DESCRIPTIVE BULLETIN

REF615 ANSI
Feeder protection and control

The REF615 is a dedicated feeder protection and control relay perfectly aligned for the protection, control, measurement and supervision of utility substations and industrial power systems.

—
REF615 ANSI 5.0 FP1

REF615 is a member of ABB's Relion® family and a part of its 615 protection and control product series. The 615 series protection and control relays are characterized by their compactness and withdrawable design. Engineered from the ground up, the 615 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability of substation automation devices.

Application
The REF615 provides main protection for overhead lines, cable feeders, and busbar systems of distribution substations. It can be applied for protection and control of grounded and ungrounded distribution systems. Flexible order coding allows for choosing current-only or current-and-voltage configurations to best fit your distribution feeder application needs.

Protection and control
The REF615 is the most powerful, advanced and simplest feeder protection relay in its class, perfectly offering time and instantaneous overcurrent, negative sequence overcurrent, phase discontinuity, breaker failure, thermal overload, and voltage metering and protection. The relay also features optional high impedance fault (HIZ) protection for grounded and ungrounded distribution systems. Also, the relay incorporates a flexible three-phase multi-shot auto-reclose

function for automatic feeder restoration in temporary faults on overhead lines.

Enhanced with safety options, the relay offers a three-channel arc-fault detection system for supervision of the switchgear.

The REF615 also integrates basic control functionality, which facilitates the control of one circuit breaker via the relay's front panel human machine interface (HMI) or remote control system. To protect the relay from unauthorized access and to maintain the integrity of information, the relay has been provided with a four-level, role-based user authentication system, with individual passwords for the viewer, operator, engineer, and administrator levels. The access control system applies to the front panel HMI, embedded web browser based HMI, and the PCM600 relay setting and configuration tool.

Standardized communication
REF615 supports the new IEC 61850 standard for inter-device communication in substations. The relay also supports the industry standard DNP3.0 and Modbus® protocols. The implementation of the IEC 61850 substation communication standard in REF615 encompasses both vertical and horizontal communication, including GOOSE messaging and parameter set-

ting according to IEC 61850-8-1. The substation configuration language enables the use of engineering tools for automated configuration, commissioning, and maintenance of substation devices.

Pre-emptive condition monitoring
For continuous knowledge of the operational availability of the REF615 features, a comprehensive set of monitoring functions to supervise the relay health, the trip circuit, and the circuit breaker health is included. The breaker monitoring can include checking the wear and tear of the circuit breaker, the spring charging time of the breaker operating mechanism and the gas pressure of the breaker chambers. The relay also monitors the breaker travel time and the number of circuit breaker operations to provide basic information for scheduling breaker maintenance.

The IEC 61850 implementation in REF615 also includes fast peer-to-peer communication, over the substation bus. Use GOOSE communication between REF615 IEDs of the incoming and outgoing feeders of a substation cooperate to form a stable, reliable, and high-speed busbar protection system. The cost-effective GOOSE-based busbar protection is obtained by configuring the IEDs and the operational availability of the protection is assured by continuous supervision of the protection IEDs and their GOOSE messaging over the station bus. No separate hard-wiring is needed for the horizontal communication between the switchgear cubicles.

