VICOR

Modular Solutions for Your Power System

COMPONENTS • POWER • EASE-OF-USE • PERFORMAN
INNOVATION • EFFICIENCY • EXPERTISE • CONFIGURA
ME • VOLUME • RELIABILITY • FLEXIBILITY • LONGEVI
MWORK • PROVEN • DENSITY • QUALIFIED • COMPE
SOLUTIONS • INTEGRATION • SUPPORT • OPPORTUNI

Stress-Free Electrical Safety for Power Designers

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June 2018

Safety Webinar Outline

- **Webinar Focus**
- **System Safety**
  - Appliance Insulation Classes
  - Isolation
  - Creepage and Clearance
  - Hi-Pot Test Classifications
  - Selection and Use of X and Y Capacitors
  - Fuses
- **Design for Safety**
  - Proactive Approach
  - Contacting Vicor
  - Vicor Product Safety Documentation
    - Locating Safety Certificates
    - Information Provided in the Safety Certificate
- **Additional Internal and External Resources**
- **Q & A session**

Webinar Focus

This material intended for engineers and managers

GOALS

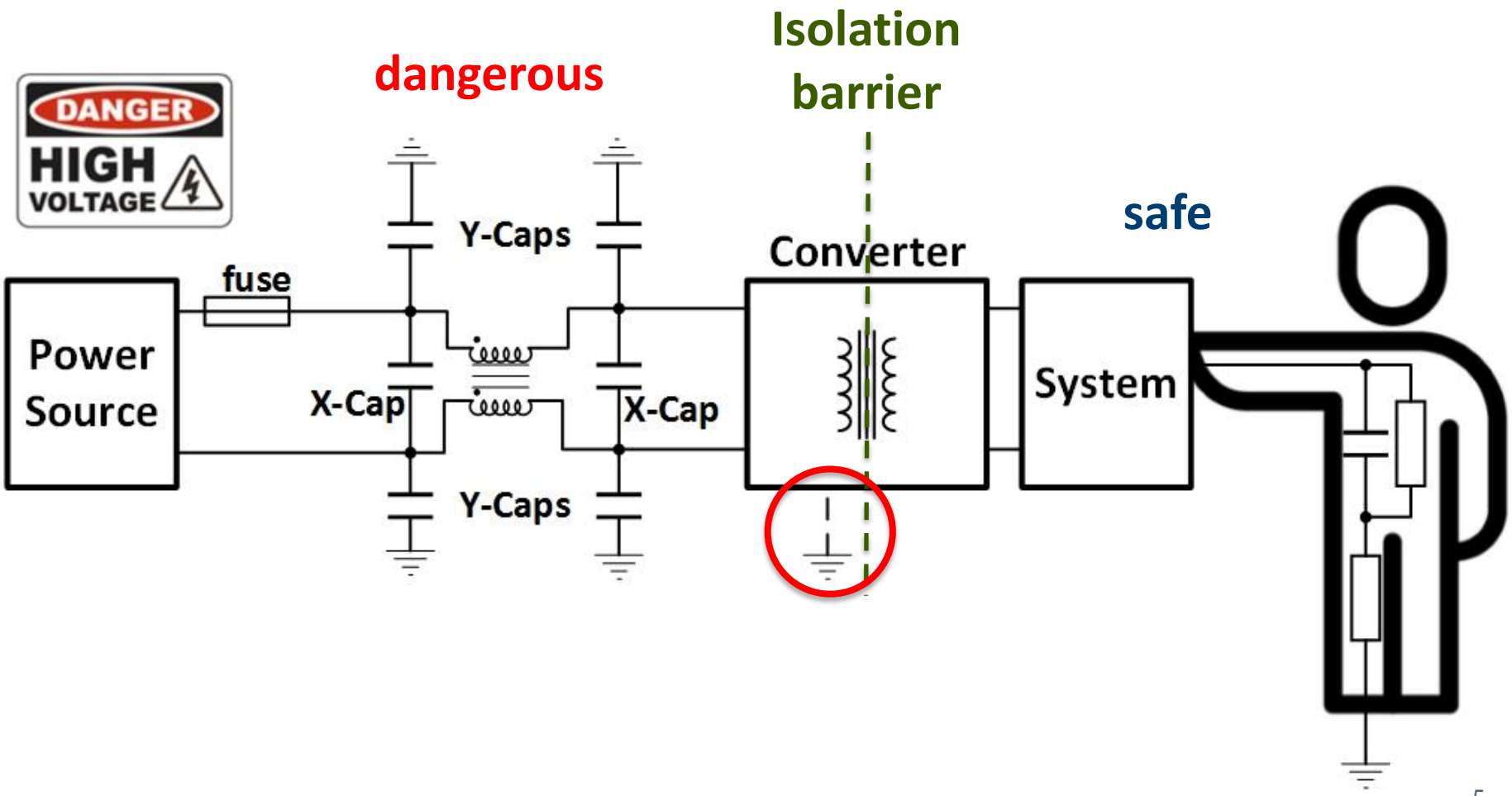
- Summarize electrical safety aspects of Vicor Power Components
- Show where to find electrical safety qualification details

WORKING APPROACH

- Vicor Global Applications team supports Customer Engineering
- ADVICE: Engage team early in the design cycle

