



Relion® 605 series

Feeder protection and control / Feeder protection

REF601 / REJ601

Product Guide

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Feeder protection and control / Feeder protection REF601 / REJ601	1MDB07212-YN
Product version: 2.2FP1	Issued: 2014-06-23
	Revision: C

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 three alternative application configurations, as indicated in Table 2.

Table 1. Standard configurations

Description	Relay type
Feeder protection and control with sensor	REF601
Feeder protection and control with conventional current transformer	REF601
Feeder protection with conventional current transformer	REJ601

Table 2. Application configurations and supported functions

	Related products		REJ601 / REF601	REJ601 / REF601	REF601
Functionality	ANSI	IEC	B	C	D
Protection					
Non-directional overcurrent protection, low-set stage	51	3I>	•	•	•
Non-directional overcurrent protection, high-set stage	50-1	3I>>	•	•	•
Non-directional overcurrent protection, instantaneous stage	50-2	3I>>>	•	•	•
Earth-fault protection, low-set stage	51N	Io>	•	•	•
Earth-fault protection, high-set stage	50N	Io>>	•	•	•
Three phase transformer inrush detector	68	3I2f>	•	•	•
Three-phase thermal protection for feeders, cables and distribution transformers	49	3Ith>	-	•	•
Phase discontinuity protection	46PD	I2/I1>	-	•	•
Negative-sequence overcurrent protection	46	I2>	-	-	•
Circuit breaker failure protection	51BF/51NBF	3I>/Io>BF	-	•	•
Master trip	86	Master Trip	•	•	•
Two setting group			•	•	•

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Table 3. Application configurations and supported functions, continued

	Related products		REJ601 / REF601	REJ601 / REF601	REF601
Functionality	ANSI	IEC	B	C	D
Control (Function only available in REF601)					
Breaker control functionality	I <-> O CB	I <-> O CB	•	•	•
Auto-reclosing	79	O -> I	-	-	•
Condition monitoring					
Trip circuit supervision	TCM	TCS	•	•	•
Measurement					
Three-phase current measurement	3I	3I	•	•	•
Residual current measurement	I _n	I _o	•	•	•
Negative phase sequence current	I ₂	I ₂	-	-	•
Thermal level	θ	θ	-	•	•
Operation counter	-	-	-	•	•

• = 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 tripping's 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 according IEC 61

255-3 and ANSI C37.112, Normal Inverse (NI), Very Inverse (VI), Extremely Inverse (EI), Long-time Inverse (LI) respective Moderate inverse, Normal Inverse, Very inverse, Extremely inverse and a special characteristic RI inverse (RI) for better co-ordination with rest of the network.

Further relay offers thermal overload protection for feeder, cable and transformer, negative phase sequence protection, phase discontinuity protection and circuit breaker failure protection. Relay also has feature of auto-reclose function for overhead line feeders.

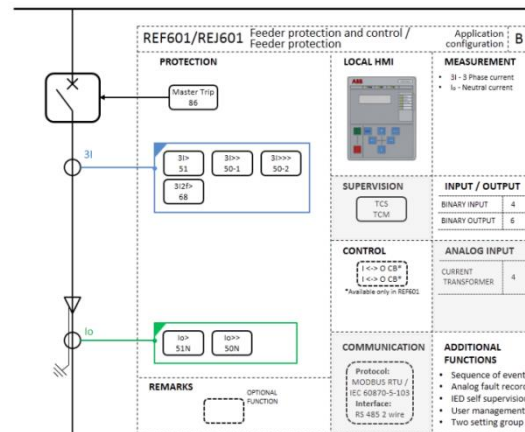


Figure 1. Functionality overview for REF601 standard configuration B with current transformer inputs

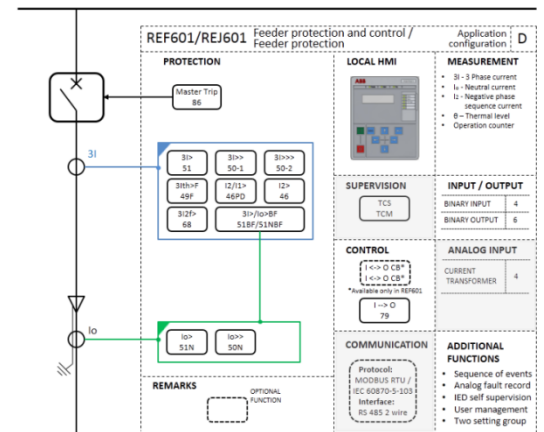


Figure 3. Functionality overview for REF601 standard configuration D with current transformer inputs

