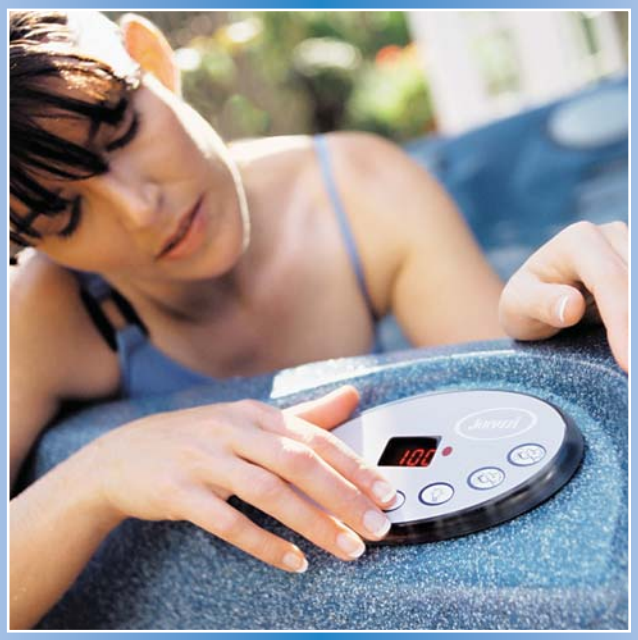
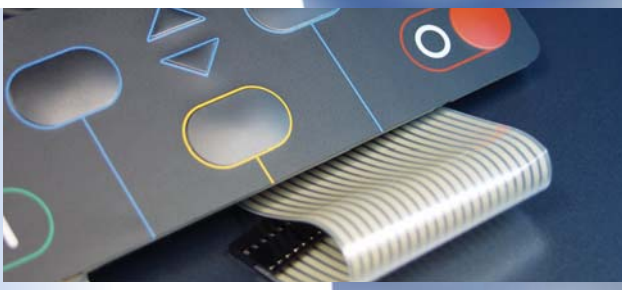
Custom Engineered
Solutions for Harsh
Environment Survivability

Membrane
SWITCHES





THE BERGQUIST COMPANY

Registered Firm
ISO 9001:2000

Quality

The Bergquist Company does more than pay lip service to quality; we're committed to it! Quality is the cornerstone of our engineering and manufacturing success. The Bigfork plant, where membrane switches are made, is currently ISO 9001:2000 certified.

Bergquist Switches

Bergquist: Your Single Source for Custom Membrane Switches

The Bergquist Company is the leader in engineering and manufacturing of high quality, custom membrane switches for a wide variety of applications, including:

- Automotive
- Medical instruments
- Consumer/industrial electronics
- Business equipment
- Commercial appliances
- Recreation products

Materials – The Key to Bergquist Success

We began building membrane switches at a time when many companies' switches were failing in the field. Our engineers and scientists realized that the key to making durable membrane switches is to understand not only the electronics of the switch, but also the chemistry of the materials, the interaction of layers, and how the combinations work in harsh environments.

Today, our laboratory facilities in Minnesota are used to research material compatibility in membrane switches and develop processes that improve switch performance, durability and reliability.

In the pages that follow, you'll see in detail how Bergquist HeatSeal® membrane switches provide you with the most cost-effective, most durable solutions available.

Customer Focused

The Bergquist Company is clearly and consistently focused on our customers. Ensuring total customer satisfaction with our products and relationships has always been our company's primary objective.

Our knowledgeable, courteous and diligent Customer Service Representatives work with our customers to develop demand management programs that allow us to customize manufacturing schedules to suit individual customer requirements.

Delivery

We schedule consistent on-time deliveries using:

- Customized demand-management systems
- Forecasts
- Kan Bans
- E-Scheduling
- Material authorizations
- Annual contracts
- Any other customer-preferred methods

Our manufacturing facility utilizes an MRPII system to ensure on-time delivery of your product. You get what you want, when you want it!

Quality

Every aspect of Bergquist engineering and manufacturing is firmly anchored in our commitment to quality. Membrane switch manufacturing facilities are ISO 9001:2000 certified.

High Standards

Bergquist is a company whose high standards embrace product quality, integrity, confidentiality and partnering. Rely on Bergquist for professional and knowledgeable customer service.

Ready to Serve You

Whether you are developing a new product requiring a membrane switch, or seeking a different or second source for an existing product, we invite you to switch to Bergquist by calling us toll-free today at (800) 347-4572.

The Bergquist Advantage

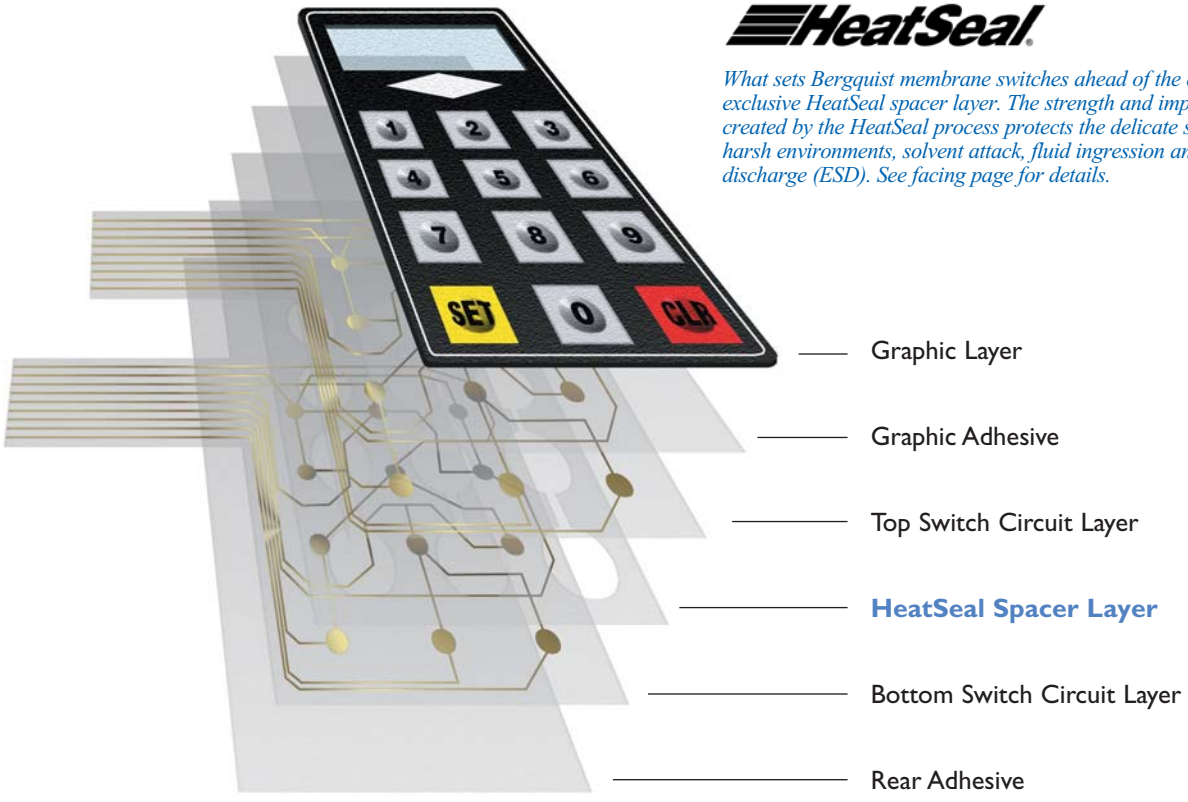
Why Bergquist is Better: HeatSeal® Technology