Bus protection via GOOSE

—
01

—
02

—
01 REF615 V5.0 ANSI
Functional Application D

—
02 REF615 V5.0 ANSI
Functional Applications F

REF615 V5.0 FP-1 ANSI Func Appl D
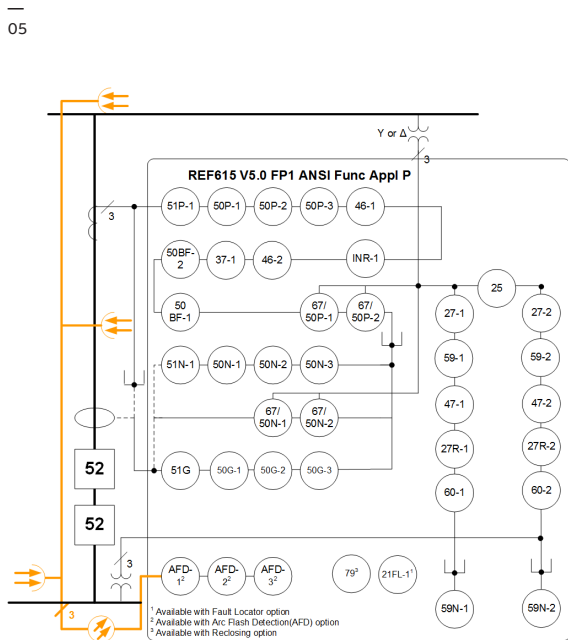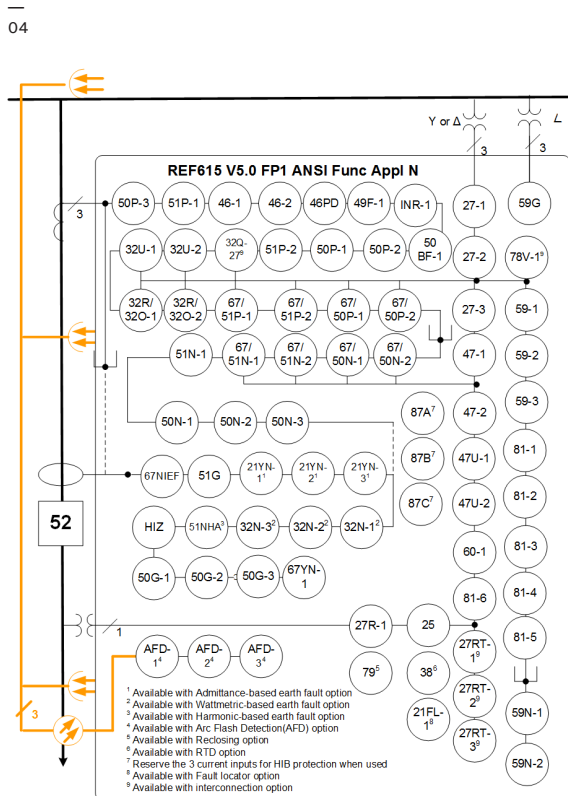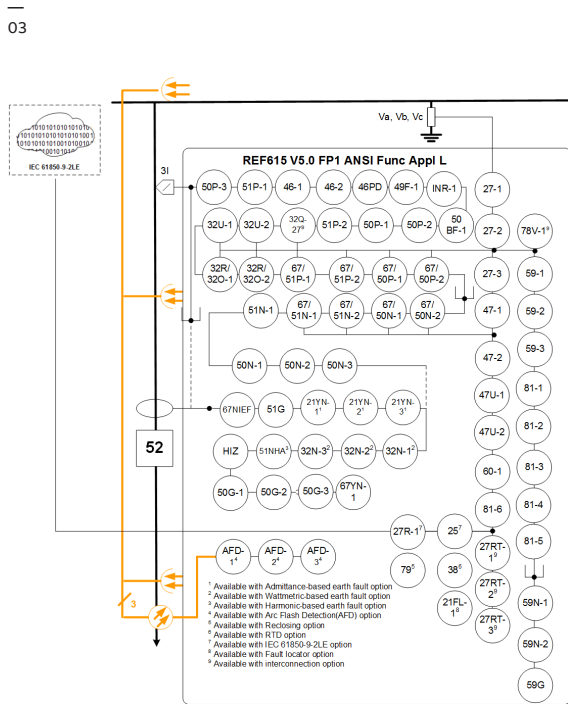