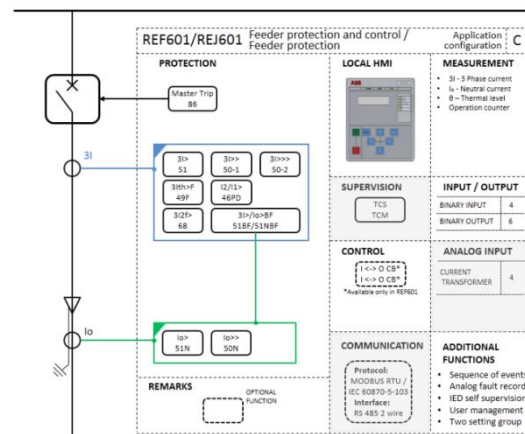


Figure 2. Function overview for REF601 standard configuration C with current transformer inputs

4. Application

The REF601/REJ601 is 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.

The relay with application configuration B offers, non-directional over current and earth-fault protection. The residual current for the earth-fault protection is derived from the phase currents. When applicable, the core-balance current transformers can be used for measuring the residual current, especially when sensitive earth-fault protection is required.

The application configuration C additionally offers thermal overload protection for feeders, cables and transformers, phase discontinuity protection and circuit breaker failure protection.

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The application configuration D provides highest functionality with incorporation of negative phase sequence protection and multi shot auto-reclose functionality making relay suitable for overhead line feeders.

5. Optimised 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

6. Control

The relay offers control of one circuit breaker with dedicated push-buttons and guidance on local HMI for opening and closing. It includes two dedicated outputs for breaker control. The breaker control is also possible through optional MODBUS / IEC 60870-5-103 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. The values measured can be accessed locally via the user interface on the relay or remotely via the communication interface of the relay.

The relay continuously measures negative sequence current, thermal level and counter values if these functions are supported as per application configurations.

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 ms. Event log includes trip circuit supervision status, protection operation status, binary I/O 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 analogue 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 cannot 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.

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The relay supports a built-in test mode which enables user to test the relay HMI and binary 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. There is availability of 2 different password protection, one which is a combination of different navigation keys which is default one and other with Alpha-numeric password. User can select either of password depending on their requirement.

13. Local HMI

Local HMI of relay contains LCD display, LED indicators and navigation keys. The measurement, recorded data, events, setting can be viewed in display. 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 indications. Display supports built in multiple languages.

14. Inputs and outputs

The relay with conventional CT variant is equipped with four 1A or 5A analog current inputs, three for phase current and one for earth current measurement.

The relay with sensor variant is equipped with three Rogowski sensor inputs along with an

additional earth-current input suitable for a 1A which can be connected to core-balanced current transformer / split core current transformer. More details of sensor provided in "Section 15 - Sensor technology".

The relay has four binary inputs. The binary inputs can be configured for various functions like Blocking, Protection reset, Breaker position, Breaker control and trip circuit supervision. In turn these signals can be mapped at binary output and LEDs for indications. Individual input can be configured 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 / trip signals, External trip / open, external close command, trip circuit supervision status etc. One dedicated output contact is available for Unit ready / IRF status indication.

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

15. Sensor technology

Sensors based on Rogowski coil principle have been introduced in order to get benefit of improved performance like saturation of conventional current transformer and equipment size reduction. ABB is offering two types of sensors - KECA and KEVCR which employs the Rogowski coil principle for measurement of current. Albeit this principle is far from new, now it is possible to exploit the advantages of sensor with the advent of numerical relays like REF601.

Rogowski coil is a toroidal coil without an iron core, placed around the primary conductor in the same way as the secondary winding in a current transformer. However, the output signal from Rogowski coil is not current, but a voltage. Due to absence of ferromagnetic core, the sensor is linear up to the highest currents.

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The wide measurement range of sensors with high accuracy eliminates the need for high variants of conventional instrument transformers, resulting in simplified engineering, logistics and reduced inventory. The low level voltage signals and integrated secondary cables contribute to easy and fast installation with enhanced safety.

16. Communication

The relay is available with optional communication feature with Modbus RTU protocol or IEC 60870-5-103 on RS-485 bus with two wire connection. This allows relay to connect to

control and monitoring system through serial communication for remote monitoring.

