Special “Hall Effect” Sensor configuration of the Sucker vacuuming robot

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Report 2

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Abstract

This paper introduces the special sensor constructed and used on the Sucker, an autonomous mobile robot designed to avoid obstacles while vacuuming a variety of surfaces. Instead of purchasing a fifty-dollar Hall effect sensor that is ready to go, I decided to put the parts together myself for under ten dollars. I plan to use the hall effects to determine the robots velocity. I chose the hall effects because of there robustness, considering that I will be working in dusty and dirty environments, the hall effects are a much better choice than photo reflectors that rely on a clean environment.

Hall effect design and construction

Hall effect integrated circuits (IC's) "Panasonic DN6851" were ordered from Digi Key, these are bi-directional Hall effect circuits. The IC's switch high when in the presence of an alternating magnetic field (north pole then south pole), they can be operated from 3.6 volts to 16 volts and only need 8 mA. Figure one shows the internal circuitry of the IC.

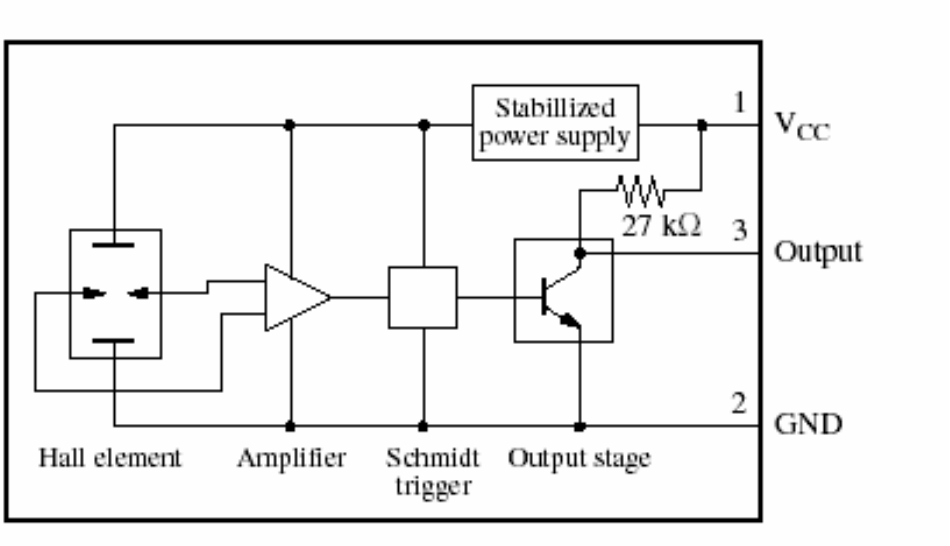


Figure 1: Panasonic DN6851 internal block diagram.

Once the IC's were in hand I tested to see how sensitive they would be to the magnets I was planning on using. I powered the hall effects and connected it to an oscilloscope, and then I started to pass the magnet in front of the sensor until the sensor went high. With these particular magnets (from Home Depot) the sensor responded from 0 - .25 inches from the tip. I noticed that the sensor responded a bit better from the face of the sensor sensing from 0 - .50 inches. Please see figure 2 for tip, and face configurations.