REF615 V5.0 FP1 ANSI Func Appl F

—
03
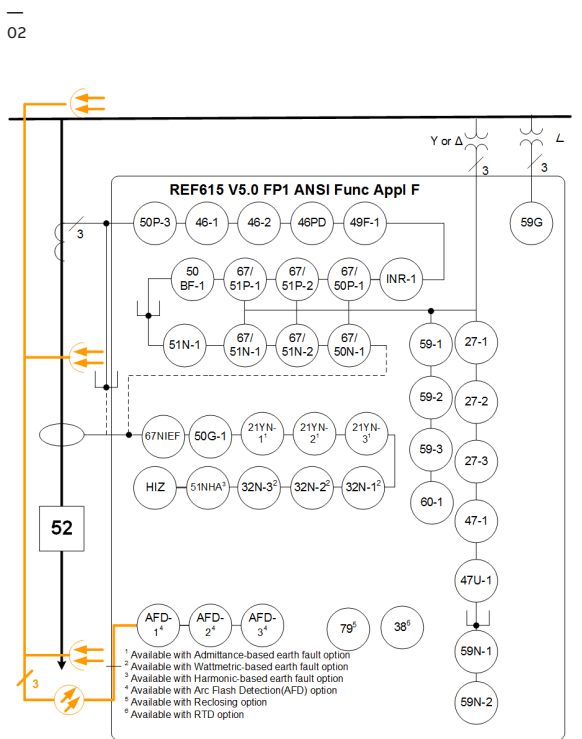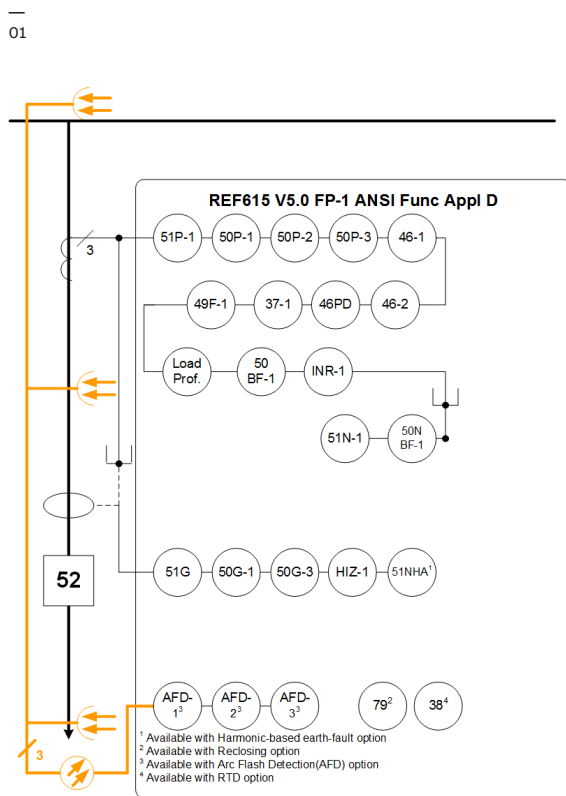
—
03 REF615 V5.0 ANSI
Functional Application L

—
04 REF615 V5.0 ANSI
Functional Application N

—
05 REF615 V5.0 ANSI
Functional Application P

—
04

REF615 V5.0 FP1 ANSI Func Appl L

Va, Vb, Vc

IEC 61850-9-2LE

3I

50P-3	51P-1	46-1	46-2	46PD	49F-1	INR-1	27-1
32U-1	32U-2	32Q-27[9]	51P-2	50P-1	50P-2	50 BF-1	27-2	78V-1[9]
32R/32O-1	32R/32O-2	67/51P-1	67/51P-2	67/50P-1	67/50P-2	27-3	59-1
51N-1	67/51N-1	67/51N-2	67/50N-1	67/50N-2	47-1	59-2
50N-1	50N-2	50N-3	47-2	59-3
67NIEF	51G	21YN-1[1]	21YN-2[1]	21YN-3[1]	47U-1	81-1
HIZ	51NHA[3]	32N-3[2]	32N-2[2]	32N-1[2]	47U-2	81-2
50G-1	50G-2	50G-3	67YN-1	60-1	81-3
					81-6	81-4
27R-1[1]	25[7]	81-5
79[5]	38[6]	27RT-1[9]
21FL-1[8]	27RT-2[9]	59N-1
27RT-3[9]	59N-2
59G

