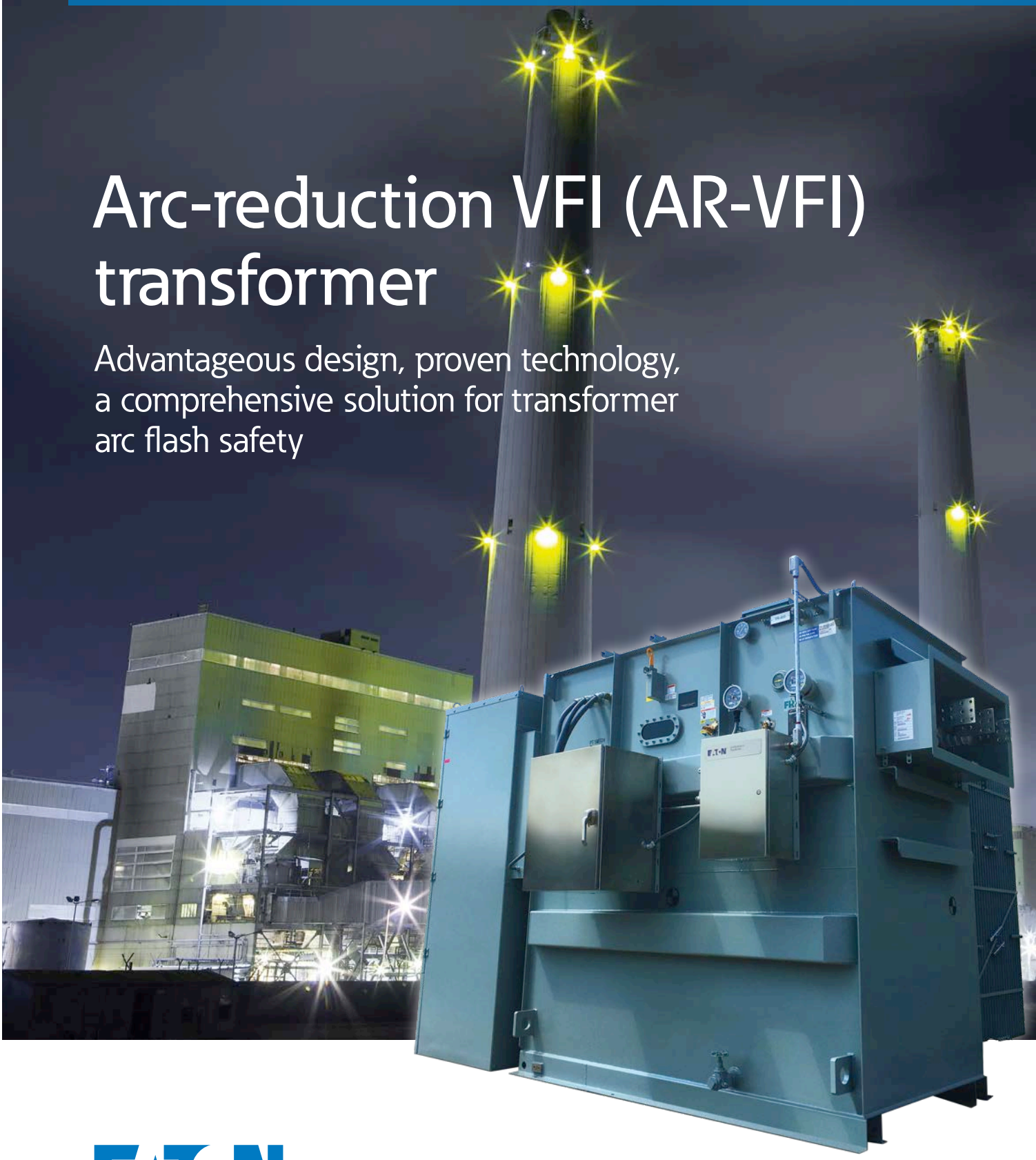
AR-VFI
(Arc-reduction vacuum fault interrupter)
Padmount and substation distribution transformer

COOPER POWER SERIES

Arc-reduction VFI (AR-VFI) transformer

Advantageous design, proven technology, a comprehensive solution for transformer arc flash safety



Powering Business Worldwide

Eaton AR-VFI transformer with external relay control box and integral primary and secondary 50/51 protection

Never compromise on safety

Eaton's Cooper Power™ series AR-VFI transformer is built with the intelligence to reduce incident energy in downstream arc flash zones and mitigate the danger posed by power distribution equipment. Utilizing Eaton's proven vacuum fault interrupter (VFI) technology paired with a microprocessor-based relay system, anomalies are sensed and transmitted through the integral control package to isolate the downstream equipment in less than 4 cycles clearing time—maximizing electrical safety and system reliability.

