Power supplies general

Power supplies

In plant construction or mechanical engineering, or in any other situations in which electrical controls are used, a safe and reliable power supply is needed to supply the process with power.

The functional reliability of electronic controls and therefore the reliable operation of automated installations is extremely closely linked to the resistance of the load power supply to failure. Final control elements as well as input and output modules will only respond to command signals if the power supply is operating reliably.

In addition to general requirements such as reliability, particular demands are placed on the electromagnetic compatibility (EMC) of the power supply with reference to the tolerance range of the output voltage as well as its ripple.

Important factors that determine problem-free implementation are, in particular:

- An input current with a low harmonic content
- Low emitted interference and
- Adequate immunity (noise immunity) to interference

EMC	Types of interference
Emission (emitted interference)	Interference caused by television and radio reception Interference coupling with data lines or power supply cables
Immunity (immunity to interference)	Faults on the power cable due to switching non-resistive loads such as motors or contactors Static discharge due to lightning strikes Electrostatic discharge through the human body Conducted noise induced by radio frequencies

Certain disturbing phenomena

General notes on DC power supplies

The DC power supply is a static device with one or more inputs and one or more outputs that converts a system of AC voltage and AC current and/or DC voltage and DC current to a system with different values of DC voltage and DC current by means of electromagnetic induction for the purpose of transmitting electrical energy.

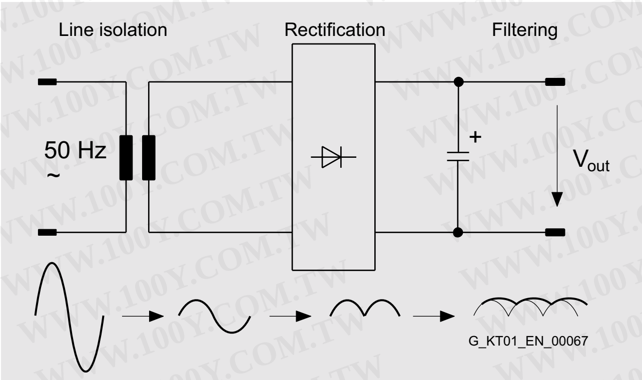
The type of construction of a DC power supply is usually decided by its intended use.

Unstabilized DC power supplies

The AC mains voltage is transformed using 50 Hz/60 Hz safety transformers to a protective extra-low voltage and smoothed with down-circuit rectification and capacitor filtering.

In the case of unstabilized DC power supplies, the DC output voltage is not stabilized at a specific value, but the value is varied in accordance with the variation in (mains) input voltage and the loading.

The ripple is in the Volt range and is dependent on the loading. The value for the ripple is usually specified as a percentage of the DC output voltage level. Unstabilized DC power supplies are characterized by their rugged, uncomplicated design that is limited to the important factors and focussed on a long service life.



Block diagram of an unstabilized power supply

Stabilized DC power supplies

Stabilized DC power supplies have electronic regulation circuits that maintain the DC voltage at the output at a specific value with as little variation as possible. Effects such as variation in input voltage or changes in load at the output are electrically compensated in the specified function area.

The ripple in the output voltage for stabilized DC power supplies lies in the millivolt range and is mainly dependent on the loading at the outputs.

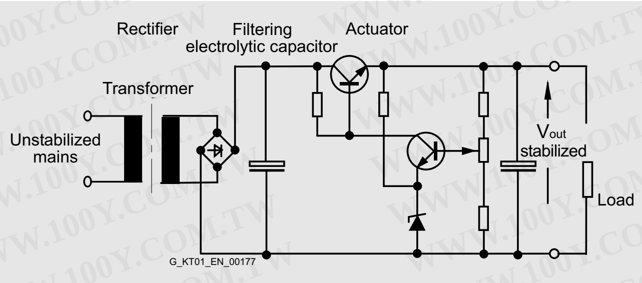
Stabilized DC power supplies can be implemented on different functional principles. The most common types of circuit are:

- Linear stabilized power supplies
- Magnetic voltage stabilizer
- Secondary pulsed switched-mode power supplies
- Primary pulsed switched-mode power supplies

The most suitable principle for a particular application case will depend mainly on the application. The objective is to generate a DC voltage to supply the specific load as inexpensively and as accurately as possible.

Stabilized DC power supplies (continued)

Linear stabilized power supplies



Block diagram: Linear regulator

The linear regulator operates according to a conventional principle. The supply is provided from an AC supply system (one, two or three conductor supply).

A transformer is used to adapt it to form the required secondary voltage.

The rectified and filtered secondary voltage is converted into a stabilized voltage at the output by a regulation section. The regulation section comprises a final control element and a control amplifier. The difference between the stabilized output voltage and the unstabilized voltage at the filter capacitor is converted into a thermal loss in the final control element. The final control element functions in this case like a rapidly changeable ohmic impedance. The thermal loss that arises in each case is the product of output current and voltage drop over the final control element.

This system is extremely adaptable. Even without any further modifications, several output voltages are possible. In the case of multiple outputs, the individual secondary circuits are generated from separate secondary windings of the input transformer. Some applications can only be resolved in accordance with this circuit principle. Especially when highly accurate regulation, minimal residual ripple and fast compensation times are required.

The efficiency is, however, poor and the weight and volume are considerable. The linear regulator is therefore only an economical alternative at low power ratings.

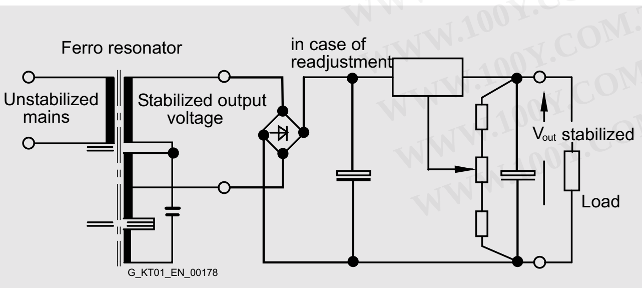
Advantages:

- Simple, well-proven circuit principle
- Good to excellent control characteristics
- Fast settling time

Disadvantages:

- Relatively high weight and large volume due to the 50 Hz transformer
- Poor efficiency, heat dissipation problems
- Low storage time

Magnetic stabilizer



Block diagram: Magnetic stabilizer

The complete transformer comprises two components. The so-called "ferro resonator" and a series connected auxiliary regulation section. The input winding and the resonance winding of the magnetic stabilizer are decoupled to a large extent by means of the air gap. The magnetic stabilizer supplies a well-stabilized AC voltage. This is rectified and filtered. The transformer itself is operated in the saturation range.

