General-Purpose Self-Contained Photoelectric Switches

HP7 series

Suitable for a variety of applications and conditions.

- Wide range of configurations and specifications
- Improved resistance to interference (e.g., fluorescent lights)
- Threaded metal mounting holes for more reliable installation
- Different frequency thru-scan model for stress-free installation
- Inexpensive, to meet current market needs
- Auto Adjust button for situations where detection is difficult

Nothing escapes his notice, no matter what the conditions.

Warning

- Designed for general industrial use, not for safety equipment.
- Do not connect this device to AC power. Doing so might cause rupture or burnout.

Handling precautions

- Tighten the mounting screws to a maximum torque of 0.8 N·m.
- Holes for mounting brackets should be 3.5 mm in diameter or less.
- After the power is turned on, the switch starts to operate in 60 ms at most (80 ms for HP7-C).
- For outdoor use, put inside a case, etc. To prevent direct exposure to sunlight and rain/water.
- Avoid locations with strong vibration or impact. They may cause optical axis misalignment.
- Shield the lens from water and oil. Water or oil on the lens can cause faulty operation.
- Do not expose to chemicals (Organic solvents, acids, alkalis).
- Use a cover or change the mounting direction to ensure correct switch operation if there is heavy interference from ambient light.
- When used in a very dusty environment, be sure to take countermeasures to keep dust away from the lens surface by using a sealed case or air purging.
- Even when oil-resistant cable is used, do not use in a location subject to continuous splashing by water or oil, or where the unit is immersed in liquid. Ensure that the end of the cable is not subject to splashing by water or oil.
- A bend in the cable immediately after it exits the device should have a radius of at least 30 mm. Avoid use in which the cable receives repeated bending stress. Do not apply a force of 50 N or higher (30 N or higher for low-temperature cable types).

Wiring precautions

- If a cable extension is necessary, use wire at least 0.3 mm² in cross-sectional area and at most 100 m long.
- If the cable of the photoelectric switch are laid in the same conduit as high-voltage or power lines, inductance may cause malfunction or damage. Isolate the photoelectric switch's cable or lay it in a separate conduit.

Adjustment method

Thru-scan model and retroreflective model

1. Move the emitter and receiver (Main body and reflector in case of a retroreflective model) up, down, right, and left, and then align them in the center of the area where the green stable-operation indicator lights up.
2. Check switch operation using a target object then use the Auto Adjust button to adjust the sensitivity setting.

Diffuse-scan model

1. Mount the photoelectric switch pointing toward the desired detection position.
2. Check switch operation using a target object then use the Auto Adjust button to adjust the sensitivity setting.

Other product names, model numbers and company names may be trademarks of the respective company.
High-performance photoelectric switches suitable for a wide range of applications

**HP7 series**

**Resolves installation issues!**

- Light axis is hard to adjust over long distances (Thru-scan and retroreflective models) with low reflectance (Diffuse scan)
- Interference between side-by-side switches.
- Need to reverse the switch configuration or move switches.

**Simple to operate and delivers reliable detection**

Long-range thru-scan models have a light-operated indicator on the front, and retroreflective models send out a visible red light beam for light axis alignment over long distances. Diffuse-scan models offer the best long-distance detection standards in the industry along with consistent detection of darker colors.

**No constraints**

Thru-scan switches using different frequencies can be installed side by side without mutual interference protection filter or reversed switch orientation. (The 4 m type with its short detection range reduces malfunctions caused by mutual interference between adjacent rows of switches.) Diffuse-scan and retroreflective models are fitted with automatic interference suppression that allows two units to be used side by side.

**Photoelectric switches may be tripped by inverter fluorescent lights or LEDs.**

**Reliable in various lighting**

New algorithms achieve major improvement in resistance to external optical interference.

**Designed for modern lighting**

- Plastic threaded holes are not strong enough, so threads are stripped if screws are tightened too tightly or too quickly.

**Stronger mounting holes**

Threaded metal mounting holes provide improved mechanical strength. In addition to the standard brass threads, SUS304 threads are available.

**Cutting oil mist near metalworking lines reduces switch life.**

- Improved resistance to oil

Modified polyallylate resin with excellent resistance to oil is employed (thru-scan and diffuse-scan models). Polyallylate resin lenses offer improved resistance to the effects of oils and chemicals.

**Improved resistance to oil**

- It takes time to adjust the light axis.
- You can’t be sure it is set correctly (it may be used for a long time).

