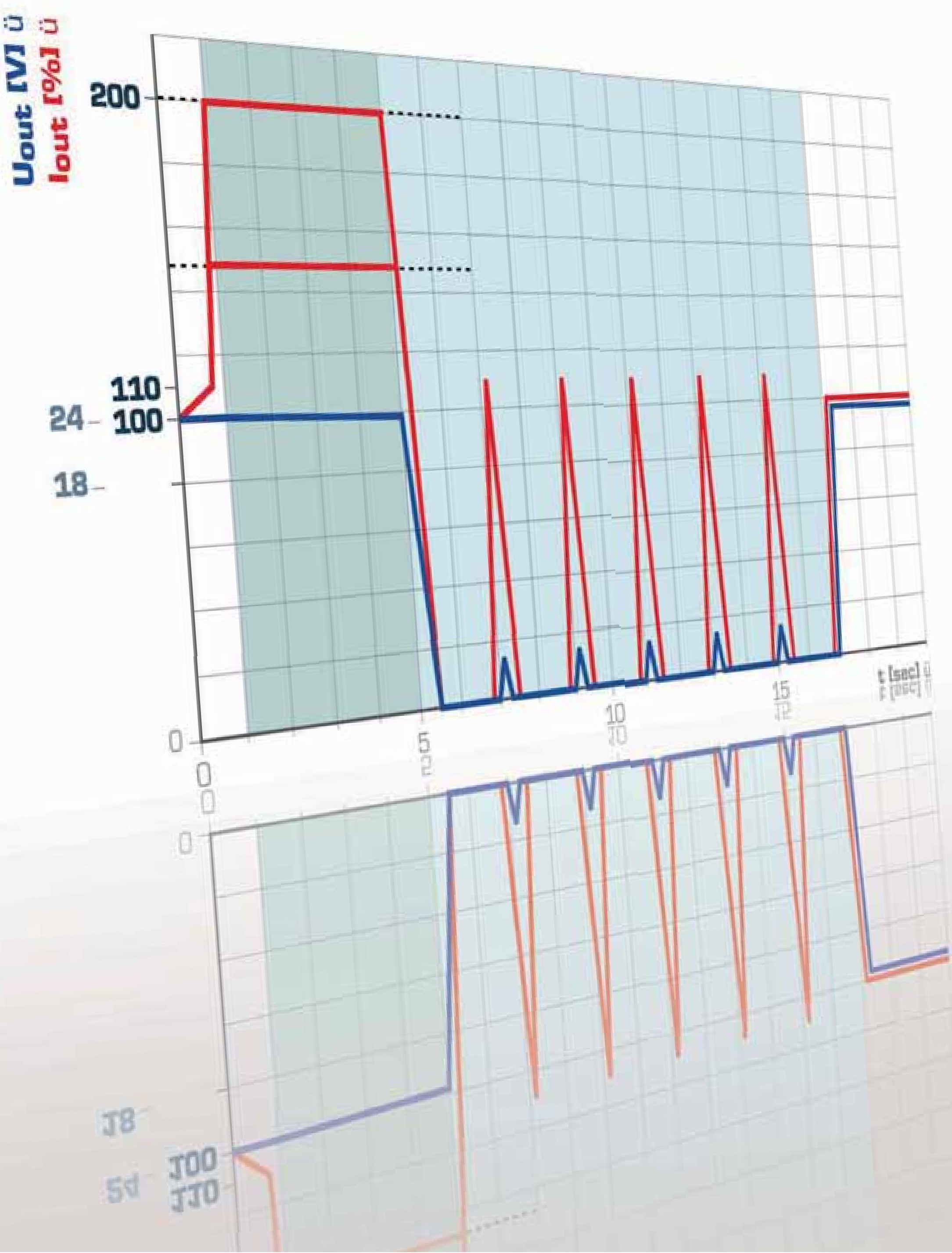
Technical informations

Content



POWER VISION

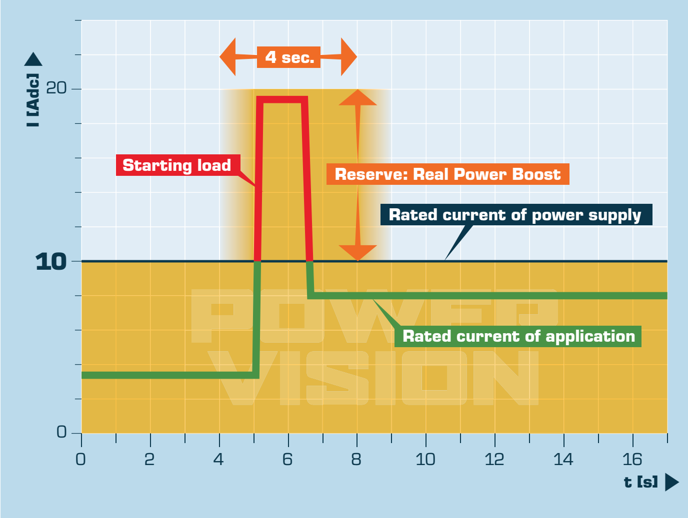
powerful
comprehensive
communicative
programmable
energy-efficient

The perfect
power supply system

Real Power Boost: For reliable starting up to 200 % power reserve

Conventional switch mode power supplies typically set current limiting at 1.1 times the rated output current. The use of these power supplies becomes very problematic as soon as heavystarting loads are switched in, since these power supplies are not able to make available suffi cient current for them. The PowerVision series has power reserves which can make available twice the current at constant voltage for at least 4 seconds. This makes for reliable operation and removes the need for expensive overdimensioning of switch mode power supplies.

