# TIDA-00642 Foot controller Using Analog Hall Sensor

### Design Overview

TIDA-00642 uses analog Hall Sensor DRV5053 and OpAmp LMV612 to achieve a foot controller circuit with approximate linear response and adjustable quiescent offset and the full scale output range.

### Design Resources

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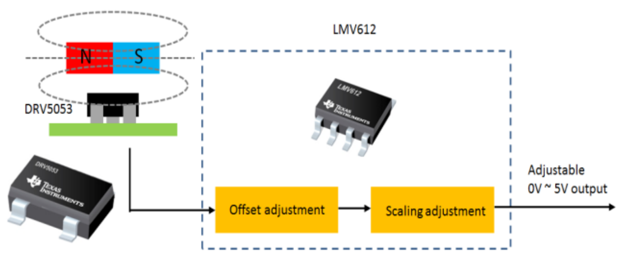
|---|---|
| TIDA-00642 | Design Folder |
| DRV5053 | Product Folder |
| LMV612 | Product Folder |
| OpAmp Application Guide | |




### Design Features

- Approximate linear response of the position to output voltage
- Adapt with wide magnet types and range of flux density
- 0 to 5V full scale output ability
- Adjustable quiescent offset voltage at zero magnet field
- Adjustable wide range system sensitivity
- Low power RRIO amplifier stage
- Cost effective

### Featured Applications

- Foot controller
- Industrial control stick
- Industrial foot pedal
- Key stroke monitor
- General position or angular sensing

## *1. Introduction*

Analog Hall sensor can be used as position or angular sensing with the benefits of no contact and wearing, high stability and repeat positioning accuracy and wide sensibility range. There are normally two major methods of the configuration of the magnet and the Hall senor, non-linear and linear way. This design gives introduction of the two methods and focuses on the linear configuration, and gives OpAmp circuit design to achieve wide adaption to different applications.

## 2. Magnet Configuration

The following figures show the two configurations of the magnet and Hall sensor. In non-linear way, the magnet is approaching the Hall sensor with one of its pole. The output is non-linear to the approaching distance. In linear configuration, the Hall sensor is placed at the mid position of the magnet as the quiescent position, no perpendicular flux through the Hall sensor. When the magnet departs from the quiescent position, the output can change two-way up or down depending on the moving direction. With the help of OpAmp stage, both the two configurations can output 0 to 5V continual analog signal. Please refer to **Figure 1** and **Figure 2** for the two configurations.