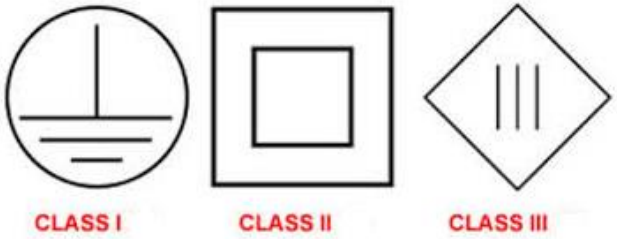
System Safety

Block diagram of a Power Supply



Appliance Insulation Classes

- Vicor Products may be used in Class I, Class II and Class III category products



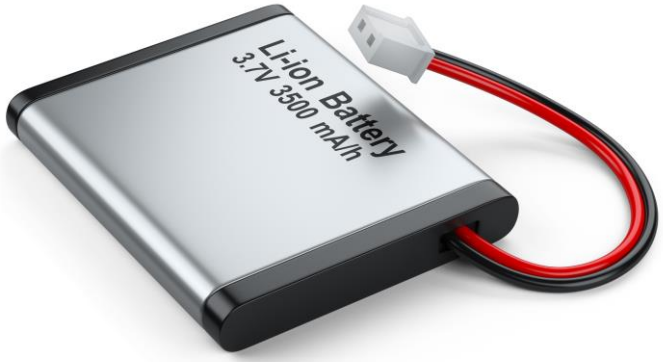
- Class I – PE (Protective Earth) connection mandated. Basic insulation.
- Class II –No PE connection mandated. Double or Reinforced insulation deployed.
- Class III – Appliance designed to be sourced from SELV, no *non-SELVs* permitted internally or at the output(s) [limit of 42.4V peak]
- Functional Insulation is used at designer's discretion

