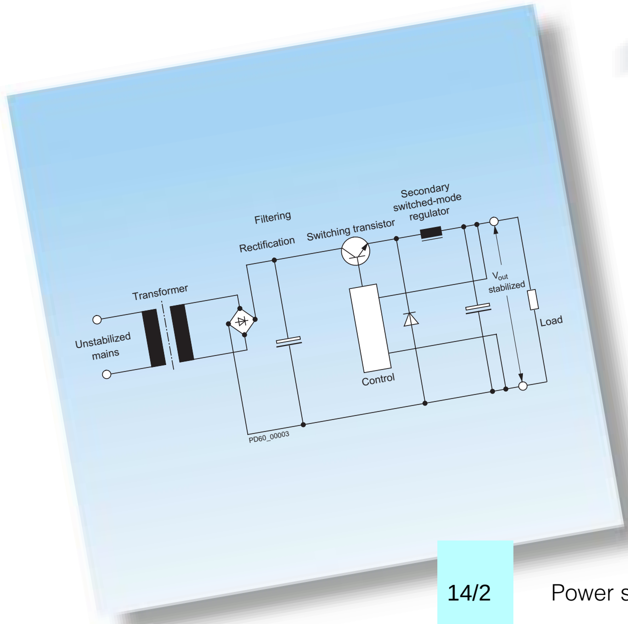

Technical information and configuring notes

Power supplies general

Power supplies

Whether in facility or mechanical engineering, wherever electric controls are implemented a safe and reliable power supply is needed to provide the process with energy.

Uninterrupted function of electric controls and reliable operation of automated facilities is closely linked to a fail-safe load power supply. Only if its uninterrupted operation is ensured, actuators as well as input and output components execute commands properly.

In addition to usual requirements such as safety, the electromagnetic compatibility (EMC) of the power supply must meet special requirements concerning output voltage tolerance ranges and fundamental ripple.

Particularly important for unproblematic implementation are:

- Current consumption low in harmonics
- Low interference emission and
- Sufficient interference immunity to disturbances

EMC	Interference phenomenon
Interference emission	Influencing television and radio reception Disturbances on data or power supply lines
Interference immunity	Interference on the mains supply cable caused by switching processes on non-ohmic loads such as motors or contactors Static discharge caused by lightning stroke Electrostatic discharge caused by the human body Line-connected interference induced by radio frequencies

Table 1 Selection of interference phenomena

DC power supplies general

A DC power supply is a static device with one or more inputs and one or more outputs converting a system of alternating voltage and alternating current and/or direct voltage and direct current into a system of direct voltage and direct current - usually with different values - by electromagnetic induction for transmitting electric power.

The differences in design of DC power supplies are mainly determined by their intended application.

Unstabilized DC power supply

The AC line voltage is transformed into safety extra-low voltage with 50 Hz/60 Hz safety isolating transformers and consecutively smoothed by rectification and capacitor filtering.

With unstabilized DC power supplies, the DC output voltage is not stabilized to a certain value, but the value changes depending on the fluctuation of the (mains) input voltage and the load.

The ripple is within Volt range and depends on the load. The ripple is usually expressed in percent, proportional to the DC output voltage value. Characteristic for unstabilized DC power supplies is their design: rugged, simple, limited to the essentials and built to last.

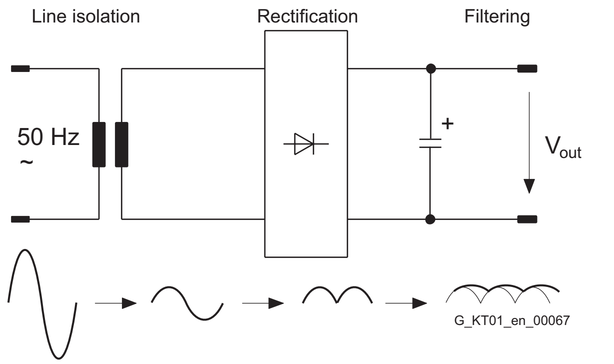

Fig. 1 Basic connection diagram of an unstabilized power supply

Stabilized DC supply

Stabilized DC supplies feature electronic control circuits to keep the value of the direct output voltage on approximately one particular value. Influences such as input voltage fluctuations or varying load on the output are electrically compensated within the assigned function range.

The output voltage ripple of stabilized DC power supplies is within the millivolt range and depends to a large extend on the load at the output.

Stabilized DC power supplies can be realized with various functional principles. The most common circuit types are:

- In-phase controlled power supplies
- Magnetic voltage regulators
- Secondary switched-mode power supplies
- Primary switched-mode power supplies

It depends on the field of application, which of the circuit principles described in the following is best suited for the application. The aim is to reproduce a good direct voltage for supplying the respective loads as inexpensively as possible.

Stabilized DC power supply (continued)

In-phase controlled power supplies

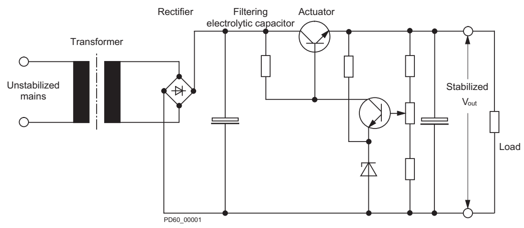

Fig. 2 Basic circuit diagram in-phase regulator

The in-phase regulator, also called linear controller, functions on a conventional principle. It is supplied by an AC system (single, two or three-wire system).

The supply voltage is matched to the secondary voltage with a transformer.

A controller transforms the rectified and filtered secondary voltage into a stabilized voltage at the output. The controller consists of an actuator and the control amplifier. The difference between stabilized output voltage and unstabilized voltage at the filter capacitor is transformed into heat loss at the actuator. In this process the actuator functions as a quickly variable ohmic resistor. The produced heat loss is the product of output current and voltage drop on the actuator.

This system is very variable. Several output voltages can be realized with no effort. In general, the individual secondary circuits are generated from separate secondary windings of the input transformer if several output voltages are to be produced. Some applications can only be carried out according to this circuit principle. Especially when precise control, low residual ripple and short settling times are required.

However, the efficiency is quite low and weight and volume are high. Therefore, the in-phase controller is an inexpensive alternative only for small performances.

Advantages:
- Simple well-proven circuit principle
- Good to best control properties
- Short settling time

Disadvantages:
- Comparatively high weight and large volume due to the 50 Hz transformer
- Low efficiency, cooling problems
- Short storage time

Magnetic regulator

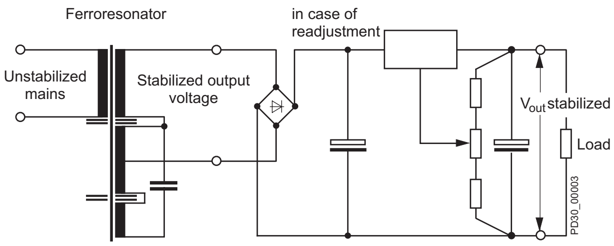

Fig. 3 Basic connection diagram magnetic regulator

The complete converter is composed of two components: the so-called ferroresonator and an additional controller connected in series. The input winding and the resonance winding of the magnetic regulator are almost completely isolated from each other by leakage air gaps. The magnetic regulator alone supplies a well stabilized alternating voltage. It is rectified and filtered. The converter itself is operated in the saturation region.

Often an in-phase regulator or a secondary switched-mode regulator is connected in series to the ferroresonator to reach higher control precision.

The technology of the magnetic regulator is reliable and rugged, but also large, heavy and rather expensive.

Advantages:
- Good to best control properties in combination with in-phase regulators connected in series
- Considerably higher efficiency than in-phase regulators alone

Disadvantages:
- Ferroresonator is frequency-dependent
- Power supplies are large and heavy due to magnetic components

Secondary switched-mode power supplies:

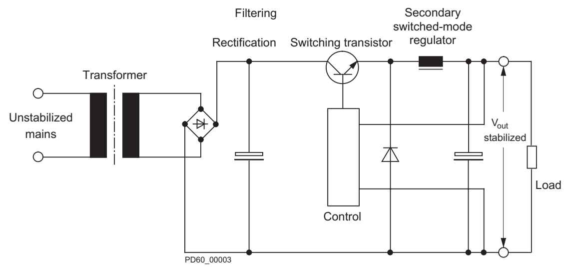

Fig. 4 Basic connection diagram secondary switched-mode power supply

The circuits are separated by a 50 Hz transformer. After the power has been rectified and filtered, it is switched impulsive at the output via a switching transistor into the filtering and storing circuit. Mains pollution is low due to the transformer at the input functioning as a filter.
Efficiency of this circuit is very high.