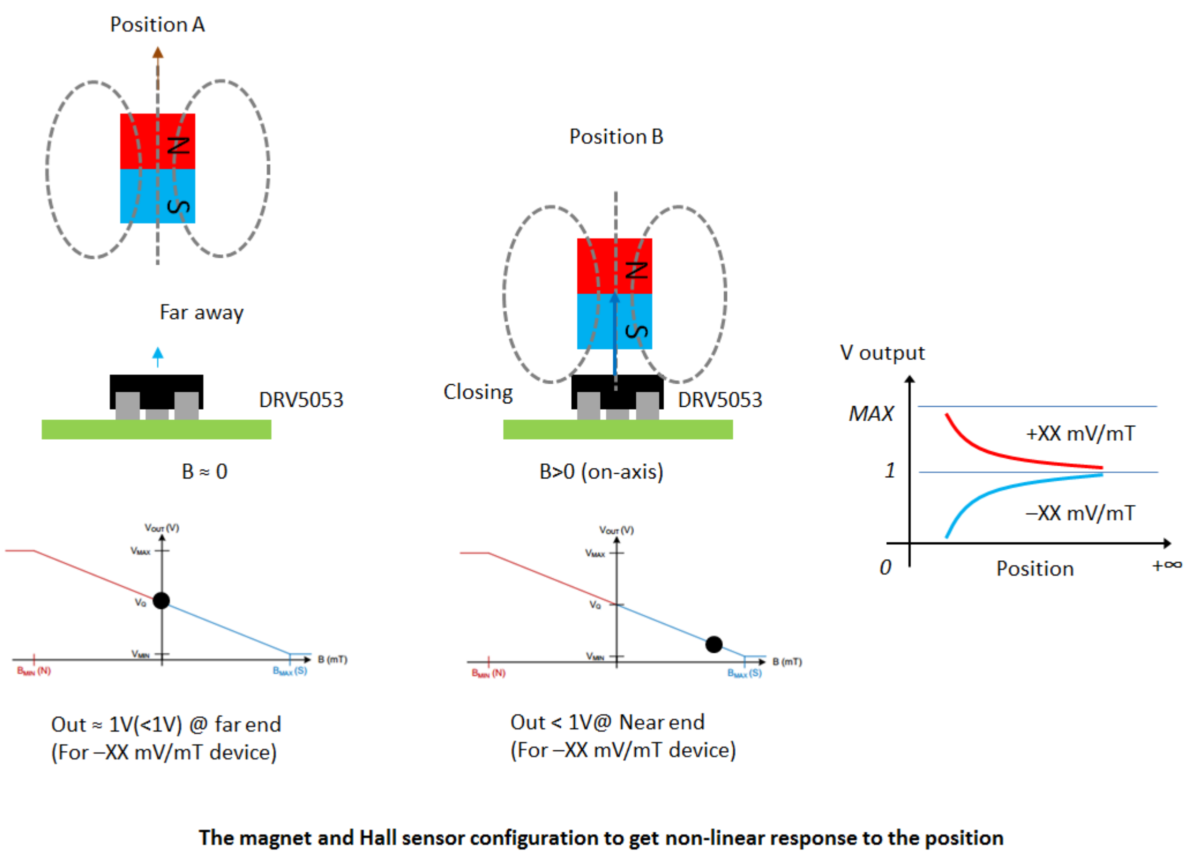



**Figure 1. Non-linear magnet configuration**

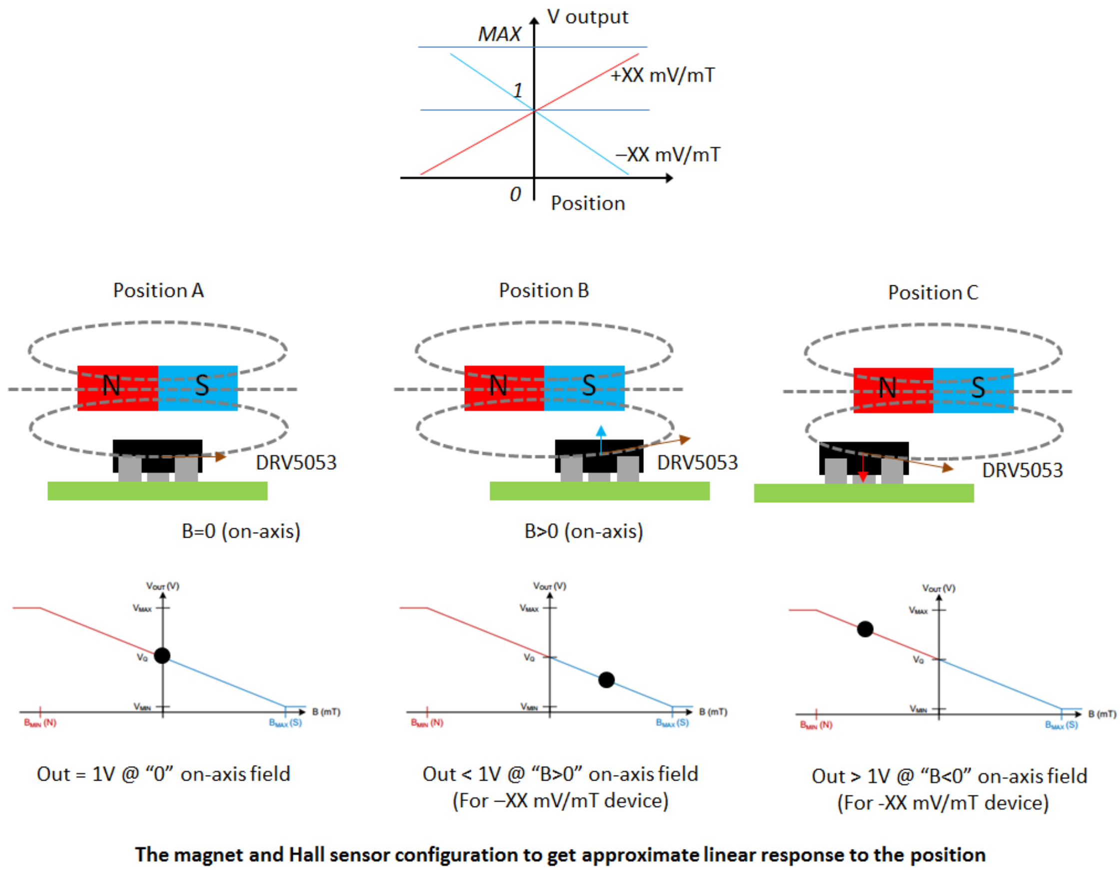



**Figure 2. Linear magnet configuration**

## *3. OpAmp Circuit*

The output of DRV5053 is about 0.2V to 1.8V with the quiescent 1V at zero field or no perpendicular flux to the sensing surface. In non-linear configuration, the output range is limited either from 0.2V to 1V or from 1V to 1.8V. An OpAmp stage is introduced in this design. It deals with the raw Hall sensor output signal with adjustable offset and scaling range, shown in **Figure 3**.

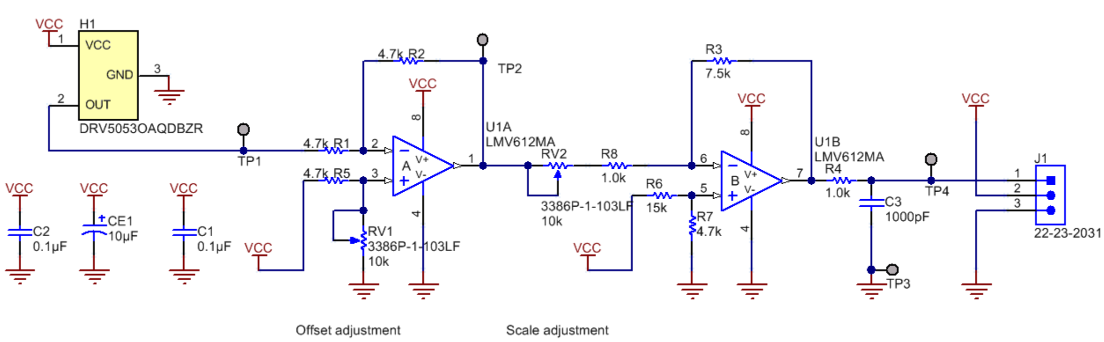



**Figure 3. OpAmp stage**

A low cost low power RRIO OpAmp LMV612 is used for the condition circuit. U1A is used for offset adjustment. The offset is not defined as only to the quiescent point of DRV5053. Actually any fixed position along the full stroke of the magnet can be set as offset point mechanically. When the relative position of the magnet and Hall sensor is fixed at the designed offset point, the final output voltage can be adjustment by RV1. U1B is used as the amplitude amplifier stage with adjustable gain tuning by RV2. Also there is a RC filter at the final output with R4 and C3.

**Basic tuning guide of the system:**

1. Tuning RV1 for the designed fixed offset output
2. Place the magnet to its MIN MAX stroke and tuning RV2 to get designed output range
3. Release or return the fixed offset point, back to step 1 readjustment the offset point
4. Back to step 2 to readjustment the offset output
5. Repeat 1 to 4 steps to get both the designed offset the scaled output range.
6. Note that the adjustment range of offset and scaling is also related to the mechanical magnet configuration and the magnetic field. Do possible adjustment of the mechanical configuration if needed.
7. The OpAmp parameters are also adjustable for special sensing range and output coverage. It is recommend to change R5 for extend offset adjustment ability and R3 for extend gain range.

For the detail design and analysis of the OpAmp circuit, please refer to the following application guide. [http://www.ti.com/lit/an/snla140b/snla140b.pdf](http://www.ti.com/lit/an/snla140b/snla140b.pdf)

### *4. Lab Test Data*

The following lab test data is done in a typical sew machine foot controller. The following figure shows the mechanical configuration of the controller box. It is configured in linear way.

