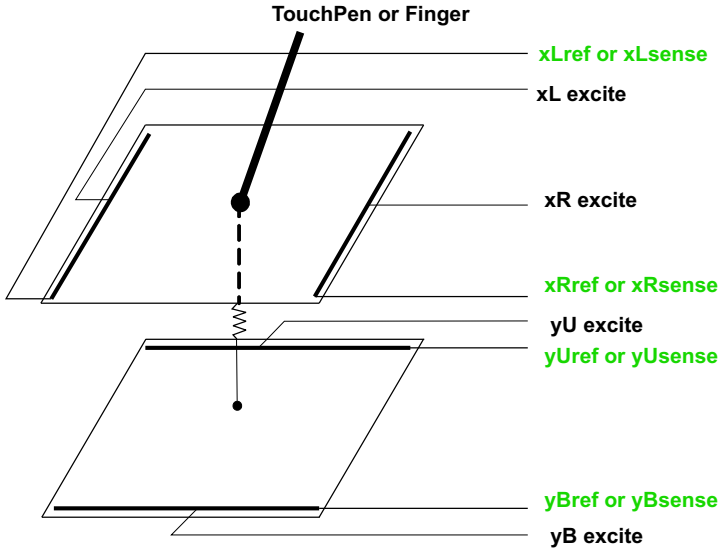

Figure 3. The 8-Wire Resistive TS Structure

Example 2: The same as Example 1, except that both the TSC and TS are 8-wire. So, to measure the X-location:

- The TSC applies a voltage crossing X+ to X–.
- The measured voltage at Y+ is obtained (e.g., 1 V) and also gets the X+ Sense and X– Sense at each of the two X-layer's ends.
- The TSC then samples, converts, and stores/transfers three sets of data: the X data (= 1365 or 1/3 × 4095); the X+ end data (e.g., 200); and the X– end data (e.g., 3900);
- The final X-data is: (1365–200)/(3900-200) × 4095 = 1289 .

3 Using 4-Wire TSC to Control 8-Wire Screen

Can a TI 4-wire touch screen controller be used to control an 8-wire touch screen? Yes, and this section shows how.

One way to connect an 8-wire TS to a TI 4-wire TSC is shown by Table 1, where the 8-wire TS's *Excite* and *Sense* wires are shorted and routed to the corresponding wire at the 4-Wire TSC.

Table 1. Connection From 8-Wire TSC to 4-Wire TSC

From 8-Wire TS Pin	Connected to 4-Wire TSC Pin
Left Excite and Sense	X+
Right Excite and Sense	X–
Up Excite and Sense	Y+
Bottom Excite and Sense	Y–

Connecting only the Excites of the 8-wire TS to the corresponding pins at the TSC can also work functionally. But, keeping the 4 sense wires floating may introduce extra noise to the panel.

