This webinar brought to you by the Relion® product family
Advanced protection and control IEDs from ABB

Relion®. Thinking beyond the box.

Designed to seamlessly consolidate functions, Relion relays are smarter, more flexible and more adaptable. Easy to integrate and with an extensive function library, the Relion family of protection and control delivers advanced functionality and improved performance.

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ABB Protective Relay School Webinar Series

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REF615R – Feeder Protection & Control

Presenter

Bob Wilson

Bob graduated from Purdue University and joined Westinghouse Electric Corp. After receiving a Masters degree in Electrical Engineering from Carnegie Mellon University, Bob was a Systems Analysis Engineer responsible for software designed to automate system-wide coordination. He then transferred to Kansas City where he assumed the role of District Engineer and eventually moved to the Houston area where he currently resides.

In his current role as Regional Technical Manager, he supports ABB's Substation Automation and Protection Division, providing technical support to customers throughout the South Central United States. Bob is a senior member of IEEE and has authored and presented several papers in power system protection at a variety of technical conferences throughout the United States. He is a Registered Professional Engineer in the states of Pennsylvania and Texas.
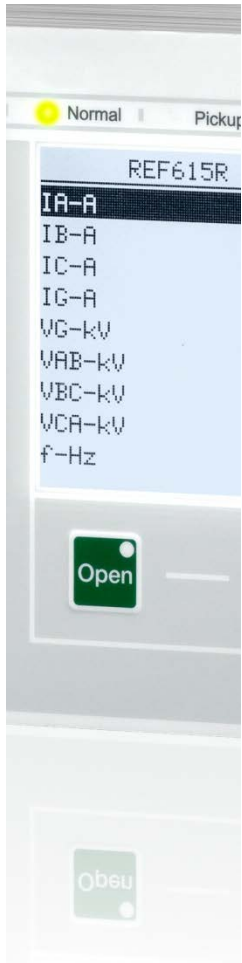
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REF615R - Feeder Protection and Control
Agenda

- Introduction

- Relion® Family

- Product Overview

- Physical Overview

- HMI Features

- Functional Overview

- Summary

REF615R - Feeder Protection and Control
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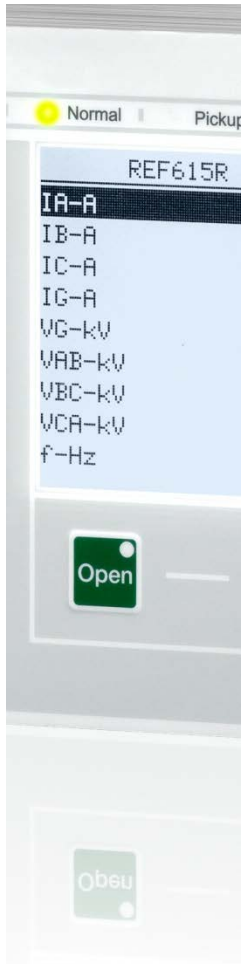
- **Introduction**

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Introduction
Why refurbish/replace relays?

- Outdated technology

- Cost to repair/replace obsolete assemblies

- Inadequate protection functions

- Inability to support Smart Grid applications

- Regulatory standard compliance

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Introduction
Cost of refurbishment/replacement

Cost of refurbishment include:

- Modifying drawings

- Mechanical changes to cabinets, doors or cut-outs

- Wiring and labeling

- Integration into existing substation automation system

- Testing & commissioning - Bay, HMI & control center(s)

Most of these costs exceed the price of a relay

How do we reduce these costs & risks to accelerate refurbishment?

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Reducing upgrade costs
What to look for?

Mechanical compatibility

   Utilize existing cutout and existing CT, VT, I/O wiring

Enhanced performance & functionality

   Features that improve operational efficiency

   Simplify user experience

   Features that improve personal safety

Communication & security

   Support legacy and modern communication interfaces

   Provide multiple protocol support without impacting cost

   Provide easy migration into existing automation system

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Reducing upgrade costs
What to look for? (cont)

Future proof

> Make it possible to extend application capability without additional hardware (I/O, wiring, etc)
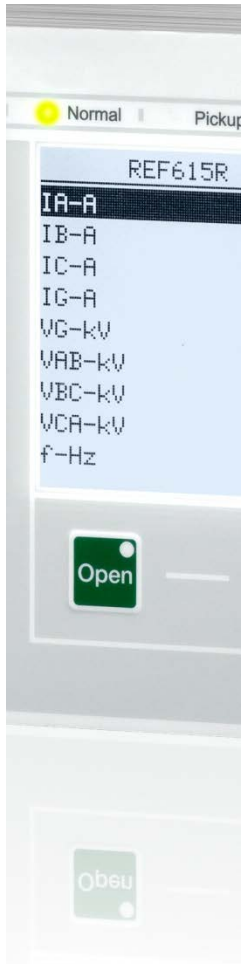
Reliability & maintenance

> Designed product life for 15+ years of uninterrupted operation

> Draw-out and modular design (low MTTR)

> Support easy diagnosis of faults (with limited skills)
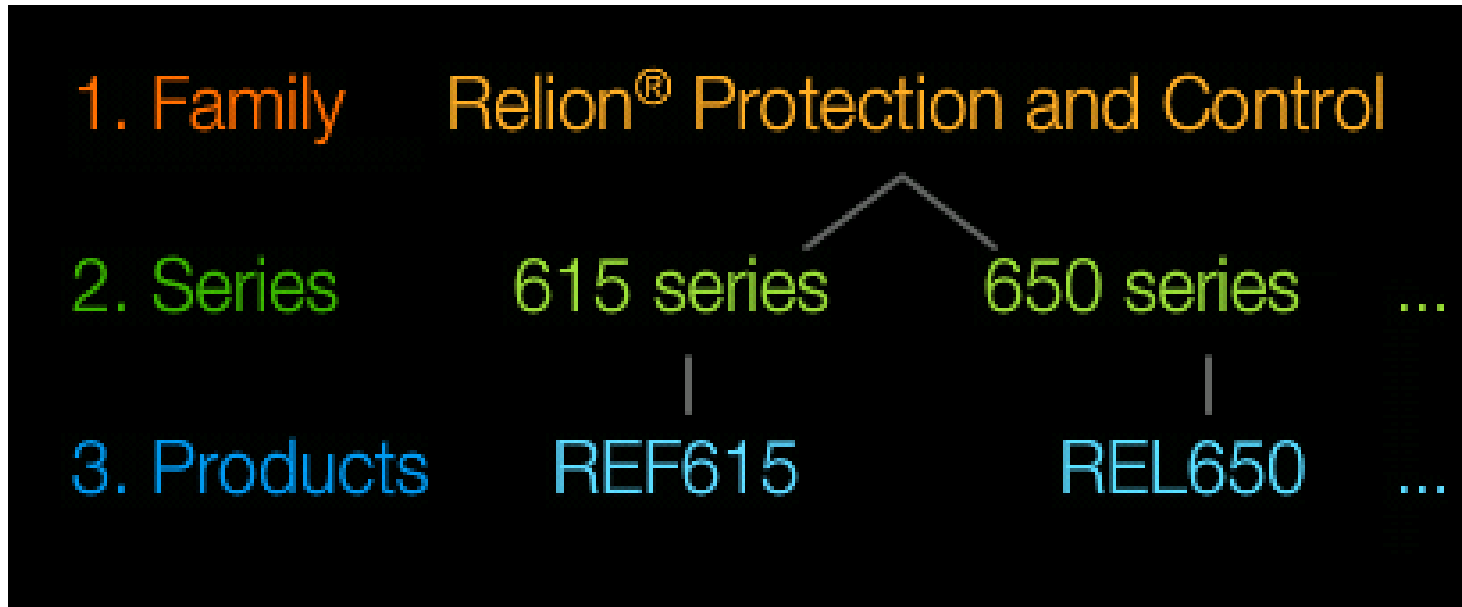
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Relion® family
Thinking beyond the box

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Relion® family
Naming

1. Family   Relion® Protection and Control

2. Series   615 series   650 series   ...

3. Products   REF615   REL650   ...

Relion® family
Six series for protection and control

❑ Covering transmission and distribution

- **670 series**
  Optimized for transmission applications

- **650 series**
  Your best choice for sub-transmission applications

- **630 series, 620 series**
  Flexibility and performance for demanding utility distribution and industrial applications

- **615 series**
  Compact and powerful solution for utility distribution and industrial applications. Includes REF615R.