52

AFD-1[4] AFD-2[4] AFD-3[4]

3

[1] Available with Admittance-based earth fault option
[2] Available with Wattmetric-based earth fault option
[3] Available with Harmonic-based earth fault option
[4] Available with Arc Flash Detection(AFD) option
[5] Available with Reclosing option
[6] Available with RTD option
[7] Available with IEC 61850-9-2LE option
[8] Available with Fault locator option
[9] Available with interconnection option

REF615 V5.0 FP1 ANSI Func Appl N

Y or Δ

50P-3	51P-1	46-1	46-2	46PD	49F-1	INR-1	27-1	59G
32U-1	32U-2	32Q-27[9]	51P-2	50P-1	50P-2	50 BF-1	27-2	78V-1[9]
32R/32O-1	32R/32O-2	67/51P-1	67/51P-2	67/50P-1	67/50P-2	27-3	59-1
51N-1	67/51N-1	67/51N-2	67/50N-1	67/50N-2	47-1	59-2
50N-1	50N-2	50N-3	87A[7]	47-2	59-3
67NIEF	51G	21YN-1[1]	21YN-2[1]	21YN-3[1]	87B[7]	47U-1	81-1
HIZ	51NHA[3]	32N-3[2]	32N-2[2]	32N-1[2]	87C[7]	47U-2	81-2
50G-1	50G-2	50G-3	67YN-1	60-1	81-3
					81-6	81-4
27R-1	25	81-5
79[5]	38[6]	27RT-1[9]
21FL-1[8]	27RT-2[9]	59N-1
27RT-3[9]	59N-2

52

AFD-1[4] AFD-2[4] AFD-3[4]

3

[1] Available with Admittance-based earth fault option
[2] Available with Wattmetric-based earth fault option
[3] Available with Harmonic-based earth fault option
[4] Available with Arc Flash Detection(AFD) option
[5] Available with Reclosing option
[6] Available with RTD option
[7] Reserve the 3 current inputs for HIB protection when used
[8] Available with Fault locator option
[9] Available with interconnection option

—
05

REF615 V5.0 FP1 ANSI Func Appl P

Y or Δ

51P-1	50P-1	50P-2	50P-3	46-1
50BF-2	37-1	46-2	INR-1	25	27-1	27-2
50 BF-1	67/50P-1	67/50P-2	27-1	59-1	59-2
51N-1	50N-1	50N-2	50N-3	47-1	47-2
67/50N-1	67/50N-2	27R-1	27R-2
51G	50G-1	50G-2	50G-3	60-1	60-2

52
52

AFD-1[2] AFD-2[2] AFD-3[2]   79[3] 21FL-1[1]   59N-1 59N-2

3

[1] Available with Fault Locator option
[2] Available with Arc Flash Detection(AFD) option
[3] Available with Reclosing option

