Ultra-low-power Status Indication Device

T. Burch, C. Beyer, S. Bitterli, M. Fretz, J. Kaufmann, E. Schaller, R. Nussbaumer•, B. Zemp•

CSEM has developed an ultra-low power low-cost indication device to display the status of electrical fuses for mains powered devices. The indicator is based on polymer dispersed liquid crystals, excels state-of-the-art solutions based on LEDs and complies with the latest IEC norms regarding power consumption and safety. The development was conducted in cooperation with SCHURTER AG.

Fuses are among the first components in the history of electrical power engineering. Without fuses, the use of electricity as an energy source would be too risky. Because of their simple design and reliable function, electrical fuses have become the epitome of safety in electrical circuits.

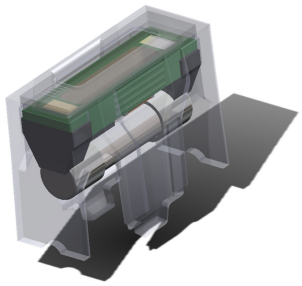

Figure 1: Graphical representation of a fuse holder with integrated status indicator based on PDLC film.

Most fuses in electrical building installations are equipped with a fuse state indicator to recognize broken fuses at first glance. However, in mains powered devices fuses are mostly mounted in fuse holders without indicator, mainly because there is no suitable and inexpensive solution around. Originally, fuse indicators for mains powered devices were based on miniature light bulbs which consume quite some energy, lack galvanic isolation and therefore, mostly due to non-compliance to latest IEC norms, disappeared from the market. Recent solutions use LEDs as an indicator. But these designs require dedicated electronics such as AC-DC power converters to drive the LEDs and therefore add complexity to the otherwise simple system.

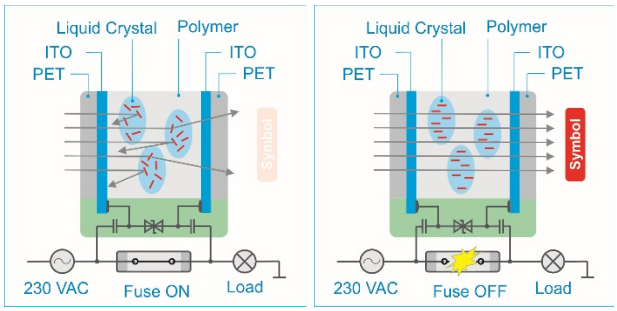

Figure 2: Schematics of operational principle for the novel ultra-low-power status device developed in cooperation with SCHURTER AG.

The novel indicator developed at CSEM (Figure 1) is based on polymer dispersed liquid crystals (PDLC). These materials consist of a polymer liquid crystal film sandwiched between two indium tin oxide (ITO) coated PET films.

In the off-state, the PDLC appears opaque because it strongly scatters light due to the refractive index mismatch between the misaligned LC droplets and the polymer, whereas in the on-state the PDLC becomes transparent because of the LC reorientation in the electric field. This effect is exploited to make a symbol visible or invisible behind the PDLC element, depending on the state of the fuse (Figure 2). To control the state, the voltage built-up across the tripped fuse is directly applied to the PDLC element using a simple capacitive voltage divider. No complex electronics are required, and the power consumption is about 10 times lower than of indicators based on LEDs.

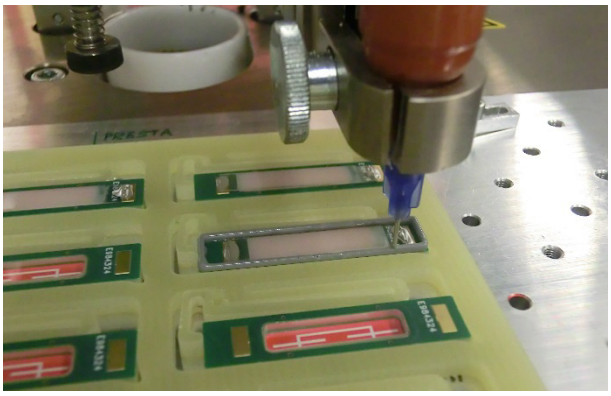

Figure 3: Small series production of fuse status indicators in the laboratory.

The development was conducted in two phases. First, the light transmissions of different PDLC samples were determined as a function of control voltage, frequency, and temperature. At the same time, the PDLC materials were subjected to environmental tests including temperature shock, humidity, and accelerated aging tests. The investigated materials differed noticeably in transmission and temperature behavior. In a second phase, manufacturing and packaging processes have been developed in order to produce indicators of different sizes and shapes and protect the films from environmental impacts. Processing the individual PDLC layers by means of specifically developed laser cutting techniques, as well as the reliable electrical contacting of the ITO layers presented a particular challenge. Both could be satisfactorily solved. Ultimately, a manufacturing and packaging solution could be found with high potential for industrialization (Figure 3).

Parallel to the PDLC packaging, the mechanical design of the entire fuse holder and the integration of the indicator was developed. Dedicated elastomeric connectors have been used to contact the PDLC film to the fuse. This design simplifies the entire mechanical structure and production assembly, since no metallic clamps or springs are required to be installed (Figure 1). The novel ultra-low-power status indication device offer compact design while reducing the production cost by 50% compared to state of the art devices.

The novel status display is now part of a technology platform, which in future can also be used in smaller fuse holder types or in different other products where indication of a binary status is of interest. A market launch in near future is envisioned.

• SCHURTER AG