



FA Report: Eagle 12V Adaptor Insertion Issue

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- Failure symptom
- Root cause
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Failure Symptom

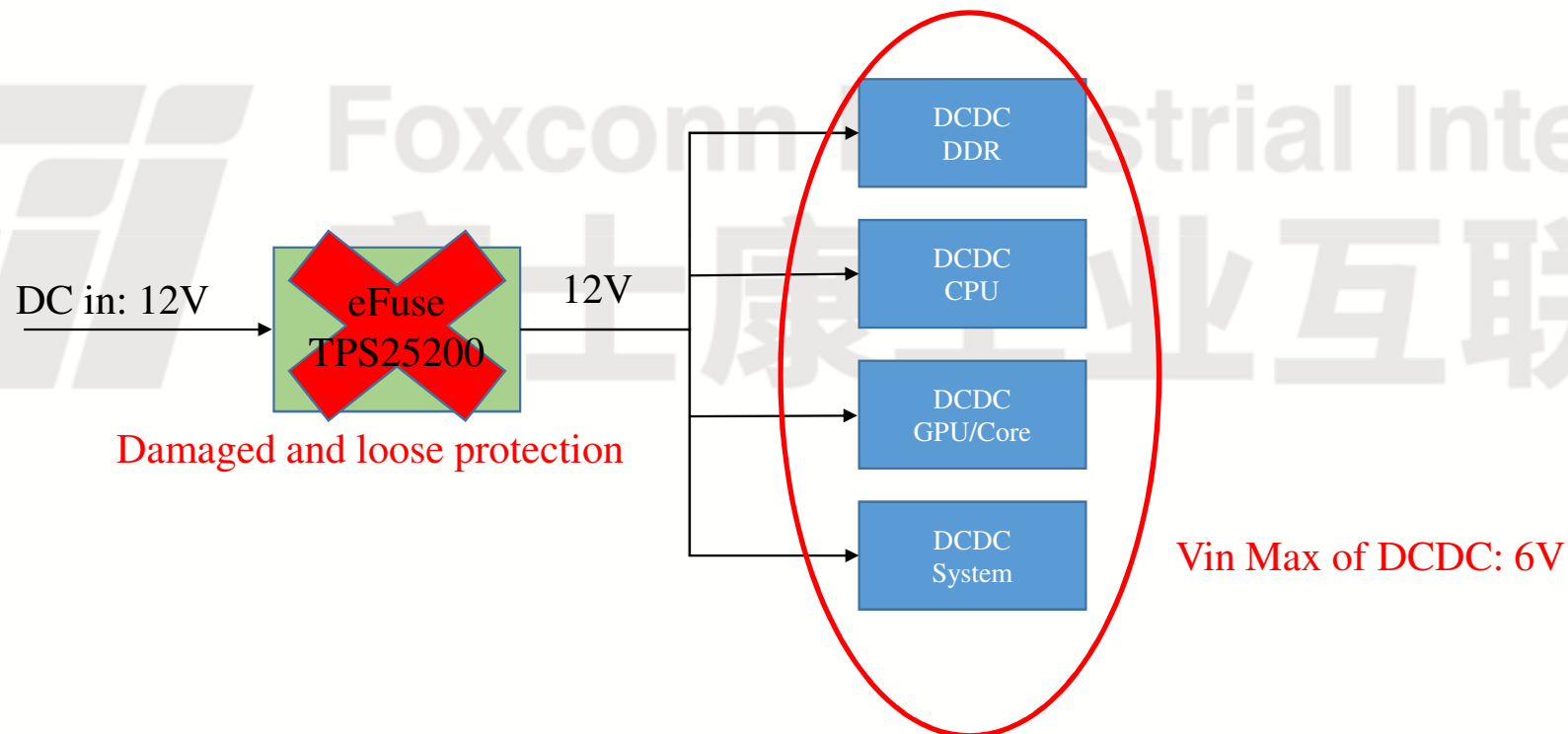
- We received 3 pcs failure units that unable to power on the BOX using 5V adaptor after plugging in/out 12V adaptor by customer (SKB and ALT).
 - 2 failure units were damaged by SKB, the test method is plug in/out 5V adaptor -> plug in/out 12V adaptor several times -> plug in 5V adaptor (DC side).
 - 1 failure unit was reproduced by ALT, and failed only by plug in/out 12V adaptor at DC side without any IO connected (ALT only took one unit to test then found the failure).
 - ALT sent 3 failure PCBA and the 12V adaptor which caused the BOX damaged to FXN.