- **610 series**
  Dedicated protection for utility distribution and industrial applications

- **605 series**
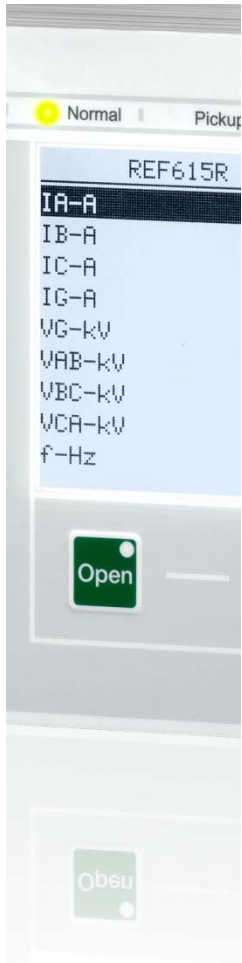 Simplicity for secondary distribution applications
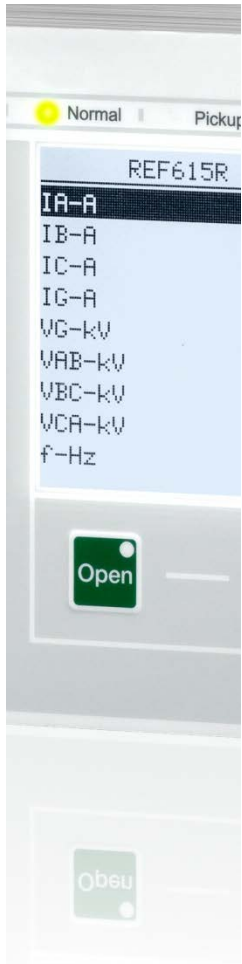
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Product overview
REF615R value benefits

1. REF615R is ideal for new distribution protection and control designs

2. REF615R replaces older technology relays with state-of-the art technology

3. REF615R is the quickest and most economical DPU2000R replacement solution

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Product overview
REF615R highlights

- Affords DPU2000R migration solution to customers

  - Available while DPU2000R still manufactured

- Delivers four major 'ease of replacement' benefits

  - Same form and fit eliminates panel cutting or rack repositioning

  - Wire-alike for I/O and CT/VT connections

    - Same terminal numbers eliminates drawing changes other than product name

    - Same spatial location eliminates breaking wire bundles

  - Exceeds comparable protection and control

  - Near SCADA-alike for DNP3.0 and Modbus

- Designed to replace ANSI and IEC DPU2000Rs

  - Qualified to ANSI and IEC standards for utilities, industrials

  - Ring lug terminals

- Certified UL Listed for industrials

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Product overview
Design tailored for DPU2000R upgrade

- One configuration tailored to meet and exceed the DPU2000R configurations

    - Standard: 587R… (ANSI); 687R… (IEC)

    - Synch Check: 587C… (ANSI); 687C… (IEC)

    - SEF: 587E… (ANSI); 687E… (IEC)

- Pre-configured at the factory and programmable by user

- Front panel (LHMI) order code options to match DPU2000R Standard OCI and Enhanced OCI front panels

- Advanced protection and communication options

- Possible to add, delete and change signal connections for binary inputs, binary outputs and between function blocks using signal matrix tool

- Possible to implement far more complex logic applications graphically using the application configuration tool
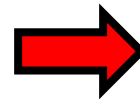
Product overview
Design tailored for DPU2000R upgrade
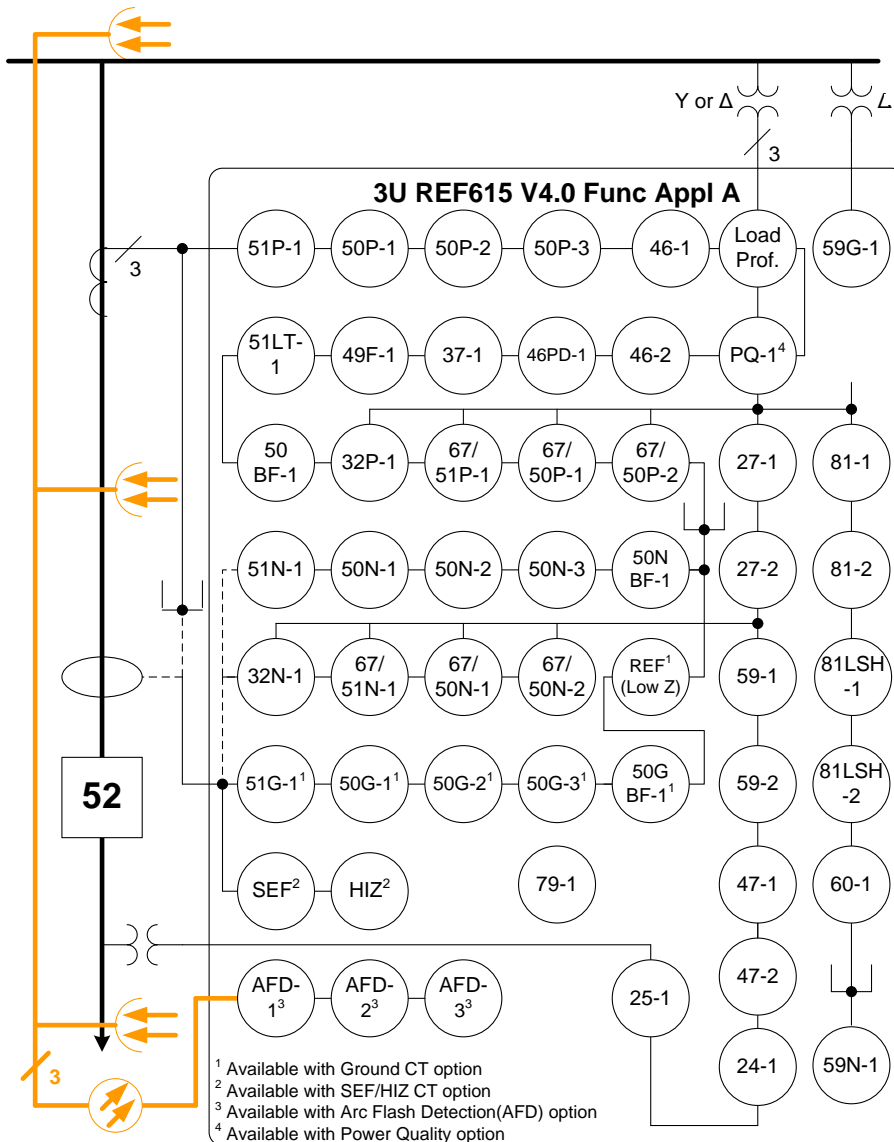

Standard OCI

Enhanced OCI

REF615R

...and any other 3U feeder relay upgrade
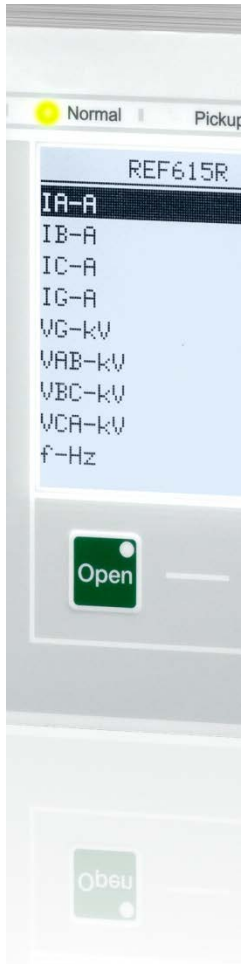
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Product overview
Functional application A

3U REF615 V4.0 Func Appl A

Y or Δ   ⊥   3

51P-1	50P-1	50P-2	50P-3	46-1	Load Prof.	59G-1
51LT-1	49F-1	37-1	46PD-1	46-2	PQ-1[4]	
50 BF-1	32P-1	67/51P-1	67/50P-1	67/50P-2	27-1	81-1
51N-1	50N-1	50N-2	50N-3	50N BF-1	27-2	81-2
32N-1	67/51N-1	67/50N-1	67/50N-2	REF[1] (Low Z)	59-1	81LSH-1
51G-1[1]	50G-1[1]	50G-2[1]	50G-3[1]	50G BF-1[1]	59-2	81LSH-2
SEF[2]	HIZ[2]		79-1		47-1	60-1
AFD-1[3]	AFD-2[3]	AFD-3[3]		25-1	47-2	
					24-1	59N-1

3

3

52

[1] Available with Ground CT option
[2] Available with SEF/HIZ CT option
[3] Available with Arc Flash Detection(AFD) option
[4] Available with Power Quality option

