GMN
GM NAMEPLATE

Commercial appliance
Capacitive touch

CASE STUDY

The challenge

Looking to transition from mechanical switches to "touch" technology, a leading US-based commercial appliance manufacturer approached GMN to develop a new generation capacitive touch user interface for their refrigerator freezers. While the customer wanted to give GMN the utmost flexibility in terms of designing the capacitive circuit, they had already developed a universal motherboard and were set on icon sizes. As a result, the pinout and switch sizes were already determined and the engineers at GMN had to work through these limitations to strategize the circuit layout.

Additionally, during development the customer decided to revise the circuit configuration to incorporate backlit switches. This prompted GMN to introduce Pedot ink, a special clear polymer ink, in the circuit to fulfill the project needs, which presented additional printing and processing challenges to the project.

Project goals

- **Create a circuit design and trace routing for the capacitive touch-enabled appliance**
- **Reduce crosstalk and fine-tune circuitry to achieve the target signal-to-noise ratio**
- **Effectively print and process the Pedot ink used in circuit**

The solution

The customer engaged GMN to design a capacitive touch circuit that would ultimately be sandwiched between a dead-front glass overlay and a pre-designed motherboard. After learning about the pre-determined switch sizes, switch locations, and pin locations, GMN chose to utilize mutual capacitance sensing since it could be matrixed to utilize the limited

4

DIFFERENT INKS

number of pins available. The engineering team went through several rounds of designing and fine-tuning the circuit layout to achieve the targeted signal-to-noise ratio, shielding, and response time.

Based on the initial design and target resistance requirements, GMN utilized its rapid prototyping capabilities to develop a mutual capacitance circuit with standard inks (silver, carbon, and dielectric). After receiving the prototype, the customer updated the circuit design to incorporate backlit switches by mounting discrete LEDs on the existing motherboard. But as the primary design of the circuit employed only standard conductive inks, the opacity of the inks would block the light from the LEDs, resulting in inconsistent lighting and shadowing. GMN resolved this issue by introducing a Pedot ink to the circuit, in addition to the standard inks. Although, the inclusion of Pedot ink was not straightforward and presented several hurdles and complexities.

Firstly, as a clear polymer ink, Pedot ink was extremely difficult to print and process on the production floor. Its inherent transparent nature made it challenging and laborious to examine line breaks during printing. Additionally, during the initial prototyping phase, the circuit was designed with three distinct layers of ink printed in three separate print passes. So, the introduction of Pedot ink added another ink layer and print pass to the process, which translated to a longer curing time. To overcome this hiccup, GMN brought into play its two-colored web printing line. Equipped with a tower dryer and higher drying capacity, the web line allowed for two print passes in a single set up, thereby accelerating the production time.

While designing the capacitive switches, the goal was to mitigate external noises to enhance signal strength and optimize sensitivity. However, the resistance of the Pedot ink was much higher than the standard conductive inks, which led to decreased signal strength. Then, the engineering team's efforts to amplify signal strength resulted in substantial cross-talk. Finally, GMN modified the shielding into an intricate pattern of crosshatches on the circuit to shield areas of concern from cross-talk without excessive switch desensitization. These patterns were continuously adjusted and tuned for better performance.

TWO-COLORED WEBLINE

- ☑ TOWER DRYER
- ☑ HIGHER DRYING CAPACITY
- ☑ IDEAL FOR HIGH VOLUMES

After multiple rounds of prototyping, the capacitive circuit design was finalized and given the green light for full-volume production. While the customer's design teams were based in North and South America, their final integrator was based in China. Therefore, to simplify the logistics for the project, GMN decided to run the final production of the part in its Singapore Division. Equipped with automated testing equipment, GMN's Singapore Division cruised through production. The Production Part Approval Process (PPAP) for design verification and part validation ensured consistency across all manufactured products. To keep pace with the high volumes of this project, GMN's Seattle, WA Division also supplemented a small portion of the run as well.

CAPABILITIES & SUPPORT SERVICES

- ☑ **CAPACITIVE TOUCH**
- ☑ **RAPID PROTOTYPING**
- ☑ **TECHNICAL PRINTING**
- ☑ **ENGINEERING SUPPORT**
- ☑ **GLOBAL MANUFACTURING**

Once the capacitive sensor was developed, the customer leveraged GMN's know-how to implement the same technology in other appliance models. GMN truly mobilized its global manufacturing resources to work in a consortium with the customer's America-based design team and China-based integrator. GMN's technical expertise, experience, and rapid prototyping capabilities enabled the commercial appliance manufacturer to effortlessly enter the new world of capacitive touch.