Direct current distribution

Choosing and implementing protective devices

Complementary
technical information

Direct current distribution

Choosing and implementing circuit breakers

This document illustrates the use of the Acti 9 product range for the protection of direct current distribution applications of voltage less than **500 V.**

There is also a circuit breaker offer dedicated to photovoltaic applications: C60PV-DC (low breaking capacity 1.5 kA and higher voltage 800 V).

Choice

Choosing the rating

The thermal tripping curve of a circuit breaker is the same in direct current as in alternating current (50/60 Hz). The rule for choosing is therefore the same: to ensure protection against circuit overloads, choose a circuit breaker with a rating (In) less than or equal to the current (Iz) allowed to pass through the cable.

Circuits with momentary current direction reversal

In the case of circuits with momentary current direction reversal:

- **C60H-DC circuit breakers cannot be used**
- iC60 circuit breakers can be use

Examples of circuits with momentary current direction reversal

- Paralleled energy sources (photovoltaic cells, generators, generating sets, etc.).

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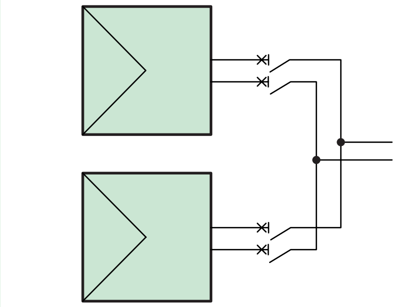

- Batteries with rectifier/charger.

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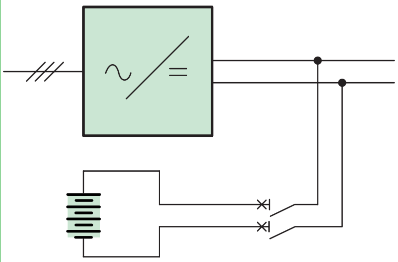

- Motor protective devices capable of operating as a generator.

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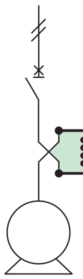
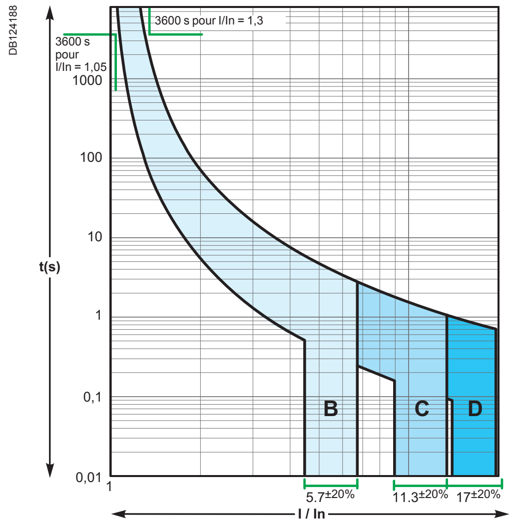


■ Use of the C60PV-DC is specifically dedicated to photovoltaic (PV) applications (generally higher voltages with low breaking capacity).

Direct current distribution

Choosing and implementing circuit breakers



Example: iC60, B, C, D curves, ratings from 6 A to 63 A.

Choosing the curve

The magnetic tripping threshold must be:

- ■ higher than the inrush currents due to loads (motors, capacitors, etc.)
- ■ lower than the short-circuit current at the installation point, which depends on:
- □ the short-circuit power of the source (indicated by the manufacturer),
- □ the impedance of the supply line.

In direct current:

- ■ the short-circuit power of the sources is generally low: batteries, photovoltaic panels, generators, electronic converters, etc
- ■ the loads generate lower inrush currents than in alternating current (e.g. motor start-up: 2 to 4 times the rated current)
- ■ the magnetic threshold of Acti 9 circuit breakers (relative to the rated current) is higher than in alternating current.

Circuit breaker	iC60 / C120 / NG125				C60H-DC
Curve	Z	B	C	D	C
Magnetic tripping threshold	3,4 …5 In	4,5 …7 In	9…14 In	14…20 In	7….10 In

> Generally, choose a C60H-DC circuit breaker or a B-curve iC60 circuit breaker.

Note: It may be necessary to choose a C curve or a D curve for very high inrush current applications (e.g., electronic equipment with particularly large capacitive filters).

Choosing the breaking capacity

The choice of circuit breaker with respect to the breaking capacity depends on:

- ■ the earthing system
- ■ the network voltage
- ■ the short-circuit current at the installation point in question.

Note: The breaking capacities are given for a time constant (L/R) equal to 0.015 s..

Reading the tables

- ■ Select the table according to the earthing system.
- ■ Select the circuit breaker corresponding to the network:
- □ the circuit breaker(s) to be installed is/are identified based on the rating and short-circuit current,
- □ the type of connection (number of poles, position relative to the load, isolation of polarities) is indicated according to the voltage.

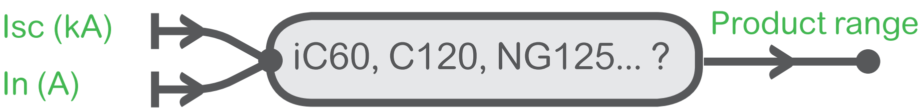
Direct current distribution
Choosing and implementing circuit breakers

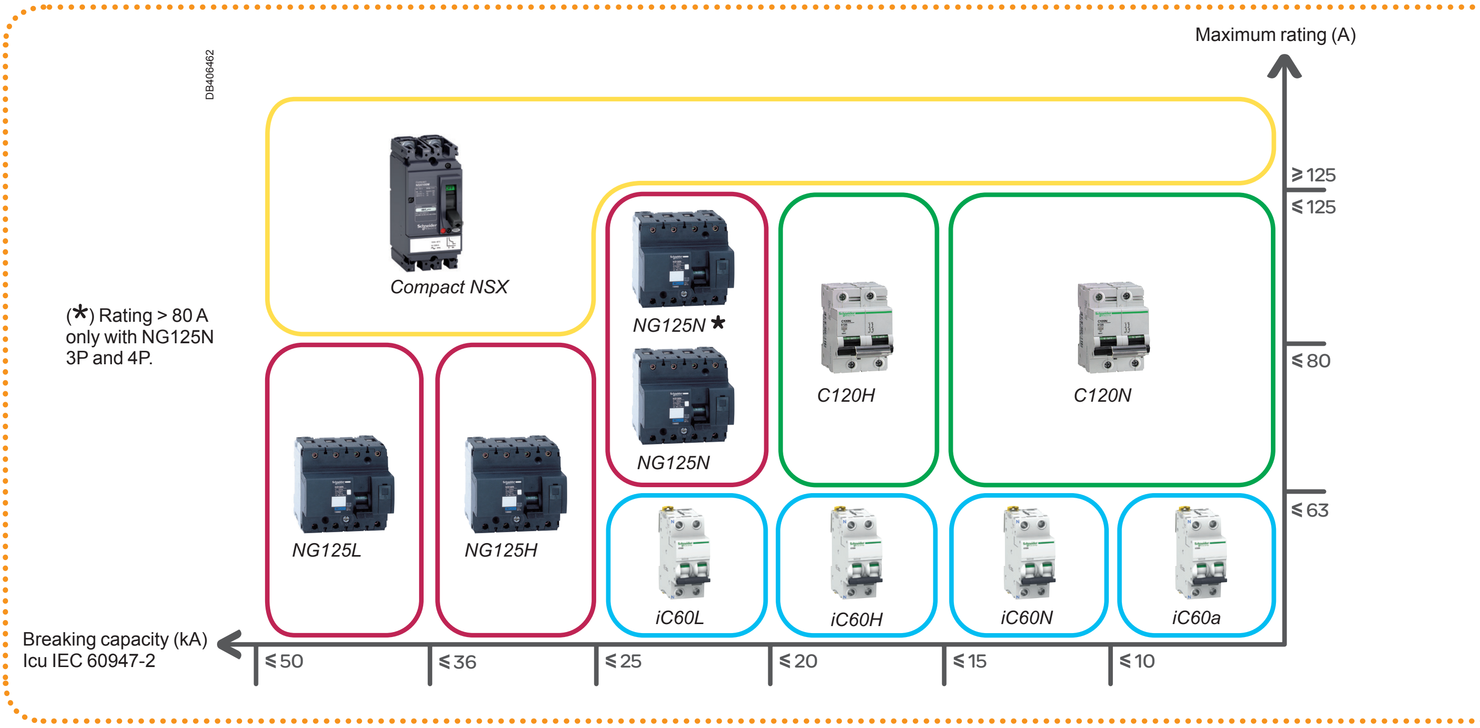
iC60, C120, NG125 offer

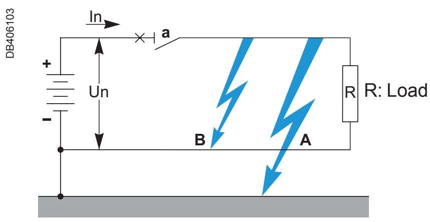
Choosing circuit breakers for distribution with earthed polarity

The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 60 V DC for the iC60 offers and 125 V DC for the C120 and NG125 offers







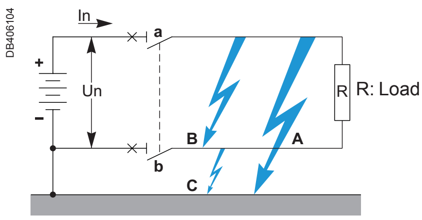
1 The figure shows a source with the negative polarity earthed.

Fault condition analysis 1

Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A, B	Isc	Un	a	Isc at Un on the poles connected to the positive polarity

Isc: presumed short-circuit current.
Un: rated network voltage.

> All the circuit-breaker poles must be on the non-earthed polarity.



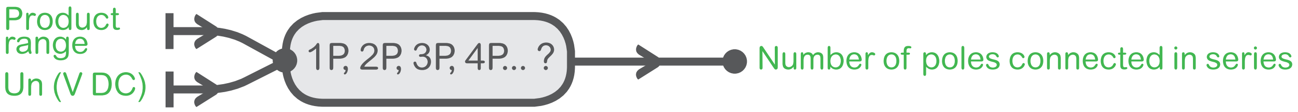
2 The figure shows a source with the negative polarity earthed.