The ferro resonator frequently has a linear regulator connected to the output to improve the control accuracy. Secondary pulsed switched-mode regulators are frequently also connected to the output.

The magnetic stabilizer technique is reliable and rugged but is also large-volume, heavy and relatively expensive.

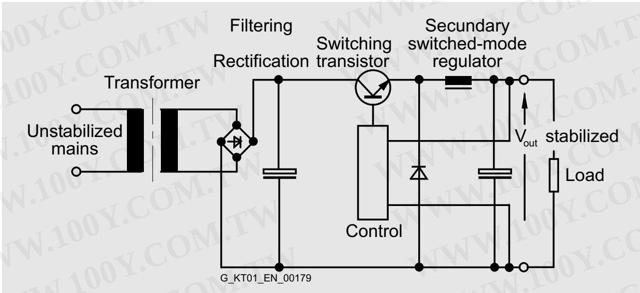
Advantages:

- Good to excellent control characteristics in combination with series connected linear regulators
- Significantly better efficiency than a linear regulator alone

Disadvantages:

- The ferro resonator is frequency dependent
- The power supplies are large and heavy due to the magnetic components

Secondary pulsed switched-mode power supplies:



Block diagram: Secondary pulsed switched-mode power supply

Isolation from the supply system is implemented in this case with a 50 Hz transformer. Following rectification and filtering, the energy is switched at the output by means of pulsing through a switching transistor in the filtering and storage circuit. Thanks to the transformer at the input, that acts as an excellent filter, the mains pollution is low.
The efficiency of this circuit is extremely high.

This concept offers many advantages for power supplies with numerous different output voltages.

To protect the connected loads, however, care must be taken; in the event of the switching transistor breaking down, the full, unstabilized DC voltage of the filter capacitor will be applied to the output. This danger, however, also exists in the case of linear stabilized power supplies.

Advantages:

- Simple design and high efficiency
- Multiple outputs, also galvanically isolated from one another, are easily implemented by means of several secondary windings
- Fewer problems with interference than with primary pulsed switched-mode power supplies

Disadvantages:

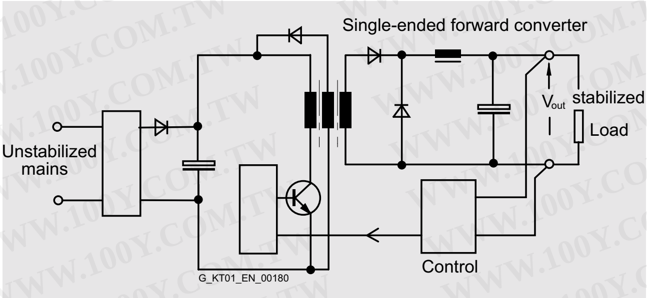
- The 50 Hz transformer makes the power supplies relatively large and heavy
- The output ripple (spikes) correspond to those of a primary pulsed switched-mode power supply

Stabilized DC power supplies

Stabilized DC power supplies (continued)

Primary pulsed switched-mode power supplies:

In other literature, the term SMPS (Switch Mode Power Supply) or primary switched-mode regulator is often used.



Block diagram: Single-ended forward converter

The primary switched-mode regulators are available in many different circuit variants. The most important basic circuits are single-ended forward converters, flyback converters, half-bridge converters, full-bridge converters, push-pull converters and resonance converters.

The general principle of operation of the primary switched-mode regulator is shown in the block diagram of the single-ended forward converters.

The unstabilized supply voltage is first rectified and filtered. The capacitance of the capacitor in the DC link determines the storage time of the power supply on failure of the input voltage. The voltage at the DC link is approximately 320 V DC for a 230 V supply. A single-ended converter is then supplied with this DC voltage and transfers the primary energy through a transformer to the secondary side with the help of a pulse width regulator at a high switching frequency. The switching transistor has low power losses when functioning as a switch, so that the power balance lies between > 70 % and 90 % depending on the output voltage and current.

The volume of the transformer is small in comparison with a 50 Hz transformer due to the high switching frequency because the transformer size taking into account the higher switching frequency is smaller. Using modern semiconductors, switching frequencies of 100 kHz and above can be achieved. At excessively high switching frequencies, the switching losses increase, so that in each case a compromise has to be made between a high efficiency and the largest possible switching frequency. In most applications, the switching frequencies lie between 20 kHz and 250 kHz depending on the output power.

The voltage from the secondary winding is rectified and filtered. The system deviation at the output is fed back to the primary circuit through an optocoupler. By controlling the pulse width (conducting phase of the switching transistor in the primary circuit), the necessary energy is transferred to the secondary circuit and the output voltage is regulated. During the non-conducting phase of the switching transistor, the transformer is demagnetized through an auxiliary winding. Just enough energy is transferred as is removed at the output.
The maximum pulse width for the pulse/pause ratio for these circuits is < 50 %.

Advantages:

- Small magnetic components (transformer, storage reactor, filter) thanks to the high operating frequency
- High efficiency thanks to pulse width regulation
- Compact equipment units
- Forced-air cooling is not necessary up to the kW range
- High storage times are possible on mains failure by increasing the capacitance in the DC link
- Larger input voltage range is possible

Disadvantages:

- High cost circuit, many active components
- Higher costs for interference suppression
- The mechanical design must be in accordance with HF criteria

Primary switched-mode power supplies have become more and more popular over the last few years. Especially due to the small size, low weight, high efficiency and excellent price/performance ratio.

Summary

The most important characteristics of the circuit types described above are summarized in Table 2.

	Circuit types			
Comparison criteria	**Primary switched-mode**	**Secondary switched-mode**	**Linear regulator**	**Magnetic stabilizer**
Input voltage range	Very large	Medium	Very small	Large
Regulation speed	Medium	Medium	Very fast	Slow
Storage time after power failure	Very long	Long	Very short	Long
Residual ripple	Medium	Medium	Very low	Medium
Power loss	Very small	Small	Large	Very small
Frame size	Very small	Medium	Very large	Large
Weight	Very light	Medium	Heavy	Very heavy
Interference suppression costs	Very large	Medium	Low	Medium

Comparison criteria for basic circuit variants

14

Supply system data

When dimensioning and selecting plant components, the mains data, mains conditions and the operating modes must be taken into account for these components.