—

Functions and features

Included = •, Optional = ◦	ANSI Function	REF615 Functional Application										
		Firmware Version 4.0, 4.2						Firmware Version 5.0 FP-1				
		A	B	C	D	E	F[1]	D	F	L	N	P
Protection												
Phase overcurrents	51P, 50P	•	•	•	•	•	•	•	•	•	•	•
Phase long time overcurrent	51LT	•	—	•	•	—	•	—	—	—	—	—
Directional phase overcurrents	67P	—	—	◦	•	—	•	—	•	•	•	•
Phase power directional	32P	—	—	◦	•	•	•	—	—	—	—	—
Underpower	32U	—	—	—	—	—	—	—	—	•	•	•
Reverse Power/Overpower	32R/32O	—	—	—	—	—	—	—	—	•	•	•
Neutral overcurrents	51N, 50N	•	•	•	•	•	•	•	•	•	•	•
Ground overcurrents	51G, 50G	◦	•	◦	◦	•	•	•	•	•	•	•
Harmonics-based ground-fault protection	51NHA	—	—	—	—	—	—	◦	◦	◦	◦	—
Admittance-based ground-fault protection	21YN	—	—	—	—	—	—	—	◦	◦	◦	—
Wattmetric-based ground-fault protection	32N	—	—	—	—	—	—	—	◦	◦	◦	—
Transient/intermittent ground-fault protection	67NIEF	—	—	—	—	—	—	—	◦	◦	◦	—
Bus protection via GOOSE messaging	87B	•	•	•	•	•	•	•	•	•	•	•
Bus protection High Impedance[1]	87B	•[1]	—	—	—	—	—	—	—	—	•	—
Directional neutral overcurrents	67N	—	—	◦	•	—	•	—	•	•	•	•
Neutral power directional	32N	—	—	◦	•	•	•	—	—	—	—	—
Sensitive earth fault	50SEF	◦	—	◦	◦	—	—	•	•	•	•	—
Negative sequence overcurrents	46	•	•	•	•	•	•	•	•	•	•	•
Load sheds and restorations	81LSH	—	—	◦	•	—	—	—	—	—	—	—
Underfrequencies, overfrequencies, rate-of-changes	81	—	—	◦	•	—	—	—	—	•	•	—
Cable fault detection (CFD) for underground and overhead feeder cables	CFD	◦	—	◦	◦	—	—	—	—	—	—	—
High impedance fault (HIZ)	HIZ	◦	—	◦	◦	—	—	•	•	—	•	—
Thermal overload	49F	•	•	•	•	•	—	•	•	•	•	—
Phase discontinuity	46PD	•	—	•	•	—	—	•	•	•	•	—
Cold load inrush detection (seconds, minutes)	62CLD	•	•	•	•	•	•	•	•	•	•	•
Switch onto fault	SOTF-1	—	—	—	—	—	—	•	•	•	•	—
Undercurrent	37	•	•	•	•	•	•	—	—	—	—	—
Restricted earth fault (REF), low impedance	87LOZREF	◦	—	◦	◦	—	—	—	—	—	—	—
Phase undervoltages	27	—	—	◦	•	•	•	—	•	•	•	•
Remanent undervoltage[1]	27R	—	—		•[1]	—	•	—	—	◦	•	•
Phase overvoltages	59	—	—	◦	•	•	•	—	•	•	•	•
Phase sequence overvoltages	47	—	—	◦	•	•	•	—	•	•	•	•
Ground overvoltage	59G	—	—	—	•	—	—	—	•	•	•	—
Neutral overvoltage	59N	—	—	◦	•	•	•	—	•	•	•	•
Circuit breaker failure	50BF	•	•[2]	•	•	•[2]	•	•	•	•	•	•
Three-phase Inrush Detector	INR	—	—	—	—	—	—	•	•	•	•	•
Electrically latched/self-resetting trip digital outputs	86/94	•	•	•	•	•	•	•	•	•	•	•
Arc flash detection via three lens sensors	AFD-1, AFD-2, AFD-3	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Control												
Control for one breaker		•	—	•	•	—	—	•	•	•	•	•
Control for breaker and a half		—	—	—	—	—	—	—	—	—	—	—
Control for two breakers		—	•	•	—	•	•	—	—	—	—	•
Control for disconnector		—	—	—	—	—	—	•	•	•	•	•
Control for earthing switch		—	—	—	—	—	—	•	•	•	•	•
Autoreclose	79	◦	—	◦	◦	—	—	◦	◦	◦	◦	◦
Synchronism check	25	—	—	—	—	—	•	—	—	◦	•	•

—

Functions and features (continued)