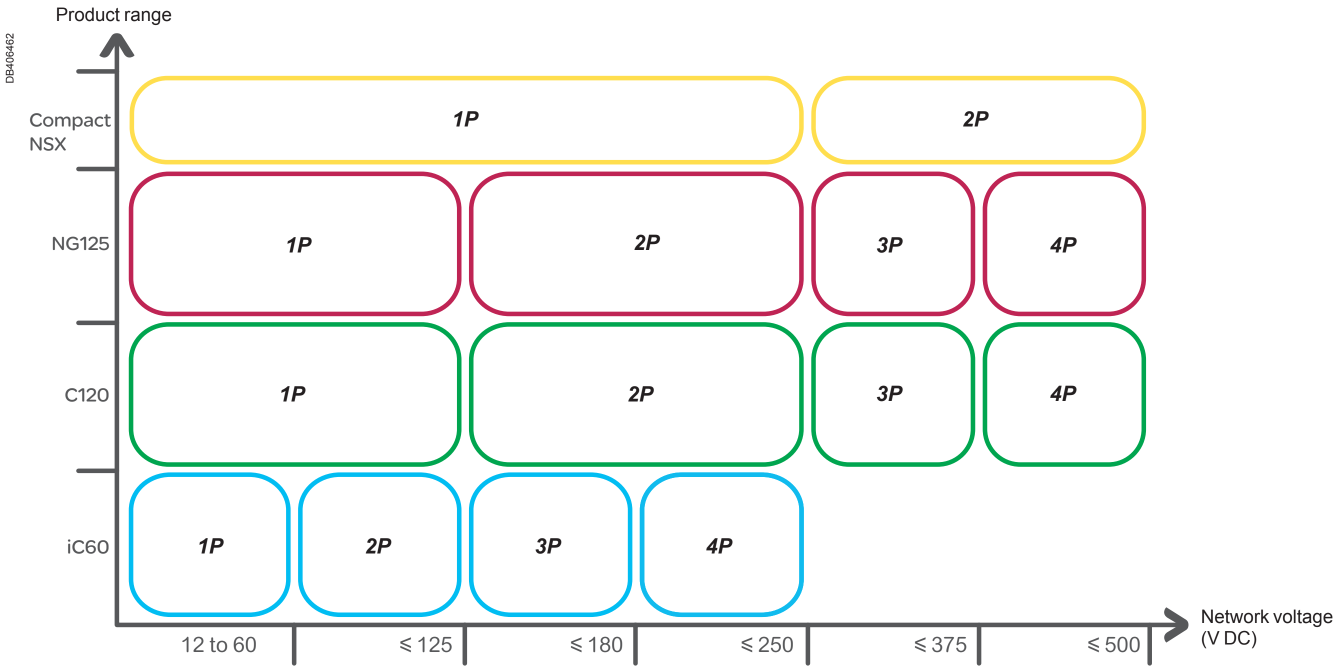
Fault condition analysis 2

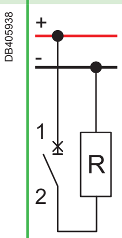
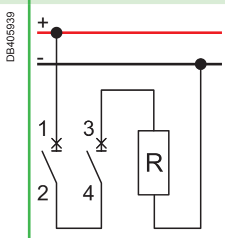
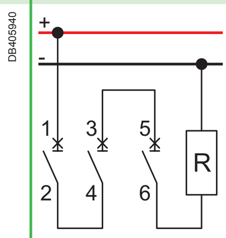
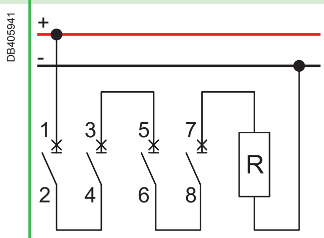
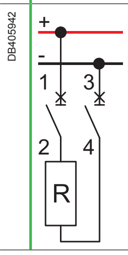
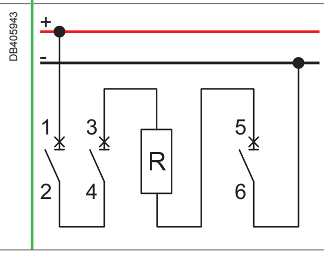
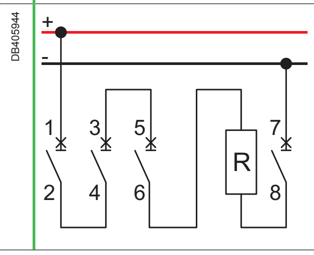
Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Isc	Un	a	Isc at Un on the poles connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on all the poles connected in series
C	-	-	b	No breaking needed

Isc: presumed short-circuit current.
Un: rated network voltage.

> All the circuit-breaker poles must be on the non-earthed polarity. One pole on the earthed polarity will allow isolation to be performed.





Isolation	Number of poles and connection diagram			
	1P	2P	3P	4P
Not required 1				
Required 2				

R: Load.

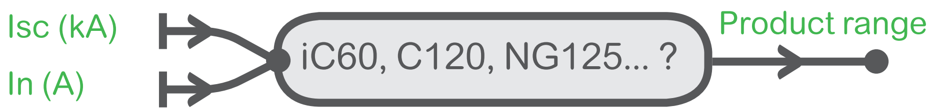
Direct current distribution
Choosing and implementing circuit breakers

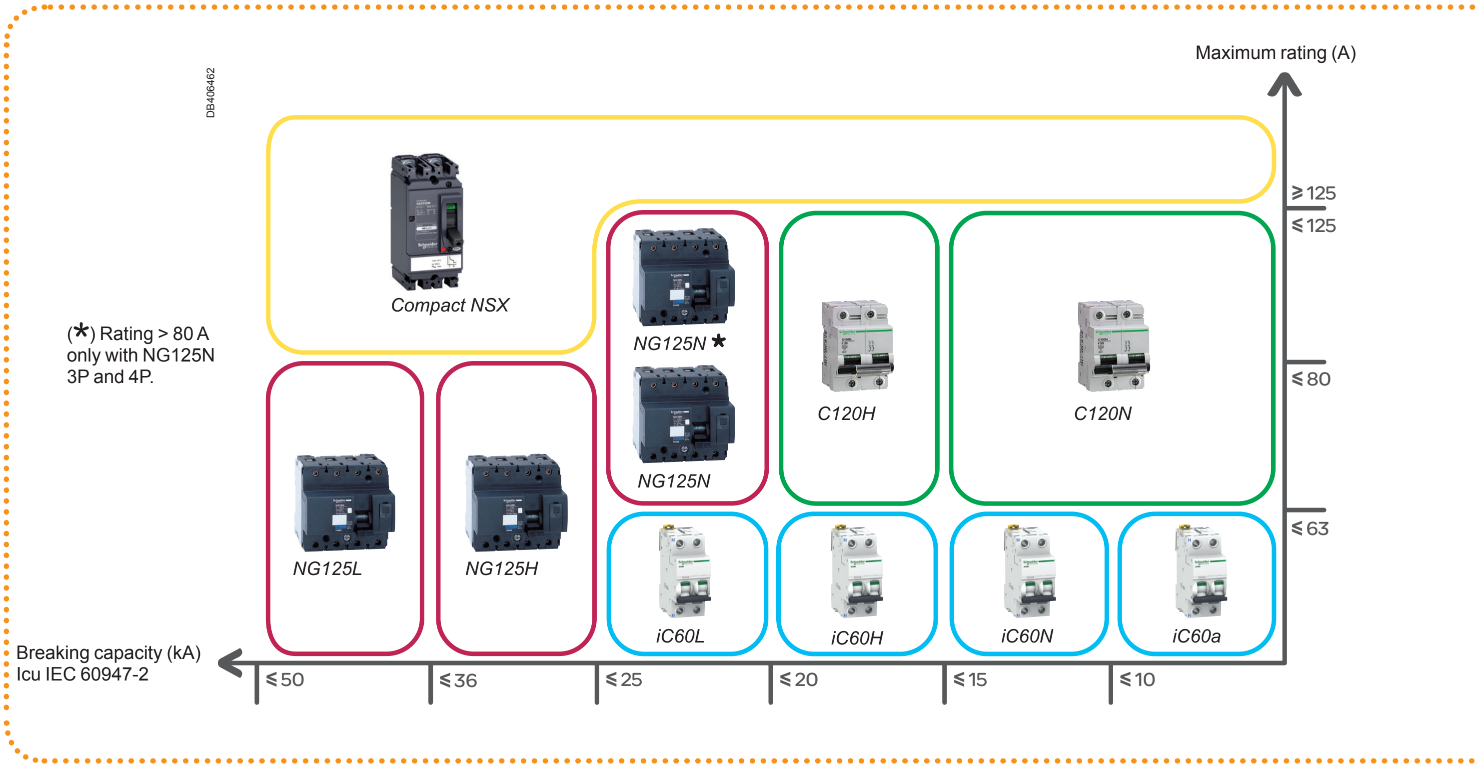
iC60, C120, NG125 offer

Choosing circuit breakers for distribution with earthed mid-point

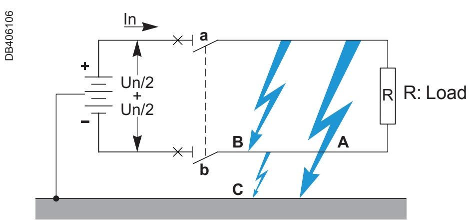
The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 60 V DC for the iC60 offers and 125 V DC for the C120 and NG125 offers