Examples

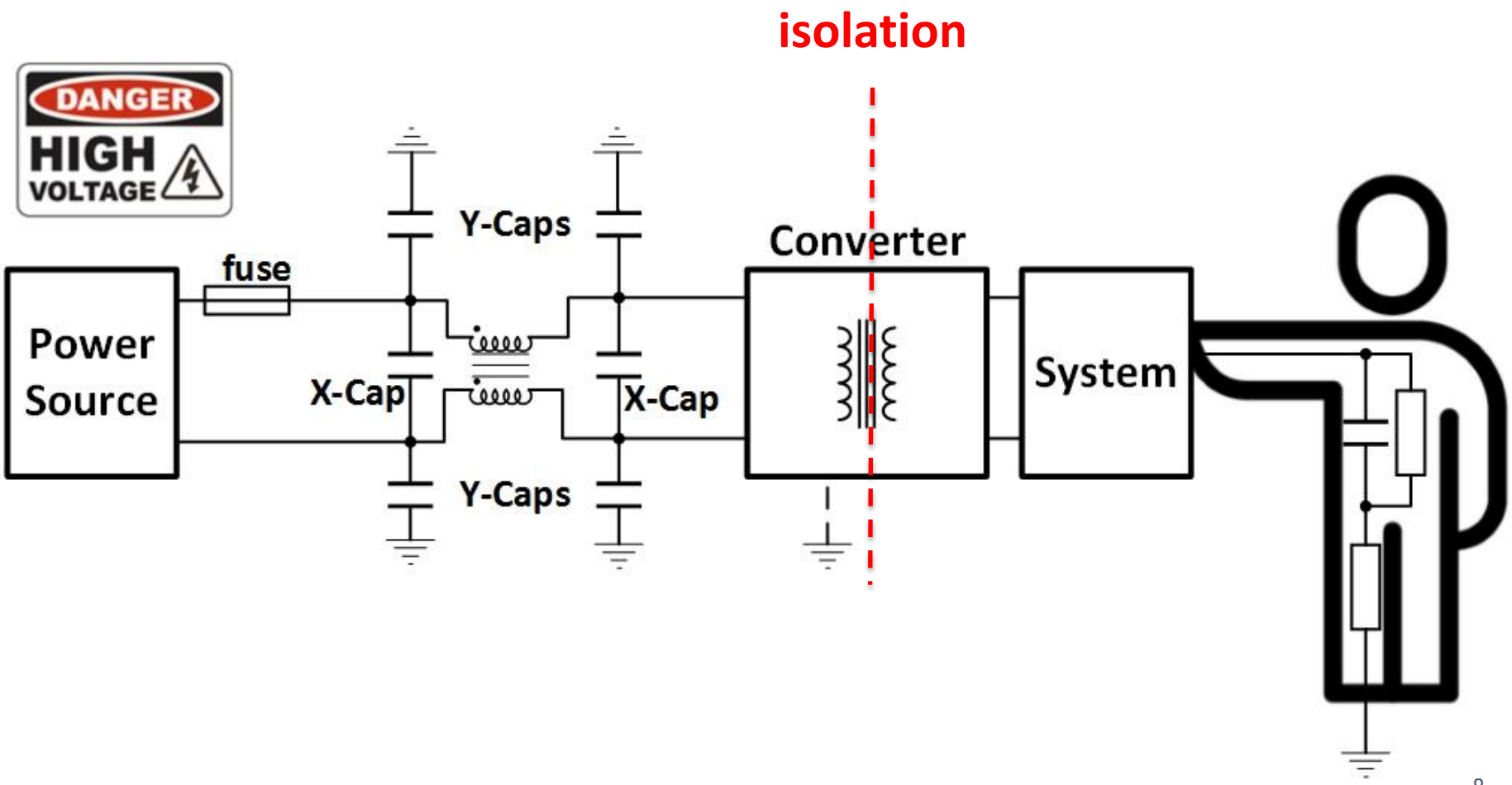
Class I
PE mandatory

Class II
No PE connection

Class III
SELV voltage

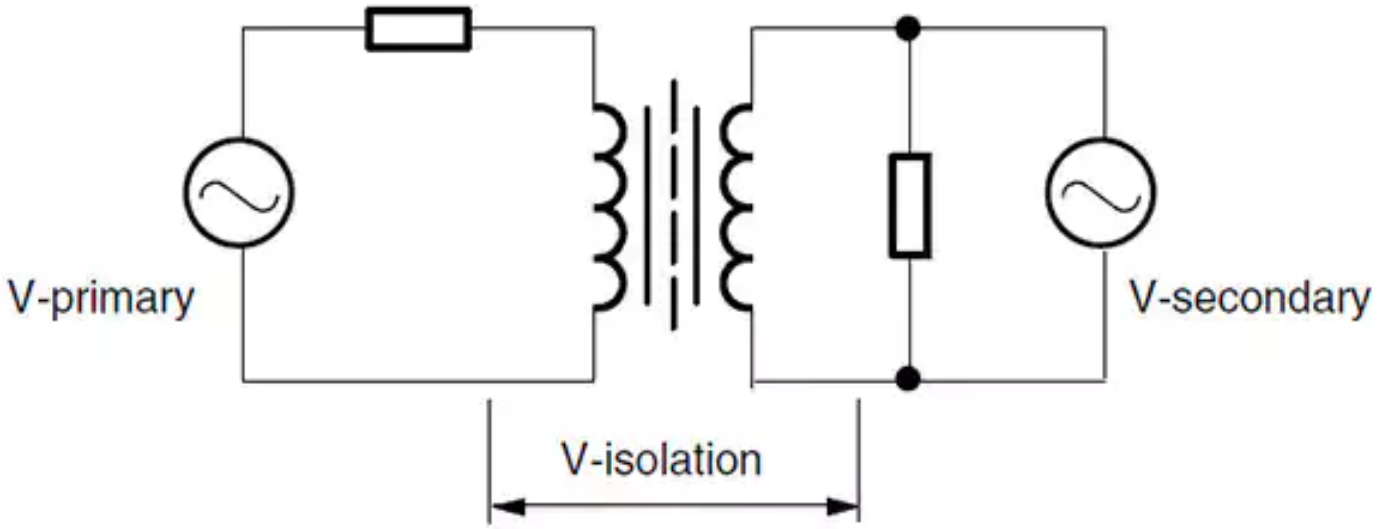


Isolation


isolation
DANGER
HIGH
VOLTAGE
Y-Caps
fuse
Converter
Power
Source
X-Cap
X-Cap
System
Y-Caps

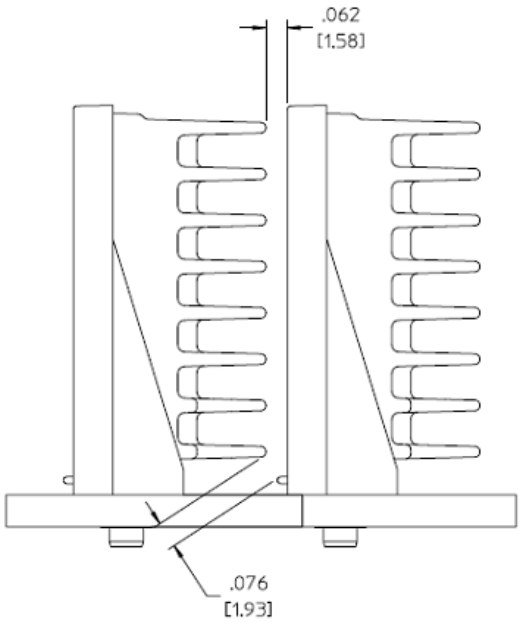
Isolation

