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

Power and productivity
for a better world™

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Presenter

Joe Xavier

Joe Xavier graduated in Electrical & Electronics Engineering from Mahatma Gandhi University, India and started his career as a protection engineer with ALIND. In 1996 he joined ABB India and served over 13 years before moving to the United States. During these years Joe has been involved with Application, Marketing of Protection, Automation and other Power Products & Systems of ABB.

Currently, Joe is the Regional Technical Manager serving the West region, located in Camas WA. He is responsible for technical support of ABB Distribution Automation & Protection Products.
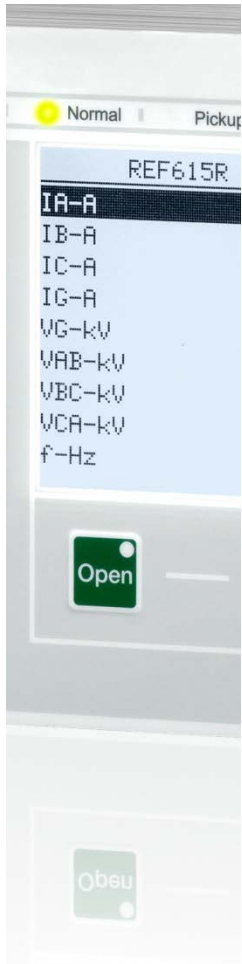
Joe is an active member of IEEE PES - PSRC
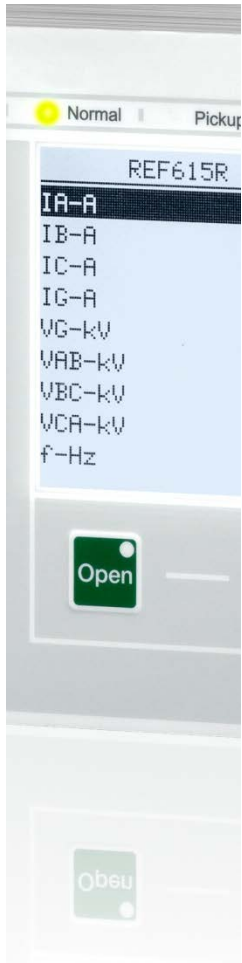
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REF615R - Feeder Protection and Control
Agenda

- 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 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- Outdated technology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

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 cost of refurbishment
What to look for?

Mechanical compatibility

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

Enhanced performance & functionality

    Facility to improve the operational efficiency

    Simplify user experience

    Additional functions to improve personal safety

Communication & security

    Support legacy and modern communication interfaces

    Multiple protocol support without impacting cost

    Easy adaptation into existing automation system

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Reducing cost of refurbishment
What to look for? (2)

Future proof

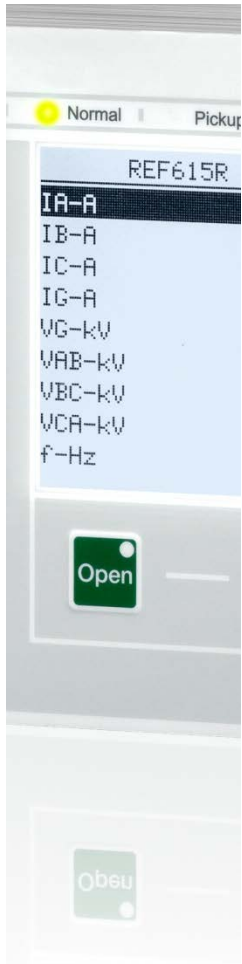Possible to extend application capability without additional hardware addition (I/O, wiring, etc)

Reliability & maintenance

A relay designed for 15+ years of uninterrupted operation

Draw-out and modular design (low MTTR)

Support easy diagnosis of faults (with limited skills)
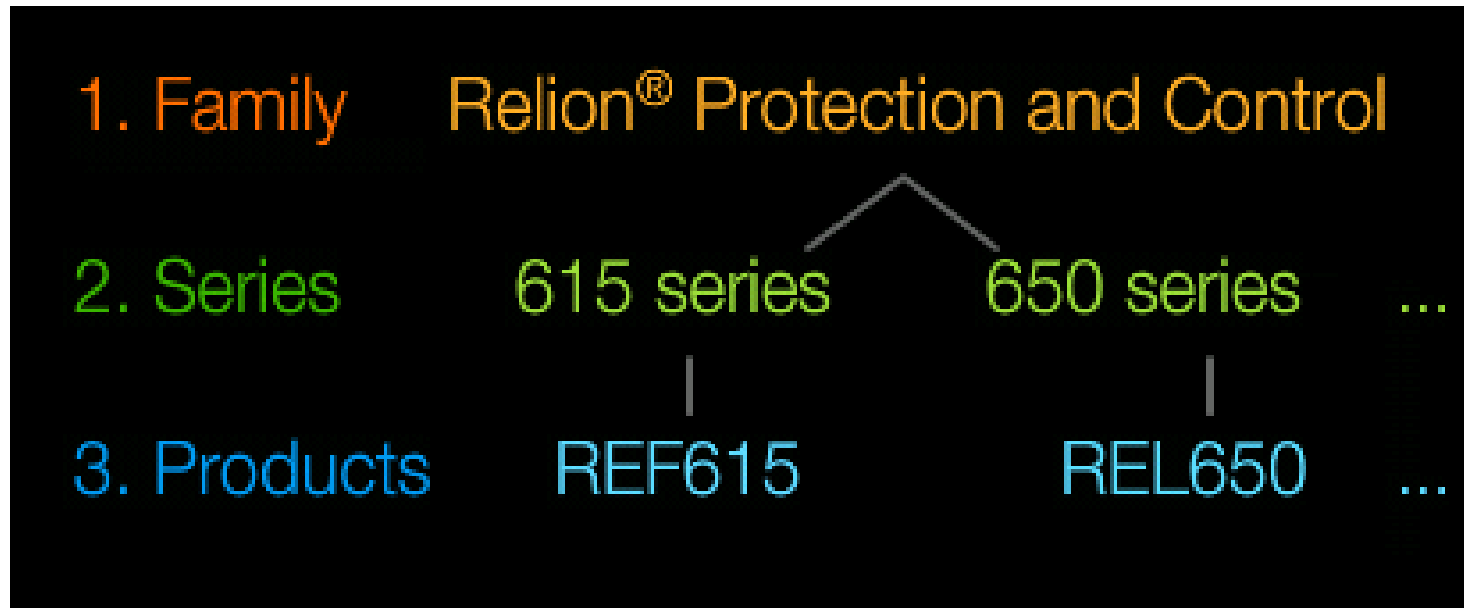
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- **Relion® Family**

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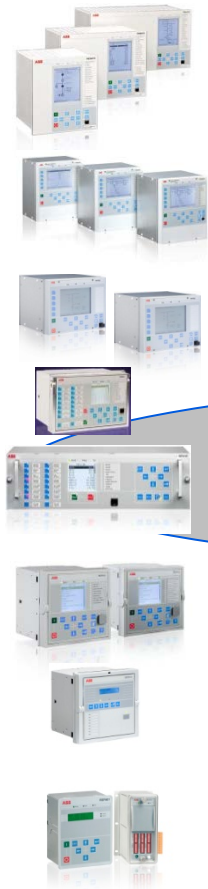
- Summary

Relion® family
Thinking beyond the box

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Relion® family
Naming

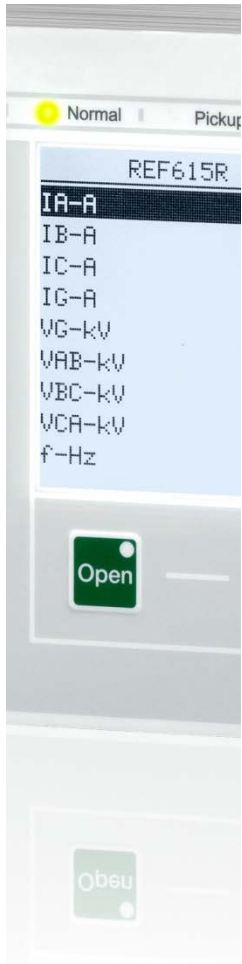|		
1. Family	**Relion® Protection and Control**	
2. Series	**615 series**	**650 series** ...
3. Products	**REF615**	**REL650** ...

