

Interlink Electronics FSR® Force Sensing Resistors®

4-Zone Mouse Sensor and USB Interface Chip Integration Guide

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1.0 Introduction

The 4-zone Force Sensing Resistor (FSR) paired with a suitable actuator can be implemented as a finger-actuated "mouse" pointing module. This pointing module provides accurate 360-degree mouse control. Users control direction by applying pressure in the direction of the desired movement and adjust speed by altering the amount of pressure on the device.

The purpose of this document is to guide users through the successful integration of a USB controller chip (microprocessor) and the Interlink Electronics 4-zone FSR.

2.0 Scope

This Integration Guide provides the OEM integrator with all of the necessary technical information to successfully integrate the Interlink Electronics 4-zone FSR and USB microcontroller chip into products such as:

- NEMA-rated industrial pointing devices
- industrial keyboards
- military computers

Sensor and chip part numbers are detailed in section 10.

3.0 Theory of Operation

The most basic FSR consists of two membranes separated by a thin air gap. The air gap is maintained by a spacer around the edges and by the rigidity of the two membranes. One of the membranes has two sets of fingers which are interdigitated and electrically distinct; each set connects to one trace on the tail. The other membrane is coated with FSR ink. When the two layers are pressed together, the FSR ink shorts the two traces together with a resistance that depends on applied force.

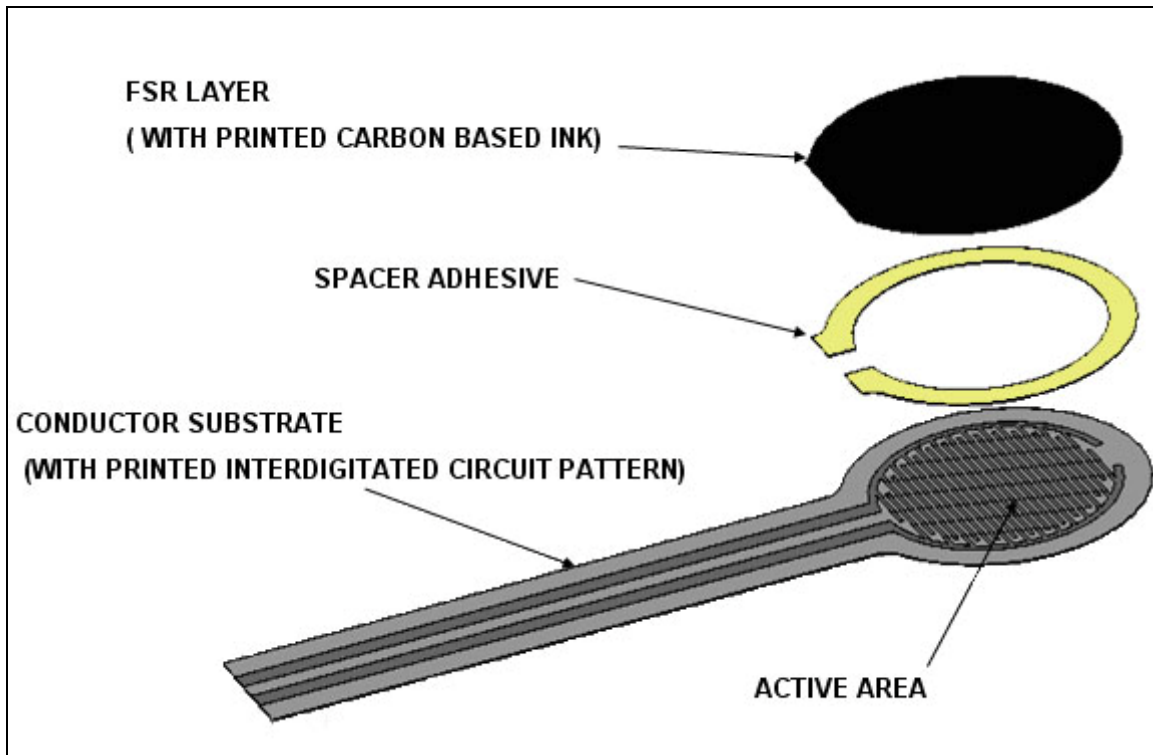


Figure 1: Exploded view of a standard single-zone FSR

The 4-zone FSR is simply a combination of four basic FSRs arranged in a North, South, East, West pattern. Each zone interpenetrates into the two zones on either side of it. This overlapping of the zones allows us to determine how much force is in each zone relative to the others. Once the relative force in each zone is known, the direction and speed of the mouse pointer can be determined.