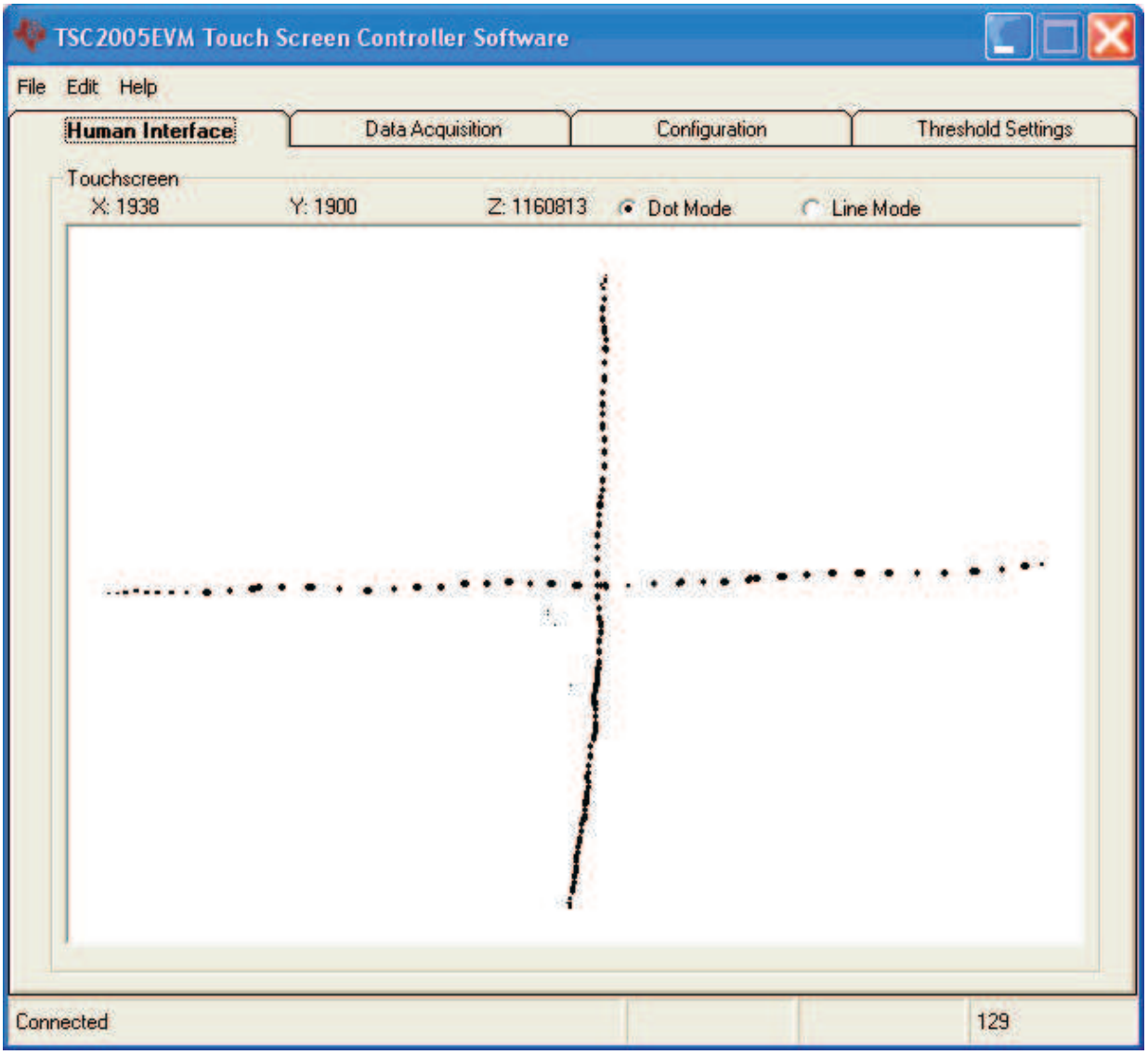

Figure 4. Touch Measure With *Excite* + *Sense* or *Excite Only* Connection

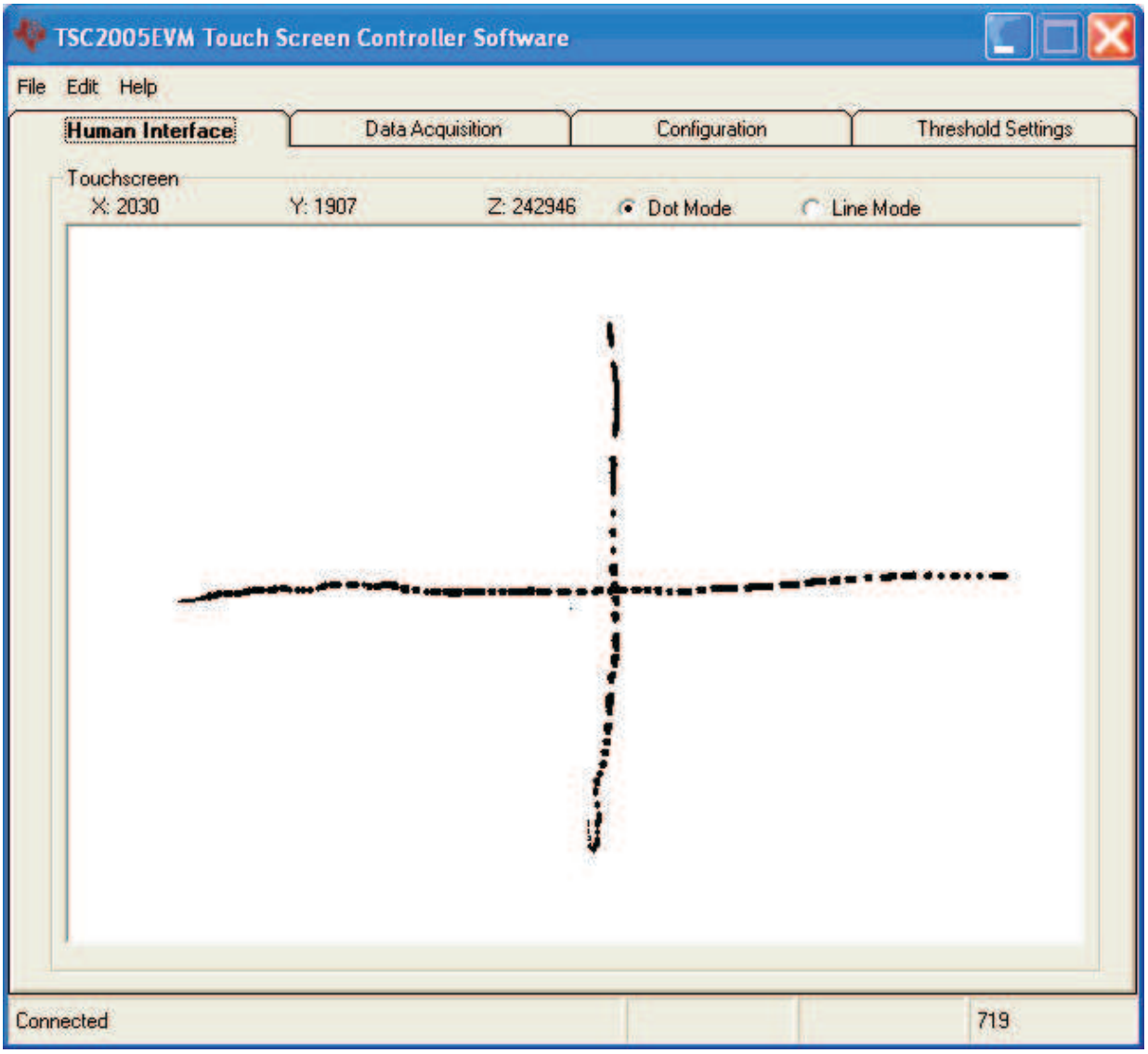

Figure 5. Touch Measure With *Sense Only* Connection

Functionally, connecting only the Sense wires also works, but the accessible range may be reduced. Figure 4 and Figure 5 show examples of some test results in which a TI TSC EVM and a 3M™MicroTouch™ 15-inch, 8-wire PL resistive touch screen were used. The touch pen was moved crossing the X- or Y-direction on the TS from one end to another. Note the differences at each of the edges under different connections. Obviously, Figure 4 and Figure 5 show that there is more unaccessible area at the edges with the *Sense Only* connection.

4 Discussions

Some features and performances of the 8-wire TS + 4-wire TSC system are discussed in this section.

4.1 Resolution

The resolution of the TS measurement is mainly decided by the number of bits of the TSC device. For example, a 12-bit TSC can ideally offer the 4096 × 4096 resolution across the whole screen; for an 8-bit TSC, the resolution is 256 × 256.

The number of points per square inch depends on the resolution (or bits) of the TSC and the size of the TS. For example, for a 12-bit TSC, the 5-inch TS, typical with width x height = 4×3, has 1024 × 1365 points per square inch; a 15-inch TS (12×9) has 341 × 455 per square inch.

With TI's TSC devices, the resolution is programmable at 8-bit, 10-bit, or 12-bit. The resolution does not change, regardless of whether the TSC is connected to control a 4-wire or an 8-wire TS.

4.2 Accuracy

Touch data accuracy is determined by the TSC's performance, as well as various other reasons such as circuit noise, power-supply fluctuation, the TS panel's mechanic vibration, environment effects, whether there is HW/SW filtering/averaging, whether there is HW/SW calibrations, etc.

When using a TI TSC, the patented ratiometric technology from TI provides high-performance measurement. This performance does not change, regardless of whether the TSC is connected to control a 4-wire or an 8-wire TS.

4.3 Connect Effect

For an explanation of the measurement error due to the TS-to-TSC connection, see Figure 6, which shows the X-axis measurement connection effect, as an example.

In Figure 6, the actual TS resistance in full X-axis is within the two points X+' and X-'; while the actual TSC reference in full X-axis is within the two points X+ and X–. They are different, which is the connection error. The error is caused mainly by the *connection* or *pigtail* resistance on the TS. For example, Figure 6 shows that the X-axis *pigtail* resistance is that from X+' to X+ and from X-' to X- on the TS connector.