17. Application warning

In case the relay REF601 is supplied with UPS step-wave or square-wave, an interposing transformer is needed to keep the supply voltage (peak voltage) below the upper limit of the relay.

These are the recommended transformer characteristics:

- Nominal Power: 20 VA
- Secondary voltage: in the range 30...150 V AC

Table 4. Input/output overview

Relay type	Analog input	Binary inputs	Binary outputs
	CT	BI	BO
REF601 Sensor variant	3+1 ¹⁾	4	6
REJ601 CT variant	4	4	6
REF601 CT variant	4	4	6

¹⁾ Support for three current sensors and one conventional current transformer input

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18. Technical data

Table 5. Dimensions

Relay type Description	Value	
Width	frame	130.0 mm
	case	121.5 mm
Height	frame	160.0 mm
	case	151.5 mm
Depth	CT variant	151.5 mm
	Sensor variant	101.5 mm
Weight	CT variant	1.43 kg
	Sensor variant	1.20 kg

Table 6. Power supply

Description	Value
Uaux nominal	24...240 V AC, 50 and 60 Hz
	24...240 V DC
Uaux variation	85...110% of Uaux (20.4...264 V AC)
	70...120% of Uaux (16.8...288 V DC)
Burden of auxiliary voltage supply under quiescent (Pq)/operating condition	< 5.0 VA
Ripple in the DC auxiliary voltage	Max 12% of the DC value (at frequency of 100 Hz)
Maximum interruption time in the auxiliary DC voltage without resetting the relay	50 ms at Uaux rated

Table 7. Energizing inputs (Conventional CT variant)

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

¹⁾ Ordering option for current input

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Table 8. Energizing inputs (Sensor variant)

Description		Value	
Rated frequency		50/60 Hz \pm 5 Hz	
Phase sensor inputs	Input type	Rogowski coil sensor	
	Rated current, I_n	250	80
	Base value, I_r	40, 80, 250, 1250	12.8, 25.6, 80, 400
	Rated transformation ratio, K_{ra}	At 50Hz : 250A / 0.15V At 60Hz : 250A / 0.18V	At 50Hz : 80A / 0.15V At 60Hz : 80A / 0.18V
Earth current inputs	Input type	Current Transformer	
	Rated current, I_n	1 A	
	Thermal withstand capability:		
	• Continuously	4 A	
	• For 1 s	100 A	
	Dynamic current withstand		
	• Half-wave value	250 A	
Input impedance		< 100 m Ω	

Table 9. 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	48...250 V AC / DC
Current drain through the supervision circuit	~ 1.5 mA
Minimum voltage over the TCS contact	20V AC / DC (15...20 V)

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Table 10. 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 11. Single-pole power output relay (XK10 : BO1)

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 35 / 220 V DC	5 A / 0.2 A
Minimum contact load	100 mA at 24 V AC/DC

Table 12. Signal output and IRF output (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	4 A/0.15 A
Minimum contact load	100 mA at 24 V AC/DC

Table 13. Degree of protection of relay

Description	Value
Front side	IP 54
Rear side, connection terminals	IP 20

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Table 14. Environmental conditions

Description	Value
Operating temperature range	-25...+55°C
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 15. Environmental tests

Description	Type test value	Reference
Dry heat test (humidity < 50%) <ul style="list-style-type: none"> Working Storing 	<ul style="list-style-type: none"> 96 h at +70°C 96 h at +85°C 	IEC 60068-2-2 IEC 60068-2-48
Dry cold test <ul style="list-style-type: none"> Working Storing 	<ul style="list-style-type: none"> 96 h at -25°C 96 h at -40°C 	IEC 60068-2-1 IEC 60068-2-48
Damp heat test, cyclic	<ul style="list-style-type: none"> 2 cycles (12 h + 12 h) at +25°C...+55°C, Rh > 93% 	IEC 60068-2-30
Damp heat test, steady state	<ul style="list-style-type: none"> 96 h at +40°C, humidity, Rh > 93% 	IEC 60068-2-78

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Table 16. Electromagnetic compatibility tests