❑ Standard configuration

- Configuration A

  Provides all the I/O and CT/VT inputs for all three DPU2000R configurations for distribution feeder protection and control with single breaker
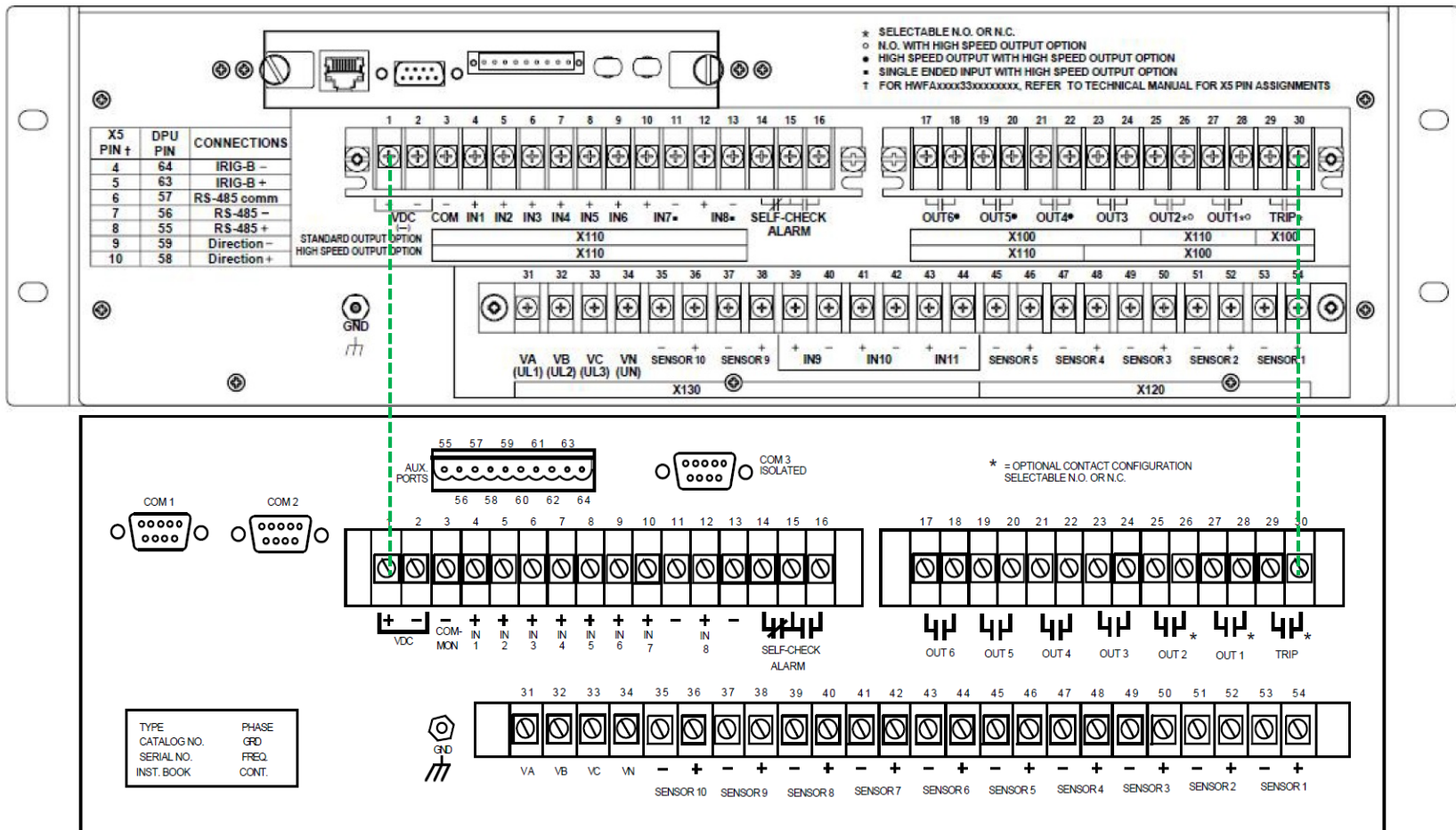
REF615R - Feeder Protection and Control
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- **Physical Overview**

- HMI Features

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REF615R physical overview
Mechanical: form & fit result

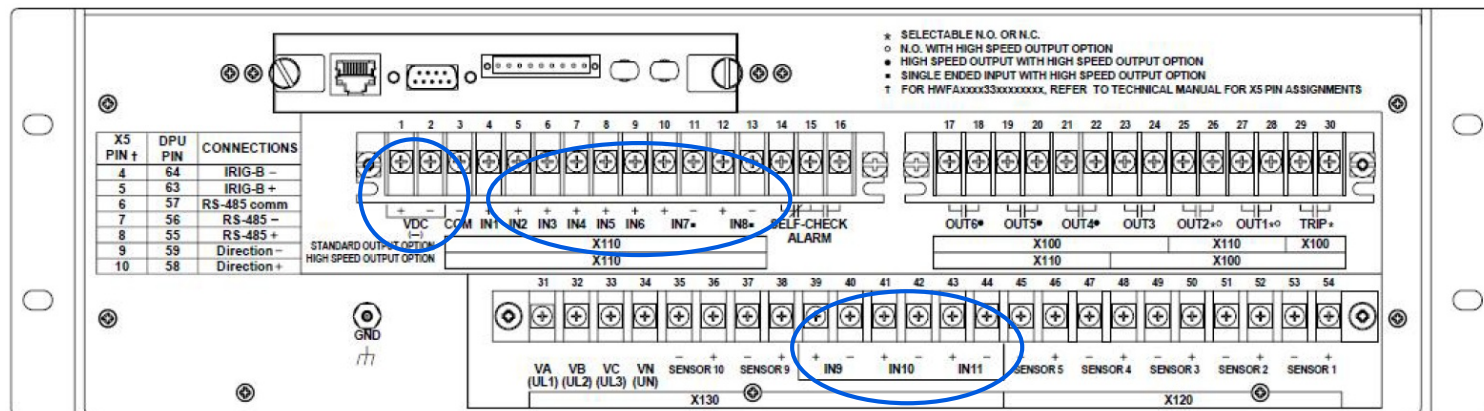**Screw terminals in same spatial location**

REF615R physical overview
Hardware: Physical (binary) inputs

- Standard I/O matches DPU2000R I/O

  - Inputs

    - $\pm$ V DC for control power

    - Six single-ended IN1 – IN6 w/ common return

    - Two double-ended inputs IN7, IN8

    - Three more double-ended inputs IN9 – IN11

REF615R physical overview
Hardware: Physical (binary) outputs

- Standard I/O matches DPU2000R I/O

  - Outputs

    - Seven trip-rated outputs

      - TRIP, OUT1 – OUT6

      - TRIP, OUT1, OUT2 configurable N.O. / N.C.

    - Form C self-check alarm

REF615R physical overview
Hardware: Physical (binary) outputs

- Output ratings match-up for **<u>standard I/O</u>**
  - Signal-rated output (SO)
    - Make and carry: 15 A for 0.5 s
    - Inductive breaker @ 125 V DC: 0.25 A
  - Trip-rated output (TO)
    - Make and carry: 30 A for 0.5 s
    - Inductive breaker @ 125 V DC: 0.25 A
  - Power-rated output (PO)
    - Make and carry: 30 A for 0.5 s
   - Inductive breaker @ 125 V DC: 5 A

Output	DPU2000R	REF615R
TRIP	T.O.	T.O.
OUT1	T.O.	T.O.
OUT2	T.O.	T.O.
OUT3	T.O.	P.O.
OUT4	T.O.	P.O.
OUT5	T.O.	P.O.
OUT6	T.O	P.O.
Alarm	T.O.	S.O.

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REF615R physical overview
Hardware: Physical (binary) outputs

❑ **Output ratings match-up for optional <u>HSO</u>**

- Signal-rated output (SO)
  - Make and carry: 15 A for 0.5 s
  - Inductive breaker @ 125 V DC: 0.25 A
- Trip-rated output (TO)
  - Make and carry: 30 A for 0.5 s
  - Inductive breaker @ 125 V DC: 0.25 A
- Power-rated output (PO)
  - Make and carry: 30 A for 0.5 s
  - Inductive breaker @ 125 V DC: 5 A

Output	DPU2000R	REF615R
TRIP	T.O.	T.O.
OUT1	T.O.	P.O.
OUT2	T.O.	P.O.
OUT3	T.O.	P.O.
OUT4	T.O.	P.O.
OUT5	T.O.	P.O.
OUT6	T.O	P.O.
Alarm	T.O.	P.O.