Heavy-starting motors and drives (as here in the case of a robot-controlled production facility) require power supplies with high power reserves.



Heavy starting: In rated operation, power can be supplied to the system via a switch mode power supply without problems. However, should a more powerful drive start up, there will be a transient increase in power requirement which goes way above the rated current of the power supply. In order to prevent the supply voltage failing completely, the power supply could be overdimensioned. However, BLOCK's PowerVision with real power boost is a more appropriate solution.

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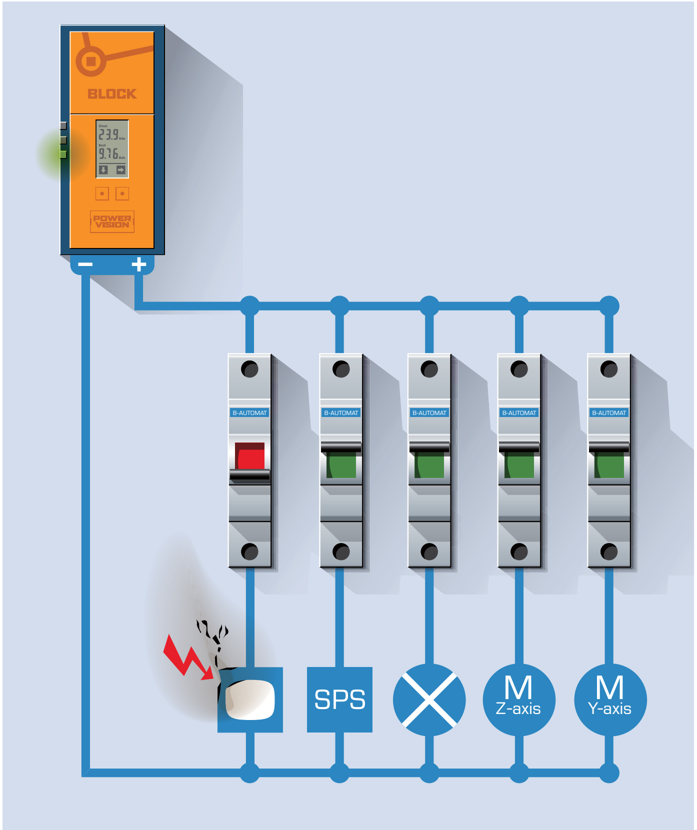
Ingenious proportions and three mounting options

All PowerVision devices are slim, compact and easy to mount. The mounting system has been developed specifically for PowerVision. In addition to the standard 35mm DIN rail mounting snap device integrated into the rear of the unit, the customer also has the possibility to mount it at a 90° angle to the mounting surface, either on a 35 mm DIN rail using the PV-TS35M or screwed directly to the wall with the PV-WB2. This allows a very high flexibility in wiring cabinet installation. Also the direct insert cage clamp terminals that ensure a permanent connection even when under vibration, makes installation even easier. Furthermore, all devices share the same structural shape. This creates more space and transparency in the wiring cabinet.

Top Boost: +60 A additional reserve
Cost-effective protection in the form of miniature circuit breakers

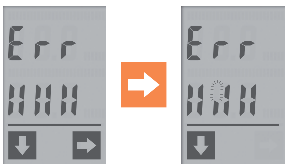
In automation technology, the system availability rates required today are generating increased overheads with regard to protection devices for 24 V load circuits. Previously, it was not possible to shut down faulty current paths selectively using conventional miniature circuit breakers, since the required high tripping current could not be provided by the switch mode power supplies. With its stabilised switch mode power supplies, BLOCK can provide a solution offering up to 60 A in excess of the rated current in the event of a short circuit. The proven short circuit and line protection provided by cost-effective miniature circuit breakers is also suitable for use with switch mode power supplies.

PowerVision's integrated top boost function provides a reliable means of tripping low-cost miniature circuit breakers.



In order for high-speed magnetic miniature circuit breakers to trip, urrents which are signifi cantly higher than the rated current are required for a period of 10 to 12 milliseconds. BLOCK's switch mode power supplies are able to supply a powerful 60 A above the rated current for 50 ms. This enables a faulty branch to be shut down selectively in the event of a short circuit whilst the remaining consumers continue to run unaffected.

Fault memory

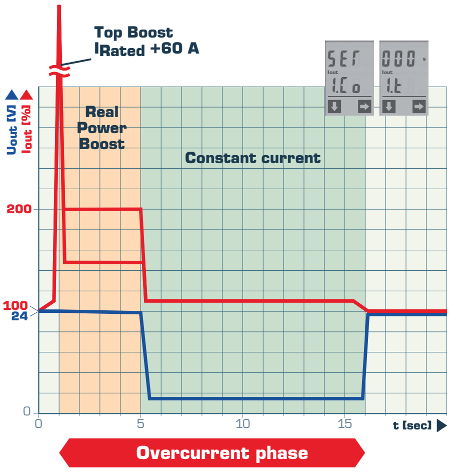


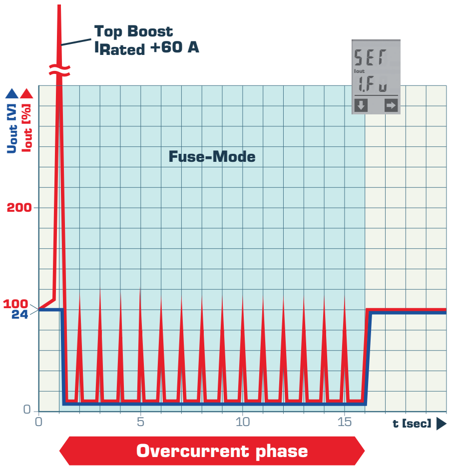
Critical operational statuses are detected by the internal electronics and memorised. The device features an integrated fault manager for self-diagnostics.

