PiezoPanel® Design Guidelines

PiezoPanel® technology is based on incorporating a **Piezo crystal** that produces a **voltage** when pressure is applied. PiezoPanels are a rugged, long-lasting alternative to traditional switching technologies because there are no moving parts to wear down, and they are typically sealed behind strong faceplate materials.

Because every PiezoPanel® we create is designed custom for your unique application, certain specifications are required for each design. This set of design guidelines was created to assist you with the design and creation of your custom PiezoPanel®. Our highly skilled engineering team will carefully review your requirements to assist in designing the optimum switch for your application.

Things to Consider when Designing your PiezoPanel®:

1. **Environmental conditions** *(indoor/outdoor, harsh environments, sunlight, etc.)*
2. **Mechanical requirements** *(material, actuations, etc.)*
3. **Electrical requirements** *(layout, resistance, shielding, etc.)*
4. **Appearance** *(embossing, color matching, selective texture, etc.)*
5. **Certifications** *(ISO, U.L., etc.)*

PiezoPanel® Construction: A standard PiezoPanel® consists of three key elements: a **faceplate**, a **Piezo switch**, and a **back panel** or **rigid substrate**. The faceplate displays any graphics and can also include windows, embossing, adhesives, or coatings. A Piezo switch consists of a top circuit, a spacer, Piezo crystals, and a bottom circuit. The upper circuit layer is a flexible polyester film used as a ground conductor and the lower circuit can either be flexible or a rigid PCB. The two circuit layers are separated by an insulating layer with openings cut at the key locations. The locations each receive a single Piezo crystal element. A typical PiezoPanel® build is shown in **Figure 1** above.

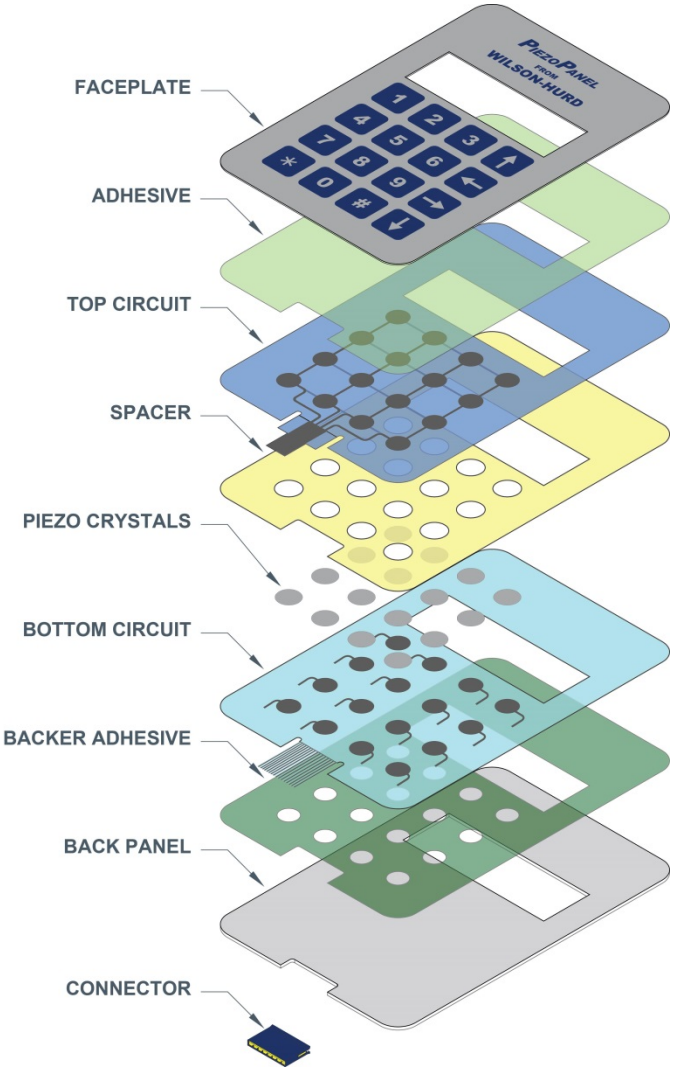

Figure 1 - Example of a common PiezoPanel® build

Faceplate Materials: A PiezoPanel® faceplate can be made out of stainless steel, anodized aluminum, rigid plastic, or glass. **Stainless steel** faceplates are extremely durable with resistance to most chemicals, salts, acids, and extreme temperatures. Graphics can be chemically etched or the stainless steel can be