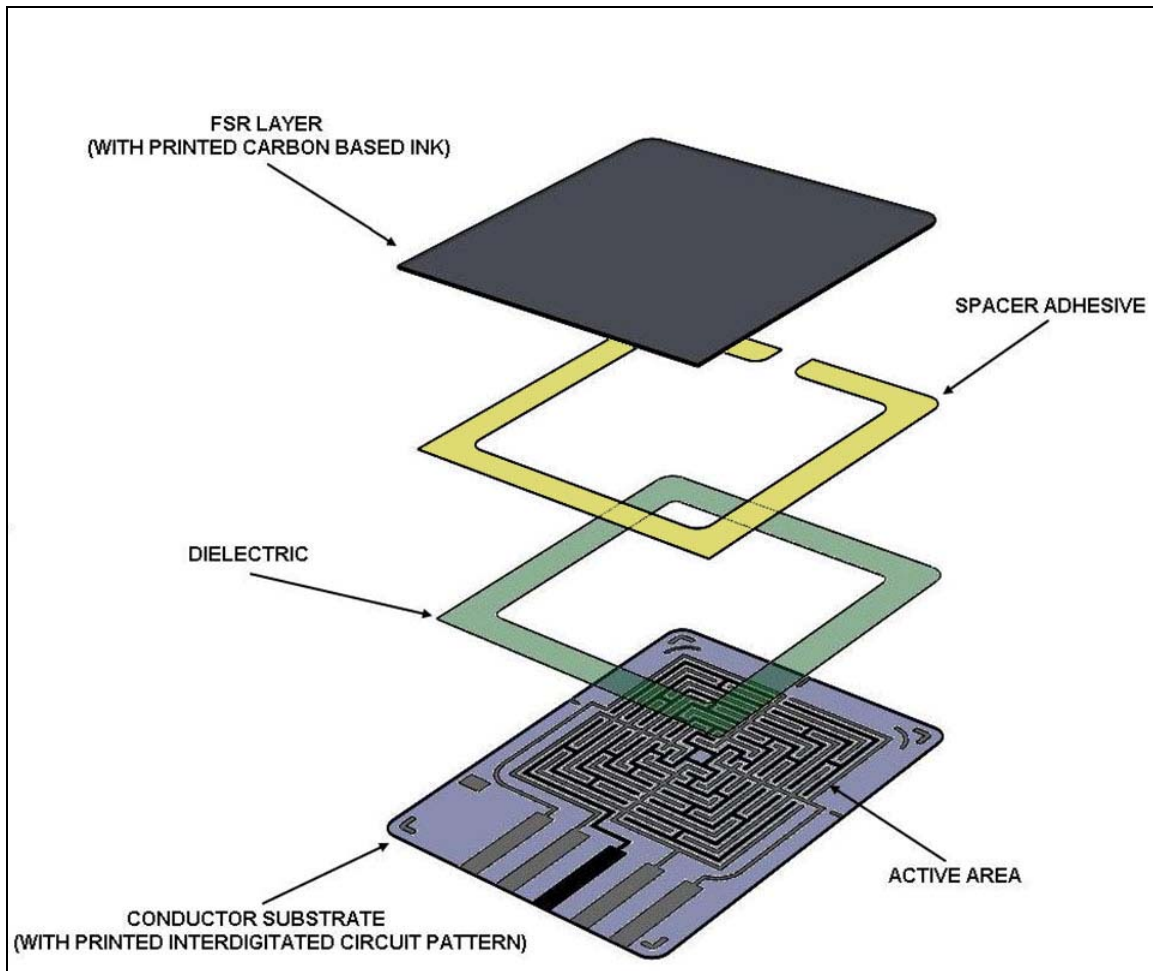


Figure 2: Exploded view of 4-zone FSR

4.0 Mounting

Mechanical installation of the 4-zone FSR has a few critical features that must be considered for mounting.

To ensure proper registration of the sensor, crop marks made in the copper layer should be included in the PCB layout. Sufficient registration accuracy is achievable by placing the FSR by eye using the crop marks.