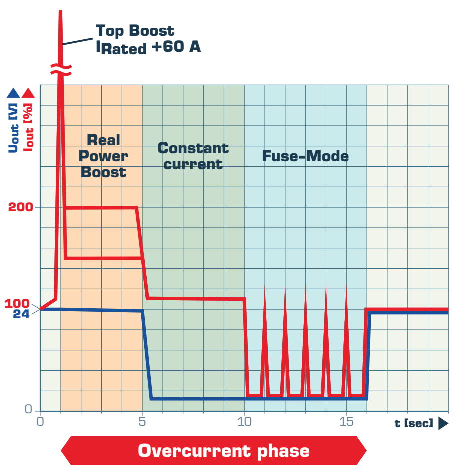
Possible errors and faults can be identifi ed by matching the flashing segments on the display to the corresponding error code. Since fault diagnostics data is saved to non-volatile memory, it will be retained even in the event of the power supply being disconnected.

Configurable overcurrent behaviour

On the Basic and Line models of the PowerVision switch mode power supplies, the output characteristics can be adapted to the most diverse requirements of a system or machine. Three different characteristics can be set.







1. permanent constant current

In constant current mode, in the event of overload following power boost, the output current is typically limited to 110 % of the rated current with simultaneously lowered output voltage.

2. permanently reduced current

In fuse mode, the output current is reduced markedly. However, the switch mode power supply does not switch off here. The display, signal outputs and the interface continue working. After around one second, the device attempts to restart the connected consumers. This procedure is repeated until the overload or short circuit has been eliminated.

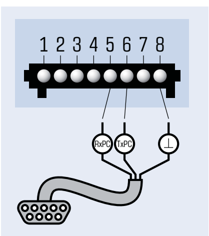
3. time-limited constant current

The switch mode power supply initially operates in constant current mode for a time that can be specifi ed. Once the specifi ed time has elapsed, the device switches to fuse mode and remains in this mode until the overload has been eliminated.

*Instead of the fuse mode, the semi-stabilised switch mode power supplies have a hiccup mode, during which the output of the devices is switched off. The display, signal outputs and the interface are also switched off.

RS-232-Schnittstelle

All PowerVision devices fitted with a serial interface can communicate with a PC or higher-level control system. Key data and possible faults are sent cyclically by the devices. Accordingly, the interface also provides a means of respondi-ng to critical operational statuses quickly. Furthermore, many parameter settings can be made via the interface. The software packages can be downloaded free of charge from the Internet. The communication cable (PV-KOK2) can be purchased as an accesso-ry from BLOCK.



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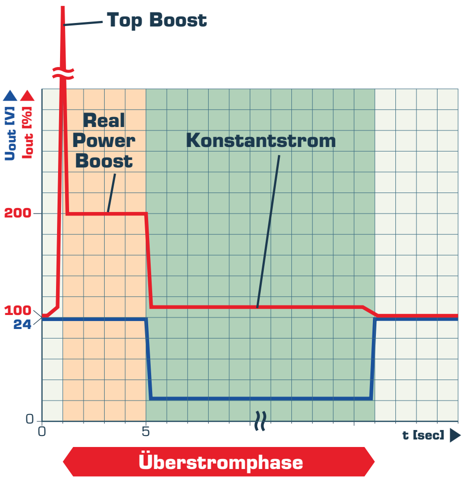
PVSE 230

Single-phase, Economy

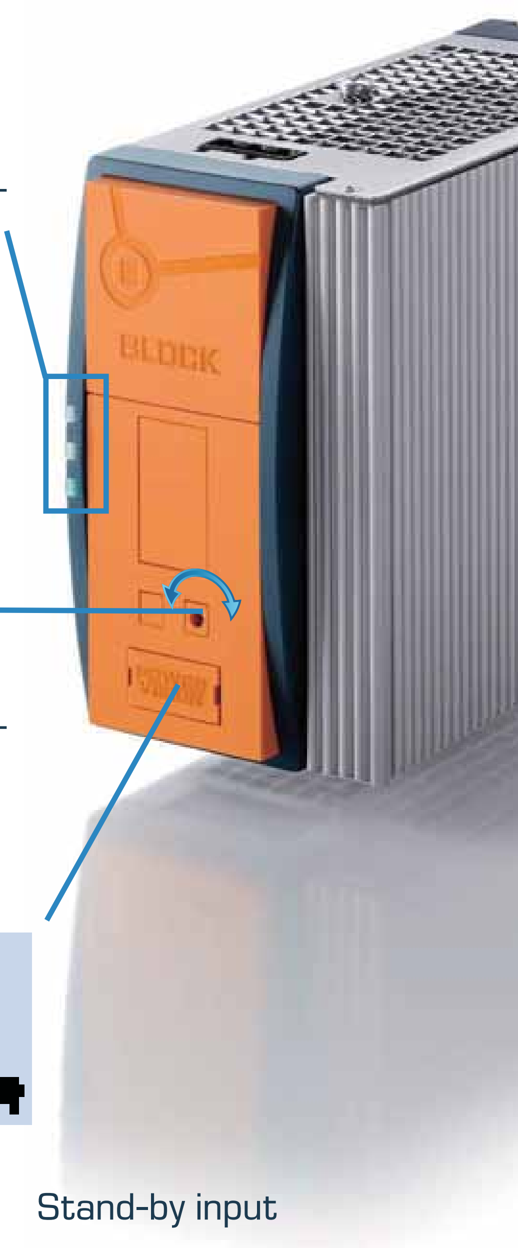
Unparalleled power reserves thanks to real power boost and top boost functions increase operational reliability for machines and systems. The device is available with active starting current limiting as an option.

