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# HA16603P/FP

Contactless Switch

# HITACHI

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## Description

The HA16603P is an IC for use with metal proximity switches. It can be used for the coin sensor circuit in vending machines and similar microprocessor sensors.

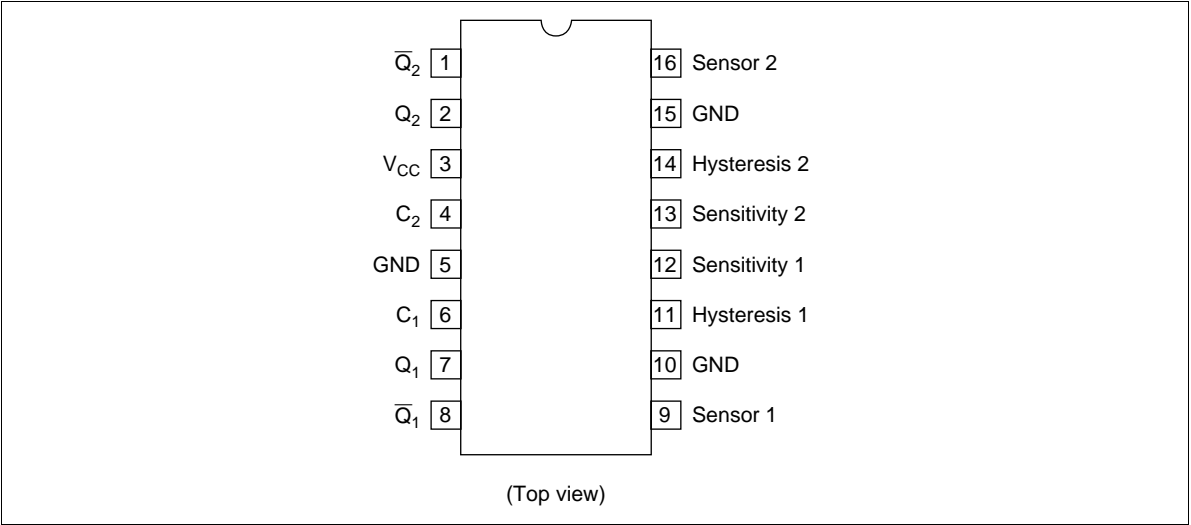
## Features

- Two proximity switch channels
- The input and output pins are arranged in pairs for convenient printed circuit board mounting.
- Wide operating power-supply voltage range: 4.75 to 30 V
- Low power with a dissipation current of only 2.5 mA
- Normal and inverted outputs can be acquired at the same time.
- The outputs is available for current-source drive only since the internal circuits are NPN transistors with open emitter outputs.

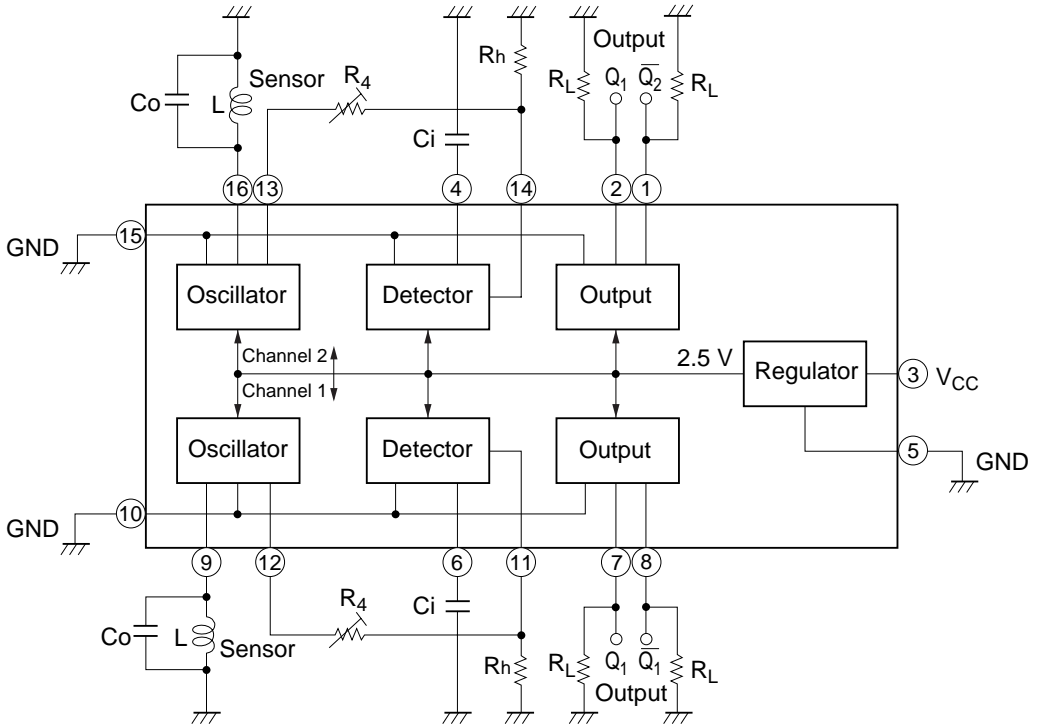
## Ordering Information

| Type No.  | Package |
|-----------|---------|
| HA16603P  | DP-16   |
| HA16603FP | FP-16DA |

