LIGHT TOUCH SWITCH DESIGN GUIDE

High Durability

Long Life

Water Resistant
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Structure Of A Panasonic Light Touch Switch

A Panasonic Light Touch Switch usually consists of a Cover, Push Plate, Film, Metal Dome, Switch Case and Immovable Contactor, shown in Example 1. These parts combine to provide superior tactile feel, push force and travel in the finished Switch.

Panasonic’s Unique Manufacturing Capabilities

**Design** – All Light Touch Switch parts are designed by Panasonic including the Metal Dome, Panasonic’s core technology.

**Die Making** – Panasonic has extensive experience in high precision die making.

**Assembly** – All Panasonic Light Touch Switches are assembled by Panasonic.

**High Volume Production** – Allows Panasonic to pass on cost savings.
Features And Benefits

High Durability
Panasonic’s experience in portable electronic devices has provided the expertise to develop Light Touch Switches with one of the highest peel-off strengths in the market.

<table>
<thead>
<tr>
<th>Static Force (Nominal)</th>
<th>2 Terminals</th>
<th>Straight</th>
<th>L-Shape</th>
<th>Half-Dive</th>
<th>Edge-Mount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel Off Strength</td>
<td>30-40N OK</td>
<td>70-80N OK</td>
<td>75-90N OK</td>
<td>90-110N OK</td>
<td>150-175N OK</td>
</tr>
</tbody>
</table>

Long Life
The Metal Dome, Panasonic’s core technology, allows a long cycle life and excellent tactile feel.

Water Resistance
A patented laser welding technology allows Panasonic’s Light Touch Switches to achieve an IP67 Rating while maintaining a sharp tactile feel.

In-House Metal Dome

Ingress Protection Through Panasonic’s Laser Welding Technology
Laser welding contributes to a higher sealing that avoids water/oil invasion through the film attached area.

*Switch is put at 1m depth of water with 30min then tested.

Water Resistance

Optimized by
- Data base
- CAE analysis
- Stress distribution
- Press technology
Light Touch Switch Types

Panasonic offers a wide assortment of Light Touch Switches in various direction, push position and size types.

**Direction Switches**
Panasonic offers both Top Push Type and Side Push Type Light Touch Switches.

**Push Position Switches**
Side Push Switches are available in SMD Type, Half Dive and Edge Mount Types.

**Small Footprint Switches**
Panasonic provides one of the world’s smallest Light Touch Switches in both Top Push Type and Side Push Type.

Light Touch Switch Characteristics

Panasonic Light Touch Switches have excellent tactile characteristics for click feeling, click sound and travel.

**Operation Force Varieties**
Control operation force by the number of Metal Domes.

**Click Sound Varieties**
Control sound by selecting various travel and push force.

**Travel Varieties**
Panasonic offers a wide variety of travel to accommodate different applications.
Choose The Right Switch

Travel And Click Ratios

Panasonic offers a wide selection of Light Touch Switches with various click ratios. Reference the diagram below showing the relationship between various travel and force, the assembly of different travels and applications for each travel.

**Note:** Click ratio is the relationship between push force and travel and is primarily used to measure the feel of a Switch.
Choose The Right Switch

Click Sound Control

Click Sound should be considered when selecting a Switch for an application. The charts below show by selecting a Switch with a lower click ratio or lower push force, the Switch will have a lower Click Sound.

