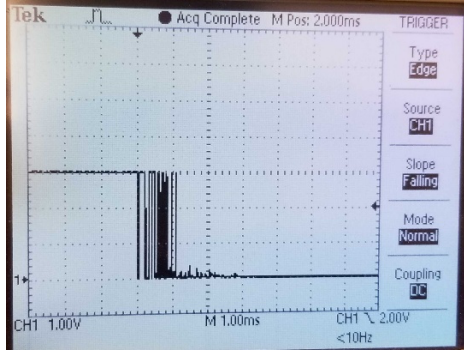
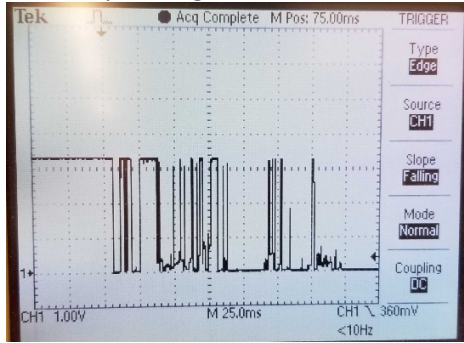
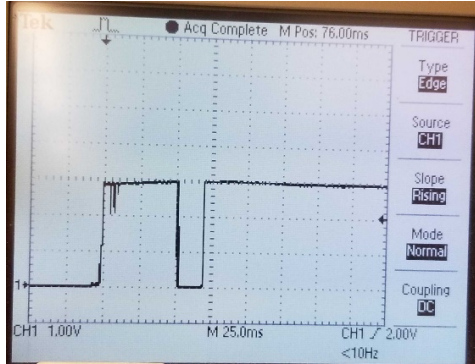


## 8D Report: AP3 Bouncy Motor Switch

0	<b>Prepare</b> Why does this problem require an 8D?	Customers on our Build 6 AP3 padlocks reported that they were unable to open and/or close the lock on the first attempt. This issue has not been seen on locks from prior production runs. The increased number of attempts to open and/or close the lock is unexpected and necessitates a structured problem-solving project.
1	<b>Assemble Team</b> Team should have the knowledge, skill and authority to solve the problem and implement corrective actions.	<b>Who is on the team:</b> Jerod Klink, CTO Konrad Hammel, Director of Hardware Engineering Kristian Nielsen, Director of Operations Brad Gall, VP of Supply Chain (Inertia – ODM partner) Mike Gaudet, Program Manager (Inertia – ODM partner) Martin Gagne, Product Development (Inertia – ODM partner) <b>Goals &amp; Objectives:</b> Document the root cause of the issues and mitigate risks in future builds
2	<b>Describe the Problem</b> What is the problem? What is the problem scope? Why is this a problem? Who is affected? Who is not? What provides us certainty?	Customers received some padlocks that did not open and/or close correctly on the first attempt. Affected padlocks would not open or close reliably on the first attempt, requiring users to repeat open and close actions.  Build 6 was manufactured between January 2020 and February 2020 (Hardware ID range 14D02 to 1ADAF). We have no reports of AP3 prior to Build 6 having similar symptoms.
3	<b>Interim Containment</b> What immediate actions do we take to contain the problem and limit impact?	Konrad created a test plan to be followed on all AP3's being shipped from the office in Canada. This plan was implemented shortly after the shipments from Canada started.
4	<b>Identify Root Cause</b> Use a 5-whys methodology, a fishbone diagram or other root cause process.	<ul style="list-style-type: none"> <li>• Why was the AP3 not opening or closing properly?             <ul style="list-style-type: none"> <li>- The software is not able to properly track the real time state of the locking mechanism which is required for proper operation.</li> </ul> </li> <li>• Why is the software not able to track the real time state of the locking mechanism?             <ul style="list-style-type: none"> <li>- The motor switch was not indicating its position correctly. The motor switch is a signal that indicates the status of the internal locking mechanism.</li> </ul> </li> <li>• Why was the motor switch not indicating the correct position?             <ul style="list-style-type: none"> <li>- We found that some switches were toggling between the engaged and disengaged states rapidly and for inconsistent durations. As well, we found some switches that were changing their states in a steady state position.</li> </ul> </li> <li>• Why were switches toggling between engaged and disengaged states?             <ul style="list-style-type: none"> <li>- The operating range for this lot of switches was larger than our previous builds. The switches were still within the spec of the manufacture.</li> </ul> </li> </ul>

		<ul style="list-style-type: none"> <li>• Why was the operating range larger than the previous builds?             <ul style="list-style-type: none"> <li>- It is common for different build lots to have slightly different tolerance ranges, but the overall specs provided by the Manufacturer will account for their variances.</li> </ul> </li> </ul>
<p>5</p>	<p><b>Identify Solutions</b>          What are the possible solutions? Identify the best. Address the root cause. What Permanent Corrective Actions will we take?</p>	<p>Konrad identified that we could classify motor switches into three categories using a test fixture that isolated the motor switch and operated on it in an ideal manner.</p> <p>Type 1 - State change of the switch stabilizes within 0.005 seconds. This is a switch operating within our tolerance range.</p>  <p>Type 2 - State change of the switch stabilizes &gt; 0.005 seconds. This is a switch operating within the manufacturer's full tolerance range.</p>  <p>Type 3 - Stabilizes within the acceptable time span, but changes states when in a static state. This is not a properly working switch.</p>  <p>Konrad created an embedded software update running inside every lock that compensates for the characteristics of Type 2 motor switches. With this firmware update, locks with Type 2 switches behave as expected within their service life. This firmware update can be easily applied in the field by our users with no additional tools or software.</p>

	<b>Identify Solutions cont.</b>	There is no fix for Type 3 motor switches, so we created a test (BMS Test) that can be run on a fully assembled AP3 which will indicate the presence of Type 3 motor switches. All locks identified with Type 3 motor switches are considered failures, should be removed from active service, and automatically qualify for RMA and credit.
6	<b>Validation</b> Verify that the solution is working as expected. Check for undesirable side-effects.	Locks with the new software saw a substantial decline in open and close failures. Any remaining inventory was re-tested and screened for BMS failure.  To validate the BMS Test procedure, failed switches are removed from the lock and tested in a jig to confirm the test identified the fault correctly.
7	<b>Prevention</b> What improvements in systems and processes will prevent this and similar problems from recurring?	We are introducing the BMS Test at the factory for all future production.  The BMS Test includes 9 additional pass/fail criteria for our automated open-and-close test procedures.
8	<b>Congratulate the Team</b>	<b>Team disbanded and resolution complete on:</b> January 2022.

This document and the information herein are Confidential Information of Sera4 Ltd.