

Hardened Switchmode Technology

An exploration of Switchmode vs SCR chargers

Bill Kaewert, CEO & CTO at SENS

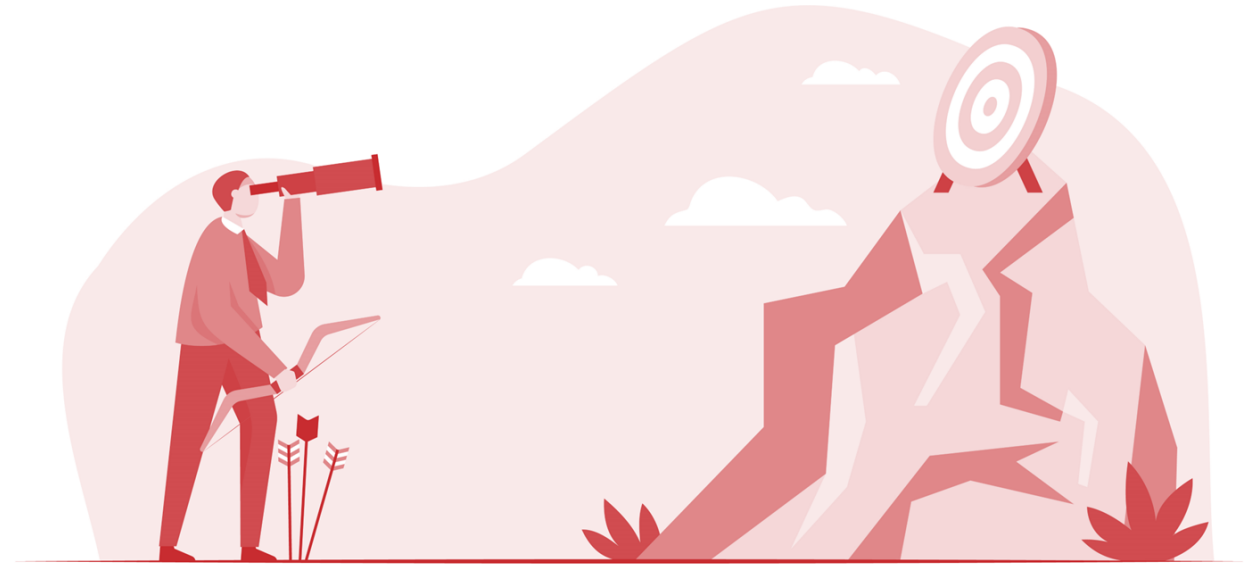


MODERNIZING
CRITICAL POWER



Goals for Modernizing Critical Power

- Educate and build community
- Open dialogue and conversation
- Encourage coming on video with us to ask your questions and share your experience. Just raise your hand or throw your question in the chat!



About This Webinar Series



When

Every 3rd Thursday at 10:30 AM
Mountain Time

Add it to your calendar and don't miss
this live conversation each month!

Every episode is recorded and will be
available on our website.



What

Many topics planned, including:

- *5 common problems switchmode chargers solve for the Utilities Industry*
- *How to read specifications*
- *And more*

But we also want to hear specific topic
ideas from you!

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- SENS is a USA based manufacturing company committed to innovative design & engineering excellence in the development of highly reliable backup system chargers and battery monitoring systems.
- To learn more, visit us at www.sens-usa.com



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- Takeaways
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SCR vs Switchmode Power Conversion

Comparing Physical Aspects

- Mass of magnetic devices is Inversely proportional to operating frequency
- Higher frequency = smaller magnetics

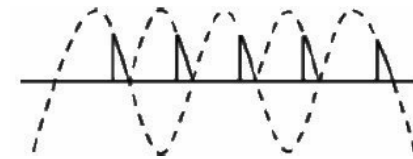
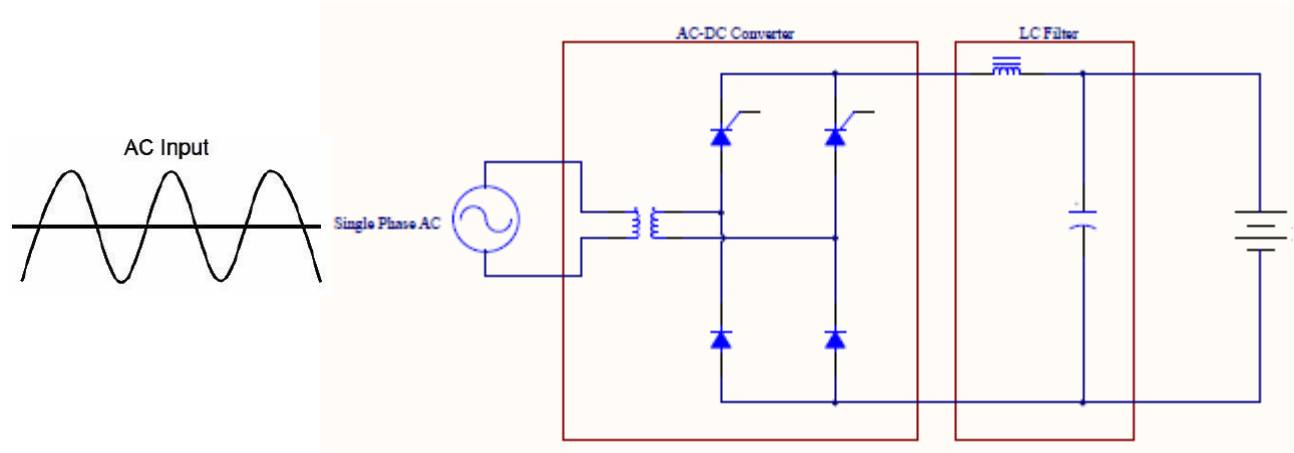
	Line Frequency (e.g. SCR)	High Frequency "Switchmode"	Comment
Operating frequency	AC Line (60 Hz)	30 kHz – 250 kHz	~ 1000X frequency
Weight	10	1	~ 10% weight
Size	10	1	~ 10-40% volume

Charger Powertrain Comparison

SCR Charger Powertrain

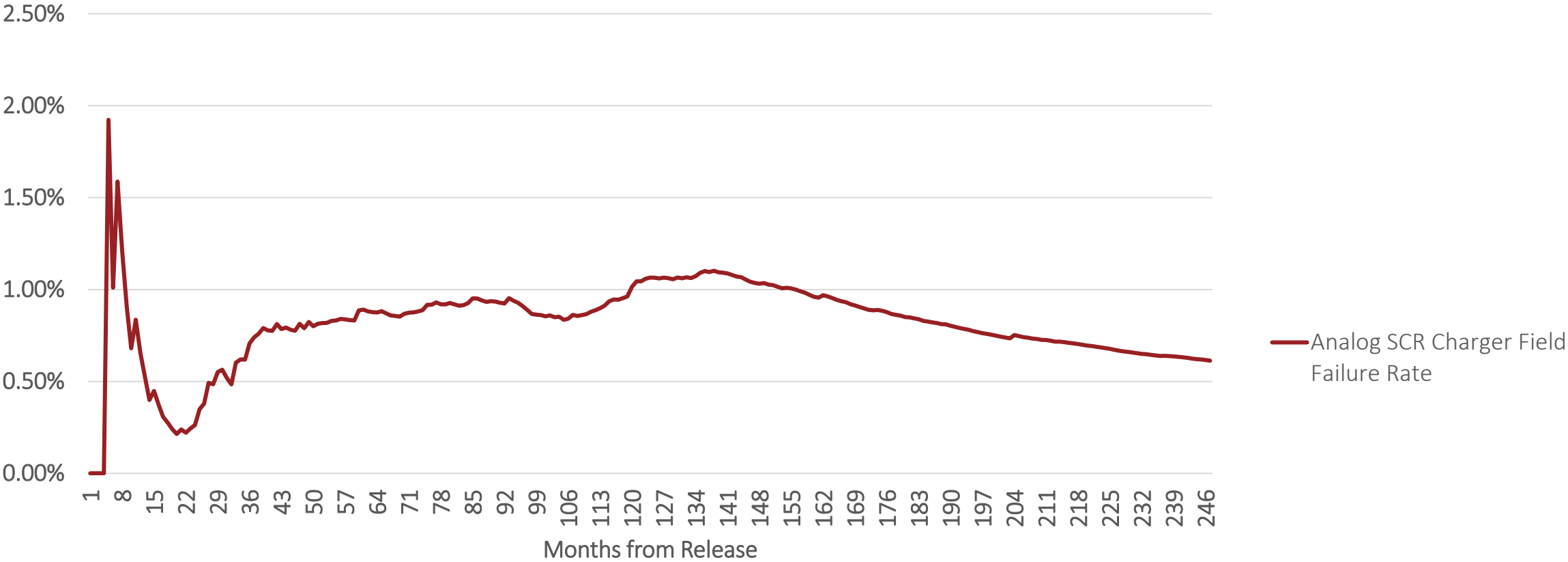
- + Simple
- + Rugged
- + Inherent resistance to AC transients