On the whole this principle offers great advantages for power supplies with many different output voltages.

The connected loads, however, must be protected against the situation that the switching transistor fails and all of the unstabilized direct voltage of the filtering capacitor is applied. This danger, however, is also applicable for linear controller power supplies.

Advantages:
- Simple design and high efficiency
- Multiple outputs, also electrically isolated from each other, are easily realized by using several secondary windings
- Less problems with interference than with primary switched-mode regulators

Stabilized DC power supply

Stabilized DC power supply (continued)

Disadvantages:
- Comparatively large and heavy due to 50 Hz transformer
- Output ripple (spikes) is equal to that of a primary switched-mode power supply

Primary switched-mode power supplies:

You will also often find the abbreviation SMPS or the term primary switched-mode regulator.

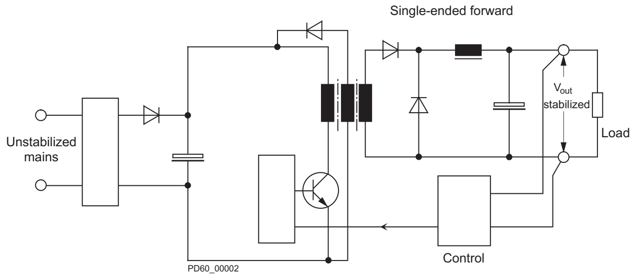

Fig. 5 Basic connection diagram single-ended forward converter

There are many circuit principles for a primary switched-mode regulator. The most significant basic circuits are single-ended forward converters, flyback converters, half-bridge converters, full-bridge converters, push-pull converters and resonance converters.

The basic connection diagram of the single-ended forward converter explains the basic principle of a primary switched-mode regulator:

First, the unstabilized mains voltage is rectified and filtered. The capacitance of the capacitor in the intermediate sector determines the storage time of the power supply in case of input voltage failure. With a 230 V mains, the voltage in the intermediate sector is approx. 320 V DC. This direct voltage supplies a single-ended converter which, in connection with a pulse-width regulator and with a high switching frequency, transmits the primary power via a transformer to the secondary circuit. In its function as a switch, the switching transistor has a low power loss so that the overall efficiency is in the range of > 70 % up to approx. 90 % depending on output voltage and current.

The size of the transformer is small compared to a 50 Hz transformer due to the high switching frequency as the size of a transformer decreases with increasing switching frequency. With modern semi-conductors, modulation frequencies of 100 kHz and more can easily be reached. However, with increasing modulation frequency, switching losses also increase. Thus, some applications will be a compromise between high efficiency and highest possible modulation frequency. For most applications modulation frequencies of approx. 20 - 250 kHz are reached depending on the output power.

The voltage of the secondary winding is rectified and filtered. Deviations at the output are fed back to the primary circuit via opto couplers. By controlling the pulse width (conducting phase of the switching transistor in the primary circuit) the required power is transmitted to the secondary circuit and the output voltage is stabilized. During the non-conducting phase of the switching transistor, the transformer is demagnetized via an auxiliary winding. Only the amount of power taken from the output is transmitted. The maximum pulse width for the duty factor is < 50 % for these circuits.

Advantages:
- Small magnetic components (transformer, storage choke, filter) due to the high operating frequency
- High efficiency due to pulse-width control
- Compact components
- No forced cooling required even in the range of kW
- High storage times in case of supply interruption by increasing the capacitance in the intermediate sector.
- Wide input voltage range possible

Disadvantages:
- Complex circuit, many active components
- Large extent of interference suppression required
- Mechanical specifications must meet HF requirements

Primary switched-mode power supplies have gained high acceptance over the last years compared to other circuit principles, primary reasons for this being their small size, low weight, high efficiency and good cost-performance ratio.

Summary

Table 2 gives an overview of the properties of the mentioned circuits that are most significant to the user.

	Circuit types			
Comparison criteria	**Primary switched -mode**	**Secondary switched-mode**	**In-phase regulator**	**Magnetic regulator**
Input voltage range	very wide	medium	very small	wide
Reaction	medium	medium	very fast	slow
Storage time after supply interruption	very long	long	very short	long
Residual ripple	medium	medium	very low	medium
Power loss	very low	low	high	very low
Size	very low	medium	very large	large
Weight	very light	medium	heavy	very heavy
Extent of interference suppression	very large	medium	small	medium

Table 2 Comparison criteria for basic circuit types

Mains specifications

When designing and choosing facility components, mains specifications, mains statuses as well as operating purposes for which the components should be implemented must be taken into consideration.

Rated voltage and frequency are significant specifications of a system. This supply system data is referred to as rated values according to international agreements.

Rated voltages and rated frequencies

Since May 1987, the standard DIN IEC 60038 "IEC-Normspannungen" (IEC standard voltages) is valid in the Federal Republic of Germany.

This standard contains exactly the international standard IEC 60038, revision 6, 1983, "IEC standard voltages".

The standard IEC 60038 is the result of international agreements to reduce the number of standard voltage values for electric power supply and traction systems, for consumer's installations and units.

Conversion of low-voltage mains

For low-voltage mains, the standard IEC 60038 replaces the voltage values 220/380 V and 240/415 V for three-phase mains of electric power supply by the single worldwide standard value of 230/400 V.

For the transitional period until the year 2003, tolerances are allowed for the operating voltages of the mains. This is to ensure safe operation of components built for the previously valid standard voltages.

Year	Standard voltage	Tolerance range
before 1987	220/380 V	-10 % to +10 %
from 1988 until 2003	230/400 V	-10 % to + 6 %
from 2003 on	230/400 V	-10 % to +10 %

Table 3 Conversion of low-voltage mains

The IEC recommendations have been adopted as national regulations by the most significant countries as far as the conditions in the respective country allow for adoption.

International mains voltages and frequencies in low-voltage mains

Country	Mains voltage
Western Europe:	
Belgium	50 Hz 230/400 – 127-220 V
Denmark	50 Hz 230/400 V
Germany	50 Hz 230/400 V
Finland	50 Hz 230/400-500[1)] – 660[1)] V
France	50 Hz 127/220 – 230/400 – 500[1)] – 380/660[1)] – 525/910[1)] V
Greece	50 Hz 230/400 – 127/220[2)] V
Great Britain	50 Hz (230/400 V)[3)]
Ireland	50 Hz 230/400 V
Iceland	50 Hz 127/220[2)] – 230/400 V
Italy	50 Hz 127/220 – 230/400 V
Luxembourg	50 Hz 230/400 V
Netherlands	50 Hz 230/400 – 660[1)] V
Northern Ireland	50 Hz 230/400 – Belfast 220/380 V
Norway	50 Hz 230-230/400-500[1)] – 690[1)] V
Austria	50 Hz 230/400 – 500[1)] – 690[1)] V
Portugal	50 Hz 230/400 V
Sweden	50 Hz 230/400 V
Switzerland	50 Hz 230/400 – 500[2)] V
Spain	50 Hz 230/400 V
Eastern Europe:	
Albania	50 Hz 230/400 V
Bulgaria	50 Hz 230/400 V
Croatia	50 Hz 230/400 V
Slovenia	50 Hz 230/400 V
Serbia	50 Hz 230/400 V
Czech Republic	50 Hz 230/400 – 500[1)] – 690[1)] V
Slovakia	50 Hz 230/400 – 500[1)] – 690[1)] V
Countries of former Soviet Union	50 Hz 230/400 – 690[1)] V
Poland	50 Hz 230/400 V
Romania	50 Hz 230/400 V
Hungary	50 Hz 230/400 V

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International mains voltages and frequencies in low-voltage mains

International mains voltages and frequencies in low-voltage mains (continued)