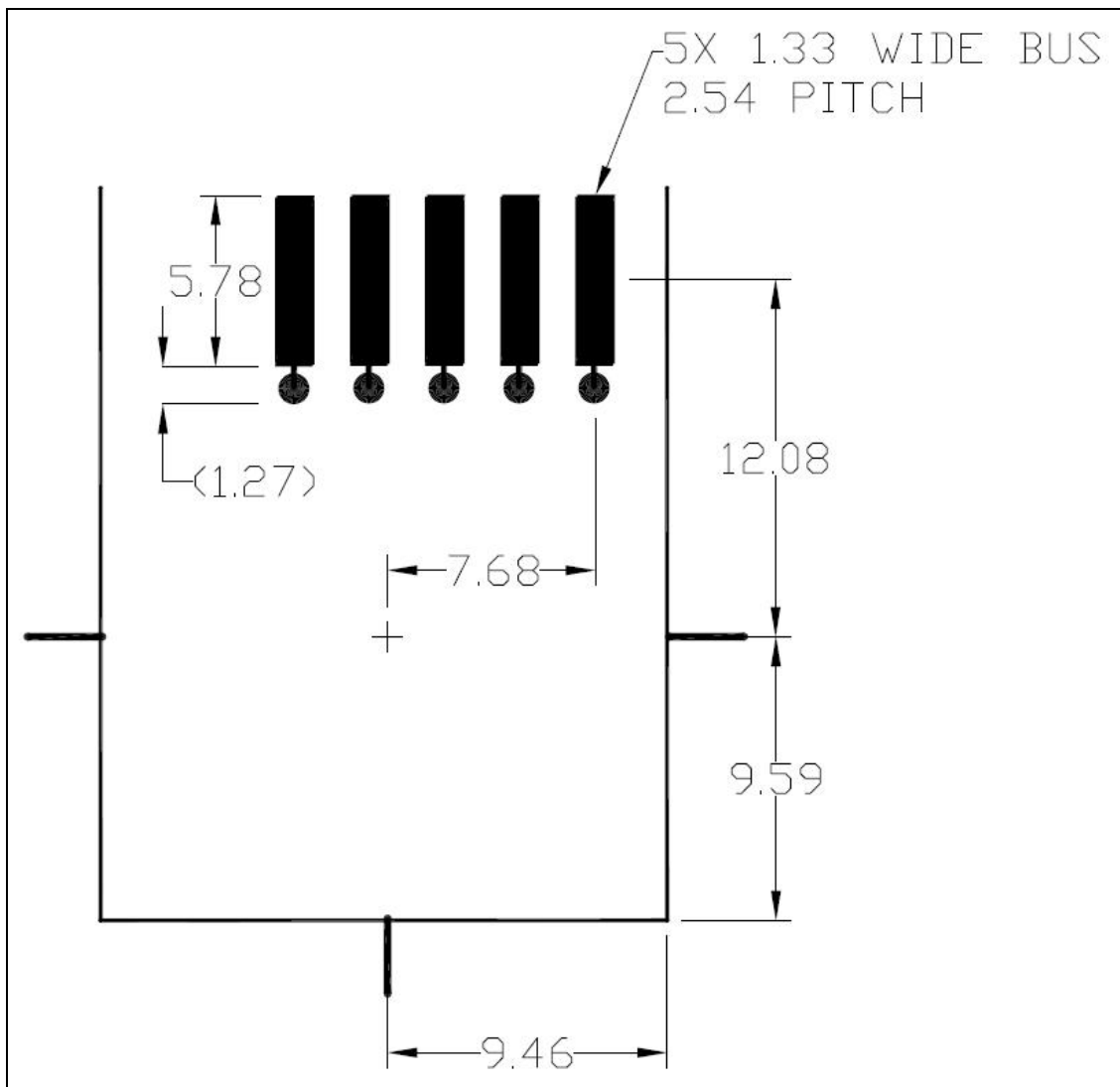
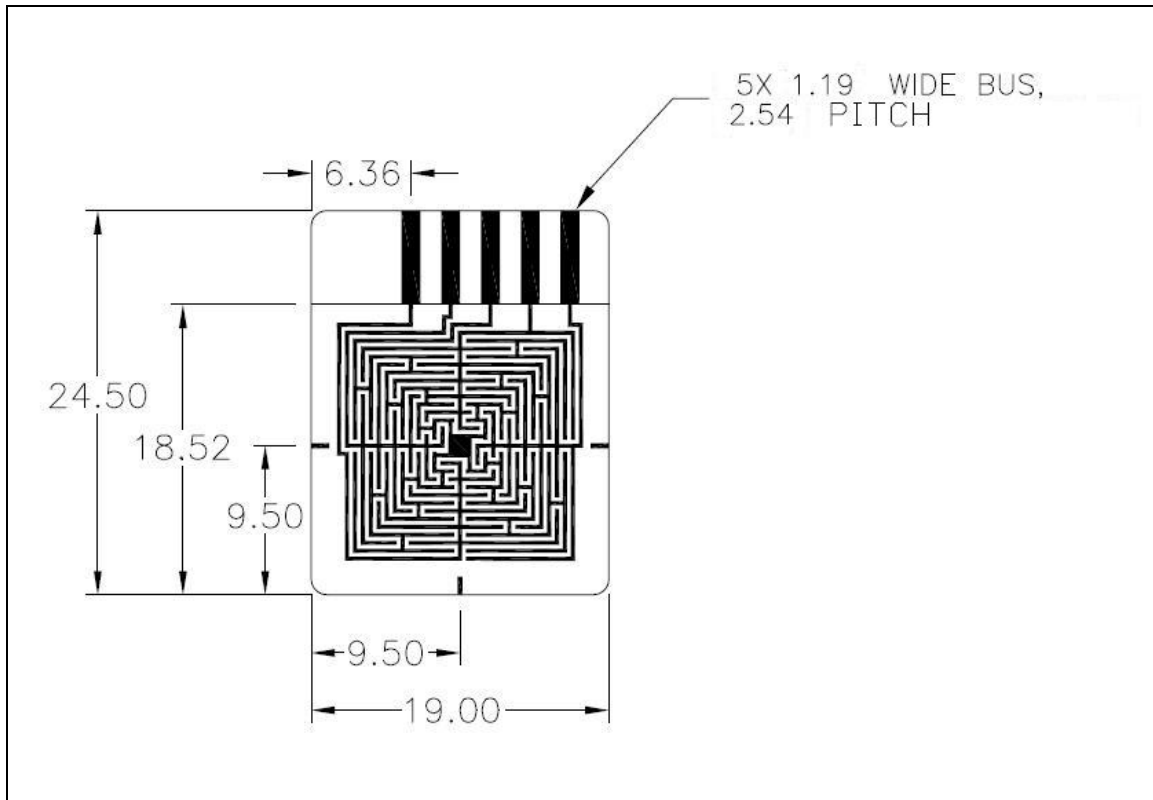