The most important data for a supply system is the rated voltage and rated frequency. These data for the supply system are designated as rated values in accordance with international agreements.

Rated voltage and rated frequency

Since May 1987, the standard DIN IEC 60038 "IEC rated voltages" has been applicable in the Federal Republic of Germany.

The international standard IEC 60038, Edition 6, 1983, "IEC standard voltages" has been included in this standard unmodified.

The IEC 60038 standard is the result of an international agreement to reduce the diverse rated voltage values that are in use for electrical supply networks and traction power supplies, load installations and equipment.

Conversion of low-voltage supply systems

In the low-voltage range, it is emphasized in IEC 60038 that 220/380 V and 240/415 V voltage values for three-phase electricity supplies have been replaced by a single internationally standardized value of 230/400 V.

The tolerances for the rated voltages of the supply systems that were specified for the transition period up to 2003 were intended to ensure that equipment rated for the previous voltages could be operated safely until the end of its service life.

Year	Rated voltage	Tolerance range
Up to 1987	220 V/380 V	-10 % to +10 %
From 1988 to 2003	230 V/400 V	-10 % to + 6 %
From 2003	230 V/400 V	-10 % to +10 %

Conversion of low-voltage supply systems

The IEC recommendations have been implemented as national regulations in the most important countries, as far as the conditions in the country allow.

International supply voltages and frequencies in low-voltage supply systems

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
Russian Federation	50 Hz 230/400 – 690[1] V
Croatia	50 Hz 230/400 V
Poland	50 Hz 230/400 V
Rumania	50 Hz 230/400 V
Serbia	50 Hz 230/400 V
Slovakia	50 Hz 230/400 – 500[1] – 690[1] V
Slovenia	50 Hz 230/400 V
Chechnya	50 Hz 230/400 – 500[1] – 690[1] V
Hungary	50 Hz 230/400 V

1) Industry only.
2) No further expansion.
3) From 2003.

Mains specifications, line-side connection

International supply voltages and frequencies in low-voltage supply systems (continued)

Country	Mains voltage
Middle-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: remainder only)
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; Fujayrah; Ras al Khaymah; Sharjah; Um al Qaywayn)	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 (in 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
South Honshu, Shikoku, Kyushu, Hokkaido, North Honshu	60 Hz 110/220 – 440[1)] V
Cambodia	50 Hz 120/208 V – Phnom Penh 220/238 V
Korea (North)	60 Hz 220/380 V
Korea (South)	60 Hz 100/200[2)] – 220/380 – 440[1)] V
Malaysia	50 Hz 240/415 V
Peoples Republic of 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

1) Industry only.
2) No further expansion.

International supply voltages and frequencies in low-voltage supply systems (continued)

Country	Mains voltage
Central America (continued):	
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
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 – 254/4401) – 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
Guyana	50 Hz 110/220 V (Georgetown), 60 Hz 110/220 – 240/480 V
Columbia	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

1) Industry only.
2) No further expansion.

Mains specifications, line-side connection

International supply voltages and frequencies in low-voltage supply systems (continued)

Country	Mains voltage
Africa (continued)**:**	
Nigeria	50 Hz 220/415 V
Rwanda	50 Hz 220/380 V
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

Connection and fusing on the line side

All SITOP and LOGO!Power supplies are built-in devices. For installation of the devices, the relevant DIN/VDE specifications or country-specific regulations must be taken into account. The supply voltage must be connected in accordance with VDE 0100 and VDE 0160. On installation, protective gear and isolating gear must be provided for disconnecting the power supply.

Power supply units cause a current inrush immediately after application of the input voltage due to charging of the load capacitor; it soon falls back to the rated input current level after a few milliseconds. Aside from the internal impedances of the power supply, the current inrush is largely dependent on the size of the input voltage applied as well as the source impedance of the supply network and the line impedance of the supply line. The maximum current inrush for SITOP power supplies is specified in the applicable technical data. It is important for dimensioning up-circuit protective devices.

Single-phase SITOP and LOGO!Power supplies are equipped with internal device protection (fuses). For connection to the supply system, only one protective device (fuse or circuit-breaker) must be provided for conductor protection in accordance with the current rating of the installed cable. The circuit-breakers recommended in the data sheets and operating instructions have been selected such that even during the maximum current inrush that can occur under worst case conditions on switching on the supply voltage, the circuit-breaker will not trip.

Three-phase SITOP power supplies do not have internal device protection. The up-circuit protective device (three-phase coupled miniature circuit-breaker or motor protection switch) protects the cables and devices. The protective devices specified in the data sheets and operating instructions are optimized to the characteristics of the relevant power supplies.

14

1) Industry only.

Overview

The quality of the mains voltage has become a decisive factor in the functioning, reliability, maintenance costs and service life of highly sensitive electronic installations and devices (computers, industrial controls, instrumentation, etc.).

Mains disturbances cause system failures and affect the function of plants as well as electronic consumers. They can also result in total failure of the installation or equipment.

The most frequent types of disturbance are:

- Long-term overvoltages
- Long-term undervoltages
- Burst interference and transients
- Voltage reduction and surges
- Electrical noise
- Momentary mains breaks
- Long-term mains breaks

Mains disturbances can be caused by a number of things, e.g.:

- Switching operations in the supply system
- Long cable paths in the supply system
- Environmental influences, such as storms
- Mains overloads

Typical causes of mains disturbances generated in-house are:

- Thyristor-controlled drives
- Lifts, air-conditioning, photocopiers
- Motors, power factor correction equipment
- Electrical welding, large machines
- Switching of lighting equipment

Disturbances in mains voltages can occur individually or in combination. Possible reasons for these disturbances and reactions can be:

Mains disturbances	Percentage of total disturbance	Effect
Overvoltage Over a long period, the mains voltage is exceeded by more than +6% (acc. to DIN IEC 60038)	approx. 15% - 20%	Can result in overheating and even thermal destruction of individual components. Causes total failure.
Undervoltage Over a long period, the mains voltage is reduced by more than 10% (acc. to DIN IEC 60038)	approx. 20% - 30%	Can result in undefined operating states for loads. Causes data errors.
Burst interference Energy-rich impulses (e.g. 700 V/1 ms) and energy-poor transients (e.g. 2500 V/20 µs) result from switching operations in the supply system	approx. 30% - 35%	Can result in undefined operating states for the loads and can lead to the destruction of components.
Voltage reduction and surges The voltage level changes suddenly and in an uncontrolled manner, e.g. due to changes in loading and long cable runs	approx. 15% - 30%	Can result in undefined operating states and destruction of components. Causes data errors.
Electrical noise A mix of frequencies superimposed on the mains due to bad grounding and/or strong HF emitters, such as television transmitters or storms	approx. 20% - 35%	Can result in undefined operating states for loads. Causes data errors.
Voltage interruption Short-term interruption of the mains voltage (up to 10 ms), due to short-circuiting in neighboring supply systems or starting of large electrical machines	approx. 8% - 10%	Can result in undefined operating states for loads especially those with insufficient mains buffering. Causes data errors.
Voltage interruption Long interruption of the mains voltage (longer than 10 ms)	approx. 2% - 5%	Can result in undefined operating states for loads especially those with insufficient mains buffering. Causes data errors.

Mains disturbances and effects

The SITOP product family offers a range of possibilities for minimizing or preventing the risk of mains disturbances at the planning stage.

Mounting, Mounting areas and fixing options

Mounting

All SITOP and LOGO!Power supplies are built-in devices. With the exception of the variants with IP65 degree of protection, the power supplies must be mounted vertically so that the air can enter the ventilation slots at the bottom of the devices and leave through the upper part of the devices. If the units are not mounted vertically (at your own risk), the ambient temperature should not exceed +45 °C and the load current should not exceed approx. 50% of the rated current value. Variants with IP65 degree of protection can be mounted in any mounting position. The minimum distances specified in the corresponding operating manual for the top, bottom, and side of the devices must be observed to ensure free air convection.

Mounting areas and fixing options

Power supply	Order No.	Required mounting area in mm (W x H)	Mounting on a standard rail acc. to DIN EN 50022		Wall mounting
			35 x 7.5 mm	35 x 15 mm	
SITOP power 24 V, one-phase and two-phase power supplies					
24 V/0.5 A	6EP1331-2BA10	22.5 x 180	X	X	
24 V/0.375 A	6EP1731-2BA00	22.5 x 180	X	X	
24 V/2 A	6EP1331-2BA00	50 x 225	X	X	
	6ES7307-1BA00-0AA0	50 x 205		1)	
	6ES7305-1BA80-0AA0	80 x 225		1)	
	6EP1732-0AA00	80 x 235		X	X
24 V/2.5 A	6EP1332-1SH12	80 x 335		X	X
24 V/3.5 A	6EP1332-1SH31	160 x 280	X	X	X
24 V/4 A	6EP1332-1SH22	80 x 335		X	X
24 V/5 A	6EP1333-3BA00	70 x 225	X	X	
	6EP1333-2BA00	75 x 225	X	X	
	6EP1333-2AA00	75 x 225	X	X	
	6ES7307-1EA00-0AA0	80 x 205		1)	
	6ES7307-1EA80-0AA0	80 x 225		1)	
	6EP1333-1AL12	160 x 230	X	X	
24 V/10 A	6EP1334-3BA00	90 x 225	X	X	
	6EP1334-2BA00	100 x 225	X	X	
	6EP1334-2AA00	100 x 225	X	X	
	6EP1334-2CA00	160 x 290			X
	6ES7307-1KA01-0AA0	120 x 205		1)	
	6EP1334-1AL12	160 x 230	X	X	
	6EP1334-1SH01	200 x 325		X	
24 V/20 A	6EP1336-3BA00	160 x 225	X	X	
	6EP1336-2BA00	320 x 225	X	X	
	6EP1536-2AA00	320 x 280	X	X	
24 V/40 A	6EP1337-3BA00	240 x 225	X	X	
SITOP power 24 V, three-phase power supplies					
24 V/10 A	6EP1434-2BA00	320 x 225	X	X	
24 V/20 A	6EP1436-3BA00	160 x 225	X	X	
	6EP1436-2BA00	320 x 225	X	X	
24 V/30 A	6EP1437-2BA00	320 x 280	X	X	
24 V/40 A	6EP1437-3BA00	240 x 225	X	X	
	6EP1437-2BA10	320 x 280	X	X	
SITOP power 24 V, uninterruptible power supplies					
DC UPS 6 A (with serial interface / USB interface)	6EP1931-2DC21 (-2DC31/-2DC41)	50 x 225	X	X	
DC UPS 15 A (with serial interface / USB interface)	6EP1931-2EC21 (-2EC31/-2EC41)	50 x 225	X	X	
DC UPS 40 A	6EP1931-2FC01	280 x 290	X	X	

Power supply	Order No.	Required mounting area in mm (W x H)	Mounting on a standard rail acc. to DIN EN 50022 35 x 7.5 mm	35 x 15 mm	Wall mounting
SITOP power 24 V, uninterruptible power supplies					
Battery module 2.5 Ah	6EP1935-6MD31	285 x 171	X	X	X
Battery module 3.2 Ah	6EP1935-6MD11	210 x 171	X	X	X
Battery module 7 Ah	6EP1935-6ME21	206 x 188			X
Battery module 12 Ah	6EP1935-6MF01	273 x 138			X
SITOP power 24 V, additional components					
Buffer module	6EP1961-3BA00	70 x 225	X	X	
Redundancy module	6EP1961-3BA20	70 x 225	X	X	
Diagnosis module	6EP1961-2BA00	72 x 190	X	X	
SITOP power alternative voltages					
3-52 V/120 W	6EP1353-2BA00	75 x 225	X	X	
2 x 15 V/3.5 A	6EP1353-0AA00	75 x 325	X	X	
48 V/20 A	6EP1457-3BA00	240 x 255	X	X	
SITOP power AS interface					
30 V/2.4 A	6EP1632-1AL01	260 x 80			X
30 V/7 A	6EP1354-1AL01	200 x 325		X	
LOGO!Power supplies					
5 V/3 A	6EP1311-1SH02	54 x 130	X	X	
12 V/1.9 A	6EP1321-1SH02	54 x 130	X	X	
15 V/1.9 A	6EP1351-1SH02	54 x 130	X	X	
24 V/1.3 A	6EP1331-1SH02	54 x 130	X	X	
5 V/6.3 A	6EP1311-1SH12	72 x 130	X	X	
12 V/4.5 A	6EP1322-1SH02	72 x 130	X	X	
15 V/4 A	6EP1352-1SH02	72 x 130	X	X	
24 V/2.5 A	6EP1332-1SH42	72 x 130	X	X	
24 V/4 A	6EP1332-1SH51	90 x 130	X	X	

1) With an additional mounting adapter.

