MICROCHIP LX7730-RTG4 Mi-V Sensors Demo User Guide

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LX7730 -RTG4 Mi-V Sensors Demo User Guide

Introduction

The LX7730-RTG4 Mi-V Sensors Demo demonstrates the LX7730 spacecraft telemetry manager being controlled by an RTG4 FPGA implementing the CoreRISCV_AXI4 softcore processor, part of the Mi-V RISC-V

Ecosystem. Documentation for CoreRISCV_AXI4 is available on GitHub.

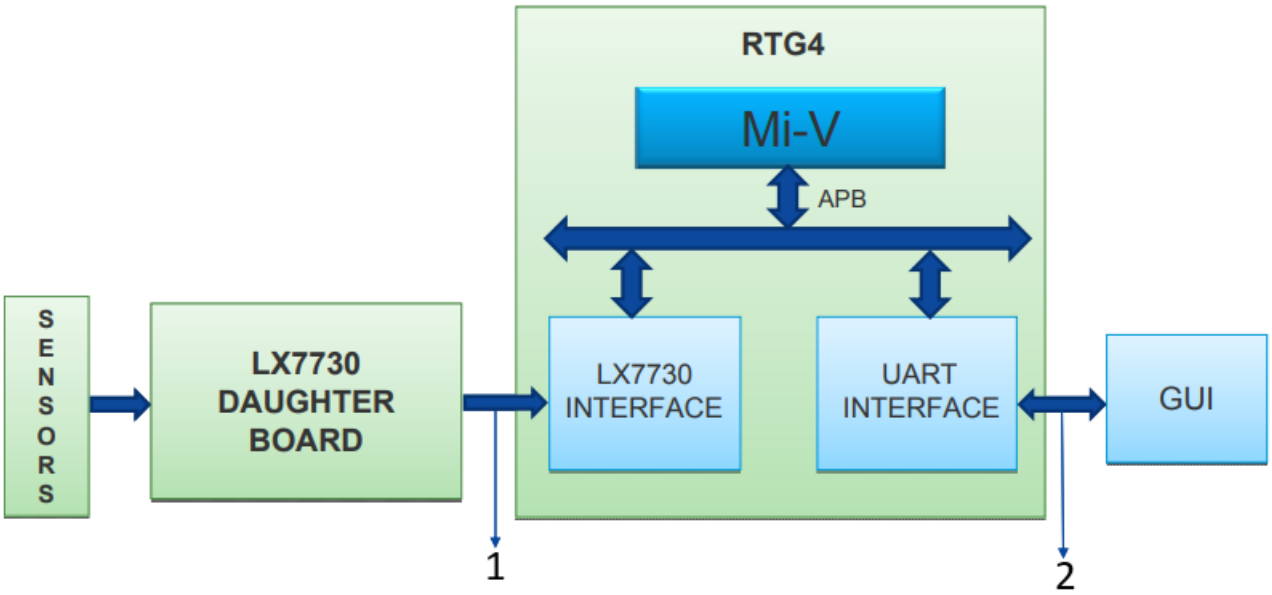


Figure 1. LX7730-RTG4 Mi-V Sensors Demo System Diagram

1. SPI frequency = 5MHz
2. Baud Rate = 921600 bits/sec

The LX7730 is a spacecraft telemetry manager that contains a 64 universal input multiplexer that can be configured as a mix of differential- or single-ended sensor inputs. There is also a programmable current source that can be directed to any of the 64 universal inputs. The universal inputs can be sampled with a 12-bit ADC, and also feed bi-level inputs with the threshold set by an internal 8-bit DAC. There is an additional 10-bit current DAC with complementary outputs. Finally, there are 8 fixed threshold bi-level inputs.

The demo comprises a small PCB containing 5 different sensors (Figure 2 below) that plugs into LX7730 Daughter Board, The daughter board in turn plugs directly into the RTG4 Dev Kit via FMC connectors on both development boards. The demo reads data from the sensors (temperature, pressure, magnetic field strength, distance, and 3-axis acceleration), and displays them on a GUI running on a Windows PC.