Country	Mains voltage
Near East:	
Afghanistan	50 Hz 220/380 V
Bahrain	50 Hz 230/400 V
Cyprus	50 Hz 240/415 V
Iraq	50 Hz 220/380 V
Israel	50 Hz 230/400 V
Jordan	50 Hz 220/380 V
Kuwait	50 Hz 240/415 V
Lebanon	50 Hz 110/190 – 220/380 V
Oman	50 Hz 220/380 – 240/415 V
Qatar	50 Hz 240/415 V
Saudi Arabia	60 Hz 127/220 – 220/380 – 480[1)] V (220/380 – 240/415 V 50 Hz: only remains)
Syria	50 Hz 115/200 – 220-380 – 400[1)] V
Turkey	50 Hz 220/380 V (parts of Istanbul: 110/190 V)
United Arab Emirates (Abu Dhabi; Ajman; Dubai; Fujairah; Ras al Khaimah; Sharjah; Umm al-Quwain)	50 Hz 220/380 – 240/415 V
Yemen (North)	50 Hz 220/380 V
Yemen (South)	50 Hz 230/400 V
Far East:	
Bangladesh	50 Hz 230/400 V
Burma	50 Hz 230/400 V
Peoples Republic of China	50 Hz 127/220 – 220/380 V (for mining: 1140 V)
Hong Kong	50 Hz 200/346 V
India	50 Hz 220/380 – 230/400 – 240/415 V
Indonesia	50 Hz 127/220 – 220/380 – 400[1)] V
Japan	50 Hz 100/200 – 400[1)] V
Southern part of Honshu, Shikoku, Kyushu, Hokkaido, Northern part of Honshu	60 Hz 110/220 – 440[1)] V
Cambodia	50 Hz 120/208 V – Phnom Penh 220/238 V
North Corea	60 Hz 220/380 V
South Corea	60 Hz 100/200[2)] – 220/380 – 440[1)] V
Malaysia	50 Hz 240/415 V
Mongolia	50 Hz 220/380 V
Pakistan	50 Hz 230/400 V
Philippines	60 Hz 110/220 – 440 V
Singapore	50 Hz 240/415 V
Sri Lanka	50 Hz 230/400 V
Taiwan	60 Hz 110/220 – 220 – 440 V
Thailand	50 Hz 220/380 V
Vietnam	50 Hz 220/380 V
North America:	
Canada	60 Hz 600 – 120/240 – 460 – 575 V
USA	60 Hz 120/208 – 120/240 – 277/480 – 600[1)] V
Central America:	
Bahamas	60 Hz 115/200 – 120/208 V
Barbados	50 Hz 110/190 – 120/208 V
Belize	60 Hz 110/220 – 220/440 V
Costa Rica	60 Hz 120/208[2)] – 120/240 – 127/220 – 254/440[2)] – 227/480[1)] V
Dominican Republic	60 Hz 120/208 – 120/240 – 480[1)] V
Guatemala	60 Hz 120/208 – 120/240 – 127/220 – 277/480[1)] – 480[1)] – 550[1)] V
Haiti	50 Hz 220/380 V (Jacmel), 60 Hz 110/220 V

1) only for industrial purposes 2) no further expansion 3) from 2003 on

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International mains voltages and frequencies in low-voltage mains (continued)

Country	Mains voltage
Central America (continued):	
Honduras	60 Hz 110/220 – 127/220 – 277/480 V
Jamaica	50 Hz 110/220 – 440[1] V
Cuba	60 Hz 120/240 – 220/380 – 277/480[1] – 440[1] V
Mexico	60 Hz 127/220 – 440[1] V
Nicaragua	60 Hz 110/220 – 120/240 – 127/220 – 220/440 – 254/40[1] V
Panama	60 Hz 120/208[1] – 120/240 – 254/440[1] – 277/480[1] V
Puerto Rico	60 Hz 120/208 – 480 V
El Salvador	60 Hz 110/220 – 120/208 – 127/220 – 220/440 – 240/480[1] – 254/440[1] V
Trinidad	60 Hz 110/220 – 120/240 – 230/400 V
South America:	
Argentina	50 Hz 220/380 V
Bolivia	60 Hz 220/380 – 480 V 50 Hz 110/220 – 220/380 V (exception)
Brazil	60 Hz 110/220 – 220/440 – 127/220 – 220/380 V
Chile	50 Hz 220/380 V
Ecuador	60 Hz 120/208 – 127/220 V
Guyane	50 Hz 110/220 V (Georgetown) 60 Hz 110/220 – 240/480 V
Colombia	60 Hz 110/220 – 150/260 – 440 V
Paraguay	60 Hz 220/380 – 220/440 V
Peru	60 Hz 220 – 220/380/440 V
Surinam	60 Hz 115/230 – 127/220 V
Uruguay	50 Hz 220 V
Venezuela	60 Hz 120/208 – 120/240 – 208/416 – 240/480 V
Africa:	
Egypt	50 Hz 110/220 – 220/380 V
Ethiopia	50 Hz 220/380 V
Algeria	50 Hz 127/220 – 220/380 V
Angola	50 Hz 220/380 V
Benin	50 Hz 220/380 V
Ivory Coast	50 Hz 220/380 V
Gabon	50 Hz 220/380 V
Ghana	50 Hz 127/220 – 220/380 V
Guinea	50 Hz 220/380 V
Kenya	50 Hz 220/380 V
Cameroon	50 Hz 127/220 – 220/380 V
Congo	50 Hz 220/380 V
Liberia	60 Hz 120/208 – 120/240 V
Libya	50 Hz 127/220[2] – 220/380 V
Madagascar	50 Hz 127/220 – 220/380 V
Malawi	50 Hz 220/380 V
Mali	50 Hz 220/380 V
Morocco	50 Hz 115/200 – 127/220 – 220/380 – 500[1] V
Mauritius	50 Hz 240/415 V
Mozambique	50 Hz 220/380 V
Namibia	50 Hz 220/380 V
Niger	50 Hz 220/380 V
Nigeria	50 Hz 220/415 V
Rwanda	50 Hz 220/380 V

1) only for industrial purposes 2) no further expansion 3) from 2003 on

International mains voltages and frequencies in low-voltage mains, line-side connection

International mains voltages and frequencies in low-voltage mains (continued)

Country	Mains voltage
Africa (continued):	
Zambia	50 Hz 220/380 V – 415 – 550[1)] V
Senegal	50 Hz 127/220 – 220/380 V
Sierra Leone	50 Hz 220/380 V
Somalia	50 Hz 220-220/440 V
Sudan	50 Hz 240/415 V
South Africa	50 Hz 220/380 – 500[1)] – 550/950[1)] V
Swaziland	50 Hz 220/380 V
Tanzania	50 Hz 230/400 V
Togo	50 Hz 127/220 – 220/380 V
Tunisia	50 Hz 115/200 – 220/380 V
Uganda	50 Hz 240/415 V
Zaire	50 Hz 220/380 V
Zimbabwe	50 Hz 220/380 V

1) only for industrial purposes

Line-side connection and fusing

All SITOP power and LOGO!Power supplies are built-in units. When installing the units, the pertinent DIN/VDE or national regulations must be observed. The supply voltage must be connected according to VDE 0100 and VDE 0160. For the installation, a protective device and an isolating device must be provided for safety isolation of the power supply.

Immediately after the input voltage has been applied, power supplies cause an inrush current as the capacitor charges up. This current declines to the rated input current after a few milliseconds. Apart from the internal impedances of the power supply, the inrush current depends to a large extent on the magnitude of the applied input voltage as well as on the source impedance of the supply system and on the line impedance of the cable. The maximum inrush current of SITOP power supplies is listed in the relevant technical specifications. It is significant for the design rating of protective devices on the line side.

Single-phase SITOP power and LOGO!Power supplies feature internal protection (a fuse). For the AC line connection it is merely necessary to provide a protective device (fuse or circuit-breaker) for line protection depending on the permissible rated current for the installed cable. The circuit-breakers recommended in the data sheets and instruction manuals have been chosen so that not even the maximum inrush current that could occur under the most unfavorable conditions when the supply voltage is applied would trip the circuit-breaker.

Three-phase SITOP power supplies feature no internal protection. The line-side protective device (three-phase coupled circuit-breaker or motor circuit-breaker) provides cable and equipment protection. Protective devices specified in the data sheets and instruction manuals are perfectly matched to the characteristics of the corresponding power supplies.

Potential mains interference factors and their sources

For highly sensitive electronic facilities and devices (computers, industrial controls, measuring technology etc.), the mains voltage quality has become a decisive factor for their proper functioning, reliability, need for maintenance and lasting service life.

Mains interference causes system failures and impedes the function of facilities as well as of electronic loads. Mains interference may lead to complete failure of facilities or devices.

