Vandal-proof Keypad: Principles of Operation and Results

reprinted from report dated 16 June 1993, author R H Brown, Product Specialist, AMP Sensors (Europe)

1) Description of Stimuli

a) PUSH — an element on the keypad is pushed using finger pressure, with a thermal insulator (3 mm rubber sheet) between finger and front plate to avoid generation of a pyroelectric response

b) TAP — an element on the keypad is tapped with a blunt object (reverse end of pen)

c) PYRO — an element on the keypad is touched lightly with a fingertip (not pushing, to avoid a mechanical response) - the keypad is normally at "room temperature" while the fingertip is warmer

2) Bandwidth of Stimuli (as measured using charge amplifier)

a) PUSH — push stimulus consists of approximate half-sine pulse, giving spectrum flat at very low frequency, falling to -3 dB at around 2 Hz

b) TAP — again, a simple pulse with flat energy content at VLF but with lower mean amplitude relative to PUSH, and -3 dB point around 8 to 10 Hz

c) PYRO — typical waveform has quite fast leading edge, followed by slow decaying exponential. Spectrum shows very high levels at very low frequency, falling off rapidly, with -3 dB around 0.2 Hz approx

3) Relative Amplitude of Stimuli (near to DC, using charge amplifier)

a) PUSH — taken as reference, so 0 dB

b) TAP — -15 dB to -20 dB

c) PYRO — +15 dB to +20 dB

4) Signal to Noise Ratio

Target element amplitude, relative to adjacent element amplitude, as measured using Configuration I: film adhered to front panel using double-coated tape.

a) PUSH — 2 to 3 dB

b) TAP — 7 to 10 dB

c) PYRO — 24 dB

5) Existing Mounting versus Rigid Clamping

Full assembly in housing, compared with keypad assembly clamped flat on bench.

a) PUSH signal level falls by 8 to 10 dB, but signal to noise improves by 3 to 8 dB at low frequencies

b) TAP signal level falls by 6 to 10 dB, signal to noise falls by 3 to 6 dB

c) PYRO signal level unchanged, signal to noise improves by 8 dB

6) Bandpass Filtering

Using the dynamic signal analyzer, the effect of very sharp (120 dB/decade) bandpass characteristics could be examined. Time traces showing 4 PUSH, 4 TAP, and 4 PYRO events each were recorded, using varying start frequency and fixed width of 10 Hz.

a) 2 to 12 Hz PUSH events give highest level, with TAP events lower and more variable. PYRO is visible but at low level

b) 3 to 13 Hz PUSH and TAP approximately equal, PYRO lower than above

c) 4 to 14 Hz fast TAP gives higher peak output, but PUSH still clear, PYRO low

d) 5 to 15 Hz PUSH now lower than TAP, PYRO very low

The optimum set-up appears to be (b) or (c)

7) Conclusions and Recommendations

Sensitivity of the keypad to slow pushes appears very low using 10 M ohm input, since this input impedance forms a high-pass filter in conjunction with the capacitance of each element. This HPF has a -3 dB frequency at around 50 Hz. The true signal from "push" is flat near DC and has -3 dB frequency around 2 Hz, and a great proportion of the signal content is lost. The key information content of the "push" stimulus (around 1 to 2 Hz) is attenuated by some 28 to 35 dB by the 10 M ohm input.

However, the signal content from the thermal or pyroelectric response of the film exists at around the same amplitude as the "push" stimulus (in the 1 to 2 Hz region), and is normally of opposite polarity. Thus, if the system bandwidth is extended to accommodate lower frequencies, the "push" and "pyro" signals will interact in a manner which is difficult to predict (warm finger on cold front plate in winter, cooler finger on hot plate in summer).

One possible improvement would be to form a band-pass filter stage for each element, with a centre frequency around 6 Hz and nominal passband from 3 to 12 Hz. Attenuation of frequencies below 3 Hz should be as steep as possible, with the upper frequencies being less critical. To accomplish this it may be required to increase the input impedance of the electronics from 10 M ohm to somewhere nearer 1 G ohm.

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