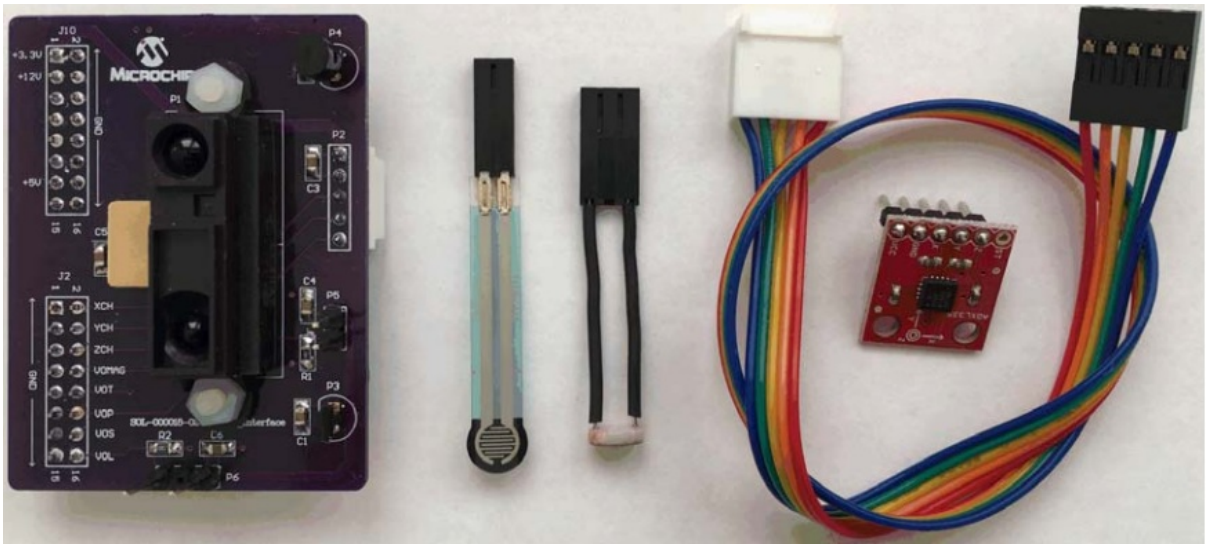


Figure 2. Sensors Demo Board with (from left to right) pressure, light, and accelerometer sensors

1 Installing the Software

Install the NI Labview Run-Time Engine Installer if not already present on your computer. If you're not sure

whether you have the drivers installed already, then try running **LX7730_Demo.exe.** If an error message appears as below, then you don't have the drivers installed and need to do so.

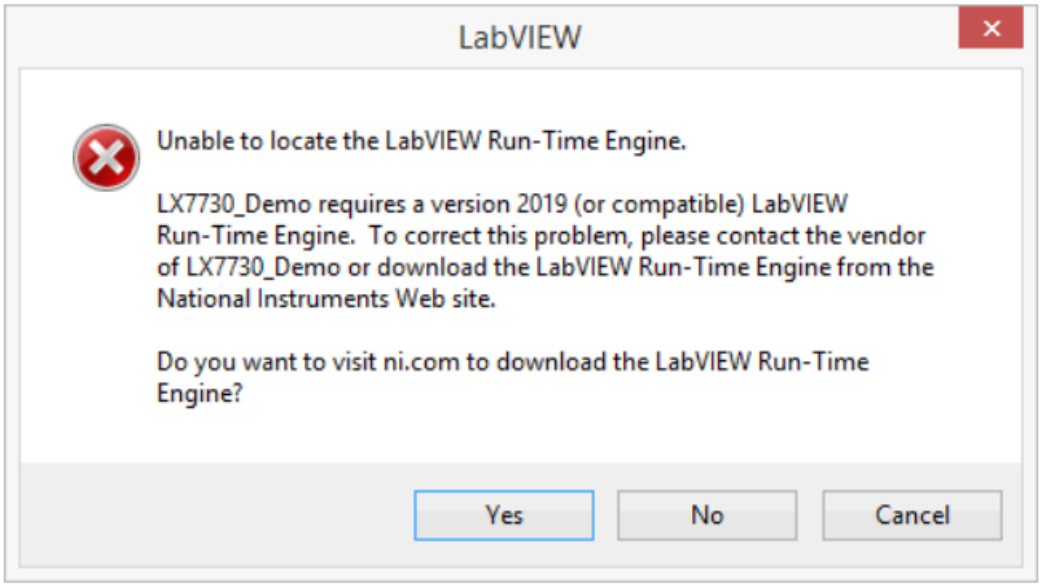


Figure 3. Labview Error Message

Power up and program the RTG4 board with LX7730_Sensorinterface_MIV.stp binary, then power it down again.

