

## FIELD-EFFECT SENSORS FOR FLUID DETECTION APPLICATIONS

### Executive Summary

Field-Effect sensing has the unique ability to detect fluids and semi-solid materials without making direct contact. If the material being targeted is conductive in nature (for example, water), and the barrier wall is non-conductive, then Field-Effect is the technology of choice. Field-Effect sensing technology is ideally suited for sump, lift station, underground vault, wet well and storm water fluid level management applications.

Since 1997, nearly 200 million Field-Effect sensors have been deployed in industries such as appliance, consumer, automotive, medical and fitness (e.g., liquid level sensing, or in touch activated machine controls). By 2005, Field-Effect sensors had become the de-facto standard for fluid level detection in marine and recreational vehicle applications, such as holding tank level monitoring and bilge pump control systems.

Over the years, pump life has been limited by the durability of a single component, the mechanical contact switch. Even though switch technology progressed through the years, overall pump durability continued to be governed by the limitations of the mechanical contact switch and associated moving parts.

Recent advancements in solid-state electronic design have enabled a generation of more reliable pump controls. Durability issues surrounding the mechanical contact switches were eliminated with the use of solid-state transistors to manage high current switching. Although this was a considerable improvement in itself, the remaining question was how to reliably detect changes in liquid level without the use of moving floats, or without making direct electrical contact with the fluid?

Non-contact sensing technology was considered to be the answer, and even though there were several technical

solutions available in the marketplace (capacitive, ultrasonic, and optical), only capacitive has proven to be practical and cost effective for residential sump pump applications. However, the limitation of capacitive is that it's prone to false actuations and pump run-on attributed to the varying mineral content of the water being managed and the associated scum build-up on the sensors themselves as the water level fluctuates. In addition, capacitive technology requires complex software algorithms to establish an environmental baseline for switching. The solution to these obstacles proved to be non-contact Field-Effect sensing technology coupled with solid-state switching components.

Engineers and plumbing professionals should consider Field-Effect a "best in class" solution when evaluating fluid level detection technologies. The added benefit of a five (5) year limited warranty makes it a wise, economical choice for facilities management professionals. No longer is the pump switch the limiting factor in an organizations scheduled maintenance activities.

### Economic Background for Residential Applications

With more than 10% of all residential structures that have full or partial basements reporting leakage from outside the structure through the basement (American Housing Survey for the United States: 2007, U.S. Department of Commerce, September 2008, Table 2-7, p. 62), the proper operation of the sump pump system for homeowners is imperative. The consequences of switch failure for residential sump pumps and their industrial equivalents extend far beyond the cost of repair.

Homeowners have always been faced with the potential cost and inconvenience of restoration of basements, but, in addition, the U.S. Environmental Protection Agency (EPA) has identified mold as an environmental pollutant that

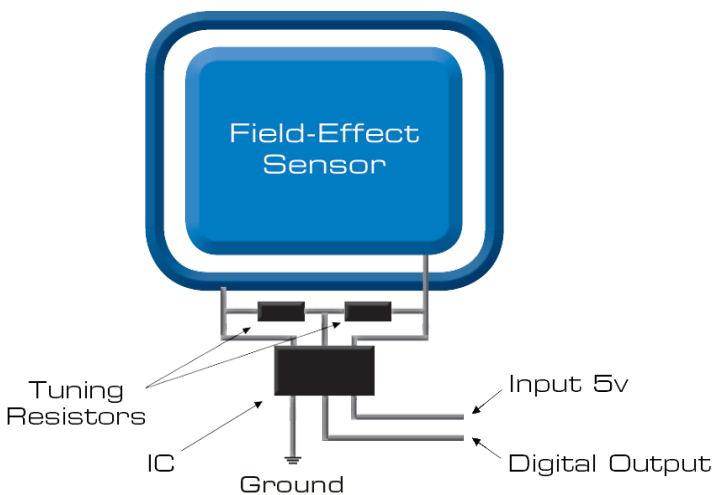
diminishes indoor air quality (IAQ). The mitigation of molds caused by indoor moisture has become a public health issue that is now reflected in the home inspection process.