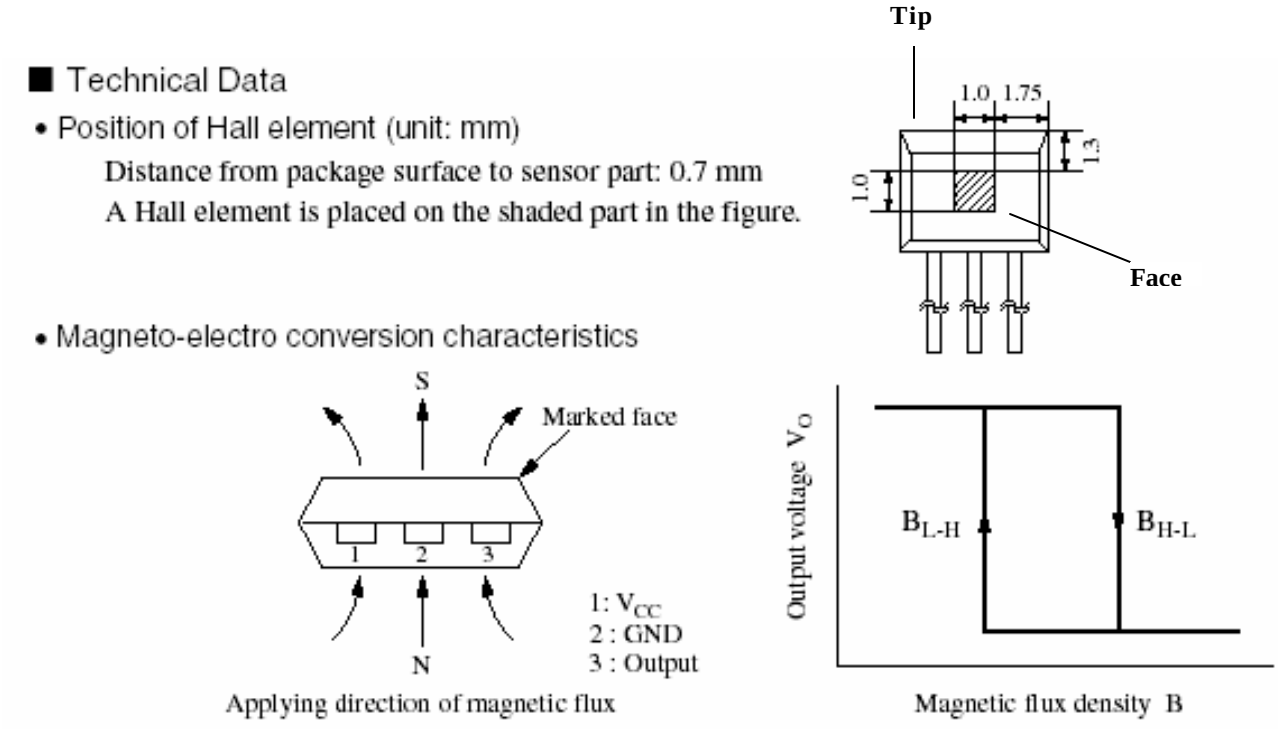


Figure 2: Placement of Hall effect element, and description of tip, and face.

Once I determined the sensitivity and sensing direction, I then inserted them into hollow threaded studs for easy mounting. The stud diameter was determined by calculating the largest cross sectional area across the face and adding in 0.10" to accommodate room for bending the leads, the final dimension needed was a 0.260" internal diameter, see figure 3 for dimensions.

From the McMaster Carr website I ordered the closest diameter stud # 94624A540 with an internal diameter of .375". I also ordered jam nuts to fasten the threaded stud. The studs I ordered are 7" long so that I can cut them into several 1.5" sections to house each sensor.

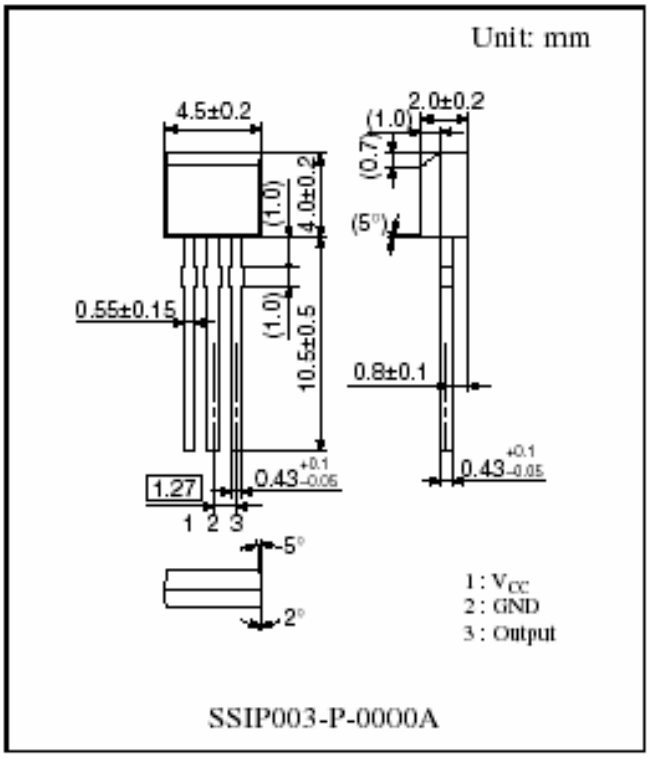


Figure 3: Dimensions for the DN6851 Hall effect IC.