Figure 3: PCB copper layer showing crop mark locations and size/location of pads.
(All dimensions in millimeters)

Copper traces should not be routed underneath the sensor; they will interfere with its proper operation. If traces must be routed towards the sensor, vias should be used to bring the traces to another layer of the board before the sensor's active area is reached. Interlink recommends that the vias do not extend more than 1.27mm from the bottom of the pads. (See Figure 3)



**Figure 4: 4-zone FSR showing overall dimensions, center of part, and size/location of contacts.
(All dimensions in millimeters)**

Heat generated during the soldering of components can damage the FSR. Therefore, the sensor should not be mounted until PCB assembly is complete. When laminating the FSR to the PCB, be sure to use a hard roller or other depression tool to ensure proper bonding of the sensor's pressure-sensitive adhesive and the removal of any air bubbles.

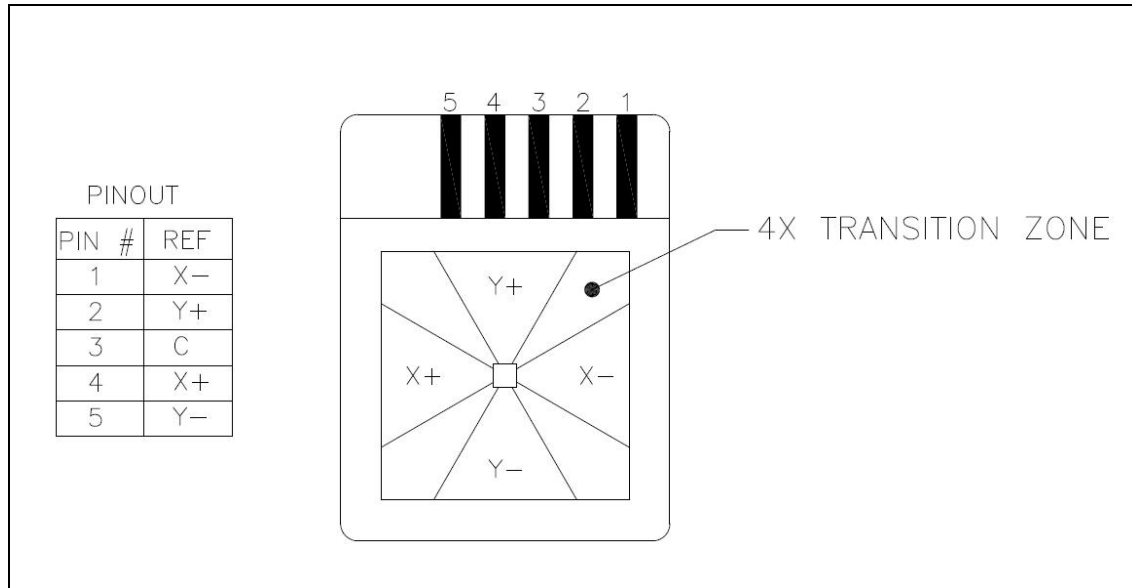


Figure 5: 4-zone FSR pinout reference. Sensor is shown with silver contacts facing away.