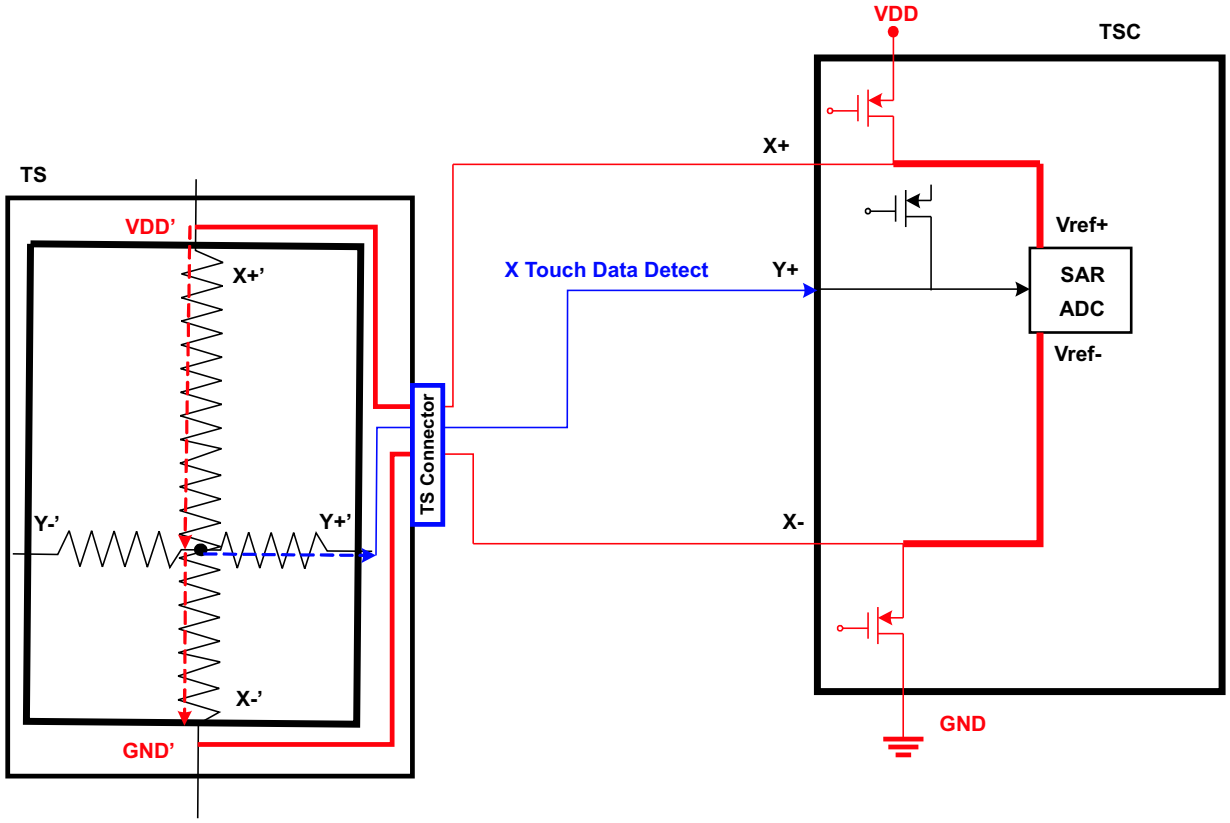

Figure 6. TS X-Data Measurement With Differential TSC

Thus, the full range of the resolution, from 0 to 4096 on 12-bit TSC, is usually not accessible due to the connection or *pigtail* resistance (that may be around several ohms to under 50 ohms). For example, from TS end-to-end, the TSC may be able to read only from 200 to 3900, not from 0 to 4096.

Using an 8-wire TS provides the extra 4 end points of reference measurements, which may be used to reduce/calibrate the *pigtail resistance* and other kind of errors on a TS.

When using a 4-wire TSC on an 8-wire TS, the combined touch system is still a 4-wire one, without the extra sense/reference benefit.

5 Conclusion

- One can use one of TI's 4-wire resistive TSCs to control a 4-wire or 8-wire TS.
- The performance of a TI 4-wire TSC does not change, whether it controls a 4-wire or an 8-wire TS.
- Because there is no extra Sense/Reference on the 4-wire TSC system, no benefit may be realized due to the extra references in an 8-wire touch system.

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