Relion® 605 series

Feeder protection and control / Feeder protection REF601 / REJ601 Product Guide

Power and productivity
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Contents

1. Description

REF601/REJ601 is a dedicated feeder protection relay, intended for the protection of utility substations and industrial power systems, in primary and secondary distribution networks. REF601/REJ601 is a member of ABB's Relion ® product family and part of its 605 series.

The relay provides an optimized composition of protection, monitoring and control functionality in one unit, with the best performance usability in its class and are based on ABB's in-depth knowledge of protection and numerical technology.

2. Relay functions

REF601/REJ601 offers pre-configured functionality which facilitates easy and fast commissioning of switchgear.

To emphasize the simplicity of relay's usage, only application specific parameters needs to set within the relay's intended area of application. The standard signal configuration can be altered by LHMI (local human-machine interface).

The relay is available in two alternative configurations, with control functionality and without control functionality.

Table 1. Standard configurations

Description	Relay type
Feeder protection and control	REF601
Feeder protection	REJ601

Table 2. Supported functions

Functionality	IEC	ANSI	REF601	REJ601
Protection				
Non-directional overcurrent protection, low-set stage	3I>	51	•	•
Non-directional overcurrent protection, high-set stage	3I>>	50-1	•	•
Non-directional overcurrent protection, very high-set stage	3I>>>	50-2	•	•
Earth-fault protection, low-set stage	Io>	51N	•	•
Earth-fault protection, high-set stage	Io>>	50N	•	•
Three phase transformer inrush detector	3I2f>	68	•	•
Master trip	Master trip	86	•	•
Control				
Circuit-breaker control	I <-> O CB	I <-> O CB	•	-
Condition monitoring				
Trip circuit supervision	TCS	TCM	•	•
Measurement				
Three-phase current measurement	3I	3I	•	•
Residual current measurement	Io	In	•	•

• = Included

3. Protection functions

REF601/REJ601 offers three-stage overcurrent and two-stage earth-fault protection functions. The transformer inrush detector function is incorporated to prevent unwanted trippings due to energizing of transformers.

The low-set stages for overcurrent and earth-fault-protection are equipped with selectable characteristics - Definite time (DT) and Inverse definite minimum time (IDMT) . The relay features standard IDMT characteristics – Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI), Long-time Inverse (LI) and a special inverse characteristic (RI) for better co-ordination with rest of the network protection.

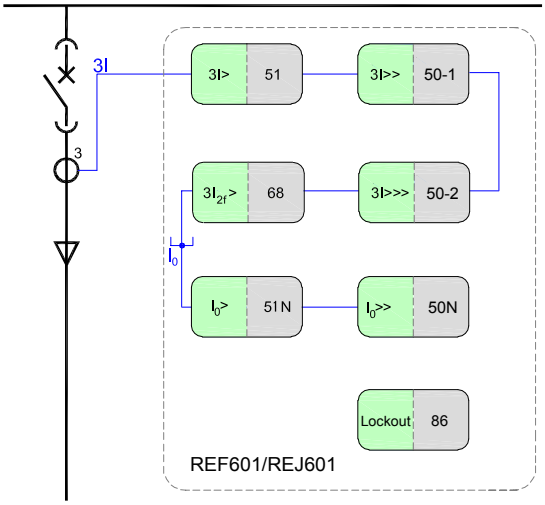

Figure 1. Protection function overview of REF601 / REJ601 with earth current-measurement by internal calculation

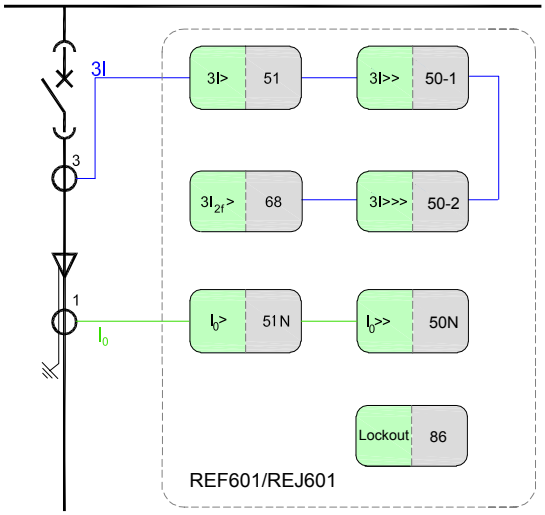

Figure 2. Protection function overview of REF601 / REJ601 with earth current measurement by external core-balance current transformer