Fault condition analysis

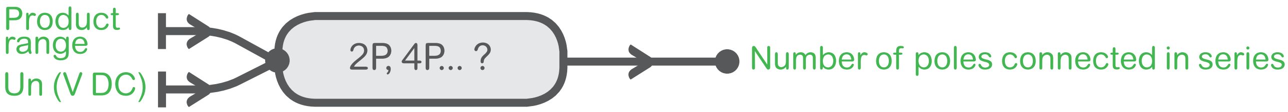


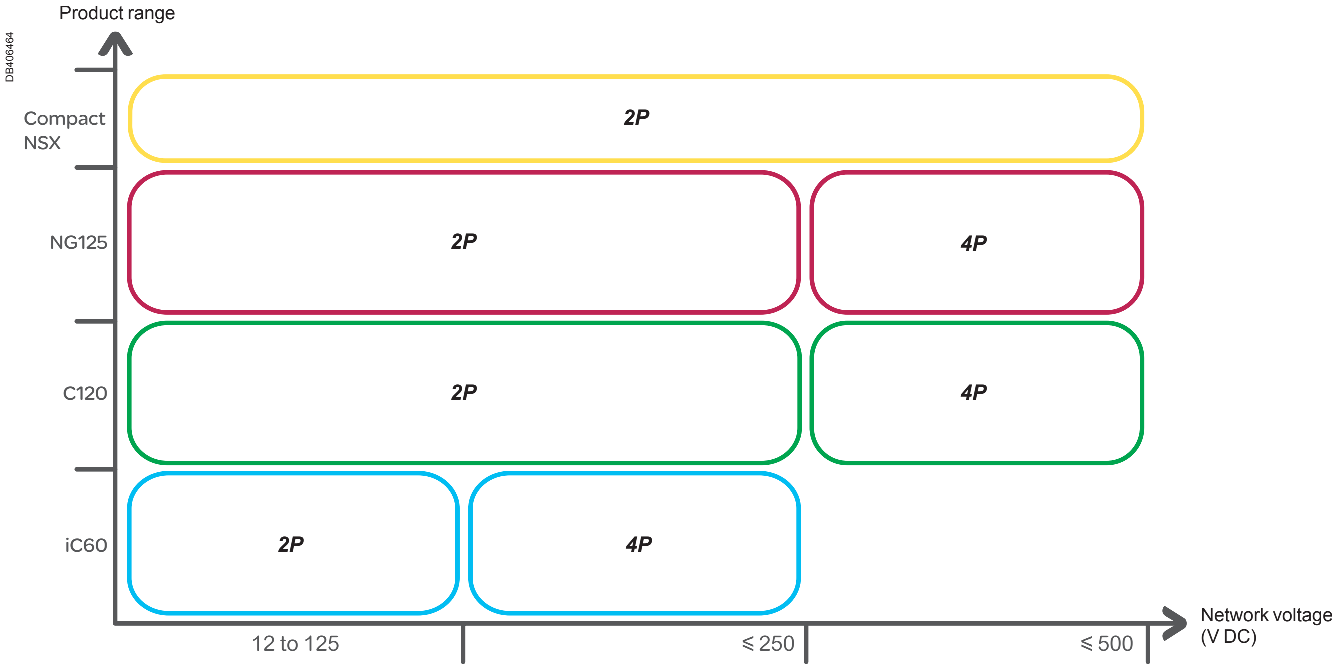
The figure shows a source with earthed mid-point.

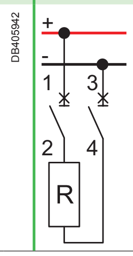
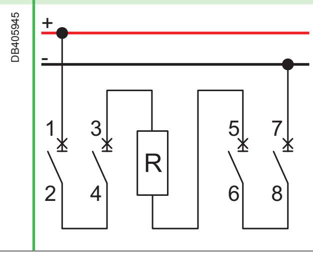
Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Isc	Un/2	a	Isc at Un/2 on the poles connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on all the poles connected in series
C	Isc	Un/2	b	IIsc at Un/2 on the poles connected to the negative polarity

Isc: presumed short-circuit current.
Un: rated network voltage.

> The circuit-breaker poles must be distributed symmetrically over the two polarities.
Obviously, this connection provides isolation.





Isolation	Number of poles and connection diagram	
	2P	4P
Required or not		

R: Load.

Direct current distribution

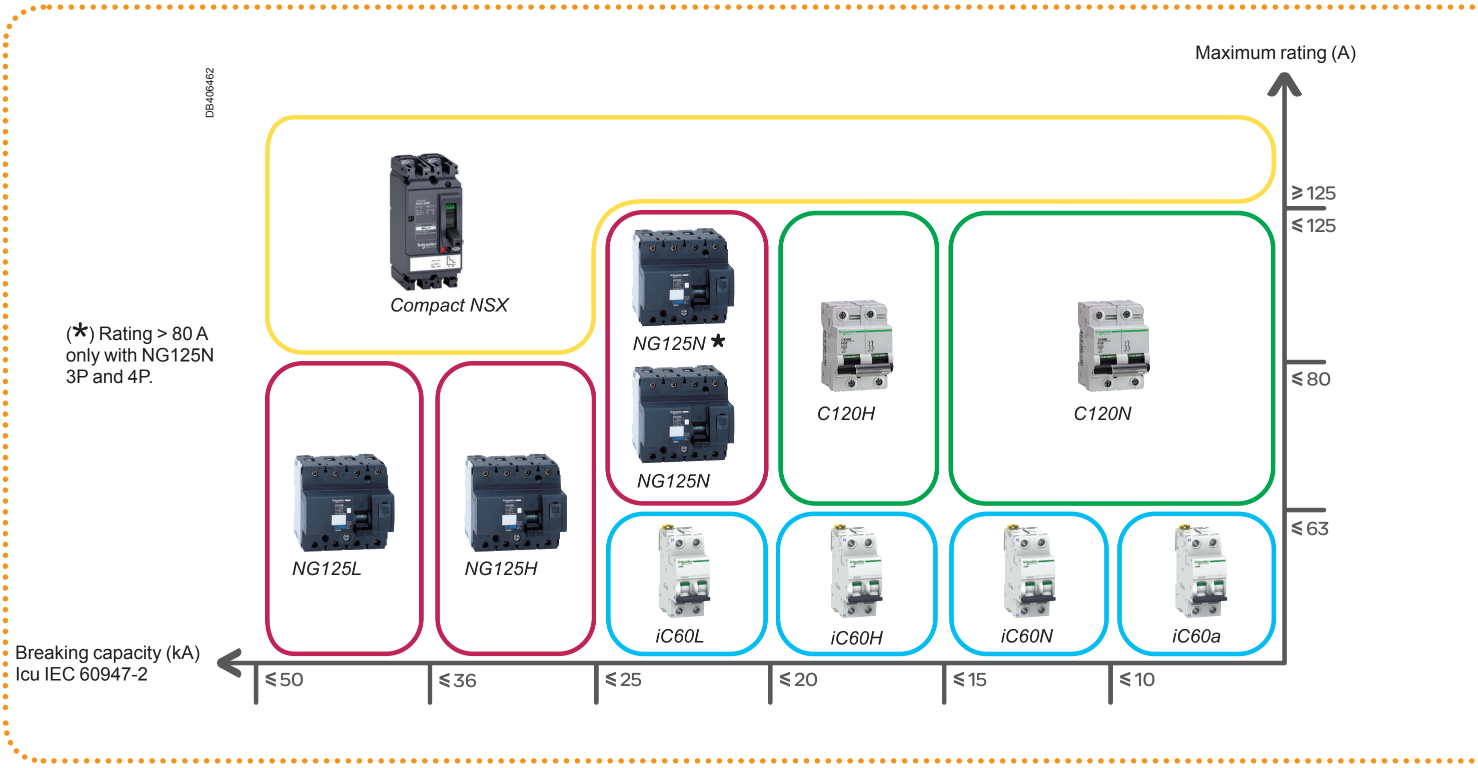
Choosing and implementing circuit breakers

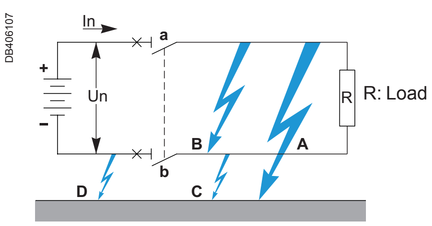
iC60, C120, NG125 offer

Choosing circuit breakers for distribution isolated from earth

The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 60 V DC for the iC60 offers and 125 V DC for the C120 and NG125 offers





The figure shows a source in IT system with a second fault (D) on the negative polarity.