5.0 Connection

The 4-zone FSR is connected to the PCB with either a pressure-sensitive z-axis conductive adhesive or a heat-bonded z-axis conductive adhesive. Both methods of adhesion are meant to provide an electrical, not mechanical bond; therefore, a mechanical means of applying constant pressure to the joint should be incorporated into the mounting of the 4-zone FSR. This will prevent the delamination of the adhesive, which can lead to an open circuit and failure of the module.

Recommended Conductive Adhesives:

- 3M 9703/9705 Anisotropic Electrically Conductive Adhesive Transfer Tape
- 3M 7303 Heat-Bondable Anisotropic Electrically Conductive Adhesive Film

Constant pressure on the sensor contacts can be applied in a couple different ways. One method is to use the module's case or housing to apply pressure to the joint through a piece of rubber. The rubber is used to take up tolerances in the design and can be made as an extension of the actuator (See Figure 4). This design can provide a long-lasting high-quality connection and is appropriate for most designs.

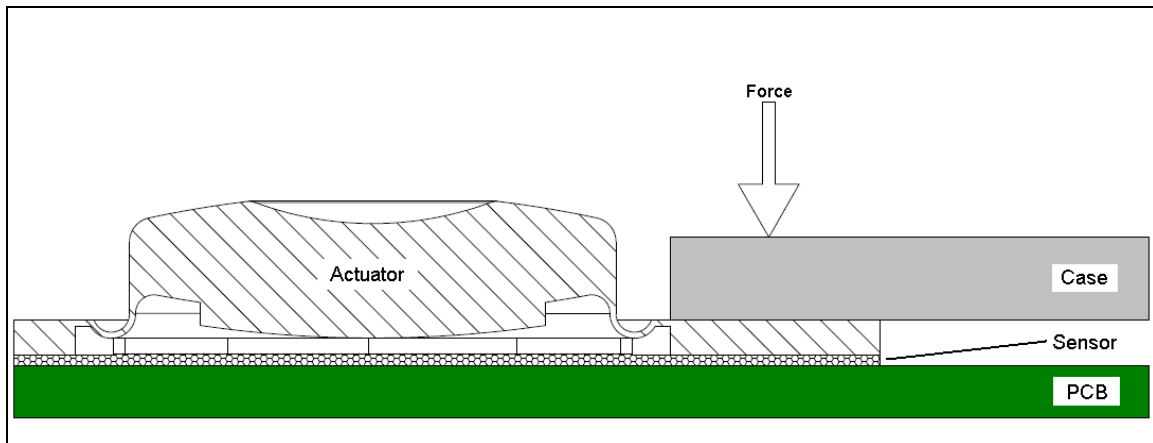


Figure 6: Cross section view showing constant pressure being applied to the sensor contacts by the module's case through an extension of the rubber actuator

Another connection method is to use a screw-down metal clamp to apply pressure to the sensor contacts through a piece of rubber. Again, the rubber is used to take up tolerances in the design. This is the most robust connection method and is appropriate for military applications.