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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**
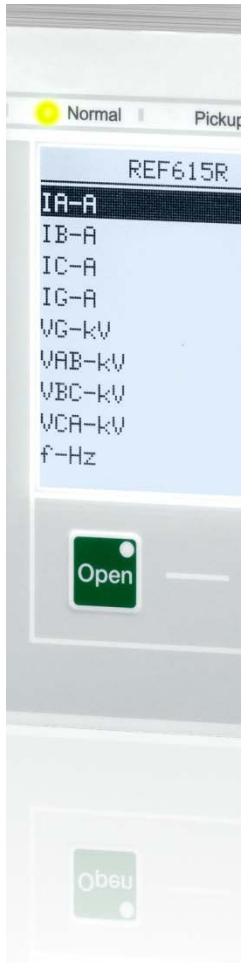 Simplicity for secondary distribution applications

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REF615R - Feeder Protection and Control
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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 relay with newest available technology

3. REF615R is world's 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

□ LHMI order code option to match DPU2000R Standard OCI and Enhanced OCI options

□ Advanced protection and communication options

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

□ Possibility to implement advanced customer application logic graphically
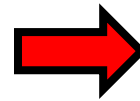
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Product overview
Design tailored for DPU2000R upgrade
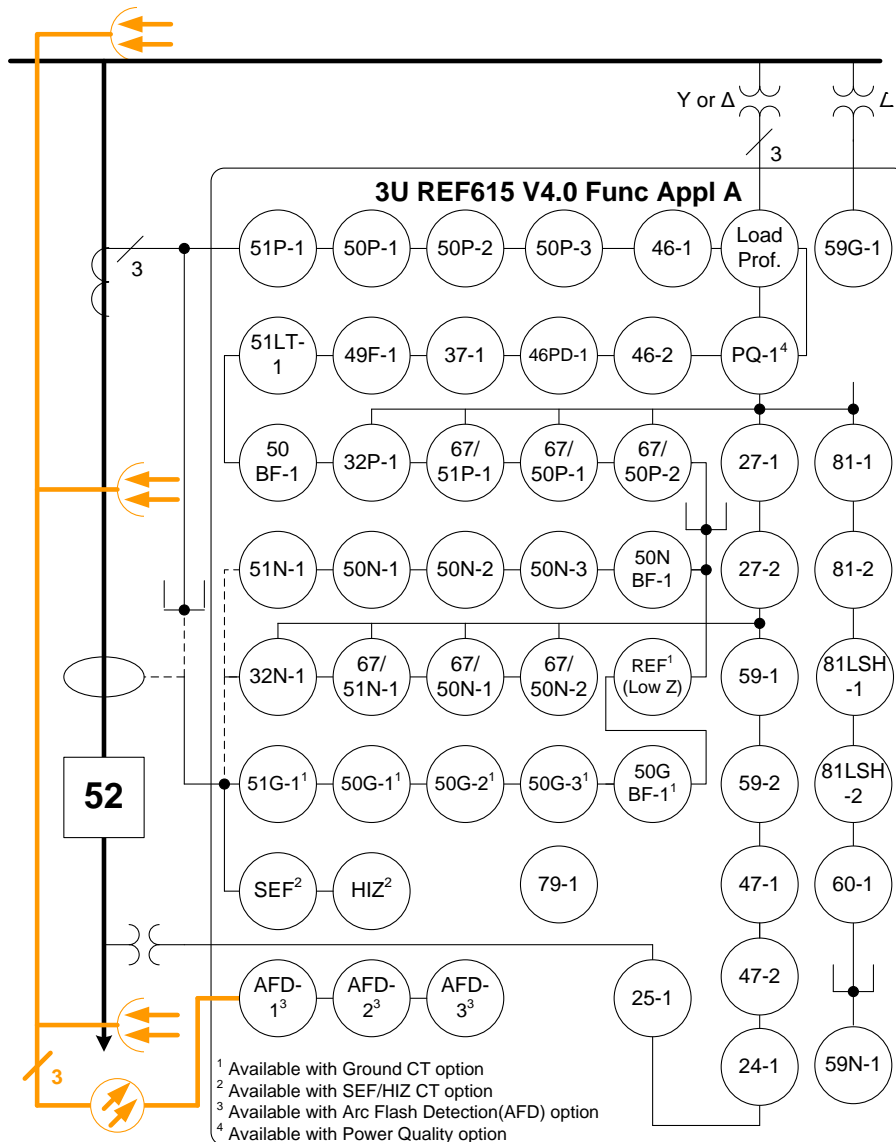

Standard OCI

Enhanced OCI

REF615R

...and any other 3U feeder relay upgrade

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Product overview
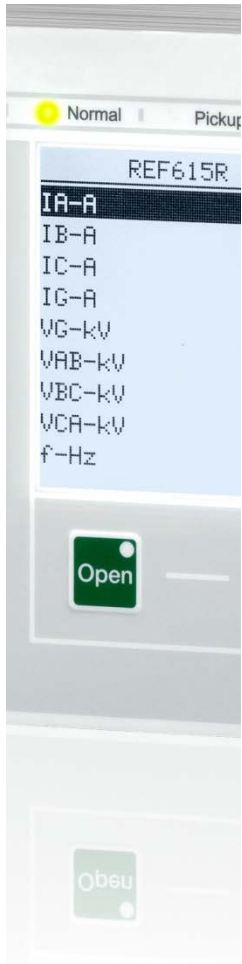## Functional application A

3U REF615 V4.0 Func Appl A

Y or Δ   ⊥
3

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

52

3

[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

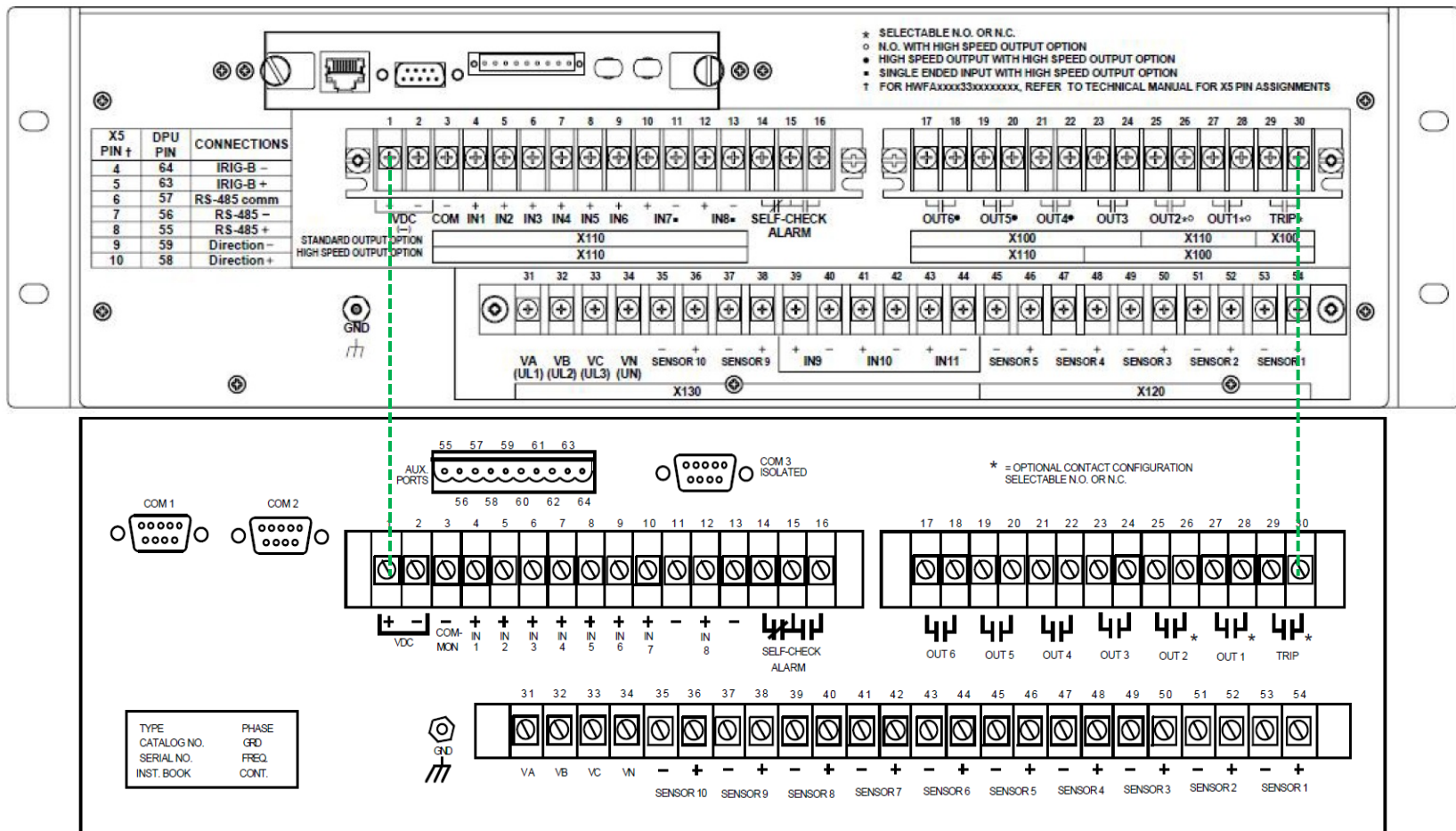# REF615R - Feeder Protection and Control
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- **Physical Overview**

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Screw terminals in same spatial location
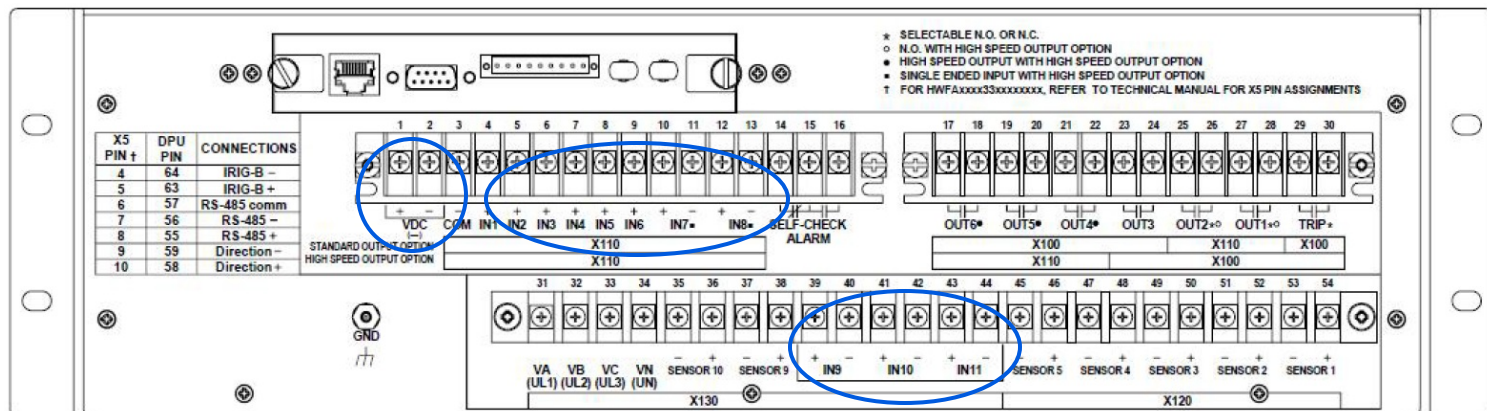
REF615R physical overview
Hardware: Physical (binary) inputs