machined to accept graphic ink. The inks used are generally enamel, epoxy, or acrylic based. **Anodized aluminum** faceplates are also extremely durable. Graphics, through the use of colored dyes, are printed and sealed under an anodic layer protecting them from abrasion and chemicals. Symbols and lettering can be reproduced with excellent sharpness and clarity. Both anodized aluminum and stainless steel faceplates display impressive weather resistance, chemical resistance, vandal resistance, and ease of cleaning. **Rigid plastic** faceplates provide a solid one piece construction when display windows are required. They are also durable and able to withstand operator abuse, but do not display the same environmental resistance capabilities as metal faceplates. When rigid plastic faceplates are used, graphics can be more detailed as more standard printing techniques can be utilized. Hard-coats can also be applied to rigid plastic faceplates to increase their durability. **Glass** faceplates are constructed out of tempered glass, providing exceptional durability against abrasions, chemical reactions, and excessive force. They also provide a solid one piece construction when windows are required by leaving certain areas as undecorated clear glass. The standard glass finish is high gloss; however matte is available on request. Virtually any graphic can be used on a glass faceplate since the graphics are applied on a second surface beneath the glass.

Color Matching: Wilson-Hurd most commonly uses the **Pantone Matching System** or **CMYK color model** to match custom colors, however when it comes to PiezoPanels this is only relevant to rigid plastic, glass, and stainless steel faceplates. There are a limited number of colors that can be used on anodized aluminum faceplates due to the anodizing process and colored dyes required. We can match to a specified or provided color. If you wish to submit a sample, we prefer that it be 2 x 2" in size. In the case of anodized aluminums, we will attempt to match colors as closely as possible.

Artwork: Please visit the Resources section on Wilson-Hurd's website to submit artwork, or simply visit the link below.

www.wilsonhurd.com/submit-artwork

We accept the following types of artwork (listed in order of preference):

- AutoCAD (2D)*
- Solidworks (3D)*
- IGES (3D)
- STEP (3D)
- DXF (2D)
- Gerber (PCB) – include dimensional of your part in one of the other formats
- Adobe Illustrator (Graphics) – include dimensions of your part
- PDF (Graphics or Dimensional Support) – with embedded fonts (Graphics)
- Postscript (Graphics) – with embedded fonts

**Most preferred forms of artwork*

Ultraviolet Hard-coats: If you are utilizing a rigid plastic faceplate, it is possible to increase its durability by applying an ultraviolet hard-coat. Some coatings are available from the manufacturer themselves, or from Wilson-Hurd.

Embossing: Embossing is a physical change to the shape of a normally flat material. Types of embossing include:

- **Pad** (pillow, plateau)
- **Dome** (spherical, machined)
- **Rim** (rail, ridge, ring, perimeter)

Embossing can be added to both metal and plastic faceplates.

Laser Cutting: Laser cutting is a form of cutting that utilizes a CO2 laser as a cost-effective alternative to steel rule die cutting. Cutting with a laser can also provide improved precision, since the laser beam is not susceptible to wear and tear during the cutting

process. This form of cutting is typically used for mainly the inner parts of a PiezoPanel®.

Tooling: Two tooling techniques are generally used when producing a PiezoPanel®, steel rule die and hard tools. **Steel rule die** tooling consists of cutting blades (rules) embedded in a wooden base and surrounded by rubber cushions. Outside shapes and interior holes can then be die cut in a single stroke. Steel rule die tooling has a tolerance of ±0.10", and lasts approximately 25,000 strikes before needing to be replaced. **Hard tools** perform the same process; however they are made out of harder steel and consist of both male and female tools, which results in a tighter tolerance of ±0.005" and an extended tooling life that can last millions of strikes before replacement.

Connectors: When selecting a connector for your PiezoPanel®, a number of factors should be considered including cost, reliability, performance, design, environment, as well as any anticipated insertions and extractions. Mechanical specifications for most interface **terminations** are standard. Consequently, circuit construction techniques can be designed for compatibility with specific types of interface termination methods.

ESD, RFI, and EMI Shielding: Shielding is generally designed into all PiezoPanels, protecting them from various possible electronic interferences. An ESD, or **Electrostatic Discharge**, is the transfer of a high potential electrical charge between objects by contact or through the air. ESD from humans to an electronic apparatus may damage or destroy circuit components. To prevent this, we provide **ESD shielding**, which generally consists of printing a carbon silver grid or the use of an aluminum foil to protect the switch. RFI, or **Radio Frequency Interference**, is high frequency radio waves that can affect how the user interface operates. **RFI shielding** can be applied to the PiezoPanel® to protect it from interference. An EMI, or **Electromagnetic Interference**, is an electromagnetic force generally produced by electrical motors in operation. Wilson-Hurd offers **EMI shielding** to protect your PiezoPanel® from this interference.

Electrical Layout: PiezoPanels require a **discrete electrical layout**. Simple interface or bridge circuitry is required to convert the piezoelectric signal from analog to digital. Interface electronics emulate either one shot, momentary, or toggle switch types.