- Heavy
- Bulky
- Inefficient
- Poor power factor (0.65 lagging)
- Slow dynamic response



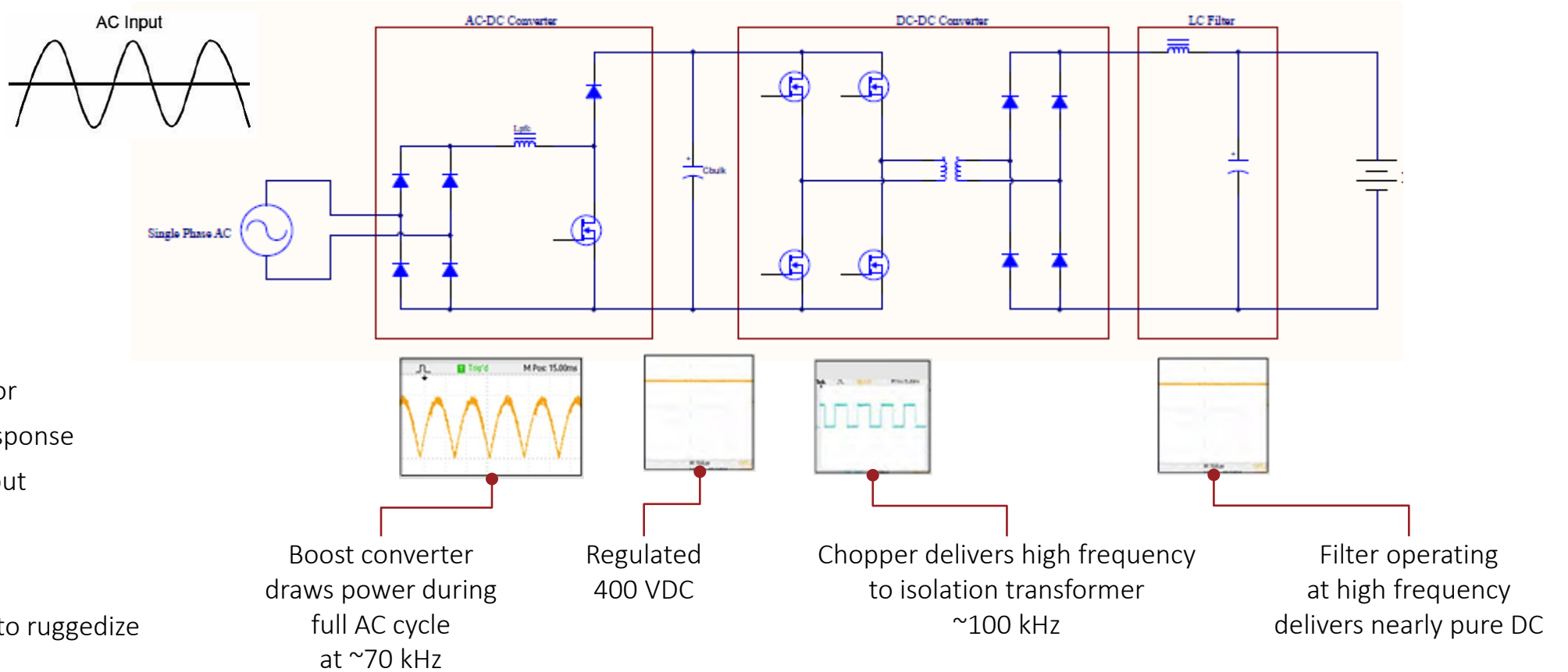
SCR turn-on point is regulated by charger control system
(voltage & current at output terminals)
Operates at 60 Hz

SCR Benefit: Outstanding Reliability



PFC Switchmode Powertrain

- + Small
- + Light
- + Efficient
- + 0.99 power factor
- + Fast dynamic response
- + Smooth DC output
- Complex
- Engineering skill to ruggedize