- 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

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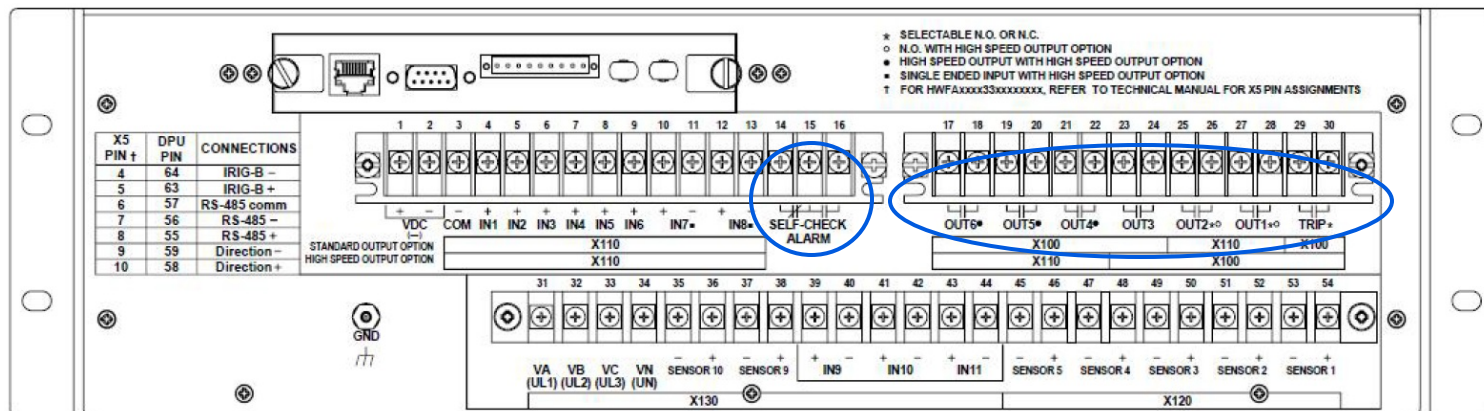
REF615R physical overview
Hardware: Physical (binary) outputs

□ **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.

REF615R physical overview
Hardware: Physical (binary) outputs

- ❑ Output ratings match-up for optional **HSO**
  - 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
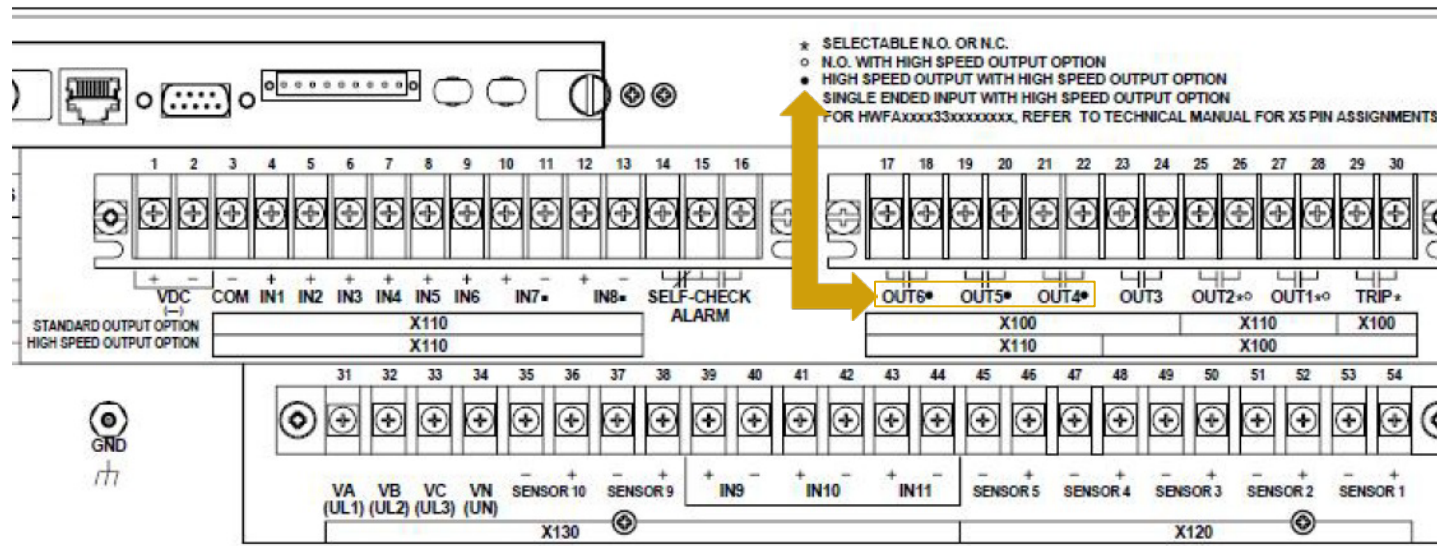
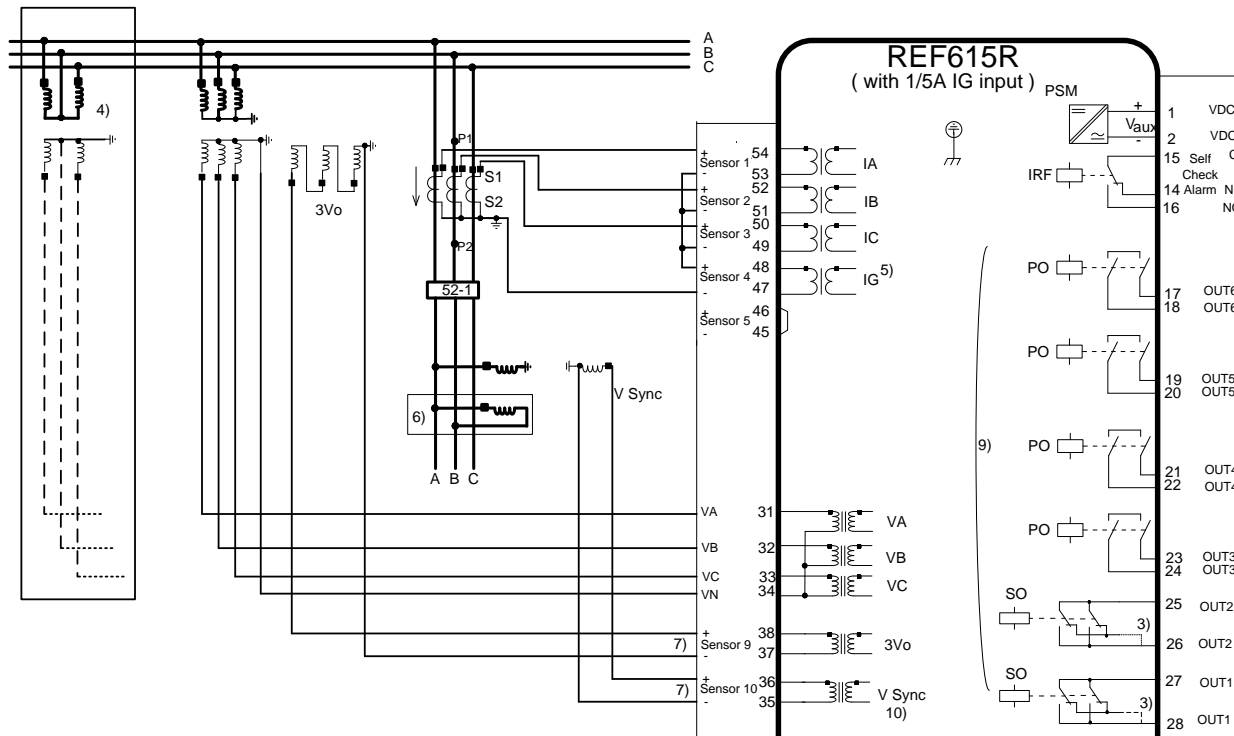# REF615R physical overview
Mechanical: Drawout assemblies

AIM 0016/0017 CARD

COM CARD

PSM CARD

BACKPLANE PCB

CCEB

BIO CARD

AIM 0006/0007 CARD

ADAPTOR PCB
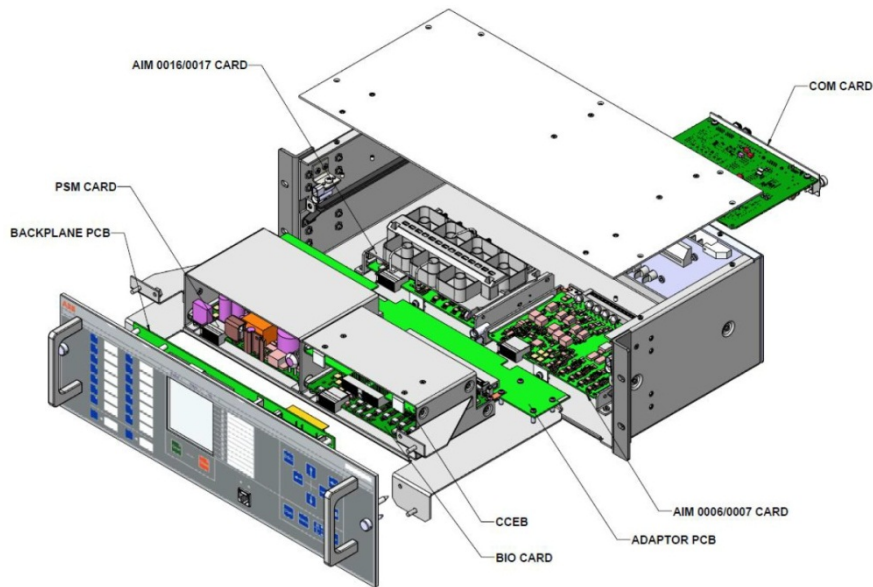
- ❑ Inner chassis withdrawable