To begin construction I soldered shielded wire to each lead on the IC; I am using shielded wire to help eliminate any noise generated from the drive motors since the IC will be mounted very close to these motors. To reduce the likely hood of unwanted short circuits I used liquid tape to insulate the wires from each other and I also used heat shrink tubing to isolate the wires from the metal threaded stud housing. To finish the job I needed to mount the sensors into the metal housing, to do this I filled the housing cavity with hot glue and then slid the IC into the housing until the face of the IC was flush with the other side, then held it in place until the glue

cooled and hardened. The process steps and the finished product can be seen below in figure 4 and 5.

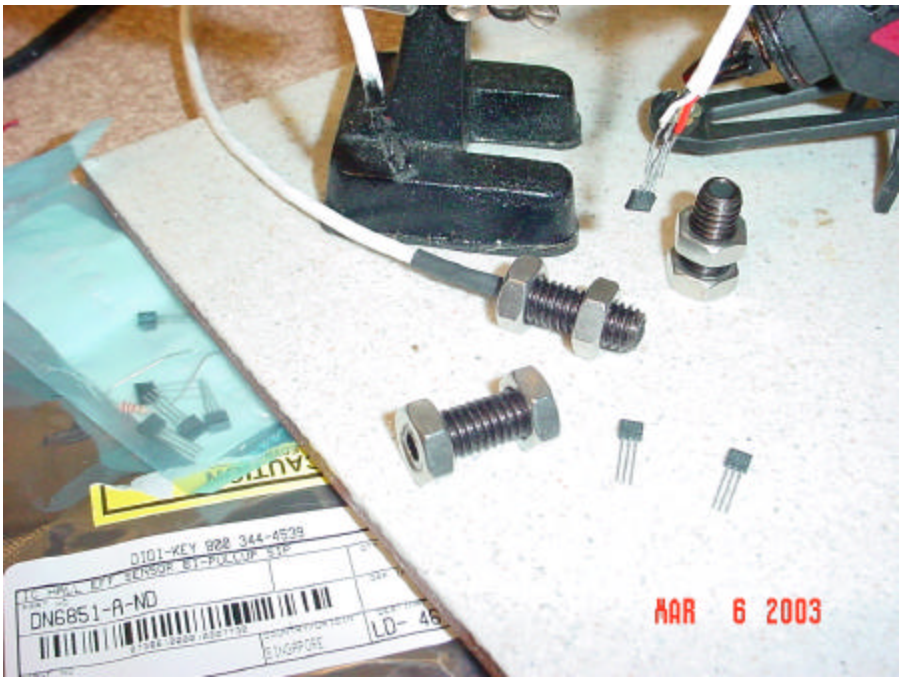


Figure 4: The process of mounting the DN6851 Hall effect IC.