Description	Type test value	Reference
1 MHz/100 kHz burst disturbance test: <ul style="list-style-type: none"> Common mode Differential mode 	2.5 kV, 1MHz, 400 pulses/s 1.0 kV, 1MHz, 400 pulses/s	IEC 61000-4-12, class III IEC 60255-22-1
Electrostatic discharge test: <ul style="list-style-type: none"> Contact discharge Air discharge 	6 kV, 150 pF/330 Ω 8 kV, 150 pF/330 Ω	IEC 60255-22-2, class III IEC 61000-4-2
Radiated, electro-magnetic field immunity test	10 V/m f=80-1000 MHz, 1.4-2.7 GHz 10 V/m f=80, 160, 450, 900 MHz, 900 PM, 1850 PM, 2150 PM	IEC 60255-22-3, class III IEC 61000-4-3
Fast transient disturbance tests: <ul style="list-style-type: none"> All ports 	4 kV, 5.0 kHz	IEC 60255-22-4, class A IEC 61000-4-4
Surge immunity test: <ul style="list-style-type: none"> Common mode Differential mode 	4.0 kV, 1.2/50 μ s 2.0 kV, 1.2/50 μ s	IEC 60255-22-5 IEC 61000-4-5
Power frequency magnetic field immunity test: <ul style="list-style-type: none"> Continuous Short duration (1 s) 	100 A/m 1000 A/m	IEC 61000-4-8
Conducted radio frequency interference tests:	10 V f=150 KHz...80 Mhz	IEC 60255-22-6, class III IEC 61000-4-6
AC Voltage dips and short interruptions:	30% / 25 period 60% / 10 periods 100% / 2.5 periods 100% / 250 periods	IEC 61000-4-11
DC Voltage dips and short interruptions	30% / 500 ms 60% / 200 ms 100% / 50 ms 100% / 5000 ms	IEC 61000-4-29
Power frequency immunity test: <ul style="list-style-type: none"> Common mode Differential mode 	300 V rms 150 V rms	IEC 60255-22-7, Class A
Pulse magnetic field immunity tests:	1000 A/m, 6.4/16 μ s	IEC 61000-4-9

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

Table 17. Insulation tests

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

Table 18. Mechanical tests

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

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Table 19. Product safety

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

Table 20. EMC compliance

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

Table 21. RoHS compliance

Description
Complies with RoHS directive 2002/95/IEC

Table 22. Data communication (optional)

Description	Type test value
Protocol	MODBUS RTU or IEC 60870-5-103
Communication port	RS485, 2 wire

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19. Protection functions

Table 23. Low-set phase overcurrent protection, stage I> / 51

Parameter	Value (Range)
Setting range of pick-up current 'I >'	0.1...2.5 x I _n in steps 0.001, infinite
Operation accuracy	± 5.0% of set value, ± 10.0% of set value for set value < 0.2
Operate time delay (DMT) 't >'	0.04...64 s in steps of 0.01
Operation time accuracy	± 5.0% of set value or ± 30 ms
Operating curve type	IEC 60255-3: Normal inverse, Very inverse, Extremely inverse, Long-time inverse ANSI C37.112: Moderate inverse, Normal Inverse, Very inverse, Extremely inverse Special curves: RI inverse
Time multiplier setting 'k'	0.02...1.6, in steps of 0.01
Operation time accuracy <ul style="list-style-type: none"> IEC and ANSI characteristics RI characteristics 	class E(5) or ± 30 ms, class E(7.5) or ± 30 ms for set value < 0.2 ± 5.0% of set value or ± 30 ms
Reset ratio	IDMT : 0.96 and DT : 0.98

Table 24. High-set phase overcurrent protection, stage I>> / 50-1

Parameter	Value (Range)
Setting range of pick-up current 'I>>'	0.2...25.0 x I _n in steps 0.001, infinite for CT variant 0.2...20.0 x I _n in steps 0.001, infinite for sensor variant
Operation accuracy	± 5.0% of set
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) 't >>'	0.04...64 s in steps of 0.01
Operation time accuracy	± 5.0% of set value or ± 30 ms
Reset ratio	0.98

Table 25. Very high-set phase overcurrent protection, stage I>>> / 50-2

Parameter	Value (Range)
Setting range of pick-up current 'I>>>'	0.2...25.0 x I _n in steps 0.001, infinite for CT variant 0.2...20.0 x I _n in steps 0.001, infinite for sensor variant
Operation accuracy	± 5.0% of set
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) 't >>>'	0.03...64 s in steps of 0.01
Operation time accuracy	± 5.0% of set value or ± 15 ms
Reset ratio	0.98

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Table 26. Low-set earth-fault protection, stage $I_{0>}$ / 51N

