Duraswitch® Technology provides Solutions for Appliance Industry

by:
Anthony J. Van Zeeland,
COO and EVP Engineering, Duraswitch Industries, Inc., USA

Introduction

Duraswitch Island switch technology is ideal for full and complete integration of electronic switch panels in the appliance industry. It integrates pushbutton, rotary and sliding type encoders, as well as analog devices by packaging each component together in a thin adhesive foam matrix. The foam provides structural integrity as well as an environmental seal. Complete integration of these devices is typically achieved in a panel thickness of less than one tenth inch (2.5mm).

Extensive research and experience in the appliance industry has indicated that solder and adhesive interconnections between individual components and the circuit electronics has been a source of failure and complexity due to the extreme performance requirements. Additionally, environmental concerns are continually driving the industry away from the use of lead/tin solder interconnections. The Duraswitch Island technology virtually eliminates this quandary.

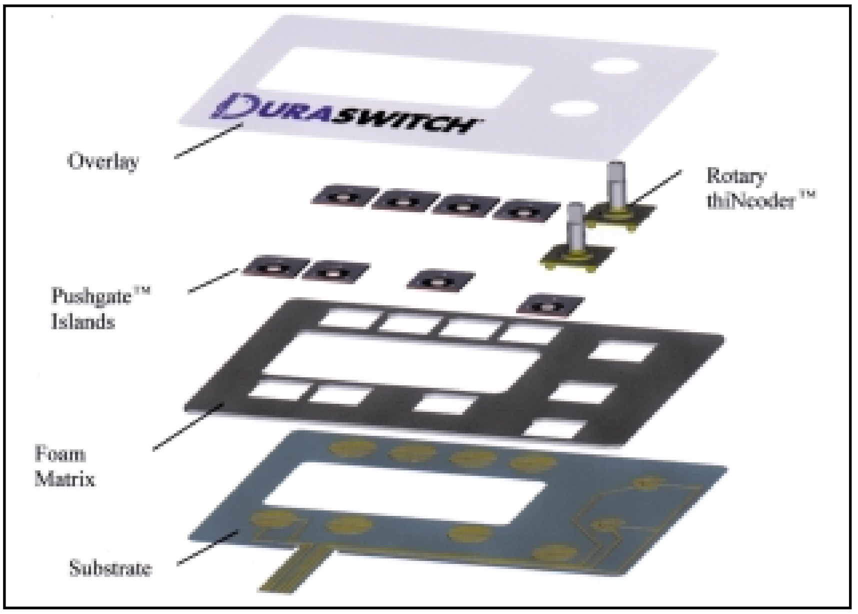

Figure 1: Duraswitch Island Switch Integration

Duraswitch Island™ Switch Technology

An exploded view of the Duraswitch Island™ Integration concept is shown in *figure 1*. A multiple pushbutton switch array and dual rotary encoder concept is depicted here. Sliding type encoders, analog devices, and directional switches such as the Duraswitch patented MagnaMouse™ can also be integrated into the circuit. Note that each individual component is contained in an isolated Island in the foam matrix. All switch circuitry is either screened or etched onto the substrate layer to form the entire circuit, leaving all interconnects between individual components intrinsically formed in the circuitry. This design eliminates the need for failure-prone component interconnections such as solder or conductive adhesives.

Pushbutton Switches

The patented Duraswitch PushGate™ Island device is a magnetically actuated pushbutton switch that employs a common refrigerator magnet. The sealed nature, reliability and ergonomic feel of these switches make them particularly applicable to the appliance industry. The unique offset cantilever action of the armature facilitates use of thick overlays like those used for electro-luminescent lighting, while maintaining tactile feel. This technology also provides the option for back-lighting through a hole in the crown of the armature. The magnet provides tactile breakaway feel and spontaneous switch actuation in addition to functioning as a return spring. The "magnetic spring" provides virtually limitless switch life with no perceivable change in tactile feel. One Pushgate sample has been tested in the laboratory to over one-half billion cycles. A cross section of a PushGate switch is shown in *figure 2*.