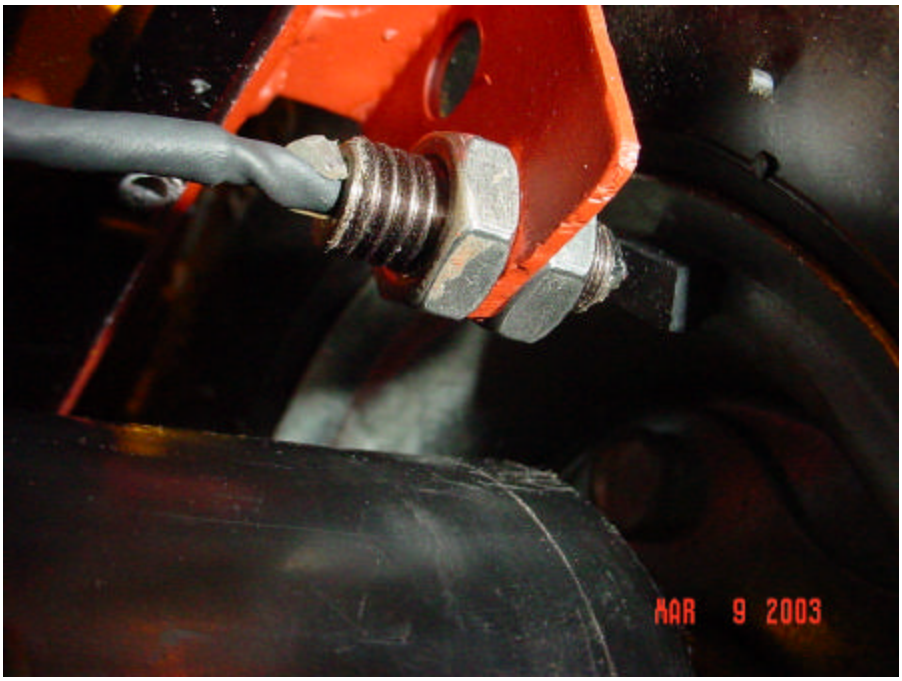


Figure 5: Mounting the DN6851 Hall effect IC on the vehicle.

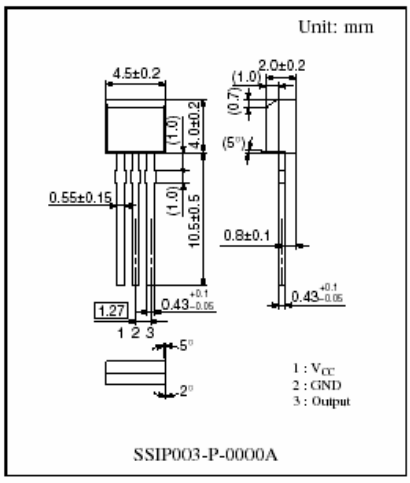
I was then able to mount 56 magnets per wheel as seen in figure 6, giving me 28 ticks per revolution. I have 10” diameter wheels and therefore I travel 1.12199 inches/tick.

Figure 5: Mounting the magnets on the right wheel for the Hall effect IC.

Following is the Panasonic DN6851 data sheet from Digi Key

DN6851

Switch type, Wide operating supply voltage range (V_{CC} = 3.6 V to 16 V)
Alternating magnetic field operation



Note) The package of this product will be changed to lead-free type (SSIP003-P-0000H). See the new package dimensions section later of this datasheet.

■ Overview

DN6851 is a semiconductor integrated circuit utilizing the Hall effect. It has been so designed as to operate in the alternating magnetic field especially at low supply voltage. This Hall IC is suitable for application to various kinds of sensors, contactless switches, and the like.

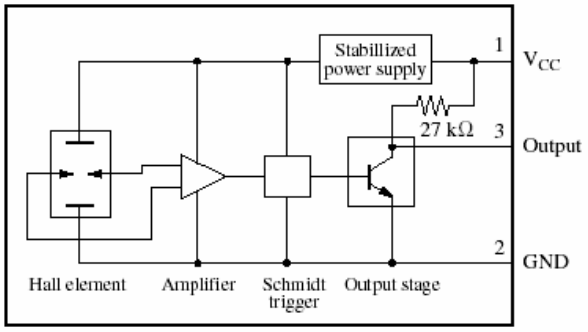
■ Features

- Wide supply voltage range of 3.6 V to 16 V
- Alternating magnetic field operation
- TTL and MOS IC are directly drivable by the output.
- The life is semipermanent because it employs contactless parts.
- SSIP003-P-0000A package
- Equipped with an output pull-up resistor (typical 27 kΩ)

■ Applications

- Speed sensor, position sensor, rotation sensor, keyboard switch, micro switch and the like

■ Block Diagram



■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	18	V
Supply current	I_{CC}	8	mA
Circuit current	I_O	20	mA
Power dissipation	P_D	100	mW
Operating ambient temperature	T_{opr}	−40 to +85	°C
Storage temperature	T_{stg}	−55 to +125	°C

Note) This IC is not suitable for car electrical equipment.