Overview

Built with intelligence and reliability for the grid of the future, Eaton's Cooper Power series AR-VFI transformer is designed with fully integrated medium-voltage vacuum interrupter (VFI), differential relay protection package, system control power transformer and 24-hour battery backup system capable of logging/sending/receiving data through the duration of an outage.

Eaton's AR-VFI transformer is based on legacy arc-reduction schemes built into one fully integrated package. Utilizing traditional sensing, computing and trip methods, the Arcflash Reduction Maintenance System™ minimizes signal proximity to reduce fault clearing times to 4 cycles or less.

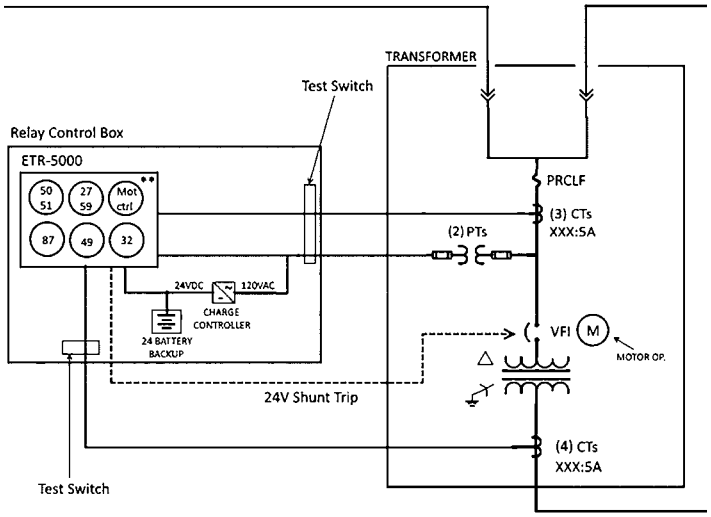
Features

- Primary and secondary 50/51 overcurrent protection
- Self-powered, adjustable differential protection
- Direct trip integral VFI
- Direct trip to local or remote breakers
- Metering and monitoring capabilities
- Eliminates human-to-energized equipment interaction
- Faster clearing time (<67 ms)
- Minimizes impacts of fault events
- Decreases annual substation downtime
- Increases power reliability
- Increases ease of maintenance and asset preservation
- Envirotemp™ FR3™ fluid-filled substation or padmount transformer, FM or UL® listed and Classified (optional)
- Integral VFI
- Integral PRCLF for up to 50 kA interrupt (recommended)
- Primary deadfront terminations (recommended)
- Wired under-oil primary and secondary CTs
- Variety of 24 Vdc differential relays with Eaton ETR standard
- Integral control power and 24-hour relay battery backup

Advantages

- Transformer and VFI tested per IEEE® C57.12.00™
- Preprogrammed relay overcurrent settings
- Entire assembly factory tested and functionally verified prior to shipment
- Standardized package offering engineered for flexibility in any application
- No additional lead-time as compared to standard Eaton transformers

Example single-line diagram of AR-VFI transformer schematic with Eaton E-Series ETR-5000 differential relay



Above package includes:
Padmount or substation style transformer, integral primary VFI, differential relay, under-oil primary and secondary CTs, under-oil primary PTs, integral 24-hour relay battery backup, motor operator for VFI.
(Relay + test switches and space heater in NEMA® 4X control box.)

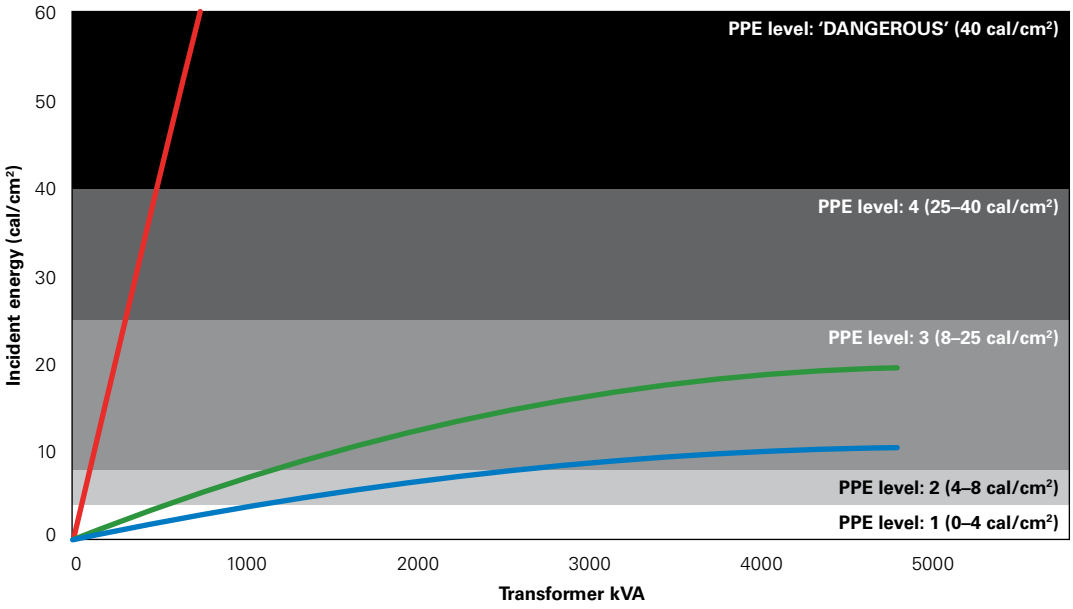
Note: Additional ANSI device elements available—see relay catalog for details.