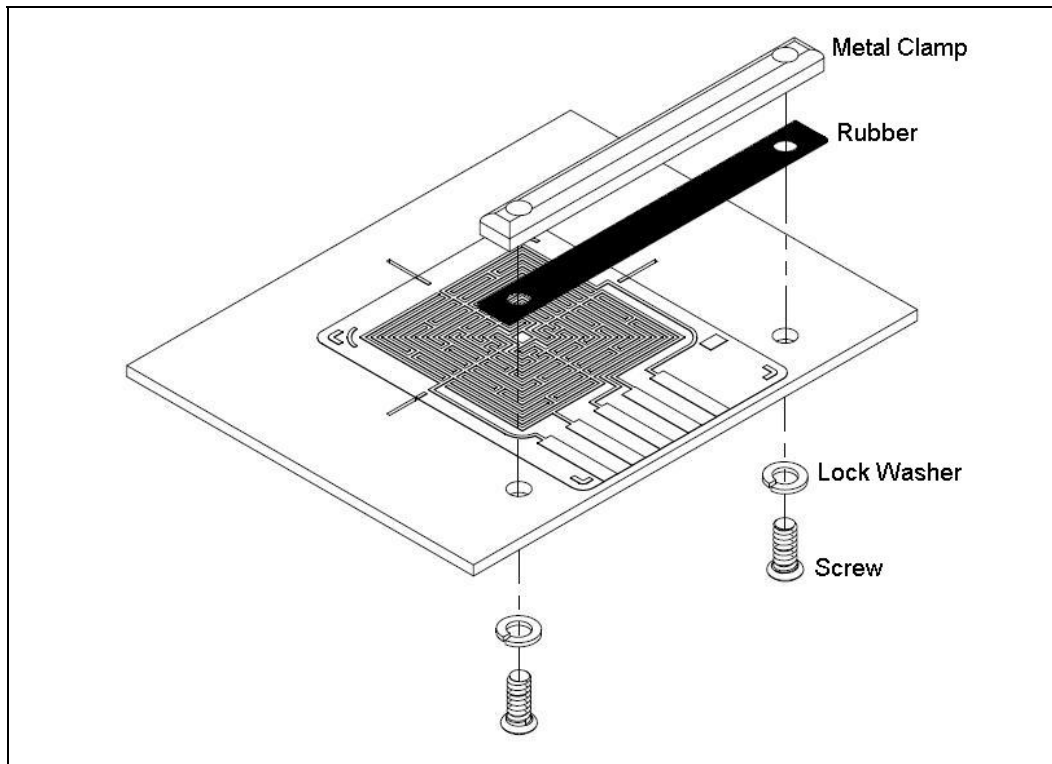


Figure 7: Exploded view of screw-down metal clamp assembly

6.0 Actuator

An actuator must be used to achieve the best pointing results with the 4-zone FSR. There are certain features on the actuator that are of special importance and extra care should be taken when designing them.

Proper alignment of the actuator over the sensor is essential for implementing a successful pointing device. Section 4 shows that the 4-zone FSR is registered to crop marks on the PCB; therefore, a registration system designed to align the actuator to the PCB should adequately ensure the correct alignment of the actuator to the 4-zone FSR.

To avoid preloading of the sensor, there must be a skirt surrounding the actuator. The skirt's job is to keep the actuator a minimum distance away from the sensor surface when not in use. However, the skirt cannot be made too tall or the module's actuation force will be adversely affected. Other design elements that should be paid close attention to are the actuator diameter and spherical radius.

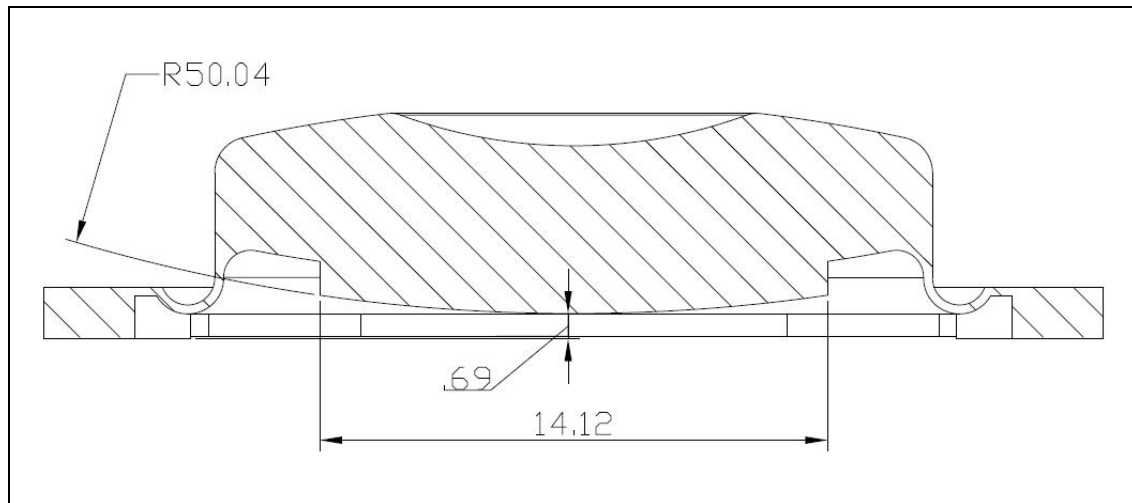


Figure 8: Cross section view of actuator. (All dimensions in millimeters)

The actuator design is vital to the correct operation of the 4-zone FSR. Interlink Electronics encourages customers to visit our website to download detailed CAD models of the rubber actuator. www.interlinkelectronics.com/FSRMouseSensor.php

7.0 USB Information

Communication to the microprocessor is done via USB and:

- Uses the low speed USB standard
- Is compatible with any USB 1.1 or 2.0 host
- Enumerates as HID device

The microprocessor reports data to the host at a rate of 50 reports/sec.

