



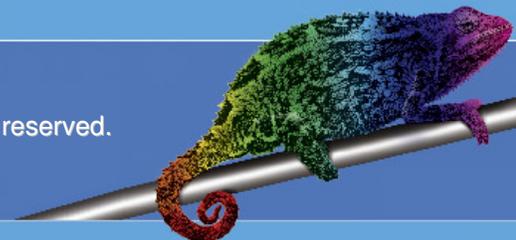
# The Third Evolution™



**Not just intelligent, but TOUGH!**  
RGB-backlit LCD keys from [E³] surpass lifetime test specifications



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# Not just intelligent, but TOUGH!

RGB-backlit LCD keys from [E<sup>3</sup>] surpass lifetime test specifications

Combining a graphical LCD display with RGB-backlighting in a push-button switch has made the SA keys from [E<sup>3</sup>] the industry leader in intelligent switch design. Their capability to display changing functions in text, graphics or animation on a 64 by 32 pixel matrix with backlighting in over 10,000 calibrated colors had set the new standard for smart switches. But how would they hold up to constant use?



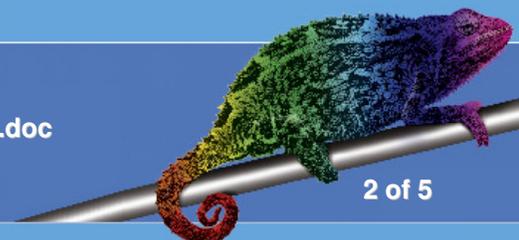
**DEVLIN**  
COMPONENTS

Devlin Electronics, the UK keyboard specialist, put this question to the test.

The SA switches are used in many commercial and industrial applications, including many 24/7 installations in broadcast centers worldwide. That makes reliable operation over many years as important a requirement as the ease of integration and use.

The new SA LCD switches were designed to exceed 3 million operations in its working life, three times the life of the earlier generation switch technology. To ensure reliability the mechanical design of the switch is completely new, with a tactile dome assembly with carbon-on-gold contacts and a key housing design that provides effective over-travel protection. The purpose of this development was to produce a more flexible and versatile device combining a longer working life with better electronic performance and a more user-responsive switching action.

Hard evidence that the switch is capable of meeting its design specifications was inevitably going to be of great interest. Devlin decided to use in-house test facilities to confirm that the published life expectancy is a reliable figure. A life test would also detect mechanical deterioration such as aging of the dome assembly, which frequently leads to early loss of the tactile feel of an otherwise functional switch.





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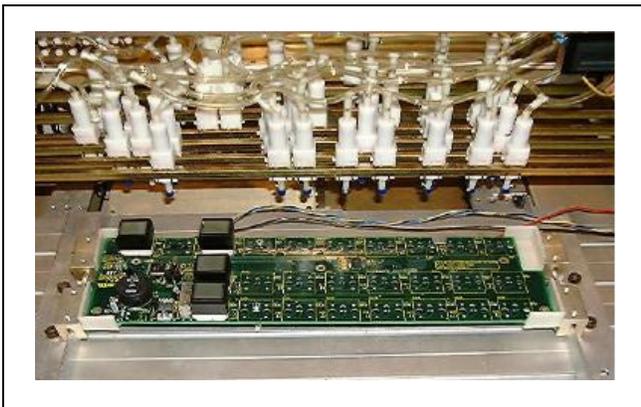
## ACCELERATED TESTING

The switching function, the backlight function and the LCD display screen were to be monitored during the test. An accelerated life test was devised, using Devlin's in-house automated life testing equipment to operate a switch sample installed in a commercially available product.

## THE TESTING PROGRAM

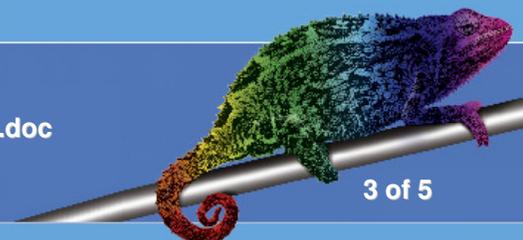
A test program was devised to run the life test apparatus, monitor the switch contact and change the display of the switch. A PC was used to control the test machine through an RS232 port and also to monitor the switching function and control the status of the [E<sup>3</sup>] keyswitch LCD display. The program monitored the keyswitch contact every time the switch was depressed. It would expect a response from the circuit within 300ms, if this was not received then an error would be logged and the test would continue. The program was therefore able to detect any missed operations.