■ Recommended Operating Range

Parameter	Symbol	Range	Unit
Supply voltage	V_{CC}	3.6 to 16	V

■ Electrical Characteristics at T_a = 25°C

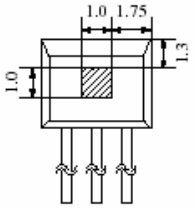
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Operating magnetic flux density	$B_{1(L-H)}$	V_{CC} = 12 V	−30	—	—	mT
	$B_{2(H-L)}$	V_{CC} = 12 V	—	—	30	mT
Low-level output voltage	V_{OL}	V_{CC} = 16 V, I_O = 12 mA, B = 30 mT	—	—	0.4	V
		V_{CC} = 3.6 V, I_O = 12 mA, B = 30 mT	—	—	0.4	V
High-level output voltage	V_{OH}	V_{CC} = 16 V, I_O = −30 µA, B = −30 mT	14.6	—	—	V
		V_{CC} = 3.6 V, I_O = −30 µA, B = −30 mT	2.2	—	—	V
Output short circuit current	$-I_{OS}$	V_{CC} = 16 V, V_O = 0 V, B = −30 mT	0.4	—	0.9	mA
Supply current	I_{CC}	V_{CC} = 16 V	—	—	6	mA
		V_{CC} = 3.6 V	—	—	5.5	mA

Note) 1. An 'A' rank type which operating magnetic flux density is ±20 mT is also available.
2. The variation of operating magnetic flux density does not depend on supply voltage due to its built-in stabilized power source. (V_{CC} should be confined to the range of 3.6 V to 16 V.)
3. A supply current increases by approximately 1 mA when its output level varies from high to low.

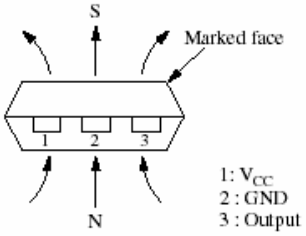
■ Technical Data

• Position of Hall element (unit: mm)

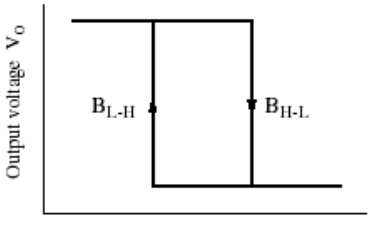
Distance from package surface to sensor part: 0.7 mm
A Hall element is placed on the shaded part in the figure.



• Magneto-electro conversion characteristics



Applying direction of magnetic flux



Magnetic flux density B

■ Caution on Use of Hall ICs

The Hall ICs are often used to detect movement. In such cases, the position of the Hall IC may be changed by exposition to shock or vibration over a long period of time, and it causes the detection level change. To prevent this, fix the package with adhesives or fix it on a dedicated case.

1. A case using an adhesive

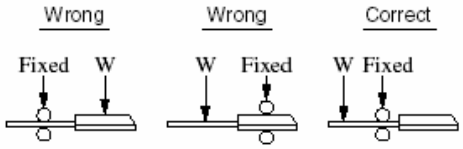
Some kinds of adhesive generate corrosive gas (such as chloric gas) during curing. This corrosive gas corrodes the aluminum on the surface of the Hall IC, and may cause a functional defect of disconnection.

If Hall IC is to be sealed after installation, attention should be given to the adhesive or resin used for peripherals and substrate cleaner, as well as to the adhesive used for Hall IC installation. Please confirm the above matter to those manufacturers before using.

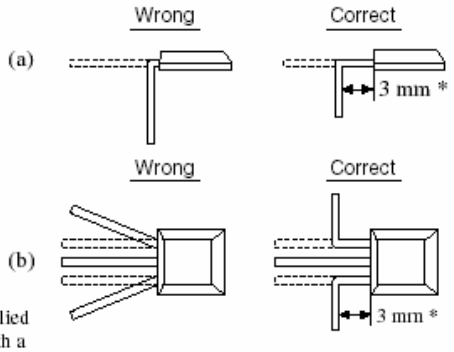
We could not select the specified adhesive, for we find it difficult to guarantee the ingredient of each adhesive.

2. A case bending lead wire

Bend the lead wire without stressing the package.