The most frequent types of interference are:
- Long-term overvoltage
- Long-term undervoltage
- Interfering impulses and transients
- Voltage dip and voltage surge
- Electric noise
- Brief supply interruption
- Long supply interruption

Mains interference may have different causes, e. g.:
- Switching operations in the system
- Long lines in the system
- Environmental causes such as thunderstorms
- Overloads

Typical causes for internally created mains interference are e. g.:
- Thyristor-controlled drives
- Elevators, air conditions, copiers
- Motors, compensation equipment
- Electric welding, large machines
- Switching of lights

The mentioned types of mains voltage interference may occur separately or as a combination of several. Possible causes for interference and effects may be:

Mains interference	Percentage of total interference	Effect
Overvoltage Mains voltage is long-term exceeded by more than +6% (acc. to DIN IEC 60038)	Approx. 15 - 20 %	May lead to overheating or even thermal destruction of components. Causes complete failure.
Undervoltage Mains voltage falls long-term short of at least -10% (acc. to DIN IEC 60038)	Approx. 20 - 30 %	May lead to undefined operating statuses of the loads. Causes data failures.
Interfering impulses High-energy pulses (e. g. 700 V/1 ms) and low-energy transients (e. g. 2500 V/20µs) are produced by switching operations in the system	Approx. 30 - 35 %	May lead to undefined operating statuses of the loads and cause destruction of components.
Voltage dip and voltage surge The voltage level changes briefly and uncontrolled, e. g. caused by load change and long lines	Approx. 15 - 30 %	May lead to undefined operating statuses and to destruction of components. Causes data failures.
Electric noise Frequency spectrum interfering the mains caused by bad grounding and/or strong sources of HF noise, such as radio transmitters, thunderstorms	Approx. 20 - 35 %	May lead to undefined operating statuses of the loads. Causes data failures.
Voltage interruption Brief interruption of mains voltage (no more than approx. 10 ms), caused by short-circuit in neighboring systems or starting of large electric machines.	Approx. 8 - 10 %	May lead to undefined operating statuses of the loads, in particular of those lacking mains buffering. Causes data failures.
Voltage interruption Long interruption of mains voltage (more than approx. 10 ms)	Approx. 2 - 5 %	May lead to undefined operating statuses of the loads, in particular of those lacking mains buffering. Causes data failures.

Table 4 Types of mains interference and effects

The product range SITOP power offers multiple possibilities to minimize or eliminate risks of mains interference in the preliminary stage.

Mounting instructions, spaces and fixing options

Mounting instructions

All SITOP power and LOGO!Power supplies are built-in units. Except for versions in degree of protection IP 65 they should be mounted vertically so that air can flow unimpeded from below through the ventilation slots at the bottom of the unit out through the ventilation slots at the top. In case of mounting orientations other than vertical (at user's own risk), the ambient temperature should not exceed +45 °C and the load current should remain below approx. 50 % of the rated current. For versions in degree of protection IP 65, any mounting position is permissible. The minimum clearances above, below and to the side of each unit specified in the relevant instruction manual must be observed to ensure free air convection.

Mounting spaces and fixing options

Power supply	Order No.	Required mounting space in mm (W x H)	Mounting on DIN rail EN 50022 35 x 7.5 mm	35 x 15 mm	Wall mounting
SITOP power supplies					
SITOP power 24 V/0.5 A	6EP1331-2BA10	22.5 x 180	X	X	
SITOP power 24 V/0.375 A	6EP1731-2BA00	22.5 x 180	X	X	
SITOP power 24 V/2 A	6EP1331-2BA00	50 x 225	X	X	
	6ES7307-1BA00-0AA0	50 x 325		1)	
	6ES7305-1BA80-0AA0	80 x 325		1)	
	6EP1732-0AA00	80 x 235		X	X
SITOP power 24 V/2.5 A	6EP1332-1SH12	80 x 335		X	X
SITOP power 24 V/3.5 A	6EP1332-1SH31	160 x 280	X	X	X
SITOP power 24 V/4 A	6EP1332-1SH22	80 x 335		X	X
SITOP power 24 V/5 A	6EP1333-2BA00	75 x 225	X	X	
	6EP1333-2AA00	75 x 225	X	X	
	6ES7307-1EA80-0AA0	80 x 325		1)	
	6ES7305-1EA00-0AA0	80 x 325		1)	
	6EP1333-1AL11	260 x 330	X	X	
SITOP power 24 V/10 A	6EP1334-2BA00	100 x 225	X	X	
	6EP1334-2AA00	100 x 225	X	X	
	6EP1334-2CA00	160 x 290			X
	6ES7307-1KA00-0AA0	200 x 325		1)	
	6EP1334-1AL11	320 x 330	X	X	
	6EP1334-1SH01	200 x 325		X	
SITOP power 24 V/20 A	6EP1336-2BA00	320 x 225	X	X	
	6EP1536-2AA00	320 x 280	X	X	
SITOP power 24 V/10 A	6EP1434-2BA00	320 x 225	X	X	
SITOP power 24 V/20 A	6EP1436-2BA00	320 x 225	X	X	
	6EP1436-3BA00	160 x 225	X	X	
SITOP power 24 V/30 A	6EP1437-2BA00	320 x 280	X	X	
SITOP power 24 V/40 A	6EP1437-2BA10	320 x 280	X	X	
	6EP1437-3BA00	240 x 225	X	X	
SITOP power buffer module	6EP1961-3BA00	70 x 225	X	X	
SITOP power DC UPS 15	6EP1931-2EC01	75 x 225	X	X	
SITOP power DC UPS 15 with RS 232	6EP1931-2EC11	75 x 225	X	X	
SITOP power DC UPS 40	6EP1931-2FC01	280 x 290	X	X	
SITOP power battery module 2.5 Ah	6EP1935-6MD31	285 x 171	X	X	X
SITOP power battery module 3.2 Ah	6EP1935-6MD11	210 x 171	X	X	X
SITOP power battery module 7 Ah	6EP1935-6ME21	206 x 188			X
SITOP power battery module 12 Ah	6EP1935-6MF01	273 x 138			X
SITOP power 3 -52 V/120 W	6EP1353-2BA00	75 x 225	X	X	
SITOP power 2 x 15 V/3.5 A	6EP1353-0AA00	75 x 325	X	X	
SITOP power 30 V/2.4 A	6EP1632-1AL01	260 x 80			X
SITOP power 30 V/7 A	6EP1354-1AL01	200 x 325		X	

1) with additional mounting adapter

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Mounting spaces and fixing options, planning and design aids, parallel connection

Mounting spaces and fixing options (continued)

Power supply		Order No.	Required mounting space in mm (W x H)	Mounting on DIN rail EN 50022 35 x 7.5 mm	35 x 15 mm	Wall mounting
LOGO!Power supplies						
SITOP power	5 V/3 A	6EP1311-1SH01	72 x 110	X	X	
	12 V/1.9 A	6EP1321-1SH01	72 x 110	X	X	
	15 V/1.85 A	6EP1351-1SH01	72 x 110	X	X	
	24 V/1.3 A	6EP1331-1SH01	72 x 110	X	X	
	48 V/0.65 A	6EP1351-1SH11	72 x 110	X	X	
SITOP power	5 V/6.3 A	6EP1311-1SH11	126 x 110	X	X	
	12 V/4.5 A	6EP1322-1SH01	126 x 110	X	X	
	15 V/4 A	6EP1352-1SH01	126 x 110	X	X	
	24 V/2.5 A	6EP1332-1SH41	126 x 110	X	X	
	48 V/1.25 A	6EP1352-1SH11	126 x 110	X	X	

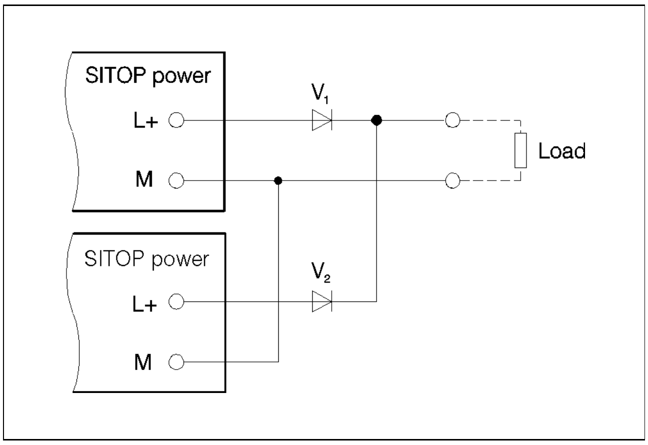
Planning and design aids

Instruction manuals containing mounting instructions, dimension drawings and basic connection diagrams with terminal markings are available for planning and design as downloads from the internet in different file formats (also for CAD applications). You can find the SITOP power homepage at:

• SITOP
www.siemens.de/sitop

Parallel connection for redundancy

Two SITOP power supplies of the same type can be connected in parallel via diodes (see figure: V1, V2) to achieve redundancy. 100 % redundancy of two SITOP power supplies can only be achieved if the total load current is not higher than the current one SITOP power can supply by itself and the supply at the primary side is also configured with redundancy (i. e. a primary-side short-circuit of the power supply does not trip a common circuit-breaker and thus disconnects both power supplies from the system).
Parallel connection with decoupling diodes for redundancy is permissible for all SITOP power supplies. The diodes V1 and V2 are used for decoupling. They should have a reverse voltage rating of at least 40 V and a current rating of at least the maximum output current of the connected SITOP power.