Bergquist manufactures membrane switches using HeatSeal, a proprietary dry film adhesive bonding technique developed for applications where conventional membrane switches often fail. Key benefits of HeatSeal include:

- Bonds top and bottom circuit layers together
- Protects the electrical integrity of your switches
- Provides permanent seal from outside environment

Inadaquate sealing of switch layers is a major cause of failure. Moisture, temperature extremes and chemicals are typical enemies of standard PSA (pressure-sensitive adhesive) membrane switches. To overcome this issue, Bergquist's exclusive HeatSeal fabrication process thermally bonds switch layers together with heat and pressure. The lamination strength is superior to pressure-sensitive adhesive construction and there is no need to externally vent the spacer layer. The result is a complete seal which protects the electrical integrity of your membrane switch.

Bergquist developed the HeatSeal process so you can design a membrane switch for almost any environment. Bergquist membrane switches operate under water, in dust and dirt, in high and low temperature extremes, and in critical-reliability environments such as hospitals where harsh cleaners are commonly used. No other membrane switch manufacturer has developed a fabrication technique as durable as the Bergquist HeatSeal membrane switch.



HeatSeal

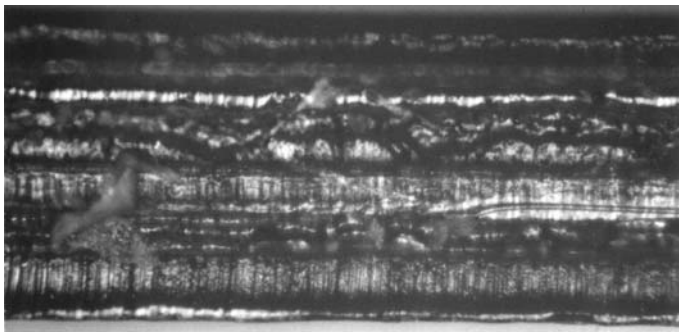
What sets Bergquist membrane switches ahead of the competition is our exclusive HeatSeal spacer layer. The strength and impenetrable lamination created by the HeatSeal process protects the delicate switch circuitry from harsh environments, solvent attack, fluid ingression and electrostatic discharge (ESD). See facing page for details.

HeatSeal Holds Up Under Pressure

PSA Switches

Typical air distribution within a pressure sensitive adhesive (PSA) membrane switch at time of manufacture is shown in Figure 3. The buildup of air pressure differential as the membrane switch is raised to an elevation of 40,000 feet is shown in Figure 4. The air pressure within the switch becomes great enough to force its way through the micro fissures in the PSA until the air pressures between the switch and the environment have equalized.

The resulting distribution of air within the switch once it has returned to a normal elevation is shown in Figure 5. The memory within the polyester does not have enough force to draw air back into the switch cavities. The end result is a collapsed, electrically shorted switch.



10X microscopic view of PSA material shows air gaps inherent in the nature of the material, thus making it susceptible to leakage under higher or lower air pressure.

FIGURE 3: PSA Switch - Air Pressure @ Equilibrium

FIGURE 4: PSA Switch - Air Pressure @ Higher Altitude

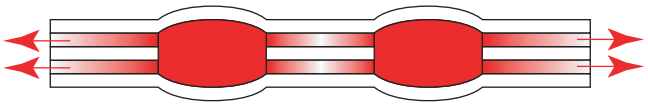
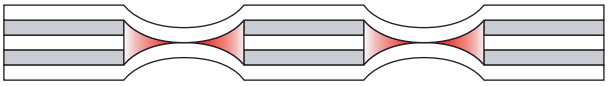


FIGURE 5: PSA Switch - Air Pressure @ Normal Altitude

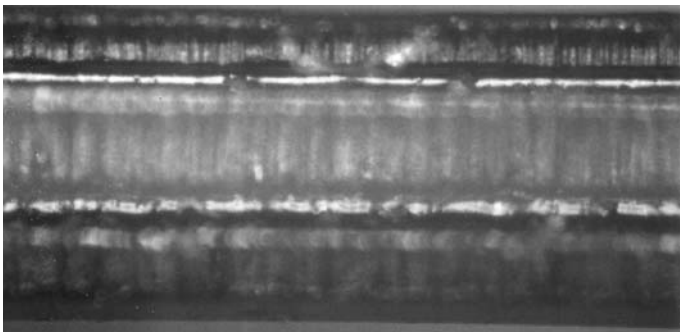


Bergquist HeatSeal Switch Construction

Figure 6 depicts the typical distribution of air within a HeatSeal membrane switch at time of manufacture.

The buildup of air pressure differential as the HeatSeal switch is raised to an elevation of 40,000 feet is shown in Figure 7. The air pressure buildup will increase the actuation force of the switch at elevation. However, the force of the air pressure cannot overcome the bond strength of HeatSeal. The resulting, unaffected distribution of air within the HeatSeal membrane switch once it has returned to normal elevation is shown in Figure 8.

