

DS-VFI transformer
Medium-voltage padmount transformer

COOPER POWER
SERIES

Dual Source VFI (DS-VFI) transformer

The ultimate protection and automation solution for medium-voltage distribution systems.

EATON

Powering Business Worldwide



Save space. Save time. Get back online.

The compact, versatile solution for power delivery and automation.

Eaton's Cooper Power™ series Dual Source VFI (DS-VFI) transformer provides automatic source recovery, built-in overcurrent protection, and grid automation schemes for the modern electrical distribution system.

Designed with flexibility for multiple applications, the DS-VFI transformer combines state-of-the-art switchgear controls and automation with proven high-efficiency liquid-filled transformer technology in a single assembly, enabling complete medium- to low-voltage distribution protection and automation in a compact, cost-effective package.

Overview

The DS-VFI transformer comes standard with dual motor operated vacuum fault interrupters and a local Eaton ETR-5000 protection and automation controller.

The ETR-5000 relay can be configured with various firmware packages to tailor control and automation functionality to your specific medium-voltage distribution architecture (see Type 1, 2 and 3 packages).

Integrated current transformers provide the ETR-5000 relay with real time, independent current measurement for each source feed, allowing the protection system to monitor overcurrent events both internal and external to the transformer assembly.

Line-side voltage sensors present at each source feed allow the ETR-5000 to continually monitor the health of the source, providing the system necessary information for safe automatic source transfer.

At the heart of the DS-VFI transformer resides the core and coil. Rated up to 4,000 kVA, with primary connection up to 35 kV 150 kV BIL, the DS-VFI transformer offers robust and high efficiency voltage transformation for you most critical applications.

Automatic protection and outage recovery for critical-load commercial and industrial applications.

Standard features

- Substation or compartmental padmount style transformer per specification
- Dual motor operated VFIs with aux. contacts (for VFI ratings, see page 8)
- Local ETR-5000 differential relay and automation controller
- Integral primary under-oil CTs for each feed (six total CTs)
- Integral line-side voltage sensors for each feed (three voltage dividers per source)
- Visible on/off/ground switch (optional)
- NEMA 4X UL Listed control box containing:
 - ETR-5000 differential relay
 - CT/PT test switches
 - Integral 120 Vac CPT source power
 - 24 VDC battery backup system
 - Space heater with thermostat
 - VFI open/closed/tripped status lights
 - Local motor control interface
 - A/B preferred source selector switch
 - Manual/automatic selector switch
 - VFI 86 lockout indicators and lockout reset switches
 - Gauges and alarm devices wired to relay (as requested)

Advantages

- Consolidated, factory-validated design
- Factory programmed protection and automation scheme
- Greatly reduced on-site labor
- Less hassle sourcing compatible components
- Lower operational cost
- Lower total ownership cost
- Increased system reliability and resilience
- Reduced downtime from outages
- Quick feed changer over scheme to reduce gen-set runtime (several hours reduced to <6 sec)
- Greatly reduced air permitting costs due to reduced gen-set demand
- Fewer pieces of equipment, overall
- Less cable, connectors and terminations