- ❑ PCBA access in < 15 minutes

- ❑ Outer chassis includes CT connections

- ❑ Cold swapping different inner chassis and outer chassis allowed for same order code

  - ▪ Writing settings clears 'IED Composition change'

- ❑ Inner chassis and outer chassis orderable

  - ▪ Inner: JWFA…

  - ▪ Outer: RWFA…

REF615R physical overview
Hardware: Analog inputs for standard Ground CT

❑ **Typical connections match DPU2000R**

  ▪ 587R…, 587C… 687R… 687C…

  ▪ Vsynch and 3V0 available for "R" users if desired

REF615R physical overview
Hardware: Analog inputs for standard SEF CT

❑ **Typical connections match DPU2000R**

- 587E…, 687E…

- Vsynch available for "E" users if desired

- Same SEF connections externally
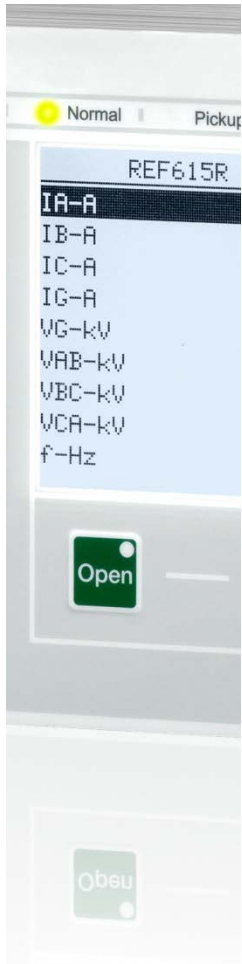
  - Internally connected to one SEF/HIZ input
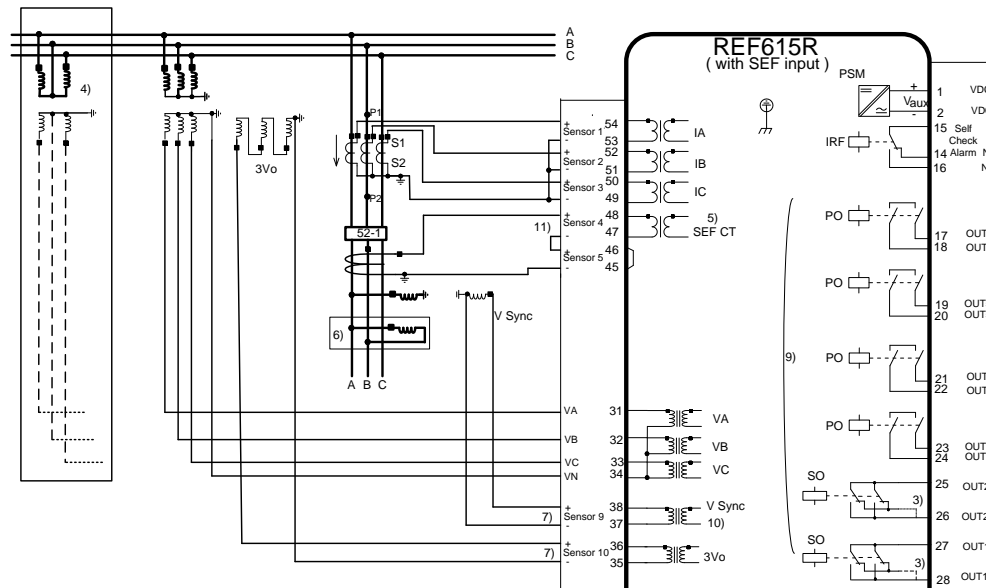
REF615R physical overview
Hardware: More than wire-alike
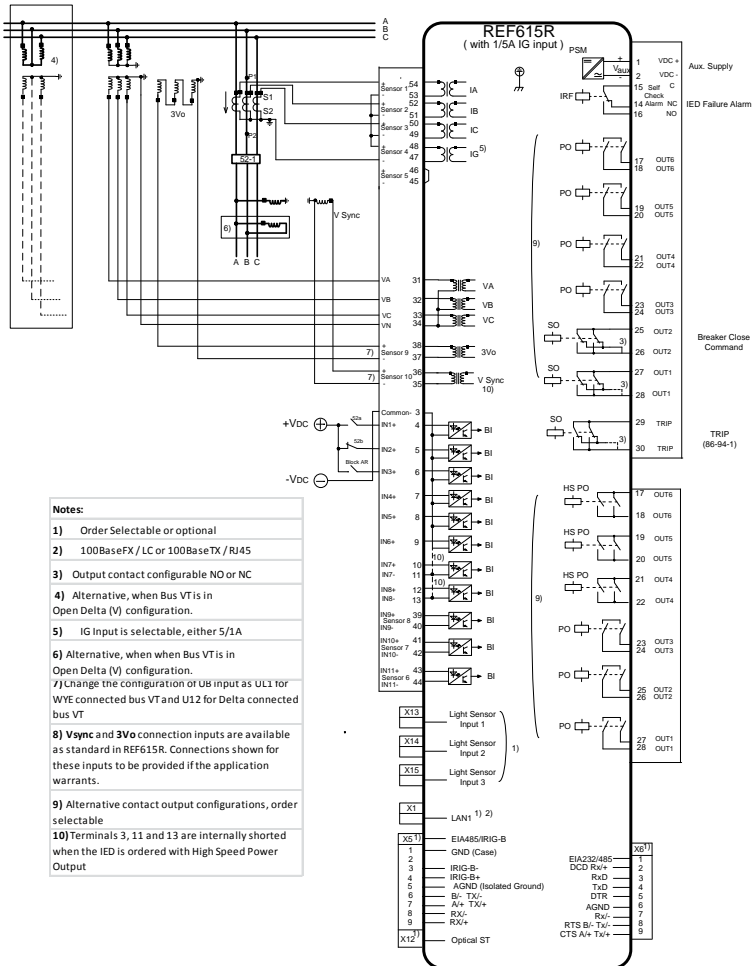
- **DPU2000R 587R… units**
  - Synch check available
  - 3V0 source input available

- **DPU2000R 587C… units**
  - Synch check available
  - 3V0 source input available

- **DPU2000R 587E… units**
  - Synch check available
  - 3V0 source input available

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

- Functional Overview

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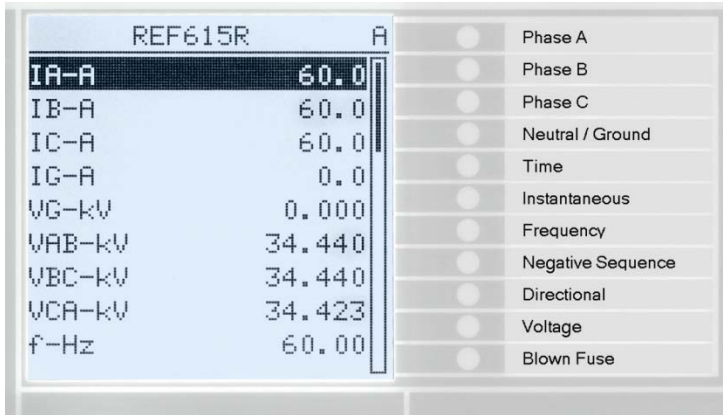
REF615R HMI features
Local human machine interface (LHMI)

- 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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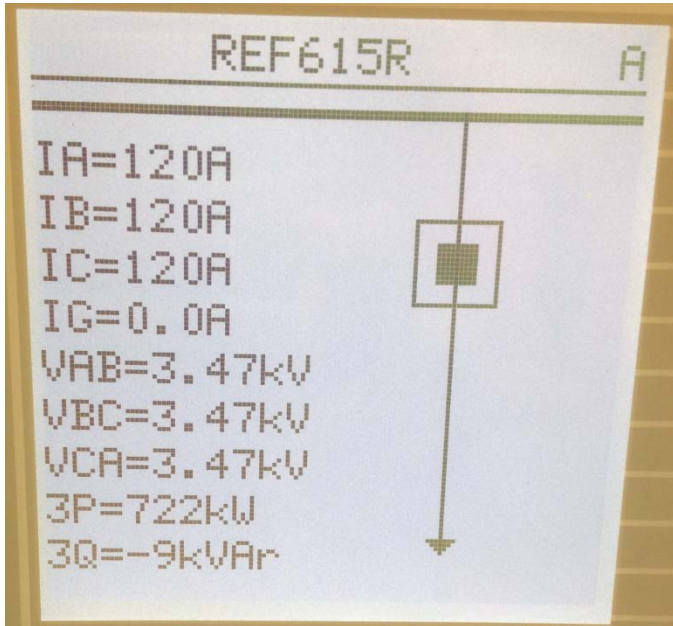# REF615R HMI features
Large display and programmable LEDs