Planning aids

For planning and construction, operating manuals with mounting options, dimension drawings, and principle circuits with pin names in different file formats (suitable for CAD applications) are available for download on the Internet.

Additional information is available in the Internet under:

http://www.siemens.com/automation/sitop

Parallel connection for redundant operation and performance enhancement

Parallel connection for redundant operation

Two SITOP power supplies of the same type can be connected in parallel through diodes for a redundant configuration. Hundred percent redundancy only exists for two power supplies when the total load current is no higher than that which one power supply can supply alone and when the supply for the primary side is also implemented redundantly (i.e. a short-circuit on the primary side will not trigger a shared fuse which would disconnect both power supplies from the mains).

Parallel connection with decoupling diodes for redundant operation is permitted for all SITOP power supplies. The diodes V1 and V2 are used for decoupling. They must have a blocking voltage of at least 40 V and it must be possible to load them with a current equal to or greater than the maximum output current of the respective SITOP power supply. For diode dimensioning, see the following note "General information on selection of diodes".

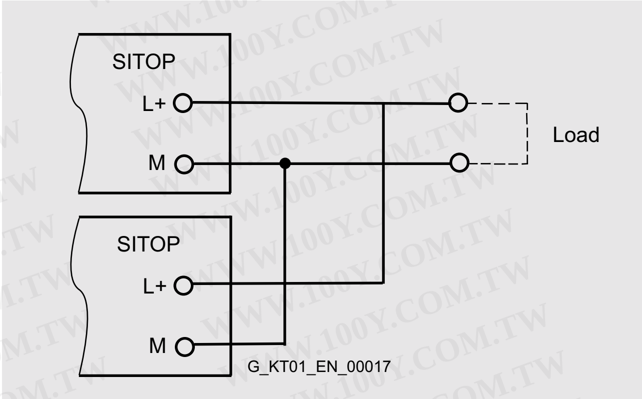
As a simple alternative to diode dimensioning, the prepared add-on module "SITOP modular redundancy module" (Order No. 6EP1961-3BA20, see Section 8) is available for redundant connection of two power supplies.

General information on selection of diodes:

The diodes must be dimensioned for the maximum dynamic current. This can be the dynamic current during power-up in the short-circuit case or the dynamic current during a short-circuit in operation (the largest of the two values should be taken from the relevant technical specifications).

To dissipate the significant power losses of the decoupling diodes (current x diode conductive-state voltage), the diodes must be mounted on suitably dimensioned heat sinks.

An additional safety margin is recommended, because the output capacitor integral to the power supply generates an additional peak current in the short-circuit case. This additional current flows only for a few milliseconds which is a period (< 8.3 ms, so-called permissible surge current for diodes) in which diodes are permitted to be loaded with a multiple of the rated current.



Parallel connection of two SITOP power supplies for redundant operation

Example 1

Two single-phase SITOP modular power supplies with 10 A rated output current (Order No.: 6EP1334-3BA00) are connected in parallel. The dynamic current in the event of a short-circuit during operation is approx. 30 A for 25 ms.

The diodes should therefore have a loading capability of 40 A to be safe, the common heat sink for both diodes must be dimensioned for the maximum possible current of approx. 24 A (RMS sustained short-circuit current) x diode conductive-state voltage.

Example 2

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

The selected diodes should therefore have a loading capability of 100 A to be safe, the heat sink per diode must be dimensioned for the continuous possible current of 54 A x diode conductive-state voltage.

14

Parallel connection for performance enhancement

To enhance performance, identical types of most SITOP power supplies can be connected in parallel galvanically (the same principle as parallel connection for redundant operation, but without decoupling diodes):

Advantage

The costs for mounting the diodes onto heat sinks and the not insignificant power losses of the decoupling diodes (current x diode conducting-state voltage) are avoided.

The types permitted for direct galvanic parallel connection are listed in the relevant technical specifications under "Output, parallel connection for performance enhancement".

Precondition

- The output cables connected to terminals L+ and M of every SITOP power supply should be installed with an identical length and cross-section (or the same impedance) to the common external linking point.
- The SITOP power supplies connected in parallel must be switched simultaneously using a common switch in the mains supply line (e.g. using the main switch available in control cabinets).
- The output voltages of the power supplies must be measured under no-load operation before they are connected in parallel and are permitted to differ by up to 50 mV. This usually corresponds to the factory default setting. If the output voltage is changed in the case of variable power supplies, the M terminals should first be connected and then the voltage difference between the L+ output terminals measured under no-load conditions before these are connected. This voltage difference must not exceed 50 mV.

Note

With a direct galvanic connection in parallel of more than two SITOP power supplies, further circuit measures may be necessary for short-circuit and overload protection!

Parallel connection for redundant operation and for performance enhancement

Almost 100% redundancy

Using the types permitted for direct galvanic parallel connection (see the relevant technical specifications under "Output, parallel connection for performance enhancement"), the performance can be increased without the need for decoupling diodes and redundancy of almost 100% can be implemented by direct galvanic parallel connection of an additional power supply of the same type to the power supplies required to satisfy the performance requirements. This means that at least one more power supply is required than is necessary for the sum of all load currents.

A decoupling diode is normally required for redundancy to ensure that a power supply that has failed as a result of short-circuiting of the outputs (especially as a result of short-circuiting the output electrolytic capacitor) does not also short-circuit the power supply that remains intact. A redundancy of almost 100% can be implemented with this type of circuit.

Example

A load current of up to 40 A is required, the power supply must operate on both 400 V and 500 V three-phase supplies (without switch-over).