VFI ratings

Nominal voltage		15 kV	15 kV	25 kV	35 kV
Maximum design voltage, kV		15.5	15.5	27.0	38.0
3-second withstand current (sym.), kA		12.5	16.0	12.5	12.5
Fault interrupting	Continuous current, (max), A	900	900	900	900
	Interrupting current (sym./asym.)	12.5/20.0	16/25.8	12.5/20.0	12.5/20.0
	Making current (sym.), kA	12.5	16.0	12.5	12.5
Load-break switching	Load switching, A	900	900	900	900
	3-shot make and latch (asym.), kA	20	25.8	20	20
Minimum full life fault interrupting duty cycle per IEEE Std C37.60™ -2003 standard (2 duty cycles)		Number of operations			
Percent of interrupting current rating:	15–20%	88	88	88	88
	45–55%	112	112	112	112
	90–100%	32	32	32	32
Total		**232**	**232**	**232**	**232**

Transformer secondary incident energy vs. transformer kVA

(Three-phase 480 V secondary ANSI standard impedance 5.75%, 18" working distance—IEEE 1584—2018 calculations)



Shown on the left is a comparison of incident energy in the transformer secondary compartment as transformer kVA increases. Calculated values using the updated IEEE 1584-2018 standard show more accurate and stringent incident energy values for transformers. Designs highlighted in this study are traditional overcurrent protection, new AR-VFI design with 50P pickup and AR-VFI with arc-light sensing.

Power reliability and personnel protection

Arc flash safety requirements are drastically increasing as our grid expands and more stringent codes and regulations are released.

- **Dead-front connections** provide safety where applicable, but these terminations are seldom an option for high-current transformer secondaries. Arc flash energy calculations have revealed these areas can present a serious problem for worker access and equipment maintenance. (Zones with incident energy above 40 cal/cm^2 are inaccessible until upstream device is opened).
- **Space limitations** can be a major driver in system design and integration. Eaton's AR-VFI transformer reduces the footprint of a comparable legacy system (MVS + dry-type transformer + LVA) by up to 60%, allowing a fully functioning Arcflash Reduction Maintenance System to be installed in locations that may previously been impossible.

AR-VFI ratings (transformer/interrupt)

- 150–12,000 kVA
- Primary voltage through 34.5 kV, 150 kV BIL
- 900 A continuous current on primary
- 12.5 kA rms interrupting at 15/25/35 kV (16 kA at 15 kV optional)
- Up to 50 kA rms interrupting rating with VFI and under-oil partial range current limiting fuse

Relay compatibility

- Eaton E-Series differential relays standard
- Schweitzer (SEL)
- Others as applicable

Monitor transformer alarm signals

- Liquid temperature gauges
- Liquid level gauges
- Winding temperature indicators
- Pressure/vacuum gauges
- Rapid rise relay
- Cover-mounted pressure relief device
- 4–20 mA transducers
- Power metering/monitoring

Standardized communications

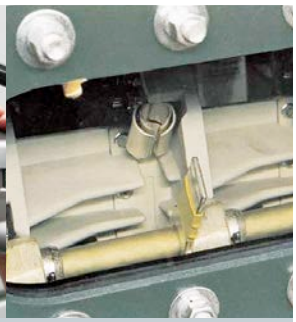
- Ethernet, serial or fiber
- Modbus® RTU/TCP, DNP RTU/TCP/UDP, IEC61850, PROFIBUS®
- Power Xpert® compatible

External control box

External drain valve

External gauges

IR windows



Visible disconnect

Additional AR-VFI transformer arc mitigation options

Combat arc flash hazards with Eaton's full stack of risk management solutions:

- External control boxes and external gauges
- External drain valve/sampler
- External loadbreak switches and visible disconnect windows
- IR windows
- External nameplates (*not shown*)

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