Two SITOP power supplies connected in parallel for redundancy

Parallel connection for increased output

For increased output, most of the SITOP power supplies can directly, i. e. without decoupling diodes, be connected in parallel to supplies of the same type (same principle as for connection in parallel for redundancy, but without decoupling diodes).

Advantage
Mechanical mounting of the diodes on heatsinks and considerable power loss of the decoupling diodes (current x diode conducting-state voltage drop) are avoided.
Types approved for direct connection in parallel can be found in the relevant technical specifications under "Output, parallel connection for increased output".

Prerequisite

- The output conductors connected to each SITOP power supply at the terminal L+ and M should feature the same length and cross-section (or same impedance) up to the external point of common coupling, if possible.
- SITOP power supplies connected in parallel should be switched on simultaneously with a common switch in the mains supply cable (e. g. with the main switch provided in control cabinets).
- The SITOP power output voltages measured with no load of supplies not yet connected in parallel must not differ by more than 50 mV.
  This usually corresponds to the default settings.
  In case the output voltage is changed on an adjustable SITOP power supply, the M terminals should be connected and the voltage difference measured with no load between the SITOP power output terminals L+, which are not yet connected.

  This voltage difference must not exceed 50 mV.

Parallel connection, General notes on the diodes

Parallel connection for redundancy and increased power

Almost 100 % redundancy

With the types permissible for direct parallel connection (refer to the relevant technical specifications under "Output, parallel connection for increased output"), the power output can be increased without decoupling diodes whilst simultaneously achieving almost 100 % redundancy. This is done by directly connecting an additional SITOP power supply of the same type in parallel to the SITOP power supply of the required rating, i. e. at least one SITOP power supply more than required for the total of all load currents.

The purpose of the decoupling diode usually required for redundancy is to prevent short-circuiting of the intact power supplies in the event of a power supply failure caused by a short-circuit at the output (especially a short-circuit of the output electrolytic capacitor).

However, this theoretical case is not to be expected with SITOP power in practice. Therefore, almost 100 % redundancy can be achieved with this circuit principle.

Example

Load current of up to 40 A is required. The power supply must be capable of operating in a three-phase 400 V as well as a 500 V system (without system transfer).

The three-phase SITOP power 20 A (Order No.: 6EP1436-2BA00) is suitable. For load currents of up to 40 A, direct parallel connection of two SITOP power 20 is required. By connecting a single additional SITOP power 20, increased output and redundancy are achieved at the same time (if one of the three power supplies no longer supplies an output voltage, the remaining two 20 A power supplies are sufficient to provide a total load current of 40 A).

General notes on the diodes

The diodes should be intended for maximum dynamic current. This may be the dynamic current for starting on short-circuit or the dynamic current in case of short-circuit in operation (the higher value of both should be taken from the relevant technical specifications).

To be able to dissipate the considerable power loss of the decoupling diodes (current x diode conducting-state voltage drop), the diodes must be equipped with adequately dimensioned heatsinks.

An additional safety reserve is useful, because the output capacitor in the SITOP power supply provides an additional peak current in case of a short-circuit. This additional current, however, lasts only for a few milliseconds and is therefore within a time range (< 8.3 ms, permissible surge current for diodes), during which diodes may be subjected to a multiple of their rated current.

Example 1

Two single-phase SITOP power with 10 A rated output current (Order No.: 6EP1334-2BA00) are connected in parallel. The dynamic current for starting on short-circuit is approx. 38 A for 200 ms.

Thus, for safety reasons the diodes should feature a current rating of 40 A, the heatsink should be rated at the maximum possible current of 21 A (RMS sustained short-circuit current) x diode conducting-state voltage.

Example 2

Two SITOP power with 40 A rated output current (Order No.: 6EP1437-2BA10) are connected in parallel. The dynamic current in case of short-circuit in operation is approx. 70 A for 600 ms, the RMS value is < 54 A.

Thus, for safety reasons, the diodes should feature a current rating of 100 A, the heatsink should be rated at the maximum possible continuous current (see technical specifications: current limitation) of 54 A x diode conducting-state voltage.

Diode type

For SITOP power 40 (also for SITOP power 10 A, 20 A and 30 A), for example, the ISOTOP module BYV 54V-50 (50 V reverse voltage) is suitable.

- Manufacturer: SGS Thomson
- Distributor: e. g. Spoerle

Advantage:

Each module contains two diodes isolated from each other and from the baseplate with a DC current rating $I_{F\,AV}$ of 50 A each; the RMS value $I_{F\,RMS}$ is 100 A. For current load of 55 A the voltage drop is only approx. 0.8 V.

Note:

The ISOTOP module

BYV 54V-200 (200 V reverse voltage), usually available from distributors, is also suitable.

Connection in series for increased voltage

To produce a load voltage of 48 V DC, up to two 24 V SITOP power supplies of the same type can be connected in series. The SITOP power outputs L+ and M are isolated from PE at a minimum of 60 V DC (clearances in air and leakage paths as well as RI suppression capacitors at L+ and M with respect to PE), so that there is a choice of grounding the following points for this type of series connection (see figure):

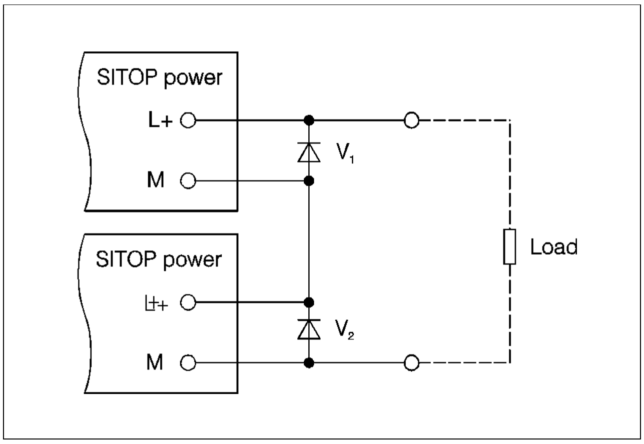
- M of the lower SITOP power (results in + 48 V DC in respect to PE)
- The middle M/L+ between both SITOP power (results in ± 24 V DC in respect to PE)
- L+ of the upper SITOP power (results in - 48 V DC in respect to PE)

Note:
In case of malfunctions, the continuously permissible SELV of a maximum of 60 V DC cannot be ensured for an in-series connection of two units.

The purpose of the diodes V1 and V2 is to protect the output electrolytic capacitor in the SITOP power from a reverse voltage > 1 V.

On account of the rise times which are not absolutely simultaneous (even when the units are activated with a common power switch, usually starting delay differences of some 10 ms may occur) the faster SITOP power unit supplies current from its L+ output to the M input of the slower unit, thus theoretically reversing the charge of its output electrolytic capacitor unacceptably.

Due to internal LC filters, the internal rectifier diode on the secondary side of the slower SITOP power receives this current a few milliseconds later so that the external diode of each SITOP power with its anode connected to M and cathode connected to L+ may never be omitted. These diodes, however, are only subjected to dynamic load so that the surge current rating of 8.3 ms (specified in the data sheets of suitable diodes) can serve as a basis for design rating and cooling of the diodes with heatsinks is usually not required.