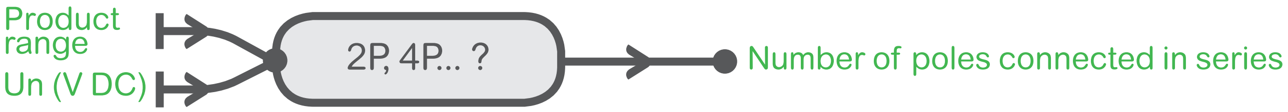
Fault condition analysis

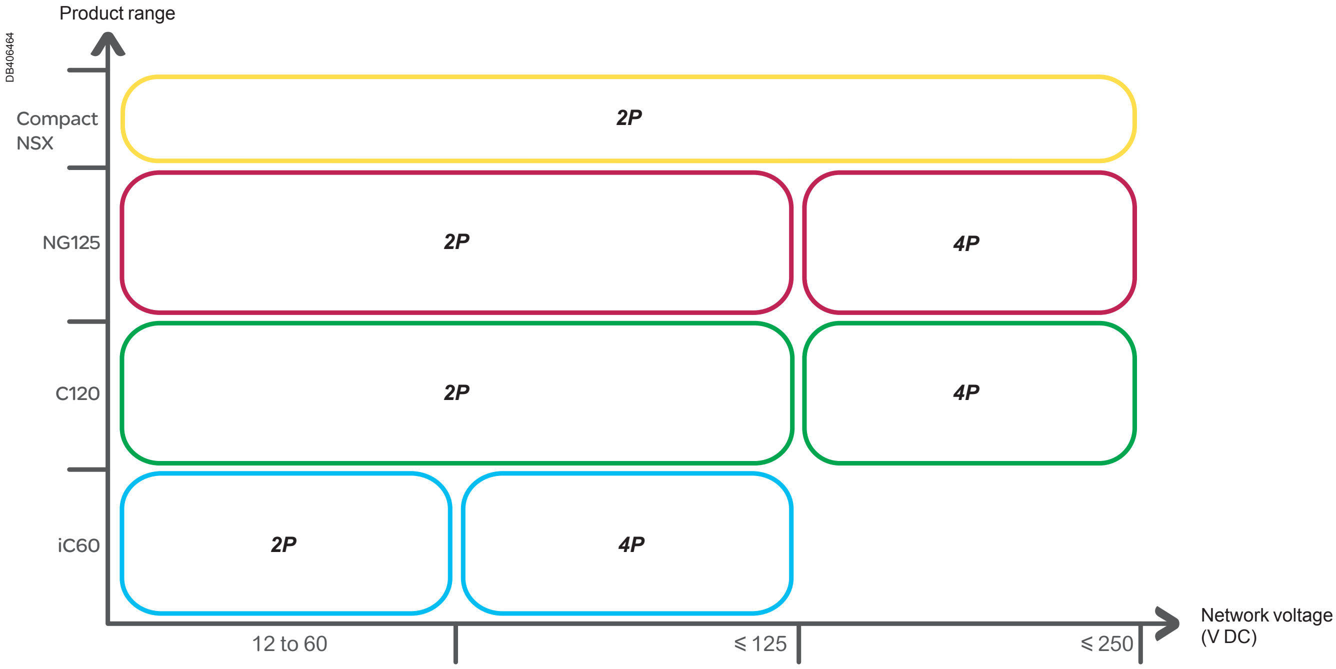
Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Low	Low	a	No breaking needed
A and D	Id (1)	Un	a	Id at Un on the poles connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on all the poles connected in series
C	Low	Low	b	No breaking needed

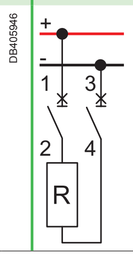
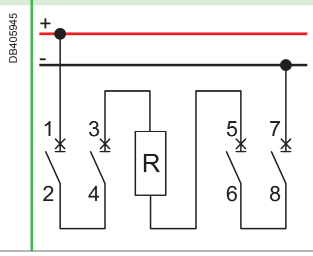
Isc: presumed short-circuit current.
Un: rated network voltage.

(1) Fault current values acceptable according to the installation rules.
- If Isc < 10 kA: fault current ≤ 0.15 Isc.
- If Isc > 10 kA: fault current ≤ 0.25 Isc.

> The circuit-breaker poles must be distributed symmetrically over the two polarities.
Obviously, this connection provides isolation.





Isolation	Number of poles and connection diagram	
	2P	4P
Required or not		

R: Load.

Direct current distribution

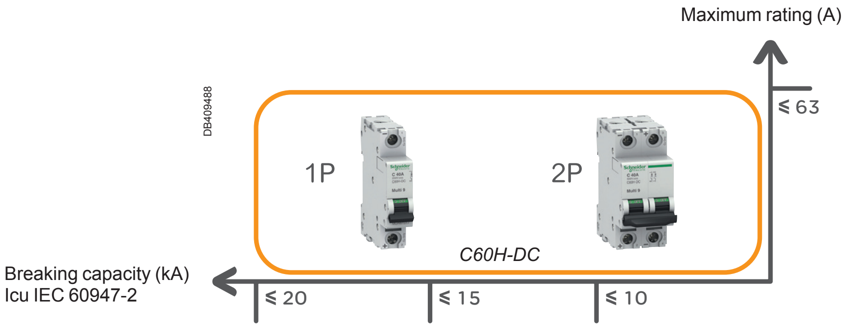
Choosing and implementing circuit breakers

C60H-DC offer

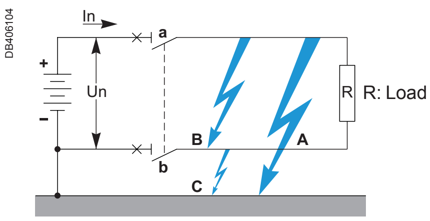
Choosing circuit breakers for distribution with earthed polarity

Unlike the preceding offers, the C60H-DC offer comprises polarised circuit breakers reserved exclusively for direct current applications.
As we saw earlier, it is therefore not compatible in the case of circuits with (even momentary) current direction reversal. The same applies to "mixed" networks operating successively in AC and DC (e.g. safety devices).

It is an offer corresponding to the C curve and ranging up to 63 A.



"-" polarity earthed



The figure shows a source with the negative polarity earthed.

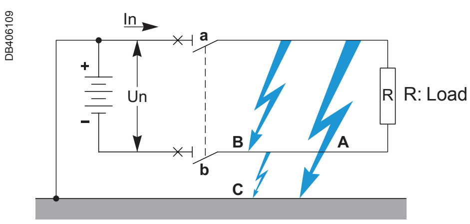
Fault condition analysis with "-" polarity earthed

Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Isc	Un	a	Isc at Un on the pole connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on the both poles
C	-	-	b	No breaking needed

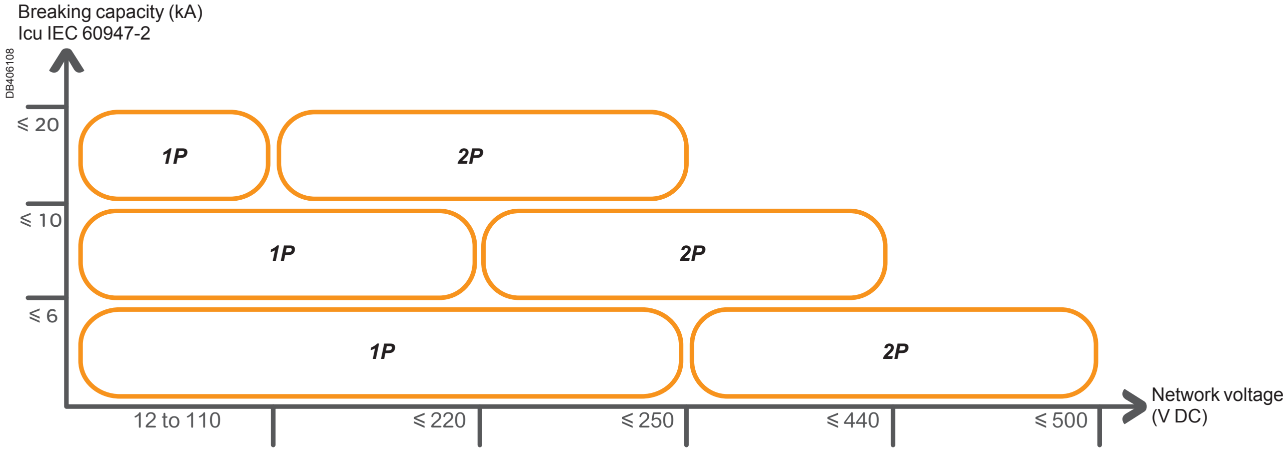
Isc: presumed short-circuit current.
Un: rated network voltage.

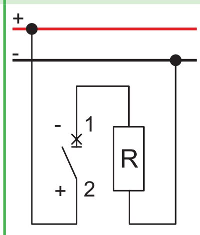
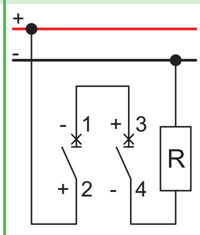
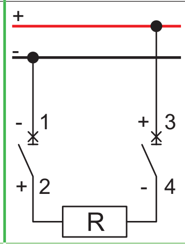
> All the circuit-breaker poles must be on the non-earthed polarity. One pole on the earthed polarity will allow isolation to be performed.

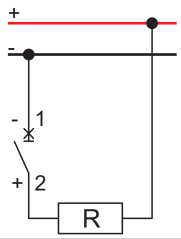
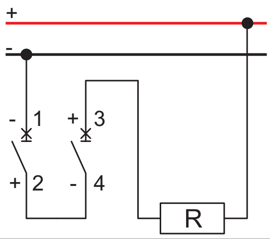
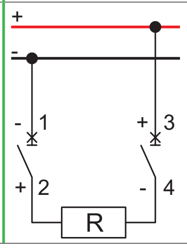
"+" polarity earthed



The figure shows a source with the positive polarity earthed.



Isolation	Number of poles and connection diagram	
"-" polarity earthed	**1P**	**2P**
Not required		
Required		

Isolation	Number of poles and connection diagram	
"+" polarity earthed	**1P**	**2P**
Not required		
Required		

R: Load.

Direct current distribution

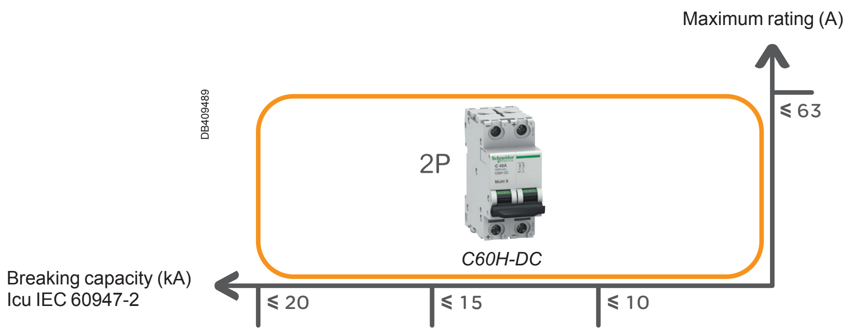
Choosing and implementing circuit breakers

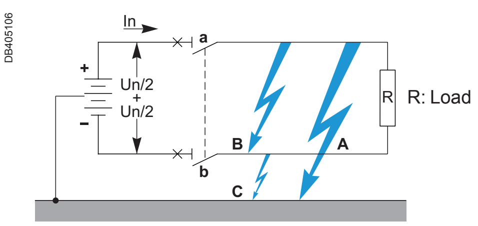
C60H-DC offer

Choosing circuit breakers for distribution with earthed mid-point

Unlike the preceding offers, the C60H-DC offer comprises polarised circuit breakers reserved exclusively for direct current applications.
As we saw earlier, it is therefore not compatible in the case of circuits with (even momentary) current direction reversal. The same applies to "mixed" networks operating successively in AC and DC (e.g. safety devices).