7.1 Device PID and VID

- This IC's Product ID (PID): 0x0002
- Interlink's Vendor ID (VID): 0x214A

7.2 Data Packet

The data packet from the chip is organized as:

- Byte 0
 - Bit 0 is the Left Button status
 - Bit 1 is the Right Button status
 - Bit 2 is the Middle button status
- Byte 1 reports the X direction. The values range from -127 to +127 counts.
- Byte 2 reports the Y direction. The values range from -127 to +127 counts.

7.3 USB Suspend Mode

The chip will *not* respond to a "suspend" command from the host. It will always stay active with the current consumption as described in section 8.3.

Note: This device will not wake the host from suspend mode.

8.0 Electrical Specifications

8.1 Controller Chip

The controller chip used in this schematic is microchip PIC18F14K50. This IC, when combined with Interlink's proprietary FW, forms the controller engine for this sensor type.

8.2 Clock Signal

The default setting for a clock signal comes from a 6MHz crystal. To meet your needs, Interlink can supply another version of this chip that will work with a direct clock signal.

8.3 Operating Current

Under normal operation, the device draws between 10mA to 12mA. This current draw is typical of a full assembly (chip, sensor, etc).

8.4 Mouse Speed Configuration

Mouse speed can be configured by the user. R1 is the controlling factor for this. The default value that is recommended by Interlink is 3.3K Ω . If desired, the user can change R1 values to slow down or speed up the mouse. In order to achieve a higher speed, the R1 value must be increased. Interlink recommends that the user should not exceed the limits of 1K Ω to 10K Ω . (See Figure 8)

