Design Recommendations

Figure 1

1. Minimum distance from edge of keypad: 1.0 mm.
2. Typical membrane dimension: key size + 2.5 mm.
3. Typical guide hold spacing: 30-50 mm.
4. Minimum radius dimension: 2.0 mm.
5. Typical corner radius dimension: => 1.0 mm.
6. Minimum key pitch dimension: => 4.0 mm.
7. Minimum guide hole dimension: => 1.5 mm.
8. Minimum distance from hole to membrane of switch: 1.0 mm.
9. Minimum membrane spacing dimension: 1.0 mm.

Figure 2

1. Minimum clearance between bezel and keys: 0.3 mm.
2. Minimum key pitch dimension: 4.0 mm.
3. Typical pill size dimension (circular pills): 2.0-8.0 mm.
4. Typical pill thickness dimension: 0.4-0.5 mm.
5. Typical chamfer dimension: 0.5 mm.
6. Typical chamfer angle dimension: 45°.
7. Typical air channel dimension: 1.5-2.0 mm.
8. Typical base thickness dimension: 1.0 mm.
**Force-stroke curve of rubber keypad**

1. Peak point  
2. Contact point  
3. Return point  
4. Return-peak point  

F1. Peak force  
F2. Contact force  
F3. Return force  
F4. Return-peak force  

Click ratio = \( \frac{(F_1 - F_2)}{F_1} \times 100\% \)

F3 >= 15g

***Poor tactile feeling when click ratio is less than 0.50***  
***Good tactile feeling when click ratio is higher than 0.50***

<table>
<thead>
<tr>
<th>Structure</th>
<th><img src="image1.png" alt="Image" /></th>
<th><img src="image2.png" alt="Image" /></th>
<th><img src="image3.png" alt="Image" /></th>
<th><img src="image4.png" alt="Image" /></th>
<th><img src="image5.png" alt="Image" /></th>
</tr>
</thead>
<tbody>
<tr>
<td>Force–Stroke Curve</td>
<td><img src="image6.png" alt="Image" /></td>
<td><img src="image7.png" alt="Image" /></td>
<td><img src="image8.png" alt="Image" /></td>
<td><img src="image9.png" alt="Image" /></td>
<td><img src="image10.png" alt="Image" /></td>
</tr>
<tr>
<td>Force Range (grams)</td>
<td>20~350</td>
<td>30~250</td>
<td>30~150</td>
<td>30~80</td>
<td>30~200</td>
</tr>
<tr>
<td>Stroke Range (mm)</td>
<td>0.5~3.0</td>
<td>7~1.5</td>
<td>0.5~3.0</td>
<td>2.0~4.0</td>
<td>1.0~2.5</td>
</tr>
<tr>
<td>Cycle Life (kk)</td>
<td>0.5~2.0</td>
<td>0.5~2.0</td>
<td>1.0~5.0</td>
<td>5.0~20</td>
<td>0.5~3.0</td>
</tr>
<tr>
<td>Typical Uses</td>
<td>Telephone, Remote Control, Automotive, Radio, Toys, Calculator, etc.</td>
<td>Telephone, Remote Control, Toys, Games, Calculator, etc.</td>
<td>Telephone, Remote Control, Toys, Measuring Instruments, Office Machine, etc.</td>
<td>Computer, Typewriter, etc.</td>
<td>Telephone, Typewriter, Test Instruments, etc.</td>
</tr>
</tbody>
</table>
Information about silk-screen printing

- Various colors of graphics are possible.
- Best results will be obtained with a flat-key top surface.
- Graphics can be printed positively or negatively.

**Minimum graphics thickness**

**w**: printing area (colors)

**w1**: graphics area

Maximum graphics area \( w1 \leq W - 0.4 \text{[mm]} \)

For maximum printing area, refer to figure below.

**Concave shape**

**Convex shape**
BackLite Series

The BackLite Series has been developed in order to improve visibility in the dark as well as in daytime. The BackLite Series is mostly suitable for designs with back-light requirements. The BackLite Series is made from translucent silicone rubber. The transmissive underlayer colors are oversprayed or printed followed by opaque black or dark coating to highlight the graphics. Various colors of graphics are possible. Graphics per customer's artwork film are made by either laser etching or chemical erosion. The chemical erosion process is suitable for flat keytop surface only. Laser etching process is suitable for any key shape. The backLite Series is always combined with our Duracoat Series for the best reliability and distinctive finish.

Features:
- Good light shielding on keypad surface
- Superior visibility on graphics
- Available for any key shape
- Temperature range: -40ºC ~ + 90ºC
Duracoat series

Duracoat Series offers a sprayed polymer layer on a silicone rubber keypad surface. After application, the polymer layer is bonded to the surface by a vulcanization process at approximate 200 degree C. The silicone rubber keypad can have a simulated "Plastic Moulded" finish after Duracoat treatment. This special process further protects keytop printing and reduces friction between key and frame, avoiding sticking keys.