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REF615R physical overview
Hardware: High-speed outputs (HSO) option

- Outputs
  - Assigned to OUT4 – OUT6
  - Power-rated outputs
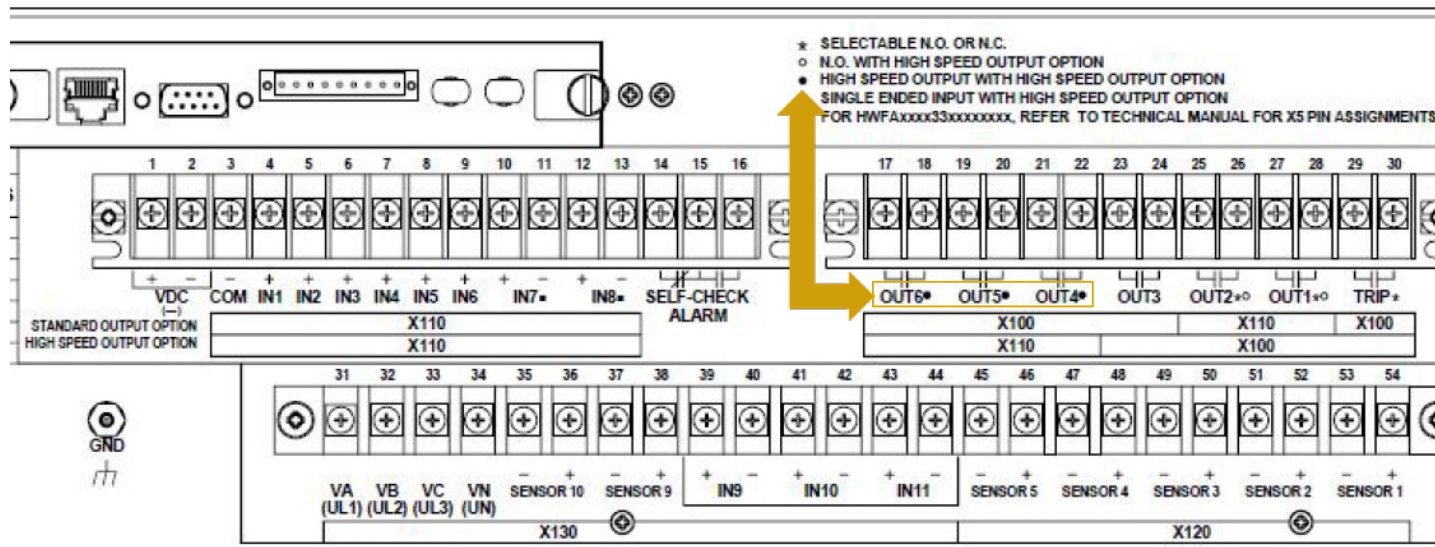
REF615R Physical Overview
Mechanical: Form & fit dimensions

- X-y-z mounting dimensions match those of DPU2000R

  - Same panel cutout without bezel

  - Same panel cutout with bezel

  - Same depth behind panel/rack

  - Same projection mounting option as DPU2000R

    - Shallow space behind panel

- Front panel projects 5/8" further than DPU2000R

  - Additional screws gained additional specification

    - IEC-60255-22-1 Class II (DPU2000R only Class I)

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REF615R - Feeder Protection and Control
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- **HMI Features**

- Functional Overview

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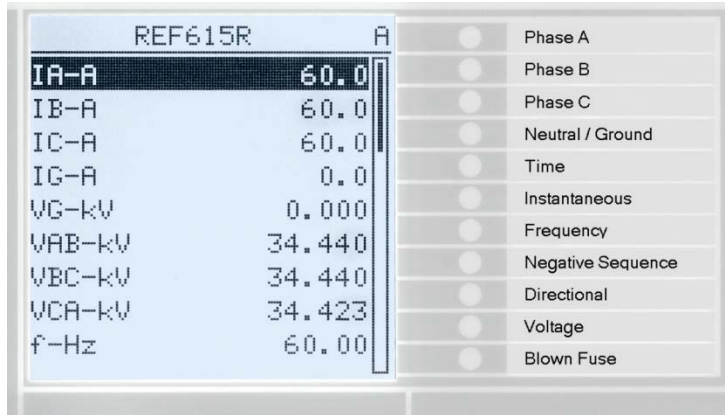
REF615R HMI features
Local human machine interface (LHMI)

- RJ45 Ethernet connector

- IED configuration modifications in PCM600

- IED access using the web-browser-based HMI

- LED indication on the local HMI during data transfer

- Auto-detect – supports both crossover and regular cables

- Automatic address detection

- 16 programmable pushbuttons available to all users

- Additional programmable LEDs for all users where pushbuttons are not utilized

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REF615R HMI features
Large display and programmable LEDs

- **Large LCD standard**

- Mono-spaced 10 x 20 characters, variable width 8 x 8 (or more) characters

- Background light with power-saving mode

- **11 user-programmable LEDs standard**

- Controlled by user defined logic in the Application Configuration Tool (ACT)

REF615R HMI features
Single-line diagram (SLD) programming on LCD
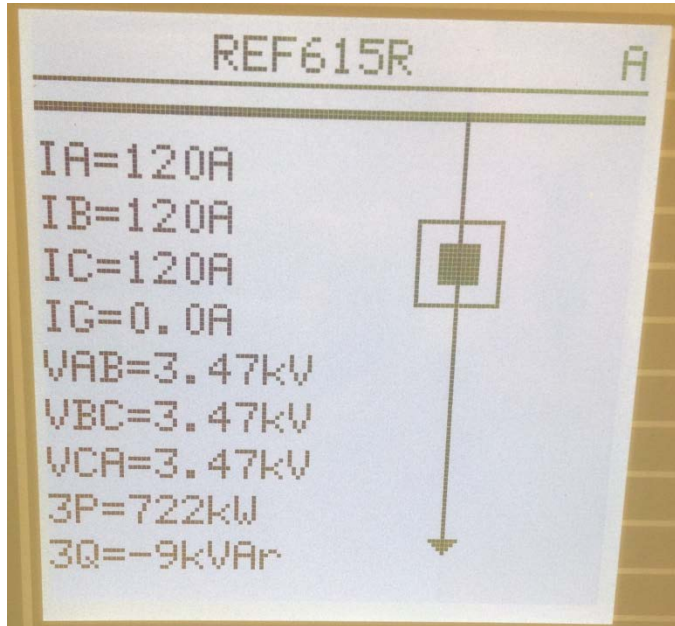
- SLD screen is fully programmable

- Show SLD and metering values in one view or separate views

- Include text and counters, e.g., breaker operations

- Two programmable SLD screens provided

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REF615R HMI features
Configurable single line diagram

IED
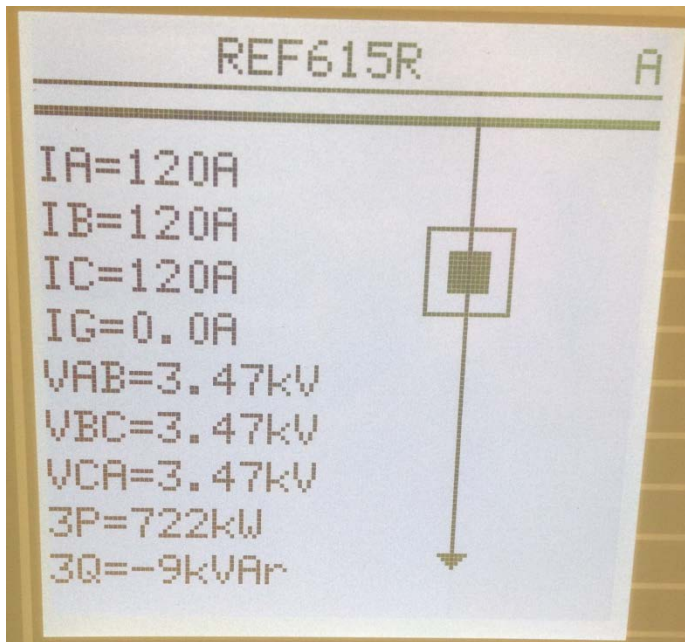
Graphical Display Editor
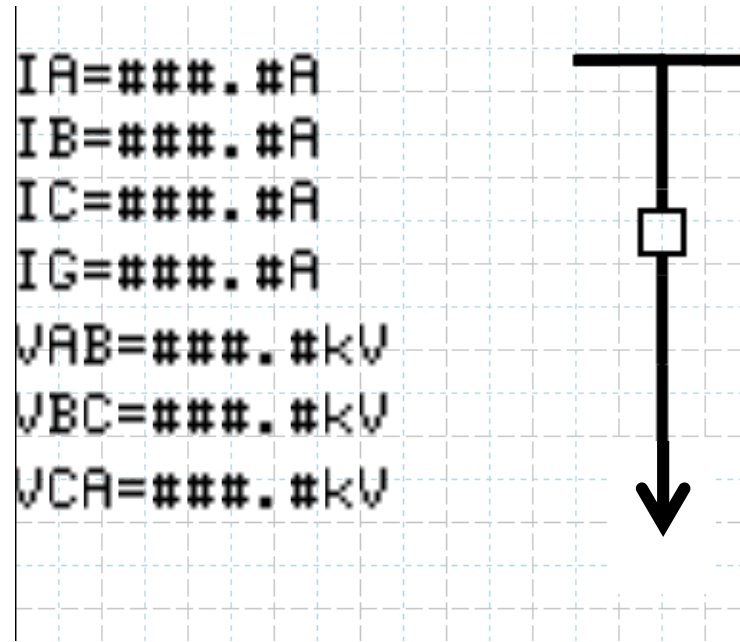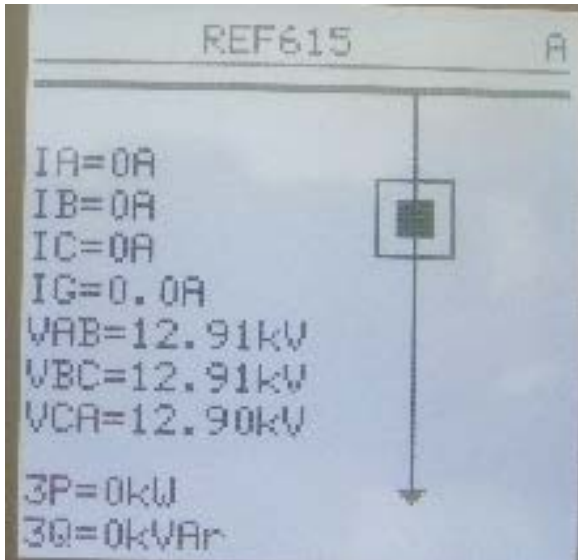
REF615R HMI features
Power system metering
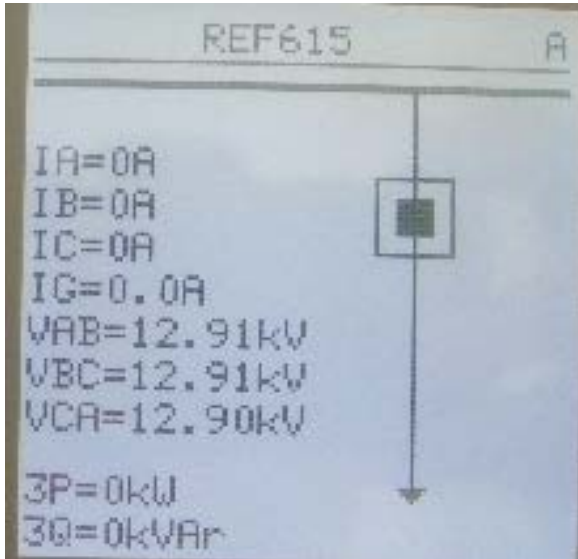
- Increased Measurements values