Circuit Types: PiezoPanels can be manufactured with two different types of circuits:

- **Piezo Crystals**: A Piezo crystal consists of a crystal such as quartz, rochelle salt, tourmaline, or various synthetics that act as a transducer converting electrical force (voltage) into mechanical force and vice versa. A single crystal is placed at each key location in the Piezo switch. Pressure applied to the key location forces mechanical distortion; causing the crystal to produce a voltage approximately 2.5 V/N. Piezo crystals have been mechanically and electronically tested above 1.5 billion operations.
- **Printed Piezo:** A printed Piezo applies the same Piezo crystal technology to a printed format. The Piezo element is printed onto a flexible substrate. This type of circuit is generally recommended for high volume applications.

Windows & Lenses: Window material is offered in both acrylic and polycarbonate. When it comes to durability, acrylic is inherently less prone to scratches than polycarbonate, and is more optically clear. Polycarbonate however, is more durable and will not break or shatter. The type of window you choose for your PiezoPanel® depends on the type of display you plan on using. **LCD displays** need clear windows. Anti-glare is okay for LCD displays within .125",

however gloss is required for distances greater than .125". **VFDs** are a bit more forgiving and may accept a matte finish if the user will be close to the window. **Segment LED displays** require even less clarity. A velvet texture can be acceptable if the display is close (<.040"). Matte or fine textures should work okay at an increased distance (.040"-.062"), but gloss or antiglare should be used for greater distances (>.062"). **Discrete LED displays** work well under velvet textures. If you are using a glass or plastic faceplate on your PiezoPanel®, the window can be integrated into the faceplate by leaving certain areas undecorated.

Visible & Audible Feedback: We offer **LEDs**, **electro-luminescence**, **fiber optics**, and **light guide film** for backlighting options. Additionally, VFD, LED, and LCD displays can be incorporated into your PiezoPanel®. Adjustable audible feedback is also available.

Back Panels: Depending on the level of durability required for your PiezoPanel®, you can either choose a metal or a plastic back panel.

Backer Adhesive Selection:

100 MP Acrylic: Highest performing 3M **PSA** with resistance to solvents and up to 500°F.

200MP High Performance Acrylic: Excellent resistance to solvents and up to 400°F.

220 Industrial Acrylic: Good chemical resistance and shear strength. Resists up to 350°F.

300MP High Strength Acrylic: Bonds low surface energy (LSE) plastics and resists heat up to 250°F.

Moisture Resistant Designs: It is highly recommended that the switch be environmentally sealed in order to protect it against humidity, dirt, and liquid spills. **Environmental sealing** is achieved by applying an acrylic adhesive to both sides of the spacer layer. Any exposed contacts should also be coated with **carbon** to avoid damage from condensation. In particularly harsh environments additional precautions should be taken, including a **perimeter seal** which places a barrier in-between the switch and the perimeter of the part.

Technical Details:

Type	Specification
Operating Force	6-12 oz. *(Note: a specific operating force can be custom designed into your PiezoPanel®)*
Operating Force Speed	Approximately 10 N/s
Mechanical Loads	Accommodates loads from 200N/cm^2 to 5000 N/cm^2
Number of Actuations	>50 million actuations
Operating Temperature	-40°C (-40°F) to 60°C (140°F)
Storage Temperature	-60°C (-76°F) to 80°C (176°F)
Output Capacitance	Standard value: 5 to 20 nF, Typical value: 7 nF
Signal Impulse Time Constant	Typical Value: 70ms (7nF, 100MΩ)
Output Signal	Output voltage is determined by operating force & speed; faceplate material; faceplate thickness. ≈2.5 V/N

GLOSSARY

Actuation: The process that causes a switch to change position, i.e. to open or close.

Actuation Force: The minimum force required to electrically close a switch contact.

Actuator: A formed or molded protrusion to make contact with the center of a switch location, improving tactile feedback.

Anodized Aluminum: Aluminum that has been put through an electrolyte process in which a hard protective oxide film is deposited onto its surface.

Back Panel: A rigid substrate or subpanel to which the back surface of a Piezo switch is attached.

Capacitance: The property exhibited by two conductors separated by a dielectric, whereby an electric charge becomes stored between the conductors.

Carbon: A non-metallic element that conducts electricity.

Circuit: The main functioning component of a switch.

CMYK Color Model: Also known as process color and four color, it is a color model used in color printing utilizing the four inks cyan, magenta, yellow, and key (black).

Color Matching: The physical creation of a color in the range of one-dimensional hues.

Connector: A device that provides electrical connection.

Current (A or I) Unit, Amp: The flow of electricity, i.e., the characteristic drift movement of carriers such as ions, electrons, or holes. I=E/R

Debossing: Similar to embossing, except the area is lowered in relation to the substrate.