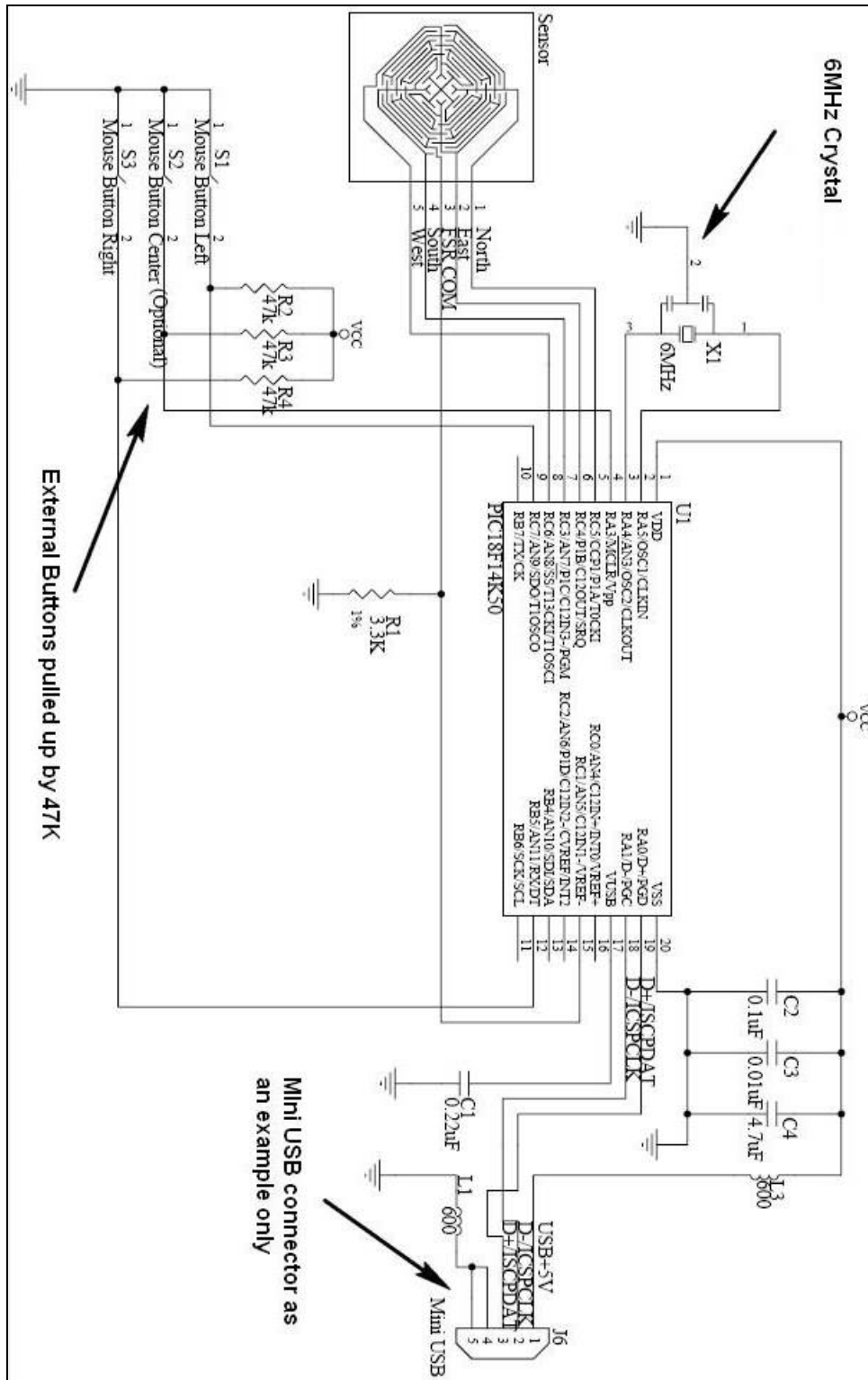


Figure 9: Recommended schematics for the controller chip

9.0 Controller Chip Example Bill of Materials

Used	Part Type	Designator	Description
1	0.01uF	C3	CAP,CER,0.01UF,10%,50V,0603
1	0.1uF	C2	CAP,CER,0.1UF,10%,25V,0603
1	0.22uF	C1	CAP,CER,0.22UF,5%,16V,0603
1	4.7uF	C4	CAP,CER,4.7UF,10%,6.3V,0603
2	600	L1 L3	Ferrite Chip, 600 Ohm, 500mA, 0805,SMD
1	3.3K	R1	Resistor, 3.3K OHM, Metal Film, 0402, 1%, 100ppm
3	47k	R2 R3 R4	Resistor, 47K OHM, Metal Film, 0402, 1%, 100ppm
1	PIC18F14K50	U1	MCU, PIC18F14K50, SSOP20 With Interlinks FW
1	6MHz	X1	Ceramic Resonator, 6MHz, SMD, w/caps
3	No Momentary	S1, S2, S3	Tactile & Jog Switches SPST-NO 200g Force GW SMD

Table 1: Controller chip example bill of materials

10.0 Orderable Part Numbers

- **Hardware Development Kit (54-00016)**
 - QTY 1 MicroModule Demo with USB Cable
 - QTY 5 Programmed Microchip PIC18F14K50 microprocessors¹
 - QTY 5 4-Zone Mouse Sensor, Square
 - QTY 5 4-Zone Mouse Sensor, Square with Conductive Adhesive
 - QTY 5 4-Zone Mouse Sensor, Square with tail and solder tabs²
 - QTY 1 USB Flash Drive with Product Literature
 - 4 Zone Mouse Sensor and USB Interface Chip Datasheet
 - 4 Zone Mouse Sensor and USB Interface Chip Integration Guide
- **Programmed Microprocessor, PIC18F14K50, Tape & Reel (54-00005)**
- **4-Zone Mouse Sensor, Square (34-00002)**
- **4-Zone Mouse Sensor, Square with Conductive Adhesive (30-79069)**
- **4-Zone USB High Temperature Microprocessor (24-00178)**

11.0 Intellectual Property & Other Legal Matters

Interlink Electronics holds several domestic and international patents for its Force Sensing Resistor technology. FSR and Force Sensing Resistor are company trademarks. All other trademarks are the property of their respective owners.

The product information contained in this document provides general information and guidelines only and must not be used as an implied contract with Interlink Electronics. Acknowledging our policy of continual product development, we reserve the right to change, without notice, any detail in this publication. Since Interlink Electronics has no control over the conditions and method of use of our products, we suggest that any potential user confirm their suitability for their own application.

¹ Microprocessors covered here are capable of measuring any of the 4 Zone FSR's offered by Interlink Electronics.

² Sensors provided with tail extension and solder tabs for ease of connection during hardware development.

12.0 Contact Interlink Electronics

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