Overload behaviour



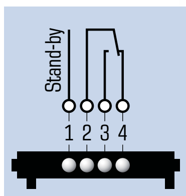
LED signalling

The Economy version is equipped with two LEDs that indicate the current operational status. When the device is running without any errors, the green LED lights up. The red LED signals undervoltage at the power supply output.



Setting the output voltage

The output voltage can be set to between 22.0 and 29.5 V DC on the front panel.



Isolated signal contact

The PVSE 230 switched mode power supply is equipped with an isolated DC OK signalling output. If the output voltage falls below the level set previously, the internal relay drops out. This fault can be queried via the changeover contact.

Stand-by input

The stand-by input allows targeted switch-on and switch-off of the power supply. When an external DC voltage is applied at the stand-by input, the output of the device is not enabled and the switched mode power supply remains on stand-by.

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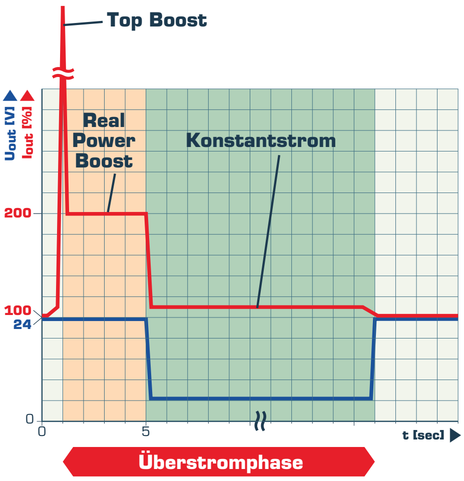
PVSE 400

Three-phase, Economy

The PVSE 400 is an affordable Economy switched mode power supply with high-precision output voltage, and is designed to meet all automation technology requirements. The power supply is optimised for the key task of supplying the voltage and current. Unparalleled power reserves thanks to real power boost and top boost functions increase operational reliability for machines and systems. The device is available with active starting current limiting as an option.

POWER VISION

Overload behaviour

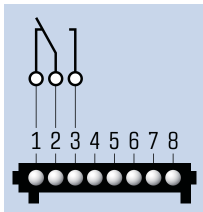


LED signalling

The Economy version is equipped with two LEDs to indicate the operational status. When the device is running without any errors, the green LED lights up. The red LED signals undervoltage at the power supply output.

Setting the output voltage

The output voltage can be set to between 22.0 and 28.8 V DC on the front panel.



Isolated DC OK output

The PVSE 400 switched mode power supply can be supplied with an isolated DC OK signal output as an option. In the event of undervoltage at the output, the internal relay drops out. This fault can be queried via the changeover contact.

PVSB 400

Three-phase, Basic

POWER VISION

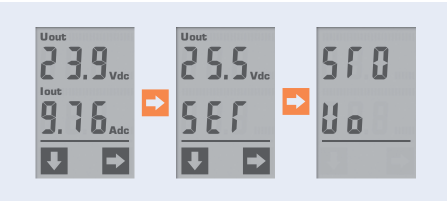
A smart combination: high-performance power supply with additional output monitoring. In carrying out its key task of supplying voltage and current, the PVSB switched mode power supply is able to increase the operational reliability of machines and systems by drawing on the unparalleled power reserves provided by its real power boost and top boost functions. The device is available with active starting current limiting as an option. Its major plus point is the integrated control unit, which continuously monitors voltage and current at the output. The device also boasts a display and function keys as well as four active signal outputs and an RS-232 interface.

Output monitoring for a more preventive approach

The current and voltage of the PVSB switched mode power supply output are monitored continuously. Key information can be read directly from the display. The integrated control unit is able to detect potential faults affecting equipment at an early stage, store the associated data and output signals accordingly.

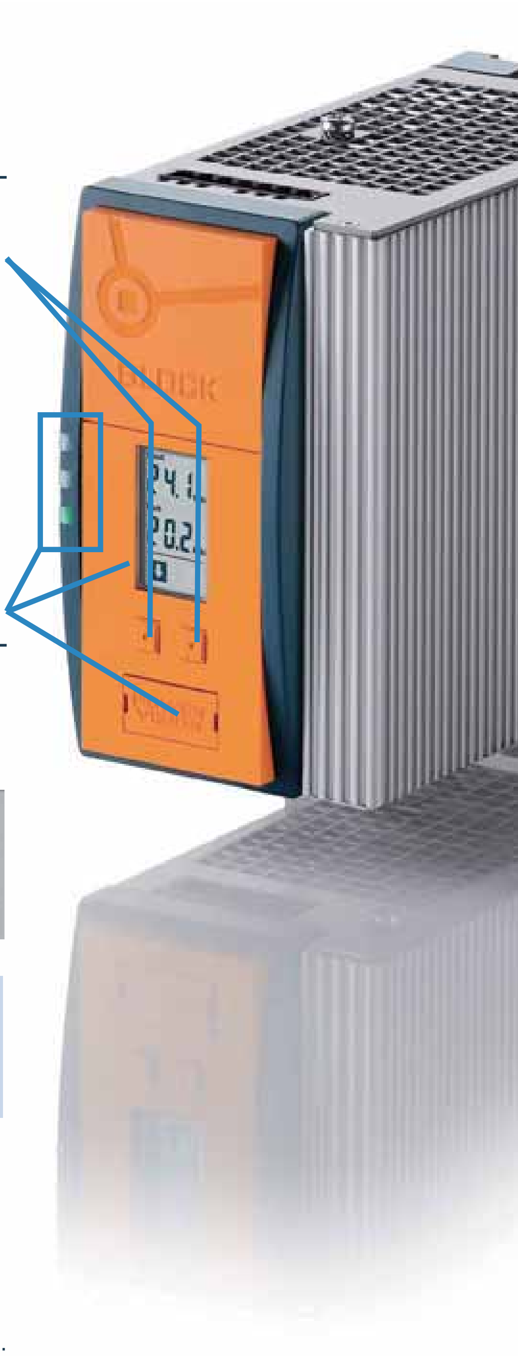
Potential faults the PVSB is able to detect:
Overcurrent When the output current exceeds the rated output current.
Undervoltage When the output voltage falls below the configurable DC OK limit value.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display or the interface:
Output current
Output voltage
Max. output current
Min./max. output voltage
Visualisation of all faults
Types of faults
Hour counter