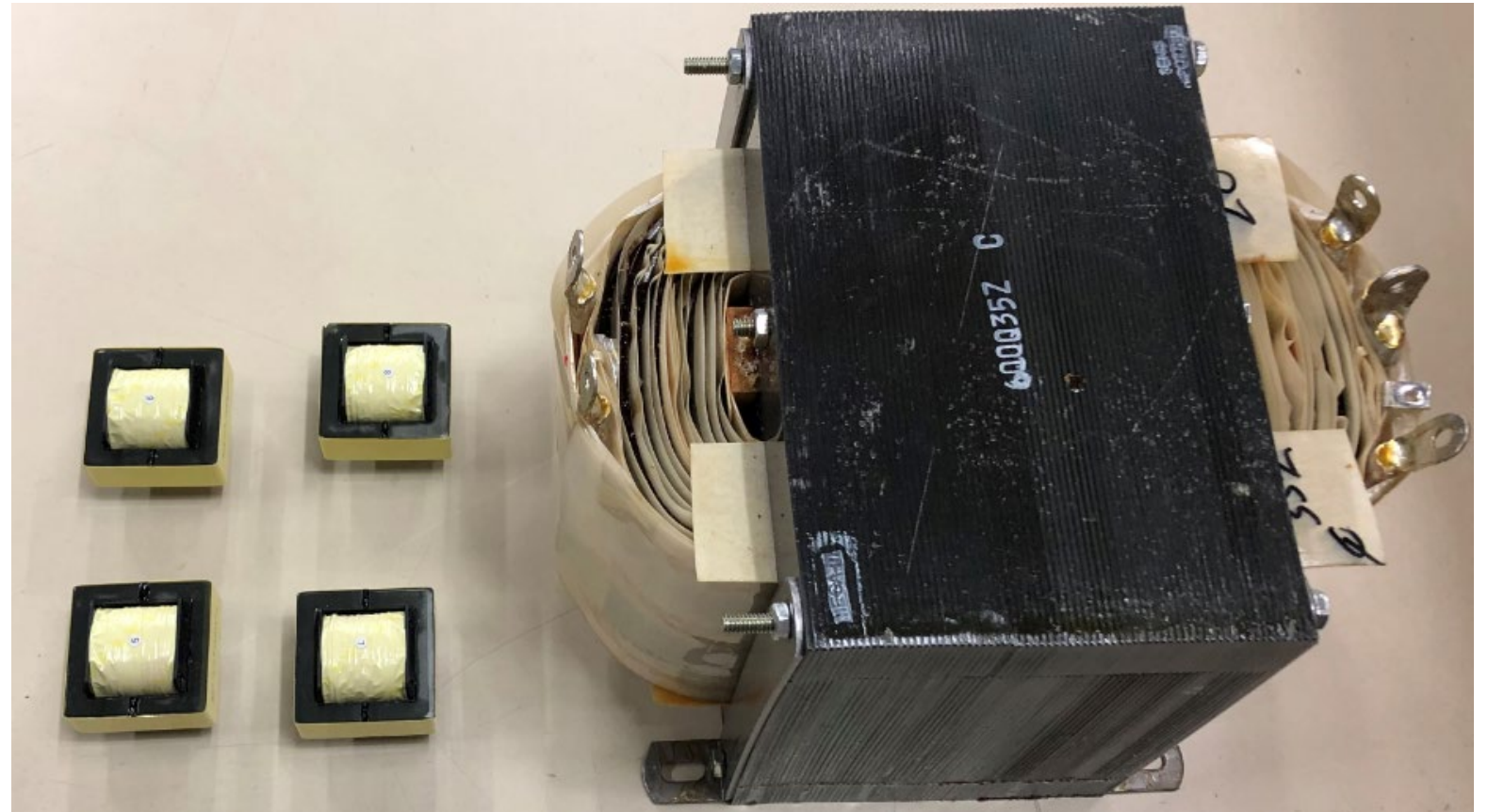


Field Failure Comparison of SCR vs. Switchmode

What would you expect to see?

Size & Weight Comparison

- 7 kW output power:
2.7 lbs. vs 127 lbs.
isolation transformer
- Even bigger difference
in output filter size &
weight



Switchmode Benefit: Modular Design

- Easy to service
- Easy to upgrade
- N+1 redundancy
- Easy dual AC feeds
- Easy dual DC bus

