KEYPAD APPLICATION GUIDE

The Application Guide is an aid in the design and development of silicone keypads and specialty products. Silicone combines excellent feel, reliability and long life in the most rugged environment. Silicone keypads are used in a wide range of applications including medical, industrial, instrumentation and communications equipment.

Silicone material is supplied to the keypad industry in two forms, liquid and gumstock. Liquid silicone is a two part system mixed as it is used; gumstock is a one part system that has a shelf life. Both are heat cured. Liquid silicone has the consistency of vaseline while gumstock is more like putty or clay. Silicone is measured for hardness in a shore A scale. The lower the number, the more silicone there is in the product and the softer it feels. The higher the numbers the less silicone and the more filler there is in the product and the harder it feels. Fillers and tensile strength.

Molding silicone rubber varies by process. The tools themselves are very similar and are usually made from P20 steel or 6061 aluminum. Wear on the tooling is usually negligible over the life of a project unless fillers that cause abrasion are added.

The types of molding processes are liquid, compression, transfer and extruding. Liquid molding is a closed loop system and molded under pressure using computer controlled repeatable equipment. Compression molding is open-air system similar to a waffle iron, material is hand cut and weighed. Transfer molding is a combination of compression molding and gumstock material pushed into a mold under low pressure. Extruding molding uses gumstock molding processes for continuous product such as tubing.

The Application Guide includes:
- Material and Processes
- Design Recommendations
- Mechanical Tolerances
- Drawing Information
- Graphics Criteria
- Terminology

DESIGN RECOMMENDATIONS

Mechanical Keypad:
1. Distance of a key’s diaphragm to the edge of the keypad’s matte and any through hole is 0.040”.
2. Minimum key pitch dimension is 0.080”.
3. Distance between two diaphragms is 0.040” (measured at base of diaphragm).
4. The smallest blend radius of key’s side wall to top of key is 0.010”.
5. Typical key taper is 1° depending on key height.
6. Typical chamfer dimension on tactile keypad is 0.020”.
7. Typical chamfer angle on tactile keypad is 45.
8. Clearance between a bezel to a key is 0.012”.
9. Typical base (mat) thickness is 0.040”.
10. Standard air channel geometry is 0.080” to 0.125” wide by 0.010” to 0.013” deep.
11. Conductive contact area is 0.030” based on keypad application and size.
12. Sealing bead(s) top and/or bottom for environmental design requirements.
13. Assembly aids via bosses and/or perimeter lip to hold rubber keypad to feature.
   • Through hole diameter is 0.025”
   • Corner radius on matte and key’s 0.015”
   • Corner radius on matte and key’s 0.015”
**DESIGN RECOMMENDATIONS**

**Display/ LED Lightpipe/ Window Opening:**
1. Maximum depth of undercut for feature window opening is 0.250”.
2. Underside lip for window opening is the depth of undercut (#14) x 0.660”.
3. Minimum size for molded in silicone window/lightpipe is 0.060”.
4. Minimum thickness for molded in silicone window is 0.030”.
5. Minimum height for molded in silicone lightpipe is 0.030”.
6. Minimum distance from window/lightpipe to edge is 0.030”.
7. Min / Max wrap around underside is 0.060” to 0.500”. Deeper wraps may be considered depending on design.
8. Sealing rib diameter is 0.030”.

**Keypad Wrap-Around Design:**
The wrap-around design offers unique capabilities in silicone rubber. Using liquid injection process, one can create hand held units similar to complete plastic cases. With the wrap-around feature, an appealing product can be designed with all the protection requirements for harsh environments.

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**TYPICAL PART TOLERANCES**

- \(< 0.400\) 0.004
- \(0.401 \text{ - } 0.800\) 0.006
- \(0.801 \text{ - } 1.200\) 0.008
- \(1.201 \text{ - } 1.600\) 0.010
- \(1.601 \text{ - } 2.000\) 0.012
- \(> 2.001\) 0.6%

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**RECOMMENDED GRAPHIC PARAMETERS**

**Graphic Design:**
1. Solid colors can be screened up to the edge of flat keytop.
2. On curved keytops, solid colors can be screened up to 0.015” to the tangent point of the outer radius.
3. Distance from edge of the keypad to legend is 0.015”.
4. Distance of matte legends to key is dependent on key height.
5. Minimum line weight for legends is 0.007”.
6. Minimum text height is 0.050”.
7. Color consistency is within 1 Delta for production run. Typical screening tolerances are 0.015”.