Parameter	Value (Range)
Setting range of pick-up current ' $I_{0>}$ '	External earth measurement : 0.01...2.0 x I_n in steps 0.001, infinite Internal earth measurement : 0.1...2.0 x I_n in steps 0.001, infinite
Operation accuracy	External earth measurement : $\pm 5.0\%$ of set value External earth measurement : $\pm 10.0\%$ of set value, for set value < 0.05 Internal earth measurement : $\pm 15.0\%$ of set value
Operate time delay (DMT) ' $t_{>}$ '	0.04...64 s in steps of 0.01
Operation time accuracy	External earth measurement : $\pm 5.0\%$ of set value or ± 30 ms Internal earth measurement : $\pm 10.0\%$ of set value or ± 30 ms
Operating curve type	IEC 60255-3: Normal inverse, Very inverse, Extremely inverse, Long-time inverse ANSI C37.112: Moderate inverse, Normal Inverse, Very inverse, Extremely inverse Special curves: RI inverse
Time multiplier setting 'k'	0.02...1.6, in steps of 0.01
Operation time accuracy <ul style="list-style-type: none"> IEC and ANSI characteristics RI characteristics IEC and ANSI characteristics RI characteristics 	External earth measurement : class E(5) or ± 30 ms External earth measurement : class E(7.5) or ± 30 ms Internal earth measurement : $\pm 5.0\%$ of set value or ± 30 ms Internal earth measurement : $\pm 10.0\%$ of set value or ± 30 ms
Reset ratio	IDMT : 0.96 and DT : 0.98

Table 27. High- set earth-fault protection, stage $I_{0>>}$ / 50N

Parameter	Value (Range)
Setting range of pick-up current ' $I_{0>>}$ '	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 : $\pm 5.0\%$ of set value Internal earth measurement : $\pm 15.0\%$ of set value
Operation mode	Definite time, Instantaneous
Operate time delay (DMT) ' $t_{0>>}$ '	0.04...64 s in steps of 0.01
Operation time accuracy	External earth measurement : $\pm 5.0\%$ of set value or ± 30 ms Internal earth measurement : $\pm 10.0\%$ of set value or ± 30 ms
Reset ratio	0.98

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Table 28. Transformer inrush detection, 3I2f> / 68

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%

Table 29. Thermal overload protection, 3Ith> / 49

Parameter	Value (Range)
Initial thermal level of apparatus ϑ_0	0.0...100%, in steps of 1%
Reference current leading to thermal calculation "I _b "	0.1 ... 1.5 x I _n , in steps of 0.1
Heating time constant of object ' τ '	1.0...300 min, in steps of 1.0
Cooling time constant of object ' τ_{Ls} '	1.0...300 min, in steps of 1.0
Alarm value, ϑ_{alm}	50...200%, in steps of 1%
Operate value, ϑ_{trip}	50...200%, in steps of 1%
Start inhibit value, $\vartheta_{startinhibit}$	50...200%, in steps of 1%
Options for calculating thermal value during power interruption, $\vartheta_{powerOFF}$	1...4 ¹⁾
Operation time accuracy	3% of 5time constant or $\pm 30s$
Reset ratio	0.98

¹⁾ Options for calculating thermal image during power interruption shall be as below

- 1 = On restoration of power, new value of current after power on will be considered to calculate new value of thermal image for interruption period Δt .
- 2 = On restoration of power, new value of thermal image is calculated for interruption period Δt considering that current has remained constant value during power interruption.
- 3 = Power interruption of the IED assumes no change of thermal image during interruption period.
- 4 = Power interruption of the IED resets the thermal image to the set value defined by setting ϑ_0 .

Table 30. Phase discontinuity protection, I2/I1> / 46PD

Parameter	Value (Range)
Start value, 'I2/I1>'	10...100%, in steps of 1%
Operate delay time, 'tI2/I1>'	0.1 ... 64 s, in steps of 0.1
Block the phase discontinuity protection	0 = No, 1 = Yes
Operation accuracy	$\pm 5.0\%$ of set value
Operation time accuracy	3% of set or $\pm 30 ms$
Reset ratio	0.98

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Table 31. Negative sequence overcurrent protection, I₂> / 46

Parameter	Value (Range)
Start value, 'I ₂ >'	0.1...1.5 x I _n , in steps of 0.01
Operate delay time, 'tI ₂ >'	0.1 ... 300 s, in steps of 0.1
Block the negative phase sequence protection	0 = No, 1 = Yes
Operation accuracy	± 5.0% of set value
Operation time accuracy	3% of set value or ± 30ms
Reset ratio	0.98

