Control Panel
Technical Guide

How to choose the circuit breaker and transfer switch for a generator set

Schneider Electric
Standby power supply by generator set

Everything has been planned so that this will not happen...

If it is not controlled, the disappearance of the ‘mains’ power supply of a facility is an event with potentially serious consequences, endangering the occupants, disrupting critical activities and causing economic loss.

A standby generator set is the commonly adopted solution to temporarily supply power when the main source fails. An immediate and reliable service is expected, whatever happens to the electrical installation.

Aspects of the set's electrical design which deserve special attention

Apart from sizing the set’s power, certain technological options are important with regard to reliability of service.

They concern, in particular:
- Protecting of the set from electrical faults
- Mains/Generator switchover.

The aim of this guide is to help technicians in their design work, according to IEC standards.
Mains power supply source:
power distributor's network

Incomer circuit breaker

Standby generator set:
engine + generator

Set protection circuit breaker

‘Mains/Generator’ transfer switch

Main low voltage switchboard
of the electrical installation

STANDBY GENERATORS

> **Standard**

Normal service requirements.

Set built for an installation whose precise characteristics are not known.

Optimized solution from a technical and economic viewpoint.

Selection of components from the selection table
> pages 4 to 7

> **Safety**

Local regulatory requirements.
Selective electrical protection.
Heightened reliability, regular tests.

These safety services are covered by specific regulations requiring selective electrical protection and reliable source switching.

Efficient solution, with technological options that make it possible to achieve the requirements.

Principles for design of safety installations, recommendations
> pages 14 to 17

> **Mission critical**

Regulatory requirements related to the building’s activity.
Selective electrical protection, architecture allowing operating redundancy.
Heightened reliability, regular tests.

Design of the standby generator set comes within the framework of an electrical installation project, which is complex due to stringent service requirements.

The requisite technical knowledge is outside the scope of this guide.

General principles for design of critical installations
> pages 16 to 19

> Hospitals

> Data centers

> Industrial Processes

> Airports

> etc.

> Offices, Shops

> Small industry

> Small infrastructure etc.

> High-rise buildings

> Shopping malls

> Tunnels

> etc.

Mission critical

Hospitals

Data centers

Industrial Processes

Airports

etc.
Quick component selection table

Generator sets up to 45 kVA

<table>
<thead>
<tr>
<th>Power PRP (40°C) (kVA)</th>
<th>Current LTP (27°C) (kVA) @ 400 V / 50 Hz (A)</th>
<th>Curve</th>
<th>Rating (A)</th>
<th>Type</th>
<th>CC class</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>11</td>
<td>14.4</td>
<td>B</td>
<td>16</td>
<td>Acti 9 iC60N 16 A – B 4P</td>
</tr>
<tr>
<td>15</td>
<td>16.5</td>
<td>21.7</td>
<td>B</td>
<td>25</td>
<td>Acti 9 iC60N 25 A – B 4P</td>
</tr>
<tr>
<td>20</td>
<td>22</td>
<td>28.9</td>
<td>B</td>
<td>32</td>
<td>Acti 9 iC60N 32 A – B 4P</td>
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<td>25</td>
<td>27.5</td>
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<td>B</td>
<td>40</td>
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<td>27</td>
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<td>39</td>
<td>B</td>
<td>40</td>
<td>Acti 9 iC60N 40 A – B 4P</td>
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<td>32</td>
<td>35.2</td>
<td>46.2</td>
<td>B</td>
<td>50</td>
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<tr>
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<td>38.5</td>
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<td>B</td>
<td>50</td>
<td>Acti 9 iC60N 50 A – B 4P</td>
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<tr>
<td>40</td>
<td>45</td>
<td>57.7</td>
<td>B</td>
<td>63</td>
<td>Acti 9 iC60N 63 A – B 4P</td>
</tr>
</tbody>
</table>

(1) Circuit breakers in accordance with the IEC 60947-2 standard – for a 40°C environment (for 60°C, derate by 10%)

(2) Transfer switching equipment in accordance with the IEC 60947-6-1 standard - Two devices of this type are needed, with mechanical and electrical interlocking

(*) Each reference must be completed by a coil voltage code > see details on page 7

The addition of a residual current protection relay to the circuit breaker is recommended: Associated RCD: Acti9 Vigi iC60 – 100 mA earth leakage module.