These illustrations show the overall protection strength of Bergquist HeatSeal. HeatSeal's strength and impenetrable lamination protects the delicate switch circuitry from harsh environments, solvent attack, fluid ingression and electrostatic discharge (ESD).



10X microscopic view of HeatSeal material shows solid nature of the material, thus making it impervious to leakage under higher or lower air pressure.

FIGURE 6: HeatSeal Switch - Air Pressure @ Equilibrium

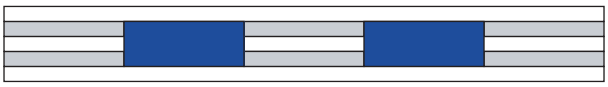
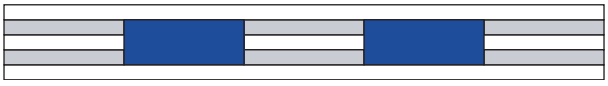


FIGURE 7: HeatSeal Switch - Air Pressure @ Higher Altitude

FIGURE 8: HeatSeal Switch - Air Pressure @ Normal Altitude



Testing

Testing Programs

Anyone can *claim* to be the best. At Bergquist, we can *prove* it! Our commitment to testing before, during and after production is among the reasons why Bergquist HeatSeal membrane switches are known throughout the world for their high reliability.

While PSA switches are adequate for some applications, engineers cannot always identify what the end use environmental conditions will be. Bergquist HeatSeal switches are designed, manufactured and tested to hold up in the toughest environments imaginable.

Bergquist Testing Includes:

Materials

Bergquist lab technicians use the latest technology and equipment to test materials before and after manufacturing to maintain quality control. Material from suppliers is checked regularly to identify any changes that may affect the switches. In addition, TGA (Thermo Gravimetric Analysis) equipment can be used to identify the exact "fingerprint" of a material.

Other equipment is used to measure the adhesion between switch layers, and to simulate environmental conditions (see HeatSeal testing, pages 5-8).

Switch Actuation

Specialized devices operate switches through millions of actuations to test reliability. Other testing conducted in the Bergquist laboratory includes switch functional performance testing, high temperature humidity testing, and low temperature testing on switch packages.

Electrical

A custom software program logs the electrical resistance of each key on every switch manufactured. This information is stored in a database for each customer. A barcode on each switch can be scanned to call up detailed switch information.

Temperature Endurance Test

Test Purpose

To determine the effect of temperature on the bond between the layers of a membrane switch. In this test we evaluate switch bodies constructed using a Bergquist HeatSeal spacer and a pressure sensitive acrylic spacer.

Method

Bergquist uses test method ASTM D-1876-72 for measuring peel resistance between the switch layers. Samples are prepared using the following spacer materials and cut into one-inch-wide specimens for peel testing:

FIGURE 9: Instron Test Machine

A) .005" Mylar™ polyester film (top), .009" pressure sensitive acrylic spacer, .005" Mylar polyester film (bottom).

B) .005" Mylar polyester film (top), .008" HeatSeal spacer, .005" Mylar polyester film (bottom).

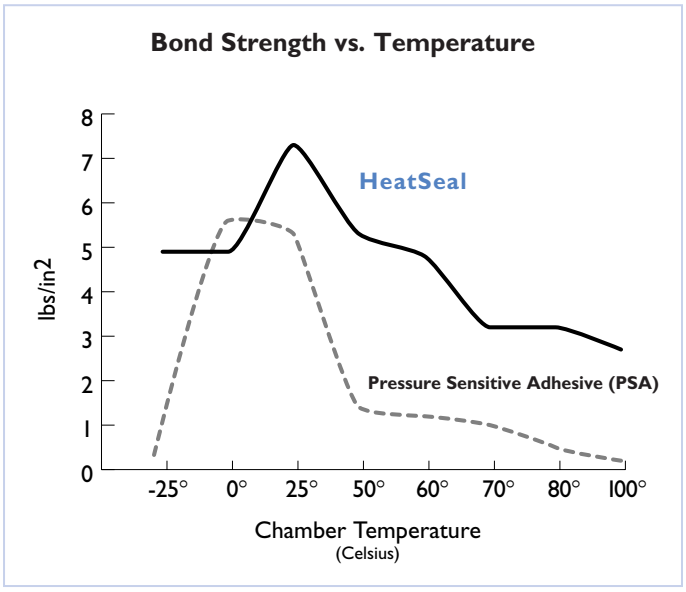
Three (3) samples of each construction are prepared for testing at eight temperatures: -25, 0, 25, 50, 60, 70, 80 and 100°C.

Each test specimen is placed in the grips of an Instron Test Machine (see Figure 9) and conditioned at the specified temperature for five (5) minutes. The top and bottom layers are then separated at a rate of ten (10) inches per minute. A chart recorder is used to record load versus displacement. The average peel strength of each specimen is determined by measuring load at each half inch of separation until ten (10) readings are taken. Peel strengths are reported in units of pounds per inch width.

Summary

The data demonstrates that the peel adhesion of PSA adhesive varies greatly with temperature, while HeatSeal peel adhesion remains relatively stable (see Figure 10). At temperatures exceeding 50°C, PSA is susceptible to delamination through both internal and external stresses inherent in membrane switch constructions. Examples of these forces are interference fits, differences in coefficients of thermal expansion, and upward force due to connector/tail placement. Any delamination of the switch layers will leave the circuit vulnerable to fluid ingression and/or contamination (i.e. electrical failure).

FIGURE 10: Peel adhesion at temperature



Testing

General Purpose Cleaners Test

Test Purpose

To determine the effect of common household cleaners on the switch bodies of membrane switches constructed with a Bergquist HeatSeal spacer and with a pressure sensitive acrylic spacer.

Set Up

Standard 3 x 4 matrix switches 2.6" x 3.0" with 3" tails are used for testing. All switches are constructed one month prior to any testing. Spacers tested are as follows:

1) Bergquist HeatSeal spacer – .008" total thickness (.005" base polyester with .0015" of HeatSeal adhesive on each side).
2) Pressure sensitive acrylic spacer – .009" total thickness (.005" base polyester with .002" of acrylic adhesive on each side).