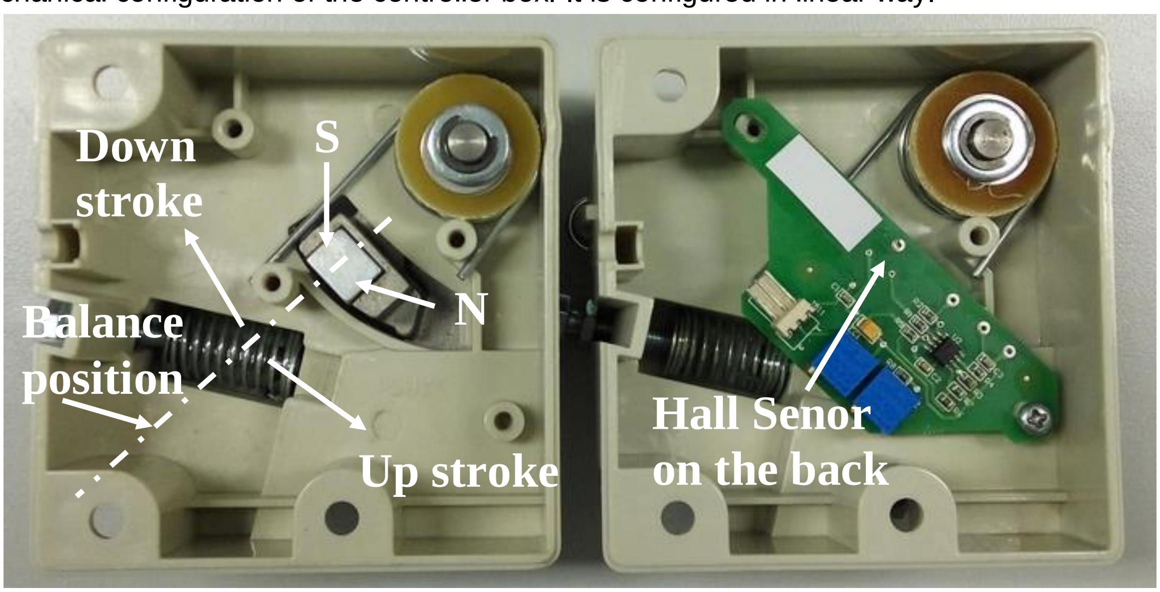
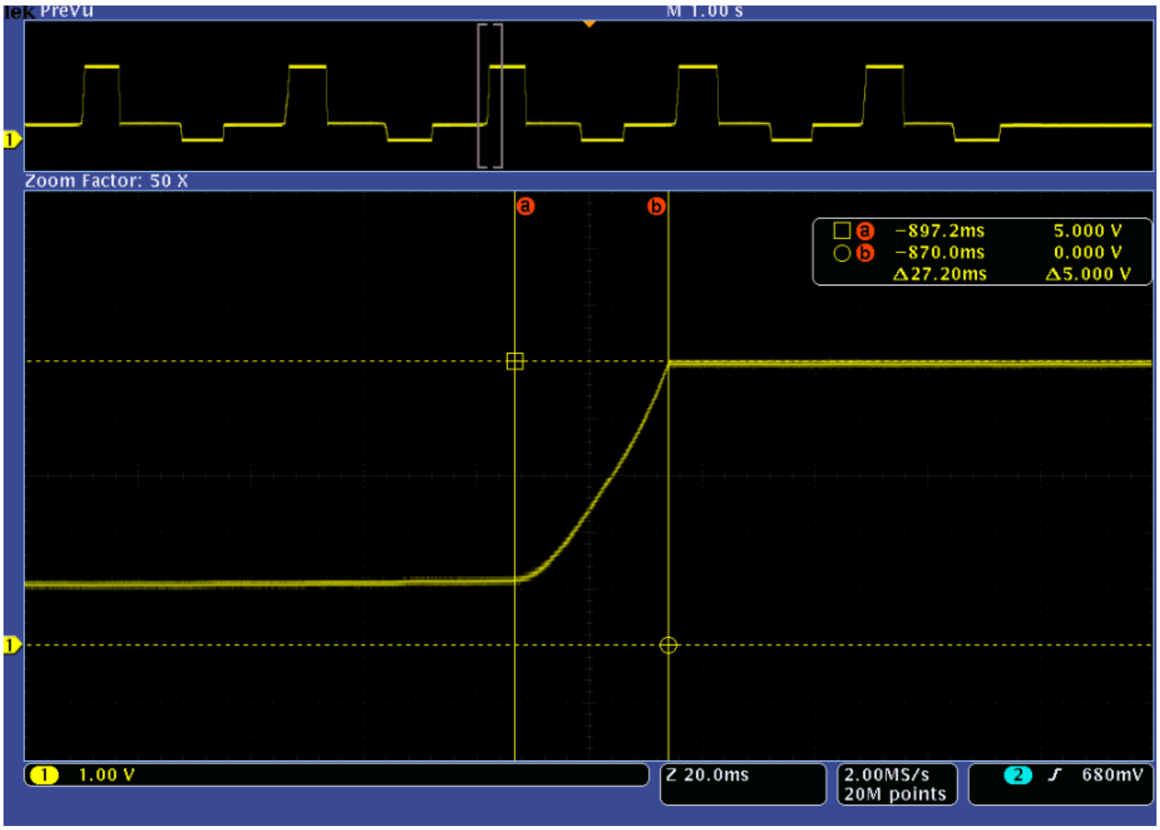