⚠️ CC type transfer switching equip: selectivity not guaranteed for tripping of a downstream CB; contactor welding possible upon short circuit.
Generator sets up to 450 kVA

### Generator sets up to 450 kVA

- **Standby Standard**
- **400 V 50 Hz**

#### Generator sets up to 450 kVA

- **Standby**
- **Standard**

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**Puissance** | **PRP (40°C) (kVA)** | **LTP (27°C) (kVA)** | **Current @ 400 V / 50 Hz (A)** | **Curve** | **Rating (A)** | **Type** | **Reference** | **CC class** |
---|---|---|---|---|---|---|---|---|
45 | 50 | 65 | TM-G | 80 | Easy pact CVS100B + TM-G 80 4P: LV510748 | Easypact TVS LC1E65** |
50 | 55 | 72.2 | TM-G | 80 | Easy pact CVS100B + TM-G 80 4P: LV510748 | Easypact TVS LC1E65** |
60 | 66 | 86.6 | TM-G | 100 | Easy pact CVS100B + TM-G 100 4P: LV510749 | Easypact TVS LC1E80** |
70 | 77 | 101 | TM-G | 100 | Easy pact CVS100B + TM-G 100 4P: LV510749 | Easypact TVS LC1E80** |
80 | 90 | 115.5 | TM-G | 125 | Easy pact CVS160B + TM-G 160 4P: LV516743 | Easypact TVS LC1E95** |
90 | 100 | 129.9 | TM-G | 160 | Easy pact CVS160B + TM-G 160 4P: LV516743 | Easypact TVS LC1E120** (3) |
105 | 116 | 151.6 | TM-G | 160 | Easy pact CVS160B + TM-G 160 4P: LV516743 | Easypact TVS LC1E120** (3) |
125 | 138 | 180.4 | TM-G | 200 | Easy pact CVS250B + TM-G 200 4P: LV525742 | Easypact TVS LC1E160** (3) |
135 | 150 | 194.9 | TM-G | 200 | Easy pact CVS250B + TM-G 200 4P: LV525742 | Easypact TVS LC1E160** (3) |
150 | 165 | 216.5 | TM-G | 250 | Easy pact CVS250B + TM-G 250 4P: LV525743 | Easypact TVS LC1E200** (3) |
165 | 175 | 238.2 | TM-G | 250 | Easy pact CVS250B + TM-G 250 4P: LV525743 | Easypact TVS LC1E200** (3) |
180 | 203 | 259.8 | Adj. | 400 | Easy pact CVS400F + ETS 2.3 400 A 4P: LV540506 | Easypact TVS LC1E300** (3) |
200 | 223 | 288.7 | Adj. | 400 | Easy pact CVS400F + ETS 2.3 400 A 4P: LV540506 | Easypact TVS LC1E300** (3) |
250 | 275 | 360.8 | Adj. | 400 | Easy pact CVS400F + ETS 2.3 400 A 4P: LV540506 | Easypact TVS LC1E400** (3) |
300 | 300 | 404.1 | Adj. | 400 | Easy pact CVS400F + ETS 2.3 400 A 4P: LV540506 | Easypact TVS LC1E400** (3) |
315 | 341 | 454.7 | Adj. | 630 | Easy pact CVS630F + ETS 2.3 630 A 4P: LV563506 | Easypact TVS LC1E500** (3) |
365 | 420 | 526.8 | Adj. | 630 | Easy pact CVS630F + ETS 2.3 630 A 4P: LV563506 | Easypact TVS LC1E500** (3) |
410 | 450 | 591.8 | Adj. | 630 | Easy pact CVS630F + ETS 2.3 630 A 4P: LV563506 | Easypact TVS LC1E500** (3) |

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1. **Puissance**
2. **Type**
3. **Reference**

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**Notes:**

- **(1)** Circuit breakers in accordance with the IEC 60947-2 standard – for a 40°C environment (for 60°C, derate by 10%)
- **(2)** Transfer switching equipment in accordance with the IEC 60947-6-1 standard - Two devices of this type are needed, with mechanical and electrical interlocking
- **(3)** LC1E120, LC1E500 contactor: 3 poles only – 4-pole contactors: choose from the TeSys F product range

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**Integrated RCD:** Vig ME for CVS 100 and 160 A (LV429213), Vig MH for CVS 250 (LV431536), Vig MB for CVS 400 and 600 (LV432456)