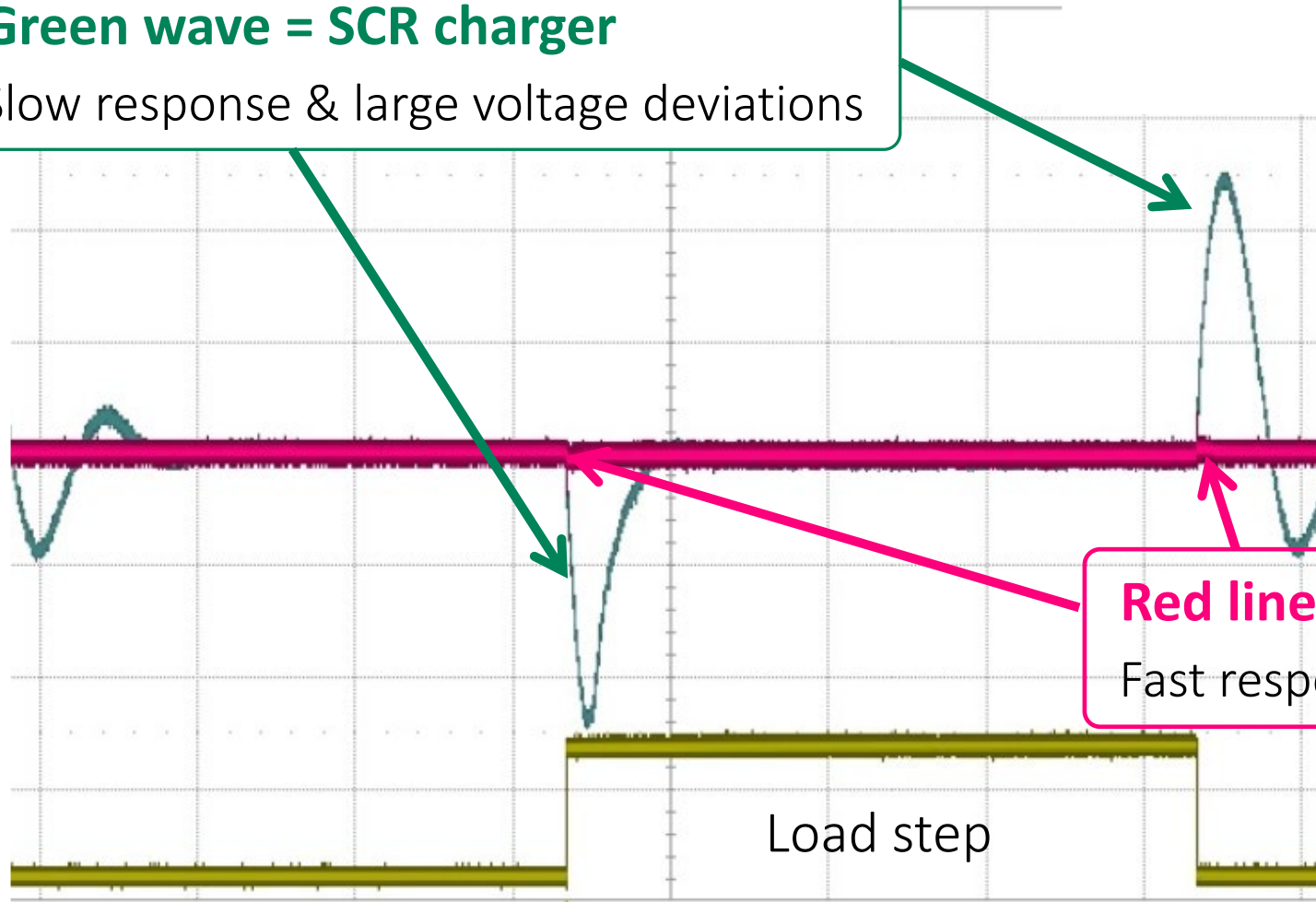


Switchmode Benefit: Fast Dynamic Response

Green wave = SCR charger

Slow response & large voltage deviations

Fast vs. slow
dynamic response

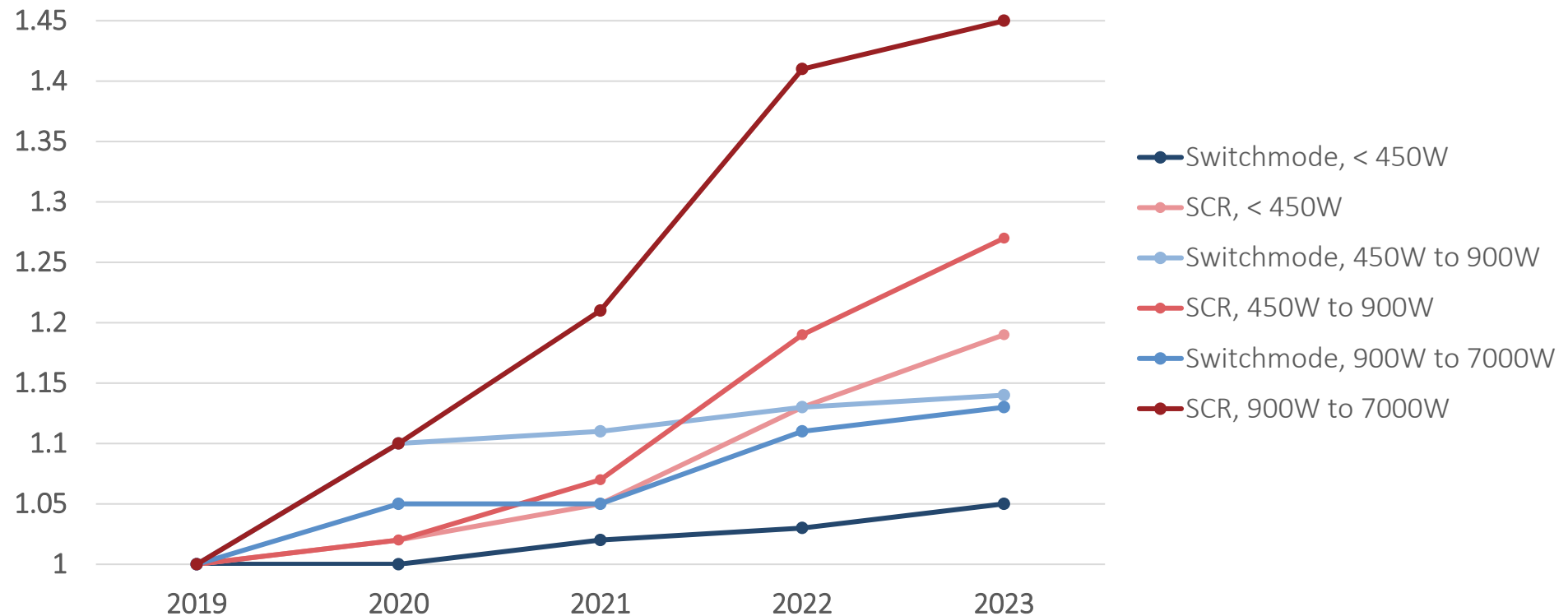


Red line = Switchmode

Fast response & little deviation

Switchmode Benefit: Lower Cost

Summary of Factory Cost Inflation Indexed to 2019



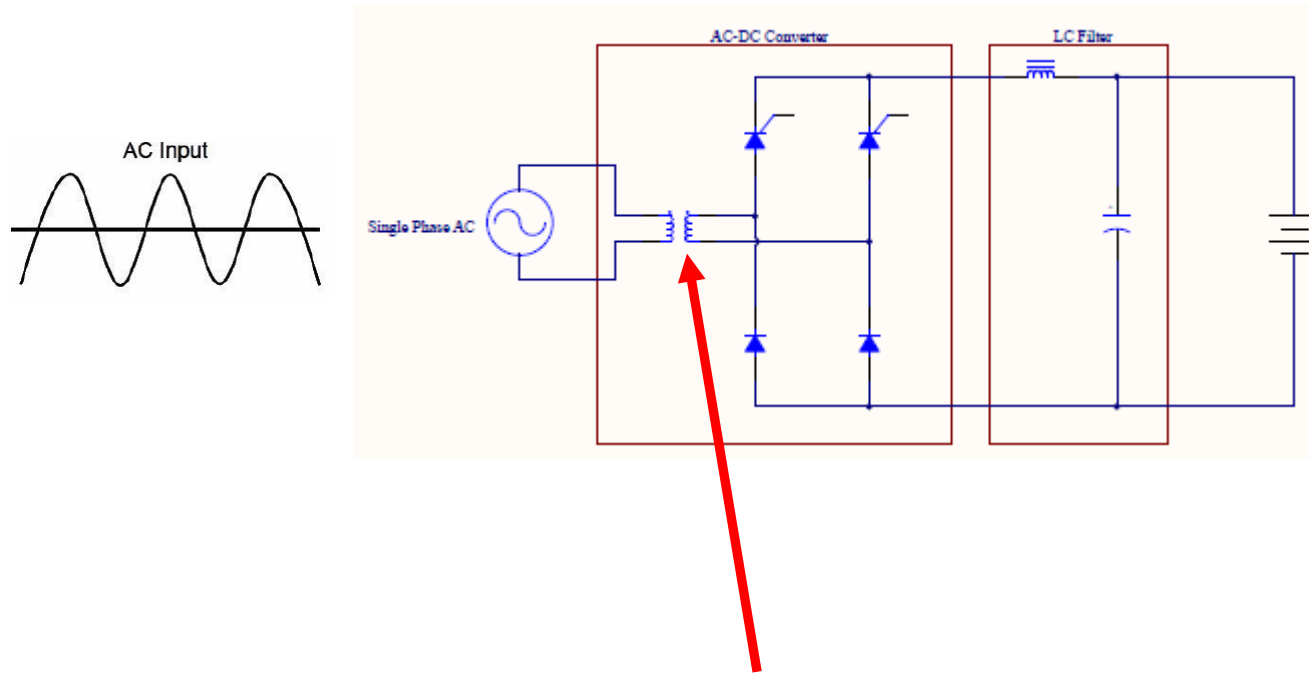
Why Isn't Switchmode Used Everywhere?

Bad Experiences By Electric Utilities

Reputation of vulnerability to AC voltage overstress (“blowing up”)



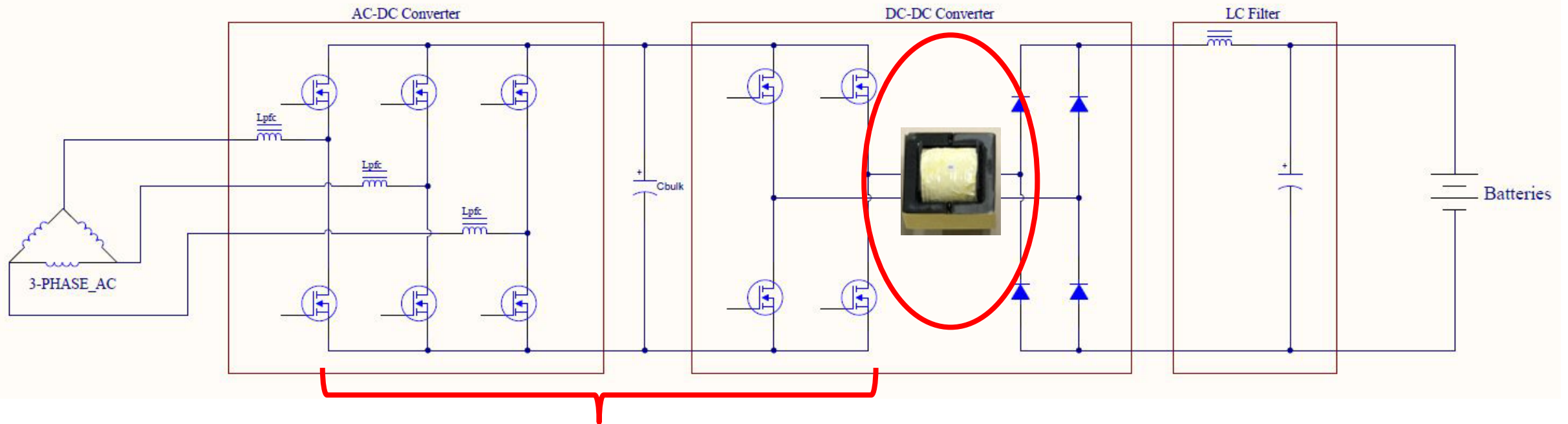
Note Location of Power Transformer in SCR