4. Application

The REF601/REJ601is a protection relay aimed at protection and control of incoming and outgoing feeders in MV distribution substations. The relay can be applied for the short-circuit over current and earth-fault protection of overhead lines and cable feeders of distribution and sub-distribution network.

The inrush current stabilization function allows the relay to be used as main protection of distribution transformers and back-up protection of large transformers.

5. Optimized for limited space

With its compact size and unique technical features, REF601/REJ601 is an ideal relay for retrofits, compact switchgears and switchgear with limited space. The relay has small mounting depth and does not have any loose mounting accessories, while the press-fit mounting arrangement makes it suitable for quick and easy installation on switchgear panels.

6. Control

The relay REF601 offers control of one circuit breaker with dedicated push-buttons on local HMI for opening and closing. It includes two dedicated outputs for breaker control. The breaker control is also possible through optional MODBUS communication.

7. Measurement

The relay continuously measures phase currents and earth current. Earth current can be measured using external core balance current transformer or can be calculated internally.

During service, the default view of display shows the most loaded phase current in primary terms (Amps) and the earth current in terms of nominal value of CT. The values measured can be accessed locally via the user interface on the relay or remotely via the communication interface of the relay.

8. Event log

To collect sequence-of-events (SoE) information, the relay incorporates a non-volatile memory with a capacity of storing 100 events with associated time stamps with resolution of 1 milli second. Event log includes trip circuit supervision status, protection operation status, binary I/O status, blocking status and relay fault code. The event logs are stored sequentially, the most recent being first and so on. The non-volatile memory retains its data also in case the relay temporarily loses its auxiliary supply.

The event log facilitates detailed post-fault analysis of feeder faults and disturbances. The SoE information can be accessed locally via the user interface on the relay front panel or remotely via the communication interface of the relay.

9. Recorded data

The relay stores fault records of analog values for last five trip events in non-volatile memory. The fault recording is triggered by the trip signal of protection function. Each fault record includes the current values for three phases and earth current of five different instances along with time stamp.These records enable the user to analyze the five most recent power system events.

The relay records the number of phase and earth fault trip events into dedicated trip counters. These trip counters can not be reset by the user and are stored in non-volatile memory.

The recorded information can be accessed locally via user interface on the relay front panel and can be uploaded for subsequent fault analysis.

10. Self-supervision and test function

The relay's built-in self-supervision system continuously monitors the state of the relay hardware and the operation of the relay software. Any fault or malfunction detected will be used for alerting the operator. A permanent relay fault will block the protection functions of the relay to prevent incorrect relay operation.

The relay supports a built-in test mode which enables user to test the relay HMI and trip outputs.

11. Trip-circuit supervision

The trip-circuit supervision continuously monitors the availability and operability of the trip circuit. It provides open-circuit monitoring both when the circuit breaker is in its closed and in its open position. It also detects loss of circuit-breaker control voltage.

12. Access control

To protect the relay from unauthorized access and to maintain the integrity of information, the relay is armed with a three level, role-based user authentication system with individual password for the operator, engineer and administrator level. The password is a combination of different navigation keys.

13. Inputs and outputs

The relay is equipped with three 1A or 5A analog current inputs. The relay has an additional earth-current input suitable for a 1A or 5A which can be connected to core-balanced current transformer / spit core current transformer.

The relay has four number of binary inputs with wide auxliliary voltage 24V-240V AC/DC. The binary inputs can be configured for various functions like Blocking, Protection reset, Breaker position, Breaker control and trip circuit supervision. Individual input can be configured as either as “Inverted” or “Non Inverted”.