Included = •, Optional = ◦	ANSI Function	REF615 Functional Application										
		Firmware Version 4.0, 4.2						Firmware Version 5.0 FP-1				
		A	B	C	D	E	F(1)	D	F	L	N	P
Control (continued)												
Control for earthing switch		—	—	—	—	—	—	•	•	•	•	•
Autoreclose	79	◦	—	◦	◦	—	—	◦	◦	◦	◦	◦
Synchronism check	25	—	—	—	—	—	•	—	—	◦	•	•
Number of pages in HMI		1	1	1	1	1	1	2	2	2	2	2
Customizable HMI		•	•	•	•	•	•	•	•	•	•	•
User programmable LED's		11	11	11	11	11	11	11	11	11	11	11
Monitoring and supervision												
Trip circuit monitoring	TCM	•	•(2)	•	•	•(2)	•	•	•	•	•	•
Breaker condition monitoring	52CM	•	•(2)	•	•	•(2)	•	•	•	•	•	•
Fuse failure	60	—	—	◦	•	•	•	•	•	•	•	•
Current circuit supervision	CCM	•	—	•	•	—	—	•	•	•	•	•
Metering												
Three-phase currents	IA, IB, IC	•	•	•	•	•	•	•	•	•	•	•
Sequence currents	I1, I2, I0	•	•	•	•	•	•	•	•	•	•	•
Ground current	IG	—	—	—	—	—	—	•	•	•	•	•
Demand phase currents		•	•	•	•	•	•	•	•	•	•	•
Maximum and minimum demand values		•	•	•	•	•	•	•	•	•	•	•
Three-phase voltages	VA, VB, VC	—	—	•	•	•	•	—	•	•	•	•
Sequence voltages	V1, V2, V0	—	—	•	•	•	•	—	•	•	•	•
Ground voltage	VG	—	—	—	•	—	—	—	•	—	•	—
Power and energy (1-phase, 3-phases) and power factor	P, E, PF	—	—	•	•	•	•	—	•	•	•	•
Fault location	FLO	—	—	•	•	—	—	—	—	◦	◦	◦
Frequency	f	—	—	—	—	—	—	—	•	•	•	•
RTD/mA measurement		—	—	—	—	—	—	◦	◦	—	◦	—
Power quality - Current Total Demand Distortion (TDD), Voltage Total Harmonic Distortion (THD), Sags (dips), Swells, and Interrupts	PQ	◦	◦	◦	◦	◦	◦	—	—	◦	◦	◦
Automation and communications												
Max number of Digital Inputs		18	14	14	16	11	15	16	16	16	16	16
Max number of Digital Outputs		13	13	13	10	10	10	10	10	10	10	10
Max number of High-Speed Outputs (HSOs are optional and take the place of some digital outputs)		3	3	3	3	3	3	3	3	3	3	3
Current and Voltage sensor inputs		—	—	—	—	—	—	—	—	•	—	—
Sample values per IEC 61850-9-2LE		—	—	—	—	—	—	—	◦	◦	◦	◦
Front 100Base-TX Ethernet (RJ45) port		•	•	•	•	•	•	•	•	•	•	•
Rear 100Base-TX Ethernet (RJ45) port		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear 100Base-FX Ethernet (LC) port		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear 100Base-TX Ethernet(RJ45) + RS-485(1x4-wire or 2x2-wire) + IRIG-B ports		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear 100Base-FX Ethernet(LC) + RS-485(1x4-wire or 2x2-wire) + IRIG-B ports		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear [2 * Ethernet 100FX (LC) + Ethernet 10/100BaseT (RJ45) + serial glass fiber (ST)] w HSR/PRP		◦(1)	—	◦(1)	◦(1)	—	◦	◦	◦	◦	◦	◦
Rear 100Base-TX and -FX Ethernet (1 * LC, 2 * RJ45) + serial glass fi ber (ST) ports w HSR/PRP		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear 100Base-TX Ethernet (3 * RJ45) + serial glass fiber (ST) ports w HSR/PRP(4)		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
Rear [2 * Ethernet 100FX (LC) + Ethernet 10/100BaseT (RJ45)] w HSR/PRP		—	—	—	—	—	—	◦	◦	◦	◦	◦