**Click Sound Control by Click Ratio**

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Comparison</th>
<th>Hearable area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push Force</td>
<td>3.6 N</td>
<td>3.6 N</td>
<td><img src="sample1-sample2-comparison" alt="Comparison Chart" /></td>
</tr>
<tr>
<td>Click Ratio</td>
<td>52.66 %</td>
<td>40.94 %</td>
<td><img src="sample1-sample2-hearable" alt="Hearable Area Chart" /></td>
</tr>
</tbody>
</table>

**Click Sound Control by Operation Force**

<table>
<thead>
<tr>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Comparison</th>
<th>Hearable area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push Force</td>
<td>1.66 N</td>
<td>1.26 N</td>
<td><img src="sample1-sample2-comparison" alt="Comparison Chart" /></td>
</tr>
<tr>
<td>Click Ratio</td>
<td>49.00 %</td>
<td>49.00 %</td>
<td><img src="sample1-sample2-hearable" alt="Hearable Area Chart" /></td>
</tr>
</tbody>
</table>
**Design Recommendations**

**Structure Of A Panasonic Light Touch Switch**

When designing in a Light Touch Switch, Mechanical Design, Click Feel and Reliability should be considered.

<table>
<thead>
<tr>
<th>Mechanical Design</th>
<th>Click Feel</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin and Small Design</td>
<td>Click Feel</td>
<td>Life Cycle</td>
</tr>
<tr>
<td>Thin Bezel To Increase Battery Volume</td>
<td>Travel</td>
<td>Water Resistance</td>
</tr>
</tbody>
</table>

**Mechanical Design**

Mechanical Design considers the length, width and height of the Switch, along with other dimensional characteristics and push direction.

- Thin And Small Switch Package
- Various Push Direction and Position

**Click Feel**

Click Feel considers the click ratio, travel and sound.

- High Click Ratio
- Middle Travel
- Various Click Feeling

**Reliability**

Reliability considers life cycle, ingress protection and solder rise.

- High Life Cycle Performance
- Resistance Against Water
- Resistance Against Flux Intrusion

**Supported By**

- Molding Technology
- Mechanical Design Skill

- Panasonic Metal Dome Technology
- Laser Welding Technology

- Panasonic Metal Dome Technology
- Laser Welding Technology
- Original Blast Process Technology
Design Recommendations

Peel Off Strength

All external forces that could be applied to the Switch need to be reviewed when considering which Switch to design in. In general, Panasonic Light Touch Switches have one of the highest Peel Off Strengths in the world. Peel Off Strength is the strength at which the Switch would be sheared off from the PCB due to a high force or impact. Panasonic Switches have various mounting constructions which enhances the Peel Off Strength. Please reference the chart below which displays the Peel Off Strength of various Panasonic Light Touch Switches.