**Separate RCD:** Vigirex RH21.

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**CC type transfer switching equip.: selectivity not guaranteed for tripping of a downstream CB; contactor welding possible upon short circuit.**
Quick component selection table

Generator sets larger than 450 kVA

<table>
<thead>
<tr>
<th>Power PRP (40°C) [kVA]</th>
<th>LTP (27°C) [kVA]</th>
<th>Current @ 400 V / 50 Hz (A)</th>
<th>Curve</th>
<th>Rating (A)</th>
<th>Type</th>
<th>CB class</th>
</tr>
</thead>
<tbody>
<tr>
<td>455</td>
<td>500</td>
<td>656.7</td>
<td>Adj.</td>
<td>800</td>
<td>Compact NS800N + Micrologic 5.0: 33337</td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>570</td>
<td>721.7</td>
<td>Adj.</td>
<td>800</td>
<td>Compact NS800N + Micrologic 5.0: 33337</td>
<td></td>
</tr>
<tr>
<td>550</td>
<td>600</td>
<td>793.9</td>
<td>Adj.</td>
<td>800</td>
<td>Compact NS800N + Micrologic 5.0: 33337</td>
<td></td>
</tr>
<tr>
<td>600</td>
<td>660</td>
<td>866</td>
<td>Adj.</td>
<td>1000</td>
<td>Compact NS1000N + Micrologic 5.0: 33347</td>
<td></td>
</tr>
<tr>
<td>660</td>
<td>725</td>
<td>952.6</td>
<td>Adj.</td>
<td>1000</td>
<td>Compact NS1000N + Micrologic 5.0: 33347</td>
<td></td>
</tr>
<tr>
<td>725</td>
<td>800</td>
<td>1046.4</td>
<td>Adj.</td>
<td>1250</td>
<td>Compact NS1250N + Micrologic 5.0: 33357</td>
<td></td>
</tr>
<tr>
<td>800</td>
<td>880</td>
<td>1154.7</td>
<td>Adj.</td>
<td>1250</td>
<td>Compact NS1250N + Micrologic 5.0: 33357</td>
<td></td>
</tr>
<tr>
<td>880</td>
<td>960</td>
<td>1270.2</td>
<td>Adj.</td>
<td>1600</td>
<td>Compact NS1600N + Micrologic 5.0: 33367</td>
<td></td>
</tr>
<tr>
<td>910</td>
<td>1000</td>
<td>1313.5</td>
<td>Adj.</td>
<td>1600</td>
<td>Compact NS1600N + Micrologic 5.0: 33367</td>
<td></td>
</tr>
<tr>
<td>1000</td>
<td>1100</td>
<td>1443.4</td>
<td>Adj.</td>
<td>1600</td>
<td>Compact NS1600N + Micrologic 5.0: 33367</td>
<td></td>
</tr>
<tr>
<td>1250</td>
<td>1375</td>
<td>1804.2</td>
<td>Adj.</td>
<td>2000</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
<td></td>
</tr>
<tr>
<td>1350</td>
<td>1485</td>
<td>1948.6</td>
<td>Adj.</td>
<td>2000</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
<td></td>
</tr>
<tr>
<td>1500</td>
<td>1650</td>
<td>2165.1</td>
<td>Adj.</td>
<td>2500</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
<td></td>
</tr>
</tbody>
</table>

(1) Circuit breakers in accordance with the IEC 60947-2 standard
(2) Transfer switching equipment in accordance with the IEC 60947-6-1 standard - Two devices of this type are needed, with mechanical and electrical interlocking

The addition of a residual current protection relay to the circuit breaker is recommended:
> Integrated RCD: Micrologic 7.0 for Compact, Masterpact
> Separate RCD: Vigirex RH21.
Coding of Easypact TVS (LC1E ••) contactor references

**Frequency**  | **Code**  
---|---
50 Hz | 5
60 Hz | 6
50/60 Hz | 7

**Coil voltage**  | **Code**  
---|---
24 V | E
48 V | F
110 V | M
220 V | U
380 V | Q
415 V | N
440 V | R

**Rated operation current (AC3)**  | **Auxiliary contact configuration**  | **Code**  
---|---|---
EasyPact TVS 3-pole | 06...38 1NO (or 1 NC) | 01 (or 10)
40...160 1NO +1 NC | none
200...630 no auxiliary contact | none