    - Phase to phase voltages

    - Residual voltage

    - Power factor

    - Apparent, active and reactive power, with an accuracy of 1.5%

    - Active and reactive energy, with an accuracy of 1.5%

    - Accumulated energy values registered bi-directionally

    - Values shown in primary quantities

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REF615R HMI features
Additional power system metering

- Frequency with VT Inputs

- Single-phase power and energy values
    - kW, kVAr, kVA
    - kW-Hr, kVAr-Hr, kVA-Hr

- Demand power values
    - kW, kVAr
        - 1-phase, 3-phase

- Minimum and maximum demand values
    - Amperes
    - kW, KVAr
   - 1-phase, 3-phase

REF615R HMI features
Access control

- Individual user accounts with role-based access control protects the IED from unauthorized access

- Four access levels: viewer, operator, engineer and administrator

- Applies to:

  - Front-panel user interface

  - Web browser based user interface

  - PCM600

- Passwords programmable by the administrator
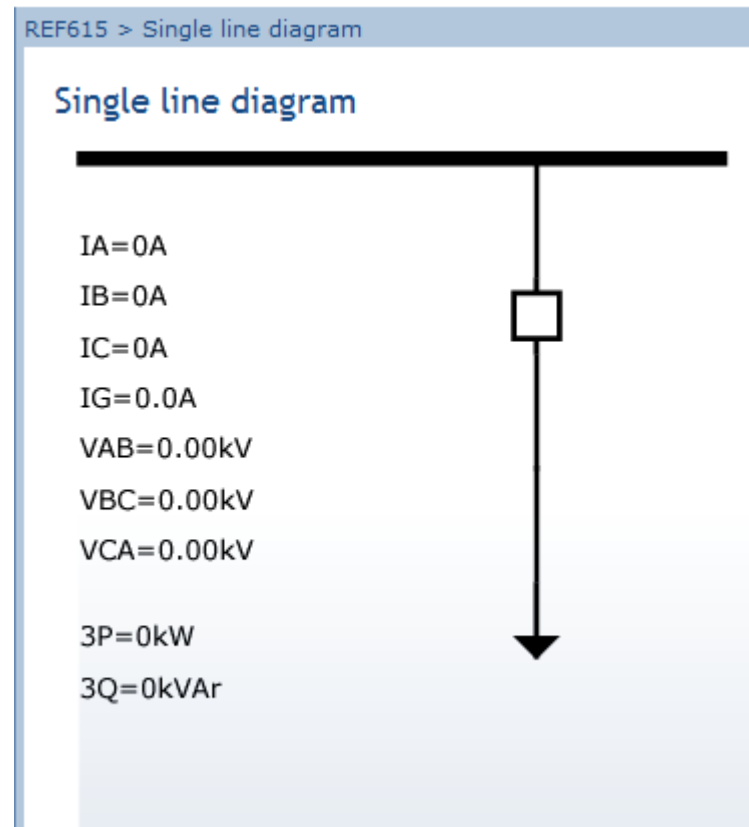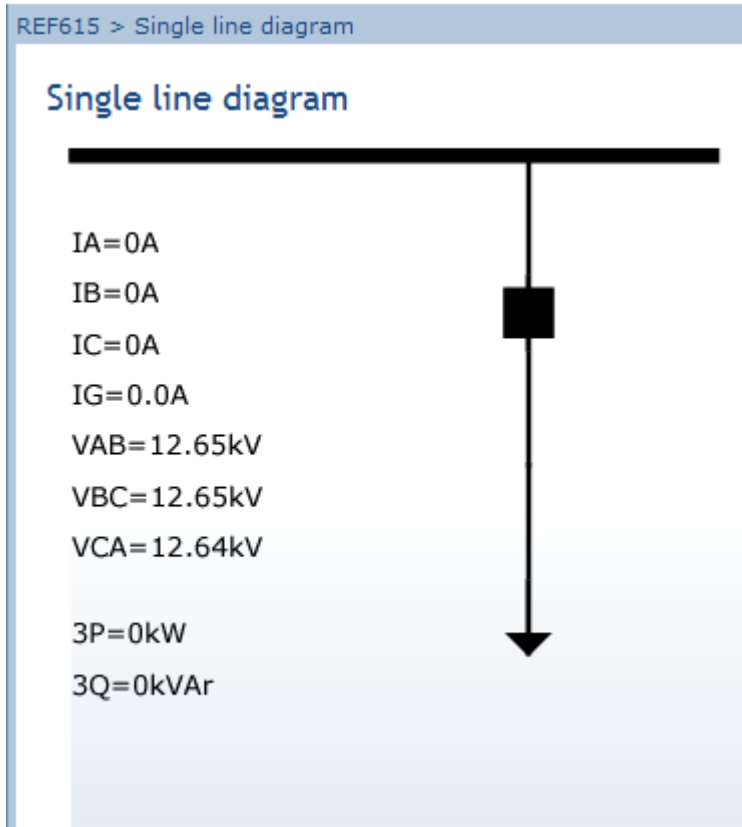
REF615R HMI features
Web-browser based user interface
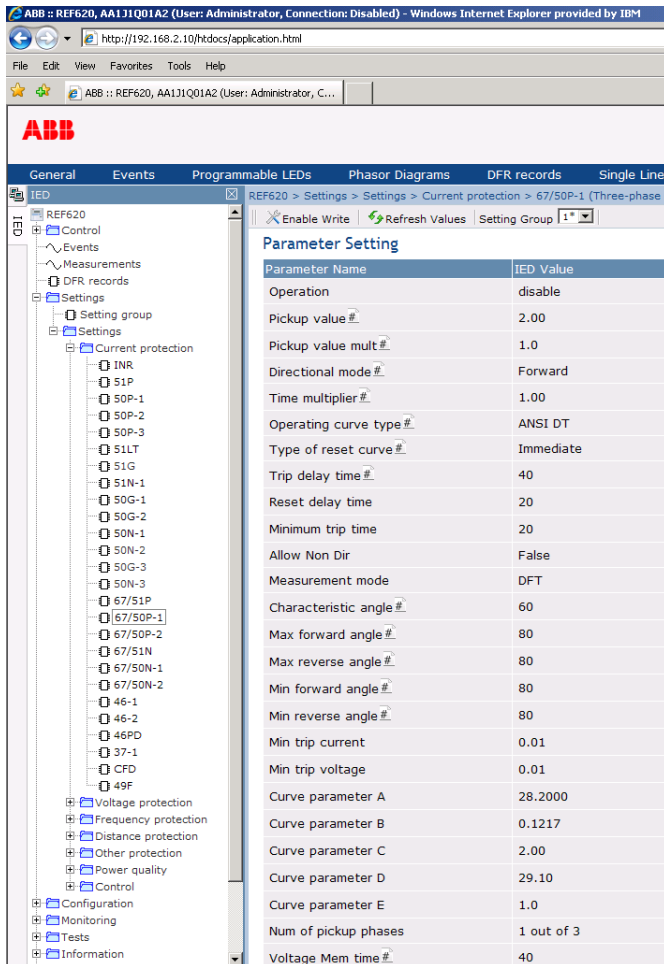
- Local or remote IED access using a web browser connection