The three-phase 20 A SITOP modular power supply (Order No.: 6EP1436-3BA00) is suitable for this purpose. For load currents up to 40 A, direct galvanic parallel connection of two SITOP modular power 20 supplies is necessary. By connecting another SITOP modular 20 in parallel, performance enhancement and redundancy are implemented simultaneously (if one of the three power supplies fails to supply an output voltage, the remaining two 20 A power supplies are capable of supplying a total load current of 40 A).

Note

With a direct galvanic connection in parallel of more than two SITOP power supplies, further circuit measures may be necessary for short-circuit and overload protection!

Series connection to increase the voltage

Series connection to increase the voltage

To generate a load voltage of e.g. 48 V DC, two 24 V SITOP power supplies of the same type can be connected in series. The SITOP outputs L+ and M are isolated up to at least 60 V DC against PE (air gaps and creepage distances as well as radio interference suppression capacitors on L+ and M against PE), so that with this type of series connection (see Figure), the following points can be earthed:

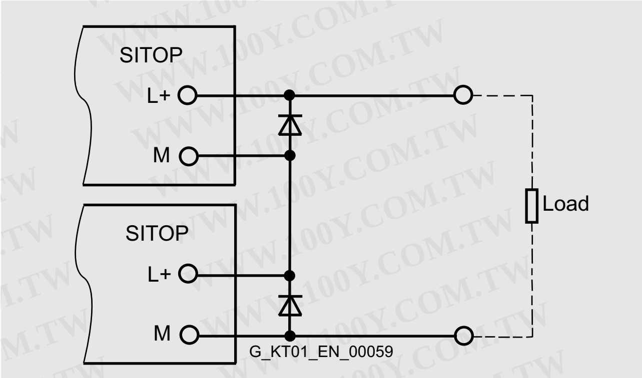
- M of the lower power supply (results in +48 V DC against PE)
- Midway M/L+ between both power supplies (results in ± 24 V DC against PE)
- L+ of the upper power supply (results in – 48 V DC against PE)

Note:

If two devices are connected in parallel, it cannot be guaranteed that the voltage will remain below maximum permissible SELV voltage of 60 V DC in the event of a fault.

The purpose of diodes V1 and V2 is to protect the electrolytic output capacitor integrated in the power supply against reverse voltages > 1 V. As a result of the not absolutely simultaneous power-up (even when a common mains switch is used for switching on, differences of a few tens of milliseconds can occur between the various start-up delays), the SITOP power which starts up more quickly supplies current from output L+ to the M output of the slower SITOP power whose output electrolytic capacitor is then theoretically impermissibly discharged.

The internal LC filter causes the internal rectifier diode on the secondary side to accept this current a few milliseconds later; this means that the external diode connected with its anode to M and cathode to L+ is essential on each power supply. These diodes are, however, only loaded dynamically, so the 8.3 ms surge current loading capability (specified in the data sheets for suitable diodes) can be used as a basis for dimensioning and it is not usually necessary to cool the diodes using heat sinks.



Series connection: Two SITOP power supplies for doubling the voltage

Example:

Two single-phase SITOP power supplies with 10 A rated output current (Order No.: 6EP1334-2BA00) should be connected in series to increase the voltage. They supply approximately 38 A dynamically for 200 ms on power-up in the short-circuit case or e.g. also with loads with a high-capacitance input capacitor that momentarily act as a short-circuit at the start.

Suitable diodes for V1 and V2 are, for example, of Type SB 340 [1)] (Schottky diode in axially wired enclosure DO-201AD with approx. 5.3 mm diameter and approx. 9.5 mm length of body).

40 V are permissible as the blocking voltage, and the stationary direct current load capacity $I_{F\ AV}$ is 3 A. The important dynamic surge current loading capacity $I_{F\ SM}$ important in this case is sufficient for the selected SITOP power supply (more than 100 A for 8.3 ms). For SITOP power supplies with a low rated output current, this diode can also be used, but is over-dimensioned.

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

14

1) We do not accept any liability for this diode recommendation.

Battery charging with SITOP power supplies

The SITOP modular power supplies 5 A to 40 A with stabilized output voltage that can be set between 24.0 V and 28.8 V supply a constant output current of approximately 1.2 x rated current under overload conditions (e.g. a completely discharged 24 V lead-acid battery). In the case of a V/I characteristic set for parallel operation, the battery will be charged with a constant current until approximately 95% of the set SITOP output voltage has been achieved. The charging current is then continuously reduced from 1.2 x rated current at 95% of the set voltage to approx. 0 A or the self-discharge current of the battery at 100% of the set output voltage, i.e. resistance characteristic in this range.

As reverse voltage protection and polarity reversal protection, we recommend that a diode suitable for at least 1.2 x rated current of the power supply with a blocking voltage of at least 40 V is connected in series with the + output (anode connected to + output of the SITOP modular and cathode connected to positive pole of the battery).

The output voltage of the power supply must be set at no-load to the end-of-charge voltage plus the voltage drop at the diode. For an end-of-charge voltage of e.g. 27.0 V DC (usual at 20 °C to 30 °C battery temperature; in each case, compliance with the specifications of the battery manufacturer must be observed!) and 0.8 V voltage drop at the diode, SITOP modular must be set to 27.8 V during no-load operation.

General note for using SITOP power supplies as a battery charging unit

When SITOP modular is used as a battery charging unit, the regulations of VDE 0510 or the relevant national regulations must be observed and adequate ventilation must be provided. The SITOP modular power supplies are designed as rack-mounting units, and protection against electric shock should therefore be provided by installation in an appropriate housing.

The value recommended by the battery manufacturer must be set as the end-of-charge voltage (depending on the battery temperature). An ideal temperature for the lead-acid battery is between +20 and 30 °C and the recommended end-of-charge voltage in this case is usually about 27 V.

Fusing of 24 V power supply circuits and selectivity

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).