Type 1 DS-VFI transformer: Main-main application

Type 1 functions

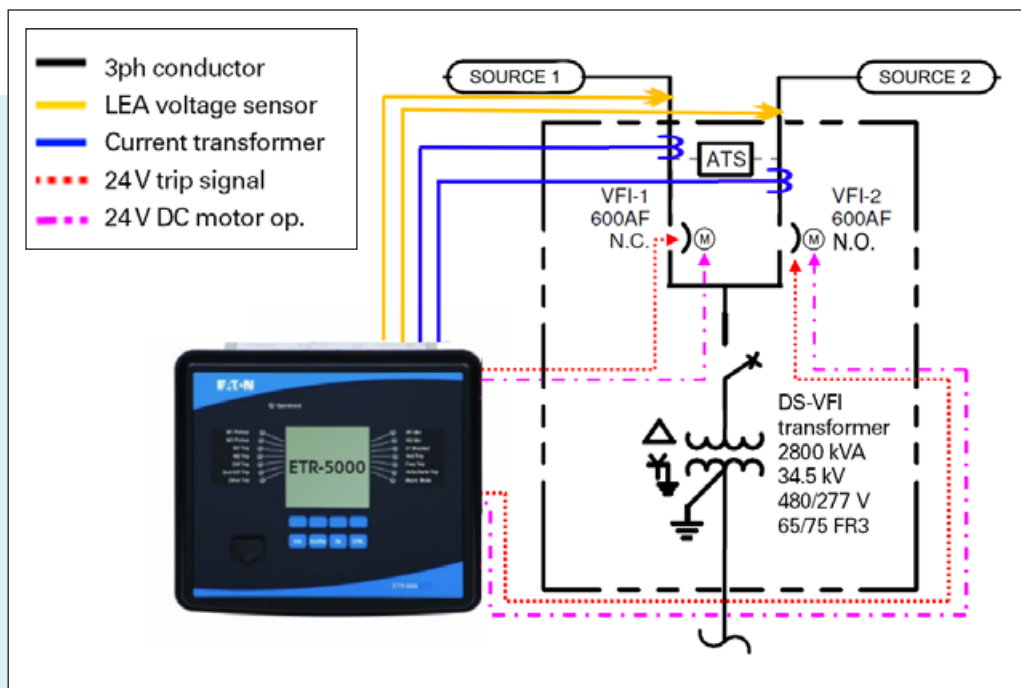
- Dual primary feeder overcurrent (50/51) protection
- Over/undervoltage (59/27) protection
- Local/remote control of VFIs
- Factory-programmed automatic open-source transfer
- Eaton “preferred source” auto-restoration logic
- Parallel source prevention
- Electromechanical (86) lockouts for both VFIs
- Trip circuit monitors for both VFIs
- Digitally enabled asset monitoring

Application

When connected to a main-main type system, the DS-VFI transformer utilizes the dual internal vacuum fault interrupters and integral control scheme to provide dual feeder overcurrent protection (50/51) and automatic open-source transfer during overvoltage/loss-of-voltage events for main-main applications.

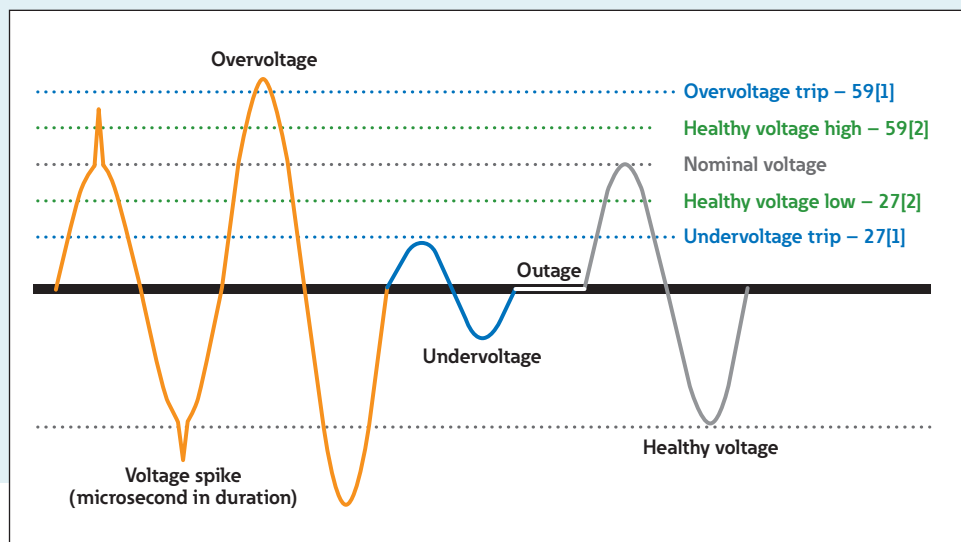
Integrated into a compact liquid-filled transformer, the system provides **preferred source logic** to maintain continuity of service via a user-selected preferred source. Simultaneously, the active VFI and protective relaying provide fast-reacting overcurrent protection for the transformer.

By performing a safe automatic recovery, your system can be back online within seconds without the need to run expensive backup generators while manually reconfiguring your system.