The relay has six output contacts, two power outputs and four signalling outputs. The output contacts can be configured for different functions like routing of Protection start and trip signals, External trip /open and external close command, trip circuit supervision status etc. One dedicated output contact is available for Unit ready / IRF status indication.

The relay has six LED indications on LHMI which are configured for Ready / IRF, Protection start, Protection trip, Phase fault trip, Earth fault trip and Trip circuit fault.

All binary input and output contacts are pre-configured according to default configuration, however can be easily reconfigured by using the LHMI menu.

14. Communication

The relay is available with optional communication feature with Modbus RTU protocol on RS-485 bus with two wire connection. This allows relay to connect to control and monitoring system through serial communication for remote monitoring.

Table 3. Input/output overview

Relay type	Analog input	Binary inputs/outputs	
	CT	BI	BO
REJ601	4	4	6
REF601	4	4	6

15. Technical data

Table 4. Dimensions

Description	Value	
Width	frame	130.0 mm
	case	122.0 mm
Height	frame	160.0 mm
	case	152.0 mm
Depth		151.5 mm
Weight	relay	1.43 kg

Table 5. Power supply

Description	Value
U_{aux} nominal	24...240 V AC, 50 and 60 Hz
	24...240 V DC
U_{aux} variation	85...110% of U_{aux} (20.4...264 V AC)
	70...120% of U_{aux} (16.8...288 V DC)
Burden of auxiliary voltage supply under quiescent (Pq)/operating condition	< 12.0 VA
Ripple in the DC auxiliary voltage	Max 12% of the DC value (at frequency of 100 Hz)
Maximum interruption time in auxiliary DC voltage without resetting the relay	50 ms at U_{aux} rated

Table 6. Energizing inputs

Description		Value	
Rated frequency		50/60 Hz ± 5 Hz	
Current inputs	Rated current, I_n	1A[1)]	5A[1)]
	Thermal withstand capability:		
	• Continuously	4 A	20 A
	• For 1 sec	100 A	500 A
	Dynamic current withstand:		
	• Half-wave value	250 A	1250 A
	Input impedance	< 100 m Ω	< 20 m Ω

1) Ordering option for current input

Table 7. Binary input

Description	Value
Rated voltage	24...240 V AC / DC
Operating range	85...110% of U_n for AC and 70...120% of U_n for DC
Current drain	2...20 mA
Power consumption / input	< 0.5 W
Input sensing time	25 ms
Trip-circuit supervision (TCS): (BI2) • Control voltage range • Current drain through the supervision circuit • Minimum voltage over the TCS contact	 48...250 V AC / DC ~ 1.5 mA 20V AC / DC (15...20 V)

Table 8. Double-pole power output (XK2 : BO2)

Description	Value
Rated voltage	240 V AC / DC
Continuous contact carry	8 A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 48/110/220 V DC (two contacts connected in series)	5 A / 3 A / 1 A
Minimum contact load	100 mA at 24 V AC / DC

Table 9. Single-pole power output relay (XK10 : BO1)

Description	Value
Rated voltage	240 V AC / DC
Continuous contact carry	8A
Make and carry for 3.0 s	15 A
Make and carry for 0.5 s	30 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 35/220 V DC	5A / 0.2 A
Minimum contact load	100 mA at 24 V AC / DC

Table 10. Single-pole signal and IRF output relay (XK2 : BO3, BO4, BO5, BO6)

Description	Value
Rated voltage	240 V AC / DC
Continuous contact carry	6 A
Make and carry for 3.0 s	8 A
Make and carry for 0.5 s	10 A
Breaking capacity when the control-circuit time constant L/R<40 ms, at 35/220 V DC	4A / 0.15 A
Minimum contact load	100 mA at 24 V AC / DC