**Keytops Considerations for Graphic Screening:**
1. Minimum radius allowable for printing over the edge is 0.375”.
2. On legend overrun onto matte surface, a minimum transition radius of 0.010” is required.
3. Maximum curvature depth for concave keytops with a minimum radius of 0.375” is 0.060”.
4. Maximum curvature height for convex keytops with a minimum radius of 0.375” is 0.060”.

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**TYPICAL DRAWING INFORMATION**

- Overall Keypad Size
- Keypad Mat Thickness
- Keypad Dimensions
- Mounting Hole Details
- Mounting Boss Details
- Radii Dimensions (keypad and buttons)
- Key Spacing
- Actuation Force (grams)
- Material Specifications (durometer)
- Legends & Color(s) (PMS numbers, etc.)
- Keypad Color
ACTUATION FORCES OF CERTAIN KEY SHAPES & STYLES

<table>
<thead>
<tr>
<th>Name Of Shape</th>
<th>Cone</th>
<th>Double Cone</th>
<th>Bell/Cone</th>
<th>Cone</th>
<th>Double Cone</th>
<th>Flat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profile Of Shape</td>
<td>![Cone Profile]</td>
<td>![Double Cone Profile]</td>
<td>![Bell/Cone Profile]</td>
<td>![Cone Profile]</td>
<td>![Double Cone Profile]</td>
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<td>Force Vs. Travel</td>
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Rubber keypads can be designed so that they achieve a positive tactile response when the operator depresses the keypad. To achieve good tactile feel that is inherent in the rubber keypad the keypad should have at least .060” of travel and should have an actuation force of between 50 and 170 grams.

As an alternative, a tactile layer can be incorporated in between the rubber keypad and the circuitry layer, which will enable a good tactile feel even with small keys and minimal travel distances. This option, which utilizes either stainless steel domes or formed polydomes, does add cost to the project.

Rubber keypads should be designed with a minimum return force of 30 grams in order to eliminate the potential of sticking keys.

TACTILE RESPONSE

- **F** = Return Force
- **A** = Actuation force
- **C** = Contact force

- Snap Ratio = (A-C)/A
- A = 350 grams
- C = 230 grams
- (350-230)/350=0.343
## TERMINOLOGY

**Actuation Force:** The force required to collapse the web of a rubber keypad in conjunction with polydome, metal dome, mechanical switch or rubber only.

**Air Channel:** Air path(s) on the bottom of rubber keypads that allows for air passage when rubber is depressed.

**Alignment Hole:** Through hole in rubber keypad that is used to position keypad in enclosure.

**Base Matte:** Silicone sheet material that joins all keys on a rubber keypad. Also known as mat.

**Bezel:** The faceplate or cover, typically plastic or metal, used to secure a keypad to a printed circuit board or switch.

**Bossses:** Small posts used for positive alignment of rubber keypad in bezels or assemblies.

**Compression Set:** The measurement of a material’s ability to recover its original size and shape after compression under prescribed conditions.

**Conductive Rubber:** Silicone keypad impregnated/coated with conductive material.

**Color Matching:** The visual and electronic analysis of a mixed silicone rubber material compared to a supplied color sample.

**Diaphragm / Web:** The thin hinged area that permits a rubber key to flex.

**Durometer:** A measurement range of hardness for silicone rubber.

**Key Height:** The measured distance from the bottom of a keypad (base matte) to the top surface of a key.

**Legend:** Printed graphic (symbol, letter or number) on the top of the rubber surface.

**Life:** The number of actuations realized before the rubber diaphragm/web ruptures.

**Reversed-Out Graphics:** Graphics that allow rubber color or masking color to be seen through top surface printing on keypad.

**Positive-image Graphics:** Single or multi-color printing on top of key surface.

**Stroke / Travel:** Distance from the contact surface of a rubber part to a surface.

**Swell:** The increase in volume of rubber when in contact with petrochemicals for a determined period.

**Tactile Feel:** The response of rubber while depressing. For tactile rubber keypads, it is a critical function of the diaphragm web geometry.

**Tear Strength:** The tear strength is a measure of the resistance of rubber to tear forces. The tear strength is calculated by dividing the maximum force load by the thickness of the rubber.

**Wear or Abrasion Resistance:** The resistance of a particular ink or coating to manual wearing. The testing process is usually a Norman tester with the number of cycles legends can perform before wear is noticeable.