**EasyPact TVS 4-pole**  | **Main contact**  | **Code**  
---|---|---
06...95 4NO | 004
06...95 2NO + 2NC | 008

**Rated operation current (AC3)**  | **Code**  
---|---
EasyPact TVS 3-pole | 06...630
EasyPact TVS 4-pole | 06...95

**Type**  | **Designation**  
---|---
Contactor | EasyPact TVS

**Accessories for interlocked contactor assembly**

**Contacts with screw clamp terminals**  
Using 2 identical contactors  
**Mechanical interlock**  | **Set of power connections**  | **Mechanical interlock**  
---|---|---
LC1E06...E12 | LAEP1 | LAEM1
LC1E18/E25 | LAEP12 | LAEM1
LC1E32/E38 | LAEP2 | LAEM1
LC1E40...E65 | LAEP3 | LAEM1
LC1E60/E65 | LAEP4 | LAEM1
LC1E120/E160 | – (DIY) (1) | LAEM5
LC1E200/E250 | – (DIY) (1) | LAEM6
LC1E320 | – (DIY) (1) | LAEM7
LC1E400 | – (DIY) (1) | LAEM7
LC1E500 | – (DIY) (1) | LAEM7
LC1E630 | – (DIY) (1) | LAEM8

Generator set protection

What you should know

Number of circuit breaker poles: 4-pole device recommended

- Three-pole circuit breaker
- Four-pole circuit breaker

When the earthing system is not known, the choice of a four-pole circuit breaker allows ex-post adaptation to all constraints (even if it means using it as a three-pole device in the case of a non-distributed neutral). The same reasoning will apply in choosing the transfer switching equipment.

Overload protection: choice of circuit breaker rating

- The installation rules (IEC 60364) require overload protection for the cable between the generator and the installation.
- However, it is the characteristics of the generator which often determine the choice of its protection system, when it has an overload resistance less than that of the cable.
- To optimize protection, choose a circuit breaker whose tripping threshold \( \text{Ir} \) is adjustable.

**Allowance for max. power: PRP or LTP**

The set’s PRP (Prime Running Power) is the power available for a variable load, during an unlimited period. A 10% overload is permissible.

Or

The set’s LTP (Limited Time Running Power) is the power that it can supply for at most 500 hours per year at a constant load. No overload is permissible.

**Rating (Ir)**: that corresponding to the current \( \text{In} \) for selected power or that immediately higher

\( \text{Ir} \) for 40°C ambient temperature. 50°C: \( \text{Ir} + 5\% \); 60°C: \( \text{Ir} + 10\% \)

**Example:**

<table>
<thead>
<tr>
<th>PRP = 70 kVA / 400 V</th>
<th>In: 100 A - possible overload 110 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTP = 77 kVA / 400 V</td>
<td>In: 110 A - overload prohibited</td>
</tr>
</tbody>
</table>

Schneider Electric circuit breaker \( \text{Ir} = 100 \text{ A} \):

- Non-tripping guaranteed 1.05 x \( \text{Ir} \): 105 A
- Tripping guaranteed < 2 h 1.3 x \( \text{Ir} \): 130 A
Protection: adapted to the operating characteristics of the generator

The characteristics define 3 types of situations depending on the current delivered by the generator:

> Normal situation: the max. current can be maintained for a long time
> Risk: the current may reach or exceed its overload value; the circuit breaker must open
> Destruction: the short-circuit current is destructive when it occurs for more than a few seconds

Protection by circuit breaker with thermomagnetic or electronic tripping device?

Its tripping curve must be located in the mandatory tripping region

Thermomagnetic tripping device

A circuit breaker with a low magnetic threshold (tripping at 3 x In) will protect better than a circuit breaker with a standard magnetic threshold (tripping between 5 and 10 x In).

Recommended choice: circuit breaker Acti 9 B curve or EasyPact + TMG tripping device

However, with this solution a high-risk region persists.

Electronic tripping device

The electronic tripping device allows precision adjustment of its tripping curve according to the desired profile.

The Micrologic electronic tripping device combined with a Compact or Masterpact circuit breaker is the ideal protection solution.

The circuit breaker must be able to prevent damage to the generator by tripping on a low short-circuit current.