**High-intensity red LED**

Due to high-intensity four-element LED, light spot is easy to be recognized, helping to save time during light axis adjustment.

**Auto Adjust button**

If there is a problem, press this button to return to stable detection.

**Operation varies depending on who set the sensitivity.**

**Adjusting the sensitivity takes time.**

**Switches don’t operate in freezers at −35 °C.**

- Low temperature use OK

Can be used in warehouses refrigerated to −35 °C (low-temp. cord models). The operating temperature range is −35 °C to +55 °C, the widest in the industry (low-temp. cord models).

**Operation of the standard model is guaranteed down to −30 °C.**

**Low temperature use OK**

- Cutting oil mist near metalworking lines reduces switch life.

**Designed for use in just about any environment!**

- Cutting oil mist near metalworking lines reduces switch life.
- Unreliable detection of black (etc.) objects with low reflectance (Diffuse scan)
- Consistent detection of transparent (etc.) objects is short-lived (retroreflective sensor)

<table>
<thead>
<tr>
<th>Long-range Thru-scan model</th>
<th>Retroreflective model</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 m</td>
<td>5 m</td>
</tr>
<tr>
<td>Long-range Diffuse-scan model</td>
<td>1 m</td>
</tr>
<tr>
<td>Wide-beam Diffuse-scan model</td>
<td>10 cm</td>
</tr>
<tr>
<td>Retroreflective detection of transparent objects</td>
<td>2 m</td>
</tr>
</tbody>
</table>

**Light-operated indicator**

Thru-scan models using different frequencies can be installed side by side without mutual interference protection filter or reversed switch orientation. (The 4 m type with its short detection range reduces malfunctions caused by mutual interference between adjacent rows of switches.) Diffuse-scan and retroreflective models are fitted with automatic interference suppression that allows two units to be used side by side.

**Thru-scan switches using different frequencies can be installed side by side**

Thru-scan switches using different frequencies can be installed side by side without mutual interference protection filter or reversed switch orientation. (The 4 m type with its short detection range reduces malfunctions caused by mutual interference between adjacent rows of switches.) Diffuse-scan and retroreflective models are fitted with automatic interference suppression that allows two units to be used side by side.

**Thru-scan models (Red, infrared): 2 switches**

**Thru-scan models (Red): 4 switches (using mutual interference protection filter)**

**Diffuse-scan model / Retroreflective model**

**Diffuse-scan model**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Retroreflective model**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Long-range thru-scan models**

- Interference between side-by-side switches.
- Need to reverse the switch configuration or move switches.

**Retroreflective models**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Diffuse-scan models**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Retroreflective detection of transparent objects**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Long-range thru-scan models**

- Interference between side-by-side switches.
- Need to reverse the switch configuration or move switches.

**Retroreflective models**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints

**Diffuse-scan models**

- Reliable in various lighting
- Simple to operate and delivers reliable detection
- No constraints
HP7 Series Applications

With its wide range of possible configurations, the HP7 meets a variety of detection needs. The HP7-C1 series has been added to the product portfolio for the detection of transparent objects.

Long-distance detection

Use to detect objects that have fallen from mobile racks or popped out of stacker cranes. The light-operated indicator on the front makes adjustment of the light axis easy.

HP7-T4 _ Detection range: 30 m

Substrate detection

Use for detection of objects passing the inlets/outlets of furnaces, where air may be thick with dust and smoke. The 30-meter detection capability makes longer service life possible.

HP7-T4 _ Detection range: 30 m

Reduction of mutual interference

Use when switches need to be closely packed to judge workpiece size, etc. The combined use of standard and different-frequency switches and the mutual interference protection filter enables serial installation of multiple switches.

HP7-T_1 standard frequency + HP7-T different frequency + HP-U02 (Filter)

Note: This combination is for the red beam models only.

Glass detection

Use to reduce mutual interference between adjacent lines of switches. The short detection range restricts the possibility of mutual interference.

HP7-T5 _ Detection range: 4 m

External light interference countermeasure

Use different-frequency thru-scan models to prevent false tripping of switches from image processing lighting in the printing and check processes. Different-frequency thru-scan models are especially resistant to external interference.

HP7-T __

Detection of transparent objects

Use for reliable detection of PET bottles and glass bottles. Consistent detection of any type of bottle, with or without contents.