Located UPSTREAM of semiconductor switches

60 Hz transformer is a low-pass filter. It blocks high frequencies

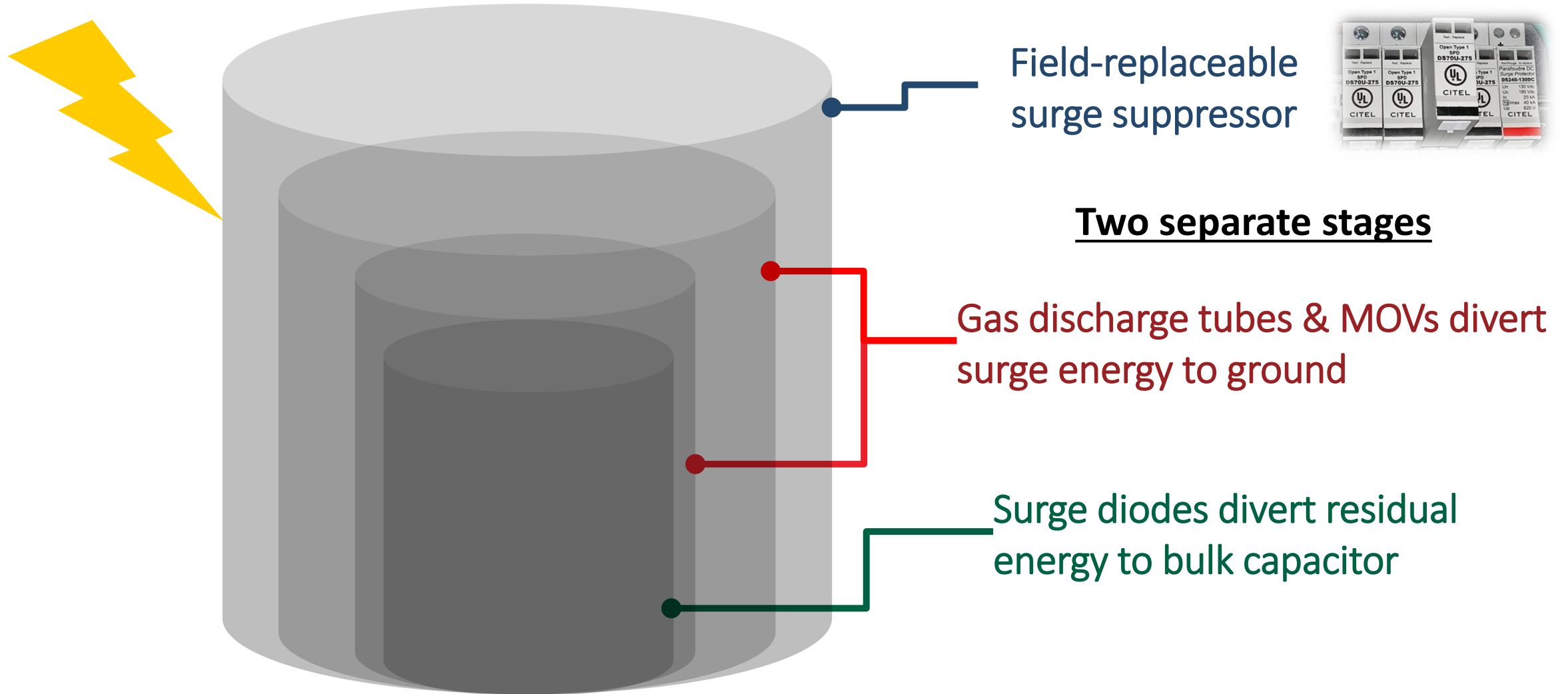
Inherent Vulnerability of Switchmode



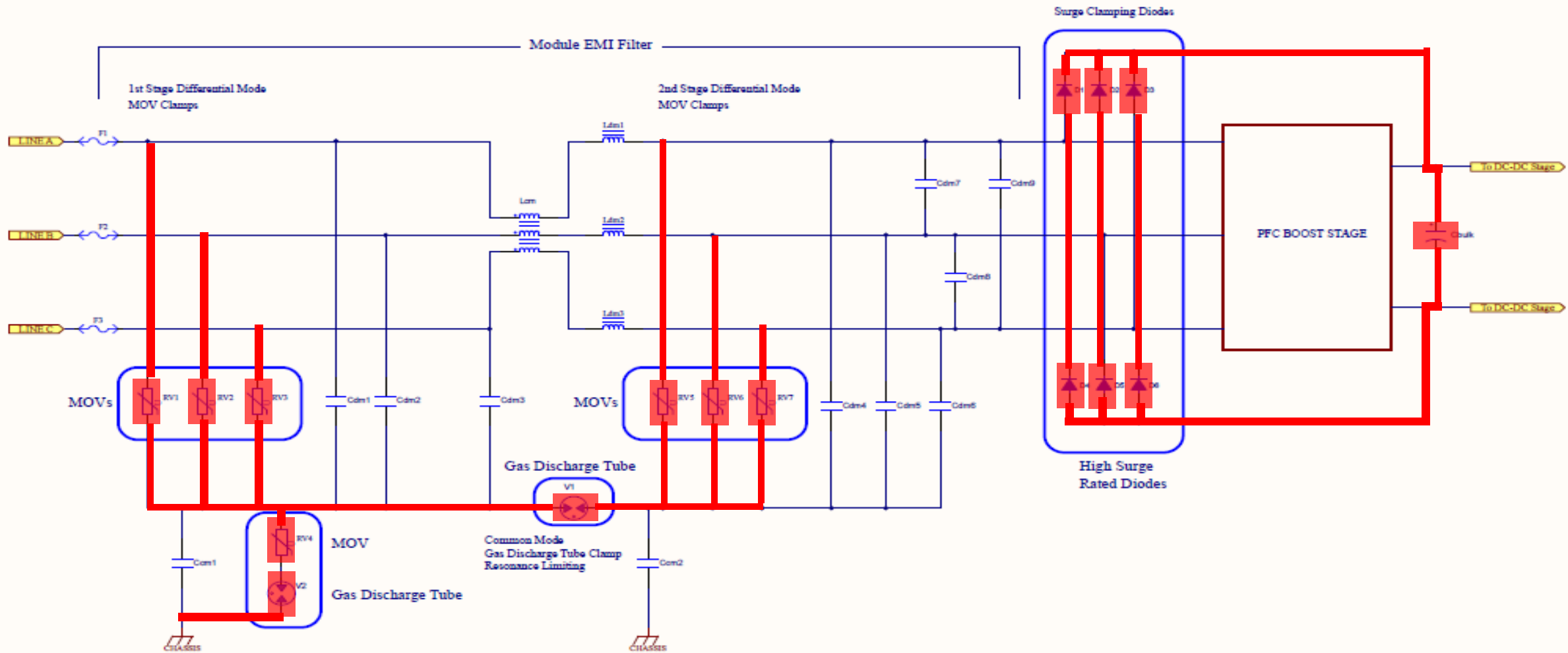
Power semiconductors located
ahead of transformer

Location of transformer doesn't
protect power devices

Protection Strategy: “Layered Defenses”