Illustration of the adjustable tripping curve: no risk region persists

Example of chart of short-circuit resistance time – Generator with In = 100 A
Insulation fault protection system

What you should know

Protection by a Residual Current Device (RCD)

This is mandatory:

- in a TN system when the main circuit breaker does not trip fast enough in the event of a phase-to-earth fault (in particular with C curves or TM-D tripping devices: see previous chapter)
- in a TT system
- on mobile units

When the generator set is provided with power sockets, they must be protected by RCDs of 30 mA sensitivity.

Principle of RCDs

RCDs monitor any earth current leak. They are activated upon a fault exceeding a current threshold after a time lag. The threshold and the time lag can be adjustable.

'Vigi module' type RCD:

To be associated electrically and mechanically with a circuit breaker.

- **Advantage:** no auxiliary power supply.
- **Disadvantages:** size, less installation flexibility, commercial reference depending on the rating of the main circuit breaker.

'Rresidual current relay' type RCD:

This RCD, independent of the circuit breaker, measures the earth fault current by means of a current transformer placed on the neutral earthing of the generator. Its ‘fault’ output contact controls the tripping coil (MX or MN) of the main circuit breaker.

- **Advantage:** one product reference and one size irrespective of the set’s power.
- **Disadvantages:** requires a tripping coil in the main circuit breaker and an auxiliary power supply.

RCDs are by definition very sensitive. Due to their position at the incoming end of the installation in the generator set, it is recommended to choose selective versions, of the 'S' type, with an adjustable time lag (when there is no information concerning the downstream installation).
The choice of a TMD tripping device or a C-curve circuit breaker combined with an RCD would, in the event of a short circuit, entail a response time that is dangerous for the generator even if it still contribute to the protection of human life.

Combination of RCD + circuit breaker

Installation rules such as IEC 60364 require checking the conformity of the time for automatic disconnection of the power supply in the event of a phase-to-earth fault.

In practice, setting the ‘magnetic’ threshold of a TMG tripping device to 3 x In or choosing a B-curve circuit breaker combined with an RCD offers satisfactory protection of the electrical installation.
Transfer switching equipment

What you should know

<table>
<thead>
<tr>
<th>Transfer switching equipt. classes as per IEC 60947-6-1</th>
<th>CB</th>
<th>PC</th>
<th>CC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circuit breakers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contactors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-circuit withstand</td>
<td>✔</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Breaking capacity in the event of a short circuit</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Necessary coordination</td>
<td>-</td>
<td></td>
<td>With the circuit breaker upstream</td>
</tr>
<tr>
<td>Selection criteria</td>
<td>Icu = ultimate breaking capacity</td>
<td>Iq = conditional short-circuit current of the combination circuit breaker + switch or contactor.</td>
<td>Must be greater than the prospective short-circuit current of the installation</td>
</tr>
</tbody>
</table>

Recommended solution up to 410 kVA

Contactors with electrical and mechanical interlocking

This CC class solution is economical. The installation’s safety is ensured by choosing a coordinated contactor + circuit breaker combination, but with no guarantee of absence of contact welding.

Selection of contactors according to the coordination table

The table on pages 4 and 5 shows coordinated contactor + circuit breaker combinations according to type 1, in accordance with the IEC 60947-4-1 standard, up to the breaking capacity of the upstream circuit breaker.

Type 1 coordination specifies that the effect of the short circuit on all coordinated products is safe for the operators.

Repair or replacement is needed to resume operation.

(*) The designer of the electrical installation should check the coordination of the Mains contactor with the Mains source protection.
Recommended solution above 410 kVA

Circuit breaker + switch with electrical and mechanical interlocking integrated into the main LV switchboard

Since the transformer is generally near the main LV switchboard, this solution is optimized, and ensures good reliability:
> A single circuit breaker performs the functions of switchboard incoming end protection and ‘Mains’ source switching
> One switch is sufficient to ensure switching to the generator set
> The circuit breaker and switch have been designed to interface directly with an interlocking mechanism

Savings can be achieved by using different ratings for Mains and Generator, when the generator set is sized for partial backup of the electrical installation.

Feasible combinations: Mains circuit breaker + Generator circuit breaker or switch

<table>
<thead>
<tr>
<th>Mains</th>
<th>NSX100/160/250</th>
<th>NSX400</th>
<th>NS630b/630</th>
<th>NT06</th>
<th>NT16</th>
<th>NW08</th>
<th>NW40</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSX100/160/250</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NSX400 - 630</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NS630b… NS1600</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NT06… NT16</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>NW08… NW40</td>
<td></td>
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</tr>
</tbody>
</table>

These combinations allow the use of an interlocking mechanism, irrespective of the size or rating of the devices.
Standby power supply for safety installations

Permanence of the power supply can be important to maintain the safety of building users in the event of a mains failure.