Setting the output voltage

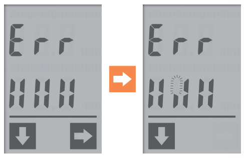
The output voltage can be set to between 22.0 and 28.8 V DC either digitally using the keys on the device itself or automatically via the interface. Whenever the device is switched on, it will automatically restore the final voltage value stored in its memory.



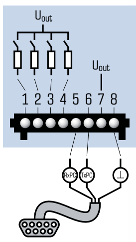
Communication with the user

Via the LEDs: Non-critical faults are indicated as warnings by the yellow LED, whilst critical faults are signalled by the red LED.

Via the display: The device features an integrated fault memory for self-diagnostics. The precise nature of any potential faults can be easily identified thanks to the display's system of flashing segments.



Via the active signal outputs: There are four active signal outputs on the front of the PVSB for watchdog functions. The corresponding statuses can be transferred to the higher-level control system. Because the outputs switch the output voltage, they do not need to be conditioned prior to digital signal processing. Two of the four signal outputs can be user-defined with the free parameterisation software, e.g. for the purpose of generating a group signal for all critical statuses.



Via the interface: The devices can communicate with a PC or higher-level control system via the serial interface. All the switched mode power supply's key data is sent cyclically, so the user can both view relevant data and respond to critical operational statuses. The PVSB can also be parameterised via this interface.
The PowerVision software packages required for communication can be downloaded free of charge from **www.block-trafo.de.**

PVSL 400

Three-phase, Line

Our top-of-the-range model featuring built-in input and output monitoring: The integrated control unit also supports permanent current and voltage output monitoring for comprehensive supply input monitoring. With real power boost and top boost, the PVSL switched mode power supply boasts high power reserves to ensure maximum operational reliability. The device is available with active starting current limiting as an option. It features a display and function keys as well as four active signal outputs and an RS-232 interface..

POWER VISION

PVSL for tidier wiring cabinets

A PVSL renders the use of various other modules in the wiring cabinet superfluous. The Line version is able to monitor the phase sequence direction and check for failed input phases - as well as keeping an eye on the quality of the incoming supply! Thanks to faster response times in the event of a power failure, there is even time for important data to be stored for restarting the machine.

Input and output monitoring for a more preventive approach

In addition to the features supported by the PVSB model, the PVSL switched mode power supply is equipped with an integrated supply input monitoring function.

Potential faults the PVSL is able to detect:
Supply undervoltage When the input voltage of at least one supply input phase falls below a configurable threshold value.
Supply overvoltage When the input voltage of at least one supply input phase exceeds a configurable threshold value.
Phase error When a supply input phase fails.
Phase sequence error When the connected phase sequence direction is anticlockwise.
Frequency error When the power frequency is outside the frequency range of 44 to 66 Hz.
Power failure When at least two supply input phases fail (typical response time 4 ms).
Communication error When the internal communication test fails.
Overcurrent When the output current exceeds the rated output current.
Undervoltage When the output voltage falls below the configurable DC OK limit value.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display:
Supply input voltage
Power frequency
Phase sequence direction
Output current
Output voltage
Max. output current
Min./max. output voltage
Types of faults
Hour counter

Key information that can be obtained via the display or the interface:
Supply input voltage
Power frequency
Phase sequence direction
Output current
Output voltage
Max. output current
Min./max. output voltage
Visualisation of all faults
Types of faults
Hour counter

Information that can only be obtained via the interface:
Supply input voltage of the individual phases

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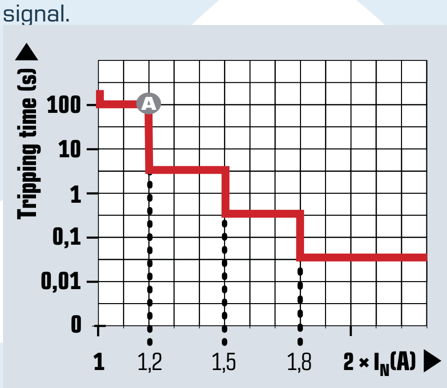
PVFE

Electronic circuit breaker
Economy

A reliable means of detecting faults in circuits: the circuit breaker with additional current and voltage monitoring. Since overcurrents are detected quickly and reliably, just the affected circuit can be shut down - even if long cables are being used. The functions supported by the integrated control unit include voltage and current monitoring. The devices feature a display, function keys, several signal outputs and an RS-232 interface

Tripping characteristics

Rated currents can be set separately for each channel in 1 A increments. Depending on the level of a possible overcurrent, the affected channel will be shut down safely and reset in accordance with a stored protection characteristic. This is where the flexibility of the PVFE module comes to the fore, since it allows scope for adjusting the tripping time taken to shut down a current path. Once a channel has been shut down, it can be reactivated either via the keys on the module or by means of an external signal.