HP7-CM _ Detection range: 1 m

Note: Installing a specially designed slit can improve consistency of detection.
How to use the Auto Adjust button

If switch operation is not consistent at factory default settings, press the Auto Adjust button to adjust sensitivity automatically.

Tuning without a workpiece

In certain applications involving thru-scan and retroreflective switches, the target may not block the switch beam properly due to unwanted reflection and/or permeation of light. In some cases, diffuse-scan switches may erroneously recognize background as the target. Tuning without a workpiece is the first step in trying to resolve the problem. Tuning without a workpiece refers to tuning with no target object present.

- **Thru-scan and retroreflective switches**: Automatically adjusts sensitivity to trigger the switch at approximately half the intensity of the light received when there is no target object present.
- **Diffuse-scan switch**: Automatically adjusts sensitivity to trigger the switch at approximately twice the intensity of the light received when there is no target object present.

Switch is triggered by background

![Image](image1.png)

Erroneously detects background as the target when operated at factory default settings (Maximum sensitivity).

Tune without a workpiece. Background information is suppressed.

Cardboard boxes are now detected consistently and reliably.

Light seeps through semi-transparent target object

![Image](image2.png)

Light passes through semi-transparent target objects, affecting detection consistency.

Tune without a target object.

Target is now detected correctly. Note: For objects with high transparency, use the HP7-C transparent object detection switch. Be sure to test it on the actual target objects.

Unwanted reflections affect detection consistency

![Image](image3.png)

Reflected light passes through gaps in the target object, causing detection errors.

Tune without a target object.

Palettes are now detected correctly.

Two-point tuning

Two-point tuning is used in situations where tuning without a workpiece does not achieve the required results, or where it is necessary to detect target objects at a specific location. Sensitivity is automatically set to a value mid-way between the state when the target is present and when the target is absent.

**False detection**

![Image](image4.png)

The switch detects background objects such as the conveyor.

First, the switch is exposed to the no-target state.

Next, the switch is exposed to the state with a target present. The switch is now able to distinguish between the two states.

Position tuning

The switch can be adjusted to detect an object at a specific position. The sensitivity is automatically set for detection at that position.

**Detection in a specific position**

![Image](image5.png)

The aim is to sense the target object as it reaches the designated position.

Position tuning is performed at the required position.

The switch operates around at this position. Note that the sensing distance can vary by as much as 15% from the set distance.
<table>
<thead>
<tr>
<th>Detection method / Configuration</th>
<th>Detection range / Light source</th>
<th>Catalog listing</th>
<th>Different-frequency model No.</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thru-scan</td>
<td>30m</td>
<td>HP7-T41</td>
<td>HP7-T46</td>
<td>NPN</td>
</tr>
<tr>
<td>15m</td>
<td>HP7-T11</td>
<td>HP7-T16</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>15m</td>
<td>HP7-T21</td>
<td>HP7-T26</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>4m</td>
<td>HP7-T31</td>
<td>HP7-T36</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>4m</td>
<td>HP7-T41</td>
<td>HP7-T46</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>Retroreflective</td>
<td>5m</td>
<td>HP7-P11</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>3m</td>
<td>HP7-P12</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>3m</td>
<td>HP7-P12</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>1m</td>
<td>HP7-A45</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>0.5m</td>
<td>HP7-A46</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>Diffuse-scan</td>
<td>1m</td>
<td>HP7-A31</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>0.5m</td>
<td>HP7-A32</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>Wide-beam diffuse scan</td>
<td>100m</td>
<td>HP7-D23</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>50m</td>
<td>HP7-D24</td>
<td></td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>Retroreflective transparent object detection</td>
<td>2m</td>
<td>HP7-C15</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>Special optics</td>
<td>1m</td>
<td>HP7-C16</td>
<td></td>
<td>NPN</td>
</tr>
<tr>
<td>For PET &amp; glass bottle detection</td>
<td>1m</td>
<td>HP7-C26</td>
<td></td>
<td>NPN</td>
</tr>
</tbody>
</table>

**Note:** HP7-T thru-scan: Emitter model number is HP7-E and receiver model number is HP7-R. Products with operation modes other than those specified above are also available (for example, HP7-P13 and HP7-CM5: NPN (I)).