In that case the generator source powers the lighting of areas used for evacuation, smoke extractors, elevators reserved for emergency responders, etc.

Additional requirements apply to generator sets in this case (appended: IEC 60364-5-56)
Selectivity requirement: only the circuit breaker closest to the electrical fault should trip

Transfer switching equipment’s impact on selectivity

The EasyPact CVS circuit breaker with TMG 100 A thermomagnetic tripping device does not allow selectivity with the Acti9 iC60N C-curve circuit breaker.

The Compact NSX circuit breaker with Micrologic 2.2 electronic tripping device allows selectivity with the Acti9 iC60N C-curve circuit breaker.

Safety requirement: the transfer switching equipment must withstand short-circuit currents without any damage

Transfer switching equipment’s impact on safety

Transfer switching equipment with contactors:
A short circuit in the installation is likely to cause welding of the Mains contactor contacts. Switchover to the generator set will become impossible.

Safe switchover to the generator set, without risk of contact welding.

The coordination study of the various protection and switching devices must be performed for the complete installation in accordance with the IEC 60364-5-56 standard.
Integration of the transfer switching equipment in the main LV switchboard facilitates study performance.
Standby power supply for safety installations

Integration of the transfer switching equipment in the MLVSB is the preferred solution.

(1) Circuit breakers in accordance with the IEC 60947-2 standard – the addition of a residual current protection relay is recommended

(2) Transfer switching equipment in accordance with the IEC 60947-6-1 standard - Two devices of this type are needed, with mechanical and electrical interlocking

RCD: if used it should be chosen to ensure selectivity:
> Integrated RCD: Vigil MH 100/160 (LV429211) and 250 A (LV431536) and Vigil MB 400 to 630 A (LV432456)

### Generator sets up to 410 kVA

<table>
<thead>
<tr>
<th>Power PRP (40°C) kVA</th>
<th>LTP (27°C) kVA</th>
<th>Current @ 400 V / 50 Hz (A)</th>
<th>Rating (A)</th>
<th>Type</th>
<th>CB class</th>
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CB class transfer switching equipment recommended in main LV switchboard
Generator sets exceeding 450 kVA

<table>
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<tr>
<th>Power PRP (40°C) (kVA)</th>
<th>LTP (27°C) (kVA)</th>
<th>Current @ 400 V / 50 Hz (A)</th>
<th>Curve (A)</th>
<th>Rating (A)</th>
<th>Type</th>
<th>CB class</th>
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<tbody>
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<td>455</td>
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<td>500</td>
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<td>793.9</td>
<td>Adj. 800</td>
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<td>Adj. 1000</td>
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<td>Adj. 1600</td>
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<td>Adj. 2000</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
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<td>1350</td>
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<td>Adj. 2000</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
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<td>1500</td>
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<td>2165.1</td>
<td>Adj. 2500</td>
<td>Masterpact NW20H1 + Micro 5.0 A</td>
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</tbody>
</table>

(1) Circuit breakers in accordance with the IEC 60947-2 standard – the addition of a residual current protection relay is recommended
(2) Transfer switching equipment in accordance with the IEC 60947-6-1 standard - Two devices of this type are needed, with mechanical and electrical interlocking

RCD: If used it should be chosen to ensure selectivity:
> Integrated RCD: Micrologic 7.0
> Separate RCD: Vigirex RH99.
Standby power supply for mission critical installations

A reliable power supply is critical to ensure uninterrupted surgical operations, breathing assistance systems, premature infant care, etc.

Power failure to certain industrial processes has serious consequences.

Like those of safety installations (reliability, selectivity), the characteristics of these installations are also enhanced: redundant standby sources, test modes, parallel connection of sources, etc.
Source switchover without cutoffs

There are solutions that can limit the impact of cutoffs during switching:
> during scheduled cutoffs of the Mains source
> during generator set tests
> upon return to the Mains source

One of the solutions is coupling of the generator set for a time less than or equal to 10 seconds in parallel with the network.

High power or very high availability

Parallel coupling of generator sets is used to increase the standby power or compensate for any unavailability of a generator (maintenance, malfunction, etc.).