During switch actuation, and as the PushGate button is initially depressed, the left side of the armature breaks away from the magnet allowing the armature to contact the first switch electrode located on the substrate. This process is almost imperceptible to the touch. As the switch is further depressed, the right-hand side breaks away and spontaneously makes contact with the second electrode on the substrate. This closes the circuit and creates a very definite, crisp, tactile "CLICK". The

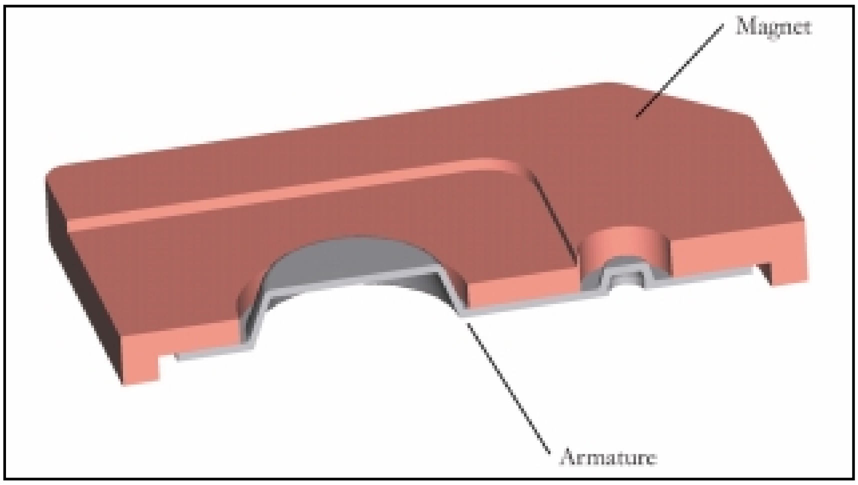

Figure 2: Duraswitch PushGate Island Switch

force/travel characteristic curve of this switch is shown in *figure 3*. Note how the curve emulates that of a mechanical switch that has become known and loved by appliance operators for years. In fact, due to the freedom allowed by armature geometry and magnet material, virtually any force/travel curve can be produced.

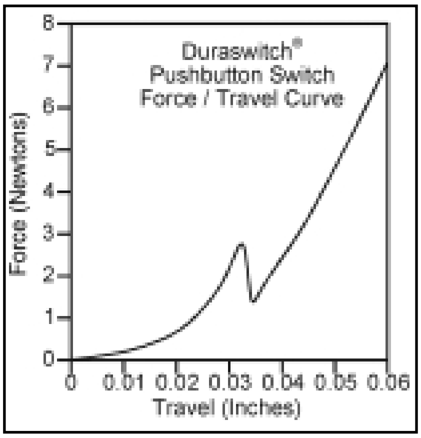

Figure 3: Duraswitch Pushbutton Switch Force/Travel Curve

The individual Island PushGate modules are fabricated as freestanding subassemblies that are easily inserted into the individual cutouts in the foam matrix, requiring no mechanical or electrical connections. The switch overlay, or graphics layer, is then placed over the entire assembly where it is held in place and sealed from the environment by the foam adhesive layer. Laboratory submersion tests have shown this sealing technique to be effective in water as well as harsh chemicals, colas, and sodas, for extensive periods without compromising the integrity of the seal or the switch. Additionally, the intrinsic elasticity of the foam has been tested to accommodate variations in atmospheric pressure due to changes in altitude.

Encoders

Duraswitch thiNcoders™ also use magnets, but they employ a slightly different technology. These switches provide mechanical and visual feedback to the user while he or she enjoys ergonomic and operator friendly panels. He or she knows which functions have been selected simply by looking at the switch knobs.

The basic concept is shown in *figure 4*. The switch armature is attracted to the film layer by a magnetic field emanating from magnets located in the actuator on the opposite surface. As the actuator is moved laterally in any direction, the armature follows the magnet while maintaining contact with the substrate on the opposite side of the film layer. Electrical contacts are printed, or etched, on the armature side of the film layer. This concept allows the switch armature and the electrical contacts to be sealed from the environment by the film layer.

The design shown in *figure 4* includes two magnetically attracted balls as an armature. The individual balls are attracted to the conductor side of the film layer, as well as to each other, by the magnetic field of opposing magnets. As the actuator is moved, the individual balls roll into, and out of, contact with the switch electrodes on the film layer. The rolling action of the balls maintains good electrical contact and produces very low wear and erosion of the individual switch contacts as opposed to the rapid contact degradation experienced with typical brush type encoders.