### Connection options

**HP7-T** Type is incompatible with low-temperature cables.

<table>
<thead>
<tr>
<th>Connection Type</th>
<th>Model No. Suffix</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 m Cable</td>
<td>-L005</td>
</tr>
<tr>
<td>5 m Cable</td>
<td>-L010</td>
</tr>
<tr>
<td>M12 Preloaded Connector 30 cm Cable</td>
<td>-C005</td>
</tr>
<tr>
<td>M12 Preloaded Connector 50 cm Cable</td>
<td>-C055</td>
</tr>
<tr>
<td>M12 Preloaded Connector 1 m Cable</td>
<td>-C010</td>
</tr>
<tr>
<td>Quick Lock Preloaded Connector, 30 cm Cable</td>
<td>-S003</td>
</tr>
<tr>
<td>Quick Lock Preloaded Connector, 1 m Cable</td>
<td>-S010</td>
</tr>
<tr>
<td>M8 Connector</td>
<td>-T</td>
</tr>
<tr>
<td>Low-temperature Cable: 2 m</td>
<td>-D</td>
</tr>
<tr>
<td>Low-temperature Cable: 5 m</td>
<td>-D050</td>
</tr>
</tbody>
</table>

### Reflector

<table>
<thead>
<tr>
<th>Name</th>
<th>Configuration</th>
<th>Catalog listing</th>
<th>Description</th>
<th>Detection range by photoelectric switch (mm) (reference value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE-R8</td>
<td>47 x 47 mm</td>
<td>HP7-T41</td>
<td>50 to 500</td>
<td></td>
</tr>
<tr>
<td>FE-R12</td>
<td>30.8 x 30.8 mm</td>
<td>HP7-T11</td>
<td>50 to 1,500</td>
<td></td>
</tr>
<tr>
<td>FE-R17</td>
<td>47 x 47 mm</td>
<td>HP7-T21</td>
<td>50 to 1,000</td>
<td></td>
</tr>
<tr>
<td>FE-R18</td>
<td>30.8 x 30.8 mm</td>
<td>HP7-T31</td>
<td>50 to 760</td>
<td></td>
</tr>
<tr>
<td>FE-R21</td>
<td>37 x 58 mm</td>
<td>HP7-T41</td>
<td>20 to 450</td>
<td></td>
</tr>
<tr>
<td>FE-R22</td>
<td>47 x 47 mm</td>
<td>HP7-T21</td>
<td>20 to 450</td>
<td></td>
</tr>
<tr>
<td>FE-R23</td>
<td>8.6 x 29.5 mm</td>
<td>HP7-T21</td>
<td>20 to 200</td>
<td></td>
</tr>
<tr>
<td>FE-R24</td>
<td>22.5 x 39.2 mm</td>
<td>HP7-T21</td>
<td>20 to 200</td>
<td></td>
</tr>
<tr>
<td>FE-R501</td>
<td>35 x 40 mm</td>
<td>HP7-T21</td>
<td>20 to 200</td>
<td></td>
</tr>
<tr>
<td>FE-R502</td>
<td>70 x 80 mm</td>
<td>HP7-T21</td>
<td>20 to 200</td>
<td></td>
</tr>
</tbody>
</table>

**Reflector sheet**

Use at 70% or less of the max. detection range.

**Accessories**

<table>
<thead>
<tr>
<th>Name</th>
<th>Configuration</th>
<th>Catalog listing</th>
<th>Description</th>
<th>Compatible model</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP-B08</td>
<td>Bottom-mounting L-bracket</td>
<td>All models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-B09</td>
<td>Bottom-mounting L-bracket</td>
<td>All models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-B10</td>
<td>Rear-mounting L-bracket</td>
<td>All models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-B11</td>
<td>Wraparound vertical mounting bracket</td>
<td>All models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-B12</td>
<td>Wraparound horizontal mounting bracket</td>
<td>All models</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-SV05</td>
<td>Vertical slit</td>
<td>HP7-T..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-SV10</td>
<td>Horizontal slit</td>
<td>HP7-T..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-SH05</td>
<td>Horizontal slit</td>
<td>HP7-T..</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP-SC01</td>
<td>Silt for transparent object detection</td>
<td>HP7-CL_S/CM_S..</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Horizontal mounting**

<table>
<thead>
<tr>
<th>Silt width</th>
<th>Catalog listing</th>
<th>Scanning distance</th>
<th>Scanning distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 x 6.4 mm</td>
<td>HP-S-05</td>
<td>1.2 m</td>
<td>0.4 m</td>
</tr>
<tr>
<td>1.0 x 6.4 mm</td>
<td>HP-S-10</td>
<td>3 m</td>
<td>0.7 m</td>
</tr>
<tr>
<td>2.0 x 6.4 mm</td>
<td>HP-S-20</td>
<td>5 m</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