- Functions:
  - Viewing of alarm LEDs and event lists
  - Saving of event data
  - Parameter setting
  - Signal monitoring
  - Real-time Measurement viewing
  - ***Phasor diagram viewing***
    - ***Magnitudes, angles***
    - ***Phase and sequence values***
  - Downloading of disturbance records

- User access level authentication

REF615R HMI features
WebHMI Single Line Diagram View

REF615 > Single line diagram

Single line diagram

IA=0A

IB=0A

IC=0A

IG=0.0A

VAB=12.65kV

VBC=12.65kV

VCA=12.64kV

3P=0kW

3Q=0kVAr

REF615 > Single line diagram

Single line diagram

IA=0A

IB=0A

IC=0A

IG=0.0A

VAB=0.00kV

VBC=0.00kV

VCA=0.00kV

3P=0kW

3Q=0kVAr

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REF615R HMI features
Communication protocols and interfaces

- Protocols and interfaces

- Time synchronization

Interfaces/Protocols	Ethernet		Serial	
	100BASE-TX (RJ45)	100BASE-FX (LC)	RS-232/RS-485	Fiber-optic (ST)
DNP3.0 Level 2+ over TCP/IP	•	•	-	-
Modbus over TCP/IP	•	•	-	-
IEC 61850-8-1	•	•	-	-
SNTP	•	•	-	-
FTP	•	•	-	-
DNP3.0 Level 2+ serial	-	-	•	•
Modbus RTU/ASCII	-	-	•	•
IRIG-B time synchronization	-	-	•	•

REF615R HMI features
Communications

- Matching most popular communication options
  - Type 2 (RS232 & RS485, IRIG-B)
  - Type 8 (Dual RS485, IRIG-B)
  - Ethernet (Cat5 <u>or</u> Fiber, SNTP)
- REF615R communication options better
  - Ethernet standard plus optional serial
  - No need for separate networks

One port: Ethernet 100FX (LC)	N	A
One port: Ethernet 10/100BaseT (RJ45)	N	B
Two/three ports: [Ethernet 100 FX (LC) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B	A	A
Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B	A	B
Four ports: [Ethernet 2 * 100FX (LC) + 10/100BaseT (RJ45) + serial glass fiber (ST)]	A	H
Four ports: [Ethernet 100FX (LC) + 2 * Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)]	A	K
Four ports: [Ethernet 3 * 10/100BaseT (RJ45) + serial glass fiber (ST)]	A	L
Three ports: Ethernet 10/100BaseT (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST)] + IRIG-B	3	3

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REF615R HMI features
Language options

- Additional HMI languages of "Spanish" and "Portuguese" supported

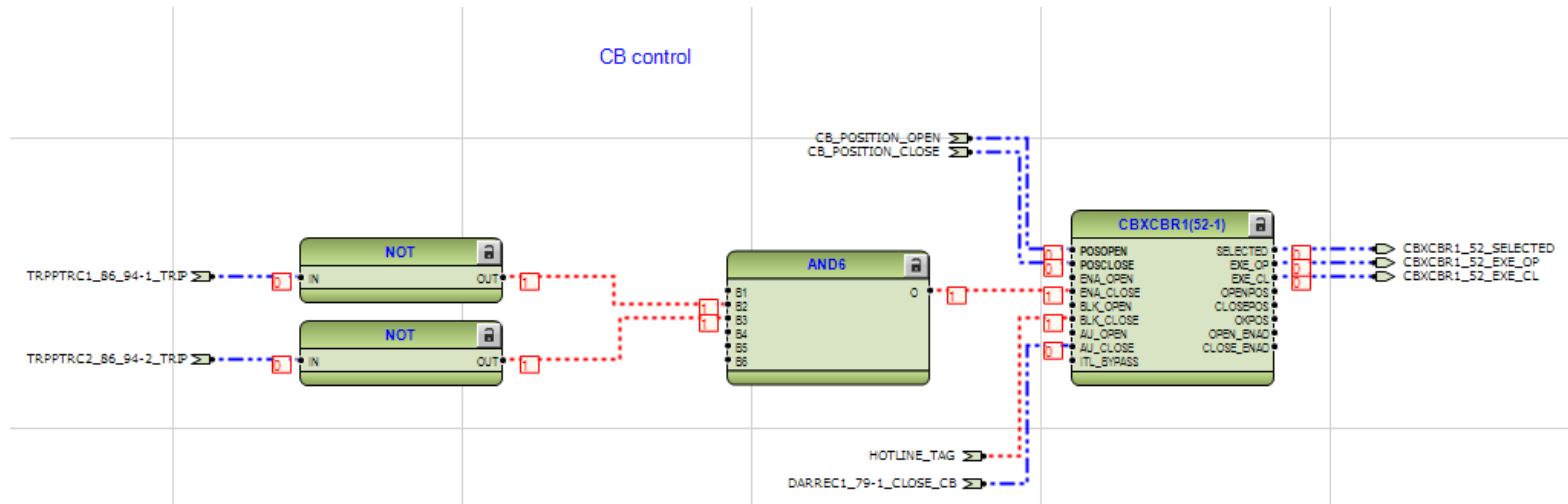- Language translations apply to LHMI and WebHMI menus

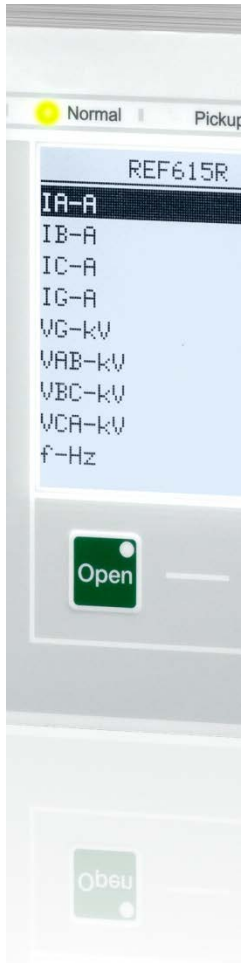| 12) Language	English	1
	English + Spanish	5
	English + Portuguese	8

REF615R HMI features
Application configuration in PCM600

- Graphical user interface with logic debug feature

  - Real-time color coded logic connection

  - Red indicates asserted (logical 1 status)

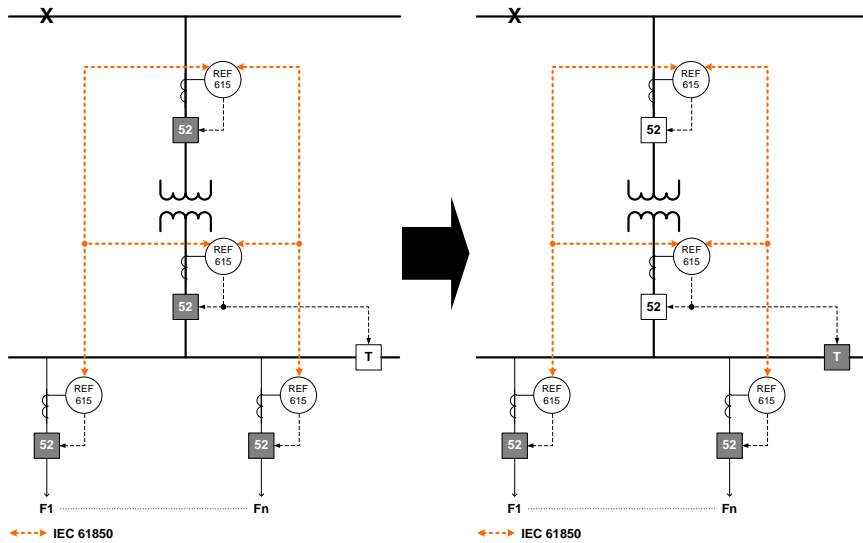 - Blue indicates non-asserted (logical 0 status)