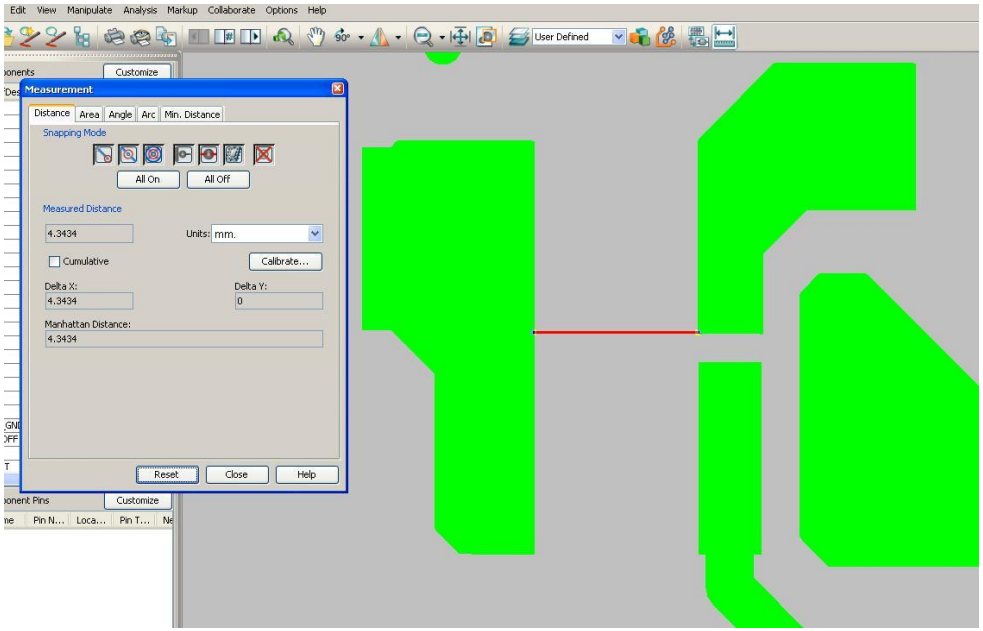
- Isolation voltage levels declared in the datasheets
- Certain Vicor products are non-isolated – see Safety Certificates
- Physical relief provided internal to Vicor products
- Designers must not compromise isolation when introducing opto-coupler/transformer based feedback for regulation