Bending method of lead wire



Bending position of lead wire

*: The distance can be within 3 mm, if no stress is applied to the resin mold by tightly fixing the lead wires with a metallic mold or the like.

3. Power supply line/Power transmission line

If a power supply line/power transmission line becomes longer, noise and/or oscillation may be found on the line. In this case, set the capacitor of 0.1 μF to 10 μF near the Hall IC to prevent it.

If a voltage of 18 V or more is thought to be applied to the power supply line (flyback voltage from coil or the ignition pulse, etc.), avoid it with external components (capacitor, resistor, Zener diode, diode, surge absorbing elements, etc.).

4. V_{CC} and GND

Do not reverse V_{CC} and GND. If the V_{CC} and GND pins are reversely connected, this IC will be destroyed. If the IC GND-pin voltage is set higher than other pin voltage, the IC configuration will become the same as a forward biased diode. Therefore, it will turn on at the diode forward voltage (approximately 0.7 V), and a large current will flow through the IC, ending up in its destruction. (This is common to monolithic IC.)

5. Cautions on power-on of Hall IC

When a Hall IC is turned on, the position of the magnet or looseness may change the output of a Hall IC, and a pulse may be generated. Therefore, care should be given whenever the output state of a Hall IC is critical when the supply power is on.

6. Fixing a Hall IC

When the Hall IC of an insertion type package installed by soldering the lead wire only is to be used under vibration, fix it firmly with a holder. Otherwise, vibration may cause metal fatigue in the lead wire of Hall IC, resulting in wire breakage.

7. On fixing a Hall IC to holder

When a Hall IC is mounted on the printed circuit board with a holder and the coefficient of expansion of the holder is large, the lead wire of the Hall IC will be stretched and it may give a stress to the Hall IC.

If the lead wire is stressed intensely due to the distortion of holder or board, the adhesives between the package and the lead wire may be weakened and cause a minute gap resulting in the deterioration of its resistance to moisture.

Sensitivity may also be changed by this stress.

■ Caution on Use of Hall ICs (continued)

8. On using flux in soldering

Choose a flux which does not include ingredients from halogen group, such as chlorine, fluorine, etc. The ingredients of halogen group may enter where the lead frame and package resin joint, causing corrosion and the disconnection of the aluminum wiring on the surface of an IC chip.

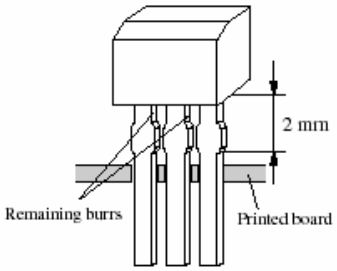
9. In case of the magnetic field of a magnet is too strong

Output may be inverted when applying a magnetic flux density of 100 mT or more. Accordingly, magnetic flux density should be used within the range of 100 mT.

10. On mounting , deburring and soldering of insertion type package

If the leads of a Hall IC in an insertion type package are inserted up to their root part through holes on the printed circuit board, abnormal stress is applied to the package and the reliability of the Hall IC is likely to deteriorate. So, when mounting each Hall IC of the insertion type, insert the leads in due degree at which the bottom face of the package is separated at least 2 mm from the top face of the PCB.

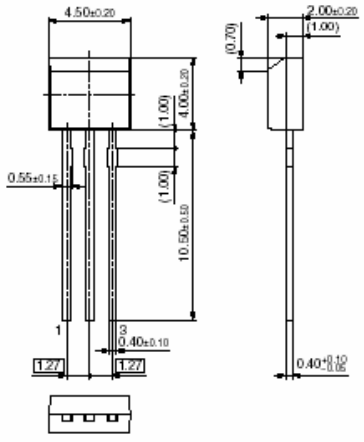
Also note that burrs of epoxy resin may be left sticking to the lead wires. (We are trying to remove such burrs as much as possible in the deburring process, but in some cases, they are not perfectly removable.)



When soldering the leads, remember to separate the soldering position by 2 mm or more from the resin part of the package.

■ New Package Dimensions (Unit: mm)

• SSIP003-P-0000H (Lead-free package)



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