Dome Point and Variations

Acceleration and Tilt Sensors: FID-820/870

The dome point is FUJITSU Takamisawa’s unique, easy-to-use, long-lasting, and highly reliable pointing device with a non-contact magnetic field sensor.

Features

- Exceptional ease of operation
- High reliability
- Customizable interface
- 360° detection capability
- Acceleration can be detected in terms of magnitude, time, and direction
- Detects angle of tilt up to 30°
- Detects tilt in any direction in a 360° circle

Product Overview

The dome point uses FUJITSU Takamisawa’s unique, non-contact magnetic field detection method. When the cap, which serves as an operating button, is pressed, an internal permanent magnet is deflected at an angle. The change in the magnetic field resulting from the deflection of the magnet is detected as a change in voltage at Hall elements in the base board. This allows the direction and degree of the cap tilt to be calculated and used to operate a pointing device. FUJITSU Takamisawa has used the technology of the dome point to combine multiple pointing devices in a line of three-dimensional controllers (see Photo 2 on p. 89) with three-axis control. In addition, we have used this technology to develop an acceleration sensor and tilt sensor.
Figure 1 shows product applications of the dome point. The acceleration and tilt sensors do not require physical contact and can detect acceleration and tilt in all directions, producing a 256-count digital output. With firmware and interface customization, this device is easy to use in a wide variety of applications.

The Principle of the Dome Point

Figure 2 (see p. 90) shows the principle of detection by the Hall element. The Hall element acts as a detector when a current (I) is passed by applying an electrical field (B) to the semiconductor inside the hold element, creating a voltage (V) proportional to the strength of the field. The output voltage (V) from the Hall element is proportional to \( IB \sin \theta \) and is insensitive to fields parallel to the X-Y plane. Thus, by optimally placing the Hall element, it is possible to efficiently detect electrical fields in the Z-axis direction. This capability has been used in developing a two-dimensional tilt sensor.

Figure 3 (see p. 90) shows the basic configuration of the tilt sensor. Two Hall elements each are placed along the X- and Y-axes on the printed circuit board, where the Z-axis field from the magnet is strong. The magnet is placed above, where it can be slanted in any desired direction. The Hall element toward which the magnet is moving detects a stronger field, and the Hall element in the opposite direction detects a weaker field. As a result, a difference in output voltage arises between the two Hall elements on each axis. The difference in output voltage in each pair of Hall elements is used to configure a detector, which is highly sensitive to tilt and can be detected as a linear function of output voltage.
Figure 2. Hall Element Detection Principle

- Z-Axis Magnetic Field B
- Y-Axis
- X-Axis
- Electric Current (I)
- Voltage (V)

Figure 3. Basic Configuration of the Deflection Detection Sensor

- Magnet Tilt
- Magnetic Field Change
- Magnetic Field Detected by Hall Element
- Tilt Detection and Degree Data Output

Table 1. FID-820/870 Specifications

<table>
<thead>
<tr>
<th></th>
<th>31 mm x 26 mm x 25 mm</th>
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</thead>
<tbody>
<tr>
<td>External Dimensions</td>
<td></td>
</tr>
<tr>
<td>Tilt Angle</td>
<td>±30°</td>
</tr>
<tr>
<td>Weight</td>
<td>9g</td>
</tr>
<tr>
<td>Resolution</td>
<td>256 Levels (can be customized)</td>
</tr>
</tbody>
</table>
Product Characteristics

**Dome Point**

The principle described above can be used to construct a variety of pointing devices. Here we will introduce a preloaded type device with an accurate center return mechanism.

Figure 4 shows a cross-sectional view. The magnet is placed along the axis of the operating cap, and a spring mechanism is constructed to provide easy operation with maximum tilt angle setting, center recovery power, and operating power. This mechanism is placed so that it can effectively apply a magnetic field to the Hall elements installed on the printed circuit board, and it is contained in a one-piece housing.

Table 1 (see p. 90) shows the specifications of the dome point.

**Dome Point Features**

- Exceptional ease of operation
  - Can tilt 30° in any direction around a 360° circle
- Uniform operability in all directions
- High reliability
- FUJITSU Takamisawa’s unique, maintenance-free, non-contact magnetic field detection method
- Customizable interface

**Applications**

The dome point can be used in electronic games, vehicle navigation systems, Internet terminals, portable phones, digital TV controllers, multimedia remote controls, and many other applications.

Three-dimensional operation is possible by using multiple dome points placed on each operating axis. A line of application products, such as the 3D controller (ErgoPoint 3D) shown in Photo 2 (see p. 89), have been developed.

**3D Controller Applications**

The dome point can be used in 3D controllers, such as 3D-CAD/CAM/CAEs and 3D-CG 3D controllers.

![Figure 4. Dome Point Cross Section](image-url)
**Figure 5. Acceleration Sensor Principle**

The dome point key technology serves as the basis for the development of an acceleration sensor. Figure 5 shows the principle of the acceleration sensor, and Figure 6 shows a sample application.

A movable axis equipped with the magnet structure shown in Figure 4 (see p. 91) is used. The operating cap is replaced with a spring and weight unit appropriate to the magnitude of the acceleration to be detected. Both the direction and magnitude of the acceleration are detected by the tilt of the moving magnet and output from the unit.

**Acceleration Sensor Features**

The acceleration sensor offers the following features:

- 360° detection capability
- Acceleration can be detected in terms of magnitude, time, and direction

**Applications**

The acceleration sensor can be used in many applications, such as gesture inputs and vehicle-mounted devices.

**Tilt Sensor**

The dome point element technology also serves as the basis for the development of the tilt sensor. Figure 7 (see p. 93) shows a sample application. A movable axis is equipped with a magnet, and a weight for angle detection is placed facing downward. The unit is constructed to output both the direction and angle of tilt in any direction.
Tilt Sensor Features

The tilt sensor offers the following features:

- Detects angle of tilt up to 30°
- Detects tilt in any direction in a 360° circle

Applications

The tilt sensor can be used in these applications:

- Body tilt or fall detection units
- ATMs, vehicles, etc.
- Theft-prevention detectors

Circuit Configuration

Figure 8 shows the common circuit blocks of the dome point, acceleration sensor, and tilt sensor.

Changes in the magnetic field caused by changes in the movable axis are detected and computed in all directions in analog terms by the four Hall elements on the X- and Y-axes. The output is converted to 256-level digital values and output through the interface. The interface can be configured for easy connection to a variety of application system configurations.
Application Development

We have introduced other applications of the dome point, acceleration sensor, and tilt sensor. These easy-to-use devices can be adapted to a wide variety of applications using magnetic detection, with 256-level digital output from non-contact elements, firmware, and customized interfaces. Also, the devices can be combined into compound units, including development of applications for three-dimensional operation using multiple units. New uses offer the potential for discovery of even more new applications.

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