**Note:** specific constraints for choosing generator circuit breakers:
> They must resist the sum total of short-circuit currents of the generator sets + possibly the main source (if used in parallel)
> They do not prevent parallel operation of the generator sets (no interlocking)
> They allow total selectivity with the downstream protective devices
Summary: generator set applications

Application by application: technological constraints and options

<table>
<thead>
<tr>
<th>Applications</th>
<th>Standard standby</th>
<th>Safety standby</th>
<th>Mission critical standby</th>
<th>Fixed production</th>
<th>Mobile production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main operating features</td>
<td>&gt; Simplicity</td>
<td>&gt; Compliance with regulations</td>
<td>&gt; Compliance with regulations</td>
<td>&gt; Reliability</td>
<td>&gt; Resistance to severe environments</td>
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<tr>
<td></td>
<td>&gt; Low cost</td>
<td>&gt; Reliability</td>
<td>&gt; Reliability</td>
<td>&gt; Availability</td>
<td>&gt; Tolerance to divers loads and installations</td>
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<td>Generator operating mode</td>
<td>Stand by</td>
<td>Stand by</td>
<td>Stand by</td>
<td>Permanent service</td>
<td>Permanent service</td>
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<tr>
<td>Special characteristics and functions</td>
<td>-</td>
<td>&gt; Protective device selectivity, &gt; Regular tests</td>
<td>&gt; Advanced architectures &gt; Selectivity &gt; Redundancy &gt; Coupling to the grid</td>
<td>Coupling to the grid</td>
<td>-</td>
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<tr>
<td>Special characteristics and functions</td>
<td>Recommended</td>
<td>Electronic</td>
<td>Electronic Advanced</td>
<td>Electronic Advanced</td>
<td>TMG/ B curve</td>
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<td>Possible</td>
<td>Electronic</td>
<td>Electronic</td>
<td>Electronic</td>
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<td>Residual current device (RCD)</td>
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<td>Only if mandatory</td>
<td>Only if mandatory</td>
<td>Only if mandatory</td>
<td>Yes</td>
</tr>
<tr>
<td>Class of transfer switching equipment</td>
<td>(CC: contactor + contactor) (CB: circuit breaker + circuit breaker)</td>
<td>CC</td>
<td>CB</td>
<td>CB if necessary</td>
<td>-</td>
</tr>
</tbody>
</table>

* TMG, TMD: Thermomagnetic tripping devices for ‘G’enerator or electrical ‘D’istribution
Application by application:

**Objectives and Schneider Electric recommendation**

- **Standard standby**
  - Protection of the generator set: Its protection must be sensitive. This can be achieved by a circuit breaker with a TMG/B-curve tripping device.

- **Safety standby**
  - Continuity of service: In the event of a fault on the installation, only the relevant circuit breaker should trip (selectivity). This can be achieved with a Compact or Masterpact circuit breaker, with standard Micrologic tripping device.

- **Mission critical standby**
  - Continuity of service, reliability: Complementing selectivity and to offer maximum service guarantees for the installation, the Compact or Masterpact circuit breaker, with an advanced Micrologic tripping device, offers measuring and diagnostic functions.

- **Fixed production**
  - Reliability, availability: To offer maximum production guarantees, a protection system closely adapted to the set is provided by a Compact or Masterpact circuit breaker with an advanced Micrologic tripping device offering measuring and diagnostic functions.

- **Mobile production**
  - Ruggedness: For use on worksites, for major events, in emergency fallback situations, significant generator protection is required. This can be achieved with a circuit breaker with TMG / B-curve tripping device supplemented by a residual current device.
Product offer for generator set applications

▷ Circuit breakers, for protection of generators and cables

Acti 9 IC60  EasyPact CVS  Compact NS  Masterpact NT

▷ Residual current devices, for protection of human life

Acti 9 DPN Vigi  Vigi IC60 modules  Compact NSX Vigi  Vigirex

▷ Transfer switching equipment

CC type: Easypact TVS  CB type: Compact NS
＞ Buttons, indicators, emergency stop switch

Harmony

＞ Measuring equipment

Voltmeters and ammeters
Powerlogic multi-function metering

＞ Auxiliary circuit monitoring and control

Auxiliary circuit monitoring and control
TeSys motor starter

＞ Enclosures and thermal management

Spacial
ClimaSys

＞ Industrial power sockets

Pratika