Pin Arrangement



## Block Diagram



Notes:  $R_4$ : Sensing distance adjustment resistor

$R_h$ : Hysteresis resistor

$R_L$ : Leakage bypass resistor

$C_i$ : Detector integration capacitor

When a metallic object approaches the sensor coil L (sensor on), the outputs ⑦ and ② go to the high level and the outputs ① and ⑧ go to the low state.

Absolute Maximum Ratings (Ta = 25°C)

| Item                                 | Symbol                                     | Rating               | Unit |
|--------------------------------------|--|----------------------|------|
| Operating power-supply voltage range | V <sub>CC</sub>                            | 4.75 to 30           | V    |
| Output voltage                       | V <sub>OUT</sub>                           | 0 to V <sub>CC</sub> | V    |
| Hysteresis pin voltage               | V <sub>11</sub> , V <sub>14</sub>          | 0 to V <sub>CC</sub> | V    |
| Sensor pin voltage                   | V <sub>9</sub> , V <sub>16</sub>           | −1.3 to +2.0         | V    |
| Sensitivity pin voltage              | V <sub>12</sub> , V <sub>13</sub>          | −0.65 to +2.0        | V    |
| Capacitor pin voltage                | V <sub>4</sub> , V <sub>6</sub>            | 0 to +2.0            | V    |
| Output source current                | I <sub>o(source)</sub>                     | −7 to 0              | mA   |
| Hysteresis pin sink current          | I <sub>11</sub> , I <sub>14 (sink)</sub>   | 0 to +1.0            | mA   |
| Sensitivity pin source current       | I <sub>12</sub> , I <sub>13 (source)</sub> | −5 to +0.1           | mA   |
| Sensor pin source current            | I <sub>9</sub> , I <sub>16 (source)</sub>  | −1.0 to 0            | mA   |
| Capacitor pin sink current           | I <sub>4</sub> , I <sub>6 (sink)</sub>     | 0 to +5.0            | mA   |
| Power dissipation*                   | P <sub>T</sub>                             | 625                  | mW   |
| Capacitor pin source current         | I <sub>4</sub> , I <sub>6 (source)</sub>   | −320 to 0            | μA   |
| Operating temperature                | Topr                                       | −25 to +85           | °C   |
| Storage temperature                  | Tstg                                       | −40 to +125          | °C   |