Two SITOP power supplies connected in series for doubled voltage

Example
Two single-phase SITOP power supplies with 10 A rated output current (Order No.: 6EP1334-2BA00) are to be connected in series for increased output. They supply a dynamic current of approx. 38 A for 200 ms when starting on short-circuit (or e. g. load with high-capacitance input capacitor which initially represents a short-circuit).
An example for suitable diodes V1 and V2 is the SB 340 type[1)] (Schottky diode with axial leads, case DO-201AD with approx. 5.3 mm in diameter and approx. 9.5 mm case length).
The permissible reverse voltage is 40 V, the stationary DC current rating $I_{F\,AV}$ is 3 A, the dynamic surge current rating $I_{F\,SM}$ decisive in this case is above 100 A for 8.3 ms and therefore sufficient for SITOP power 10.
This diode [1)] may also be used for SITOP power supplies with lower rated output current (then, however, overrated).

- Manufacturer: General Instrument
- Distributor: e. g. RS Components Spoerle

Battery charging with SITOP power

In case of overload (e. g. discharged 24 V lead accumulator), the three-phase SITOP power 40 (Order No. 6EP1437-3BA00) with stabilized output voltage settable in the range of 24.0 to 28.8 V supplies a constant output current of approx. 43 A. If the V-I-current characteristic is set to parallel operation, the battery is charged with approx. 43 A constant current until approx. 95 % of the set SITOP output voltage is reached. Then the charging current decreases continuously from 43 A at 95 % of the set output voltage to approx. 0 A (or self-discharging current of the battery) at 100 % of the set output voltage (i. e. load line in this range).

We recommend to use a diode suitable for 43 A with at least 40 reverse voltage in series (anode connected to the +output of SITOP power, cathode to positive pole of the battery) for counter-voltage and reverse battery protection.

For an end-of-charge voltage of 27.0 V DC (usually at 20 °C to 30 °C battery temperature; however, manufacturer's specifications must be observed!) and e. g. 0.8 V voltage drop at the diode SITOP power has to be set to 27.8 V with no load.

General notes on using SITOP power as battery charger

When implementing SITOP power as battery charging device, the specifications of VDE 0510 or relevant national regulations must be observed. Furthermore, sufficient ventilation must be provided for the battery. SITOP power is designed as a built-in unit. It must therefore be mounted in an appropriate enclosure to provide protection.

The end-of-charge voltage should be set to the value recommended by the manufacturer (depending on the battery temperature). The ideal lead accumulator temperature is between +20 and 30 °C, the recommended end-of-charge voltage is then usually approx. 27 V.

1) We cannot take any responsibility for the diode recommendations set forth above.

Circuit-breakers in the 24 V DC output circuit, selectivity

Examples

With unstabilized rectifiers (power transformer equipped with rectifier) the output usually had to be protected with a suitable fuse so that its rectifier diodes would not fail in the event of an overload or a short-circuit (this would destroy the DC loads due to the resulting alternating voltage and lead to serious damage in most cases). Stabilized SITOP power supplies are equipped with an integrated electronic short-circuit protection complying with DIN VDE 0113 Part 1, Section 7.2.9 (November 1998) or EN 60204-1 relating to electric equipment of machines. In case of overload or a short-circuit it protects the SITOP power and the 24 V DC loads it automatically supplies against excess current.

Example 1: No fusing

Fusing the secondary side (24 V DC) for protecting the load circuits and lines is not required with SITOP power if the cross-sections are selected for the maximum possible RMS value of the SITOP power output current. Depending on the event (short-circuit or overload) this may either be the short-circuit RMS value or the current limitation value.

- Example SITOP power 20 (Order No.: 6EP1336-2BA00)
  - Rated current 20 A
  - Short-circuit RMS value < 22 A
  - Current limitation approx. 22 A

The technical specifications usually specify typical values, maximum values are approx. 2 A above the typical value.

- The example is calculated on the basis of approx. 22 A + 2 A = 24 A instead of the exact short-circuit RMS value/current-limitation value.

Example 2: Reduced cross-sections

If smaller cross-sections are used than specified in DIN VDE 0113 Part 1 or EN 60204-1, the 24 V loads must be provided with appropriate line protection (see DIN VDE 0113 Part 1 or EN 60204-1).

It is then of no importance whether SITOP power changes into switched-mode (low-impedance short-circuit) or not (overload only), because the load supply is reliably protected against an overload by the circuit-breaker in the line.

Example 3: Selectivity in case of malfunctions

In cases in which, for example, a load failing due to a short-circuit has to be detected quickly or interrupted selectively in any event before SITOP power changes to switched-mode operation (in switched-mode operation voltage would automatically be interrupted for all other 24 V DC loads for a few seconds until automatic restart) the electronic diagnosing module SITOP select (Order No.: 6EP1961-2BA00, see section 9) or suitable circuit breakers may be connected in series to the loads.

The basis for selecting the circuit-breaker is the short-circuit current - which is above the rated current - supplied by SITOP power in case of a short-circuit during operation for at least 100 ms without interruption (values can be found in the relevant technical specifications under "Output, dyn. V/I for short-circuit in operation").

It is not easy to specify the amount of the SITOP power short-circuit current flowing into the usually not ideal "short-circuit" and the amount flowing into the remaining loads.

Example 3a

The ideal case is a very low-impedance short-circuit, because almost the entire short-circuit current flows through the circuit-breaker and only a low current through the remaining loads.

Example 3b

The opposite is a rather high-impedance "short-circuit" or small overload, because the SITOP power output voltage does not drop considerably and therefore the remaining loads continue to consume almost the same current. Only the difference resulting from dyn. V/I minus rated current of the remaining loads is available for tripping the circuit-breaker.

Example 3c

The most common case in practice will usually be between case 3a (low-impedance short-circuit) and case 3b (small overload). For an approximation it can be assumed that the SITOP power output voltage drops to approx. 8 V during the "short-circuit" (this does not apply to particularly long load cables with small cross-section; in this case the resulting SITOP power output voltage should be calculated by multiplying $I_{\text{dyn. V/I}} \times R_{\text{total}}$. R_{total} results from the parallel connection of all connected load resistances with the conductor resistance of the short-circuit or from the reciprocal of all added load conductivity values).

Knowing the resulting SITOP power output voltage during the short-circuit, it is still not easy to specify the amount of current consumed by the remaining loads at the reduced voltage as at least three different cases must be distinguished:

- Ohmic loads

  They consume less current in proportion to the voltage, i. e. half the rated current at half the voltage, one third of the rated current at one third of the rated voltage.

- Inductive loads

  Even though the short-circuit causes the voltage to drop from 24 DC to e. g. 8 V DC, the current consumption initially remains the same, because the current cannot change suddenly in an inductive load. In practice inductive loads (e. g. contactors, solenoid valves etc.) have a copper wire resistance of the coil as resistive component reducing the current according to the known function i (t) = Δ V/R x $e^{-t/\tau}$. The resistance can be calculated with the rated current consumption (R = V/I_{rated}), the time constant is the ratio of inductance L/R. The inductance of such loads is usually not known (ask the manufacturer if necessary), most common are values in the 10 mH range.

  Typical example

  1.2 A rated current at 24 V DC → R = 24 V/1.2 A = 20 Ω.
  Inductance approx. 20 mH → time constant t = 20 mH/20 Ω = 1 ms. Voltage step of e. g. 24 V (low-impedance short-circuit) → after a time of e. g. 3 ms, the current in the inductive loads has dropped to the value = Δ V/R x $e^{-t/\tau}$ = 24 V/20 Ω x $e^{-t/\tau}$ = 1.2 A x $e^{-3\text{ ms}/1\text{ ms}}$ = I_{rated} x e^{-3} ≈ 0.05 x I_{rated}, or only 5 %.

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Examples (continued)

A delay of 3 ms can be neglected for the tripping of circuit-breakers so that typical ohmic-inductive loads can be treated as ohmic loads by approximation.

If, for example, the SITOP power output voltage drops from 24 V to 8 V, a typical ohmic-inductive resistor consumes only one third of the rated current after a few milliseconds.