2 Hardware Setup Procedure

You will need an LX7730 Daughter Board and an RTG4 FPGA **DEV-KIT** in addition to the Sensors Demo board. Figure 4 below shows a LX7730-DB connected to a RTG4 DEV-KIT via FMC connectors.

Figure 4. RTG4 DEV-KIT (left) and LX7730-DB with grand-daughter board (right)

The hardware setup procedure is:

- Start with the two boards unplugged from each other
- On the LX7730-DB, set the SPI_B slide switch SW4 to the left (LOW), and set the SPI_A slide switch SW3 to the right (HIGH) to select the SPIB serial interface. Ensure that the jumpers on the LX7730-DB are set to the defaults shown in the LX7730-DB user guide
- Fit the Sensors Demo board to the LX7730-DB, removing the grand-daughter board first (if fitted). Demo board connector J10 plugs into LX7730-DB connector J376, and J2 fits in the top 8 rows of connector J359 (Figure 5 below)

- Fit the Sensors Demo board to the LX7730 Daughter Board. Demo board connector J10 plugs into LX7730 Daughter Board connector J376, and J2 fits in the top 8 rows of connector J359
- Plug the LX7730 Daughter Board into the RTG4 board using the FMC connectors
- Connect the RTG4 board to your PC via USB

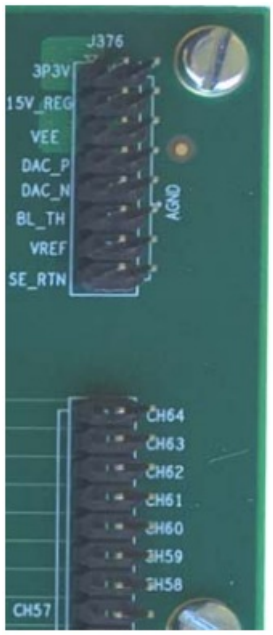


Figure 5. Location of Mating Connectors J376, J359 on the LX7730 Daughter Board for the Sensors Demo board

3 Operation

Power up the SAMRH71F20-EK. The LX7730-DB gets its power from the SAMRH71F20-EK. Run the LX7730_Demo.exe GUI on the connected computer. Select the COM port corresponding to the SAMRH71F20-EK from the drop down menu and click connect. The first page of GUI interface shows results for temperature, force, distance, magnetic field (flux), and light. The second page of the GUI interface shows results from the 3-axis accelerometer (Figure 6 below).