It is an offer corresponding to the C curve and ranging up to 63 A.





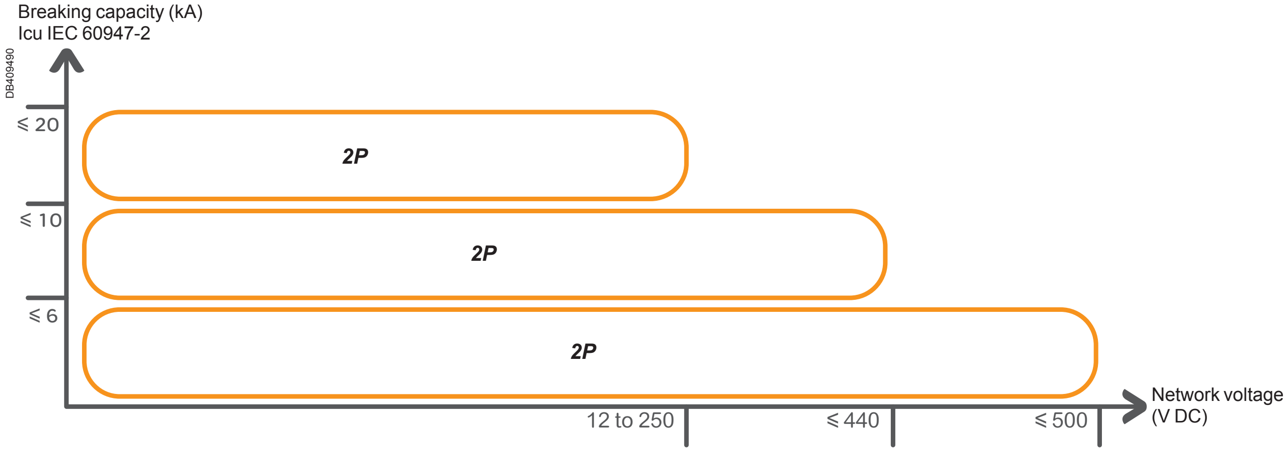
The figure shows a source with earthed mid-point.

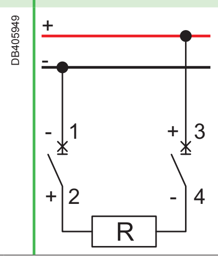
Fault condition analysis

Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Isc	Un/2	a	Isc at Un/2 on the pole connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on the both poles
C	Isc	Un/2	b	Isc at Un/2 on the pole connected to the negative polarity

Isc: presumed short-circuit current.
Un: rated network voltage.

> The circuit-breaker poles must be distributed symmetrically over the two polarities.
Obviously, this connection provides isolation.



Isolation	Number of poles and connection diagram
	2P
Required or not	

R: Load.

C60H-DC offer

Choosing circuit breakers for distribution isolated from earth

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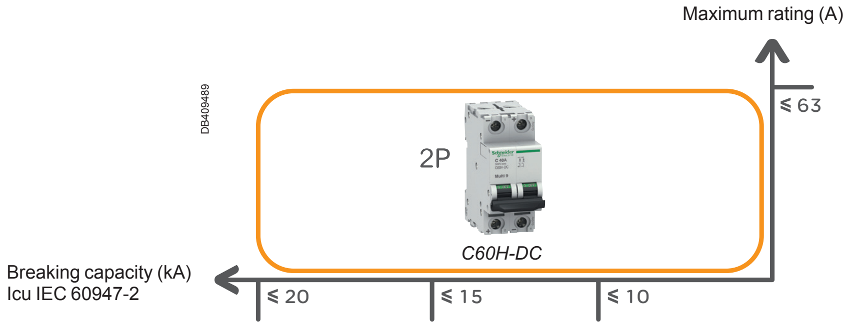

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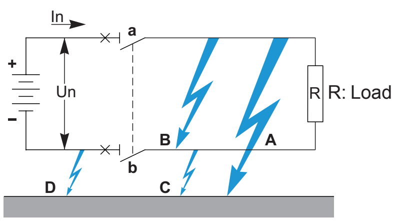


The figure shows a source in IT system with a second fault (D) on the negative polarity.

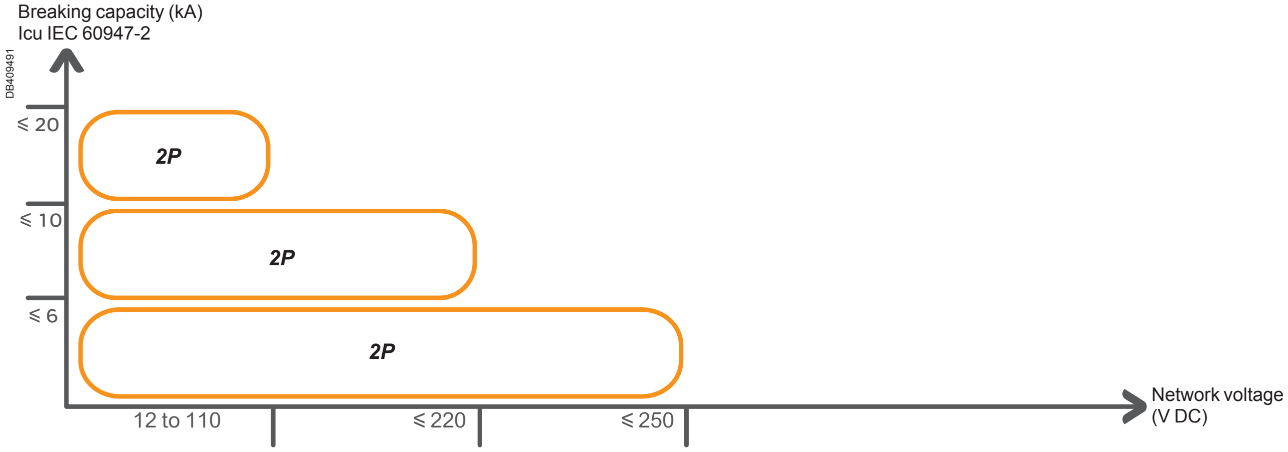
Fault condition analysis

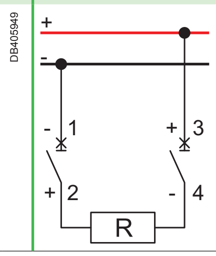
Fault	Fault current (max.)	Voltage	Poles involved in breaking	Breaking characteristics
A	Low	Low	a	No breaking needed
A and D	Id [(1)]	Un	a	Id at Un on the pole connected to the positive polarity
B	Isc	Un	a + b	Isc at Un on the both poles
C	Low	Low	b	No breaking needed

Isc: presumed short-circuit current.
Un: rated network voltage.

(1) Fault current values acceptable according to the installation rules.
- If Isc < 10 kA: fault current ⩽ 0.15 Isc.
- If Isc > 10 kA: fault current ⩽ 0.25 Isc.

> The circuit-breaker poles must be distributed symmetrically over the two polarities.
Obviously, this connection provides isolation.



Isolation	Number of poles and connection diagram
	2P
Required or not	

R: Load.

Direct current distribution

Choosing and implementing circuit breakers

Connection

Series connection

In the preceding offers we extensively used the principle of series connection of products. Series connection of the poles, by dividing the voltage per pole, optimizes the circuit breaking performance for high-voltage networks.
Series connection of the poles of a circuit breaker used in direct current therefore makes it possible to:
- divide the network voltage by the number of poles
- have the rated current for each pole
- have the circuit breaker's breaking capacity for all the poles.

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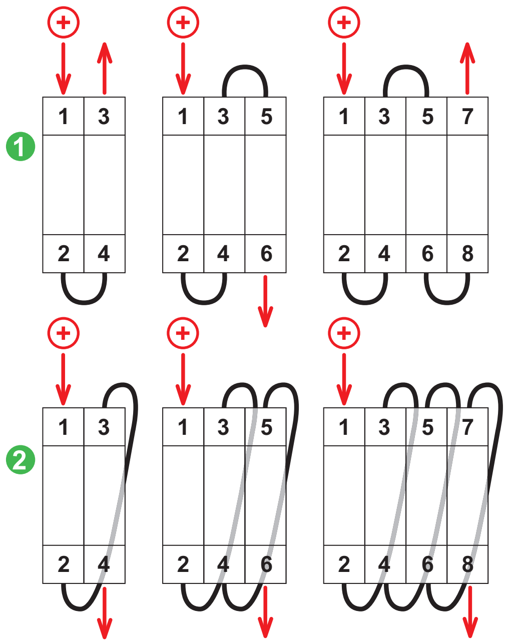

Direction of cabling and cable length

In the case of series connection, the direction of cabling has a major impact on the product's performance.

Usually the first product cabling method 1.
will be used. For special applications where there is only a single possible current direction, the second cabling method 2 is preferable, especially for electrical endurance properties.
Subsequently the cable cross section and length combination should be optimized, depending on the loads. Generally, a greater length and cross section improves performance.

Rating (In)	Cross section (mm²)	Min. shunt length (mm)
≤ 63 A	≤ 16	500
	25	200
	35	100
≤ 125 A	35	300
	50	200

Note: This table gives the minimum cable (shunt) lengths optimizing the equipment's performance according to the cable cross sections.

Clarification concerning voltage drops

Importance of allowing for voltage drops

Voltage drops are an issue that must be taken into account especially in direct current distribution due to:
- the common use of very low voltage (24, 48 or sometimes 12 V):
  - for a given resistance and current in a circuit, relative voltage drops increase as the voltage is lowered,
  - the natural voltage drop of batteries in power reserve mode, as they are discharged,
  - the criticality of the associated applications, often requiring a high level of security and continuity of service.

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Table G.52.1 – Voltage drop

Type of installation	Lighting %	Other uses %
A – Low voltage installations supplied directly from a public low voltage distribution system	3	5
B – Low voltage installation supplied from private LV supply[a]	6	8

[a] As far as possible, it is recommended that voltage drop within the final circuits do not exceed those indicated in installation type A.