- Capacitive/electronic loads
  Almost every electronic 24 V DC load (e. g. DC/DC converter 24 V DC to 5 V DC) features a capacitor in its input circuit for smoothing the input voltage and serving as a back-up capacitor or energy storage (usually some 100 to 10.000 μF aluminum electrolytic capacitors).
  If a short-circuit causes the SITOP power output voltage to drop suddenly, these electronic loads usually consume no current for approx. 10 to 20 ms, because the load back-up capacitor supplies the load. Typical circuit-breakers complying with IEC 898 (Siemens types) usually trip after approx. 12 ms (IEC 898 prescribes tripping after less than 100 ms) with corresponding excess current (10 times rated AC or approx. 14 times DC with Characteristic C, 5 times rated AC or approx. 7 times DC with Characteristic B, 3 times rated AC or approx. 5 times DC with Characteristic A). Thus, such electronic 24 V DC loads can almost be neglected. If, however, this n times rated current does not flow through the circuit-breaker to be tripped, such loads can by no means be neglected for the following reason. Up to the minimum permissible input voltage (usually approx. 18 V DC, in some cases approx. 10 V DC), electronic 24 V DC loads show static behavior like negative resistors; at half the input voltage they do not consume half the current (like a resistor), but twice the current.

Estimation for example 3c
The following values are assumed by approximation:

- SITOP power is loaded with the rated current or 100 % of the rated output power before the short-circuit (an additional safety reserve of 0.3 x rated output current for tripping circuit breakers is provided if the usual average of approx. 70 % of the rated output power is supplied).
- SITOP power output voltage drops to approx. 8 V during the short-circuit.
- An estimated 60 % of the loads are ohmic or ohmic-inductive. At approx. 8 V they consume only one third of their rated current so that approx. 20 % of the SITOP power rated output current still flow into these loads in case of a short-circuit.
- An estimated 40 % of the loads are electronic 24 V DC loads. If the current required for immediate tripping (typ. 12 ms tripping time with 14 times rated tripping DC in circuit-breakers of Characteristic C according to IEC 898 or 7 times rated tripping DC in circuit-breakers of Characteristic B or 5 times rated tripping DC in circuit-breakers of Characteristic A) starts to flow, these loads consume considerably less current on average during the first 12 ms.
  For safety reasons 30 % of the SITOP power rated output current are assumed for this calculation. Together with the 20 % assumed above for ohmic or ohmic-inductive loads, a total of 50 % of the SITOP power rated output current do not flow through the circuit-breaker to be tripped.

  Note: If the current required for immediate tripping (typ. 12 ms) does not reliably start to flow, these electronic loads consume up to twice the rated current (at 12 V) on average, so that for safety reasons 80 % of the SITOP power rated output current are assumed for the calculation in this case. Together with the 20 % assumed above for ohmic or ohmic-inductive loads, the total of 100 % of the SITOP power rated output current does not flow through the circuit-breaker to be tripped. As in example 3b, only the difference dyn. V/I minus rated current of the remaining loads is available for tripping the circuit-breaker.

Result for example 3c
(average case in practice)

- With immediate tripping (typ.12 ms tripping time at 14 times rated tripping DC in circuit-breakers of Characteristic C according to IEC 898 or 7 times rated tripping DC in circuit-breakers of Characteristic B or 5 times rated tripping DC in circuit-breakers of Characteristic A), the difference dyn. V/I minus 50 % of the SITOP power rated output current is available for tripping the circuit-breaker.
- With lower short-circuit current flowing through the circuit-breaker, only the difference dyn. V/I minus 100 % of the SITOP power rated output current should be taken as a basis for selecting the circuit-breaker for safety reasons.

  The same applies to rather high-impedance "short-circuits" (see example 3b).

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Circuit-breakers in the 24 V DC output circuit, selectivity

Selection

Procedure for selecting circuit-breakers for the 24 V DC output circuit

- The rated current of circuit-breakers according to IEC 898 should be as close as possible to or just above the maximum static load input current (see DIN VDE 0113 Part 1 or EN 60204-1).
  - Example
    Rated load current = 2.2 A,
    Maximum load input current = 2.8 A:
    3 A circuit-breaker.
  - Note
    The current consumed by 24 V DC loads on unstabilized power supplies can usually deviate by approx. 25 % from the rated value. By implementing SITOP power, this fluctuation range is reduced to only a few percent allowing for considerably better calculation. With SITOP power, the current consumption of most loads usually deviates by no more than 5 % from the rated value.
- Expected excess load currents should be covered by selecting the suitable tripping characteristic. For circuit-breakers according to IEC 898/EN 60898 (DIN VDE 0641 Part 11) the following applies in principle:
  - Low excess inrush load current = Characteristic A to B
  - High excess inrush load current = Characteristic C to D
  - Immediate tripping (< 100 ms, typ. 12 ms) should always be aimed at. In general, the difference dyn. V/I minus 50 % of the SITOP power rated output current is available for this purpose. Please refer to the following tables for suitable circuit-breakers.

Important
If the short-circuit current required for immediate tripping is not achieved, only the difference dyn. V/I minus 100 % of the SITOP power rated output current should be taken as the basis for safety reasons, in particular when connected electronic 24 V DC loads (e. g. DC/DC converter) consume a total of more than 30 % of the SITOP power rated output current. If this difference dyn. V/I minus 100 % of the SITOP power rated output current is not sufficient to trip the circuit-breaker within the time during which SITOP power supplies the current dyn. V/I without interruption (or switched-mode operation), there is no selectivity.

Order specifications and tripping characteristics for single-pole circuit-breakers 5SX2

According to IEC 898/EN 60898 (DIN VDE 0641 Part 11), suitable for up to 55 V DC (250 V AC, rated breaking capacity 6,000 A)

Rated current	Tripping characteristic	Order No.	Range of immediate tripping < 100 ms for operation with DC (AC)	Required DC for immediate tripping in < 100 ms	Required DC for immediate tripping in approx. 12 ms
1 A	**Type A**	**5SX2 101-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	2 to 5 A DC	**5 A** DC
1 A	Type C	**5SX2 101-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	5 to 14 A DC	14 A DC
1.6 A	**Type A**	**5SX2 115-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	3.2 to 8 A DC	**8 A** DC
1.6 A	Type C	**5SX2 115-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	8 to 22.4 A DC	22.4 A DC
2 A	**Type A**	**5SX2 102-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	4 to 10 A DC	**10 A** DC
2 A	Type C	**5SX2 102-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	10 to 28 A DC	28 A DC
3 A	**Type A**	**5SX2 103-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	6 to 15 A DC	**15 A** DC
3 A	Type C	**5SX2 103-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	15 to 42 A DC	42 A DC
4 A	**Type A**	**5SX2 104-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	8 to 20 A DC	**20 A** DC
4 A	Type C	**5SX2 104-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	20 to 56 A DC	56 A DC
6 A	**Type A**	**5SX2 106-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	12 to 30 A DC	**30 A** DC
6 A	**Type B**	**5SX2 106-6**	DC: 3 to 7 (AC: 3 to 5) x I_{rated}	18 to 42 A DC	**42 A** DC
6 A	Type C	**5SX2 106-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	30 to 84 A DC	84 A DC
10 A	**Type A**	**5SX2 110-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	20 to 50 A DC	**50 A** DC
10 A	Type B	**5SX2 110-6**	DC: 3 to 7 (AC: 3 to 5) x I_{rated}	30 to 70 A DC	70 A DC
10 A	Type C	**5SX2 110-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	50 to 140 A DC	140 A DC
16 A	Type A	**5SX2 116-5**	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	32 to 80 A DC	80 A DC
16 A	Type B	**5SX2 116-6**	DC: 3 to 7 (AC: 3 to 5) x I_{rated}	48 to 112 A DC	112 A DC
16 A	Type C	**5SX2 116-7**	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	80 to 224 A DC	224 A DC

Ordering specifications and tripping characteristic of Siemens single-pole circuit-breaker terminals type 8WA1 011-...

Suitable for up to 60 V DC (250 V AC)

The following space-saving circuit-breaker terminals for mere short-circuit protection can only be snap-mounted on DIN rail EN 50022-35x15. They are also available with an auxiliary switch (1 NO contact and 1 NC contact) and feature higher sensitivity than circuit breakers according to IEC 898 (EN 60898), type B.

Tripping times/ranges are within narrower tolerances than those of circuit breakers. When operated with DC, these circuit-breaker terminals do not trip at currents below the rated current, from 1.1 times the rated current, the circuit-breaker terminal may trip after as little as 100 ms.

The circuit-breaker rated value must therefore be above the load inrush current peak value. In general, however, the first three milliseconds of the load inrush current may be ignored, because no less than 20 to 100 times the rated current is required to trip the circuit-breaker terminals during this period of time.

