Littelfuse
Expertise Applied | Answers Delivered

Application Note:
Position and Level Sensing in Refrigerators and Freezers

Introduction

Appliances like refrigerators, freezers, and wine coolers traditionally consume significant amounts of energy, thus not being very environmental-friendly.

Like many modern appliances, refrigerator and freezer microprocessor based controllers allow the use of a variety of sensors to ensure proper, safe, and energy-efficient operation. Littelfuse's magnetic sensor products help make these appliances as reliable as ever.

Reed sensors and Hall Effect sensors are both very reliable and will operate over millions of cycles with long-term integrity when used with microprocessor electrical loads. Both reed and Hall Effect devices are operated by a magnetic field. Reed switches and sensors consume no power, while Hall Effect devices are semiconductors and will consume a small amount of current in both the activated and de-activated state.

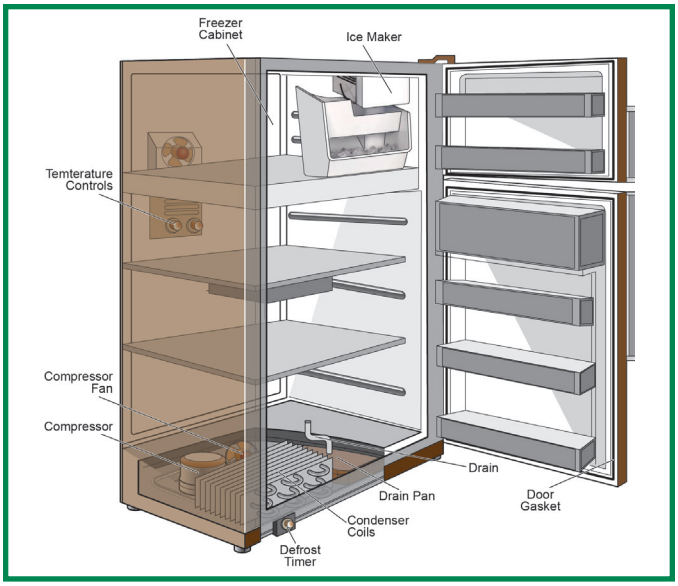

Figure 1: Components of a Refrigerator

Refrigerator and Freezer Door Position Sensing

Refrigerators equipped with a microprocessor control unit are compatible for the use of noncontact-type sensing technologies such as reed switches/sensors and Hall Effect sensors. These technologies are very compatible for the low DC voltage and current requirements of the microcontroller.

No longer is there a need for the traditional mechanical and plunger-type switches that have been previously used for directly switching 120Vac incandescent lights. Modern appliances that use the microcontroller have converted to an LED light for the interior. This is a huge advantage for energy saving.

When the door of a refrigerator, freezer, or wine cooler is opened, a light is turned on to illuminate the inside compartments. In order to accomplish this, a proximity sensor is needed to detect if the appliance door is open or closed.

A reed sensor or Hall Effect sensor can be used to detect the position of the door. For example, in refrigerators, a reed sensor is mounted to the frame of the appliance and a permanent magnet actuator is mounted to the door. Each reed switch or Hall Effect sensor and magnet actuator is positioned such a way that the reed switch or Hall Effect sensor is activated when the door is closed, and the light will turn off. When the door is open, the magnet on the door is positioned outside the sensor's activation range and the sensor is deactivated and the light will turn on in this mode. The controller uses reverse logic to control the light relative to the sensor activation.

The sensor units are not visible since these are mounted behind the panels of the frame or door, greatly improving the aesthetic appeal of the appliance. Unlike mechanical or plunger switches that have levers or buttons visible, these sensors are 'non-contact' and do not require physical contact to operate.

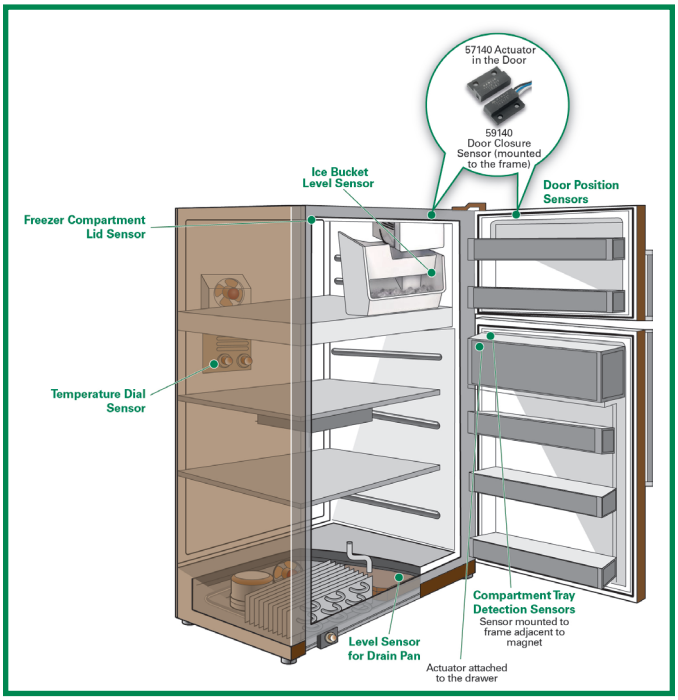

Figure 2: Sensor Positions in a Refrigerator

Littelfuse recommends the following products as door position sensors:

Table 1: Suggested Products as Door Position Sensors

Suggested Products
FLEX-14 reed switch
MDSM-4R surface mount reed switch
59025 Firecracker reed sensor
59140 flat-pack reed sensor
Custom-designed door sensor

Water/Ice Dispenser Lever Position Sensing

The water and ice dispenser on the front of a French door refrigerator unit presently does not have a sensor within this mechanism for detecting the on/off position of the dispenser. Adding a sensor would allow the microcontroller to have a closed-loop operation for this unit.

There are some options available, a digital signal or a rotary ratio-metric output, or even a linear ratio-metric output.

The digital version would be a simple reed or Hall Effect sensor mounted to the fixed frame, while the magnet would be attached to the moving lever. With this system, the water or ice is at one filling or flow rate; that is, it is either on or off.

When using a ratio-metric output Hall Effect sensor, an instantaneous feedback relative to the exact lever/magnet position on a linear response scale is available. With the exact position being monitored by a microcontroller, the system can dispense the water at various flow rates. A non-contact sensing solution would be preferred for improved long term reliability. A programmable rotary Hall Effect sensor is ideal for this application.

For instance, when the lever is in its normal open position, the voltage output from the Hall Effect sensor could be programmed to 0.5Vdc, while the maximum swing of lever movement would be programmed to 4.5Vdc. In between these values, the water flow rate can be controlled to the instantaneous position that the lever arm is positioned.

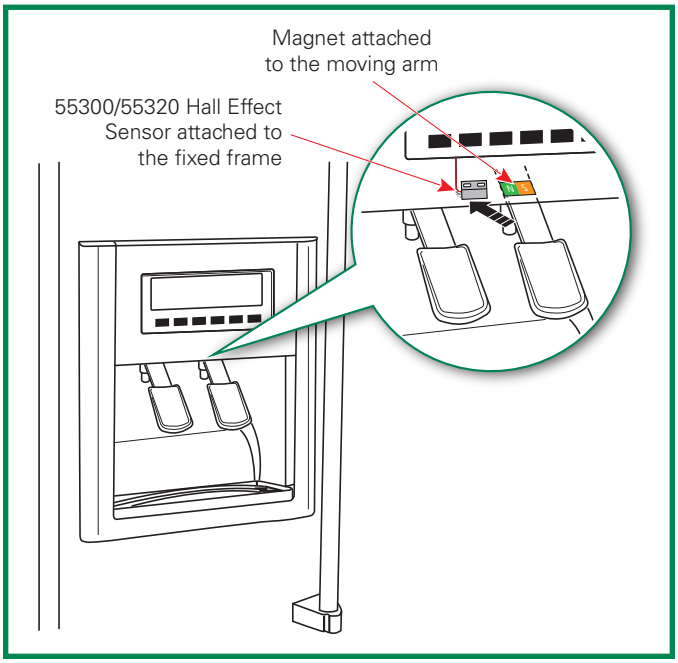

Figure 3: Sensor and Magnet Positions on a Water/Ice Dispenser

Littelfuse recommends the following products as the water dispenser lever position sensor:

Table 2: Suggested Products as Water Dispenser Lever Position Sensor

Suggested Products
55320 linear Hall Effect sensor
59140 flat-pack reed sensor
59025 Firecracker reed sensor
55300 rotary Hall Effect sensor
Custom-designed sensor

Drawer and Compartment Cover Position Sensing

There are a variety of potential sensing applications centered on the various compartments within a refrigerator and freezer. Compartment doors for butter or drawers for the produce, meats, and deli foods can also be fitted with sensors for detecting opening or closure.

All of these sensors can be a digital reed or Hall Effect output. The magnet would be mounted in the moving tray or drawer, while the sensors would be in a fixed position on the framing. If a proper closure is not obtained, a light could be activated on the unit so the user can adjust properly.

Littelfuse recommends the following products as tray and compartment cover position sensors:

Table 3: Suggested Products as Tray and Compartment Cover Position Sensors

Suggested Products
MDCG-4 reed switch
MDSR-10 reed switch
59140 reed sensor
55140 Hall Effect digital sensor
Custom-designed sensor

Ice Bucket Fill-Level Sensing

Refrigerators/freezers equipped with an internal ice maker and bucket typically uses a mechanical arm over the ice bucket to detect when the ice is filled to the top. This turns off the icemaker when the bucket is full.

Presently a mechanical switch and relative valve is used to control this. In appliances containing micro-controllers, a reed sensor can be fixed to the frame and a magnet can be attached to the arm, allowing a more reliable sensing mechanism than the existing mechanical units.