Features:
- Simulated plastic finish
- Reduced friction to prevent keys sticking
- Enhanced keytop printing protection
- Excellent abrasion resistance: over 100 cycles on RCA tester

Options:
- Glossy finish
- Matte finish
Encap Series

Encap Series is a revolution in silicone rubber keypad industry. Encap Series apply complex material; liquid polymer with special surface treatment on silicone rubber keypad. Encap Series put all advantage of silicone rubber keypad and plastic together. It provides clear, simulated plastic finish on rubber keytop.

Features

- Simulated clear plastic finish.
- Protected keypad printing.
- Assembly cost savings.
- Excellent abrasion resistance.
- Excellent bond between silicone rubber and polymer.

Options

- Hard/Glossy Encap
- Soft/Glossy Encap
PlaS Series glue the molded plastic keytop on silicone rubber keypad. Special adhesive makes it available for gluing silicone elastomer and molded plastic keytop. The adhesive bonds well between the two complex materials. PlaS Series combine all advantages of silicone rubber keypad and plastic together.

**Features**
- All key shapes available.
- Graphics on first or second surface.
- Assembly cost savings.
- Excellent bond between plastic and rubber.
SCS Parylene Coating

Parylene Conformal Coating System (Qualify by Mil-I-46058C)
The Parylene Coating provides a real conformal protecting layer.

1. High crystallinity & molecular weight (~500k)
2. Survives continuous exposure to air at 100 °C for 10 years (100,000 hrs)
3. Insoluble in any organic solvent up to 150 °C
4. Good vacuum stability (weight loss < 0.3% under 10^-6 torr, 50 °C)
5. Superior resistance to chemicals & γ-rays.
6. Excellent dielectric properties (Volume resistivity > 8.8 x 10^{16} ohm-cm)
7. Withstands impacts of more than 100 in-lb at -160 °C
8. Lowest moisture transmission rate (10 times better than epoxy under 90% RH, 37 °C)

SCS CVD Process

Chemical Vaper/Vacuum Deposition (CVD)

<table>
<thead>
<tr>
<th>Dimer(DPX)</th>
<th>Monomer(PX)</th>
<th>Polymer(PPX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 °C, 1.0 torr</td>
<td>680 °C, 0.5 torr</td>
<td>35 °C, 0.1 torr</td>
</tr>
</tbody>
</table>

1. Provide precise thin film coating (0.2 μm to 75 μm).
2. Can be coated on almost any material surface.
3. Without curing step that cause no inner stress.
4. Almost no limitation to the complex shape surface.
5. Flamable material can be coated. (ex. paper).
6. Pin hole free coating because no solvent needed.
Abrasion parameter of keypad printing

<table>
<thead>
<tr>
<th>Abrasion resistance</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>Good</th>
<th>Excellent</th>
<th>Superior</th>
<th>Excellent</th>
</tr>
</thead>
</table>

Poor - under 10 cycles
Fair - 10 ~ 15 cycles
Good - 15 ~ 30 cycles
Excellent - 50 ~ 100 cycles
Superior - 100 ~ 200 cycles

Definition of failure:
Failure occurs when a printed line breaks or a second layer of color is exposed.

Abrasion test equipment:
RCA Abrasion Wear Tester: Norman Tool model #7 IBB.
Abrasion paper: Norman Tool paper type #1189

1 cycle of abrasion test equals about 10,000 times of finger press.

Note: The above is random figures for reference only and is subject to change because of different font style of the graphics and key design.

***Joesmen reserves the right to update any information in this data sheet without any prior notice.***
Printed Circuit Board Design

Conductive rubber keypads are very reliable, but the environment in which they are used should be considered very carefully when the printed circuit board is designed. In order for any keypad to provide trouble-free operation, it is imperative that all components be designed properly, particularly the printed circuit board.

Printed circuit boards can be supplied with several different types of plating; the only type that is specifically not suitable for use with conductive rubber switches is tin-lead solder boards. Gold plating over nickel on the printed circuit board offers the lowest possible contact resistance (less than 100 ohms) for any keypad application, and a minimum layer of 30 -50 micro inches of gold over 100 - 200 micro inches of nickel is recommended for best switch performance. The width of gold traces typically ranges from 0.25 - 0.40mm, while the minimum distance between them is typically 0.30mm and the maximum is usually 0.40mm.

Nickel plating, like gold, is extremely reliable and relatively inexpensive when compared to the cost of gold-plated boards. Contact resistance for nickel-plated boards is typically less than 100 ohms, and nickel has an excellent track record in even the most severe environmental conditions. If nickel plating is used without gold, a minimum plating thickness of 200 micro inches is recommended for best overall performance. Most keypad applications utilize nickel-plated boards because of their high reliability and low cost.

Silk-screened carbon boards can also be used with conductive rubber switches, but should only be selected when contact resistance between 500 - 1,000 ohms can be tolerated. If screened carbon boards are used, the minimum distance between the traces should be 0.50mm, and the overall size of the electrode should be greater than 5.0mm.