Die Cut: To make an opening by means of a sharp edged steel knife set in a holding tool.

Discrete Electrical Layout: An electrical layout that allows a device to operate as a self-contained unit.

Discrete LED Display: An electronic flat panel display that utilizes discrete light-emitting diodes.

Electrical Actuation: Switch actuation produced by various electrical phenomena. In most cases, the switching action involves a change in state rather than a mechanical operation.

Electro-luminescent Lighting (EL): Light produced by charged phosphorous.

Electromagnetic Interference (EMI): Electromagnetic force generally produced by electrical motors in operation.

Electrostatic Discharge (ESD): Transfer of high potential electrical charge between objects by contact or through the air. ESD from humans to electronic apparatus may damage or destroy circuit components.

Embossing: A shallow profile extending above the surface of a faceplate selectively formed under heat and/or pressure with a die, i.e., rim (raised border), pad (raised keys), and raised lettering. Achieved by using a steel rule die. Material is forced upward a max of .006” to .010” from the substrate, thus creating a raised image.

EMI Shielding: A method to protect the switch from electromagnetic interference.

Environmental Shielding: The application of an acrylic adhesive to both sides of the spacer layer in a Piezo switch, to prevent damage caused by moisture.

ESD Shielding: A method to protect the switch from electro-static discharge.

Faceplate: The outermost, protective layer of a PiezoPanel®.

Feedback: The mechanism by which the operator senses that a switch has been activated; audio, visual, or tactile.

Fiber Optic: Extruded materials, such as certain plastic filaments, which provide paths for light.

Glass Faceplate: A PiezoPanel® faceplate made out of tempered glass.

Hard-Coating: A coating applied to the surface making it impervious to particular chemicals and at the same time adding scratch resistance.

Hard Tools (Class A Tools): Tooling made out of steel which results in a tighter tolerance and extended tooling life compared to steel rule die tooling.

Laser Cutting: A form of cutting that utilizes a CO2 laser.

LCD: Liquid Crystal Display

LED: Light-Emitting Diode

LED Display: A flat panel lighting or video display which utilizes light-emitting diodes.

Light Guide Film: A more recently developed backlighting technology that uses LEDs to create a solid film of light.

Operating Force: The force required to transfer the switch from one position to another.

Pantone Matching System (PMS): An ink color designation system commonly used in a variety of industries, including printing as well as the manufacturing of paint, fabric, and plastics.

Perimeter Seal: A type of environmental sealing used on switches exposed to harsh environments that places a barrier in-between the switch and the perimeter of the part.

Piezo Crystals: A crystal such as quartz, rochelle salt, tourmaline, or various synthetics that act as a transducer converting electrical force (voltage) into mechanical force and vice versa.

PiezoPanel®: A user-interface that incorporates Piezo crystal technology, which produces voltage when pressure is applied.

Piezo Switch: The electronic layer of a PiezoPanel® typically consisting of a top circuit, spacer, Piezo crystals, and bottom circuit.

Pressure Sensitive Adhesive (PSA): An adhesive that is activated by pressure.

Printed Piezo: A Piezo circuit in which the Piezo element has been printed on a flexible substrate.

Radio Frequency Interference (RFI): High frequency radio waves.

RFI Shielding: A method to protect the switch from radio frequency interference.

Rigid Plastic Faceplate: A PiezoPanel® faceplate made of a strong plastic material.

Rigid Substrate: A layer of strong material like plastic or metal.

Segment LED Display: A type of electronic display using LEDs to light segments that make up decimal numerals.

Shielding: A method used to protect the switch from interference or static discharge.

Solvent Activated Adhesive: An adhesive that requires the application of a solvent to energize its holding properties.

Spacer: An insulated non-conductive substrate with openings at switch locations to separate the upper and lower circuit layers.

Stainless Steel: A steel alloy that has a minimum of 10.5% Chromium content by mass.

Steel Rule Die: Used to fabricate plastics and adhesives to their final configuration. Outside shapes and interior holes are die cut in a single stroke. The die consists of cutting blades (rules) embedded in a wooden base and surrounded by rubber cushions.

Termination: The means to electrically connect the contact switches of a Piezo switch.

Ultraviolet Curing: A system which employs ultraviolet radiation to complete the curing process of hard-coats.

User-Interface: A device used so that two or more independent systems can meet and act on or communicate with one another.

Vacuum Fluorescent Display (VFD): A display that emits a very bright light with high contrast.

Voltage (V or E): Electromotive force, or difference of potential; E=IR, where I is current and R is resistance.

Windows: Clear portions of a faceplate to reveal LEDs or displays.

Working Voltage: Maximum recommended voltage for continuous operation of a connector.