Pre-testing of all switches is performed by following these steps:

1) 24-hour immersion in a solution of water with .2% by volume of soap added.
2) Insulation resistance readings are then taken on each switch at 100 VDC. A minimum of 1 mW insulation resistance is required for each switch to enter the testing phase.

Solutions

Eight beakers are each filled 3/4 full with a cleaning solution and four drops of green dye. The cleaning solutions are:

A) 409®
B) Fantastik®
C) Dow® Bathroom Cleaner®
D) Lysol® Tub and Tile Cleaner®

Parameters

Samples of each switch type are immersed in each of the four solutions. Each group of parts is then placed in an airtight container, to reduce evaporation, for a period of 180 days at room temperature.

409® is a registered trademark of The Clorox Company. Fantastik® is a registered trademark of SC Johnson Company. Dow® and Bathroom Cleaner® are registered trademarks of Dow Corning Corporation. Lysol® and Tub and Tile Cleaner® are registered trademarks of Reckit Benckiser, Inc.

Results (Refer to Figure 11)

- HeatSeal spacer – no visual degradation of the switch occurred in any of the switches. There were no measurable changes in the insulation resistance of any of the parts (see Figure 12).
- Pressure sensitive acrylic spacer – results varied with each solution:

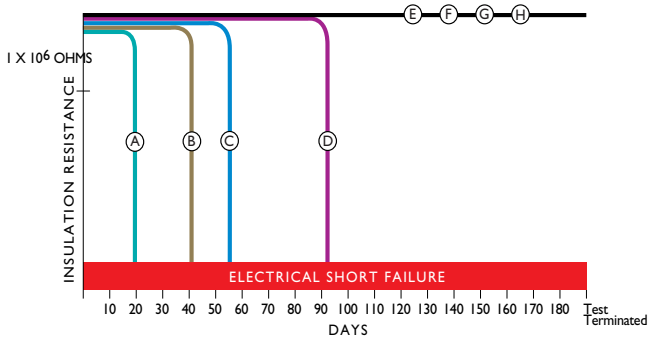
A) 409 – ingression and dissolving of the PSA adhesive occurred uniformly around the perimeter of the switch. Ist failure of insulation resistance occurred on day 20 (Figures 13 and 14).

B) Fantastik – ingression and dissolving occurred as above. Failure occurred on day 42 (see Figure 15).

C) Dow Bathroom Cleaner – ingression and dissolving occurred as above. Failure occurred on day 56 (Figure 15).

D) Lysol Tub and Tile Cleaner – ingression and dissolving occurred as above. Failure occurred on day 92 (see Figure 15).

FIGURE 11: Insulation Resistance Over Time



A) PSA Switch, 409, switch to solution insulation resistance, failure in 20 days avg.
B) PSA Switch, Fantastik, switch to solution insulation resistance, failure in 42 days avg.
C) PSA Switch, Dow Bathroom Cleaner, switch to solution insulation resistance, failure in 56 days avg.
D) PSA Switch, Lysol Tub and Tile Cleaner, switch to solution insulation resistance, failure in 92 days avg.
E) **HeatSeal Switch**, 409, switch to solution insulation resistance.
F) **HeatSeal Switch**, Fantastik, switch to solution insulation resistance.
G) **HeatSeal Switch**, Dow Bathroom Cleaner, switch to solution insulation resistance.
H) **HeatSeal Switch**, Lysol Tub and Tile Cleaner, switch to solution insulation resistance.

General Purpose Cleaners Test Results

Observations

The ingression and dissolving of the PSA adhesive was consistent around the perimeter, however at various stages some smaller areas of increased ingression would appear. These inconsistencies in ingression advancement point to inconsistency in lamination caused by air voids between the adhesive and circuit layer. These voids enhance the cleaners' ability to ingress.

Summary

This simple test shows that 409, Fantastik, Dow Bathroom Cleaner and Lysol Tub and Tile Cleaner are aggressive towards pressure sensitive acrylic adhesive. These same cleaners have no effect on the Bergquist HeatSeal switch construction.