It should be noted that there is not a single recommended pad pattern for use with rubber keypads. Printed circuit board electrode design should be developed carefully taking all switch characteristics into consideration. The most important single objective to be considered in designing any pad pattern is to provide as many shorting paths as possible so best switch operation can be realized when the button is actuated. Several common contact patterns are:

![Contact Patterns]

Pads on printed circuit boards should never be smaller than the conductive pill or contact area on the bottom of the rubber switch. It is strongly recommended that the electrode (pad) on the printed circuit board be 1.25 times the diameter of the conductive pill, or at least 1.0mm larger than the overall size of the contact on the bottom of the switch surface.
General Tolerances for Rubber Keypad

Actuation Force Tolerance Chart

<table>
<thead>
<tr>
<th>Force (g)</th>
<th>Tolerance (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 - 80</td>
<td>+/-15 Grams</td>
</tr>
<tr>
<td>90 - 110</td>
<td>+/-20 Grams</td>
</tr>
<tr>
<td>120 - 140</td>
<td>+/-25 Grams</td>
</tr>
<tr>
<td>150 - 180</td>
<td>+/-30 Grams</td>
</tr>
<tr>
<td>180 - 250</td>
<td>+/-35 Grams</td>
</tr>
<tr>
<td>250 - 350</td>
<td>+/-40 Grams</td>
</tr>
</tbody>
</table>

Dimensional Tolerance Chart

<table>
<thead>
<tr>
<th>Inches</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 0.394</td>
<td>+/-0.004</td>
</tr>
<tr>
<td>0.395 - 0.787</td>
<td>+/-0.006</td>
</tr>
<tr>
<td>0.788 - 1.180</td>
<td>+/-0.008</td>
</tr>
<tr>
<td>1.181 - 1.969</td>
<td>+/-0.010</td>
</tr>
<tr>
<td>1.970 - 2.759</td>
<td>+/-0.014</td>
</tr>
<tr>
<td>2.760 - 3.937</td>
<td>+/-0.018</td>
</tr>
<tr>
<td>&gt;3.938</td>
<td>+/-0.5%</td>
</tr>
</tbody>
</table>

Printed Legend Tolerance Chart

<table>
<thead>
<tr>
<th>Component</th>
<th>Inches</th>
<th>Millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>+/-0.006</td>
<td>+/-0.15</td>
</tr>
<tr>
<td>Line Thickness</td>
<td>+/-0.003</td>
<td>+/-0.08</td>
</tr>
<tr>
<td>Location</td>
<td>+/-0.010</td>
<td>+/-0.25</td>
</tr>
</tbody>
</table>

Color Matching

Rubber: +/-15 Macadam Units per Spectrophotometer
Print : +/-12 Macadam Units per Spectrophotometer
or 1/2 PMS shade under Macbeth Spectra Light

Rubber Hardness

 +/- 5 Durometer Shore A
**Terminology**

**Actuation Force**
The minimum force required to compress the membrane of the switch (F¹) so contact is made with the printed circuit board.

**Air Channel**
Air path from switch to switch so keytops can return to normal position after actuation. Switches are normally vented on at least two sides by air channels.

**Base**
The sheet material forming the "apron" for all switches on the keypad. The base ties or connects all switches on the keypad.

**Bezel**
The faceplate (usually plastic or metal) that "egg crates" all rubber keypad switches and typically covers the base material of the keypad so it cannot be touched by human hands.

**Click Ratio**
The difference between the actuation force (F¹) and the contact force (F²) of a switch divided by the actuation force: \( \frac{(F¹ - F²)}{F¹} \times 100\% \)
This "ratio" is extremely important when life is calculated and positive tactile feel is required in a keypad.

**Conductive Pill**
Current-carrying contact (silicone rubber impregnated with amorphous carbon) under each keytop completing electrical connection with the printed circuit board when the keytop (switch) is actuated.

**Contact Force**
The force a switch typically realizes (F²) when contact is made with the printed circuit board.

**Durometer:**
The hardness of all keytops (switches) on the keypad and the hardness of the base material as well (unless the keypad is a dual durometer keypad). The higher the durometer of the keytop or base material, the harder the material.

**Keytop**
A non-conductive, silicone-rubber, direct-contact switch (pushbutton). If the keypad is designed to have direct-contact switches, these switches will be silicone rubber, but if the keypad is designed to have indirect-contact switches, the silicone rubber dome will usually be covered with plastic keycaps.

**Membrane**
The non-conductive "hinge," "cushion" or "web" that creates tactile feel and stroke possible for each switch on the keypad.

**Printed Circuit Board**
An electrical circuit formed by applying conductive material (gold, nickel, tin lead or carbon) to fine lines or other shapes to an insulating sheet.
Stroke
Distance from bottom of conductive pill (contact) to top surface of printed circuit board.

Volume Resistivity
Electrical resistance within one (1) cm cube of conductive material. Volume resistivity is normally expressed as ohm-centimeters.