Table 32. Circuit breaker failure protection, 3I/loBF / 51BF/51NBF

Parameter	Value (Range)
Operating phase current, 'ICBFP'	0.2...2.0 x I _n , in steps of 0.1
Operating neutral current, 'loCBFP'	0.1...2.0 x I _n , in steps of 0.1
Time delay for retrip, 'tretrip'	0.06...0.5 s, in steps of 0.01
Time delay for backup protection, 'tbackup'	0.06...0.5 s, in steps of 0.01
Block the circuit breaker failure protection	0 = No, 1 = Yes
Operation accuracy	± 5.0% of set value
Operation time accuracy	3% of set value or ± 30ms
Reset ratio	0.98

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Table 33. Autoreclosing, O -> I / 79

Parameter	Value (Range)
Auto reclose initialization mode, 'AR start mode'	1 = Trip, 2 = Gen. start and trip
Type of CB ready signal available, 'CB ready'	1 = OCO, 2 = CO
Number of Auto reclose shots, 'Shot' (0 = Auto-reclose not in use)	0...4
Activate t	0.1...5 s, in steps of 0.1
Auto reclose pulse time, 'Pulse tp'	0.2...20 s, in steps of 0.1
Dead time for first auto reclose shot, 'Cycle t1'	0.2...300 s, in steps of 0.01
Dead time for second auto reclose shot, 'Cycle t2'	0.2...300 s, in steps of 0.01
Dead time for third auto reclose shot, 'Cycle t3'	0.2...300 s, in steps of 0.01
Dead time for fourth auto reclose shot, 'Cycle t4'	0.2...300 s, in steps of 0.01
Reclaim time, 'Reclaim tr'	1...300 s, in steps of 1
Auto reclosure block time, 'Block tb'	1...300 s, in steps of 1
Operation time accuracy	3% of set value or ± 30 ms

Table 34. Counter

Parameter	Value (Range)
Initial value of the counter at the start of IED, 'Value'	0...65535, in steps of 1
Binary input configured at PULSE_INPUT, 'Blconf'	1...4 (1=BI1, 2=BI2, 3=BI3, 4=BI4) '-' no selection if counter selection not needed

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20. Dimensions and mounting

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

With appropriate mounting accessories the REF601/REJ601 can be mounted on the circuit breakers type VD4 /HD4. The panel cut-out for flush mounting:

- Height : 151.5 ± 0.5 mm
- Width : 121.5 ± 0.5 mm
- Thickness of panel : 2.0 – 3.0 mm

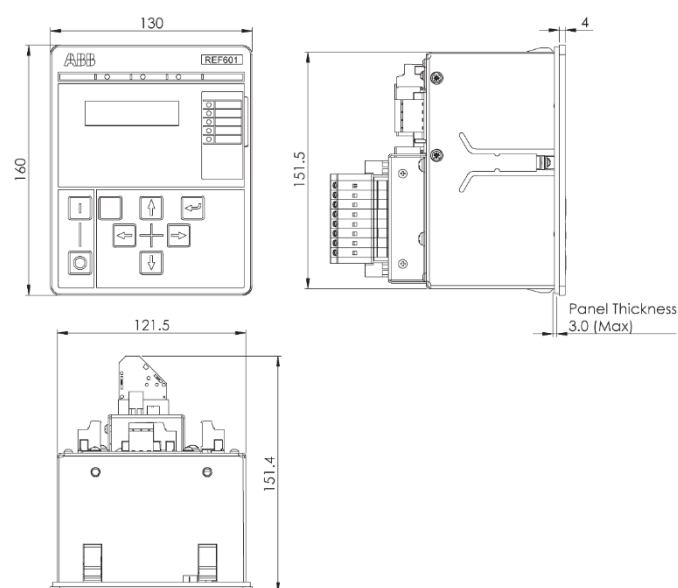


Figure 4. Dimension of REF601/REJ601 – Flush mounting CT variant

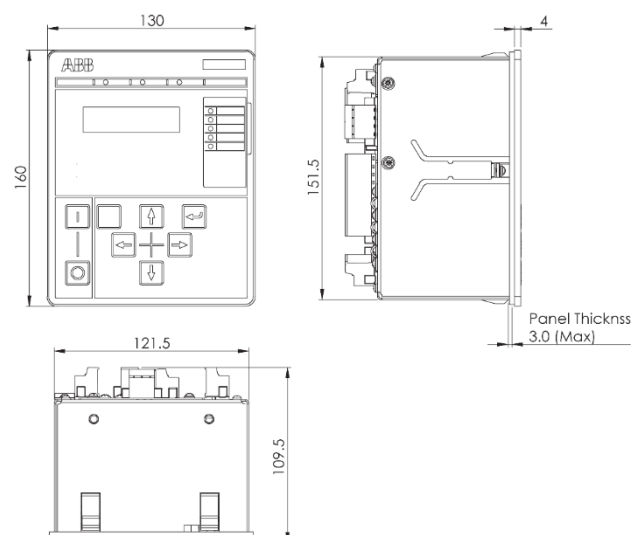


Figure 5. Dimension of REF601/REJ601 – Flush mounting sensor

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21. 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 hardware and software modules of relay.