Comprehensive monitoring of both incoming sources and all transformer alarm parameters via ETR-5000 relay

Programmable overvoltage and undervoltage trip and “healthy voltage” boundaries for each feed





DS-VFI transformer Type 2 and Type 3: Loop applications

Expanding the system to a medium-voltage loop or ring-main application, the DS-VFI transformer's protection and automation scope can be drastically increased.

Utilizing Eaton's SMP Gateway automation controller to connect the system, the DS-VFI transformers now provide full protection and automatic outage restoration for any cable fault between transformers, or an overcurrent fault within a transformer. The system will also recognize under/overvoltage scenarios at either source feed and automatically reconfigure the loop to restore transformers without power, minimizing outage duration for your critical loads.

Mounted locally to a single DS-VFI transformer, the SMP 4DP Gateway hosts a web-based HMI allowing users to have full control over the source and loop VFIs.

In systems where the transformers are fed by larger metalclad feeder switchgear, the system can be monitored and controlled from a central Eaton SMP Gateway SG-4260 and touchscreen HMI. The HMI provides real-time status information on all VFIs as well as diagnostic data for each individual transformer.

The DS-VFI system features enhanced automation safety and backup protections to ensure the system is never improperly reconfigured or left unprotected.



Type 2 and Type 3 DS-VFI transformer functions:

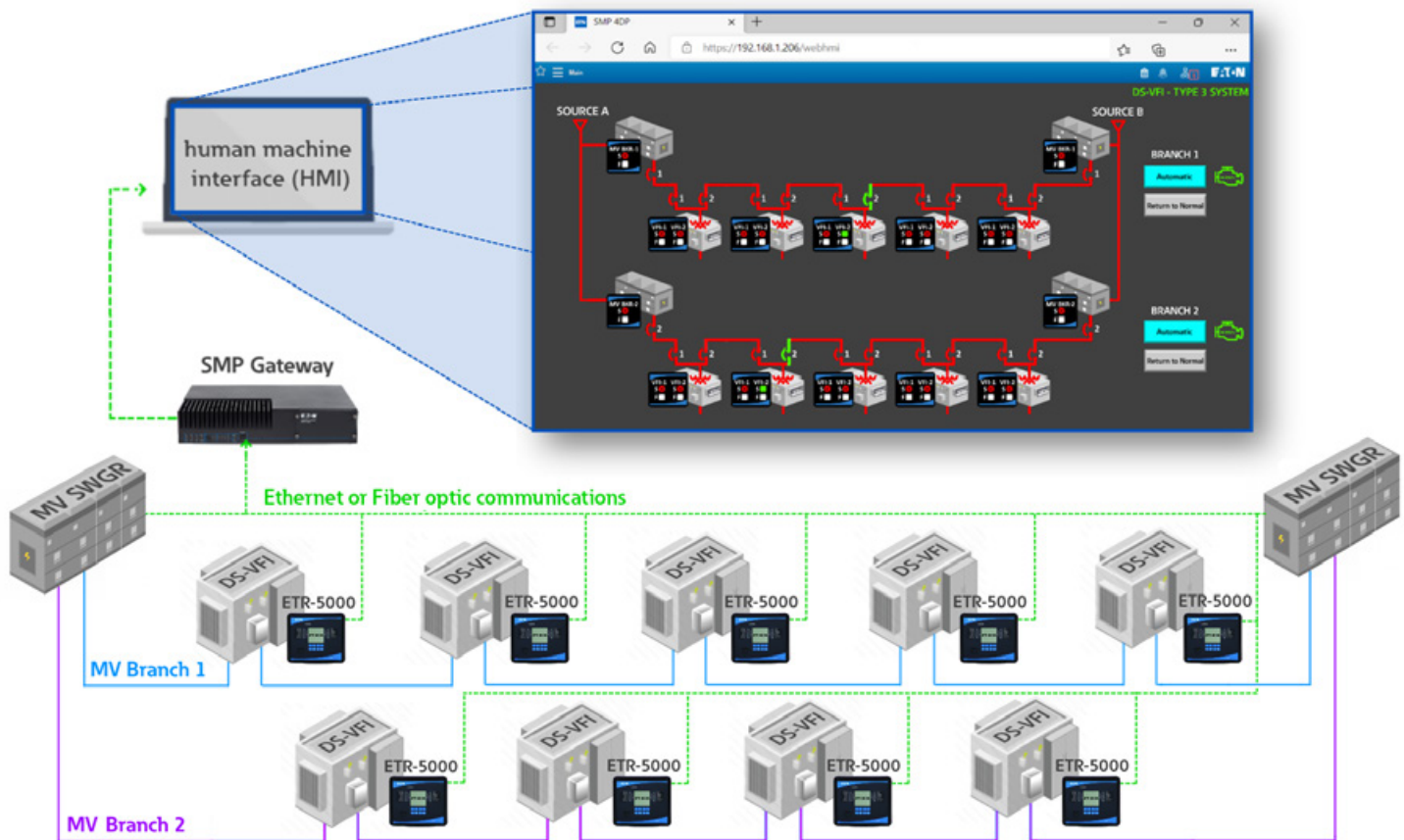
- Complete protection of medium-voltage (MV) loop and transformer control of all medium-voltage switching
- Fault location isolation and service restoration (FLISR) scheme, for transformer (87) and loop (50/51) faults
- Loss-of-source (under/overvoltage) auto-restoration
- Automatic and manual normally open (N.O.) point relocation and return-to-normal function
- Electromechanical (86) lockouts for both VFIs
- Trip circuit monitors for both VFIs
- Parallel source prevention for loop application
- Loss-of-communications automatic backup protection
- Digital monitoring of full MV distribution system
- Web-based HMI for control and monitoring (touchscreen HMI available with SMP SG-4260)
- Validated in combined fault and multi-branch systems