Creepage and Clearance

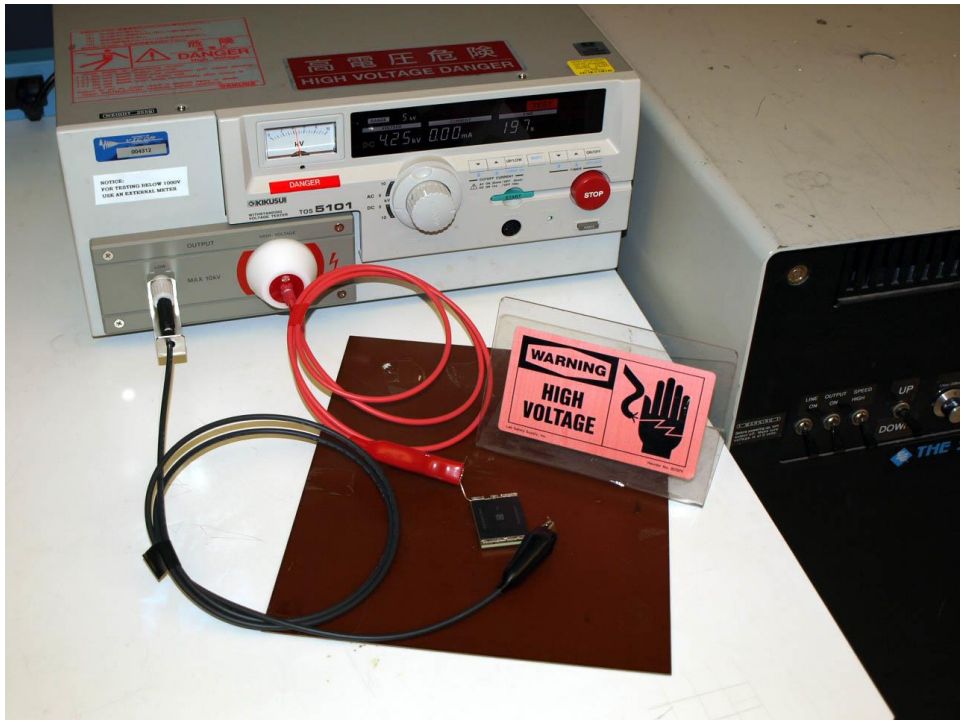
- **CREEPAGE – distance measured over an insulating surface**
- **CLEARANCE – distance measured as a straight line through air**
  - See IEC 60950-1 annex F, see also IEC 60664-1:
    Insulation Coordination of Equipment with Low Voltage





Hi-Pot Test Classifications

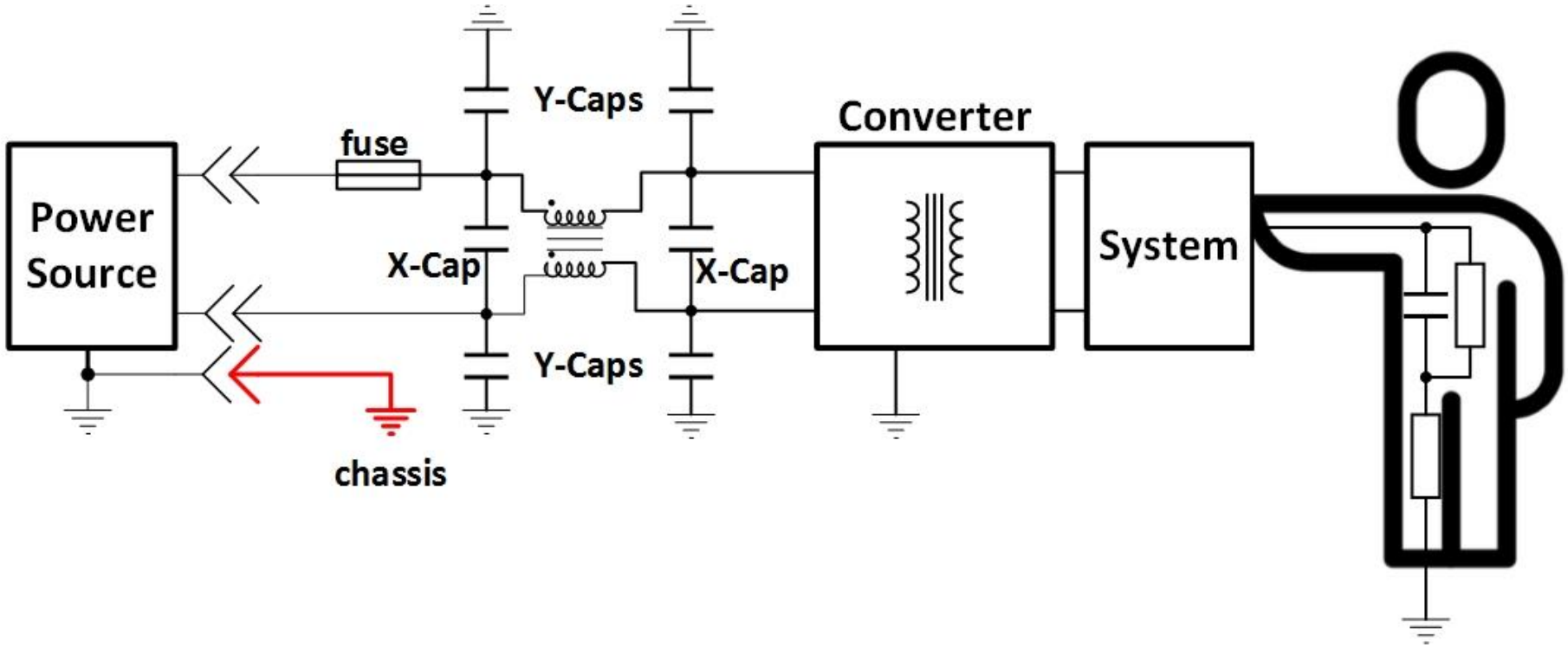
- **TYPE** test is part of the product's certification – duration 60 seconds
- **ROUTINE** test done at post-production stage 1→6 seconds typically
- Vicor products hi-pot pre-tested
- Test outcomes on the datasheet
- A customer hi-pot *post production* test should be a **ROUTINE** test of short time duration