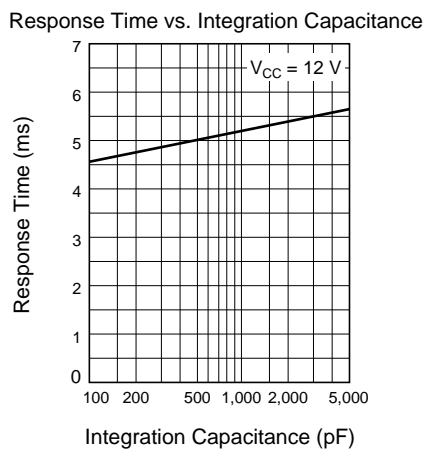
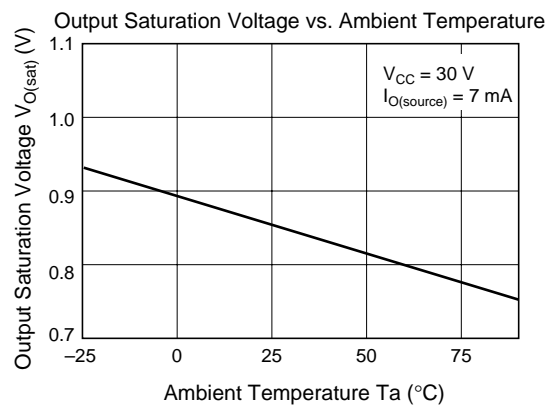
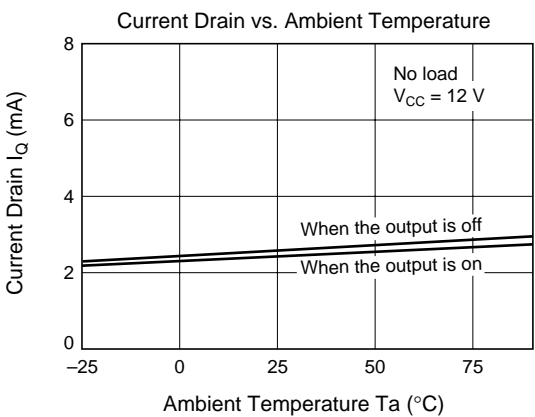
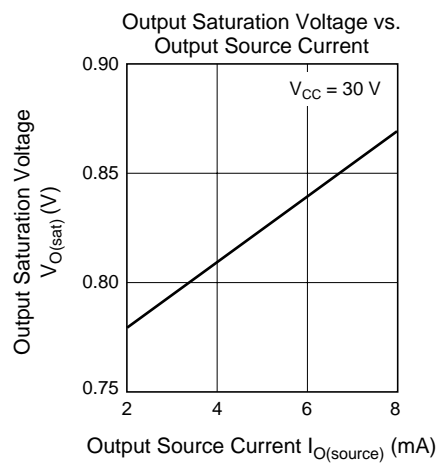
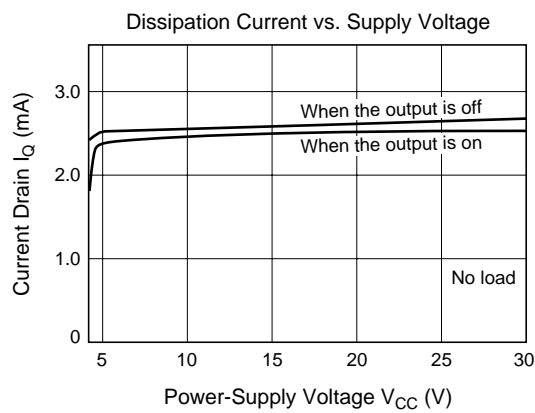
Note: When multiple maximum ratings apply to the same pin, the rating that corresponds to the smallest stress is the valid rating.

\* See notes on SOP Package Usage in Reliability section.

Electrical Characteristics (V<sub>CC</sub> = 24 V, Ta = 25°C)

| Item  | Symbol                                   | Min  | Typ | Max   | Unit | Test Condition  |            |
|---|--|------|-----|-------|------|---|------------|
| Dissipation current                           | I <sub>Q</sub>                           | —    | 2.5 | 6.0   | mA   | Sensor 1 and sensor 2: ground, V <sub>CC</sub> = 30 V, sensitivity 1 and sensitivity 2: 10 kΩ to ground |            |
| Output saturation voltage                     | V <sub>O(sat)</sub>                      | —    | —   | 1.0   | V    | (V <sub>CC</sub> – V <sub>OUT</sub> )   | Ta = 25°C  |
|   |  | —    | —   | 1.1   | V    | I <sub>O(source)</sub> = –7 mA  | Ta = –25°C |
| Output leakage current                        | I <sub>O(leak)</sub>                     | –600 | —   | —     | nA   | V <sub>CC</sub> = 30 V  | Ta = 25°C  |
|   |  | –40  | —   | —     | μA   |   | Ta = 85°C  |
| Hysteresis pin internal resistance (on state) | r <sub>CS</sub>                          | —    | —   | 260   | Ω    | I <sub>11</sub> , I <sub>14 (sink)</sub> = 500 μA   |            |
| Hysteresis pin leakage current                | I <sub>11</sub> , I <sub>14 (leak)</sub> | —    | —   | 1     | μA   | V <sub>CC</sub> = 30 V, V <sub>H</sub> = 5 V  |            |
| Oscillator frequency                          | f <sub>OSC</sub>                         | —    | —   | 1,000 | kHz  |   |            |