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- **Functional Overview**

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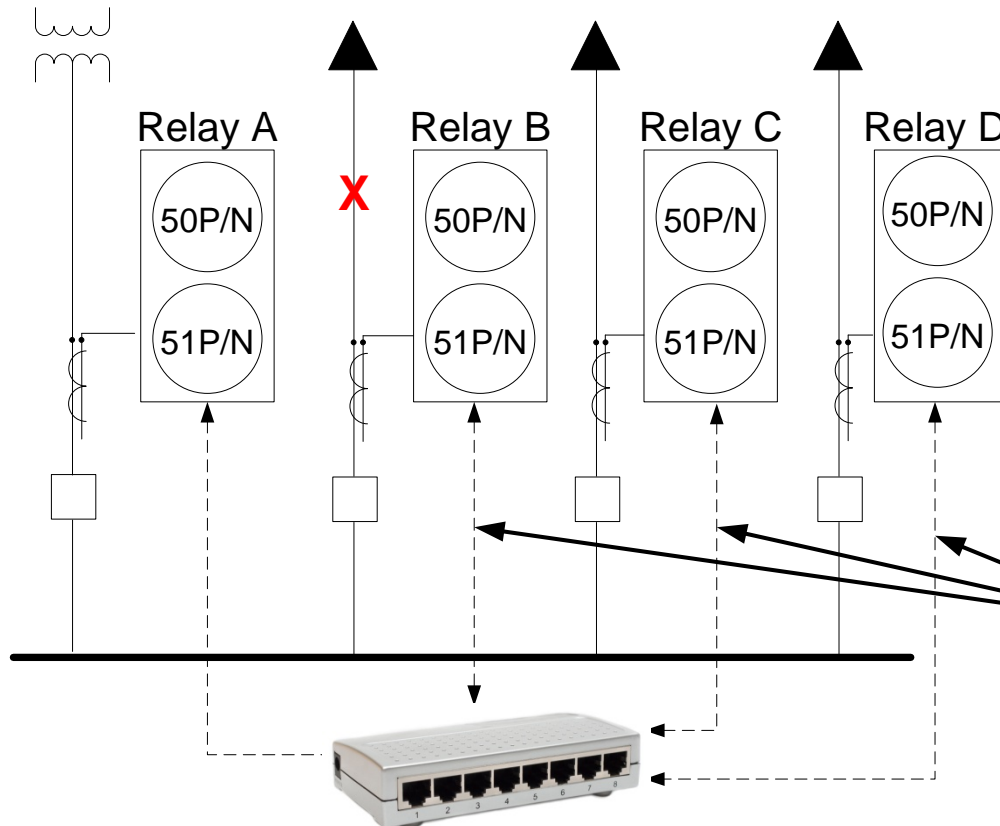# REF615R functional overview
GOOSE communication benefits

- Expandability and flexibility:
  - Flexible modifications without changing the wiring between the IEDs
  - No IED I/Os are needed for the transfer of data between the IEDs
  - Reduced wiring between the IEDs
  - Possible to add functionality like interlocking schemes between the cubicles in existing switchgear (retrofit)

- Supervised data transfer (connection and data quality)

- REF615R meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard

REF615R functional overview
GOOSE – Bus Blocking, GOOSE driven

Relay A

Relay B

Relay C

Relay D

50P/N

51P/N
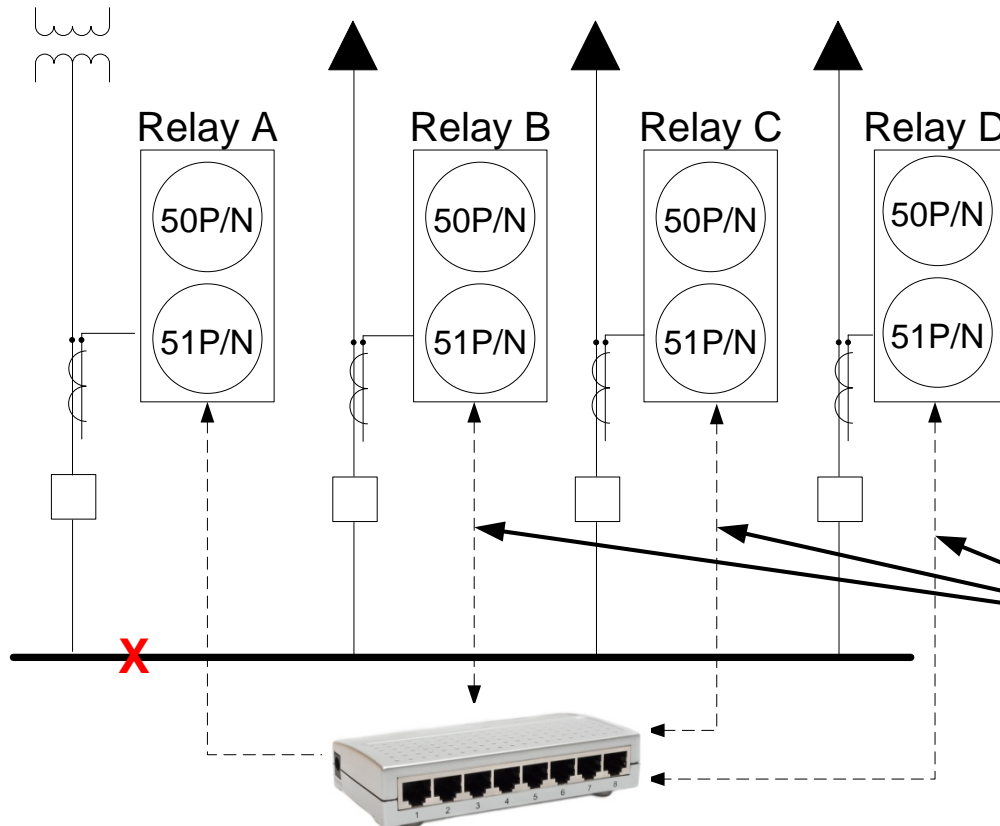
50P/N

51P/N

50P/N

51P/N

50P/N

51P/N

X

50P   Phase Instantaneous Overcurrent
50N   Neutral Instantaneous Overcurrent

Blocking Signals are Sent to Relay A over Ethernet via GOOSE

REF615R functional overview
GOOSE – Bus Blocking, GOOSE driven

Relay A | Relay B | Relay C | Relay D

50P/N | 50P/N | 50P/N | 50P/N

51P/N | 51P/N | 51P/N | 51P/N

X

| 50P | Phase Instantaneous Overcurrent |
| 50N | Neutral Instantaneous Overcurrent |

No Blocking Signals are Sent to Relay A over Ethernet via GOOSE

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REF615R functional overview
Advantages of GOOSE based scheme

- Misoperations due to CT saturation are not a concern

- Fast operation: 21-30 ms typical

- Additional feeder positions are easy to accommodate

- Open CT circuit detection can be included via logic

- Minimal additional wiring required, RJ45 or Optical Ethernet and switch

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REF615R functional overview
Auto-reclosing
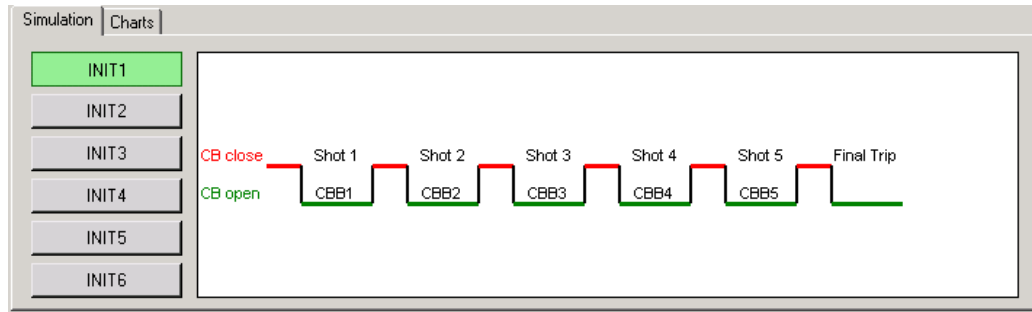
- De-energization of the fault spot for a defined period of time, followed by an automatic reclosure

- **Five** independently programmable auto-reclose **shots** in one sequence and total of **six separate sequences**

- Can be used with any CB suitable for auto-reclosing

- Can be coordinated with external synchro-checking and remote- end auto-reclosing

- Master/follower support for 1.5 and 2 breaker applications

- A separate "auto-reclosing visualization" tool part of the connectivity package

# REF615R functional overview
Arc protection (optional)
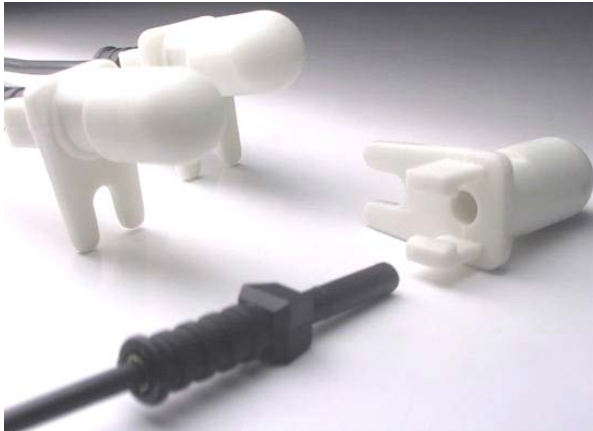
- Arc trip based on:
  - Current and light
  - Current and binary input signal
  - Light only