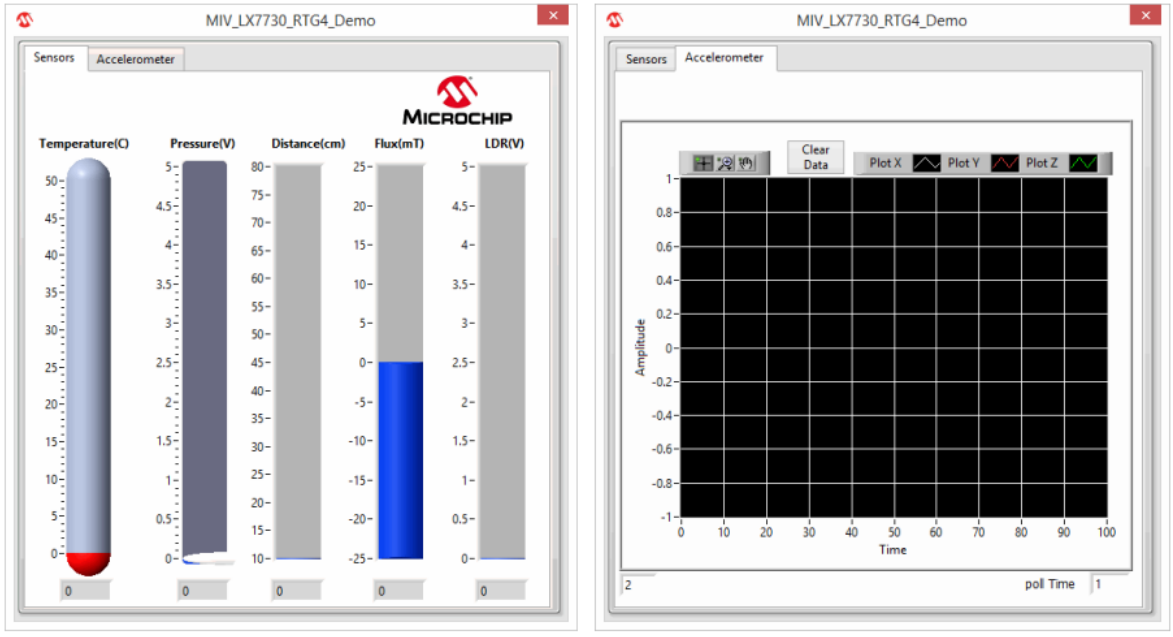


Figure 6. GUI interface

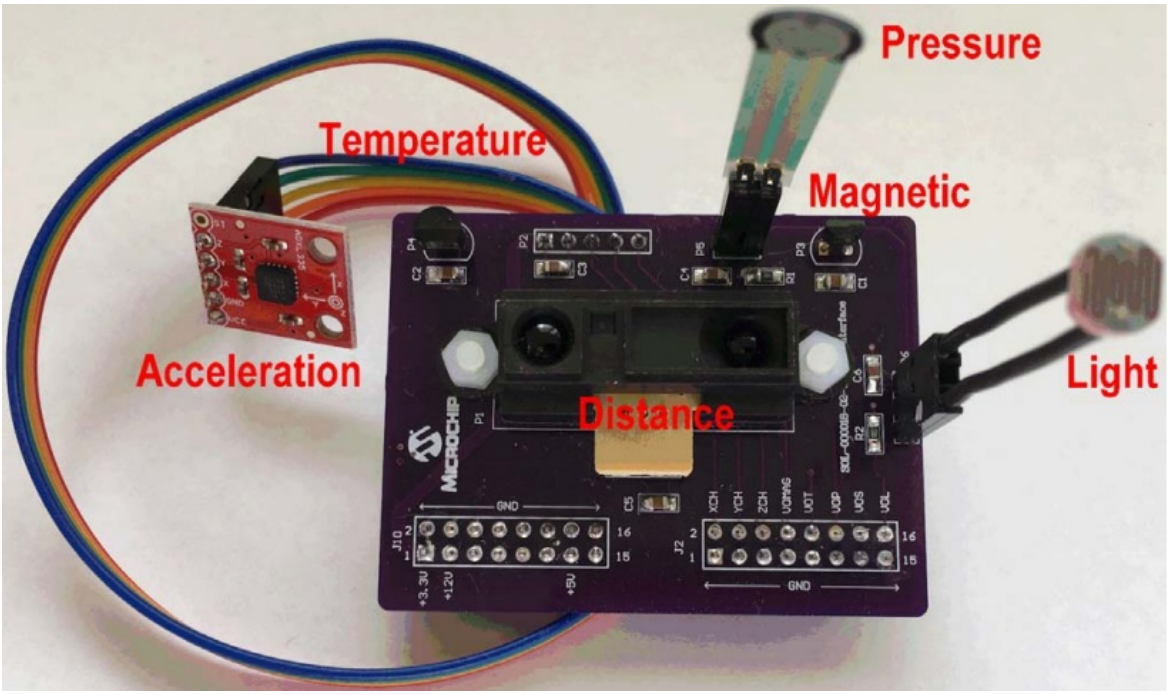


Figure 7. Location of the 6 Sensors

3.1 Experimenting with the Temperature Sensor:

Change the temperature in the range 0°C to +50°C around this sensor. The sensed temperature value will be shown in the GUI.

3.2 Experimenting with the Pressure Sensor

Press the round tip of the pressure sensor to apply a force. The GUI will show the resultant output voltage, per Figure 8 below for RM = 10kΩ load.