<table>
<thead>
<tr>
<th>Dimension (mm)</th>
<th>3.5 x 2.9 [mm] Side-op. SMD EVD-P7/P3 Series</th>
<th>3.5 x 2.9[mm] Side-op.Half Dive EVP-AN Series</th>
<th>Small-sized Side-op. SMD EVD-P3 Series</th>
<th>3.8x1.9 [mm] Side-op. SMD EVP-4X Series</th>
<th>2.8x2.3 [mm] Side-op. EM EVP-AY Series</th>
<th>4.5x2.2 [mm] Side-op. EM EVP-AE Series</th>
<th>6.2 x 2.5 [mm] Side-op. EM EVP-P4 Series</th>
<th>6.2 x 2.5 [mm] Side-op. EM EVP-P4 Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCB Cutout</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Size</td>
<td>3.5mm x 2.9mm</td>
<td>3.5mm x 2.9mm</td>
<td>4.7mm x 3.5mm</td>
<td>3.9mm x 2.05mm</td>
<td>2.8mm x 2.3mm</td>
<td>4.5mm x 2.2mm</td>
<td>6.2mm x 2.55mm</td>
<td>6.2mm x 2.55mm</td>
</tr>
<tr>
<td>Operation Force (N)</td>
<td>1.0</td>
<td>1.3</td>
<td>1.6 (O(S=T:0.20mm))</td>
<td>1.6 (O(S=T:0.20mm))</td>
<td>1.6 (O(S=T:0.30mm))</td>
<td>1.6 (O(S=T:0.12mm))</td>
<td>1.6 (O(S=T:0.13mm))</td>
<td>1.6 (O(S=T:0.15mm))</td>
</tr>
<tr>
<td></td>
<td>2.4</td>
<td>2.5</td>
<td>2.5 (O(S=T:0.7mm))</td>
<td>2.5 (O(S=T:0.7mm))</td>
<td>2.5 (O(S=T:0.7mm))</td>
<td>2.5 (O(S=T:0.7mm))</td>
<td>2.5 (O(S=T:0.7mm))</td>
<td>2.5 (O(S=T:0.7mm))</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>3.5</td>
<td>3.5 (O(S=T:0.7mm))</td>
<td>3.5 (O(S=T:0.7mm))</td>
<td>3.5 (O(S=T:0.7mm))</td>
<td>3.5 (O(S=T:0.7mm))</td>
<td>3.5 (O(S=T:0.7mm))</td>
<td>3.5 (O(S=T:0.7mm))</td>
</tr>
<tr>
<td></td>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Click Ratio (Actual)</td>
<td>30-50%</td>
<td>30-50%</td>
<td>30-50%</td>
<td>40-60%</td>
<td>30-50%</td>
<td>35-55%</td>
<td>35-55%</td>
<td>10-30%</td>
</tr>
<tr>
<td>Operating Part Strength (Actual)</td>
<td>72N Peel off</td>
<td>92N Peel off</td>
<td>102N Peel off</td>
<td>130N Metal dome deformed</td>
<td>95N Peel off</td>
<td>180N Metal dome deformed</td>
<td>150N Metal dome deformed</td>
<td>150N Metal dome deformed</td>
</tr>
<tr>
<td>Operation Part Strength (Actual)</td>
<td>9N</td>
<td>4.5N</td>
<td>9N</td>
<td>20N</td>
<td>12N</td>
<td>30N</td>
<td>30N</td>
<td>30N</td>
</tr>
<tr>
<td>Operation Life Cycle</td>
<td>100K</td>
<td>100K : 1.6,2,2N</td>
<td>500K : 1.6N</td>
<td>100K</td>
<td>200K</td>
<td>200K : 3.5N</td>
<td>500K : 2.4N</td>
<td>100K : 1.6,10N</td>
</tr>
</tbody>
</table>
Design Recommendations

Stopper

Even though Panasonic Light Touch Switches have one of the highest Peel Off Strengths in the world, it is important to provide additional mechanical support. Panasonic recommends applying a stopper to the Light Touch Switch to migrate any excessive force, as described in the diagram below.

Without Stopper

The excessive force by dropping or hitting would be directly applied on the Switch

The Switch would be peeled off from the PCB

Note: If the edge of PCB has curvature (initial and reflow), it may have mounting failure and slanting operation may not maintain Switch characteristics.

For Top Push Type Switches, Panasonic also recommends applying a Stopper. The Stopper can relieve any excessive load that is applied to the Switch.

Top Push

The Metal Dome and Switch case would receive a significant amount of load when excess load is applied onto the Switch. Snapping failure of Metal Dome and/or broken Switch case may occur.

Prevent the Switch from breaking by distributing excessive load to the Stoppers that are equipped on the knob or PCB.
Knob

Avoid exposing the Set Knob outside of the housing when designing. If the Set Knob drops, the Switch may receive the impact and could become damaged.

**Bad Example**
The knob is exposed.
The excessive force by impact would be directly applied to the Switch.

**Our Recommended Design**
The knob is NOT exposed. (The housing would serve as the stopper.)
The excessive force by dropping or hitting would be migrated by "the Stopper.”

Pre-Load

The Pre-load is force that is applied to a Switch before any user influence, this is especially important to consider for Short Travel Type Switches. There are two proposals below that minimize the Switch feeling by Pre-Load.

**Proposal 1**
Soft material absorbs the pre-load.

**Proposal 2**
Cushion sheet absorbs the pre-load.

Suppress the rattling of the knob by the deformation of soft material

Suppress the rattling of the knob by the deformation of Cushion sheet
Knob Material

Avoid exposing the Set Knob outside of the housing when designing. If the Set drops, the Switch may receive the impact and could become damaged.