- **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 ACT

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REF615R HMI features
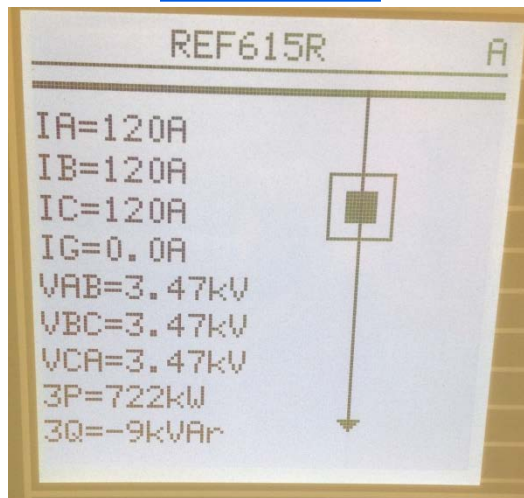## Single-line diagram (SLD) programming on LCD

- SLD page pre-programmable

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

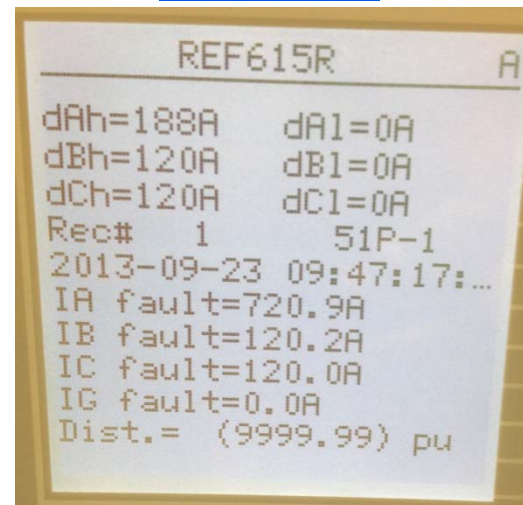- Include text and counters, e.g., breaker operations

REF615R HMI features
LCD

❑ **Support of two SLD pages**

  ▪ Page #2 defaults tailored to DPU2000R LCD

Page #1

```
        REF615R          A
  ─────────────────────────
  IA=120A
  IB=120A
  IC=120A
  IG=0.0A
  VAB=3.47kV
  VBC=3.47kV
  VCA=3.47kV
  3P=722kW
  3Q=-9kVAr
```

Page #2

```
        REF615R          A
  ─────────────────────────
  dAh=188A     dAl=0A
  dBh=120A     dBl=0A
  dCh=120A     dCl=0A
  Rec#    1        51P-1
  2013-09-23 09:47:17:…
  IA fault=720.9A
  IB fault=120.2A
  IC fault=120.0A
  IG fault=0.0A
  Dist.=  (9999.99) pu
```
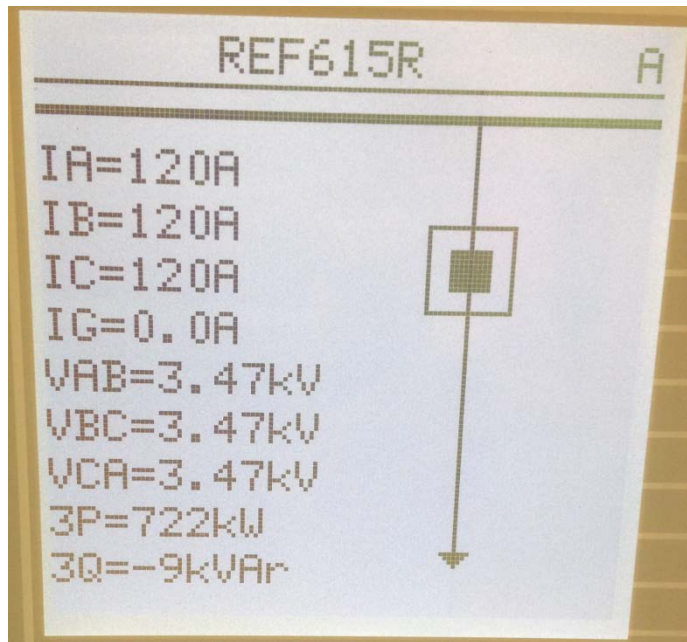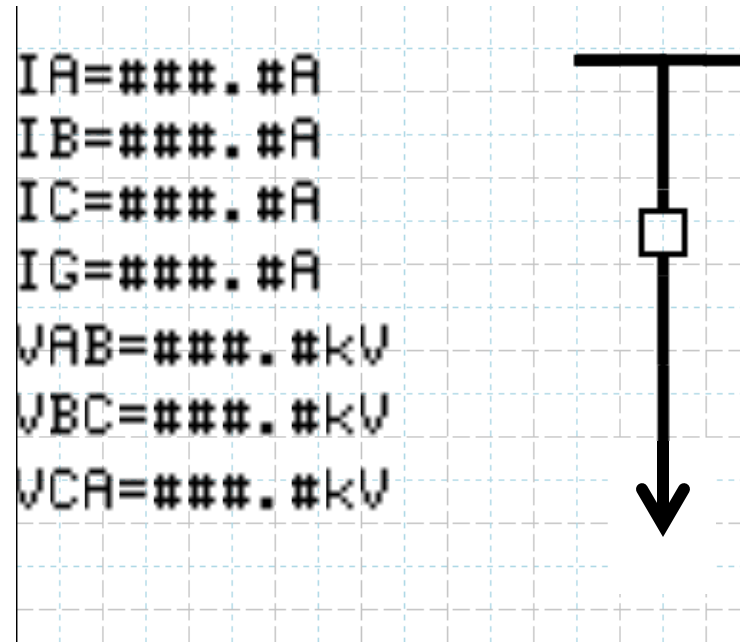
REF615R HMI features
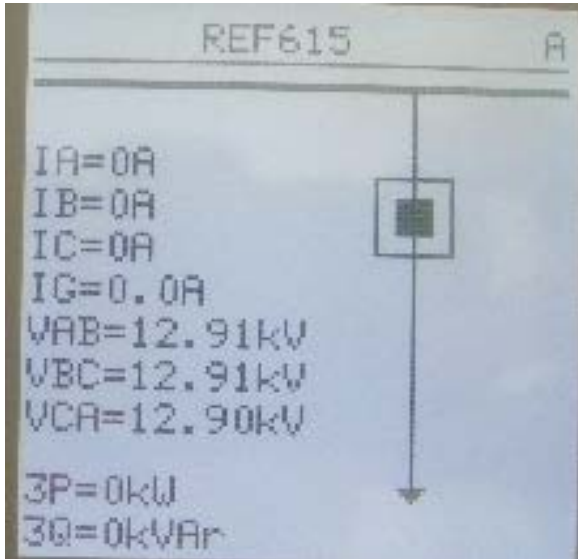## Configurable single line diagram

IED

Graphical Display Editor

REF615R HMI features
Power system metering
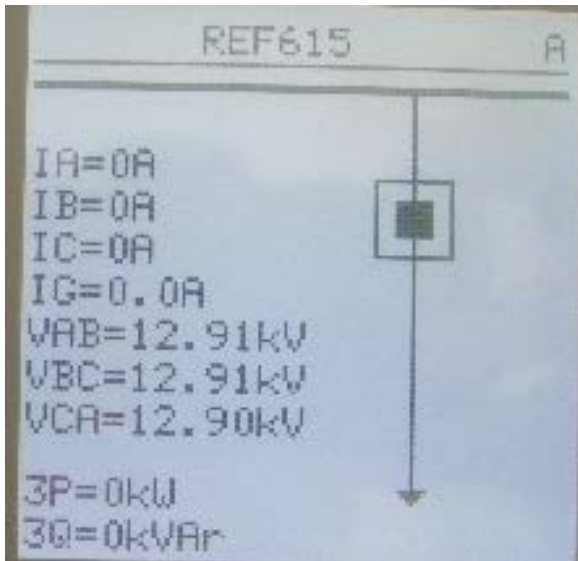

❑ Increased Measurements values

- 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

- VT connections can be either phase to phase, or phase to ground

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REF615R HMI features
Additional power system metering

REF615   A

IA=0A
IB=0A
IC=0A
IG=0.0A
VAB=12.91kV
VBC=12.91kV
VCA=12.90kV

3P=0kW
3Q=0kVAr

- ❑ 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

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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

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REF615R HMI features
Web-browser based user interface
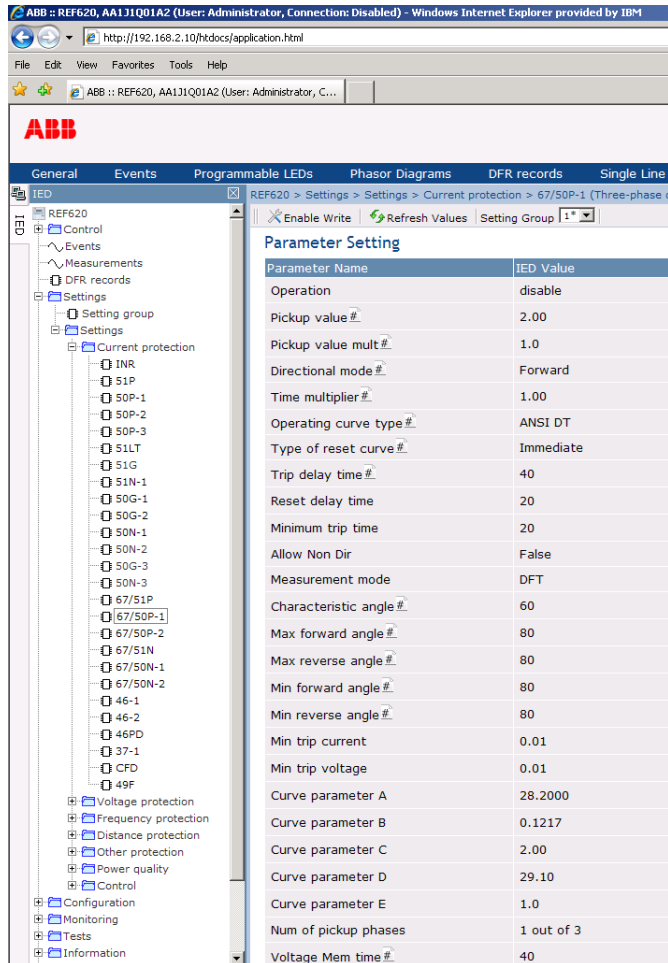
- Local or remote IED access using an IE 7.0 or IE 8.0 web browser