Table 11. Degree of protection of relay

Description	Value
Front side	IP 43
Rear side, connection terminals	IP 20

Table 12. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C
Short-time service temperature range	-25...+70°C (<16 h)
Relative humidity	< 93%, non-condensing
Atmospheric pressure	86...106 kPa
Altitude	up to 2000 m
Transport and storage temperature range	-40...+85°C

Table 13. Environmental conditions

Description	Type test value	Reference
Dry heat test (humidity < 50%) • Working • Storing	 • 96 h at +70°C • 96 h at +85°C	IEC 60068-2-2 IEC 60068-2-48
Dry cold test • Working • Storing	 • 96 h at -25°C • 96 h at -40°C	IEC 60068-2-1 IEC 60068-2-48
Damp heat test, cyclic	• 2 cycles at +25°C…+55°C Rh > 93%	IEC 60068-2-30
Damp heat test, steady state	• 96 h at +40°C, Rh > 93%	IEC 60068-2-78

Table 14. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz burst disturbance test:		IEC 61000-4-12, class III IEC 60255-22-1
• Common mode • Differential mode	2.5 kV, 1MHz, 400 pulses/sec 1.0 kV, 1MHz, 400 pulses/sec	
Electrostatic discharge test:		IEC 60255-22-2, class III IEC 61000-4-2
• Contact discharge • Air discharge	6 kV, 150 pF/330 Ω 8 kV, 150 pF/330 Ω	
Radio frequency, electro-magnetic field immunity test:	10 V/m f=80-1000 MHz 10 V/m f=80, 160, 450, 900 MHz	IEC 60255-22-3, class III IEC 61000-4-3
Fast transient disturbance tests:		IEC 60255-22-4, class A IEC 61000-4-4
• All ports	4 kV, 5.0 kHz	
Surge immunity test:		IEC 60255-22-5 IEC 61000-4-5
• Common mode • Differential mode	1.0 kV, 1.2/50 µs 0.5 kV, 1.2/50 µs	
Power frequency magnetic field immunity test:		IEC 61000-4-8
• Continuous • Short duration (1 sec)	100 A/m 1000 A/m	
Conducted radio frequency interferene tests:	10 V f=150 KHz...80 Mhz	IEC 60255-22-6, class III IEC 61000-4-6
Pulse magnetic field immunity tests:	1000 A/m, 6.4/16 µs	IEC 61000-4-9

Table 14. Electromagnetic compatibility tests, continued

Description	Type test value	Reference
Emission tests: • Conducted 150 kHz-0.5 MHz 0.5 MHz-30 MHz • Radiated 30-230 MHz 230-1000 MHz	 < 66 dB (µV/m) < 60 dB (µV/m) < 40 dB (µV/m) < 47 dB (µV/m)	IEC 60255-25 EN 55011-CISPR II

Table 15. Insulation tests

Description	Type test value	Reference
Dielectric test • Test voltage	 2 kV, 50 Hz, 1 min	IEC 60255-5 IEC 60255-27
Impulse voltage test • Test voltage	 5 kV, 1.2/50 µs, 0.5 J	IEC 60255-5 IEC 60255-27
Insulation resistance test • Isolation resistance	 > 100 M Ω at 500 V DC	IEC 60255-5 IEC 60255-27

Table 16. Mechanical tests

Description	Type test value	Reference
Vibration tests • Response • Endurance / Withstand	 10...150 Hz, 0.035 mm / 1.0 g, 1 sweep / axis 10...150 Hz, 2.0 g, 20 sweeps / axis	IEC 60255-21-1, class II
Shock tests • Response • Endurance / Withstand	 10 g, 3 pulses in each direction 30 g, 3 pulses in each direction	IEC 60255-21-2, class II
Bump tests	 10 g, 1000 bumps in each direction	IEC 60255-21-2, class II

Table 17. Product safety

Description	Type test value
LV directive	2006/95/IEC
Standard	EN 60255-27 (2005) EN 60255-1 (2009)

Table 18. EMC compliance

Description	Type test value
EMC directive	2004/108/IEC
Standard	EN 50263 (2000) EN 60255-26 (2007)