SKB 12V adaptor caused the BOX damaged

Failure Analysis

- After checking the failure units, we found all of the input/output pins of eFuse (TI, TPS25200) are short together, which loose the over voltage protection and caused the DCDCs are damaged by 12V insertion test.
- However, the maximum input voltage of eFuse is 20V which has enough space to clamp the output voltage to 0V by 12V Vin. Thus, we need to dig out the root cause of eFuse damage issue while inserting 12V adaptor.



Failure Analysis

- We've tried to reproduce the same failure symptom in FXN office, took 1pcs PCBA to do the 12V adaptor insertion test but couldn't to get any failure.
- The following table is the test result by using different kinds of 12V adaptor.
 - ❑ Adaptor: SKB adaptor (the same model as ALT reproduce the failure), Kaon adaptor.
 - ❑ AC source generator: ALL POWER APG-1005N (to generate 220V AC source).
 - ❑ Test step: 1. Plug in/out the 12V adaptor by 110V AC 20 times (use office AC source).
2. Verify the PCBA status and see if it can be power on normally by 5V adaptor in each 5 times insertion.
3. Plug in/out the 12V adaptor by 220V AC 20 times (use AC generator).
4. Verify the PCBA status and see if it can be power on normally by 5V adaptor in each 5 times insertion.

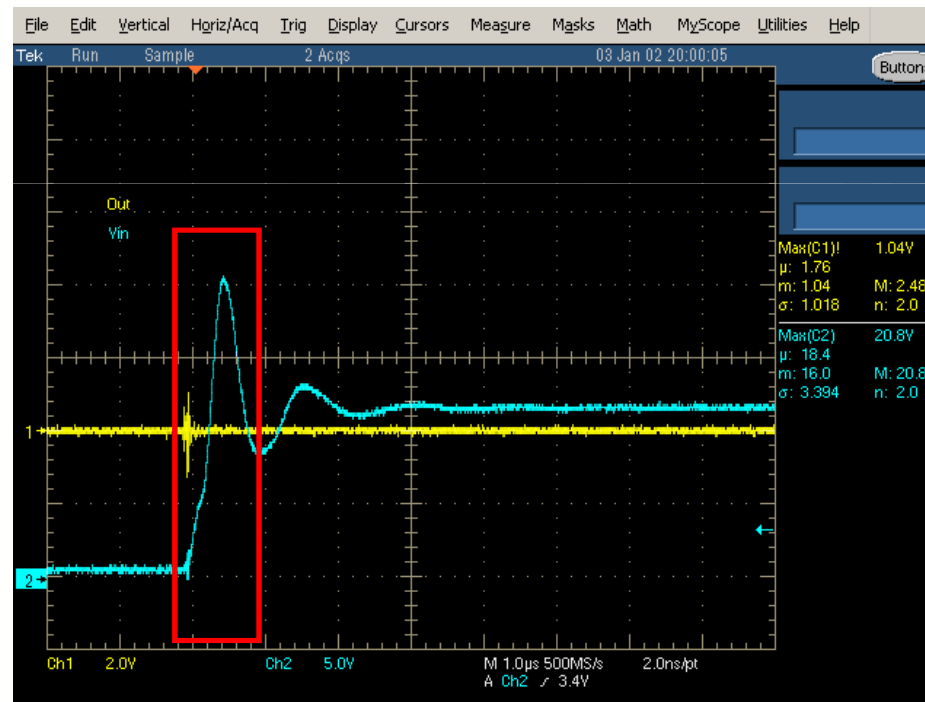
Adaptor	AC source	Plug side	Result
SKB 12V Adaptor	110V	AC side	Pass
		DC side	Pass
	220V	AC side	Pass
		DC side	Pass
Kaon 12V Adaptor	110V	AC side	Pass
		DC side	Pass
	220V	AC side	Pass
		DC side	Pass

Failure Analysis

- After measuring the waveform of input/output voltage of eFuse, we found that SKB 12V adaptor has much higher voltage spike than Kaon 12V adaptor, and increase the risk to damage the eFuse IC.



SKB 12V adaptor



Vin: Input of eFuse (DC jack side).
Vout: Output of eFuse (System side).