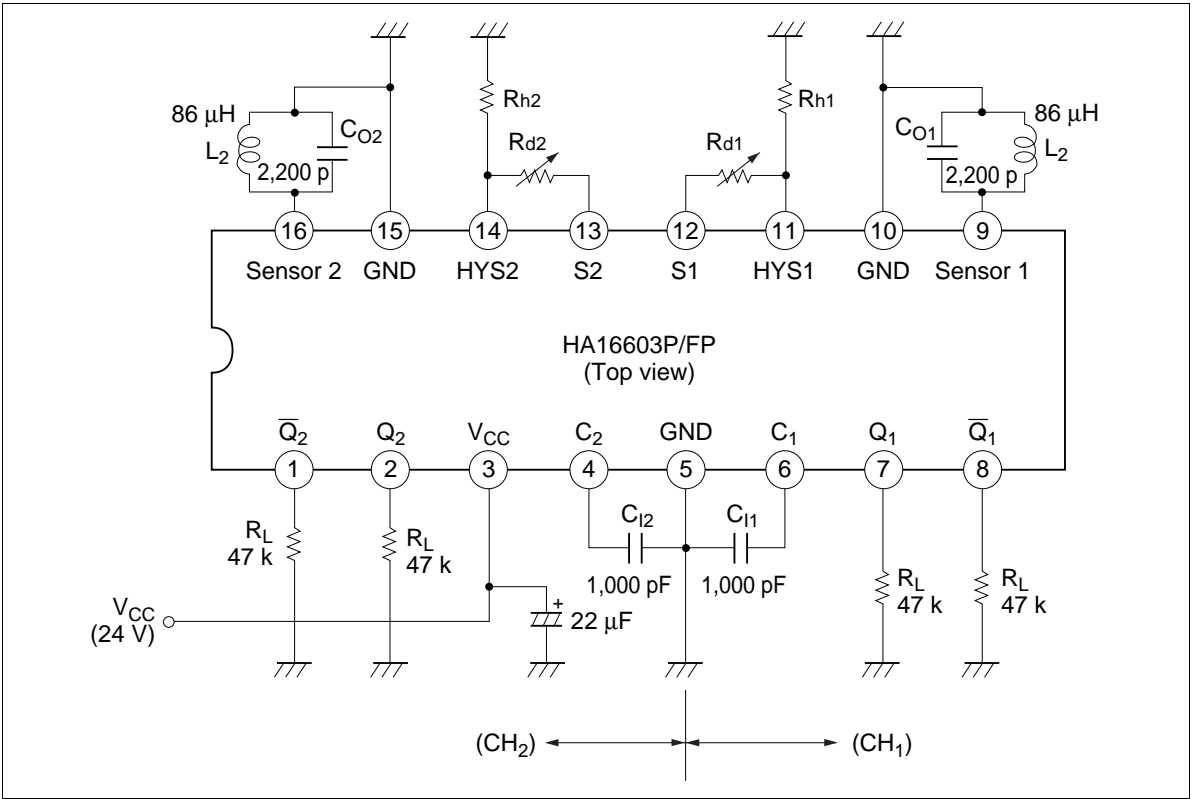
Characteristics Curves



Notes

- (1) An air-core coil must be used as the sensor coil.
- (2) This IC has 3 ground pins. All three ground pins must be connected to ground, even if only one channel is used.
- (3) If the sensitivity is set too high for a sensor coil with bad temperature characteristics, the operating temperature range may become narrow. The operating temperature range for the whole system, including the sensor coil, can be expanded by holding down the sensitivity.

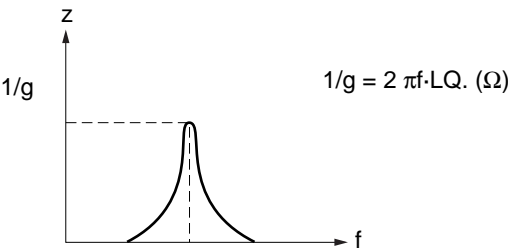
Sample Recommended Operating Circuit



The oscillator frequency is determined by the following formula.

$$f_{osc} = \frac{1}{2\pi\sqrt{LC_0}}$$

The tank circuit formed by L and C<sub>0</sub> has characteristic impedance shown in the figure. The condition for oscillation for the HA16603P is  $R_d \leq 1/g$ , and the condition for oscillation to stop is  $R_d > 1/g$ .



When  $R_d$  is connected to the hysteresis pin,  $(R_d + r_{cs} // R_h) \leq 1/g$  is the condition for oscillation to start, and  $(R_d + R_h) > 1/g$  is the condition for oscillation to stop. Note that  $r_{cs}$  is the internal resistance of the hysteresis pin.

The relationship between oscillation occurring or not and the detection of a metallic object is as follows:

Oscillation occurs: When no metallic object is detected (i.e. the sensor coil and the metallic object are separated)

Oscillation stops: When a metallic object is detected (i.e. the metallic object is near the sensor coil)