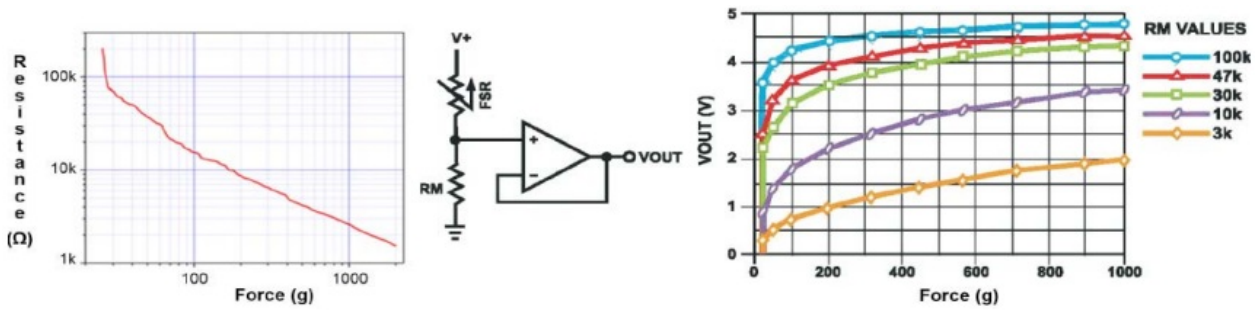


Figure 8. FSR 400 Resistance vs Force and Output Voltage vs Force for Various Load Resistors

3.3 Experimenting with the Distance Sensor

Move objects away or close (10cm to 80cm) to the top of the distance sensor. The sensed distance value will be shown in the GUI.

3.4 Experimenting with the Magnetic Flux Sensor

Move a magnet away or close to the magnetic sensor. The sensed flux value will be shown in the GUI in the range -25mT to 25mT.

3.5 Experimenting with the Light Sensor

Change the brightness of light around the sensor. The sensed light value will be shown in the GUI. The output

voltage VOUT range is 0 to 5V (Table 1 below) following Equation 1.

$V_{OUT} = 5\times\ 10000/10000 + R_d\ V$

Equation 1. Light Sensor Lux to Voltage Characteristic

Table 1. Light Sensor

Lux	**Dark Resistance R_d(kΩ)**	**V_{OUT}**
0.1	900	0.05
1	100	0.45
10	30	1.25
100	6	3.125
1000	0.8	4.625
10,000	0.1	4.95

3.6 Experimenting with the Acceleration Sensor

The 3-axis accelerometer data is displayed in the GUI as cm/s², where 1g = 981 cm/s².