When the main wiring systems of the installations are longer than 100 m, these voltage drops may be increased by 0,005 % per metre of wiring system beyond 100 m, without this supplement being greater than 0,5 %.

Voltage drop is determined from the demand by the current-using equipment, applying diversity factors where applicable, or from the values of the design current of the circuits.

IEC 60364-5-52 standard.

Cause of voltage drops

Voltage drops are caused by the sum of the resistances in series in the circuit:
- internal resistance (r) of the source
- resistance of connecting cables
- internal resistance of control and protection switchgear, often significant for circuit breakers of low rating (a few amperes) powered at very low voltage
- it is generally expressed in mΩ
- in the absence of data directly from the manufacturer, it can be calculated by dividing the power consumption by the square of the current: $r = P/I^2$
- spurious resistance of connections.

The multipolar low rating use (< 4 A) is not suitable for very low voltage networks (< 24 V DC).

Voltage drops in the circuit must be less than the rated operating tolerances of the various loads in steady-state conditions and especially at start-up (inrush current).

Examples of choices

Example 1

In a direct current distribution system, powered by a rectifier/charger of voltage 125 V with earthed "-" polarity, which circuit breakers should be installed to protect:

■ the battery outgoing feeder of permissible current Iz = 69 A, operating current Ib = 55 A, and short-circuit current 10 kA?

■ a lighting outgoing feeder of permissible current Iz = 22 A, operating current Ib = 18 A, and short-circuit current 10 kA?

If the battery outgoing feeder is with momentary current direction reversal, choose an iC60 circuit breaker:

Circuit to be protected	Choice of circuit breaker	
Ib = 55 A, Iz = 69 A	Rating	In = 63 A
No high current peak	Curve	B
Un = 125 V, Isc = 10 kA, "-" earthed	Breaking capacity	iC60N
	Connection	2 poles in series on "+"
Isolation required		1 pole on "-"

> Choose a B-curve iC60N 3P 63 A circuit breaker with 2 poles connected to the positive polarity.

If the lighting outgoing feeder is without momentary current direction reversal, choose a C60H-DC circuit breaker:

Circuit to be protected	Choice of circuit breaker	
Ib = 18 A, Iz = 22 A	Rating	In = 20 A
No high current peak	Curve	C
Un = 125 V, Isc = 10 kA, "-" earthed	Breaking capacity	C60H-DC
	Connection	1 pole on "+"
Isolation not required		No pole on "-"

> Choose a C60H-DC 1P 20 A circuit breaker with 1 pole connected to positive polarity.

Example 2

In a direct current distribution system, powered by a rectifier/charger of voltage 125 V, with earthed mid-point, which circuit breakers should be installed to protect:

■ the battery outgoing feeder of permissible current Iz = 69 A, operating current Ib = 55 A, and short-circuit current 20 kA?

■ a lighting outgoing feeder of permissible current Iz = 22 A, operating current Ib = 18 A, and short-circuit current 20 kA?

If the battery outgoing feeder is with momentary current direction reversal, choose an iC60 circuit breaker of characteristics in compliance with the installation:

Circuit to be protected	Choice of circuit breaker	
Ib = 55 A, Iz = 69 A	Rating	In = 63 A
No high current peak	Curve	B
Un = 125 V, Isc = 20 kA, earthed mid-point	Breaking capacity	iC60H
	Connection	1 pole on "+"
		1 pole on "-"
Isolation required		Provided by both poles

> Choose a B-curve iC60H 2P 63 A circuit breaker, connected symmetrically to the "+" and "-" polarities.

Direct current distribution

Choosing and implementing circuit breakers

If the lighting outgoing feeder is without momentary current direction reversal, choose a C60H-DC circuit breaker:

Circuit to be protected	Choice of circuit breaker	
Ib = 18 A, Iz = 22 A	Rating	In = 20 A
Un = 125 V, Isc = 20 kA, earthed mid-point	Breaking capacity	C60H-DC
	Connection	1 pole on "+"
		1 pole on "-"
Isolation not required		Provided by both poles

> Choose a C60H-DC 2P 20 A circuit breaker connected symmetrically to the "+" and "-" polarities.

Example 3

In a direct current distribution system powered by two rectifiers in parallel Un = 250 V, Isc (2 sources) = 35 kA, in IT system, which circuit breakers should be installed to protect:

- the pair of rectifiers of permissible current Iz = 69 A and operating current Ib = 55 A?
- a lighting outgoing feeder of permissible current Iz = 22 A and operating current Ib = 18 A?

If the pair of rectifiers is with momentary current direction reversal, choose an iC60 circuit breaker:

Circuit to be protected	Choice of circuit breaker	
Ib = 55 A, Iz = 69 A	Rating	In = 63 A
No high current peak	Curve	B or C (the magnetic threshold is far lower than the short-circuit current)
Un = 250 V, Isc = 35 kA, IT system	Breaking capacity	NG125L
	Connection	2 poles on "+"
		2 poles on "-"
Isolation required		Provided by the 4 poles

> Choose an NG125L 4P 63 A circuit breaker connected symmetrically to the "+" and "-" polarities.

The lighting outgoing feeder is without momentary current direction reversal but the short-circuit current is too great to choose a C60H-DC circuit breaker.

Circuit to be protected	Choice of circuit breaker	
Ib = 18 A, Iz = 22 A	Rating	In = 20 A
No high current peak	Curve	B
Un = 250 V, Isc = 35 kA, IT system	Breaking capacity	NG125L
	Connection	2 poles on "+"
		2 poles on "-"
Isolation not required		Provided by the 4 poles

> Choose a B-curve NG125L 4P 20 A circuit breaker connected symmetrically to the two "+" and "-" polarities.

Direct current distribution

Earth leakage protection

Residual current devices do not work on a direct current distribution system.
Earth leakage protection can be provided by circuit breakers or residual current circuit breakers installed on the upstream AC distribution system.

Residual current devices

DC networks isolated from any AC network

Residual current devices will not work with a direct current distribution system powered directly by a battery, a generating set, photovoltaic cells, etc., or a rectifier with galvanic insulation. In this case protection for users is provided by choosing a network voltage that is not dangerous and an appropriate earthing system.

Safe direct current network voltage

Environment	TN-S system		IT system
	Earthed polarity	**Earthed mid-point**	
Dry	100 V	200 V	100 V
Wet	50 V	100 V	50 V
Immersed	25 V	50 V	25 V

DC networks connected to an AC network

In the case of a direct current distribution system powered by an AC/DC converter (without galvanic insulation), earth leakage protection can be provided by circuit breakers or residual current circuit breakers installed on the AC network upstream of the converter.

Protection against direct contact

Earth leakage protection of high sensitivity (IΔn = 30 mA) is compulsory if certain circuits operating on direct current entail risks of baring of live parts (see installation standards). This protection system should be chosen as follows:

- type A or si (bipolar), if the converter is powered by a single-phase supply
- type B, if the converter is powered by a three-phase supply.

Standard IEC 60479-1 determines applicable values for the protection of users.

The choice of this protection system does not depend on the earthing system.

Protection against indirect contact

Protection against indirect contact		**Medium-sensitivity earth leakage protection IΔn ⩾ 300 mA**		
Upstream power supply		Three-phase		Single-phase
Characteristics of direct-current circuits to be protected		Without double insulation	With double insulation	
Upstream earthing system	**TT** or **IT** with non-interconnected exposed conductive parts	Type B	Type A	
	TN-S	Type A		
	IT			

Fire protection

Fire protection	**Medium-sensitivity earth leakage protection IΔn = 300 mA**
Upstream power supply	Single-phase or three-phase
Characteristics of direct-current circuits to be protected	Humid or dusty environments, ancient installations and buildings
Upstream earthing system	No influence Type A

Direct current distribution

Lightning protection

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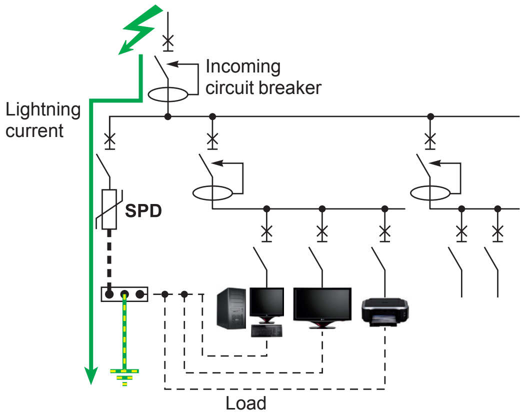

Surge protective device

In fact the operating principle of the surge protective device remains identical in direct current; the surge protective devices capture and conduct to earth the current of electric overvoltages.
Particularly if the direct current is implemented by a rectifier without galvanic insulation and if the AC network already contains a surge protective device, there will be no need for a specific protective device.
Otherwise, the surge protective device should be adapted "finely" to the network voltage (and the overvoltage resistance of the loads, which is linked to the network voltage).

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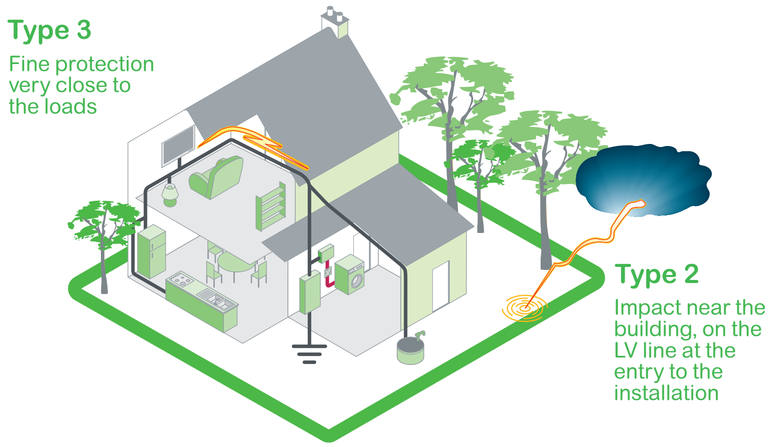

Type 1 surge protective device

The type 1 surge protective device is recommended in the specific case of service-sector and industrial buildings, protected by a lightning rod or a meshed cage. It protects electrical installations against direct lightning strokes. It can discharge the back-current from lightning spreading from the earth conductor to the network conductors.
Type 1 surge protective devices are characterized by a 10/350 µs current wave.