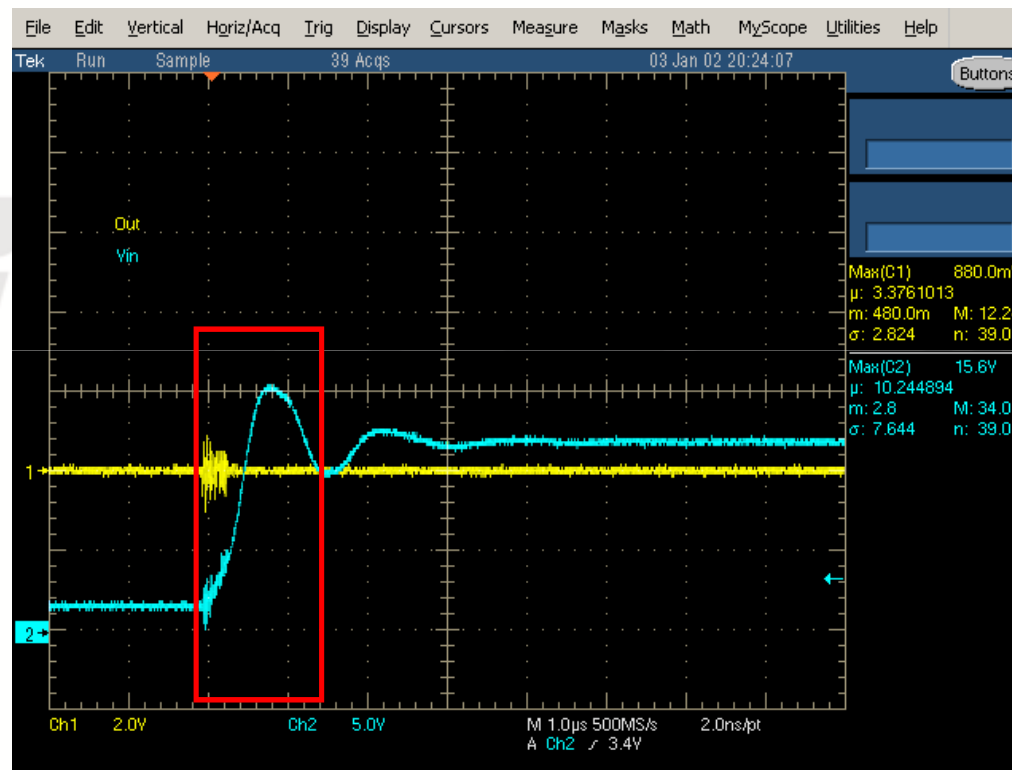
Vin has 20.8V voltage spike during adaptor insertion, which has potential risk to damage the eFuse since it only has 20V Vin clamping capability.

Although the maximum over voltage protection is 20V, it might variant by the energy distribution within a certain time that above 20V.