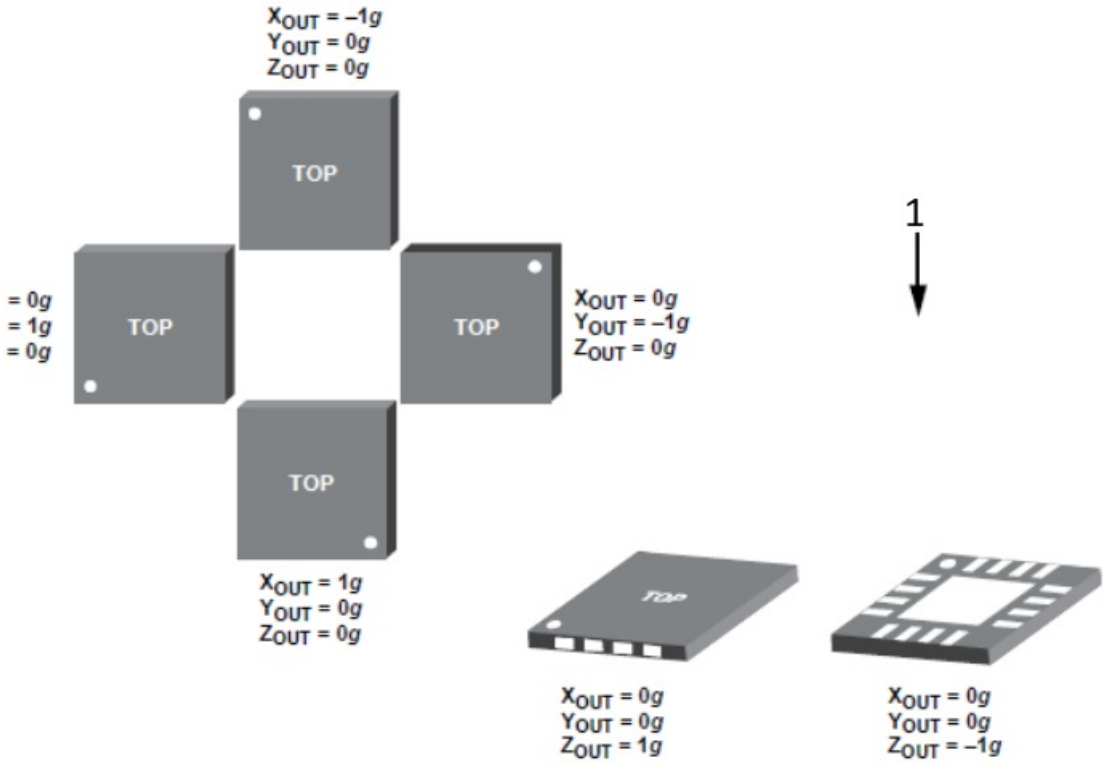


Figure 9. Accelerometer response with respect to orientation to gravity

1. GRAVITY

4 Schematic

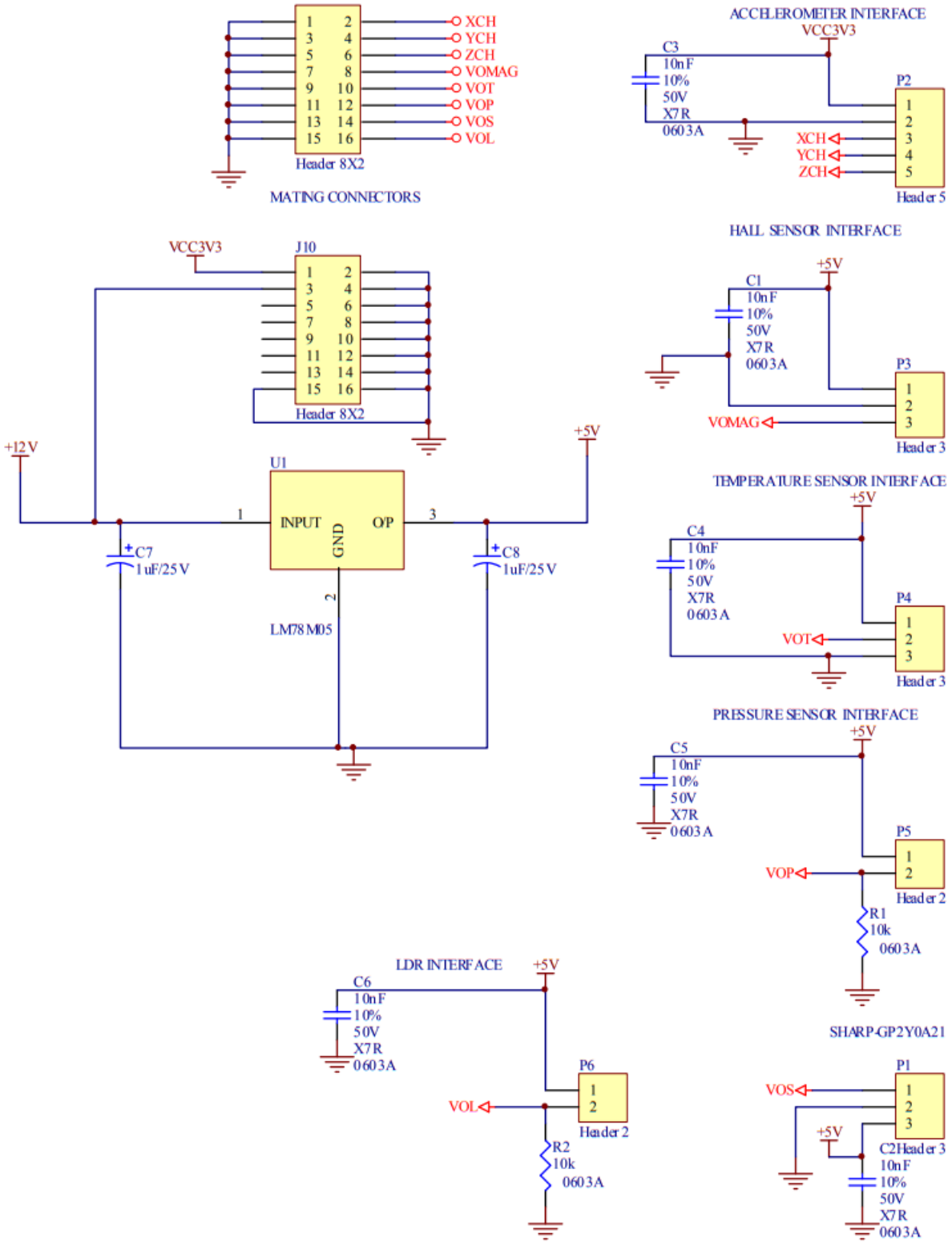


Figure 10. Schematic