Homeowners and operators of public buildings now face risks in the longer term for reporting and/or filing claims for water damage. Faced with large increases in claims for water damage, the insurance industry has established a database, known as the Comprehensive Loss Underwriting Exchange (CLUE), to facilitate the exchange of information among insurers to drop or deny coverage based on a home's history of claims or damage reports. The proper functioning of pumps and their switches is paramount to maintaining

public health and to preserving the value of residential and commercial structures for their owners.

Homeowners, installers, and other industry professionals can also take advantage of the added cost savings opportunity of purchasing a less expensive pump which does not include the switch function as part of the offering. These pumps are typically priced at the low end of the commercial spectrum, even though mechanically, they're the same sump pump being offered in the high-end systems with integrated switch capability. This retail savings can range anywhere from \$15.00 to \$80.00 depending on the pump model and retail outlet selected.

## Technical Overview



Field-Effect sensors are digital, solid-state electronic devices that can detect conductive materials such as water or the human touch. The sensor's cell design uses an integrated circuit (IC) that switches its output state when the conductive target is sensed. A Field-Effect cell is comprised of three main elements, the IC, a unique sensing electrode geometry, and two tuning resistors. Moreover, Field-Effect requires no moving parts, floats, software, or any other mechanism to operate.

When 5 VDC is supplied to the sensor, a low power, invisible field is created. The field emanates directly through any

protective dielectric barrier such as plastic or glass that may surround or cover the sensor. When a conductive object or material enters the field, the sensor detects the change and indicates an event has occurred with a corresponding output signal. The input stimulus to the field is typically water in most liquid level sensing applications, as is the case in Touch-Sensor's™ LevelGuard Home Sump Pump Control product line.

The performance advantages of Field-Effect sensors in plumbing applications include:

- **Solid-state electronic design** with no moving parts or electrical contacts to wear-out, bind, or become contaminated by fluids. All electronics are encased in rugged plastic and are completely isolated.
- **UL Listed:** (UL File# - E332036)
- **Five (5) year standard replacement warranty.** Field-Effect fluid detection sensors have been tested to over 1.5 million operational cycles without failure.
- **Fused safety protection.** Includes 15 Amp fused over-current protection against pump electrical failures.
- **Resistant to contaminants.** The low impedance nature of the Field-Effect sensor design, combined with proprietary electrode geometry, make the Field-Effect sensor highly resistant to the effects of surface contaminants and mineral buildup.

## Summary

The importance of reliability in fluid detection systems has increased over time. Under pressure to cost-reduce their products while improving system performance, manufacturers (and their vendors) have cautiously introduced innovations through their channels of distribution. Engineers and plumbing professionals now have the ability to specify a fluid level control system that meets and/or exceeds the performance needs of their system designs and client expectations.

In 2004, TouchSensor impressed the Marine Industry when it introduced the SensaSwitch 20, the world's first and only

solid-state electronic submersible bilge pump control using Field-Effect fluid sensing technology. In 2005, TouchSensor again broke new ground with the launch of the next generation SensaSwitch Ultra...the world's first and only CE rated, 2-wire, 12 and 24 VDC - 20 Amp Marine bilge pump switch. TouchSensor's success continues today, as several of the world's leading OE bilge pump manufactures have embraced the performance benefits of Field-Effect by directly integrating the technology into their products. LevelGuard is the culmination of the right technology meeting a specific customer need. Change the Spec to Field-Effect!

### About TouchSensor,<sup>™</sup> a wholly-owned subsidiary of Methode Electronics

TouchSensor engineers and manufactures Field-Effect sensors for appliance, exercise equipment, medical, automotive, marine and RV markets. Since 1997, TouchSensor has delivered nearly 200 million Field-Effect cells for use in the markets it serves. Visit [www.TouchSensor.com](http://www.TouchSensor.com) or [www.Methode.com](http://www.Methode.com) to learn more.

### About LevelGuard<sup>™</sup>

LevelGuard<sup>™</sup> introduces Field-Effect technology for fluid level detection to the residential, commercial, industrial and municipal plumbing markets. Visit <http://www.LevelGuardProducts.com> to learn more and subscribe to our email newsletter for technical updates.