Table 19. RoHS compliance

Description
Complies with RoHS directive 2002/95/IEC

Table 20. Data communication (Optional)

Description	Type test value
Protocol	MODBUS RTU
Communication port	RS485, 2 wire

16. Protection functions

Table 21. Low-set phase overcurrent protection, stage I> / 51

Parameter	Value (Range)
Setting range of pick-up current 'I >'	0.2...2.5 x I_n in steps 0.001, infinite
Operation accuracy	± 5.0% of set value
Operate time delay (DMT) 't >'	0.04...64 sec in steps of 0.01
Operation time accuracy	± 5.0% of set value or ± 30 msec
Operating curve type	IEC 60255-3: Normal inverse, Very inverse, Extremely inverse, Long-time inverse Special curves: RI inverse
Time multiplier setting 'k'	0.05, 0.1...1.6, in steps of 0.1
Operation time accuracy IEC characteristics RI characteristics	 class E(5) or ± 30 msec ± 5.0% of set value or ± 30 msec
Reset ratio	IDMT : 0.96 and DT : 0.98

Table 22. High-set phase overcurrent protection, stage I>> / 50-1

Parameter	Value (Range)
Setting range of pick-up current 'I >>'	0.5...25.0 x I_n in steps 0.001, infinite
Operation accuracy	± 5.0% of set value
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) 't >>'	0.04...64 sec in steps of 0.01
Operation time accuracy	± 5.0% of set value or ± 30 msec
Reset ratio	0.98

Table 23. Very High-set phase overcurrent protection, stage I>>> / 50-2

Parameter	Value (Range)
Setting range of pick-up current 'I >>>'	0.5...25.0 x I_n in steps 0.001, infinite
Operation accuracy	± 5.0% of set value
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) 't >>>'	0.03...64 sec in steps of 0.01
Operation time accuracy	± 15 msec
Reset ratio	0.98

Table 24. Low-set phase earth-fault protection, stage I_o > / 51N

Parameter	Value (Range)
Setting range of pick-up current 'I_o >'	External earth measurement : 0.013...2.0 x I_n in steps 0.001, infinite Internal earth measurement : 0.2...2.0 x I_n in steps 0.001, infinite
Operation accuracy	External earth measurement : ± 5.0% of set value Internal earth measurement : ± 15.0% of set value
Operate time delay (DMT) 'to >'	0.04...64 sec in steps of 0.01
Operation time accuracy	External earth measurement : ± 5.0% of set value or ± 30 msec Internal earth measurement : ± 10.0% of set value or ± 30 msec
Operating curve type	IEC 60255-3: Normal inverse, Very inverse, Extremely inverse, Long-time inverse Special curves: RI inverse
Time multiplier setting 'ko'	0.05, 0.1...1.6, in steps of 0.1
Operation time accuracy IEC characteristics RI characteristics IEC characteristics RI characteristics	 External earth measurement : class E(5) or ± 30 msec External earth measurement : class E(7.5) or ± 30 msec Internal earth measurement : ± 5.0% of set value or ± 30 msec Internal earth measurement : ± 10.0% of set value or ± 30 msec
Reset ratio	IDMT : 0.96 and DT : 0.98

Table 24. High-set phase overcurrent protection, stage I_o >> / 50N

Parameter	Value (Range)
Setting range of pick-up current 'I_o >>'	External earth measurement : 0.05...12.5 x I_n in steps 0.001, infinite Internal earth measurement : 0.5...12.5 x I_n in steps 0.001, infinite
Operation accuracy	External earth measurement : ± 5.0% of set value Internal earth measurement : ± 15.0% of set value
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) 't_o >>'	0.04...64 sec in steps of 0.01
Operation time accuracy	External earth measurement : ± 5.0% of set value or ± 30 msec Internal earth measurement : ± 10.0% of set value or ± 30 msec
Reset ratio	0.98

Table 25. Transformer inrush detection

Parameter	Value (Range)
Inrush threshold value	0.2...25 x I_n, in steps of 0.01
Ratio Setting	30%...50%, in steps of 5%

17. Dimensions and mounting

The REF601/REJ601 have been equipped with in-built press-fit mechanism. Without using an additional mounting accessories, the REF601/REJ601 can be easily flush mounted on the panel.