Integrated control unit for maximum safety

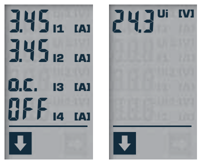
The PVFE module monitors current and voltage continuously. Key information can be read directly from the display. The integrated control unit is able to detect potential faults affecting current paths reliably, output signals accordingly and store the associated data for subsequent analysis.

Potential faults the PVFE module is able to detect:
Overcurrent When the output current of a channel exceeds the rated current.
Channel tripped When at least one channel shuts down due to an overcurrent.
Undervoltage When the input voltage falls below a configurable limit value.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display or the interface:
Output current of each channel
Input voltage
Max. output current of each channel
Min. input voltage
Visualisation of all faults
Types of faults

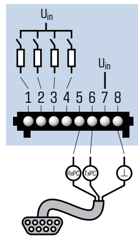
Communication with the user

❶ **Via the LEDs:** When the device is running without any errors, the green LED lights up. Non-critical statuses such as minor overcurrents or an undervoltage at the device input are indicated as warnings by the yellow LED, whilst the red LED signals situations that involve a circuit being shut down.

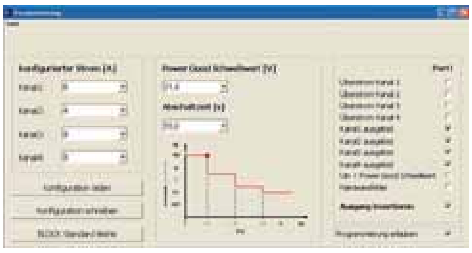


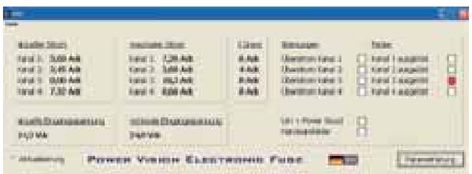
❷ **Via the display:** The output currents of the four channels are shown continuously on the display along with the input voltage. The device features an integrated fault memory for self-diagnostics in the event of a fault.

❸ **Via the signalling outputs:** The PVFE module has four active signal outputs and one isolated signal contact for watchdog functions. The active 24 V signal outputs do not need to be conditioned prior to processing as a digital signal. Signal output 1 is linked to an isolated signal contact on the underside of the device. It can be user-defined with the free parameterisation software, e.g. for the purpose of generating a group signal for tripped circuit branches.



❹ **Via the interface:** The module can communicate with a PC or higher-level control system via the serial interface. Cyclic sending of information means that the user can both view relevant data and respond to faults affecting connected circuits. Parameter settings can also be made via this interface. The PowerVision software packages required for communication can be downloaded free of charge from www.pv400.de.





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PVFB

Electronic circuit breaker
Basic

The PVFB module is the key to maximum system availability and process reliability. What makes this module really special is its integrated current limiting function, which is activated in the event of a fault and prevents a transient voltage dip on circuits not affected by a short circuit on an individual consumer branch. Accordingly, it safeguards the continued operation of vital system components. The functions supported by the integrated control unit include voltage and current monitoring. The devices feature a display, function keys, active signal outputs and an RS-232 interface.

Integrated control unit for maximum safety

The PVFB module monitors current and voltage continuously. Key information can be read directly from the display. The integrated control unit is able to detect potential faults affecting current paths at an early stage, output signals accordingly and store the associated data for subsequent analysis.

Potential faults the PVFB module is able to detect:

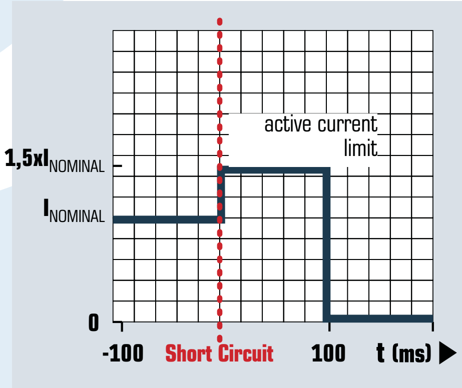
Overcurrent When the output current of a channel exceeds the rated current.
Channel tripped When at least one channel shuts down due to an overcurrent.
Undervoltage When the input voltage falls below a configurable limit value.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display or the interface:

Output current of each channel
Input voltage
Max. output current of each channel
Min. input voltage
Visualisation of all faults
Types of faults

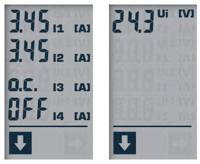
Tripping characteristics

Rated currents can be set separately for each channel in 1 A increments. In the event of an overcurrent, the current is limited and the affected channel is shut down safely and reset. Active current limiting is the only way to ensure that, in the event of a short circuit affecting an individual consumer, all other branches will remain unaffected and a voltage dip will not occur. This is where the flexibility of the PVFB module comes to the fore, since it allows scope for adjusting the tripping time taken to shut down a current path. Once a channel has been shut down, it can be reactivated using the keys on the module.



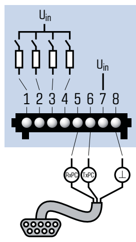
Communication with the user

❶ **Via the LEDs:** When the device is running without any errors, the green LED lights up. Non-critical statuses such as minor overcurrents or an undervoltage at the device input are indicated as warnings by the yellow LED, whilst the red LED signals situations that involve a circuit being shut down.