Type 2 – A small system of DS-VFI transformers connected directly to utility sources

- Requires single Eaton SMP Gateway 4DP installed on one transformer of the set
- Up to three (3) loops of up to eight (8) DS-VFI transformers
- Web-based HMI only

Type 3 – A large system of DS-VFI transformers connected to metal-clad MV switchgear (MVS)

- Requires single SMP Gateway SG-4260 installed within MVS
- Up to ten (10) loops of up to six (6) DS-VFI transformers plus two (2) source breakers per loop
- Web-based and optional local touchscreen HMI

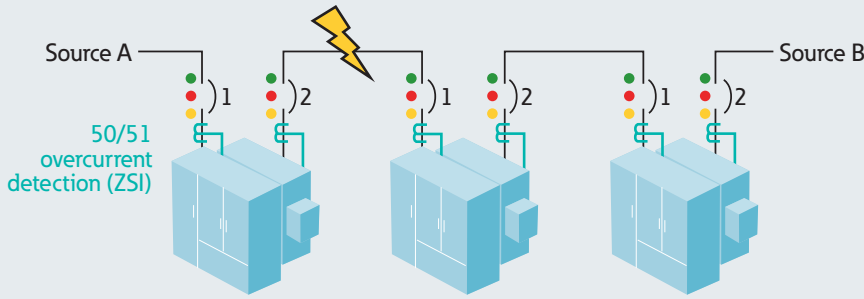


Example of Type 3 DS-VFI system shown above.

DS-VFI transformer system architecture diagram

Multiple branches of DS-VFI transformers interconnected in a loop or ring system with primary terminations tapped off one of two lineups of MV switchgear (shown above from the left and right MV switchgear, MV-A and MV-B). Each DS-VFI transformer houses a local ETR-5000 differential relay that performs the loop and transformer protection functions. Automatic loop restoration and/or source transfer schemes require MV transformer relays to be connected to substation automation controller. For Type 3 applications substation automation controller (Eaton SMP Gateway SG-4260) shall be located either MV-A or -B with optional touchscreen HMI.