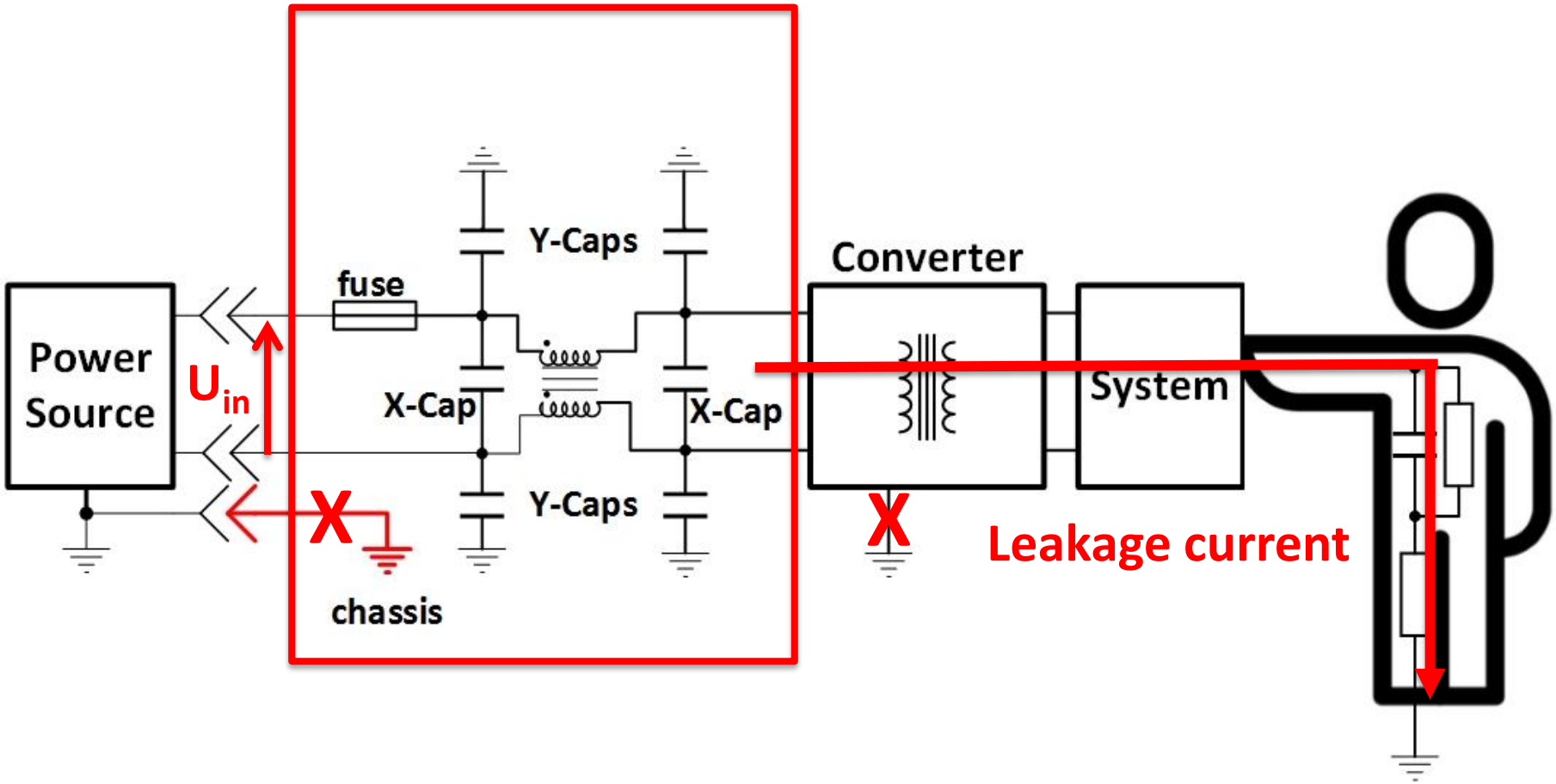
Ground Bonding Test for Class I Systems

› Ground connection needs to be tested for Class I systems

› Test procedure, parameters --- defined in the standards

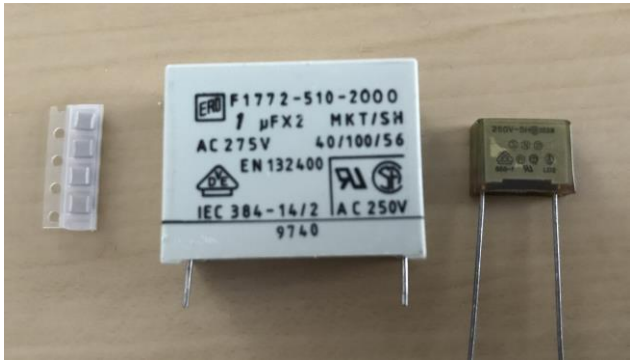


Selection and Use of X and Y Capacitors



Selection and Use of X and Y Capacitors

- **Typically required for AC sourced power**
- **The rationale for incorporating X and Y caps**
  - Controlling converter self noise
  - Suppressing conducted and radiated emissions
  - See webinar on Vicor website: Simple Ideas to Make EMI a Thing of the Past
- **X and Y caps impact both safety and EMI test results**
- **ENEC – example of harmonized approval**
- **The applicable standard IEC 60384-14**

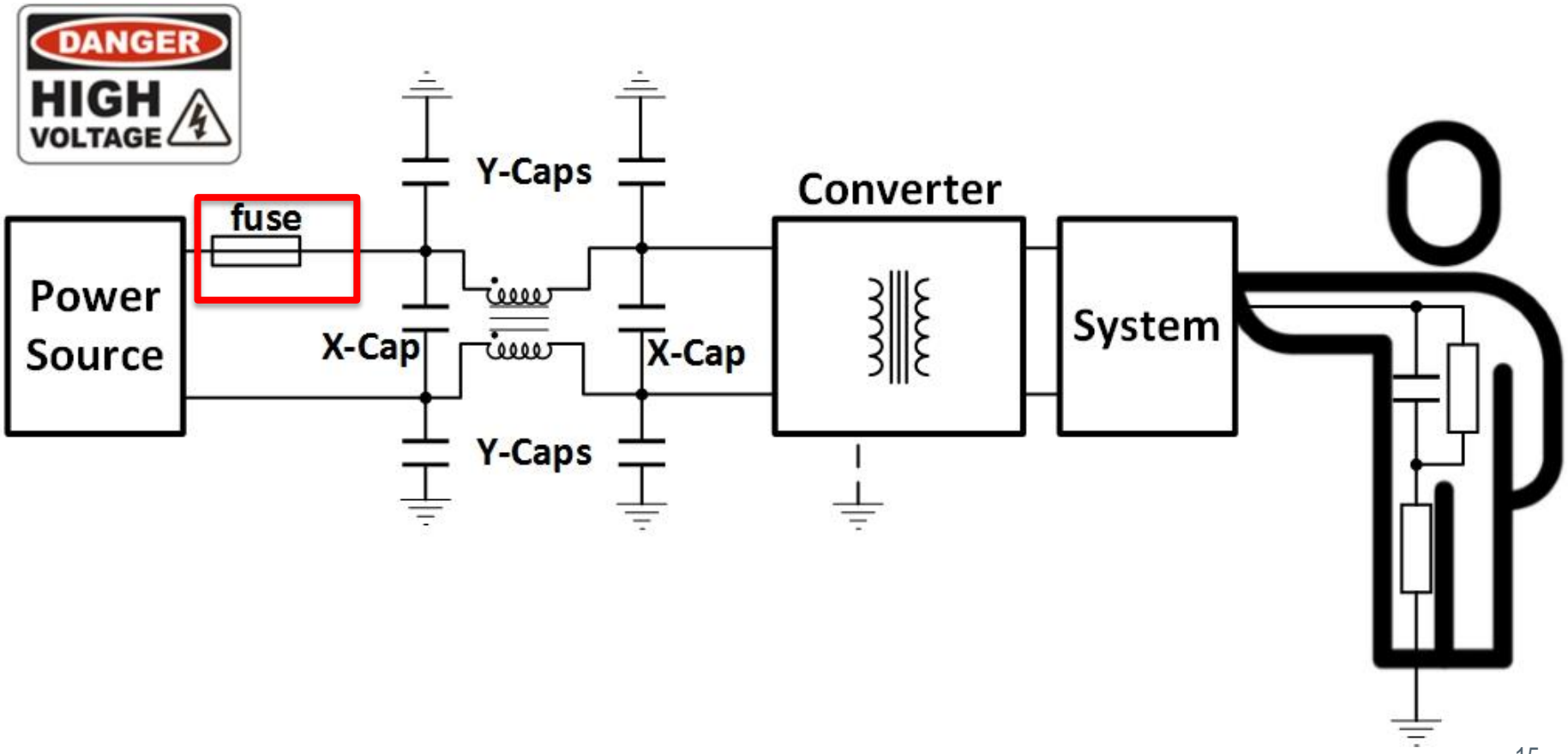


ENEC Mark

European mark of conformity (issued by Electrosuisse SEV)