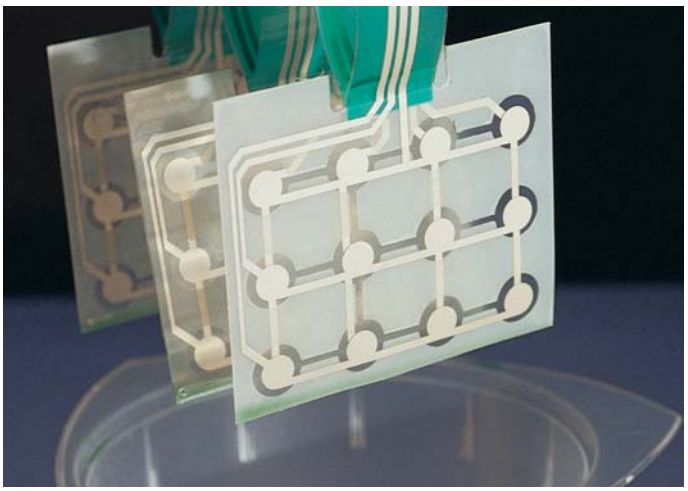


FIGURE 12: HeatSeal construction switch soaked in 409

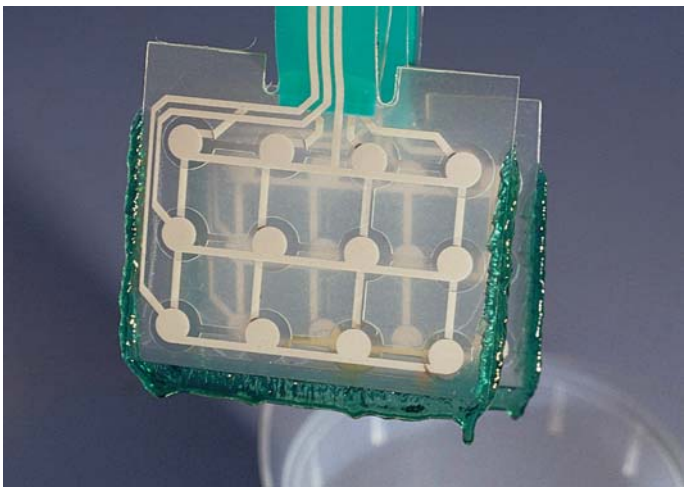


FIGURE 13: PSA construction switched soaked in 409

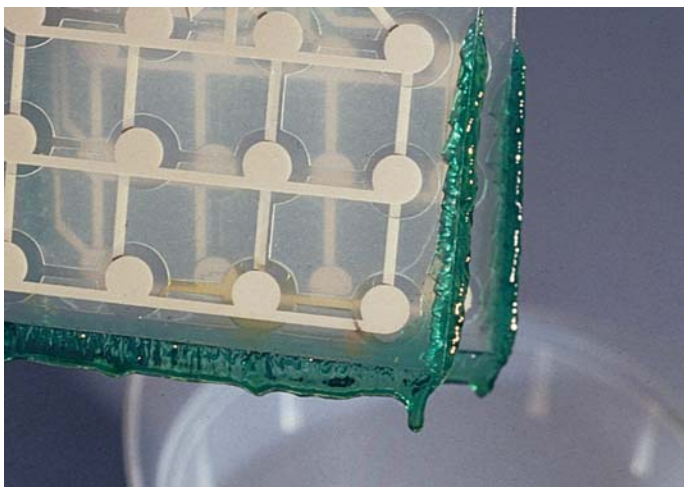


FIGURE 14: Close-up of fluid ingression into key area (PSA switch soaked in 409)

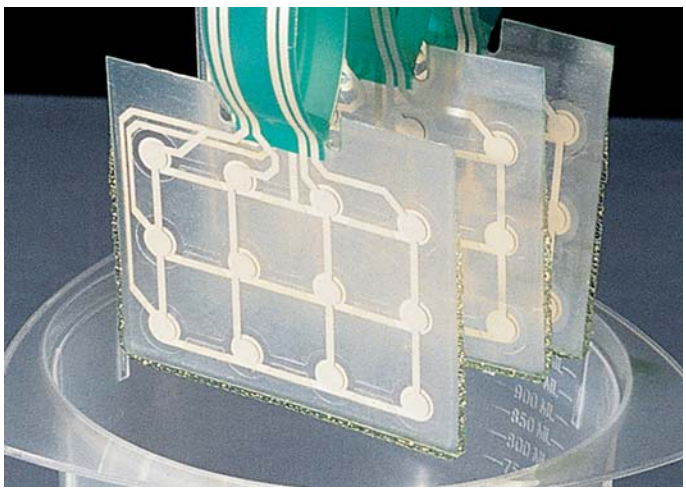


FIGURE 15: PSA construction switches soaked in other cleaners

Testing

Gasoline Test

Test Purpose

To determine the effect of gasoline on the switch bodies of membrane switches constructed with a Bergquist HeatSeal spacer and with a pressure sensitive acrylic spacer.

Set Up

Standard 3 x 4 matrix switches 2.6" x 3.0" with 3" tails are used for testing. All switches are constructed one month prior to any testing. Spacers tested are as follows:

1) **Bergquist HeatSeal spacer** - .008" total thickness (.005" base polyester with .0015" of HeatSeal adhesive on each side).
2) **Pressure sensitive acrylic spacer** - .009" total thickness (.005" base polyester with .002" of pressure sensitive acrylic adhesive on each side).

Pre-testing of switches is performed as in the General Purpose Cleaners Test.

Results

HeatSeal spacer - After 14 days of immersion in gasoline there were no visual signs of degradation. There were no measurable changes, throughout the 14-day duration of the test, in the insulation resistance measurements.

Pressure sensitive acrylic spacer - Severe dissolving of the PSA adhesive and ingression of the gasoline occurred within the first 2 hours of the test. After 2 hours the parts had failed the insulation resistance test. After fourteen days switches were completely delaminated with only some gelatinous masses of PSA adhesive left.

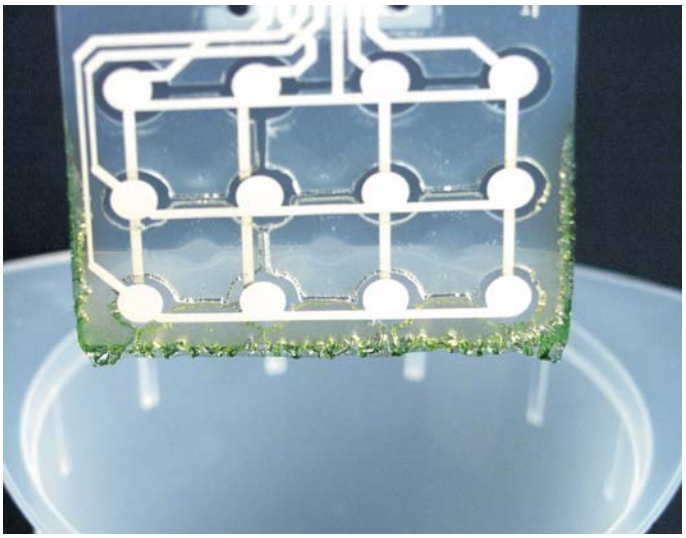


FIGURE 16: PSA switch soaked in gasoline and green dye for 10 hours indicates substantial fluid ingression and switch delamination.

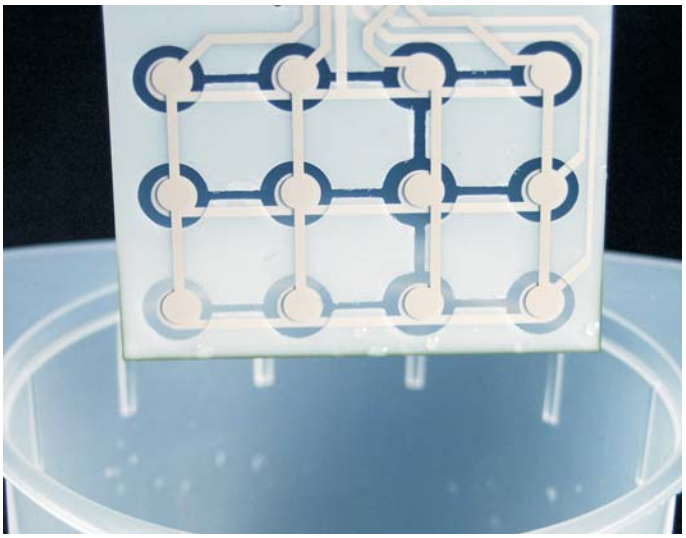


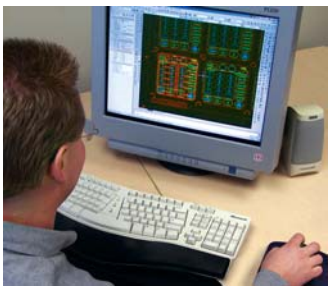
FIGURE 17: HeatSeal switch soaked in gasoline and green dye for 10 hours shows no fluid ingression or switch delamination.