- Disabled by default, enabled by PCM600 or the local front-panel interface

- Functions:
  - Viewing of alarm LEDs and event lists
  - Saving of event data
  - Parameter setting
  - Signal monitoring
  - Measurement viewing
  - Phasor diagram viewing
  - Reading of disturbance records
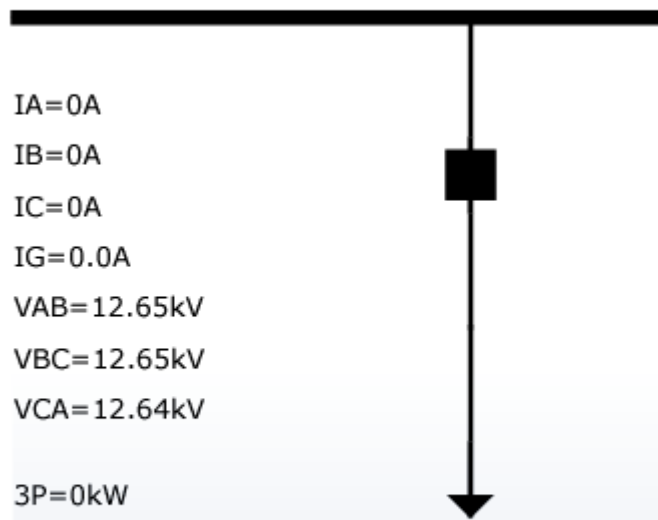
- User access level authentication

REF615R HMI features
WebHMI Single Line Diagram View
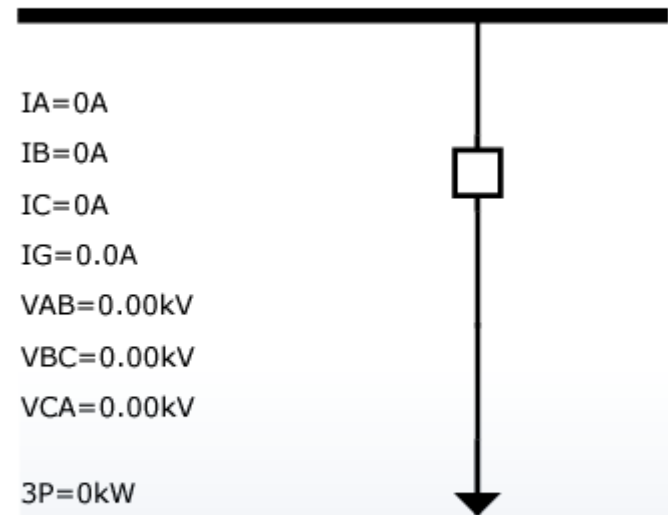

REF615 > Single line diagram

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 serial optionally

- No need for separate networks
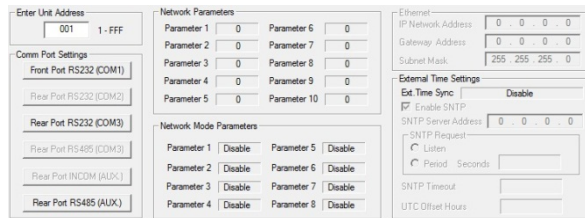
	N	A
One port: Ethernet 100FX (LC)	N	A
One port: Ethernet 10/100BaseT (RJ45)	N	B
Two/three ports: [Ethernet 100 FX (LC) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B	A	A
Two/three ports: [Ethernet 10/100BaseT (RJ45) + RS485 (1x4-wire or 2x2-wire)] + IRIG-B	A	B
Four ports: [Ethernet 2 * 100FX (LC) + 10/100BaseT (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

❑ Valuable for ANSI-influenced customers in North, Central and South American countries

❑ Language translations apply to LHMI and WebHMI menus

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

ABB

REF615R HMI features
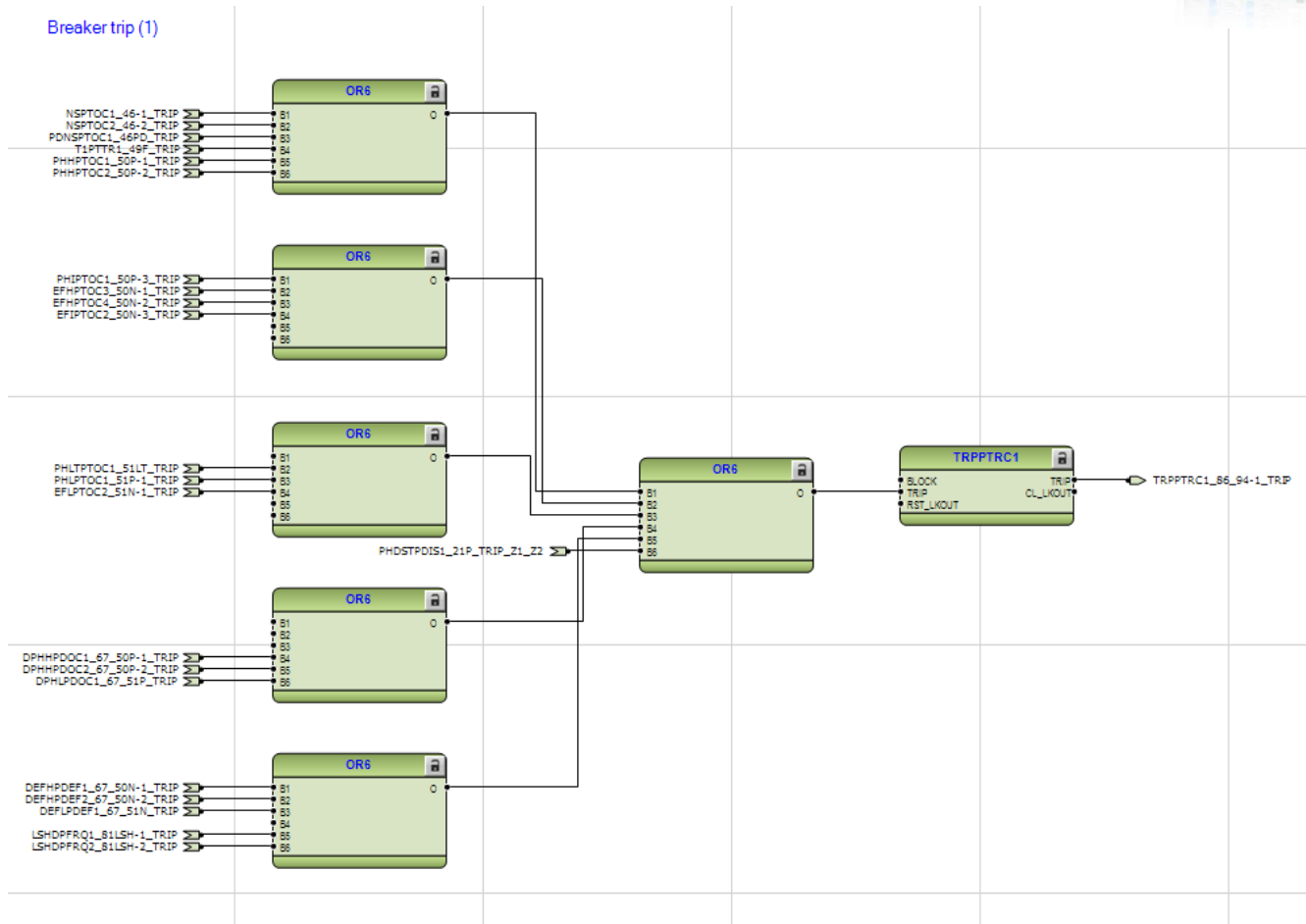## Application configuration in PCM600