The panel cut-out for flush mouting:

- Height : 152.0 ± 0.5 mm
- Width : 122.0 ± 0.5 mm
- Thickness of panel : 2.0 - 3.0 mm

With appropriate mounting accessories the REF601/REJ601 can be mounted on the ABB make circuit breakers type VD4 /HD4.

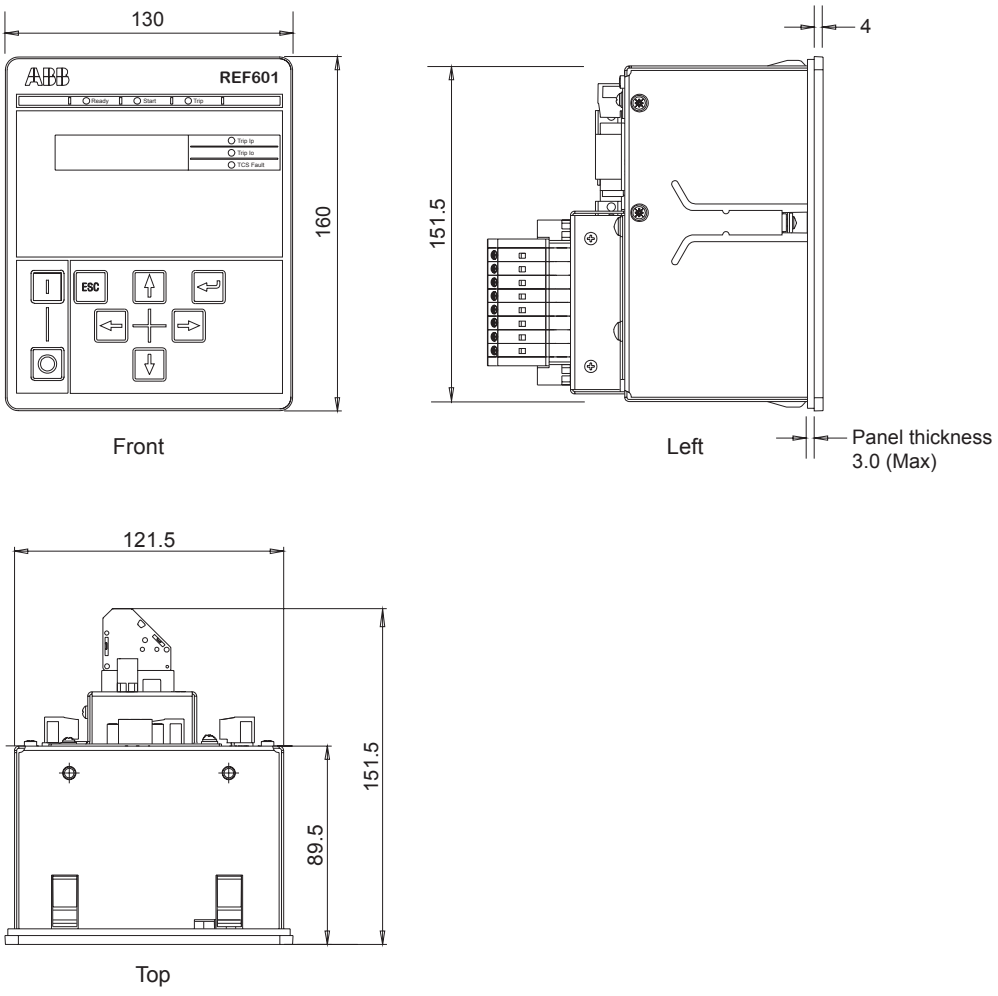

Figure 3. Dimension of REF601/REJ601 - Flush mounting

18. Selection and ordering data

The relay type and serial number label identifies the protection relay. An order number label is placed on the side of the relay. The order number consists of a string of codes generated from the hardware and software modules of the relay The serial number and order number label is placed on side of relay.