3 Layers of In-circuit Protection

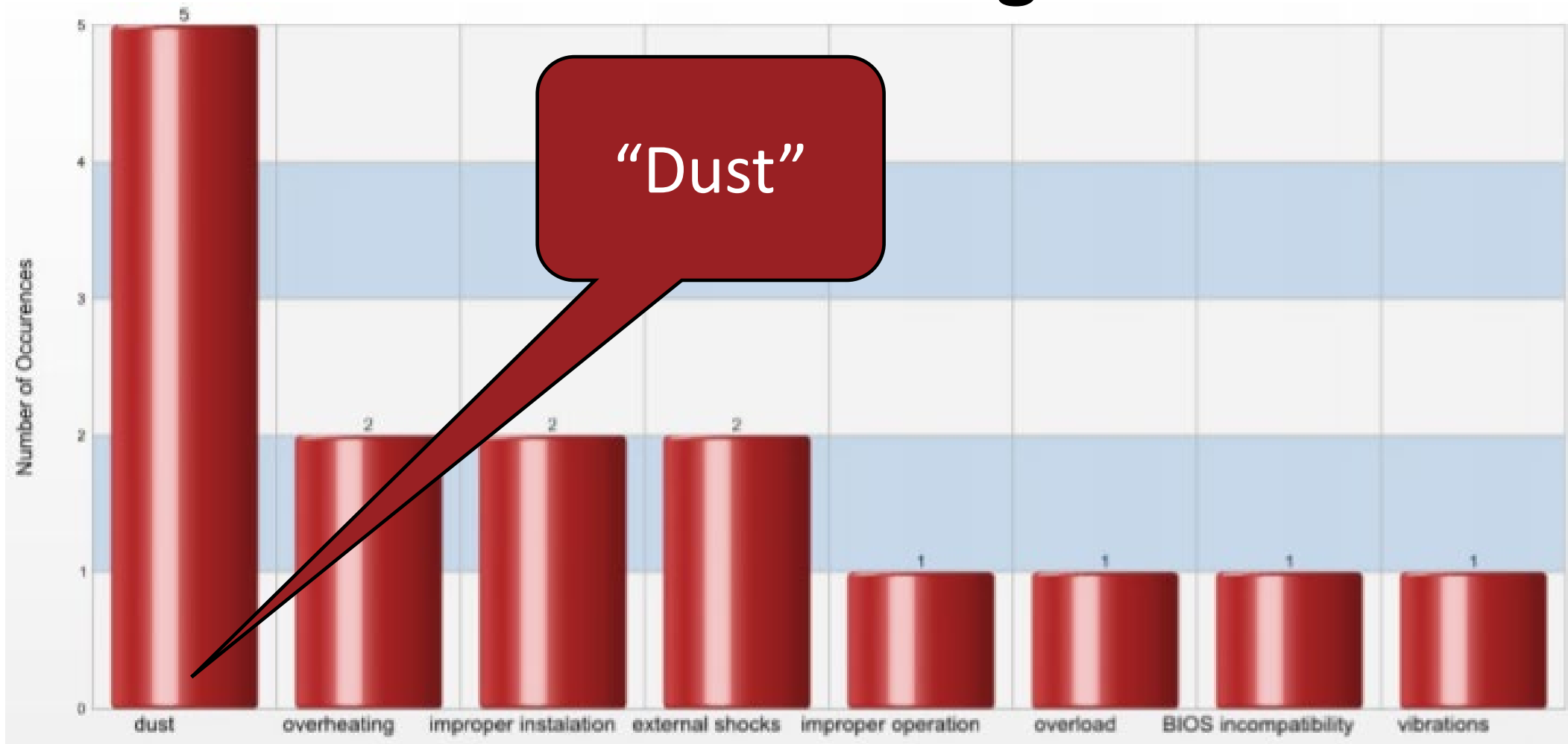


What Other Problems w/Switchmode Tech?

Reputation for cooling fan failures

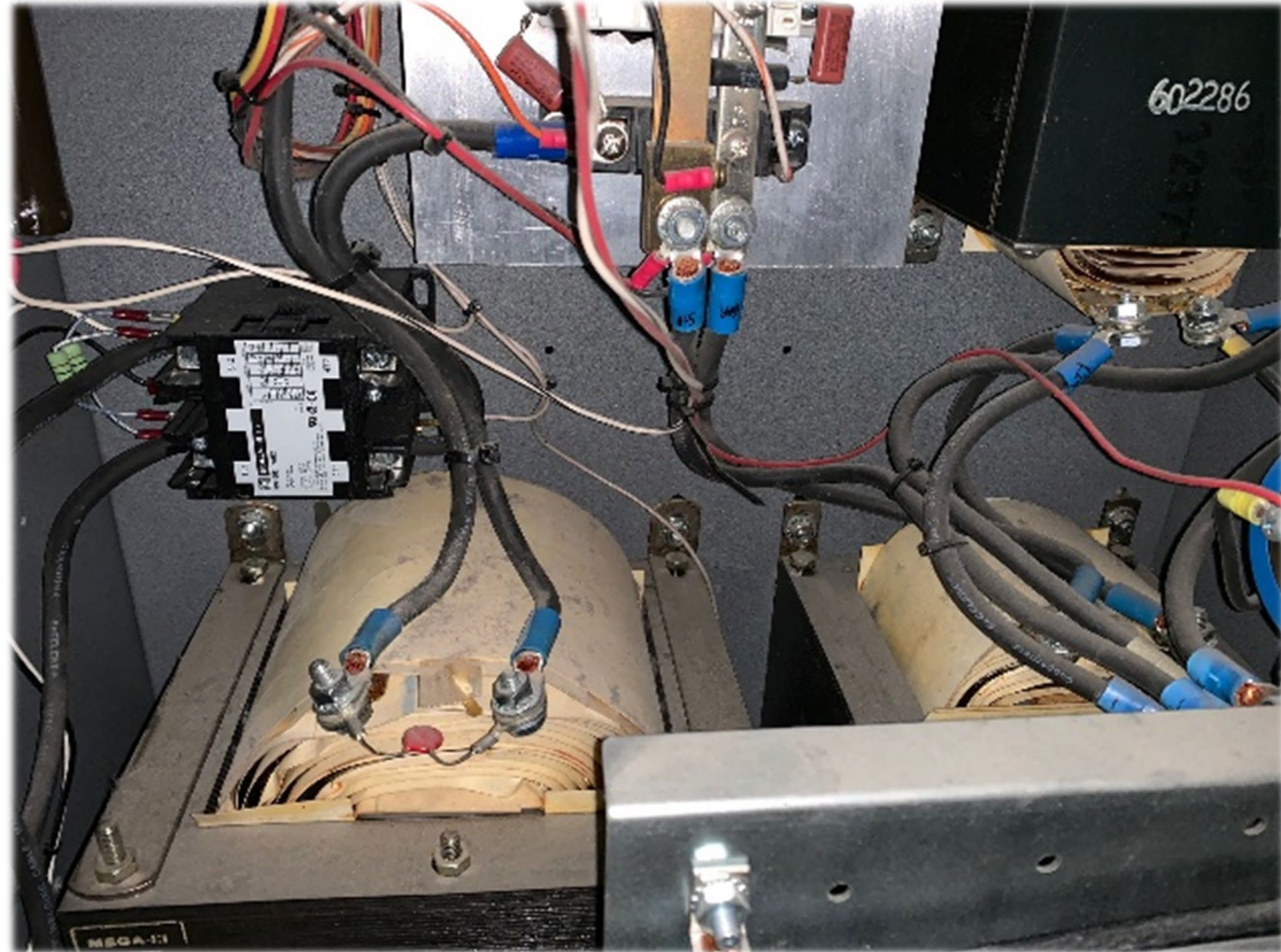


Problems With Fan Cooling



Convection Cooled Charger: 13 years

Note only minimal
dust and dirt



Fan Cooled Switchmode Inverter After 5 Years



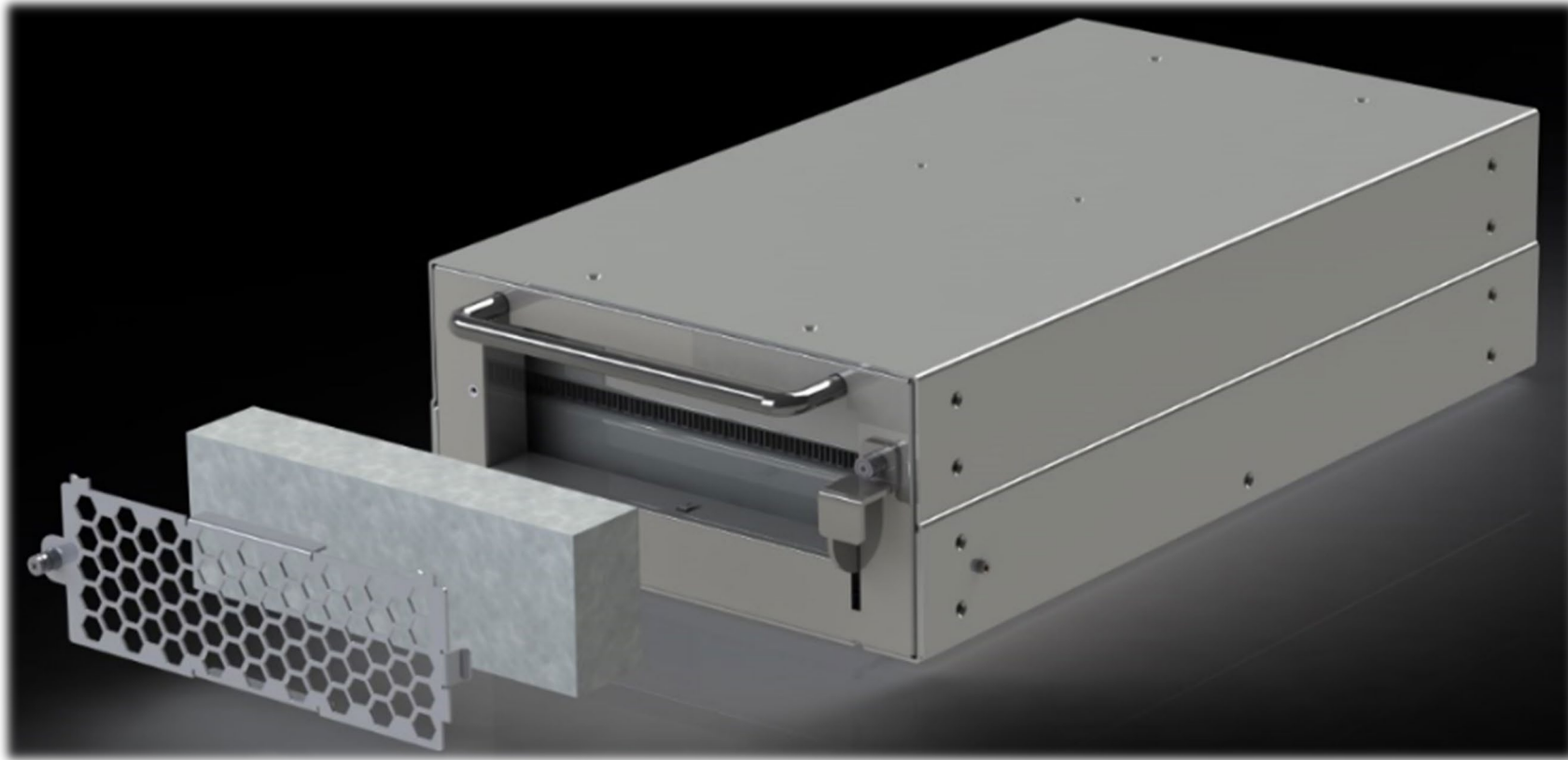
Note dirt caked onto fan blades and layered onto electronic components