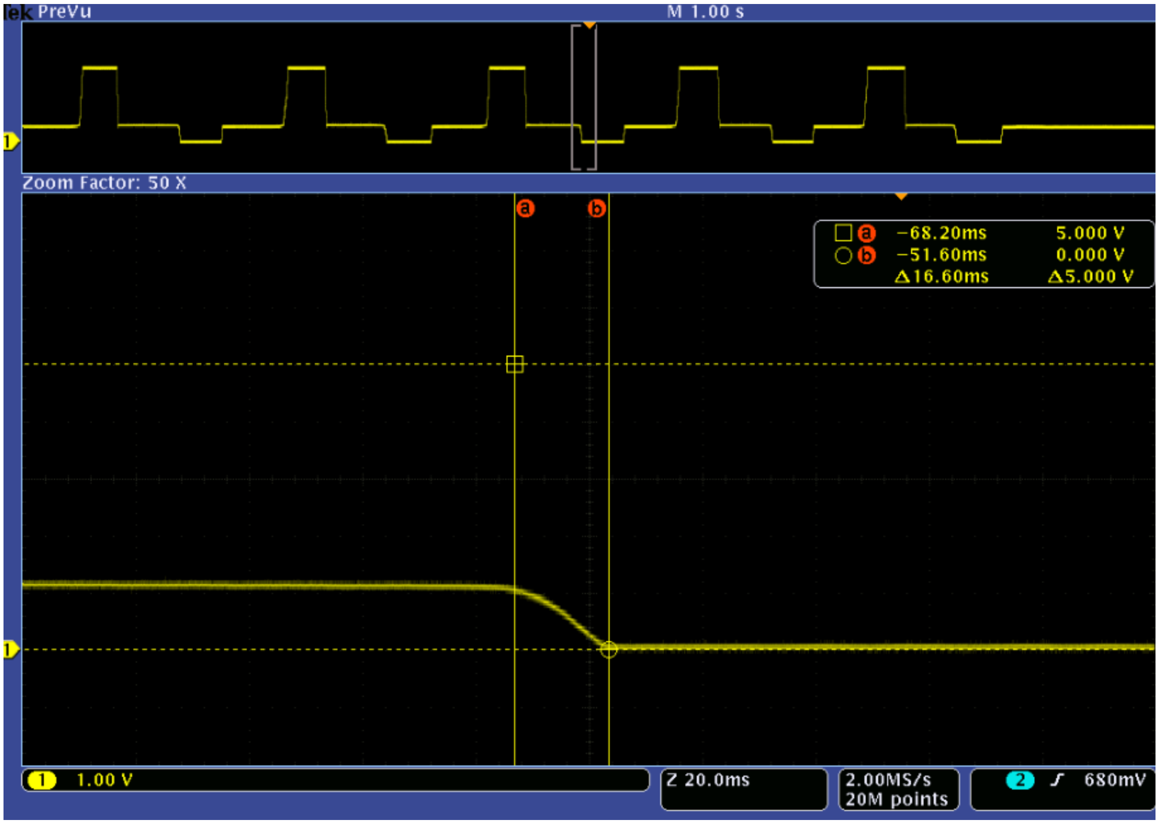

**Figure 4. Foot pedal structure**

The actuator is fixed at a mid-point between the two ends of the stroke by a dual-spring system. Controlling by the foot, the actuator can go two sides of the stroke direction. The application requires the output stay at about 1.1V when the actuator is at the balanced point (fixed offset point). When the foot strokes downside, the output goes from 1.1V down to ~0V. When the foot strokes upside, the output goes from 1.1V up to ~5V (VCC). This 0 to 5V analog signal will output to the sewing machine control unit and be taken as the speed commands of the spindle.

Below figure shows the output voltage test data.




(a) Up stroke




(b) Down stoke

**Figure 5. Output test data example**