Use the ordering key information in Fig. 4 to generate the order number when ordering complete protection relays.

REF601 B E 4 4 6 B A 1 X F

#	Description	
1	Relay type	
	Feeder protection with control	REF601
	Feeder protection w/o control	REJ601
2	Standard	
	IEC	B
3,4	Analog input / output	
	Phase and Earth current input - 1A	D4
	Phase and Earth current input - 5A	E4
5,6	Binary input / output	
	4 BI + 6 BO	46

REF601 B E 4 4 6 B A 1 X F

#	Description	
7	Serial communication	
	with RS485	B
	None	N
8	Communication protocol	
	MODBUS RTU	A
	None	N
9	Power supply	
	24...240V AC / DC	1
10	For future use	
	Undefined	X
11	Version	
	Product version 2.1	F

Example code: REF601 B E 4 4 6 B A 1 X F

Your ordering code:

Digit (#)	1	2	3	4	5	6	7	8	9	10	11
Code											

Figure 4. Ordering key for complete relay

19. Accessories and ordering data

Table 26. Communication accessories

Item	Order number
RE_601 communication card	CIM601BNNNNBANXF

20. Terminal diagram

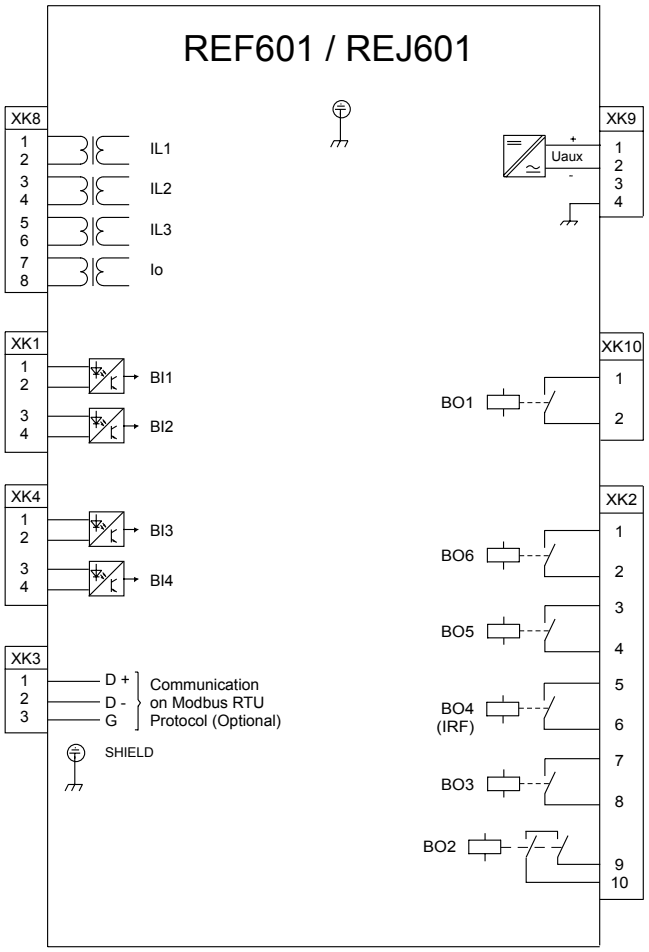

Figure 5. Terminal diagram of REF601/REJ601

21. References

The www.abb.com/substationautomation portal offers you information about the distribution automation product and service range.

You will find the latest relevant information on the REF601/REJ601 protection relay on the product page.

The download area on the right hand side of the Web page contains the latest product documentation, such as technical reference manual, installation manual, operator manual, and so on. The selection tool on the Web page helps you find the documents by the document category and language.

The Features and Application tabs contain product related information in a compact format.

22. Document revision history

Document revision/date	Product version	History
A/2012-08-15	2.1	REF601/REJ601 with CT release

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