**Vertical mounting**

<table>
<thead>
<tr>
<th>Silt width</th>
<th>Catalog listing</th>
<th>Scanning distance</th>
<th>Scanning distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 x 6.4 mm</td>
<td>HP-SC03</td>
<td>1.2 m</td>
<td>0.4 m</td>
</tr>
<tr>
<td>1.0 x 6.4 mm</td>
<td>HP-SC10</td>
<td>3 m</td>
<td>0.7 m</td>
</tr>
<tr>
<td>2.0 x 6.4 mm</td>
<td>HP-SC20</td>
<td>5 m</td>
<td>1.5 m</td>
</tr>
</tbody>
</table>

*1 Scanning distance of thru-scan switch with slit.

*2 Catalog listing of compatible switches

| HP7-T1_ | HP7-T2_ | HP7-T5_ |

*3 Scanning distance of thru-scan switch with mutual interference protection filter.
## Specification

<table>
<thead>
<tr>
<th>Catalog type</th>
<th>NPN</th>
<th>PNP</th>
<th>PCN</th>
<th>NPN</th>
<th>PNP</th>
<th>PCN</th>
<th>NPN</th>
<th>PNP</th>
<th>PCN</th>
<th>NPN</th>
<th>PNP</th>
<th>PCN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catalog listing</td>
<td>HP7-P51</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
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<td>HP7-P1</td>
<td>HP7-P1</td>
<td>HP7-P1</td>
</tr>
<tr>
<td>Power supply</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
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<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
<td>10.5 to 36 V DC</td>
</tr>
<tr>
<td>Power consumption</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
<td>14 mA max.</td>
</tr>
<tr>
<td>Scanning distance</td>
<td>3 m (with FE-RR8 reflector)</td>
<td>5 m (with FE-RR8 reflector)</td>
<td>4 m</td>
<td>15 m</td>
<td>30 m</td>
<td>0.5 m</td>
<td>1 m</td>
<td>150 mm</td>
<td>30 mm</td>
<td>0.5 to 1.0 m</td>
<td>0.5 to 1.0 m</td>
<td>0.5 to 1.0 m</td>
</tr>
<tr>
<td>Target object</td>
<td>Opaque object 80 mm dia. min.</td>
<td>Opaque object 12 mm dia. min.</td>
<td>Standard target object</td>
<td>200 × 200 mm paper, 50 % reflectivity</td>
<td>Opaque object 80 mm dia. min.</td>
<td>Opaque object 12 mm dia. min.</td>
<td>Standard target object</td>
<td>200 × 200 mm paper, 50 % reflectivity</td>
<td>Opaque object 80 mm dia. min.</td>
<td>Opaque object 12 mm dia. min.</td>
<td>Standard target object</td>
<td>200 × 200 mm paper, 50 % reflectivity</td>
</tr>
<tr>
<td>Operation button</td>
<td>Light-operated</td>
<td>Dark-operated</td>
<td>Selectable by operation button</td>
<td>Light-operated</td>
<td>Dark-operated</td>
<td>Selectable by operation button</td>
<td>Light-operated</td>
<td>Dark-operated</td>
<td>Selectable by operation button</td>
<td>Light-operated</td>
<td>Dark-operated</td>
<td>Selectable by operation button</td>
</tr>
<tr>
<td>Power supply</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
<td>36 V DC</td>
</tr>
<tr>
<td>Excess gain (Light received over the required amount)</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
<td>10000</td>
</tr>
<tr>
<td>Excess gain factor (times)</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
<td>-200</td>
</tr>
<tr>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
<td>Diffuse-scan, retroreflective, retroreflective transparent object detection</td>
</tr>
</tbody>
</table>

## Characteristics diagrams (Typical examples)

### Thru-scan models (HP7-T1, T2, T5)

<table>
<thead>
<tr>
<th>Distance (in)</th>
<th>Model</th>
<th>Thru-scan emitter</th>
<th>Thru-scan receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>HP7-T1</td>
<td>Diffuse-scan</td>
<td>Diffuse-scan</td>
</tr>
<tr>
<td>10</td>
<td>HP7-T2</td>
<td>Diffuse-scan</td>
<td>Diffuse-scan</td>
</tr>
<tr>
<td>15</td>
<td>HP7-T5</td>
<td>Diffuse-scan</td>
<td>Diffuse-scan</td>
</tr>
</tbody>
</table>