- Graphical user interface
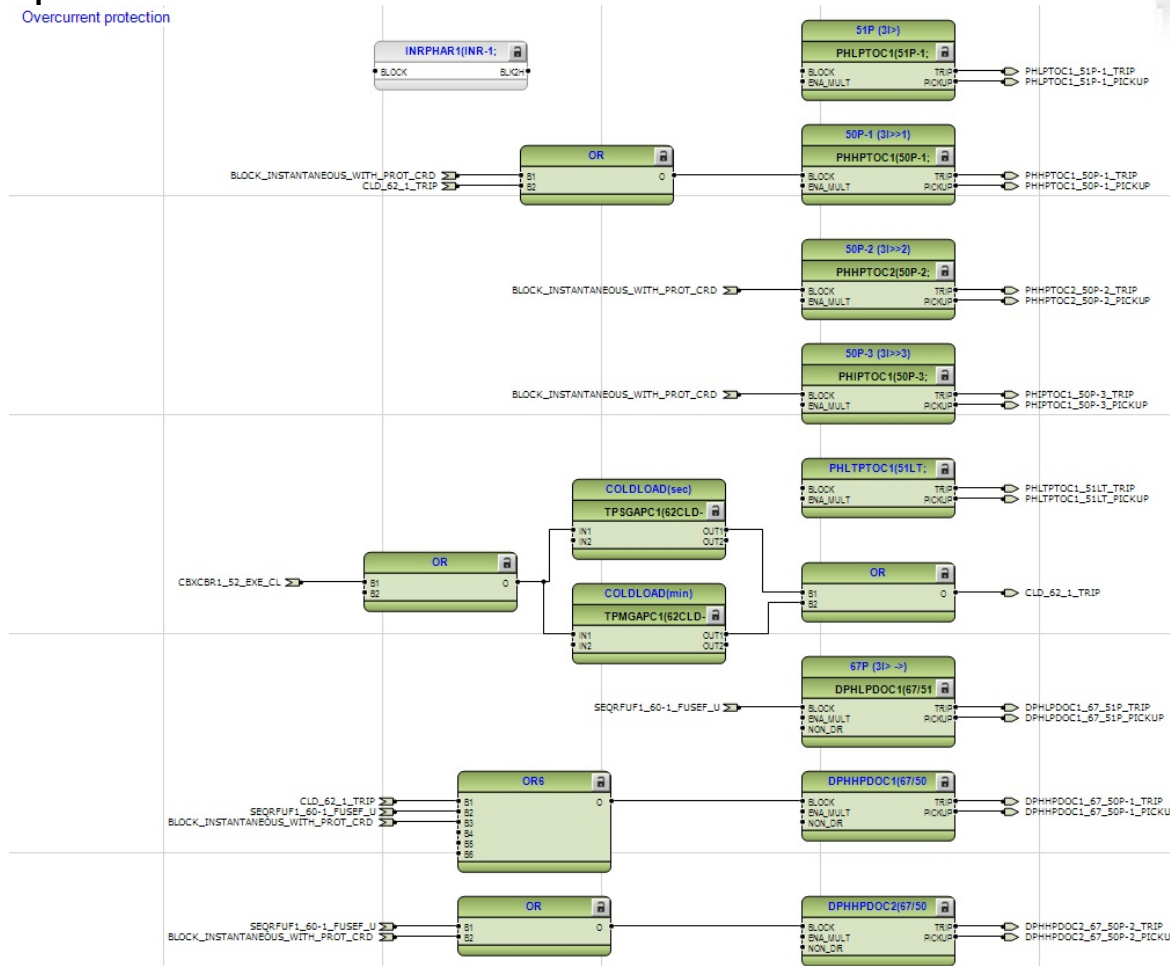
REF615R HMI features
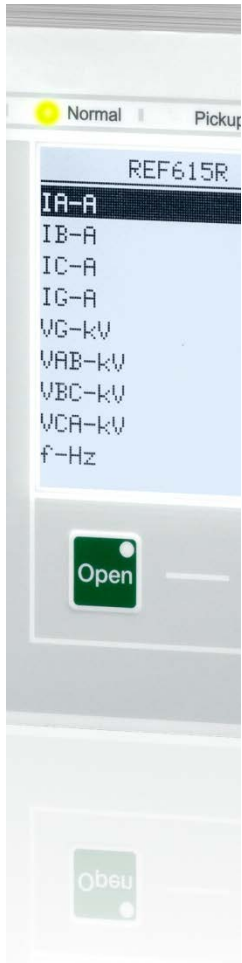## Application configuration in PCM600 (2)

- Graphical user interface
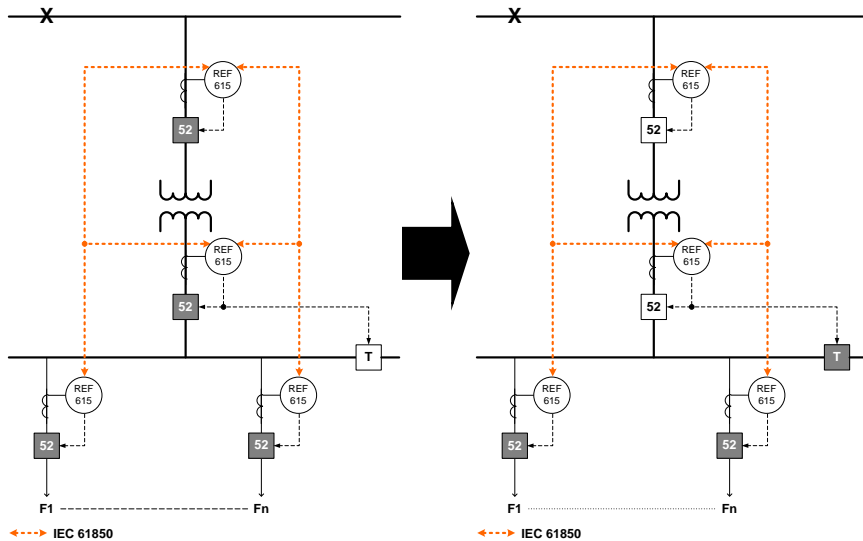

Breaker trip (1)

REF615R - Feeder Protection and Control
Agenda

- Introduction

- Relion® Family

- Product Overview

- Physical Overview

- HMI Features

- **Functional Overview**

- Summary

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
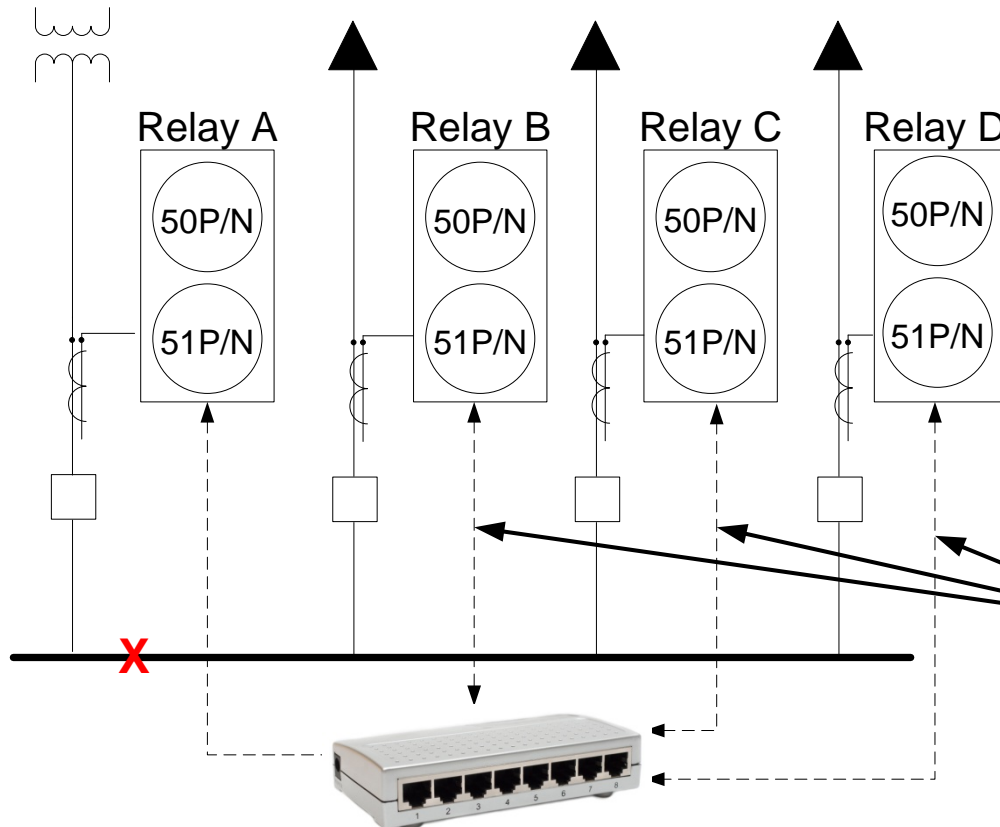## GOOSE – Bus Blocking, GOOSE driven
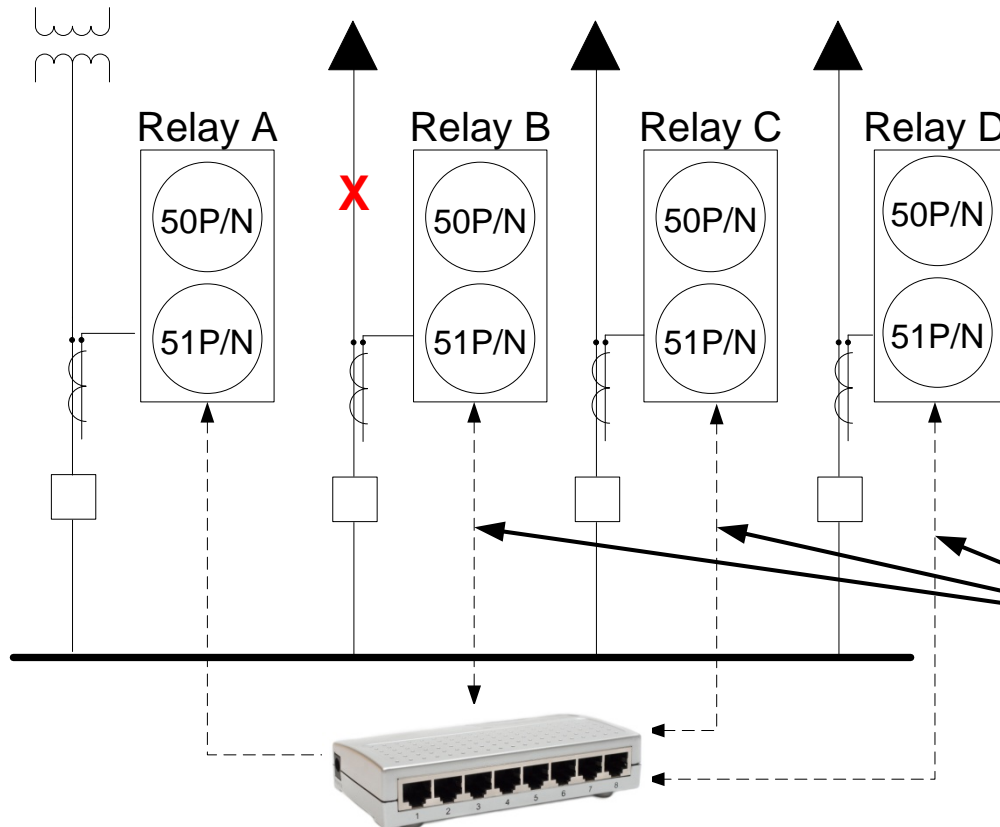
Relay A