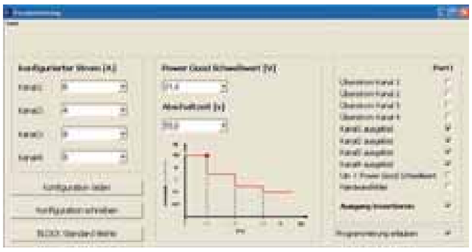


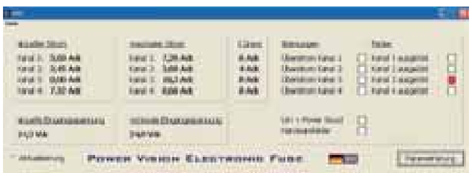
❷ **Via the display:** The output currents of the four channels are shown continuously on the display along with the input voltage. The device features an integrated fault memory for self-diagnostics in the event of a fault.

❸ **Via the signalling outputs:** There are four active signal outputs on the PVFB module for watchdog functions. The active 24 V signal outputs do not need to be conditioned prior to processing as a digital signal. Two outputs can be user-defined with the free parameterisation software, e.g. for the purpose of generating a group signal for tripped circuit branches.



❹ **Via the interface:** The module can communicate with a PC or higher-level control system via the serial interface. Cyclic sending of information means that the user can both view relevant data and respond to faults affecting connected circuits. Parameter settings can also be made via this interface. The PowerVision software packages required for communication can be downloaded free of charge from www.block-trafo.de.





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PVRE

Redundancy module
Economy

The ideal way to protect against power supply failures.
To avoid putting the operational reliability of machines and systems at risk in the event of a power supply failure, availability is safeguarded by two power supplies with the same rating which are decoupled via diodes.

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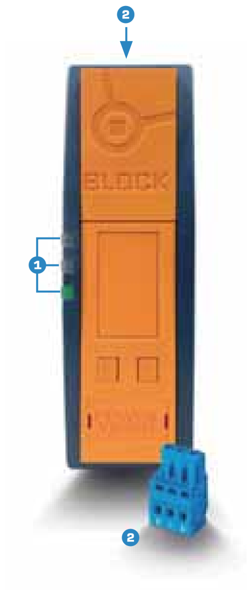
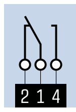


Signalling

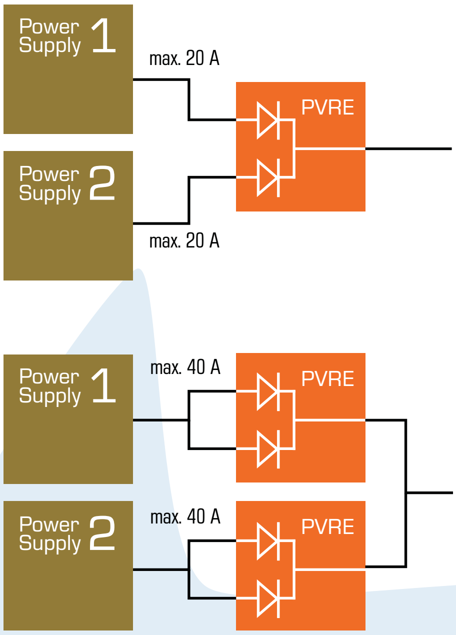
❶ **Via the LEDs:** The redundancy module features three LEDs on its front panel. The green LED signals sufficient voltage at the module output. Each of the two yellow LEDs is assigned to a connected power supply and will light up if the power supply fails.

❷ **Via the isolated signal contact:**



The changeover contacts of the integrated relay signal the operational status of the connected power supplies. During normal operation the relay is active; it drops out in the event of a power supply failure.

Basic structure of redundant power supplies



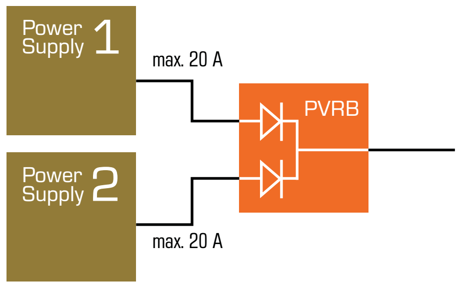
PVRB

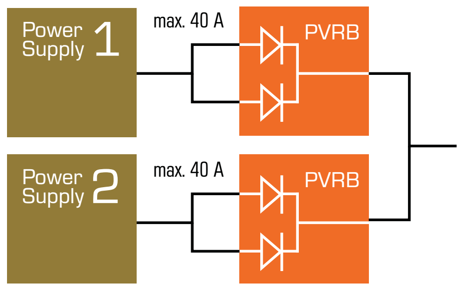
Redundancy module
Basic

A smart combination: protection and monitoring in one. To avoid putting the operational reliability of machines and systems at risk in the event of a power supply failure, availability is safeguarded by two power supplies with the same rating which are decoupled via diodes. What makes this module really special is its integrated control unit, which enables additional monitoring of the voltage and current. This means it is now even possible to keep one eye on the current and voltage conditions prevailing within a system if there are two PowerVision Economy power supplies connected. The module also boasts a display and function keys as well as active signal outputs and an RS-232 interface.

POWER VISION

Basic structure of redundant power supplies





Integrated control unit for maximum safety

The PVRB module monitors current and voltage continuously. Key information can be read directly from the display. The integrated control unit is able to detect potential faults affecting the equipment to which power is being supplied at an early stage, output signals accordingly and store the associated data for subsequent analysis.