Since each individual ball provides a separate contact, this armature concept allows for design of complicated multi-bit encoders and analog devices, such as potentiometers. Two, three and four bit encoders have been designed using a one half-inch rotor.

As is the case with the PushGate Islands, the thiNcoder's are fabricated as freestanding Island subassemblies and inserted into the foam matrix without the requirement of separate component interconnections. Duraswitch has used similar technology to create a whole host of encoders including slide switches and analog potentiometers. In the latter case, a resistive material such as screened carbon is used in place of one of the switch electrodes.

Directional Switches

Duraswitch MagnaMouse™ switches use a unique multidirectional

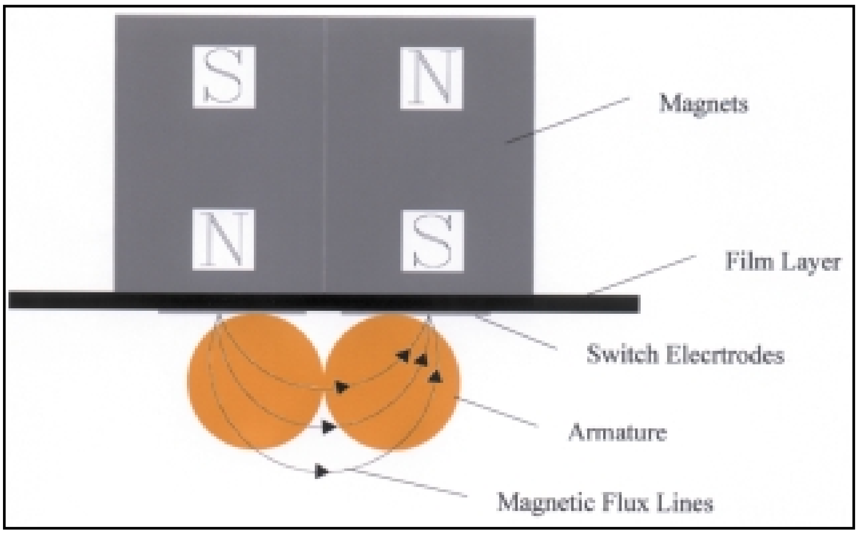

Figure 4: Duraswitch Basic thiNcoder Concept

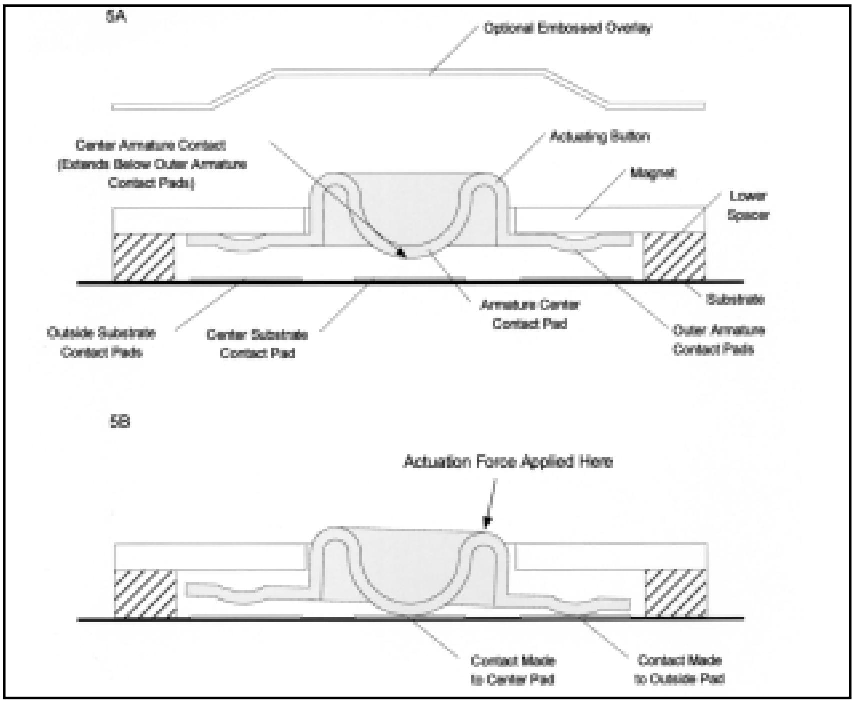

Figure 5A & 5B: Duraswitch MagnaMouse

armature that is also held in place magnetically. Directional controls have applicability in appliances as temperature selectors as well as controlling time and specific functions.