Littelfuse recommends the following products as ice bucket fill position sensors:

Table 4: Suggested Products as Ice Bucket Fill Position Sensors

Suggested Products
59140 reed flat pack sensor
55140 Hall Effect digital sensor
Custom-designed sensor

Temperature Control Dials Position Sensing

Both the freezer and refrigerator compartments have rotary temperature adjustment dials. These are usually resistive film or potentiometer-type adjusters.

In micro-controller equipped systems, a non-contact sensing solution would be preferred for improved long-term reliability. A programmable rotary Hall Effect sensor is ideal for this application; with 0.5V to 4.5Vdc output over 360 degrees of rotation.

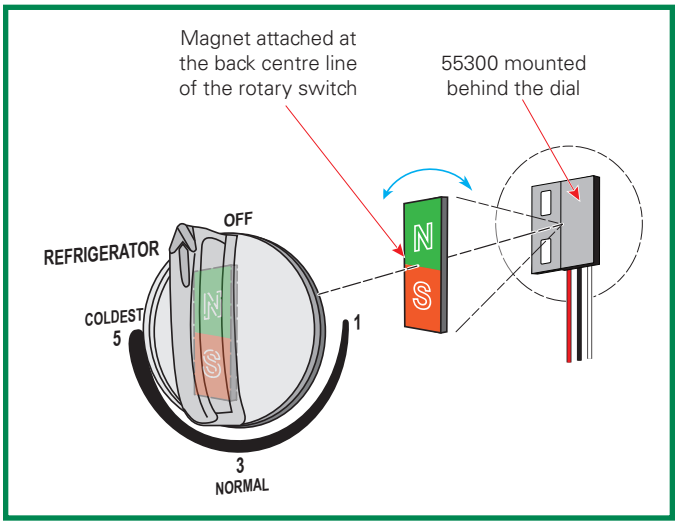

Figure 4: Temperature Control Dial Mechanism Using a Hall Effect Sensor

Littelfuse recommends the following products as temperature control dial position sensors:

Table 5: Suggested Products as Temperature Control Dial Position Sensors

Suggested Products
55300 rotary Hall Effect sensor
Custom-designed sensor

Drain Pan Level Sensor

On the bottom of most refrigerators is a shallow depth drain pan for catching leaking water from the refrigerator or freezer compartment. Since this pan is not visible, it is difficult to detect a leak until the water is visible on the floor. A reed level sensor would be of great benefit for this application.

This digital output sensor can detect when the water level is too high in the drain pan and the controller would activate an alarm or light.

Littelfuse recommends the following products as level sensors for the drain pan:

Table 6: Suggested Products as Level Sensors for the Drain Pan

Suggested Products
59630 reed level sensor
Custom-designed sensor

FEATURES AND BENEFITS OF REED SWITCHES

- Switch activation does not require physical contact
- Switch contacts are within a hermetically sealed capsule
- Resistant to moisture, dust, and other foreign objects
- Wide operating temperature range
- Reliable switching
- Long lifetime

Why to Use Reed or Hall Sensor

A reed switch is a magnetically operated switch that in most situations are normally open when there is no magnetic field present. When a magnetic field is present in proper alignment and of sufficient strength, the contacts of the reed switch will close and complete the circuit.

Reed switches and Hall Effect sensors are magnetic switching devices, sometimes called 'contactless'; that is because the actuator/magnet does not make physical contact to the switch, to change the state, unlike a Micro-switch, or a Mechanical switch.

Reed switches are perfect technology for switching microprocessor electrical loads of 1-12Vdc and small milli-amps of current. Reed switches have precious metal contacts, hermetically sealed within a glass envelop and filled with nitrogen gas. The switching cycles can last up to many millions of operations with no degradation of contact wear, because of this inherent reed switch design.

A digital Hall Effect is a semiconductor with unlimited life when driven by the proper voltage and current. Reed and Hall Effect devices are long-lasting and very reliable within very humid and varying temperature applications.

FEATURES AND BENEFITS OF HALL EFFECT SENSORS

- No physical contact required to operate the sensor
- Wide operating temperature range
- Digital or analog options for output signal
- Programmable on both digital and analog applications for tight output tolerances
- Effective for high-speed applications
- Encapsulated sensors provide additional protection against mechanical stresses
- Long lifetime and reliable sensing for millions of operations

Beyond Sensing, Littelfuse Offers Circuit Protection Solutions

In addition to sensor products, Littelfuse offers the world's broadest and deepest portfolio of circuit protection and power control solutions.

Littelfuse recommends the following products for use in these applications:

Table 7: Circuit Protection and Power Control Solutions

Application Example	Product Series
Power Control	
AC Compressor Evaporator/Condenser Fan Defrost Heater	Q60xx Triac
Light Control Ice Maker Valves	QxNx Triac
Circuit Protection	
AC Mains	TMOV, LA, C-III MOV, UltraMOV Varistors
	3AG, 5x20mm Fuses
	Holders, Blocks, Clips
Control Board	TR5/TE5 Fuse
	SMD PTC
	P4KE/SMAJ TVS
Touch Screen/Display Panel	SP1001, SP1003, SP1006 Diode Arrays
	Multilayer Varistors

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