Effective region	Europe
Product category	Electrical, Electronic appliances

Fuses in the System



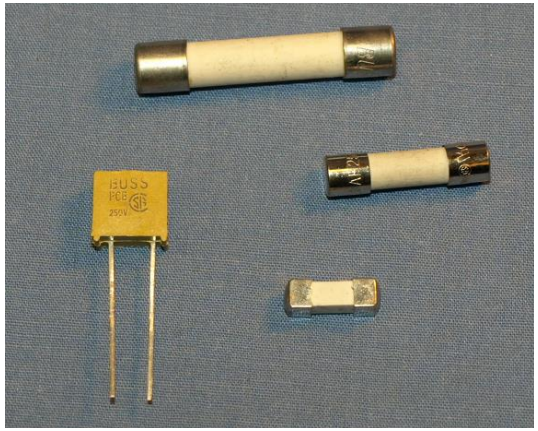
Function of the Electrical Fuse

Quickly stems large currents due to

- ground faults
- internal device failures

  May prevent a fire, if not smoke

  Open without hazard to user and equipment



Important criteria for a fuse

- current rating
- voltage rating
- speed of interrupt – circuit breakers will generally be slower
- energy or I^2t rating – alloy melts when subject to excess current
- derating for temperature

Design for Safety

Proactive Approach

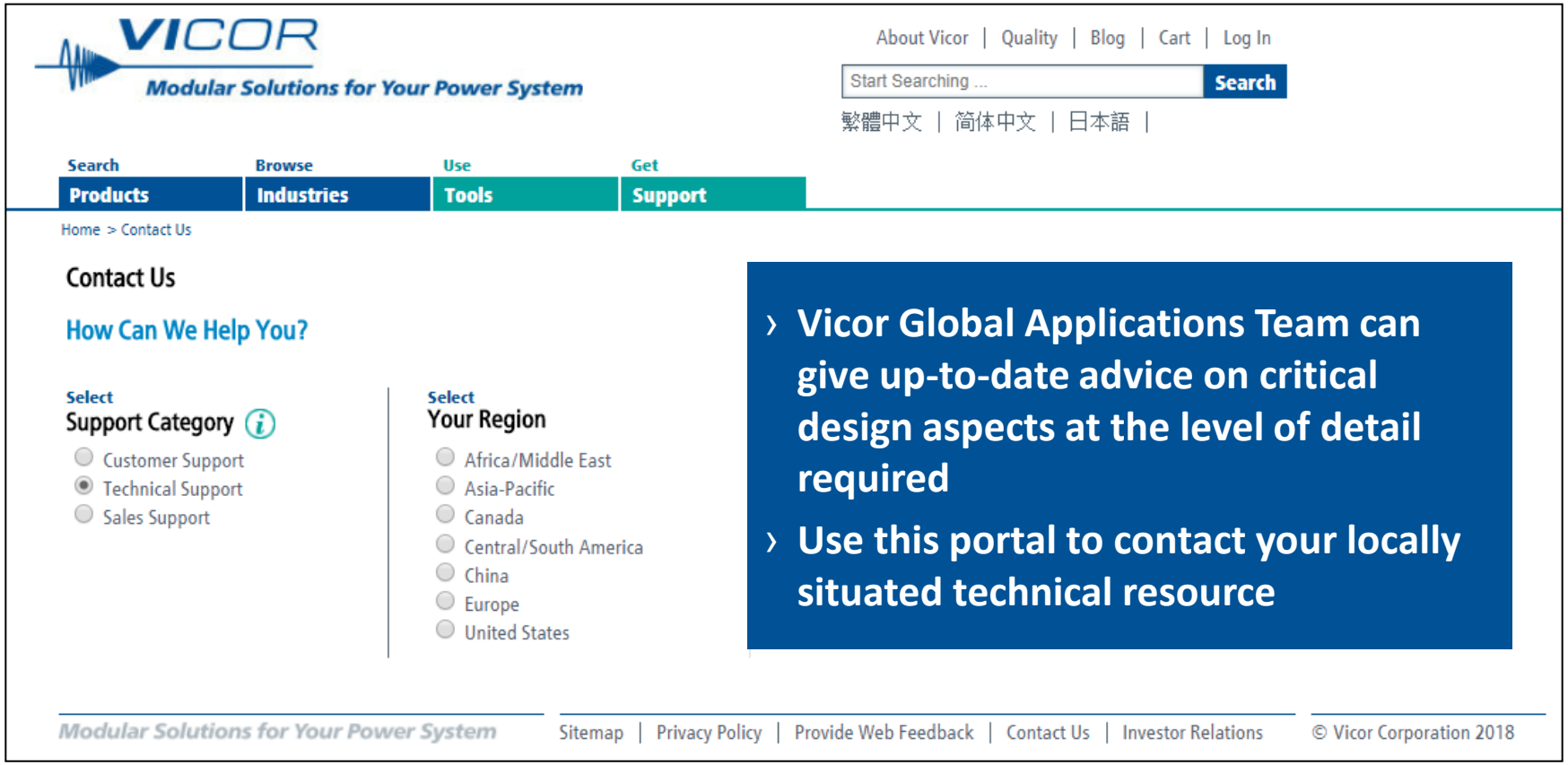
- **To guarantee Safety – a qualified Test House should be commissioned to review product**
  - safety
  - EMC compliance

  unless there is NCB approved in-house test facility

- **Once deemed satisfactory by the Test House, the manufacturer is granted the right to attach a certification mark to the tested product**