Failure Analysis



Kaon 12V adaptor

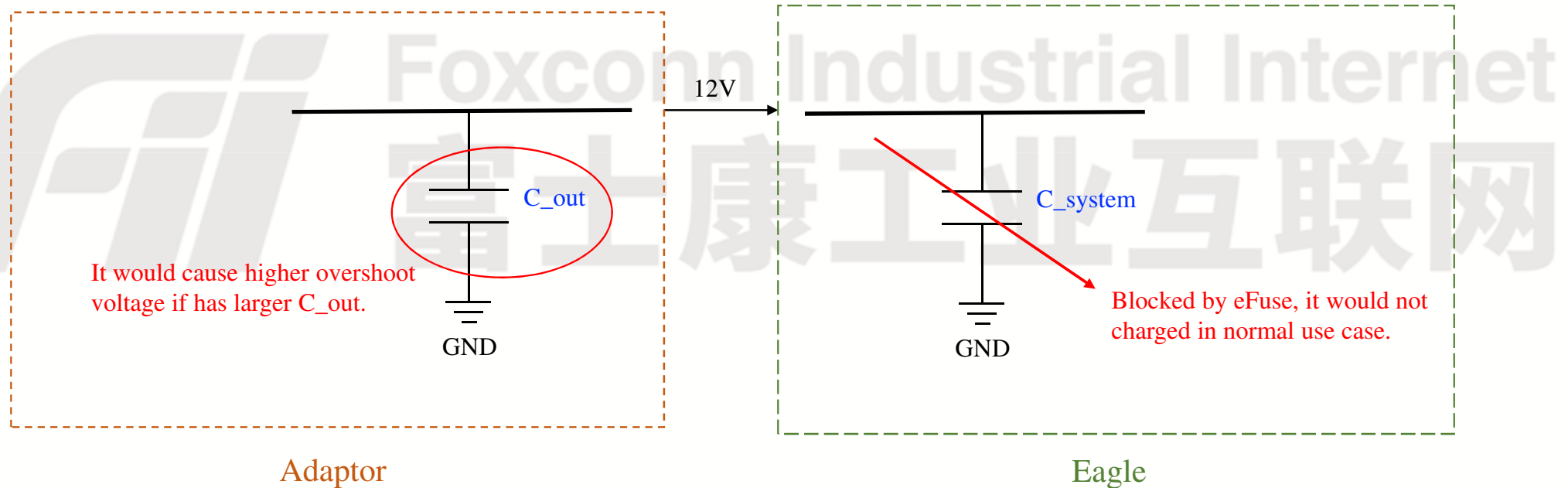


Vin: Input of eFuse (DC jack side).
Vout: Output of eFuse (System side).

It shows that the voltage spike of Kaon adaptor is 15.6V which has more margin to 20V Vin protection of eFuse.

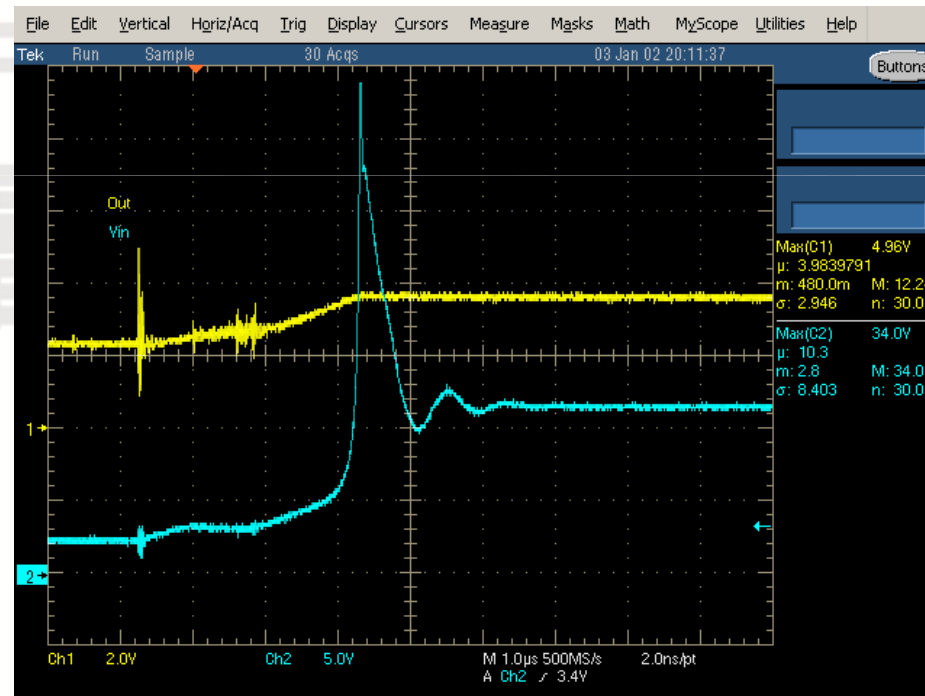
Failure Analysis

- For the deviation of voltage spike between SKB and Kaon 12V adaptors, we suspect that the output capacitance of SKB one is higher than Kaon one, and it would cause higher voltage spike if the capacitors in the adaptor is not fully discharged during insertion.



Failure Analysis

- Based on this assumption, we are able to reproduce the failure symptom at FXN office by plug in/out rapidly several times using SKB 12V adaptor, and the voltage spike is **34V** which is damage the over voltage protection of eFuse and caused the input/output of eFuse are shorted.
- *Note:** Unable to reproduce the failure symptom by using Kaon adaptor since it has smaller voltage spike.



Conclusion

- Failure symptom:
 - The eFuse and other ICs of Eagle boxes were damaged during 12V adaptor insertion test by using SKB 12V adaptor.
- Root cause:
 - The eFuse is damaged by voltage spike during 12V adaptor insertion, especially when Eagle system is not fully discharged (e.g., HDMI connected, plug in SKB 12V adaptor rapidly right after 5V adaptor is unplugged).
 - Although the maximum over voltage protection is 20V, it might variant by the energy distribution within a certain time that above 20V.
 - Current design specification of over voltage protection for 12V adaptor is based on the criteria of limitation for overshoot voltage, which is 10% overshoot voltage of rated output voltage by turn on/off from AC side.