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Materials

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"Designer" seals keep switches clean

Custom interactive dynamic seals guard switches and other components from extreme environments while transmitting mechanical motion.

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An interactive dynamic seal protects the electronics of this remote keyless-entry control. Besides making the control water resistant, the silicone-rubber seal color codes the main pushbutton switch and features a transparent viewing window for monitoring a battery-status LED that mounts on the circuit board.

Interactive dynamic seals protect electromechanical switches, rotary controls, and circuit breakers from harsh environments while leaving them accessible for manual or mechanical activation. Dynamic seals can shield in applications that are discrete — operating switches and keypads, or continuous — adjusting valves and other settings. They serve on the inside and outside of consumer, industrial, commercial, medical, and military equipment. They protect components from the weather, dust, saltwater, and ozone as well as guard them from oils, grease, acids, and cleaning solvents.

When no off-the-shelf seal is available, designers must specify a custom alternative. This is basically a process of prioritizing performance parameters. Specifically there is a trade-off between material mechanical properties (abrasion resistance, flexibility, durometer, modulus, compression set, service pressure, and tensile strengh) and resistance to ozone, chemicals, and oils or solvents. The highest priorities ultimately guide material selection. Other material constraints may include whether the seal must bond to metal or plastic inserts or act as an EMI/RFI shield.

MATERIAL MATTERS

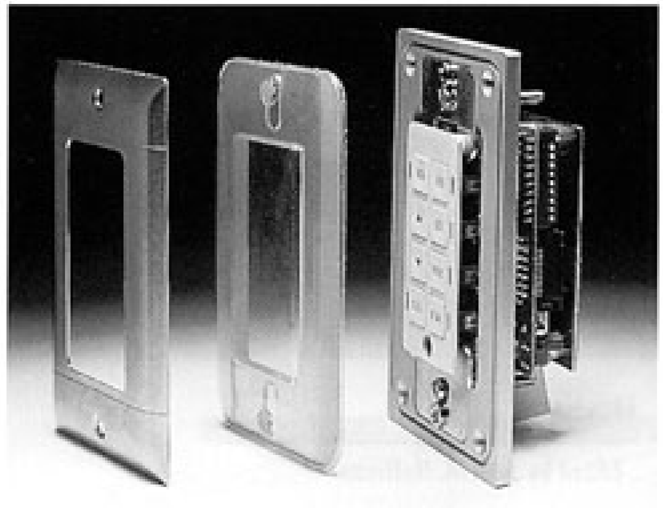
Elastomers are generally the preferred choice for a custom interactive dynamic seal. Of course, material selection really depends on the nature of the application and, more importantly, its environment. Vinyl, nylon, and plastic films may cost less but elastomeric materials typically are stronger, last longer, and withstand wide temperature variations. Moreover, they resist chemicals, have better longterm flexibility, and are highly durable which often lets them outlast the mechanical component they protect.

Elastomers are also easily colored. This gives designers the option of color-coding sections of the seal to identify different functions. Alternatively, designers also use transparent elastomers to display indicator lights in other sections. And while polycarbonates or other clear plastics can serve the same function they are too rigid for direct mechanical actuation and often don't provide good tactile feedback. Nylon and vinyl, on the other hand, lack the tear resistance of elastomers and can discolor from extended exposure to sunlight and ozone.

It can be tricky to specify the right material for a given set of mechanical and chemical requirements. As a general guide, commonly used elastomers include silicone rubber, fluorosilicone, nitrile butadiene (NBR), neoprene (ethylene propylene rubber or EPR), and ethylene-propylene-diene-monomer (EPDM).

Silicone rubber features one of the widest service temperature ranges (–150 to 500°F) and elongation values of between 100 and 800%. It offers excellent resistance to ozone, stands up well to chemicals and oil, and is fair in solvents. Its tensile strength ranges from 500 to 1,800 psi but it has limited abrasion resistance. In comparison, fluorosilicone rubber offers better resistance to oil and solvents but has a slightly narrower, –78 to 450°F, temperature range.

NBR and neoprene both have comparably higher tensile strengths ranging from 1,500 to 3,000 psi and 1,500 to 4,000 psi, respectively. In addition, NBR has better compression properties, while neoprene offers superior abrasion resistance. EPDM has a tensile strength of 1,400 to 1,600 psi and is highly resistant to both ozone and chemicals. It works less well with solvents and is not recommended for seals exposed to oils. EPDM also features excellent abrasion resistance and compression properties.



Protective seals shield vulnerable electrical and mechanical components while leaving those components accessible for manual or other mechanical activation. They serve in everything from carpet-cleaning machines and computer peripherals to the Space Shuttle.

MOVING EXPERIENCE

Custom interactive seals can be geometrically contoured to protect the entire unit interior while leaving key pads, switches, or actuators accessible for manual or mechanical manipulation. For example, designers who specify sealed switches and other components for the front panel of a product still face the problem of sealing whatever mounting holes those components need.

Ways of sealing mounting holes and other breaches in front panels include removable covers or sealing tapes and compounds. Of these, removable covers are probably least desirable. They are inconvenient and, when removed, expose components to the harmful environment. Likewise, sealing tapes and compounds often boost assembly cost and can contaminate components if misapplied.

A single, custom dynamic seal on the other hand, can be designed to cover the entire front panel, protecting not only the mounted components but also sealing mounting holes. This is often less costly than individually sealing components.

With a design in hand, the next step is a prototype seal. Ideally the prototype gets tested on the equipment to be sealed. Typically, prototypes can be made using a "soft" aluminum mold. Aluminum tooling takes as little as two weeks to build compared to triple that for steel tooling. The aluminum tooling can be used for low-volume runs of 25 to 50 parts but a steel tool is a must for larger quantities. ■

MATERIAL PROPERTIES OF INTERACTIVE DYNAMIC SEAL MATERIALS

Material	Silicone rubber	Fluorosilicone rubber	NBR (nitrile)	EPR (neoprene)	EPDM
Service temp. (°F)	–150 to 500	–78 to 450	–75 to 250	–65 to 300	–65 to 300
Resistant to					
Ozone	Excellent	Excellent	Fair	Good	Excellent
Chemicals	Good	Good	Good	Good	Excellent
Oil	Good	Excellent	Excellent	Good	Poor
Solvents	Fair	Good	Good	Fair	Good
Typical properties					
Tensile (psi)	500 to 1,800	600 to 1,400	1,500 to 3,000	1,500 to 4,000	1,400 to 1,600
Elongation (%)	100 to 800	100 to 700	400 to 600	100 to 700	500 to 600
Abrasion resistance	Fair	Fair	Good	Excellent	Excellent
Compression	Excellent	Excellent	Excellent	Good	Excellent