The principal of the MagnaMouse is shown in its most basic form in *figure 5*. This sketch shows a magnetically attracted and electrically conductive metal armature attached to a magnet in the reset position, and separated from a substrate by a lower spacer. It is shown in the reset position in *figure 5A* and in the actuated position in *figure 5B*.

The armature, with inner and outer contact pads and actuating button, is stamped as a single piece part. Note that the inner contact pad extends below the outer pads. The switch is normally actuated along the edge of the crown shown formed at the top of the armature. The outer armature contacts are formed downward and toward the edge of the armature and, depending on the application, they are formed either as discrete contact pads or as a continuous ridge extending around the perimeter of the armature.

A substrate containing electrical contacts on its upper surface is shown at the base of the mouse assembly. These contacts are arranged in various configurations about the top surface of the substrate. The actual array depends on the desired mouse function and ranges from individual discrete contact pads, arranged in a circular array, to a continuous analog variable resistor or voltage divider.

With individual discrete contact pads, the specific switch to be actuated is defined directly by the individual contact pads, and with the analog resistor, the switch is determined by a comparative circuit and an analog to digital converter in the microprocessor. The latter provides an unlimited number of switch locations.

Actuation is achieved by depressing the armature at any desired position on top of the actuating button. When the armature is depressed, as shown in *figure 5B*, the armature pads contact both the center and outer substrate pads. The outside contact pad on the substrate determines the specific function to be actuated.

Overall height of the assembled package is approximately 0.08" or 2 mm and the width and length can be designed as a custom package. Today, the minimums for width and length are limited to 1/2" or approximately 12 mm. Like the PushGate and thiNcoder products, Duraswitch has expanded the MagnaMouse technology to create numerous other products including rocker switches, large odd shaped keys and automotive mirror switches.

Summary

Duraswitch's next-generation switch technology provides multiple advantages over conventional appliance switch pads, including the elimination of solder connections, low mass, sealability, various lighting options, full multiple switch integration and user-friendly interface. With an ongoing commitment to research and development, Duraswitch continues to make significant advances in electronics switch solutions. This is reflected by numerous U.S. and foreign patents issued and pending. Duraswitch technology is available through licensees worldwide. More information on current and emerging switch technologies as well as licensing opportunities is available at **www.duraswitch.com**.

Biography

ANTHONY J. (Tony) VAN ZEELAND is a co-founder and director of Duraswitch Industries, Inc., and since its inception has served as its COO and EVP of Engineering.

Mr. Van Zeeland was a Director and executive at Monopanel Technologies, Inc., Milwaukee, Wisconsin and was VP of Engineering at Datahand Systems, Inc., from 1990 to 1997. From 1989 through 1991, Mr. Van Zeeland was an engineering consultant and project manager of a wireless video project for Go-Video, Inc., (now called Sensory Science, Inc.) Scottsdale, Arizona. Prior to 1989, Mr.Van Zeeland held managerial engineering positions at Rogers/Durel Corp., Tempe, Arizona and Oak Switch Systems, Inc., Crystal Lake, Illinois.

Van Zeeland holds a BS in Physics and a Masters of Science in Materials Engineering from the University of Wisconsin (1971). He holds numerous patents covering electro-mechanical components and materials. Possibly the most successful of his inventions prior to Duraswitch are those relating to the FTM (Full Travel Membrane) keyboard which he developed while with Oak Industries in the 1980s. Mr. Van Zeeland's research and development of this keyboard switch technology replaced existing keyboard technology and is the state-of-the-art for all computer keyboards today.

Tim Kuhn, VP Business Dev.
Email: tkuhn@duraswitch.com
Duraswitch Industries, Inc.
234 South Extension
Mesa,
AZ 85210 USA
Tel: +1-480-586-3300
www.duraswitch.com