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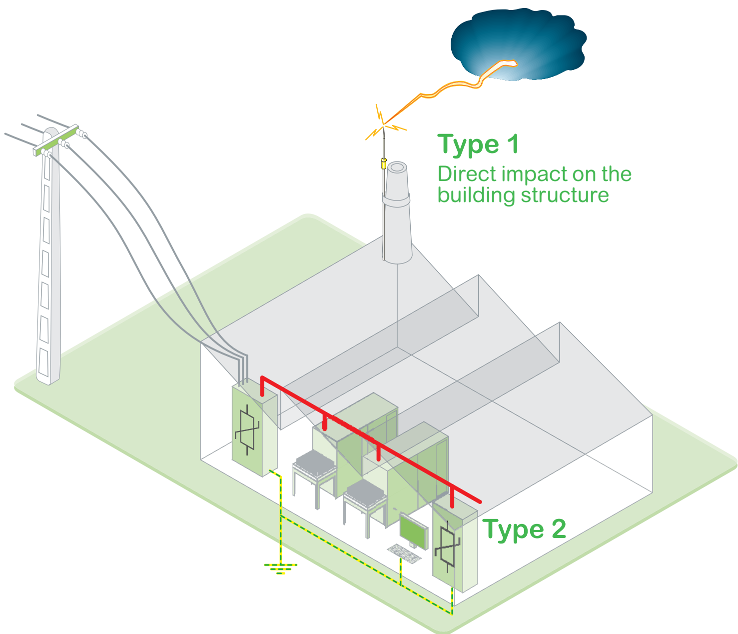

Type 2 surge protective device

The type 2 surge protective device is the main protection system for all low-voltage electrical installations. Installed in each electrical switchboard, it prevents the spread of overvoltages in the electrical installations and protects the loads.
Type 2 surge protective devices are characterized by an 8/20 µs current wave.

Type 3 surge protective device

These surge protective devices have a low discharge capacity. They must therefore mandatorily be installed as a supplement to type 2 surge protective devices and in the vicinity of sensitive loads.
Type 3 surge protective devices are characterized by a combination of voltage waves (1.2/50 µs) and current waves (8/20 µs).

Generally the direct current switching voltage should be assigned a coefficient of √2 compared with alternating current. Apart from this the principle for choosing devices according to the networks remains the same.

Network voltage	Comments	Offer
24 / 48 V	Communication	iPRI
< 200 V	Communication	iPRC
200 to 400 V	Type 2 and 3	iPRD, iPF
200 to 400 V	Type 1 and 2	iPRF1, PRD1
200 to 400 V	Type 1	PRD1 Master, PRF1 Master
600 or 1000 V	PV applications	iPRD–DC

Coordination with disconnectors
A study is underway on the coordination of our surge protective devices on direct current networks; it will enable this document to be supplemented at a later stage.

Direct current distribution

Characteristics of the distribution system

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Table 6 – Equipment having a nominal voltage below 120 V a.c. or below 750 V d.c.

DC		AC	
Nominal values		Nominal values	
Preferred V	Supplementary V	Preferred V	Supplementary V
	2,4		
	3		
	4		
	4,5		
	5		5
6		6	
	7,5		
	9		
12		12	
	15		15
24		24	
	30		
36			36
	40		
48		48	
60			60
72			
	80		
96			
			100
110		110	
	125		
220			
	250		
440			
	600		

NOTE 1 Because the voltage of the primary and secondary cells is below 2,4 V, and the choice of the type of cell to be used in various applications will be based on properties other than the voltage, these values are not included in the table. The relevant IEC technical committees may specify types of cells and related voltages for specific applications.

NOTE 2 It is recognized that for technical and economic reasons, additional voltages may be required for certain specific fields of application.

IEC 60038 standard.

The installation rules of the IEC 60364 standard apply to direct current distribution systems.

Network voltage

24 V, 48 V, 60 V, 125 V, 250 V, 500 V, 750 V.
These voltages often depend on the application or the sources used, for example:

- batteries on single-phase DC charger: voltage 240 V DC,
- batteries on three-phase DC charger: voltage 440 V DC.

Overcurrent protection

Short-circuit current

The short-circuit current depends on the source. For a distribution system powered by a battery, it can be calculated by the formula Isc (in A) = kC with:

- C the battery capacity in Ah,
- k a coefficient close to 10 and in any case always less than 20.

Example

A 125 V battery of capacity 220 Ah delivers a short-circuit current Isc between 2.2 kA and 4.4 kA.
Note: Since the Isc current value is relatively low and the distribution system is not very extensive, the maximum short-circuit current Isc at any point of the installation is taken as equal to the short-circuit current Isc of the source (value by excess).

Overload protection

For a load of operating current Ib and a duct of permissible current Iz, the duct protection by a distribution circuit breaker must have a rating In such that: Ib ⩽ In ⩽ Iz.

Short-circuit protection

The installation standards impose no particular constraint: a magnetic tripping threshold Im such that 5 In ⩽ Im ⩽ 10 In is generally advisable.

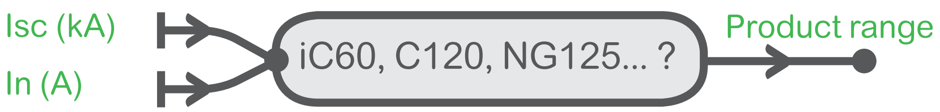
Appendix 1

iC60, C120, NG125 offer

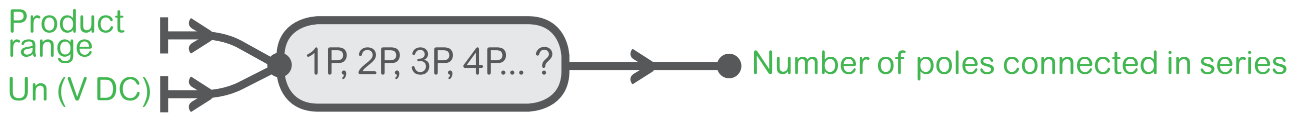
Choosing circuit breakers for distribution with earthed polarity

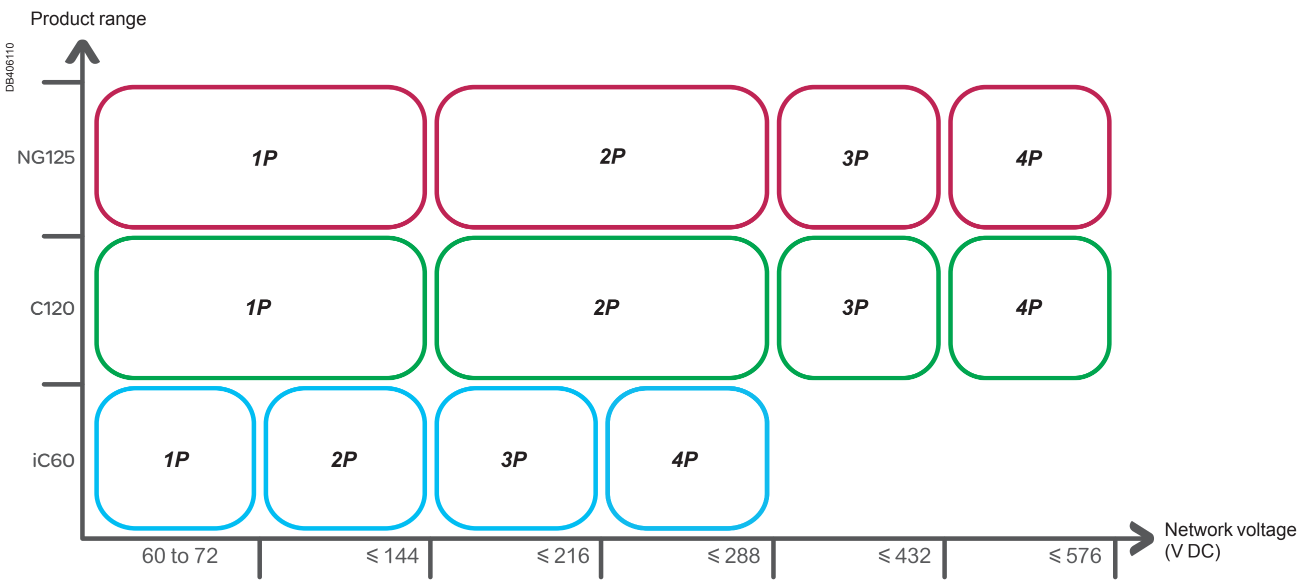
The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 72 V DC for the iC60 offers and 144 V DC for the C120 and NG125 offers



Fault condition analysis, see page 4.





Isolation, number of poles and connection diagram, see page 5.