5 PCB Layout

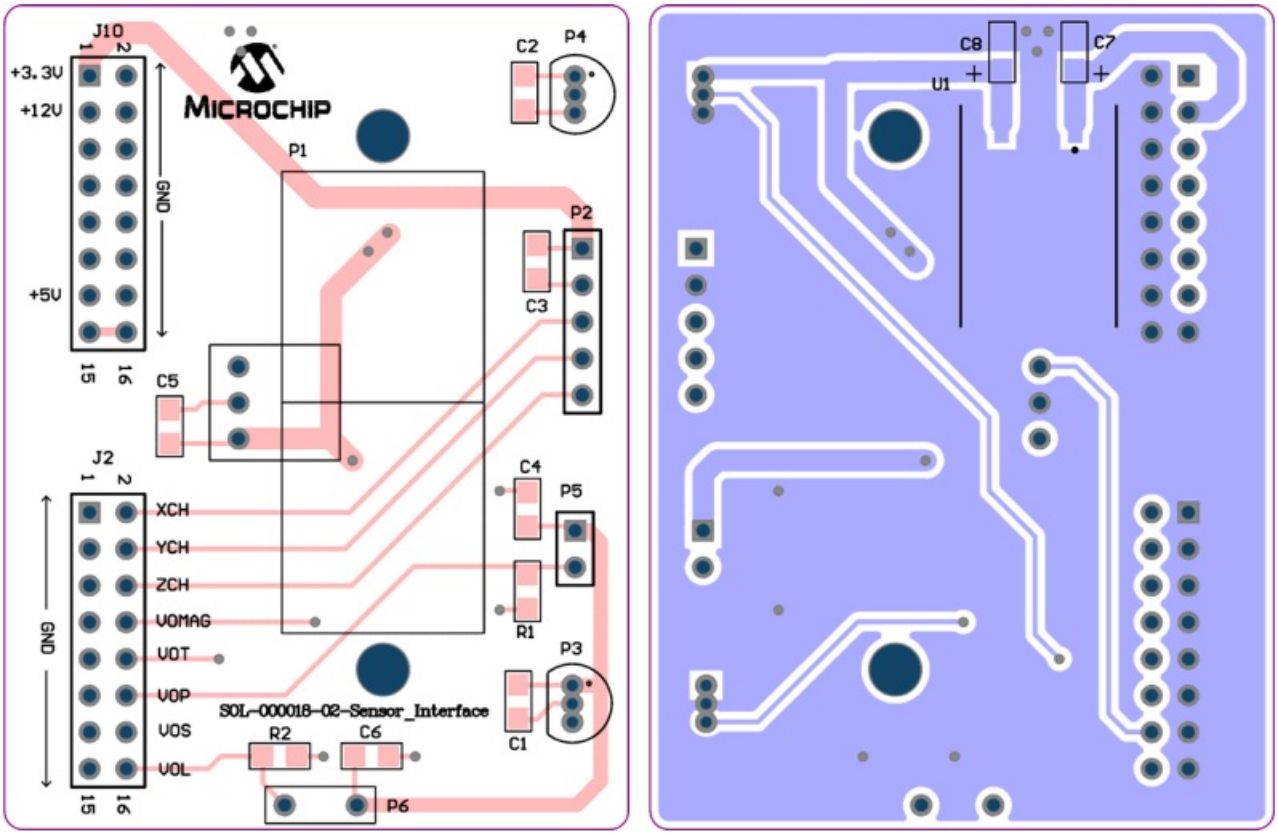


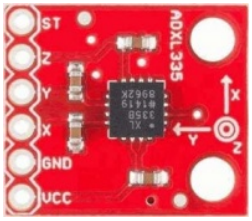
Figure 11. PCB top layer and top components, bottom layer and bottom components (bottom view)