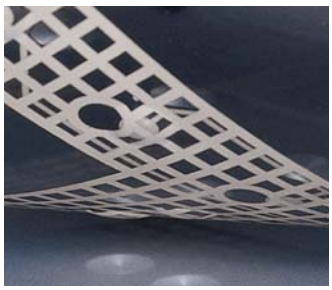
Engineering

Leading Edge Technologies

Bergquist uses leading-edge CAD systems to engineer your custom membrane switch. Our CAD professionals can import your engineering files or we can create new ones from your specifications and prints. All switch layers are engineered on the CAD system to ensure consistent base-line accuracy for all production operations.

Individual layers from CAD drawings are used for screen making and die board making, and are used to drive our laser cutter for prototypes and small production runs.





Engineering

Involve our engineering staff early in your design-build process to benefit from our switch design expertise. Our engineers are accessible and eager to assist you in ensuring that your circuit and graphic designs meet our manufacturing capabilities. For example, there should be .125" between any exposed edge and the first trace of silver to properly HeatSeal switch layers. Also, circuits should be designed to avoid dielectric jumpers and still achieve proper pin-out. Involve us early; we can help in many ways.

Operating Environment

The environment your switch will be operating in often determines the switch material and its construction. Polyester has a long flex life and is resistant to solvents. Polycarbonate is available with a tough matte texture. In many cases a hardcoat can be applied to either material for added protection. For chemical, high moisture, dusty and variable temperature environments (as well as unknown or uncontrollable environments), we recommend HeatSeal construction.

Graphic Life

The type of material, its thickness and the embossing of keys can all affect the life of the graphic layer. Polyester is recommended for long flex life. Our life testing indicates polyester outlasts polycarbonate. Embossing and contact with chemicals may also reduce polycarbonate graphic life.

Power Levels

Most membrane switches are used in logic level power applications. Generally, screened silver inks are used with switching loads under one watt. Copper foil laminate may be used when switching loads are one watt and above.

Materials - The Key to Bergquist's Success

We began building membrane switches at a time when many companies' switches were failing in the field. Our engineers and scientists realized that the key to making durable membrane switches is to understand the chemistry of the materials, the electronics of the switch, the interaction of the layers, and how the combinations work in a harsh environment.

Today, our laboratory facilities in Chanhassen, Minnesota are used to research materials compatibility in membrane switches, and develop processes that improve switch performance, durability and reliability.

Research & Development

Innovation and New Product Development are the Lifeblood of the Company.

Bergquist invests in research and development including an extensive developmental laboratory and engineering department where new products are researched, developed and tested.

Innovation

Many proprietary and patented products originated in Bergquist laboratories, including Thermal-Clad, variations of Sil-Pad materials and the HeatSeal adhesive used in Bergquist membrane switches.

Development

At Bergquist, developing new and innovative quality products is no accident. Bergquist follows a proven development methodology for new product and process development. From the first stage of development to high volume manufacturing, Research and Development is involved to assure Bergquist products meet our customers' needs.

Capabilities

Located in the Chanhassen, MN headquarters facility, the Bergquist R&D laboratory and engineering department is home to a full staff of chemical engineers, manufacturing engineers and laboratory technicians working to improve existing products and dream up new ones.

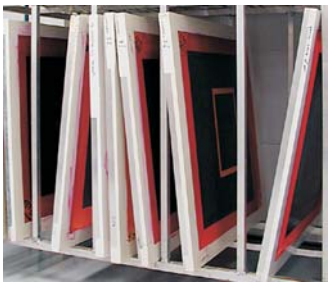
Partnership

Partnering with our customers to develop unique solutions to specific market needs enables Bergquist to be a valuable and cost-effective supplier.

Manufacturing

Accuracy and Quality

Whether it's screened silver circuits or graphics, accuracy and quality are first and foremost at Bergquist. Our state-of-the-art screen making and printing facilities feature the latest technologies and professionals who know how to use them.




Screen Making

Our state-of-the-art CAD system outputs directly to finished film via a photo laser imagesetter. Finished film is then exposed directly to screen stencils. All film layers are registered using optical equipment to ensure consistently accurate registration of screened circuitry and graphics. For accuracy, Pneumatic screen stretchers are used and each screen is tested for uniformity of pressure before use.


Screen Printing

Our screen printing facility is ISO 9001:2000 certified and a model of cleanliness, precision and efficiency. Automatic, semi-automatic and manual presses are matched to each switch project for maximum productivity and cost-efficiency.

The Bergquist Company uses a computerized color matching system to formulate custom colors for your membrane switch. This system helps us make the necessary color adjustments needed to provide colors that will match the rest of your assembly from start to finish.

Process Controls

Bergquist employs a wide variety of process control tools and techniques including:

- Variety of SPC controls to insure repeatable product quality
- Heat stabilization of circuit and graphic substrate materials
- Statistical monitoring of screen tension
- First article inspection of each screened layer
- Belt speeds and UV light output are monitored using SPC techniques for accurate process control
- UV hardcoats are cured using a Linde nitrogen curing system

Manufacturing

Every Step is Important

At Bergquist, every step in our manufacturing process, including the embossing, die cutting and assembly processes described here, is critically important to achieving the high standards that we and our customers expect.

Polyester Dome Forming and Graphic Embossing

Our specialized multi-station embossing and dome forming presses allow the operator to work quickly through consecutive operations. Our in-house dome forming equipment provides consistent tactile feel from dome to dome and lot to lot.

Die Cutting

At Bergquist, craftsmanship and technology work seamlessly together to deliver a higher quality solution. Our premium hardwood die boards are precision cut on a CNC laser cutter from approved CAD files. In our complete in-house die shop, experienced steel-rule die makers ensure long production life, accuracy and faster turnaround.