—
Functions and features (continued)

		REF615 Functional Application										
		Firmware Version 4.0, 4.2						Firmware Version 5.0 FP-1				
Included = •, Optional = ◦	**ANSI Function**	**A**	**B**	**C**	**D**	**E**	**F**[(1)]	**D**	**F**	**L**	**N**	**P**
Automation and communications (continued)												
Ethernet 100Base-TX (RJ45) + configurable RS232/RS485 + [RS485 or serial glass fiber (ST) + IRIG-B] ports[(3)]		◦	◦	◦	◦	◦	◦	◦	◦	◦	◦	◦
DNP3.0, Modbus, and IEC61850 communication protocols		•	•	•	•	•	•	◦	◦	◦	◦	◦
Records												
Sequence of events recorder	SER	•	•	•	•	•	•	•	•	•	•	•
Fault recorder	FLR	•	•	•	•	•	•	•	•	•	•	•
Digital fault (waveform) recorder	DFR	•	•	•	•	•	•	•	•	•	•	•
Load profile	LoadProf	•	—	•	•	—	—	•	•	•	•	•
Digital Fault Recorder signal channels (Analog/Digital)		4/64	4/64	4/64	4/64	4/64	4/64	12/64	12/64	12/64	12/64	12/64
Events recorder (FIFO), 1ms resolution		1024	1024	1024	1024	1024	1024	1024	1024	1024	1024	1024
Fault records		128	128	128	128	128	128	128	128	128	128	128

1 Firmware version 4.2 must be selected
2 Applicable for two breakers
3 May not be combined with Arc flash detection (AFD) option
4 HSR/PRP Redundancy option available only for 615 series 4.2 and 5.0 FP1

Analog inputs
- Three phase currents: 5/1 A programmable
- Ground current: 5/1 A programmable or 0.2 A
  Rated frequency: 60/50 Hz programmable
- Three-phase and ground voltages: programmable
  nominal secondary voltage (available as options)

Binary inputs and outputs
- Four, eight with VT inputs, binary inputs standard
- Two NO outputs with trip circuit monitoring
- Three NO outputs
- One Form C output and self-check alarm output
- Additional binary inputs and outputs available as
  options

Communication
- IEC 61850-8-1 with GOOSE messaging
- DNP3.0 Level 2+ over TCP/IP
- Modbus over TCP/IP
- Time synchronization via SNTP (primary and backup
  servers)
- Optional serial RS-485 port programmable for
  DNP3.0 Level 2+ or Modbus RTU
- Optional IRIG-B time synchronization
- Optional HSR/PRP communication
- Optional IEEE1588v2 time synchronization (available
  with REF615 V5.0 and later)
- IEC61850-9-2LE (available with REF615 V5.0 and
  later)

Product dimensions and weights
- Frame: 6.97" (177 mm) W x 6.97" (177 mm) H
- Case: 6.57" (165 mm) W x 6.30" (160 mm) H x 6.10"
  (155 mm)
- Weight: Relay - 7.72 lbs. (3.5 kg); Draw-out unit - 3.97
  lbs. (1.8 kg)

Tools
- PCM600 V2.8 for setting, configuration and data
  retrieval
- COM600 Station Automation series products V5.0
- Web browser based user interface (IE 11 or later)

Certificates
- UL Listed product, File E103204

Control voltage
- Option 1: 48 ... 250 V dc, 100 … 240 V ac
- Option 2: 24 ... 60 V dc

—
We reserve the right to make technical changes or modify the contents of this document without prior notice. With regard to purchase orders, the agreed particulars shall prevail. ABB AG does not accept any responsibility whatsoever for potential errors or possible lack of information in this document.