## TEST CONDITIONS



TEST OBJECTIVES	
<input checked="" type="checkbox"/>	Switch operated until either the switch failed or the number of operations achieved exceeded the manufacturer's specification by a margin of >50%.
<input checked="" type="checkbox"/>	Number of switch contacts made by the switch to be counted using the life-test machine.
<input checked="" type="checkbox"/>	The bitmap and backlight color displayed on the switch to be changed with each operation to confirm continued LCD and LED operation.
<input checked="" type="checkbox"/>	Measurements of the switch force-displacement characteristics were to be made before and after the test to detect any degradation.
<input checked="" type="checkbox"/>	The switch was to be disassembled and photographed after testing.
<input checked="" type="checkbox"/>	Contact resistance of switch to be measured before and after testing.
<input checked="" type="checkbox"/>	The condition of internal parts was to be examined for wear.

A sample SA6432 switch was tested in a KSA-026-020 keyboard developed at Devlin, using design guidelines recommended by [E<sup>3</sup>]. This setup should therefore be representative of the conditions under which the switch would be used by customers designing their own systems. The assembled keyboard was mounted on the base-plate of a proprietary keyswitch life test machine, which employs air-powered actuators to depress the switch. The switching force used was set to





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be approximately twice the manufacturer’s specified switch operation force.

Testing, at a rate of 3.4 cycles per second, continued until the total number of operations was approaching 5 million. At this point the operation was terminated and the switch was carefully disassembled to reveal the internal components for examination and photography. The parts that were of most interest were the switch contacts, the carbon impregnated pill, and the silicon dome.

## SUMMARY OF RESULTS

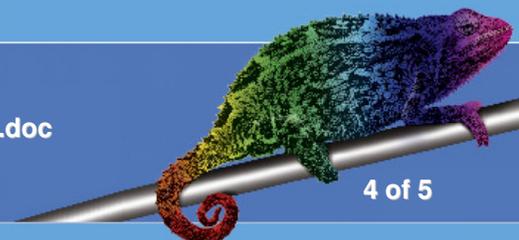
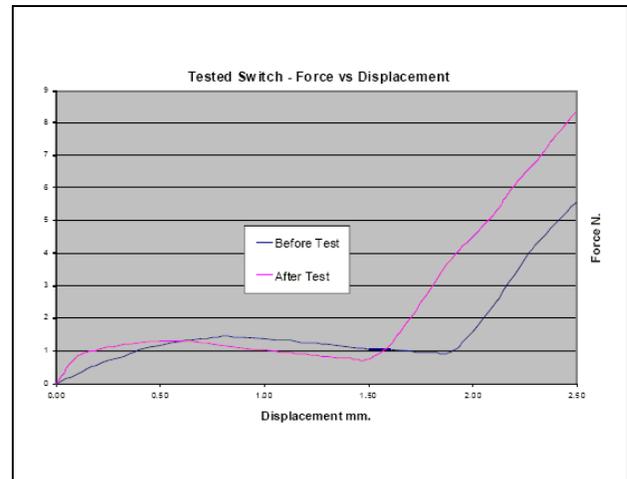
Parameter	Value	Comments
No. of Operations	5M	3M specified working life
Contact Resistance Specified Value	Ohms <200	No change
Initial Value	50	
End of Test	50	
Force/Displacement Characteristic Change	See Graph	Negligible change
Mechanical Wear		Minimal
Display Function		Unchanged

At the end of the test process the switch was still operating, the LED Backlight and the LCD display appeared unaffected. On visual inspection it was clear that there was a minimal amount of debris in the switch and all components were intact. The carbon impregnated pill showed some signs of deformation where the carbon element hit the switch contacts. Contact resistance was measured as 50 Ohms, the same value measured before the test and well within the specifications.

## CONCLUSIONS

The test conclusively proved the durability of the switches. After the test the switch was still in good condition and was continuing to function well. The most important results noted were the contact resistance and the force-displacement curve of the switch after the test. These two parameters remained almost unchanged from their before-test values.

Measurements of the switch force displacement characteristics were performed before and after the test. The shapes of the resulting curves were the same, showing the





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feel of the switch did not deteriorate after almost 5 million operations. A shift in distance of 0.4mm at which resistance is encountered was measured, but considered negligible, as the user would not notice it.

The SA switches have proven that they are not just intelligent, but tough. The reason for this superior performance lies in their mechanical design. The keycap and switch housing are designed to transfer the force applied by the key press from the top of the switch through the keycap wall to the switch base. When the key is depressed with full force, the bottom of the switch housing will rest flat on the circuit board and, thereby, transfer all excess force to the PCB before the contact element is damaged. This means that even after millions of operations the contact element is not damaged and the mechanical operation is not affected. This design has the additional advantage that the LCD glass remains isolated from the operating force of pressing the key.



For further information on the intelligent, RGB-backlit LCD keys from [E<sup>3</sup>] visit the website at [www.e3-keys.com](http://www.e3-keys.com) or e-mail at [info@e3-keys.com](mailto:info@e3-keys.com).



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