Pin registration is used in die cutting to maintain accuracy throughout all processes. Our die cutting presses are set-up, maintained and operated by highly skilled people who understand the critical nature of membrane switch quality.

Assembly

Membrane switch assembly at Bergquist is a function of skilled people and quality-driven processes. Switch layer assembly is all pin registered for consistent accuracy. The exclusive Bergquist HeatSeal process is equally precise and consistent. The result is a custom membrane switch that performs as specified and will stand the test of time.

Options

More Choices Mean Better Solutions

Bergquist offers a wide range of choices of how your HeatSeal membrane switches can look, feel and function. This page shows many of our standard features, available options and an inside look at what makes a higher quality switch.

Graphic Layer

Materials

- Polyester – offers long life and chemical resistance; 7 mil std.
- Polycarbonate – with velvet texture; 7 or 10 mil std.

Hardcoats

- Gloss, semi-gloss and matte finishes are available
- Increases chemical and scratch resistance
- Selectively applied to create display windows and decorative finishes

Colors

- Pantone (PMS) or custom matching using a color computer
- Transparent/translucent colors for back-lighting and windows
- "Deadfront" available to hide leg ends/windows until back-lit

Embossing

- Tactile formed graphic over flat circuits (typically most cost-effective)
- Pillow embossing – 0.015" typical height; generally used over polyester domes
- Rim embossing – 0.010" typ. height; for locating pads by feel

Graphic Adhesive

- 5 mil standard thickness

Switch Circuit Layers (top and bottom)

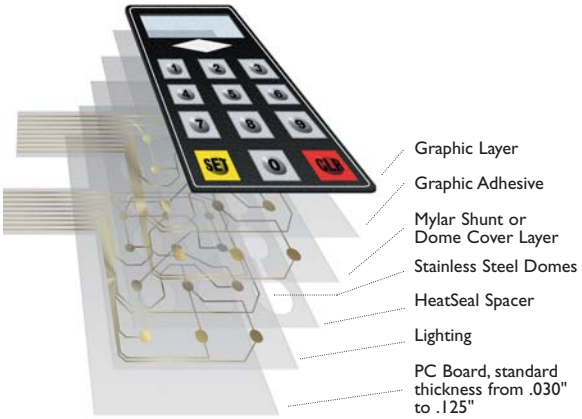
Switch Types

- Screened silver circuit – most economical; for switching loads one watt or less; typical top and bottom layer thickness is 5 mil
- PC board – copper circuitry for switching loads greater than one watt or when components (LEDs, displays, etc.) are used

Circuit Types

- Matrix and short-to-ground are most common
- Involving us early in the design stage allows us to make suggestions that help ensure a reliable membrane switch

PC Board HeatSeal Membrane Switch



Polyester Domes

- Formed into top switch circuit layer of silver circuit switches
- Formed into shunt/dome cover layer of PC board switches
- Provides tactile feel and long life; typically 24 – 30 mil height

Shielding

- Screened silver grid – applied to top side of silver circuit for ESD protection
- Aluminum and gold vapor deposition – ESD, EMI and RFI protection; adds approximately 5 mil to total thickness

Spacer Layer

- HeatSeal – internally vented preferred for most applications (PSA available - externally vented)
- 6 – 8 mil thickness typical when using polyester domes
- 6 – 14 mil thickness typical for flat switch
- Spacer thickness depends on actuation force requirements back lighting
- Electroluminescent lamp
- Fiber-optic
- LEDs – soldered on PC board switches

PC board components

- Standard PC board thickness from 0.030" to 0.125"
- Stainless steel snap domes – used on nickel-plated copper or PC boards; for tactile feel and temperatures above 150°F
- Surface mount and feed-through components

Backers or Enclosures

- Metal, FR4 or polycarbonate backers
- Plastic enclosures

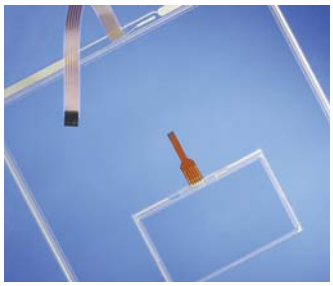
Resistive Touch System

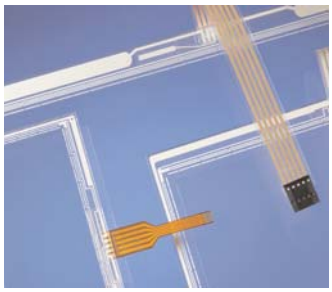
Innovative, Seamless Membrane Switch/Touch Screen Technology

Introducing a New Standard in Reliability and Redundancy for Critical Control Applications

As a world leader in both membrane switches and analog resistive touch screens, it seemed an obvious choice to combine these two technologies to create the innovative seamless RTS resistive touch system. This permits the design and manufacture of custom products having the reliability and redundancy required for medical devices, industrial controls and other critical applications.

Membrane Switch + Touch Screen = Resistive Touch Systems





Membrane Switch

Bergquist's proprietary HeatSeal membrane switches are custom engineered for use in environments where reliability is critical. The HeatSeal process thermally bonds switch layers together, providing a seal that is impervious to moisture, temperature extremes and cleaning chemicals. Options include screened silver ink or PC board circuitry, tactile graphics, rim or pillow embossing, deadfront or translucent windows and more.

Touch Screen

Bergquist's patented 5-Wire analog resistive touch screens are engineered for critical applications. Features include drift-free operation, fast speed, actuation force consistency, industry-leading light transmission and touch-point density, plus reliability up to 30 million cycles.

