LEVERAGING NEAR FIELD COMMUNICATION IN PRINTED SENSOR SYSTEMS

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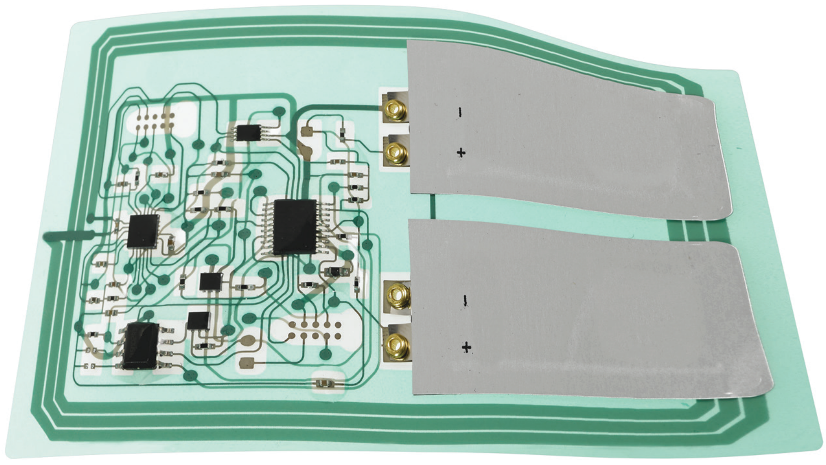

Figure 1: Smart labels, such as the Molex NFC Temperature Logging Smart Label, are fabricated on flexible substrates in sheet and roll-to-roll form.

Advances in wireless technologies have opened up new opportunities in flexible electronics. Enabling bi-directional short-range wireless communication, near field communication (NFC) is among the emerging technologies positioned to shape the architecture of flexible printed sensor systems. Printed NFC sensor devices, such as patches used in body-worn temperature monitors or tamper detection devices, require no on-board power, plugs or wired connections. The integrated chip in the patch activates only when in proximity of an NFC-enabled reader or cellular device. Producing an NFC sensor system requires a functional NFC part and a functional sensor part. Both of these key functional elements can now be more efficiently fabricated using printed silver flex manufacturing and assembly processes.

Recent developments in silver inks and printing techniques enable the printing of the conductive antenna coil traces required in each NFC label inlay or device onto substrates of highly durable and flexible polymers. Conductive inks on polyester can significantly save substrate costs compared with an equivalent copper circuit. Sensors can be formed or attached onto the same substrate, and the process supports the addition of microcontroller units and other electronics for a fully integrated solution. NFC printed sensor systems are migrating into diverse industries where disposability is desired, from shipping and logistics, to pharmaceuticals and patient monitoring in healthcare facilities.

SPECIFY FOR SPECIAL CONVERSION TO SILVER FLEX

Multiple factors must be considered when specifying the conductive inks and substrate material for a given application. This is especially true when making the transition from traditional rigid or copper flex circuitry to printed silver flex NFC-enabled sensor systems. NFC relies on the trace conductivity of the antenna coil. A bulk material with highly conductive properties, etched copper traces may be as small as 0.0762 millimeter wide. However, the conductivity of printed silver is lower than bulk copper, so the printed traces will need to be wider, especially to maintain their integrity as the polymer substrate flexes under normal use of the part.

Making a successful conversion to silver flex parts requires knowledge of the adjustments needed to properly form wider traces and design the antenna to achieve the same function as a copper-based part. An experienced design and development team should be in place to streamline the process. Advanced proprietary sheet and roll-to-roll manufacturing processes can simplify the printing of silver traces on smart labels, sensor patches, and other high-volume products. Unlike FR-4 or copper flex circuit boards, printed silver flex technology provides the option and capability to add converting pieces, such as forming a roll of NFC-enabled sensor labels or embellishing with a graphic sticker.