### Parallel displacement

<table>
<thead>
<tr>
<th>Distance (in)</th>
<th>Model</th>
<th>Parallel displacement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>HP7-T1</td>
<td>-50 to +50</td>
</tr>
<tr>
<td>10</td>
<td>HP7-T2</td>
<td>-100 to +100</td>
</tr>
<tr>
<td>15</td>
<td>HP7-T5</td>
<td>-150 to +150</td>
</tr>
</tbody>
</table>

## Output circuit diagram

### Thru-scan emitter

- **NPN** output type
- **PNP** output type

### Polarized retroreflective model

- **Thru-scan receiver, Diffuse-scan model**
- **Diffuse-scan** model

### Retroreflective transparent object detection

- **Thru-scan receiver, Diffuse-scan model**
- **Diffuse-scan** model

---

*Note: The above summary of key characteristics should not be construed as a performance guarantee. Always test first under actual conditions and allow leeway as appropriate.*
Detection area characteristics

When used with highly reflective backgrounds, tilting the switch may improve background suppression.

Target specifications

Output indicator

Connection part

Power supply indicator

Wide-beam diffuse scan model

Detection area characteristics

Wide-beam diffuse scan model

Parallel displacement

Retroreflective / Retroreflective transparent object detection model

Output indicator

Thru-scan emitter

Thru-scan emitter

Thru-scan receiver

Thru-scan receiver

M8 connector types

Retroreflective / Retroreflective transparent object detection model

Output indicator

Thru-scan emitter

Thru-scan emitter

Thru-scan receiver

Thru-scan receiver

Preloaded and M12 preloaded connector types

Retroreflective / Retroreflective transparent object detection model / Diffuse-scan

Output indicator

Operation button

Power supply indicator

Stability indicator

Light axis of emitter

Light axis of receiver

Operation button

Important:

Note: The summary of characteristics should not be construed as a performance guarantee. Always test first under actual conditions and allow leeway, as appropriate.
External Dimensions (Unit: mm)

**Silt**

<table>
<thead>
<tr>
<th></th>
<th>HP-SV</th>
<th>HP-SH</th>
<th>HP-SC01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width (mm)</td>
<td>0.5</td>
<td>1.0</td>
<td>6.4</td>
</tr>
<tr>
<td>Height (mm)</td>
<td>6.4</td>
<td>6.4</td>
<td>1.0</td>
</tr>
</tbody>
</table>

**Filter**

<table>
<thead>
<tr>
<th></th>
<th>HP-U02</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarizing direction: vertical</td>
<td>Polarizing direction: horizontal</td>
</tr>
<tr>
<td>Stainless steel spring plate</td>
<td>10.2</td>
</tr>
<tr>
<td>Polarizing filter</td>
<td>6.4</td>
</tr>
</tbody>
</table>

**Reflect (Sold separately)**

<table>
<thead>
<tr>
<th></th>
<th>FE-RR8</th>
<th>FE-RR15</th>
<th>FE-RR17</th>
<th>FE-RR21</th>
<th>FE-RR22</th>
<th>FE-RR23</th>
<th>FE-RR24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflecting area (Transparent)</td>
<td>Acrylic resin (Transparent)</td>
<td>Reflecting area</td>
<td>Reflecting area (Transparent)</td>
<td>Reflecting area (Transparent)</td>
<td>Reflecting area (Transparent)</td>
<td>Reflecting area (Transparent)</td>
<td></td>
</tr>
<tr>
<td>Reflecting area (Black)</td>
<td>Reflecting area (Black)</td>
<td>Reflecting area</td>
<td>Reflecting area (Black)</td>
<td>Reflecting area (Black)</td>
<td>Reflecting area (Black)</td>
<td>Reflecting area (Black)</td>
<td></td>
</tr>
</tbody>
</table>

**Bracket (Sold separately)**

- **Button-mounting L-bracket (HP-B08)**
- **Button-mounting L-bracket (HP-B09)**
- **Rear-mounting L-bracket (HP-B10)**
- **Wraparound vertical mounting bracket (HP-B11)**
- **Wraparound horizontal mounting bracket (HP-B12)**
After light axis adjustment, if target objects cannot be reliably detected at the factory default sensitivity (maximum sensitivity), adjust according to the instructions below.