Appendix 2

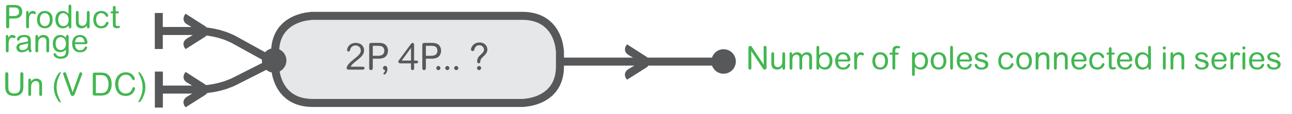
iC60, C120, NG125 offer

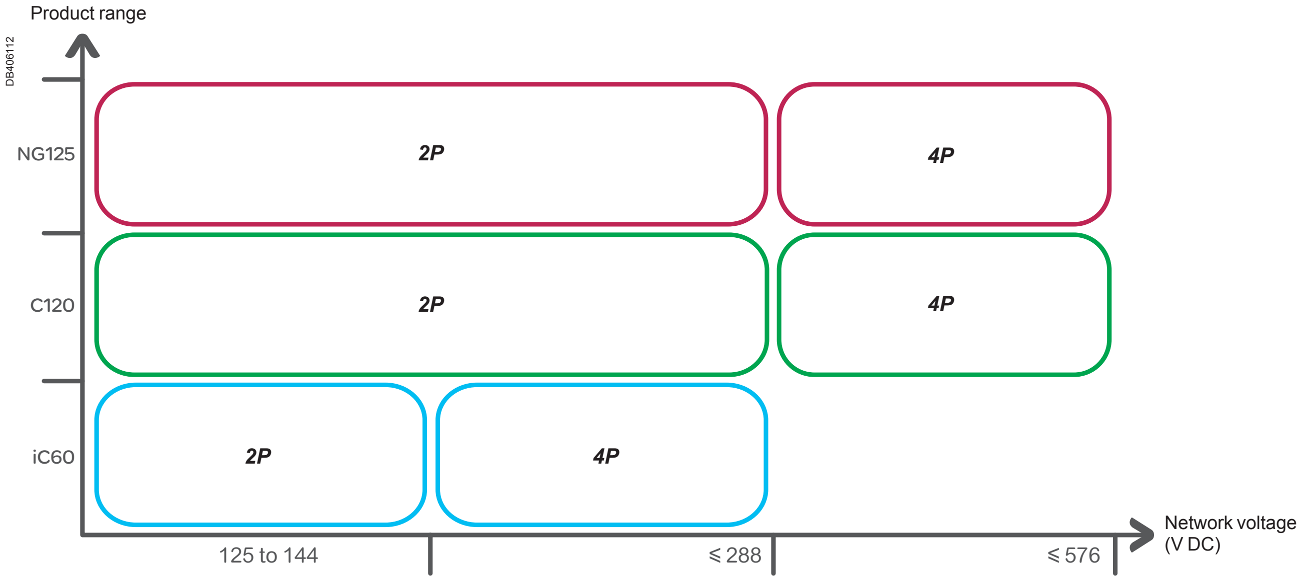
Choosing circuit breakers for distribution with earthed mid-point

The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 72 V DC for the iC60 offers and 144 V DC for the C120 and NG125 offers

Fault condition analysis, see page 6.





Isolation, number of poles and connection diagram, see page 7.

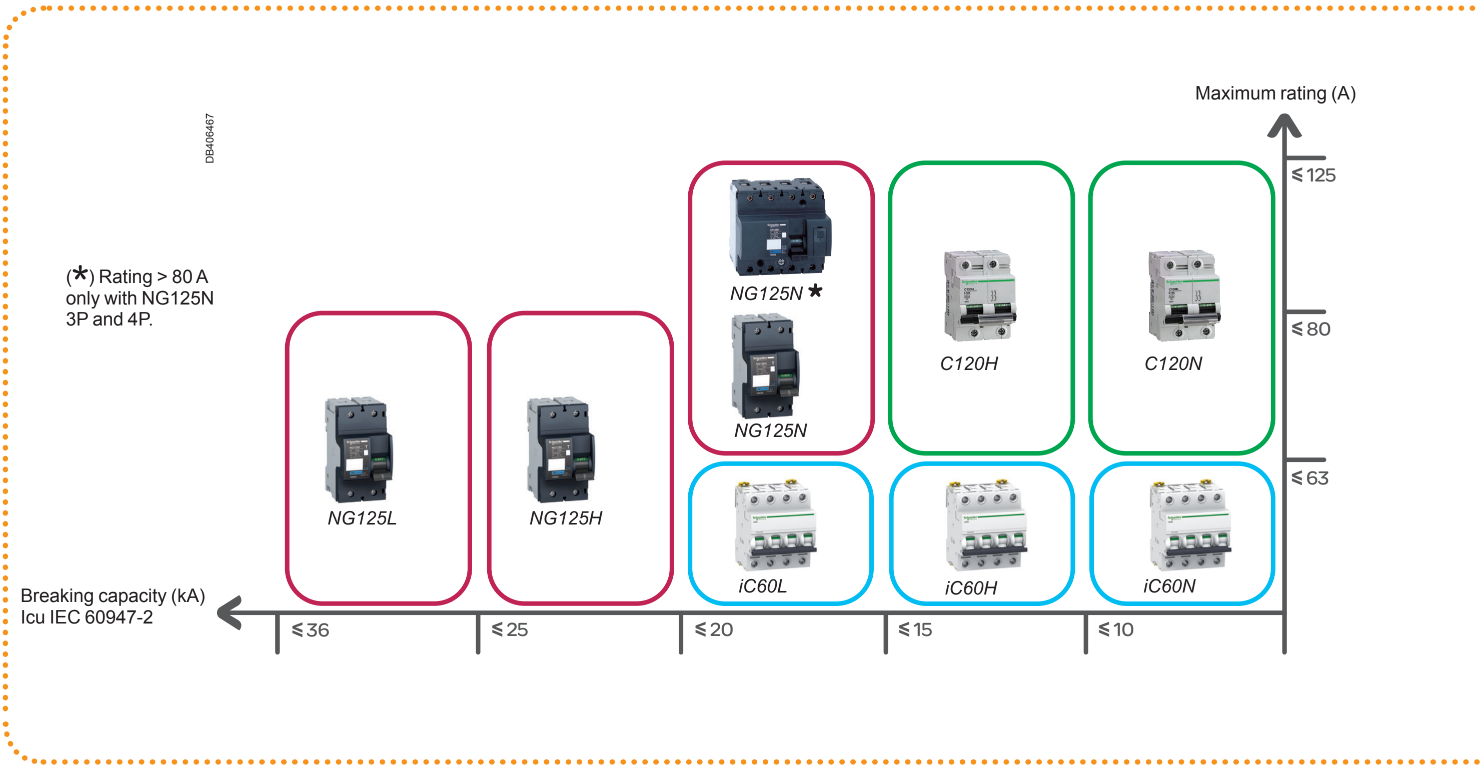
Appendix 3

iC60, C120, NG125 offer

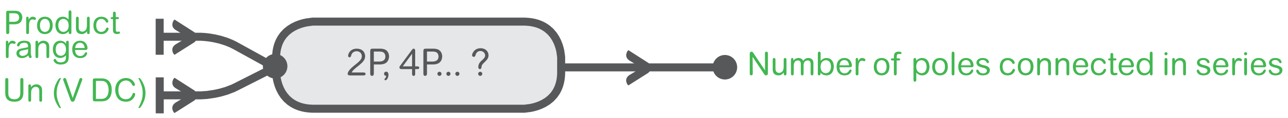
Choosing circuit breakers for distribution isolated from earth

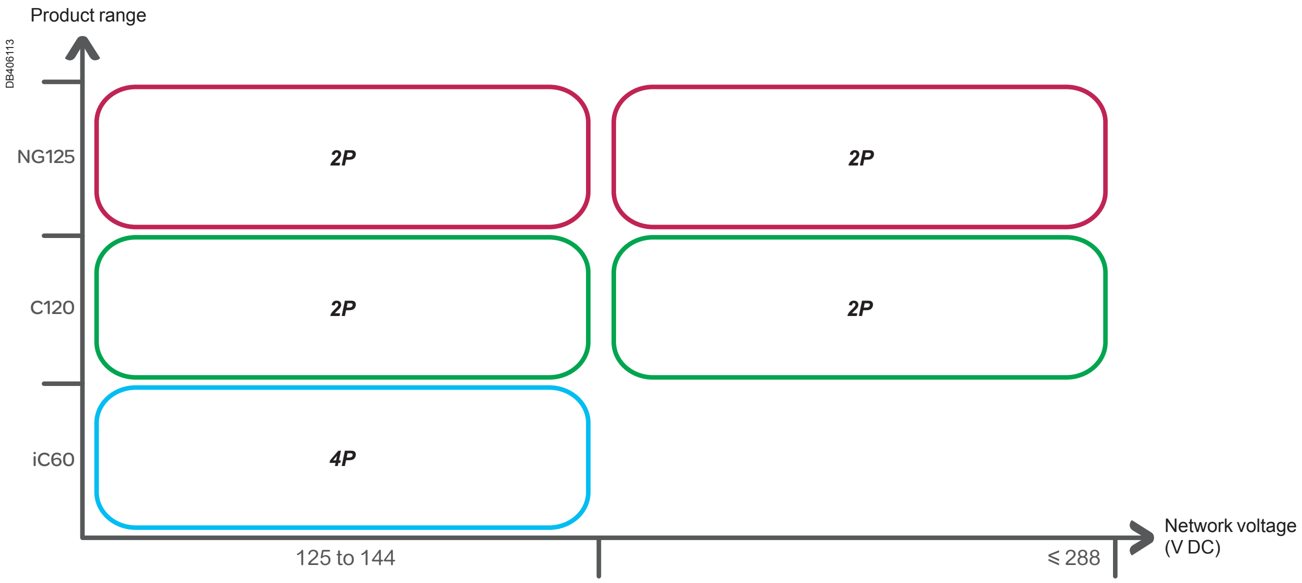
The following tables show the number of poles connected in series according to the DC network voltage, and the circuit breaking performance of our circuit breaker range.

Breaking capacity for a maximum voltage per pole of: 72 V DC for the iC60 offers and 144 V DC for the C120 and NG125 offers



Fault condition analysis, see page 8.





Isolation, number of poles and connection diagram, see page 9.

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Evolutions
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Indice	Date	Modification	Name
2.0	03/04/2017	New charte	Sonovision
1.6	13/10/2016	Changed C60H-DC pages 10 to 15	Sonovision
1.5	24/05/2015	P10 add breaking capacity for 2 P 250VDC	JPM
1.4	3/10/2013	Changed Compact NS by Compact NSX and photos	Sedoc
1.3	7/06/2013	Changed text in tables page 11 and page 12	Sedoc
1.2	5/04/2013	Changed diagram "+" polarity earthed page 11 and replace I by In, for the others	Sedoc
1.1	10/12/2012	New presentation	Sedoc
1.0	29/11/2012	Creation	Sedoc