Depending on the complexity of a printed sensor design and its intended functionality, the transition from an FR-4 circuit board to printed silver on a lower cost polymer substrate may be the best option. A conventional FR-4 with copper will most likely be the preferred technology for a complex application such as a PCB with very dense spacing of ultra-miniaturized components. The benefits of silver flex become more compelling in applications with fewer components (approximately 20 or less), resulting in a lower percentage of the substrate area being covered by silver trace. A wearable fitness or medical sensor patch, for example, provides ample space to support wider silver traces and requires the comfort of a more pliable substrate material such as polyester. Either application would additionally benefit from the lighter weight and 3-D flexibility of printed silver flex on polymer. An added benefit is that silver is also more environmentally friendly than copper, with cleaner manufacturing processes, because additive silver printing processes do not result in hazardous chemical etch waste. Any wireless data communications protocol typically consumes a substantial percentage of the overall power needed for a battery-powered device. The overall power requirements for the device can be decreased using NFC because all power for wireless data communications is delivered from the NFC reader. No power is required from the NFC-enabled sensor system providing the wireless readout. The reader transmits power and data commands to the NFC-enabled sensor system, which responds by transmitting data back to the reader. There are a number of options for designing a wireless NFC sensor system for print-based manufacturing. Identifying the best approach should occur as early as possible in the design phase.

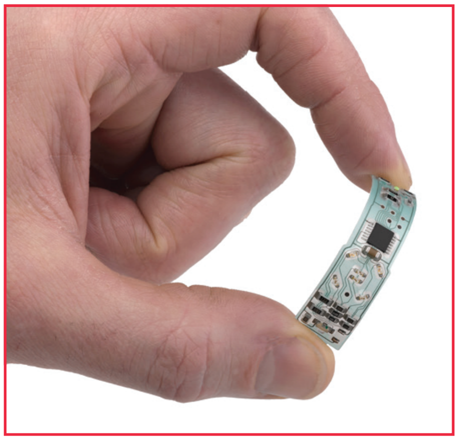

Figure 2: Depending on the complexity of a printed sensor design and its intended function, transitioning from an FR-4 circuit board to printed silver on a lower cost polymer substrate may be the best option.

APPLICATION-DRIVEN NFC SENSOR SYSTEM ARCHITECTURE

An all-in-one NFC and MCU (micro-controller unit) chip features a relatively simple system architecture. A single chip can provide well-defined capabilities and can be cost-effective. However, the functionality of the finished product will be limited to the hardware, so an all-in-one design is most suitable to meet the requirements of a highly specific application. More complex devices typically can be better supported by separate NFC and MCU chips. Dual-chip packaging can increase engineering requirements and cost, but allows for greater customization such as supporting multiple applications or product lines, and monitoring requirements that are still evolving. A two-chip solution improves versatility in the design and development cycle and delivers more sophisticated and robust functionality by allowing data logging to occur separately from the data communications portion. The MCU can be performing data logging over time, without requiring the NFC to be powered up in order to extend device battery life. Integrated into smart labels and other devices, NFC sensor systems are ideal for applications requiring logging of data and are especially beneficial in time and temperature tracking of product shelf life or in monitoring any products that are thermally or environmentally sensitive. Unlike barcode or RFID readers that transfer data one-way from a tag to the reader, an NFC chip embedded in a cellular phone can be deployed in reader-writer mode for data gathering applications. The cellular phone then facilitates long-range transfer of gathered data to servers and the cloud by using a cellular data or Wi-Fi connection. The typical range to activate an NFC sensor device varies depending on chip and antenna, but generally falls in the 4cm range. The close proximity range of the non-radiating NFC signal minimizes electromagnetic interference risks and provides a more secure communication platform with a lower risk of data breach or hacking. From a power standpoint, an NFC device can draw less overall power than Bluetooth wireless technologies, which means longer battery life for sensor systems.

DRIVING INNOVATION IN THE DIGITAL ERA

A proven technology in security access, electronic payment systems and other short-range wireless applications, NFC has only recently been fully adopted in modern cell phones and many tablets in our homes and offices. This development represents a major step toward creating the infrastructure needed to take NFC to the next level of deployment. One of the most promising aspects of printed manufacturing technology is the potential to drive innovation in the digital era. Applications that leverage silver printed sensor systems in conjunction with NFC and cellular communications can deliver an unprecedented degree of usable datadriven insights. Mobile devices and apps can provide inherent functions such as time-based sensitivity, location services, and long-range power communication to support the development of new applications for NFC sensor systems.

Customizable to meet the requirements of a variety of applications, NFC is shaping the architecture of sensor systems by reducing the energy needed for data readout. The technology also enables continuous automated monitoring without need for a battery, which can significantly extend device lifetime or reduce bill-of-material costs for sensor systems. NFC functionality aligns well with silver flex print and manufacturing processes.