Contacting Vicor

http://www.vicorpower.com/contact-us



Vicor Product Safety Documentation

› **Most Vicor products carry Safety Marks – these are located on**
  – Datasheets and sometimes on part labels too

BCM® in a VIA Package Bus Converter

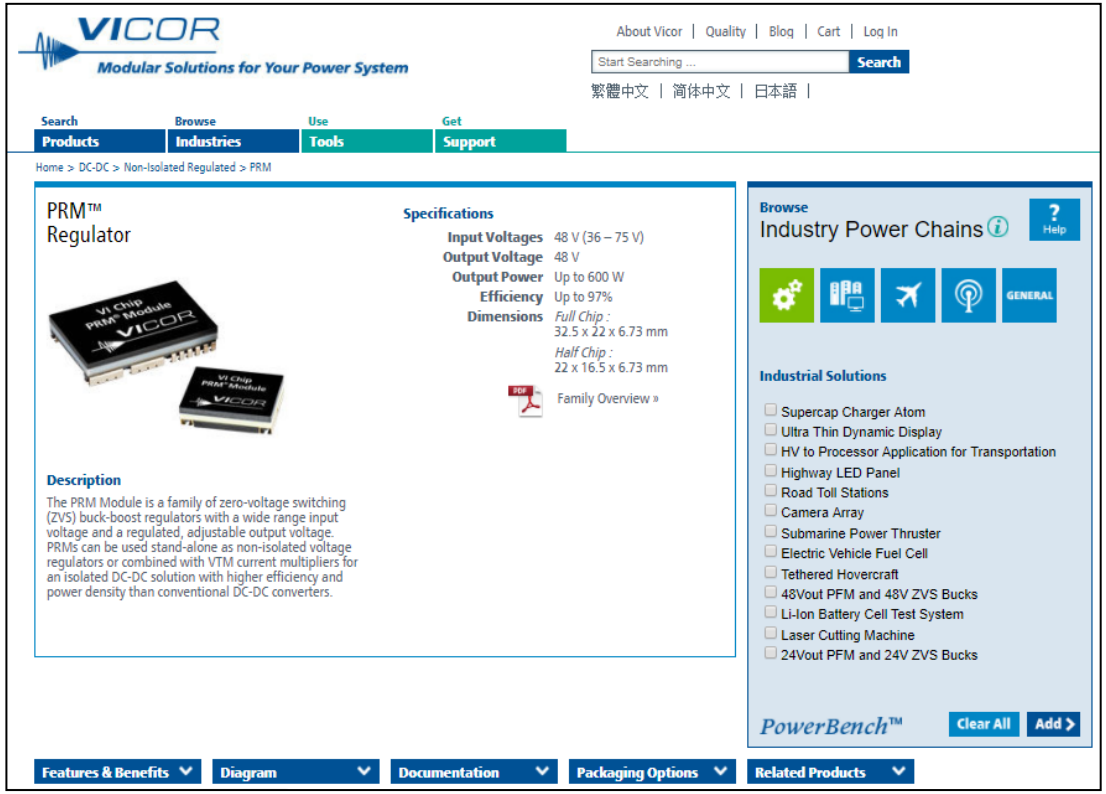
BCM4414xG0F4440yzz

BCM®
Ultra High Voltage
Bus Converter Module

› **Refer to Safety Certificates for recommended fuses, MOVs, X- and Y caps, other needed safety elements, product operational envelopes**

Locating Safety Certificates

- **Let us locate Safety Documents for an example product**
- **The PRM or Pre-Regulator Module**
  - Go to the specific PRM's web portal
  - locate the Safety Certificates under Documentation tab



Information Provided in the Safety Certificate

- Insulation and Isolation
- Fuses used in original Safety Qualification Testing
- Precautions to be adopted for integrated Vicor product

Safety Approvals

Full-Chip

PDF cURus – UL 60950-1, CSA 60950-1 »
PDF cTÜVus – EN 60950-1, UL 60950-1, CSA 60950-1 »
PDF CB Certificate – IEC 60950-1 »
PDF CE Mark – Low Voltage Directive (2014/35/EU) and RoHS Recast Directive (2011/65/EU) »

Half-Chip

PDF cURus – UL 60950-1, CSA 60950-1 »
PDF cTÜVus – EN 60950-1, UL 60950-1, CSA 60950-1 »
PDF CB Certificate – IEC 60950-1 »
PDF CE Mark – Low Voltage Directive (2014/35/EU) and RoHS Recast Directive (2011/65/EU) »

Additional Resources

- **Here are some useful Vicor links**
  - 5 Things You Should Know About DC Power
  - Glossary of Electrical Terminology
  - Best Practices Using DC-DC Bricks
- **Check out YouTube for Safety in Design of Electrical and Electronic products. Initial suggestions – search for titles containing….**
  - On The Safe SIDE - BBC2 Trade Test Film
  - CSA Group Product Certification
  - TÜV SUD Design for Safety Compliance
  - What is UL Certification?

Website Links

- **For quick reference see links to websites associated with IEC, UL, CSA and TUV standards bodies**
  - https://iecetech.org/
  - https://www.ul.com/
  - https://www.csagroup.org/service/certification/
  - https://www.tuv-sud-america.com/us-en

Q & A Session

- I would like to acknowledge the support and assistance of my colleagues at Vicor in preparing this outline presentation