- The circuit-breaker terminals already trip after 40 ms at 1.2 to 1.9 times of the rated DC.
- The circuit-breaker terminals already trip after 20 ms at 1.7 to 2.6 times of the rated DC.
- The circuit-breaker terminals already trip after 12 ms at 2.2 to 3.8 times of the rated DC.

For more detailed specifications refer to catalog NS K.

Rated current DC	Order No. without auxiliary switch	Order No. with auxiliary switch 1NO + 1NC	Required DC for immediate tripping in 40 ms	Required DC for immediate tripping in 20 ms	Required DC for immediate tripping in approx. 12 ms
2 A	**8WA1 011-1SF25**	**8WA1 011-6SF25**	2.4 to 3.8 A DC	3.4 to 5.2 A DC	4.4 to 7.6 A DC
4 A	**8WA1 011-1SF26**	**8WA1 011-6SF26**	4.8 to 7.6 A DC	6.8 to 10.4 A DC	8.8 to 15.2 A DC
6 A	**8WA1 011-1SF27**	**8WA1 011-6SF27**	7.2 to 11.4 A DC	10.2 to 15.6 A DC	13.2 to 22.8 A DC
10 A	**8WA1 011-1SF28**	**8WA1 011-6SF28**	12 to 19 A DC	17 to 26 A DC	22 to 38 A DC

Note:
The electronic diagnosis module SITOP select (Order No. 6EP1961-2BA00, see section 9) is also suitable for selective fusing of 24 V DC load circuits.

Circuit-breakers in the 24 V DC output circuit, selectivity

SITOP power/trippable circuit-breakers in the 24 V DC output circuit

Technical specifications

Type	5 A	10 A
Order No.	**6EP1 333-2BA00/ 6EP1 333-2AA00**	**6EP1 334-2BA00/ 6EP1 334-2AA00**
Input	Single-phase	
Rated voltage $V_{in\ rated}$	**120/230 V AC**	
Output	Stabilized, floating direct voltage	
Rated voltage $V_{out\ rated}$	24 V DC	24 V DC
Rated current $I_{out\ rated}$	5 A	10 A
Dyn. V/I with short-circuit in operation, typ.	20 A for 350 ms	38 A for 200 ms
Tripping of output m.c.b	The following are usually available for selective tripping in practice:	
SITOP, dyn. V/I –50 % $I_{out\ rated}$, typ.	17.5 A for 350 ms	33 A for 200 ms
CBs to IEC 898, type 5SX2 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC typ. after 12 ms)	
	1 A Type C (trips at 14 A DC typ. after 12 ms)	
	1.6 A Type A (trips at 8 A DC typ. after 12 ms)	
	–	1.6 A Type C (trips at 22.4 A DC typ. after 12 ms)
	2 A Type A (trips at 10 A DC typ. after 12 ms)	
	–	2 A Type C (trips at 28 A DC typ. after 12 ms)
	3 A Type A (trips at 15 A DC typ. after 12 ms)	
	–	4 A Type A (trips at 20 A DC typ. after 12 ms)
	–	6 A Type A (trips at 30 A DC typ. after 12 ms)
SIEMENS CB terminals, type 8WA1 011..., selectively trippable in approx. 12 ms	2 A Order No. 8WA1 011-1SF25 (trips at 7.6 A DC after 12 ms max.)	
	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after 12 ms max.)	
	–	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after 12 ms max.)
in 20 ms	–	10 A Order No. 8WA1 011-1SF28 (trips at 26 A DC after 20 ms max.)

Note

The electronic diagnosis module SITOP select (Order No. 6EP1961-2BA00, see section 9) is also suitable for selective fusing of 24 V DC load circuits.

SITOP power/trippable circuit-breakers in the 24 V DC output circuit

Technical specifications

Type	**20 A**	**40 A**
Order No.	**6EP1 436-2BA00**	**6EP1 437-2BA10**
Input	Three-phase	Three-phase
Rated voltage $V_{in\ rated}$	**400 to 500 V three-phase AC**	**400 to 500 V three-phase AC**
Output	Stabilized, floating direct voltage	
Rated voltage $V_{out\ rated}$	**24 V DC**	**24 V DC**
Rated current $I_{out\ rated}$	**20 A**	**40 A**
Dyn. V/I with short-circuit in operation, typ.	Constant current approx. 30 A	70 A for 600 ms
Tripping of output m.c.b	The following are usually available for selective tripping in practice:	
SITOP, dyn. V/I –50 % $I_{out\ rated}$, typ.	20 A (without interruption)	50 A for 600 ms
CBs to IEC 898, type 5SX2 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC typ. after 12 ms)	
	1 A Type C (trips at 14 A DC typ. after 12 ms)	
	1.6 A Type A (trips at 8 A DC typ. after 12 ms)	
	–	1.6 A Type C (trips at 22.4 A DC typ. after 12 ms)
	2 A Type A (trips at 10 A DC typ. after 12 ms)	
	–	2 A Type C (trips at 28 A DC typ. after 12 ms)
	3 A Type A (trips at 15 A DC typ. after 12 ms)	
	–	3 A Type C (trips at 42 A DC typ. after 12 ms)
	4 A Type A (trips at 20 A DC typ. after 12 ms)	
	–	6 A Type A (trips at 30 A DC typ. after 12 ms)
	–	6 A Type A (trips at 42 A DC typ. after 12 ms)
	–	10 A Type A (trips at 50 A DC typ. after 12 ms)
SIEMENS CB terminals, Type 8WA1 011..., selectively trippable in approx. 12 ms	2 A Order No. 8WA1 011-1SF25 (trips at 7.6 A DC after 12 ms max.)	
	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after 12 ms max.)	
	–	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after 12 ms max.)
	–	10 A Order No. 8WA1 011-1SF28 (trips at 38 A DC after 12 ms max.)

Note

The electronic diagnosis module SITOP select (Order No. 6EP1961-2BA00, see section 9) is also suitable for selective fusing of 24 V DC load circuits.

Circuit-breakers in the 24 V DC output circuit, selectivity

SITOP power/trippable circuit-breakers in the 24 V DC output circuit

Technical specifications

Type	20 A	40 A
Order No.	**6EP1 436-3BA00**	**6EP1 437-3BA00**
Input Rated voltage $V_{in\ rated}$	Three-phase **400 to 500 V three-phase AC**	Three-phase **400 to 500 V three-phase AC**
Output	Stabilized, floating direct voltage	
Rated voltage $V_{out\ rated}$	**24 V DC**	**24 V DC**
Rated current $I_{out\ rated}$	**20 A**	**40 A**
Dyn. V/I with short-circuit in operation, typ.	Approx. 60 A for 25 ms	Approx. 100 A for 25 ms
Tripping of output m.c.b	The following are usually available for selective tripping in practice:	
SITOP, dyn. V/I –50 % $I_{out\ rated}$, typ.	50 A for 25 ms	80 A for 25 ms
CBs to IEC 898, type 5SX2 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC typ. after 12 ms)	
	1 A Type C (trips at 14 A DC typ. after 12 ms)	
	1.6 A Type A (trips at 8 A DC typ. after 12 ms)	
	1.6 A Type C (trips at 22.4 A DC typ. after 12 ms)	
	2 A Type A (trips at 10 A DC typ. after 12 ms)	
	2 A Type C (trips at 28 A DC typ. after 12 ms)	
	3 A Type A (trips at 15 A DC typ. after 12 ms)	
	3 A Type C (trips at 42 A DC typ. after 12 ms)	
	4 A Type A (trips at 20 A DC typ. after 12 ms)	
	–	4 A Type C (trips at 56 A DC typ. after 12 ms)
	6 A Type A (trips at 30 A DC typ. after 12 ms)	
	6 A Type B (trips at 42 A DC typ. after 12 ms)	
	10 A Type A (trips at 50 A DC typ. after 12 ms)	
	–	10 A Type B (trips at 70 A DC typ. after 12 ms)
	–	16 A Type A (trips at 80 A DC typ. after 12 ms)
SIEMENS CB terminals, Type 8WA1 011..., selectively trippable in approx. 12 ms	2 A Order No. 8WA1 011-1SF25 (trips at 7.6 A DC after 12 ms max.)	
	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after 12 ms max.)	
	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after 22,8 ms max.)	
	10 A Order No. 8WA1 011-1SF28 (trips at 38 A DC after 12 ms max.)	

Note

The electronic diagnosis module SITOP select (Order No. 6EP1961-2BA00, see section 9) is also suitable for selective fusing of 24 V DC load circuits.

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