**Bad Example**
The Knob material that interacts with the Switch actuator is a "soft material".

**Panasonic Recommended Design**
The Knob material that interacts with the Switch actuator is a "hard material" with a "back-up plate".

**Weakness**
- The soft material easily deforms
- The PCB would bend when pushed causing a louder click sound

**Strength**
- Using a hard material will improve the tactile feel of the Switch
- Apply a back-up plate to reduce the PCB from bending

Note: When the quality of the material of an operation Knob is soft the actuator may be buried in the operation Knob and the tip may deform causing the Switch to lose its Travel. Panasonic recommends using hard material.

According to a Panasonic analysis, Knob material influences the Click Sound Level. The soft material provides a louder Click Sound in the high frequency domain.

### Sound Level Analysis

![Graph showing sound level comparison between ABS and Rubber (silicon) material](image)

- **Frequency (Hz)** that people feel uncomfortable
- **Plunger**: ABS φ2.0
  - Rubber (silicon) φ2.0  Hardness : 70
  - Tested Sample: 4522EM LTSW *After reflow

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### Panasonic Recommendations

- **Capacitors**
- **Connectors**
- **Circuit Protection**
- **Electromechanical**
- **Sensors**
- **Industrial Automation**
- **Resistors & Inductors**
- **Semiconductors**
- **Wireless Connectivity**

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Ingress Protection

Another characteristic to consider when designing is the Switch IP Rating. The Switch IP Rating has two numerical digits. The first digit represents the level of solids Ingress Protection with 6 being the highest level of protection, mainly dust. The second digit represents the liquid Ingress Protection.

<table>
<thead>
<tr>
<th>Solids (first number)</th>
<th>Liquids (second number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

- **Solids (first number)**
  - 0: No Protection
  - 1: Protected against objects > 50mm (hands)
  - 2: Protected against objects > 12mm (fingers)
  - 3: Protected against objects > 2.5mm (tools/wires)
  - 4: Protected against objects > 1mm (small tools)
  - 5: Protected against dust, limited ingress
  - 6: Totally protected against dust, limited ingress
  - 7: N/A
  - 8: N/A

- **Liquids (second number)**
  - 0: No Protection
  - 1: Protection against dripping water or condensation
  - 2: Protection against water spray 15 degree from vertical
  - 3: Protection against water spray 60 degree from vertical
  - 4: Protection against water spray from all directions
  - 5: Protection against low pressure jets of water
  - 6: Protection against high pressure water jets and heavy seas
  - 7: Protection against the effects of immersion (6in to 3.3ft)
  - 8: Protection against immersion

Waterproof

Panasonic’s patented laser welding technology provides an Ingress Protection level of IP67. The benefits of using the laser welding Switch are Ingress Protection and Actuator Protection while maintaining a sharp tactile feel.

<table>
<thead>
<tr>
<th>Water Proof / Oil Resistance</th>
<th>Laser Welding</th>
<th>Film adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser welding contributes to a higher sealing performance.</td>
<td>The film is attached by dissolving (Laser Welding)</td>
<td>The film is attached by Adhesive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Easy Assembling</th>
<th>Laser Welding</th>
<th>Film adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner actuator contributes to less damage caused by the actuator as assembling.</td>
<td>Inner Actuator (The Actuator is under the cover film)</td>
<td>The Actuator is sticking out on the surface</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Good Click Feel</th>
<th>Laser Welding</th>
<th>Film adhesive</th>
</tr>
</thead>
<tbody>
<tr>
<td>No adhesive contributes to a better feeling.</td>
<td>Switch Click Feel = Metal Dome Click Feel</td>
<td>Switch Click Feel = Metal Dome Click Feel + Adhesive Influence</td>
</tr>
</tbody>
</table>

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Learn more about Panasonic Light Touch Switches.