RTS Interface

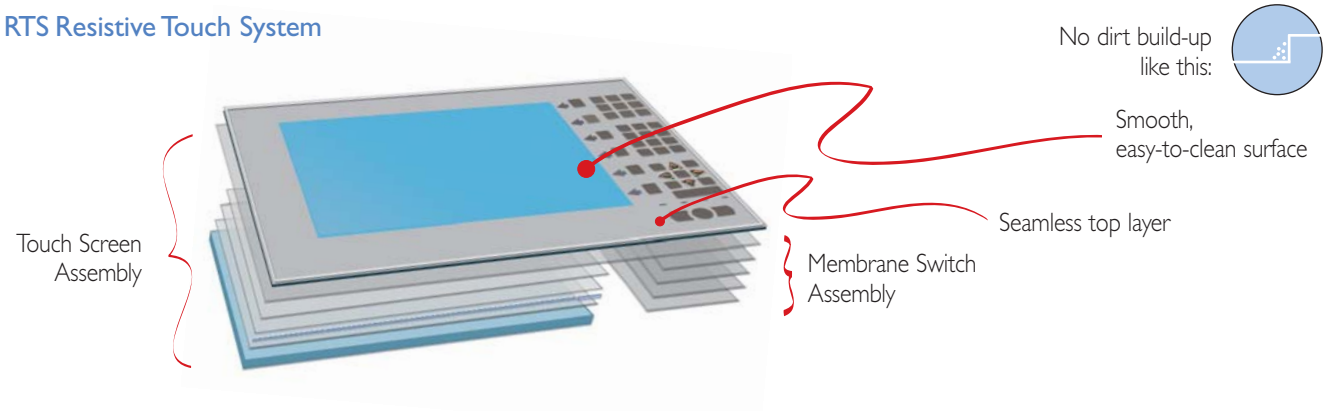
By combining membrane switch and touch screen technology into a single RTS unit, devices used in critical applications benefit from unprecedented reliability and redundancy. The many design options allow engineers extensive flexibility in the design process. Plus, the seamless top layer eliminates all cracks and crevices where build-up can cause contamination and premature failure.

Since both the membrane switch and touch screen are manufactured in house, Bergquist customers experience no dispute between vendors over product quality.

Resistive Touch System

Custom Engineered for Your Application

The Bergquist RTS resistive touch system has a seamless one-piece face that is easily cleaned, with no cracks, crevices or ledges for dirt and grime to collect. Each custom-engineered RTS unit can employ the same functional and performance features offered on all Bergquist HeatSeal membrane switches and 5-Wire resistive touch screens as shown below.



Membrane Switch Features

Graphic Layer

Polyester construction – offers long life and chemical resistance

Optional hardcoats

- Gloss, semi-gloss or matte
- Chemical and scratch resistant
- Can be used to create display windows and decorative finishes

Custom colors

- Translucent colors for back-lighting and windows
- Deadfronts to hide legends until back-lit

Variety of tactile response options

- Tactile graphic over flat circuits
- Pillow or rim embossing
- Polyester or metal domes

Switch Circuit Layers

- Screened silver circuit – for switching loads up to one watt
- Copper PCB – for switching loads greater than one watt, or when using LEDs, displays, etc.
- Screened silver shield applied to top of circuit for ESD protection

Spacer Layer

- HeatSeal – internally vented
- Thickness based on actuation force requirements

Touch Screen Features

Construction Features

- Patented design
- Custom sizes
- Diagonals as small as 3.8"
- High-accuracy off-ratio sizes
- Slim perimeter – drops into most existing 4-Wire and 8-Wire spaces
- Variety of glass thicknesses
- Flexible tail location
- Custom lengths and terminations

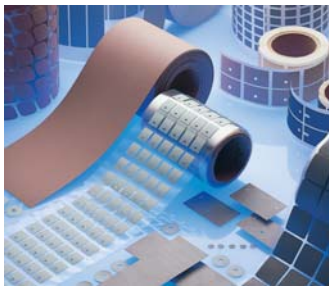
5-Wire Advantages

- 5-Wire resistive analog technology – superior to 4-Wire, 8-Wire and resistive matrix technologies
- Most durable resistive analog – drift-free operation even when exposed to temperature fluctuation
- Increased optical clarity
- Greater touch point density
- Increased speed and accuracy
- Simple 2-point calibration versus up to 25-points for others
- No external electronic correction needed (NovRam)
- Windows® compatible

Bergquist Switches

The Bergquist Company...

was founded in 1964 by Carl Bergquist as a distributor of components to electronics products manufacturers. Today, the company is a recognized authority in the manufacture and distribution of thermal products, membrane switches, electronic components and touch screens.

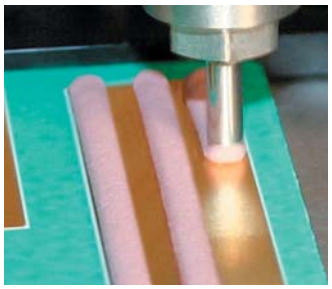


Membrane Switches

Bergquist's proprietary HeatSeal® membrane switches are custom engineered for use in harsh environments where reliability is critical. The HeatSeal process thermally bonds switch layers together, providing a seal that is impervious to moisture, temperature extremes and cleaning chemicals.

Features:

- HeatSeal, a proprietary adhesive bonding process
- Up-front problem solving through team management
- Customer-focused engineering and support



Thermal Products

Bergquist's Sil-Pad® thermally conductive insulators and Thermal-Clad® insulated metal substrates control and manage heat in electronic assemblies and printed circuit boards. Extensive research and development helps Bergquist meet the critical thermal management needs of the rapidly changing electronics industry.

Features:

- Sil-Pad and Gap Pad®, world's top heat management products
- Broad range of thermal options from interfacing to adhesives
- Thermal Clad, recognized leader in dielectric coated material

Electronic Components

Bergquist Electronics is a value-add supplier to OEMs in a wide variety of industries. The division provides assistance in design, manufacturing, global sourcing, and logistics. The division also distributes electronic components in the Midwest United States.

Features:

- Electronic components to complete engineered solutions
- Asian and European manufacturing and assembly facilities
- Customer engineering and strategic support

Touch Screens

Bergquist's 5-Wire touch screens feature unique construction and electrical functionality, making them extremely durable. 5-Wire touch screens also feature patented optical technology, providing an enhanced level of clarity and contrast.

Features:

- Drift-free operation during temperature changes
- Ability to withstand 35 million activations in a single touch-point
- Continued functionality, even with damage to top film

Labels and Graphic Overlays

This division designs and manufactures printed nameplates, graphic overlays, pressure sensitive labels, and other products to meet the product identification and interface needs of a variety of industries. With challenging application requirements, they offer a full line of U.L. recognized, CSA and CE materials.

Features:

- Full line of identity materials from rolls to custom shapes
- SharpTech® 4-color printing technology
- Broad range of graphic overlays and nameplates

DOMESTIC AGENTS

For a complete list of Bergquist sales representatives in the U.S. contact The Bergquist Company: 1-800-347-4572.

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