6 PCB Parts List

Assembly notes are in blue.

Table 2. Bill of Materials

Designators	Part	Quantity	Part Type
C1, C2, C3, C4, C5, C6	10nF/50V-0805 (10nF to 1µF acceptable)	6	Capacitor MLCC
C7, C8	1µF/25V-0805 (1µF to 10µF acceptable)	2	Capacitor MLCC
J2, J10	Sullins PPTC082LFBN-RC 	2	16 position header 0.1″ These fit to the underside of the PCB
R1, R2	10kΩ	2	Resistor 10kΩ 1% 0805

P1	Sharp GP2Y0A21 	1	Optical Sensor 10 ~ 80cm Analog Output Remove the white 3-pin plug, and solder directly to the PCB with 3 wi res
P2	SparkFun SEN-09269 	1	ADI ADXL335, ±3g 3 Axis Accelerometer on PCB
	Molex 0022102051 	1	Square pin header 5 position 0.1″ Solder to the underside of the accelerometer board, from VCC to Z. T he ST hole is unused
	SparkFun PRT-10375 	1	5 way 12″ ribbon cable 0.1″ Cut off one connector, and replace with five crimped terminals fitted i nto the polarized 5 position housing. The original, unpolarized housing plugs into the accelerometer board, with the red wire at VCC and blue wire at Z
	Molex 0022013057 	1	Housing polarized 5 position 0.1″
	Molex 0008500113 	5	Crimp connector
	Molex 0022232051 	1	Connector polarized 5 position 0.1″ Solder to the underside of the PCB, with orientation such that the red wire will be at the P2 end when the 5 way ribbon cable is fitted

P3	TI DRV5053 	1	Hall Effect Sensor Single Axis TO-92 Fit with flat face facing outward. The PCB ‘D’ outline is wrong
P4	TI LM35 	1	Temperature Sensor Analog, 0°C ~ 100°C 10mV/°C TO-92 Follow the PCB ‘D’ outline
P5	Interlink 30-49649 	1	Force/Pressure Sensor – 0.04-4.5LBS
	Molex 0016020096 	2	Crimp connector Crimp or solder a terminal to each Force/Pressure Sensor wire
	Molex 0050579002 	1	Housing 2 position 0.1″ Fit the Force/Pressure Sensor’s terminals into the outer two positions
	Molex 0022102021 	1	Square pin header 2 position 0.1″ Solder to the topside of the PCB
P6	Advanced Photonix PDV-P7002 	1	Light Dependent Resistor (LDR)
	Molex 0016020096 	2	Crimp connector Crimp or solder a terminal to each LDR wire
	Molex 0050579003 	1	Housing 3 position 0.1″ Fit the LDR’s terminals into the outer two positions

	Molex 0022102031 	1	Square pin header 3 position 0.1″ Remove middle pin. Solder to the topside of the PCB
U1	On Semi MC7805C D2T 	1	5V 1A Linear Voltage Regulator

7 Revision History

7.1 Revision 1 – May 2023

First release.

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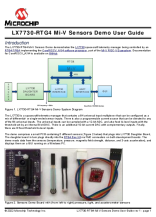	MICROCHIP LX7730-RTG4 Mi-V Sensors Demo [pdf] User Guide LX7730-RTG4 Mi-V Sensors Demo, LX7730-RTG4, Mi-V Sensors Demo, Sensors Demo, Demo

References

- { 42 ,18 , , AV }
- GitHub - RISCV-on-Microsemi-FPGA/Documentation: Documentation relevant to the available repositories on RISCV-on-Microsemi-FPGA
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