- **Thru-scan models and retroreflective models**
  Adjust in the following cases. Switch sensitivity will be set automatically so that it operates at about twice the light intensity as when there is no target object.
  - The objects are transparent or translucent
  - The objects have holes or notches
  - Not enough light is blocked by target objects because light reaches the switch from the surroundings.
  - For thru-scan models, if the set scanning distance is shorter than the following amounts, light intensity may be too strong, causing the switch to enter the state described in “Indicator lamp flashes repeatedly.”
    - HP7-T1: 1 to 3 m
    - HP7-T2: 1 to 5 m
  - Retroreflective transparent object detection models
    - Before adjusting, allow 3 minutes for warm-up after turning the power on.
    - Hold down the button for about 2 seconds until the orange indicator lamp starts flashing rapidly (at about 10 Hz), then release.
    - Without a workpiece, give the button a short press. Both LEDs turn OFF.
    - Measures light intensity without a target object and sets sensitivity as required.
    - Setup is complete (normal operation will be restored automatically).”

- **Diffuse-scan models**
  Adjust in the following cases. Switch sensitivity will be set automatically so that it operates at about twice the light intensity as when there is no target object.
  - Even when there is no target object.
  - As a result of tuning without a workpiece, target objects do not block enough light.
  - As a result of tuning without a workpiece, the switch does not receive enough light from target objects.
  - The switch will be set automatically so that it operates at a light intensity that is between the intensity with a target object and the intensity without a target object.
  - Green indicator lamp starts flashing rapidly (at about 10 Hz), then release.

- **Retroreflective transparent object detection models**
  - Switch sensitivity will be set automatically so that it operates at about twice the light intensity as when there is no target object.
  - Green indicator lamp starts flashing rapidly (at about 10 Hz), then release.
  - With a workpiece in place, give the button a short press. Both indicator lamps will flash slowly (at about 1 Hz).”

- **Thru-scan and retroreflective models**
  - Sensitivity is restored to the factory default setting. Check operation before use.

- **Thru-scan detection at any desired specific position**
  - For diffuse-scan detection at any desired specific position, use position tuning. (Positioning accuracy is a maximum of 15% of the set distance.)
  - Hold down the button for about 2 seconds until the orange indicator lamp starts flashing rapidly (at about 10 Hz), then release.

- **Setup is complete**
  - Normal operation will be restored automatically.

- **Checking LO/DO**
  - The table below lists the various states indicated by repeated flashing together with suggested responses. If the problem is not resolved, it may be necessary to try a different model of switch.

- **Indicators and LO/DO changeover**
  - The operating mode is set to default at the factory, but can be changed as outlined below. Light-operate changes to Dark-operate, and Dark-operate changes to Light-operate.
  - Press the button 5 times consecutively. Stability indicator: Light-operate
  - Output indicator: Normal operation
  - Only Orange LED blinks rapidly (about 10 Hz).
  - Set to Light-operate
  - Only Green LED blinks rapidly (about 10 Hz).
  - Set to Dark-operate
  - Setup is complete (normal operation will be restored automatically).”

- **Position tuning**
  - If target objects cannot be reliably detected even after tuning without a workpiece, adjust as shown below.
  - Green indicator lamp starts flashing rapidly (at about 10 Hz), then release.
  - With the target in position, hold down the button for about 2 seconds until both indicator lamps start flashing rapidly (at about 10 Hz), then release.

- **Setup is complete**
  - Normal operation will be restored automatically.

- **When confused, or to restore the default setting (max. sensitivity)**
  - If you wish to restore the factory default sensitivity, or if you lose track of your progress while making adjustments, do the followings to restore the factory default from any flashing status.
  - Hold down the button until the green LED starts blinking (about 7 seconds).
  - Setup is complete (normal operation will be restored automatically.)

- **Procedure shown below to check the current operating mode.**
  - Use the procedure shown below to check the current operating mode.
  - Hold down the button until the orange indicator lamp flashes rapidly (about 10 Hz) to restore the factory default setting (max. sensitivity).
Cable with connector

PA5 Series cable
Be sure to use a PA5 Series cable with connector when connecting a preleaded connector or connector-type switch.

- **PA5 Series cable with connector**

<table>
<thead>
<tr>
<th>Shape</th>
<th>Length</th>
<th>Catalog</th>
<th>Lead colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 m</td>
<td>PA5-4I SX25K</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
<tr>
<td>5 m</td>
<td>PA5-4I SX5SK</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
<tr>
<td>2 m</td>
<td>PA5-4I LX25K</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
<tr>
<td>5 m</td>
<td>PA5-4I LX5SK</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
</tbody>
</table>

**Tightening the connector**
Align the grooves and rotate the fastening nut on the PA5 connector by hand until it fits tightly with the connector on the switches side.