... and this was in a benign factory environment. Not outdoors near the coast

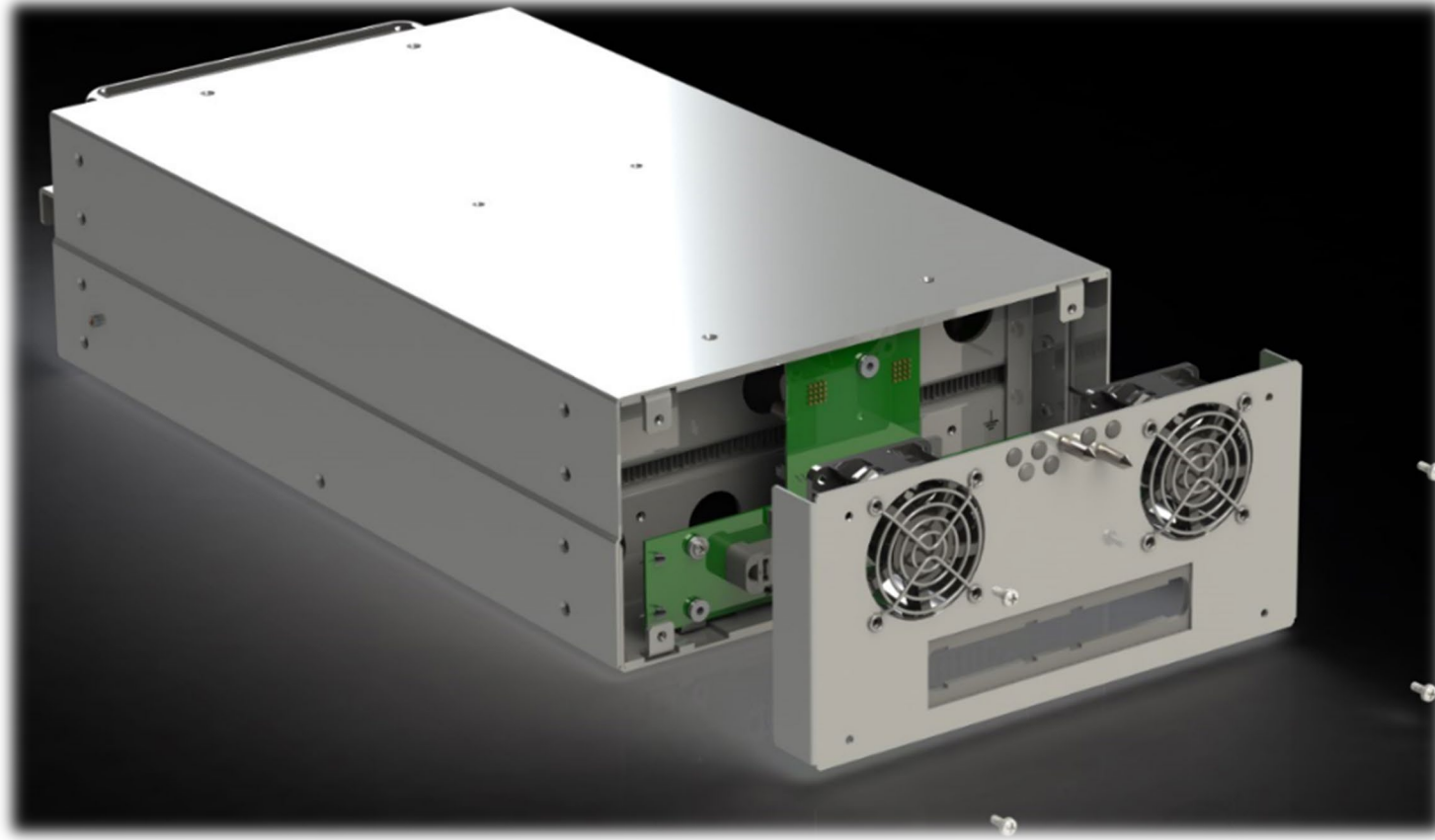
Ways to Reduce Fan Failure Risk

- Air filtration
 - *Effective, cheap, reusable, long cleaning interval, easy & safe to clean*
- Higher quality fans, plus redundancy
 - *N+1 redundant, variable speed*
 - *Premium specification*
 - *Easily field-replaceable*
 - *Alarmed*