The serial number and order number label is placed on side of relay.

Use the ordering key information in Fig. 5 to generate the order number when ordering complete protection relay.

Example code

REF601 B E4 46 B D 1 N H

#	Description	
1	Relay type	
	Feeder protection with control	REF601
	Feeder protection	REJ601
2	Standard	
	ANSI	A
	IEC	B
	Chinese	C
	CEI	J
3,4	Analog input / output	
	3 sensor and ground current input	A4
	Phase and Earth current input – 1A	D4
	Phase and Earth current input – 5A	E4
5,6	Binary input / output	
	4 BI + 6 BO	46
7	Serial communication	
	MODBUS RTU with RS485 two wire	B
	IEC60870-5-103 with RS485 two wire	C
	None	N
8	Application configuration	
	Configuration 2	B
	Configuration 3	C
	Configuration 4	D
9	Power supply	
	24...240V AC / DC	1
10	Configuration	
	Ring lug terminals	B
	Screw terminals	N
11	Version	
	Product version 2.2 FP1	H

Example order code: REF601 B E4 46 B D 1 N H

Your ordering code:

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

Figure 5. Ordering key for complete relay

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22. Accessories and ordering data

Table 35. Accessories

Item	Order number
RE_601 communication card	CIM601BNNNNBANXG

Table 36. Compatible sensors

Item	Order number
KEVCR for integrated circuit-breakers type VD4/HD4	KEVCR24OC2R0101, 630A KEVCR24AC2R0102, 1250A
KECA for other applications where relay is panel mounted For more information please refer to the catalogue reference - no. 1VLC000584.	KECA 250 B1 : 1VL5400052V0101