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

50P Phase Instantaneous Overcurrent
50N Neutral Instantaneous Overcurrent

X

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

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
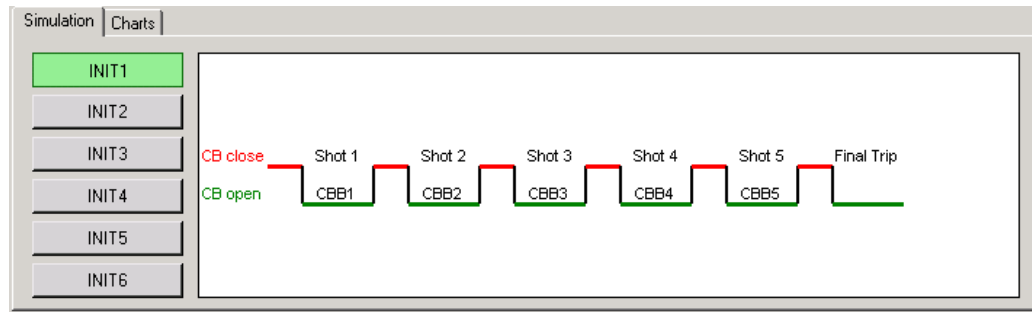
- De-energization of the fault spot for a defined period of time, followed by an automatic reclosure

- **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)
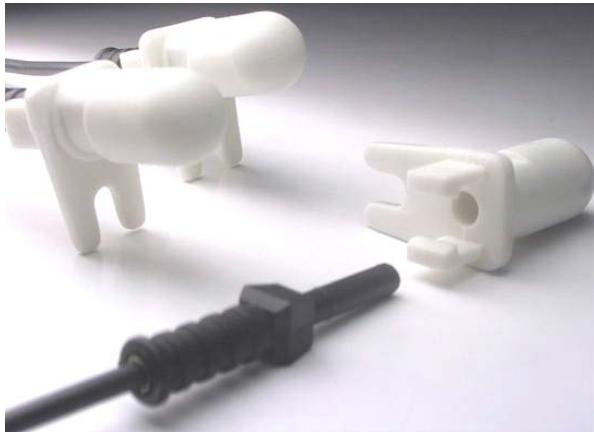
□ Arc trip based on:

- Current and light

- Current and binary input signal

- Light only

□ Separate trip value settings for phase currents and earth-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

ABB

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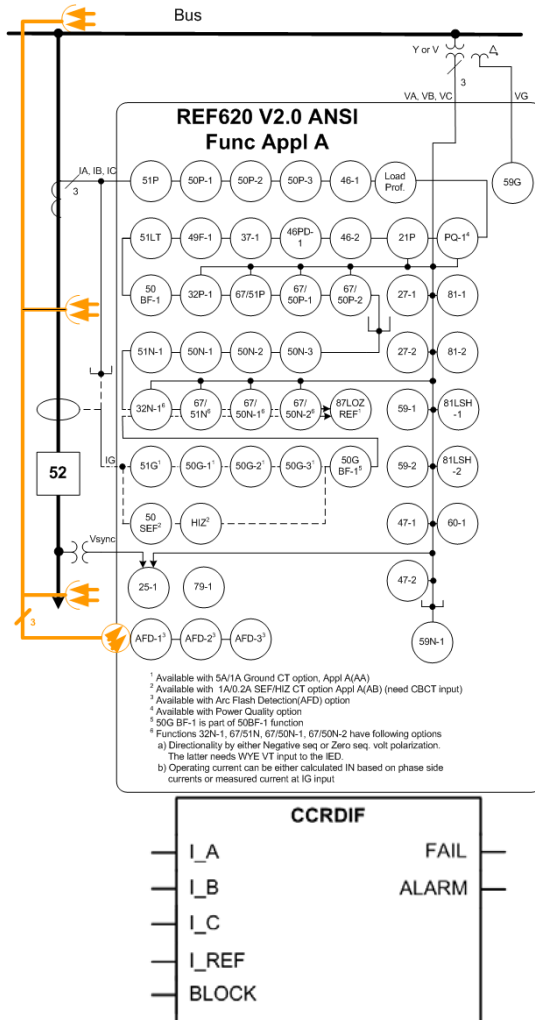
- ❑ Detects faults in the current transformer secondary circuits

- ❑ 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

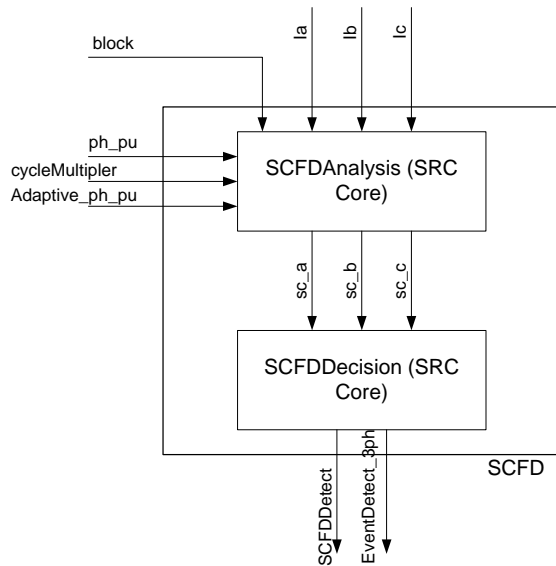- Scheduled maintenance

ABB

REF615R functional overview
Power quality

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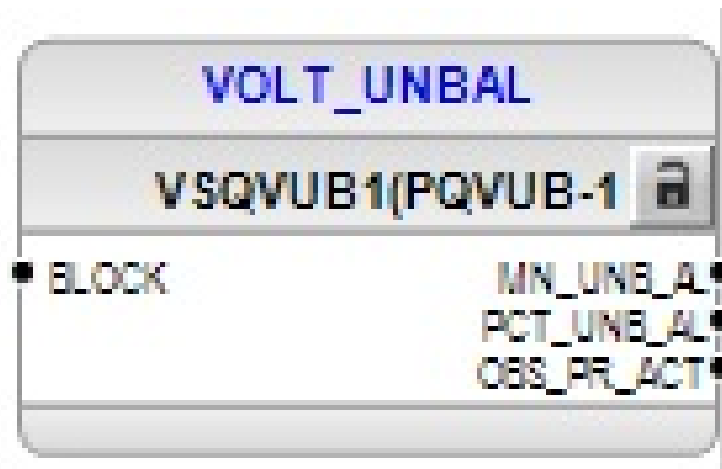
REF615R functional overview
Cable fault detection (CFD)

- 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
  - Expanding number of logical outputs
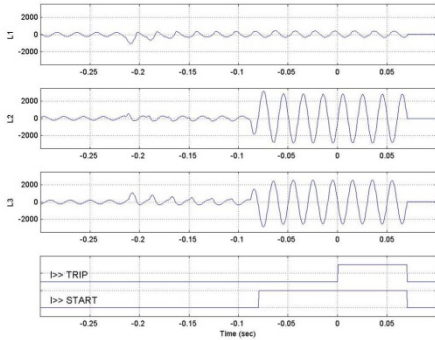 - Map to trigger DFR

REF615R functional overview
Load profile and programmable curves

- ❑ Load Profile feature

  - ▪ Better in having flexibility of values stored

- ❑ Programmable curves included standard and available for each overcurrent element

  - ▪ Easier to enter coefficients than downloading curve data

REF615R functional overview
Digital fault recorder (DFR)

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

- Triggering by:
  - Analog or binary channel
  - Manual or periodic command

- Recording modes:
  - Wave form or trend

- 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.

- Max 4 X 10 sec if six analog channels are recorded
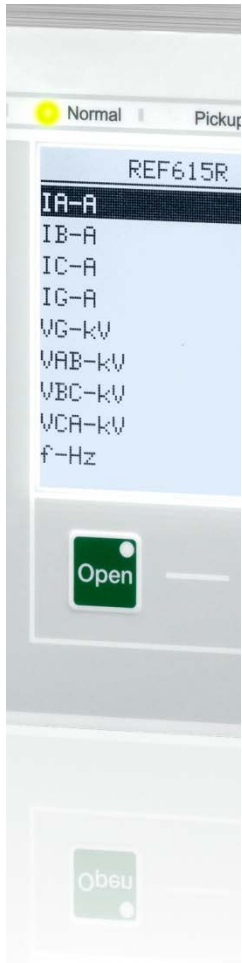
REF615R functional overview
Fault and event recording

- ❏ 128 fault records (FR)

- ❏ 1024 sequence of events (SOE) records

REF615R - Feeder Protection and Control
Agenda

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ABB

Summary
REF615R benefits

- ❏ Advanced communications – dual fiber Ethernet ports

- ❏ Embedded Web HMI and native-IEC61850

- ❏ 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

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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

❑ 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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