On the other hand, the stabilized SITOP power supplies comply with the standard applicable to the electrical equipment of machines DIN VDE 0113 Part 1, Section 7.2.9 (November 1998) or EN 60204-1 and are provided with integral electronic short-circuit protection which automatically protects both the power supply and the supplied 24 V DC circuits against an excess current in the event of an overload/short-circuit. A differentiation must be made between the following three cases with respect to fusing on the secondary side:

Example 1: No fusing

Fusing the secondary side (24 V DC) for protecting the load circuits and lines is not required if the respective cross-sections are selected for the maximum possible output current RMS value. 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 10 (Order No.: 6EP1334-2BA00)

- Rated current 10 A
- Current limitation typ. 13 to 15 A
- Short-circuit RMS value < 21 A

The technical specifications usually specify typical values, maximum values are approx. 2 A above the typical value. In the example here, a maximum possible output current RMS value of approx. 23 A must therefore be used for line dimensioning.

Example 2: Reduced cross-sections

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

It is then unimportant whether the power supply enters current limiting mode (overload) or delivers the maximum short-circuit current (low-resistance short-circuit). The load supply line is in any case protected against an overload by the line protection matched to the conductor cross-section.

Example 3: Selectivity

In cases where a load which has failed (e.g. because of a short-circuit) has to be rapidly detected or where it is essential to selectively switch it off before the power supply enters current limiting mode (with current limiting mode, the voltage would also fall for all remaining 24 V DC loads), there are two possibilities for the secondary side connection.

- **Use of a 4-channel electronic diagnosis module SITOP select (Order No.: 6EP1961-2BA00), with a current adjustable from 2 A to 10 A for each channel**
- Series connection of appropriate 24 V DC fuses or circuit-breakers

The basis for selection of the 24 V DC fuse or circuit-breaker is the short-circuit current above the rated current which the SITOP power supplies deliver in the event of a short-circuit during operation (values are specified in the respective technical specifications under "Output, dynamic V/I on short-circuit during operation").

It is not easy to calculate the amount of the short-circuit current flowing into the usually not ideal "short-circuit" and the amount flowing into the remaining loads. This depends on the type of overload (high-resistance or low-resistance short-circuit) and the type of load connected (resistive, inductive and capacitive/electronic loads).

However, it can be assumed with a first approximation in the average case encountered in practice that the difference of dyn. V/I minus 50% SITOP rated output current is available for the immediate tripping of a circuit-breaker within a typical time of 12 ms (with 14 times the rated DC with a circuit-breaker characteristic C acc. to IEC 898 or with 7 times the rated DC with a circuit-breaker characteristic B or with 5 times the rated DC with a circuit-breaker characteristic A). Please refer to the following tables for circuit-breakers appropriate for selected fusing according to this assumption.

Fusing of the output circuit 24 V DC, selectivity

List of ordering data and tripping characteristics of single-pole circuit-breakers 5SY4...

acc. to IEC 898/EN 60898 (DIN VDE 0641 Part 11), for use up to 60 V DC (250 V AC, switching capacity 10,000 A)

Rated current	Tripping characteristic	Order No.	Range for immediate tripping < 100 ms for operation with direct current (alternating current)	Required DC for immediate tripping in < 100 ms	Required DC for immediate tripping in approx. 12 ms
1 A	Type A	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 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	5SY4 106-7	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	30 to 84 A DC	84 A DC
8 A	Type A	5SY4 108-5	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	16 to 40 A DC	40 A DC
8 A	Type C	5SY4 108-7	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	40 to 112 A DC	112 A DC
10 A	Type A	5SY4 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	5SY4 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	5SY4 110-7	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	50 to 140 A DC	140 A DC
13 A	Type A	5SY4 113-5	DC: 2 to 5 (AC: 2 to 3) x I_{rated}	26 to 65 A DC	65 A DC
13 A	Type B	5SY4 113-6	DC: 3 to 7 (AC: 3 to 5) x I_{rated}	39 to 91 A DC	91 A DC
13 A	Type C	5SY4 113-7	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	65 to 182 A DC	182 A DC
16 A	Type A	5SY4 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	5SY4 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	5SY4 116-7	DC: 5 to 14 (AC: 5 to 10) x I_{rated}	80 to 224 A DC	224 A DC

Ordering data and tripping characteristics 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 50 022-35x15. They are also available with an auxiliary switch (1 NO contact and 1 NC contact) and feature higher sensitivity than circuit breakers acc. to IEC 898 (EN 60 898), 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 the rated DC.
- The circuit-breaker terminals already trip after 20 ms at 1.7 to 2.6 times the rated DC.
- The circuit-breaker terminals already trip after 12 ms at 2.2 to 3.8 times the rated DC.

Ordering data and tripping characteristics of Siemens single-pole circuit-breaker terminals type 8WA1 011-...				
Rated current DC	2 A	4 A	6 A	10 A
Order No. (without auxiliary switch)	**8WA1 011-1SF25**	**8WA1 011-1SF26**	**8WA1 011-1SF27**	**8WA1 011-1SF28**
Order No. (with auxiliary switch 1 NO + 1 NC)	**8WA1 011-6SF25**	**8WA1 011-6SF26**	**8WA1 011-6SF27**	**8WA1 011-6SF28**
Required DC for immediate tripping in 40 ms	2.4 to 3.8 A	4.8 to 7.6 A	7.2 to 11.4 A	12 to 19 A
Required DC for immediate tripping in 20 ms	3.4 to 5.2 A	6.8 to 10.7 A	10.2 to 15.6 A	17 to 26 A
Required DC for immediate tripping in approx. 12 ms	4.4 to 7.6 A	8.8 to 15.2 A	13.2 to 22.8 A	22 to 38 A

For more data, refer to catalog "Industrial switchgear" (Catalog LV 10)

Fusing of the output circuit 24 V DC, selectivity

Miniature circuit-breakers in 24 V DC circuits which are powered by SITOP power supply units

Technical specifications		
Type	**5 A**	**10 A**
Order No.	**6EP1 333-2BA00/ 6EP1 333-2AA00**	**6EP1 334-2BA00/ 6EP1 334-2AA00**
Input	Single-phase	Single-phase
Rated voltage $V_{in\ rated}$	**120/230 V AC**	**120/230 V AC**
Output	Stabilized, floating direct voltage	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 approximately 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 5SY4 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC after typ. 12 ms) 1 A Type C (trips at 14 A DC after typ. 12 ms) 1.6 A Typ A (trips at 8 A DC after typ. 12 ms)	
	-	1.6 A Type C (trips at 22.4 A DC after typ. 12 ms)
	2 A Type A (trips at 10 A DC after typ. 12 ms)	
	-	2 A Type C (trips at 28 A DC after typ. 12 ms)
	3 A Type A (trips at 15 A DC after typ. 12 ms)	
	-	4 A Type A (trips at 20 A DC after typ. 12 ms)
	-	6 A Type A (trips at 30 A DC after typ. 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 max. 12 ms)	
	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after max. 12 ms)	
	-	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after max. 12 ms)
in 20 ms	-	10 A Order No. 8WA1 011-1SF28 (trips at 26 A DC after max. 12 ms)