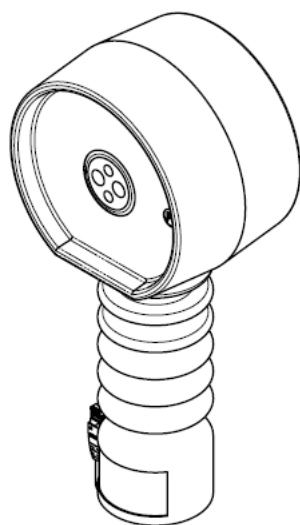


Figure 6. Outline view of KEVCR sensor

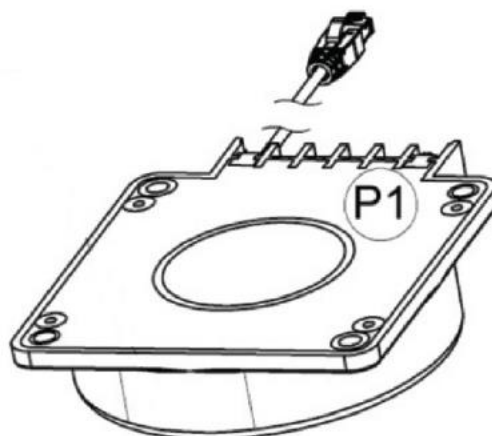


Figure 7. Outline view of KECA sensor

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23. Terminal diagram

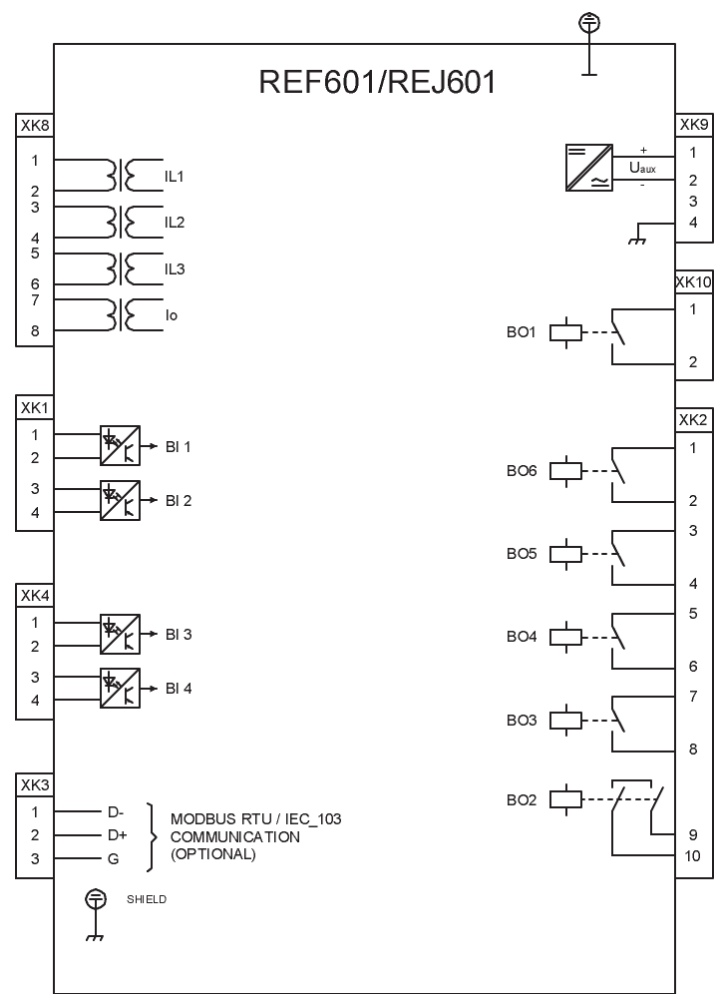


Figure 8. Terminal diagram of REF601/REJ601 for CT variant

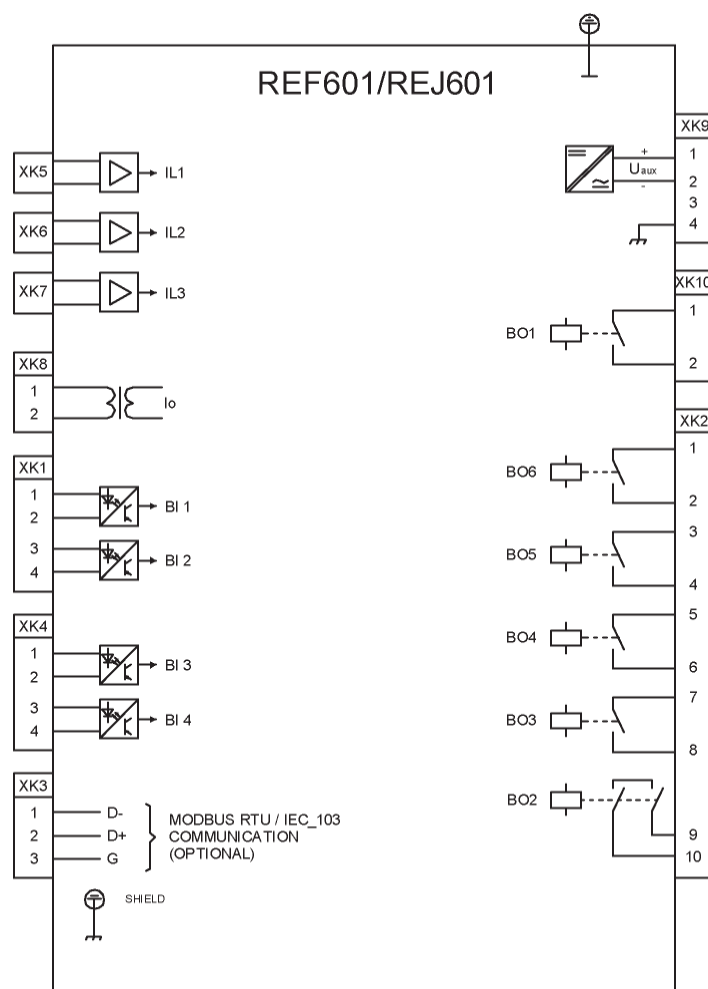


Figure 9. Terminal diagram of REF601/REJ601 for sensor variant

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24. 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, technical presentation 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.

25. Document revision history

Document revision / Date	Product version	History
A/2012-08-15	2.1	REF601/REJ601 with CT release
B/2013-03-28	2.2	Common version for REF601 /REJ601 CT and REF601 Sensor variant
C/2014-03-31	2.2 FP1	Content updated to include features of additional functions

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