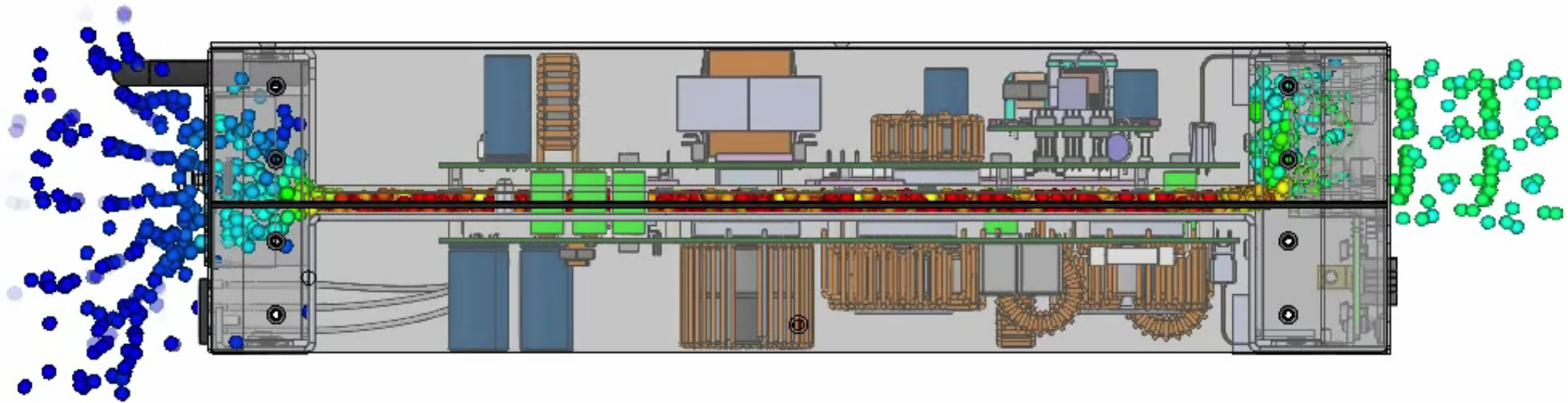
Solutions: Serviceable Air Filtration



Field-replaceable Fans Module

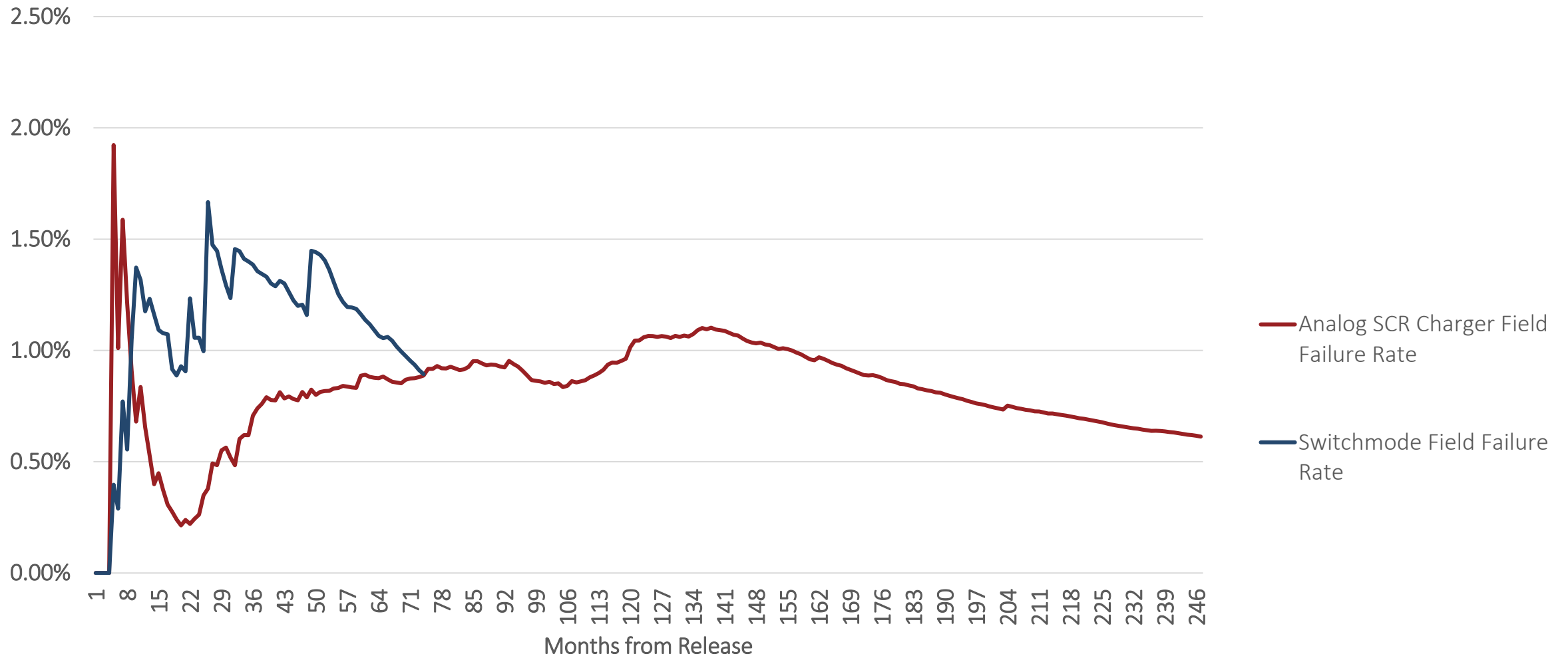


Electronics Sealed From Dirt

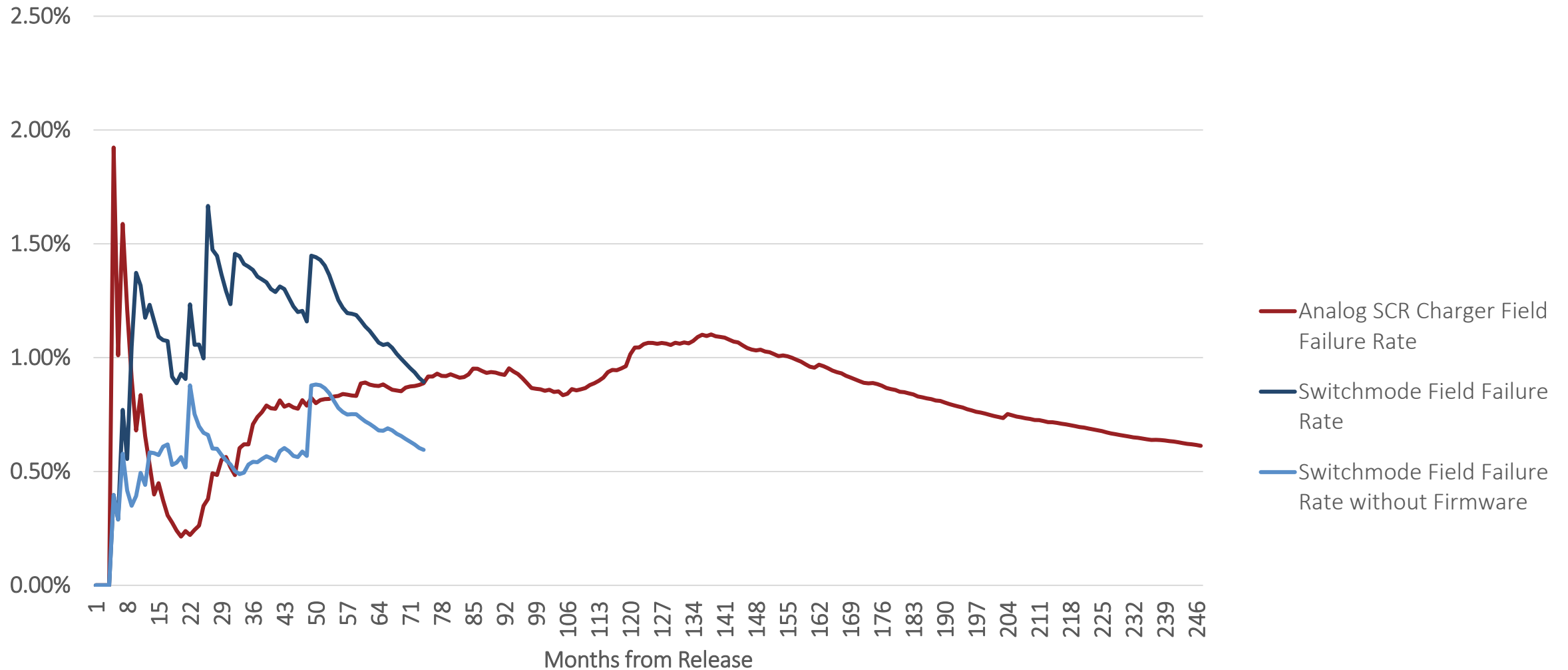


OK, So What Results Are Possible By
Addressing These Shortcomings?

Reliability Results Surprised Us



Switchmode Hardware: Even Beat SCR!



Takeaway 1

Well-designed Switchmode power converters outperform SCR technology in every way:

Performance, size, weight, dynamic response, energy efficiency, power factor, regulatory compliance, cost, MTTR... even reliability

Takeaway 2

It's engineering, not magic



1 action you can take today:

Review your current state and understand why the choices were made

Questions?



Upcoming Episode

June 15th, 10:30 AM MT



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