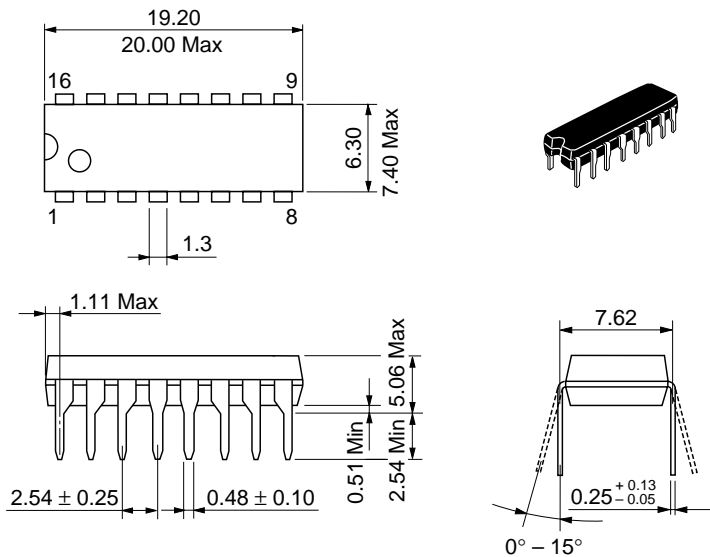
Setting the Detection Distance

Since the detection distance depends on the Q of the sensor coil and the shape, surface area, thickness, and material of the metallic object, it can only be set by testing the completed system. Note that  $R_d$  sets the detection distance.



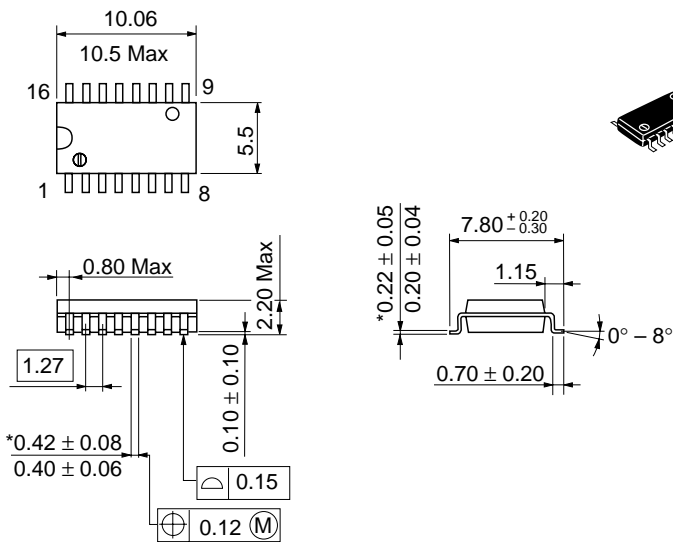
Package Dimensions

Unit: mm



|                        |          |
|------------------------|----------|
| Hitachi Code           | DP-16    |
| JEDEC                  | Conforms |
| EIAJ                   | Conforms |
| Mass (reference value) | 1.07 g   |

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

|                        |          |
|------------------------|----------|
| Hitachi Code           | FP-16DA  |
| JEDEC                  | —        |
| EIAJ                   | Conforms |
| Mass (reference value) | 0.24 g   |

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HITACHI

Hitachi, Ltd.

Semiconductor & Integrated Circuits.  
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan  
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL      NorthAmerica      : <http://semiconductor.hitachi.com/>  
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For further information write to:

|  |   |
|--|---|
| Hitachi Semiconductor (America) Inc.<br>179 East Tasman Drive,<br>San Jose, CA 95134<br>Tel: <1> (408) 433-1990<br>Fax: <1> (408) 433-0223 | Hitachi Europe GmbH<br>Electronic components Group<br>Dornacher StraÙe 3<br>D-85622 Feldkirchen, Munich<br>Germany<br>Tel: <49> (89) 9 9180-0<br>Fax: <49> (89) 9 29 30 00<br><br>Hitachi Europe Ltd.<br>Electronic Components Group.<br>Whitebrook Park<br>Lower Cookham Road<br>Maidenhead<br>Berkshire SL6 8YA, United Kingdom<br>Tel: <44> (1628) 585000<br>Fax: <44> (1628) 778322 |
|--|---|

Hitachi Asia Pte. Ltd.  
16 Collyer Quay #20-00  
Hitachi Tower  
Singapore 049318  
Tel: 535-2100  
Fax: 535-1533

Hitachi Asia Ltd.  
Taipei Branch Office  
3F, Hung Kuo Building, No.167,  
Tun-Hwa North Road, Taipei (105)  
Tel: <886> (2) 2718-3666  
Fax: <886> (2) 2718-8180

Hitachi Asia (Hong Kong) Ltd.  
Group III (Electronic Components)  
7/F., North Tower, World Finance Centre,  
Harbour City, Canton Road, Tsim Sha Tsui,  
Kowloon, Hong Kong  
Tel: <852> (2) 735 9218  
Fax: <852> (2) 730 0281  
Telex: 40815 HITEC HX

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