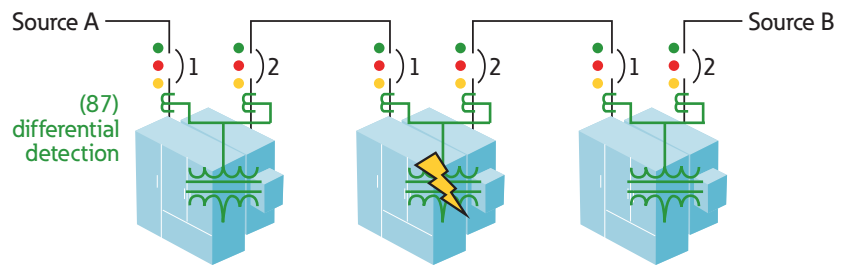
Isolate loop faults and restore power



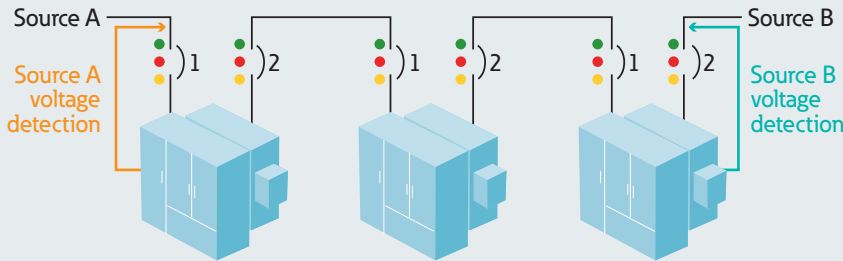
Coordinated (50/51) overcurrent protection is used to interrupt and isolate cable faults between transformers. After isolation, the SMP Gateway assess the condition of the loop and, if deemed safe, will close in the normally open point to restore power to down transformers.

Auto-reconfiguration of loop for transformer overloads

Factory-programmed (87) differential overcurrent sensing is used to directly monitor transformer loading. If current in excess of the rated load of the transformer is detected the system will automatically isolated the transformer and rearrange the loop to ensure other units remain energized.



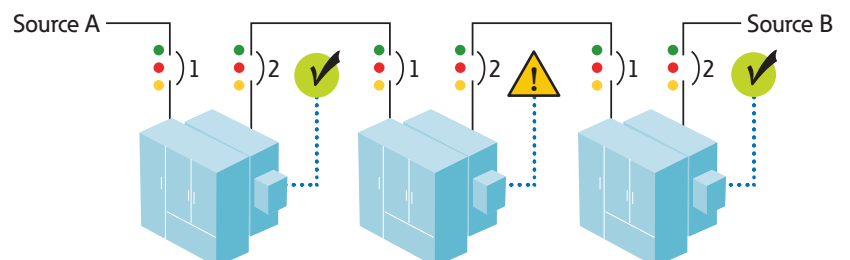
Loss-of-source automatic transfer



Line-side voltage sensors on each source transformer allow the DS-VFI system to continually monitor source voltage health and determine if an open source auto-transfer is necessary. If undervoltage or overvoltage is detected, and another healthy source is available, the system will automatically transfer the entire loop to the alternate healthy source.

Loss-of-communications backup protection

Each ETR-5000 relay utilizes high-speed GOOSE messaging and IEC 61850 protocol to perform protective functions and share status information across the system. Communications are monitored 24/7 to ensure proper system functionality. In the event of a loss of communications, the system will automatically engage backup protective settings to ensure loop and transformer faults are still cleared and isolated, and scope of the fault, and number of VFIs triggered, are minimized.



Specifications and ratings

- Range through 4,000 kVA
- Primary voltage through 35 kV (150 kV BIL)
- Dual motor operated vacuum fault interrupters (VFIs), standard
- Type 1 DS-VFI — up to 25 kA with partial range current-limiting fuses (PRCLFs), subject to availability
- Secondary voltage 208 Y/120 to 24,940 Y/14,400
- Outdoor or Indoor rated
- Substation or padmount design
- FR3™ fire-resistant dielectric fluid (optional)

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	600	600	600
	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
Loadbreak switching	Load switching, A	900	600	600	600
	3-shot make and latch (asym.), kA	20	25.8	20	20

Minimum full life fault interrupting duty cycle*

Number of operations	15 kV	15 kV	25 kV	35 kV	
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	

*Per IEEE Std C37.60™-2003 (two duty cycles)

Brightlayer digital solutions



Reveal the possibilities embedded in your data and optimize your operations with a new perspective on achieving your digital transformation goals with Eaton's Brightlayer software suites. For more information on Brightlayer digital solutions, visit Eaton.com/Brightlayer.

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