Miniature circuit-breakers in 24 V DC circuits which are powered by SITOP power supply units

Technical specifications		
Type	**5 A**	**10 A**
Order No.	**6EP1 333-3BA00**	**6EP1 334-3BA00**
Input	Single-phase, two-phase	Single-phase, two-phase
Rated voltage $V_{in\ rated}$	**120/230-500 V AC**	**120/230-500 V AC**
Output	Stabilized, floating direct voltage	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.	15 A for 25 ms	30 A for 25 ms
Tripping of output m.c.b	The following are approximately available for selective tripping in practice	
SITOP, dyn. V/I - 50% $I_{out\ rated}$, typ.	12.5 A for 25 ms	25 A for 25 ms
CBs to IEC 898, type 5SY4 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC after typ. 12 ms)	
	-	1 A Type C (trips at 14 A DC after typ. 12 ms)
	1.6 A Type A (trips at 8 A DC after typ. 12 ms)	
	-	1.6 A Type C (trips at 22.4 A DC after typ. 12 ms)
	2 A Type A (trips at 10 A DC after typ. 12 ms)	
	-	3 A Type A (trips at 15 A DC after typ. 12 ms)
	-	4 A Type A (trips at 20 A DC after typ. 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 max. 12 ms)	
	-	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after max. 12 ms)
	-	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after max. 12 ms)
in 20 ms	4 A Order No. 8WA1 011-1SF26 (trips at 10.7 A DC after max. 20 ms)	-

Fusing of the output circuit 24 V DC, selectivity

Miniature circuit-breakers in 24 V DC circuits which are powered by SITOP power supply units

Technical specifications		
Type	**20 A**	**40 A**
Order No.	**6EP1 436-2BA00**	**6EP1 437-2BA10**
Input	Three-phase	Single-phase, two-phase
Rated voltage $V_{in\ rated}$	**400-500 V 3 AC**	**400-500 V AC**
Output	Stabilized, floating direct voltage	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. 30 A constant current	70 A for 600 ms
Tripping of output m.c.b	The following are approximately 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 5SY4 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC after typ. 12 ms)	
	1 A Type C (trips at 14 A DC after typ. 12 ms)	
	1.6 A Type A (trips at 8 A DC after typ. 12 ms)	
	-	1.6 A Type C (trips at 22.4 A DC after typ. 12 ms)
	2 A Type A (trips at 10 A DC after typ. 12 ms)	
	-	2 A Type C (trips at 28 A DC after typ. 12 ms)
	3 A Type A (trips at 15 A DC after typ. 12 ms)	
	-	3 A Type C (trips at 42 A DC after typ. 12 ms)
	4 A Type A (trips at 20 A DC after typ. 12 ms)	
	-	6 A Type A (trips at 30 A DC after typ. 12 ms)
	-	6 A Type B (trips at 42 A DC after typ. 12 ms)
	-	8 A Type A (trips at 40 A DC after typ. 12 ms)
	-	10 A Type A (trips at 50 A DC after typ. 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 max. 12 ms)	
	4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after max. 12 ms)	
	-	6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after max. 12 ms)
	-	10 A Order No. 8WA1 011-1SF28 (trips at 38 A DC after max. 12 ms)

14

Miniature circuit-breakers in 24 V DC circuits which are powered by SITOP power supply units

Technical specifications		
Type	**20 A**	**40 A**
Order No.	**6EP1 436-3BA00 (6EP1 336-3BA00)**	**6EP1 437-3BA00 (6EP1 337-3BA00)**
Input	Three-phase (single-phase)	Three-phase (single-phase)
Rated voltage $V_{in\ rated}$	**400-500 V 3 AC (120/230 V AC)**	**400-500 V 3 AC (120/230 V AC)**
Output	Stabilized, floating direct voltage	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. 120 A for 25 ms
Tripping of output m.c.b	The following are approximately available for selective tripping in practice	
SITOP, dyn. V/I - 50% $I_{out\ rated}$, typ.	50 A for 25 ms	100 A for 25 ms
CBs to IEC 898, type 5SY4 1.., selectively trippable in approx. 12 ms	1 A Type A (trips at 5 A DC after typ. 12 ms) 1 A Type C (trips at 14 A DC after typ. 12 ms) 1.6 A Type A (trips at 8 A DC after typ. 12 ms) 1.6 A Type C (trips at 22.4 A DC after typ. 12 ms) 2 A Type A (trips at 10 A DC after typ. 12 ms) 2 A Type C (trips at 28 A DC after typ. 12 ms) 3 A Type A (trips at 15 A DC after typ. 12 ms) 3 A Type C (trips at 42 A DC after typ. 12 ms) 4 A Type A (trips at 20 A DC after typ. 12 ms)	
	-	4 A Type C (trips at 56 A DC after typ. 12 ms)
	6 A Type A (trips at 30 A DC after typ. 12 ms) 6 A Type B (trips at 42 A DC after typ. 12 ms)	
	-	6 A Type C (trips at 84 A DC after typ. 12 ms)
	8 A Type B (trips at 40 A DC after typ. 12 ms) 10 A Type A (trips at 50 A DC after typ. 12 ms)	
	-	10 A Type B (trips at 70 A DC after typ. 12 ms)
	-	13 A Type A (trips at 65 A DC after typ. 12 ms)
	-	13 A Type B (trips at 91 A DC after typ. 12 ms)
	-	16 A Type A (trips at 80 A DC after typ. 12 ms)
	-	20 A Type A (trips at 100 A DC after typ. 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 max. 12 ms) 4 A Order No. 8WA1 011-1SF26 (trips at 15.2 A DC after max. 12 ms) 6 A Order No. 8WA1 011-1SF27 (trips at 22.8 A DC after max. 12 ms) 10 A Order No. 8WA1 011-1SF28 (trips at 38 A DC after max. 12 ms)	