- Separate trip value settings for phase currents and ground-fault current

- Operate time typically
  - < 4 ms (high-speed outputs)

- Continuously supervises the CB, cable and busbar compartment of metal-enclosed switchgear

- Possible to block the function or change operation mode via a binary input

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REF615R functional overview
Current circuit supervision
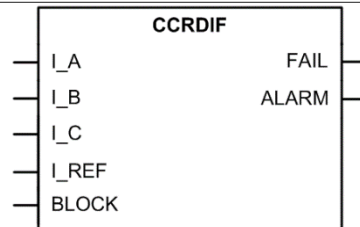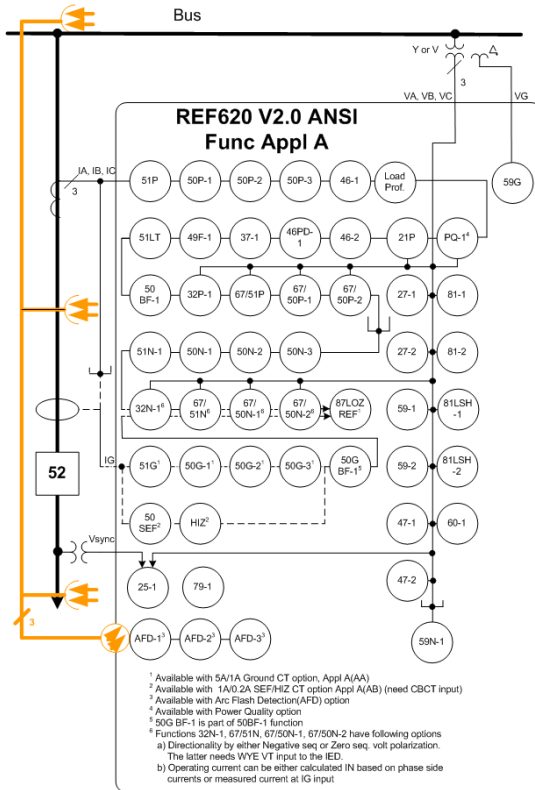
- Detects faults in the current transformer secondary circuits

- Calculates the sum of the phase currents and compares the sum with the measured single reference current from a core balance current transformer or from an other set of current transformers

- Activates an alarm and/or blocks certain protection functions to avoid unintended operation

REF615R functional overview
## CB condition monitoring

- Provides information for scheduling CB maintenance

- Monitors the wear and tear of the circuit-breaker

- Circuit-breaker gas pressure

- Circuit-breaker spring charging

- Circuit-breaker travel time

- Circuit-breaker operation counter

- Scheduled maintenance

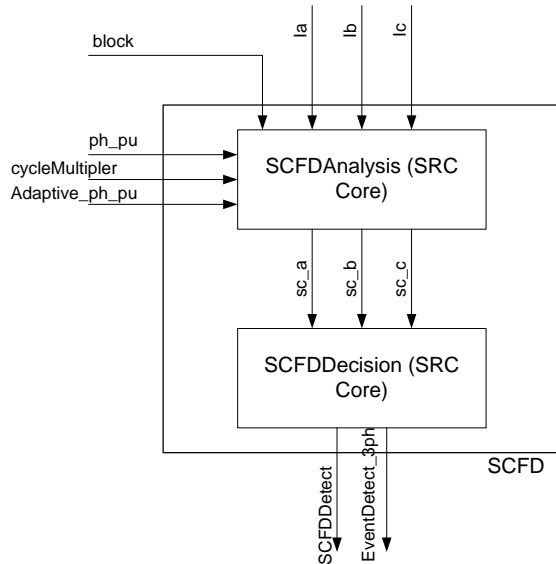**ABB**

REF615R functional overview
Power quality

- Added voltage unbalance power quality (PQ) element
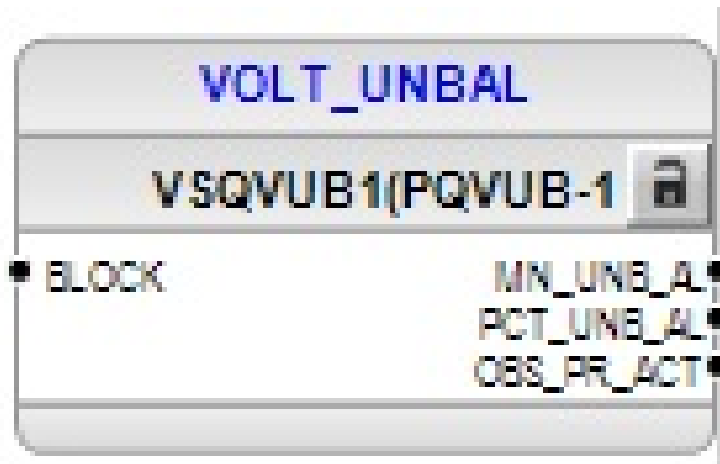
REF615R functional overview
Cable fault detection (CFD)

- Application Function Library (AFL) block

- Analog inputs
  - Phase currents – Ia, Ib, Ic

- Logical inputs
  - Block – on/off control of module

- Internal logic
  - Per-phase CFD counters - sc_a, sc_b, sc_c

- Logical outputs
  - Cable fault detection – SCFDDetect

  - Three-phase cable fault event detected – EventDetect_3ph

  - Map to trigger DFR

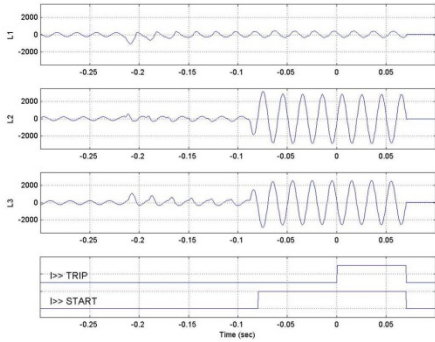**ABB**

REF615R functional overview
Load profile and programmable curves

- Load Profile feature

    - Up to 12 analog values

    - Storage is 48.7 days at 15 minute intervals

    - Other intervals available

- Programmable curve included as standard for each overcurrent element

ABB

REF615R functional overview
Digital fault recorder (DFR)

- Records all seven (7) analog channels and 64 binary channels

- Triggering by:
  - Analog or binary channel
  - Can be manually triggered

- Selectable sampling rate, 32/16/8 samples per cycle

- Max 2 X 10 sec with the highest sampling rate and the maximum number of recorded channels.

- Storage for approximately 30 records of 50 cycles length with all analog and digital signals recorded.
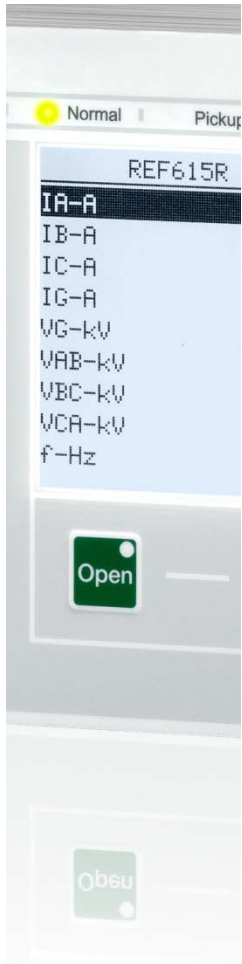
REF615R functional overview
Fault and event recording

- 128 fault records (FR)

- 1024 sequence of events (SOE) records

REF615R - Feeder Protection and Control
Agenda

- Introduction

- Relion® Family

- Product Overview

- Physical Overview

- HMI Features

- Functional Overview

- Summary

ABB

Summary
REF615R benefits

- Advanced communications – dual fiber Ethernet ports

- Embedded Web HMI and native-IEC61850

- Draw-out chassis for shorter downtime/bench testing

- Graphical programmable logic

- Dual rated CT's (5/1 A) and power supplies (48/125 Vdc)

- Superior order code flexibility
  - One functional configuration

- Environmentally friendly – no batteries, RoHS compliance

- Best warranty in business – 12 years

ABB

Summary
REF615R benefits

- Ideal for new project designs

- Same 3D form and fit as DPU2000R

- Wire-alike (I/O, CT, VT) as DPU2000R

- Same terminal numbers (I/O, CT, VT)

- Meets and exceeds DPU2000R protection

- Near SCADA-alike for DNP3.0 and Modbus

- Includes advanced, programmable LHMI (screen)

- Fast, predictable DPU2000R replacement

- Simple replacement order code for all DPU2000Rs

…thinking beyond the box!

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Visit our website for the latest product information

www.abb.com/substationautomation
www.abb.com/relion

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