PA7 Series cable
Be sure to use a PA7 Series cable with connector when connecting Preleaded Quick Lock type switch.

- **PA7 Series cable with connector**

<table>
<thead>
<tr>
<th>Shape</th>
<th>Power supply</th>
<th>Cable properties</th>
<th>Cable length</th>
<th>Catalog</th>
<th>Lead colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Vinyl-insulated cable with high resistance to oil and vibration (UL/NFPA79 CM)</td>
<td>2 m</td>
<td>PA7-4I SX25K</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 m</td>
<td>PA7-4I SX5SK</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
</tbody>
</table>

**Tightening the connector**
Align the triangle mark and mate the male and female connector side.

PA8 Series cable
Be sure to use a PA8 Series cable with connector when connecting a PA8 preleaded connector or M8 connector type switch.

- **PA8 Series cable with connectors**

<table>
<thead>
<tr>
<th>Shape</th>
<th>Power supply</th>
<th>Cable properties</th>
<th>Cable length</th>
<th>Catalog</th>
<th>Lead colors</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC</td>
<td>Vinyl-insulated cable with high resistance to oil and vibration</td>
<td>2 m</td>
<td>PA8-4I SX2M5K</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 m</td>
<td>PA8-4I SX5MK</td>
<td>brown, 2 white, 3 blue, 4 black</td>
<td></td>
</tr>
</tbody>
</table>

**Tightening the connector**
Align the grooves and rotate the fastening nut on the PA8 connector by hand until it fits tightly with the connector on the switches side.

Retroreflective transparent object detection

**Tips for using the HP7-C retroreflective transparent object detection model**

The extensive HP7-C series lineup can handle a variety of target objects and customer applications.

- **HP7-C series lineup**

<table>
<thead>
<tr>
<th>Sample model</th>
<th>Detection range</th>
<th>Beam</th>
<th>Overview</th>
<th>Features</th>
<th>Recommended target</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP7-C31S</td>
<td>2 m</td>
<td>Red</td>
<td>Standard long-distance model</td>
<td>Long-distance detection capability allows flexible usage by eliminating restrictions on installation.</td>
<td>FPD glass substrate and transparent film</td>
</tr>
<tr>
<td>HP7-CL1S</td>
<td>1 m</td>
<td>Red</td>
<td>Special optical system</td>
<td>Consistent detection by significantly reducing external interference</td>
<td>Transparent containers (FOUP and food containers) and transparent film</td>
</tr>
<tr>
<td>HP7-CM1S</td>
<td>1 m</td>
<td>InfraRed</td>
<td>For PET &amp; glass bottle detection</td>
<td>Can consistently detect any type of bottle, with or without contents</td>
<td>PET/glass bottles (with or without contents)</td>
</tr>
</tbody>
</table>

* If detection is not consistent due to the shape of target objects, specially designed slits are available to improve performance.
(More information on special slits for HP7-CL_S and HP7-CM_S: HP-SC01)

- **For HP7-C series setup procedures, refer to page 15 of this catalog.**

Tuning without a workpiece is recommended. After adjusting the light axis, easy tuning without a target object consistently sets the sensor threshold at 85% of the amount of light received.
2-point tuning is also available.

- **Recommended models for various target objects**

<table>
<thead>
<tr>
<th>Target</th>
<th>HP7-C3</th>
<th>HP7-CL</th>
<th>HP7-CL + slit</th>
<th>HP7-CM</th>
<th>HP7-CM + slit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Empty PET bottle</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Full PET bottle</td>
<td>x</td>
<td></td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Empty glass bottle</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Full glass bottle</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Food container</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>FOUP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transparent film</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FPD glass</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Recommended product
- Acceptable but "x" product is better.
- Test carefully before use.
- : Not recommended

- **Notes for reliable detection**

- Wait 3 minutes after power on before tuning or using the switch. This allows the internal temperature to stabilize.
- If the ambient temperature varies after tuning and detection becomes unreliable, retune the switch.
- Over the course of long-term use, variations in light intensity may be caused by factors such as dirt on the switch/reflector or light axis misalignment due to vibration. Regular maintenance and cleaning will prevent such problems.