

Safety of Industrial Automated Systems 2005

A New Kind of Membrane Switch Panel for Safety Applications

MEASURING THE LONG TERM RESISTANCE

- 52 368 337 actuations with maximum electrical load (manufacturer specifies a maximum of two million cycles)

After long term tests:

- Contact and insulation resistance
- Polished and etched microsection

MECHANICAL RELIABILITY ?



AIM OF THE INVESTIGATION

ARE NEW MEMBRANE SWITCH PANELS SUITABLE FOR INITIATING SAFETY FUNCTIONS?

NO/NC-Combination



Magnetic Reset Force

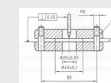
SIEMENS



Electronic Control Unit

Single Piece of Metal

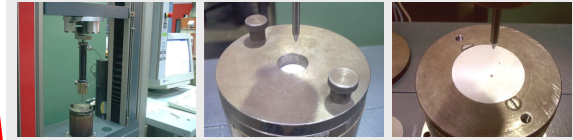
MEASURING THE PUNCTURE RESISTANCE



- Standardized method according to EN 388
- Quantitative values for trend analysis: puncture resistance [N]

COOLING LUBRICANTS ?

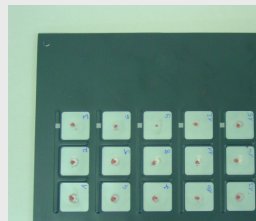
- Testing after different periods of exposure to cooling lubricants



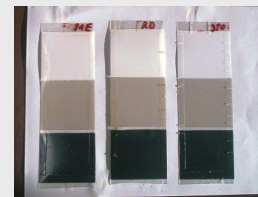
MEASURES TO CONTROL FAULTS

Possible Faults	Measures to control faults			
	Start-up self-test	Maximum period of actuation	Plausibility check	Dynamical change of state with request of actuation
Key becomes stuck in actuated position	X	X		
Key becomes stuck in not actuated position				X
Short-circuit NC			X	
Open-circuit NC			X	
Short-circuit NO			X	
Open-circuit NO			X	
Short-circuit NC to NO			X	

THE SAMPLES



Membrane Switch Panel

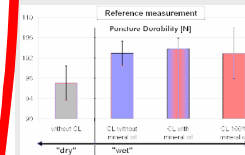


Top Layer Plastic Foils with Printed Back

MEASUREMENT

Typical Cooling Lubricants

- water soluble, without mineral oil, 5%
- water soluble, with mineral oil, 5%
- not water soluble, 100% mineral oil
- control without cooling lubricants



- "Wet" puncture durability is significantly higher due to the better lubrication
- No significant difference between the three cooling lubricants (CL)

RESULTS

- 52 368 337 actuations without any failure
- Resistances remain within normative limits
- Polished and etched microsection shows a beginning partial delamination, but due to the composition of the layers this does not lead to contact faults
- Possible faults can be detected and controlled by the electronic evaluation unit

CONCLUSION

Fault exclusion according to ISO 13849-2 (EN 954-2) for loosening of the push gate and sticking in the actuated position.

Suitable for SIL 2 of IEC 61508 if used according to the manufacturer's specification including fault detection.

RESULTS

- Fluctuation around constant level
- No universal trend
- No significant decrease
- No difference in trend between three CLs and control group