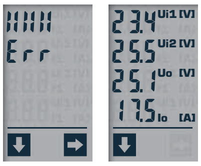
Potential faults the redundancy module is able to detect:
Overcurrent at input When one of the two input currents exceeds a configurable limit value.
Overcurrent at output When the output current exceeds a configurable limit value.
Undervoltage at input When one of the two input voltages falls below a configurable limit value.
Undervoltage at output When the output voltage falls below a configurable limit value.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display or the interface:
Input voltage 1+2
Output voltage
Input current 1+2
Output current
Min. input voltages 1+2
Min. output voltage
Max. input currents 1+2
Max. output current
Visualisation of all faults
Types of faults

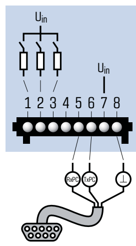
Communication with the user

❶ Via the LEDs: Non-critical statuses such as minor overcurrents are indicated as warnings by the yellow LED. An undervoltage at the output is signalled by the red LED.

❷ Via the display: The currents and voltages of the two inputs and the output are shown continuously on the display. The device features an integrated fault memory for performing diagnostics directly on the device in the event of faults. The precise nature of any potential faults can be easily identified thanks to the display's system of flashing segments.



❸ Via the signalling outputs: The redundancy module has three active signal outputs and one isolated signal contact for watchdog functions. The statuses of the signalling outputs can be transferred to the higher-level control system. Because the active signal outputs switch the input voltage, they do not need to be conditioned prior to digital signal processing. Output 1 is linked to an isolated signal contact on the underside of the device. It can be user-defined with the free parameterisation software, e.g. for the purpose of generating a group signal for multiple faults.



❹ Via the interface: The module can communicate with a PC or higher-level control system via the serial interface. Cyclic sending of information means that the user can both view relevant data and respond to faults. Parameter settings can also be made via this interface. The PowerVision software packages required for communication can be downloaded free of charge from www.block-trafo.de.

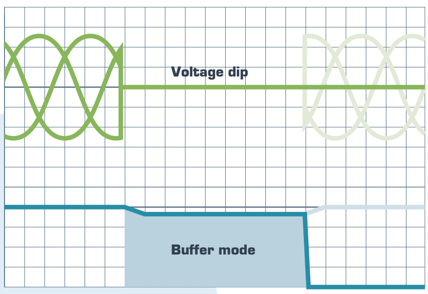
PVUC

Capacitor-based buffer module

The PVUC – powerful and maintenance-free: A buffer module is able to compensate brief power supply interruptions safely. Mains buffer times are extended for the power supplies and this increases the operational reliability of machines and systems. Transient faults are buffered and in the case of longer failures, there is sufficient time to back up important data for restarting purposes. PowerVision buffer modules are characterised by particularly long buffer times..

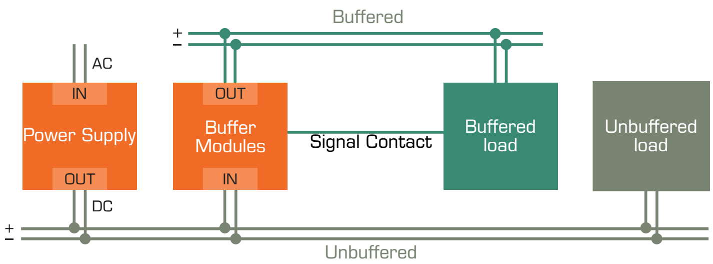
Long buffer times

In the event of a oltage dip, the buffer modules ensure that the voltage supply to connected consumers remains stable. Voltage dips can be compensated for up to 0.4 seconds at a rated current of 20 A, for example. This means that even in the case of power supply interruptions lasting longer than this, there is still enough time to back up relevant data and switch the machine to a safe state under controlled conditions.



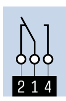
Decoupled output

Multiple buffer modules can easily be connected in parallel. The module outputs are decoupled from the inputs. This means that it is possible to specifically buffer just selected consumers.



Signalling

❶ **Via the LEDs:** There are 3 LEDs for signalling individual operational statuses. When the device is running without any errors, the green LED lights up. The red LED signals undervoltage at the buffered output of the module. The yellow LED lights up when the device is charging.



❷ **Via the isolated signal contact:** Once the internal capacitors have finished charging and there is sufficient voltage at the buffer module input, the isolated signalling output is activated. The contact drops out as soon as the module runs out of charge and the control level can respond to this change of state.

PVUA

Uninterruptible power supply

POWER VISION

The PVUA module – much more than an ordinary UPS:
A key feature of the PVUA module is its optimum battery management. It also supports complete current and voltage monitoring with numerous signalling options. The module features a display, function keys, several signal outputs and an RS-232 interface. The charging voltage for the connected accumulator module is temperature-controlled; this helps to extend the service life of the accumulator significantly, thereby minimising maintenance overheads.

Integrated control unit for maximum safety

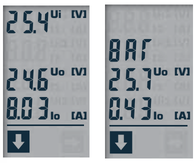
The PVUA module monitors current and voltage continuously. Key information can be read directly from the display. The integrated control unit is able to detect potential faults affecting the equipment to which power is being supplied at an early stage, output signals accordingly and store the associated data for subsequent analysis.

Mögliche Störungen, die durch das PVUA Modul detektiert werden:
Overcurrent When the output current exceeds a configurable limit value.
Output shut down When the output is shut down briefly due to an increased overcurrent.
Undervoltage at input When the input voltage falls below a configurable limit value.
Undervoltage at output When the output voltage falls below a configurable limit value.
Low accumulator charge When the charge of the connected accumulator is less then 85%.
Accumulator mode When the module is in accumulator mode.
Accumulator mode not possible When the accumulator test fails.
Low accumulator voltage When the accumulator voltage falls to a critical value in accumulator mode.
Accumulator replacement recommended When the accumulator quality test fails. It is recommended that you replace the accumulator.
Hardware fault When the device's internal self-testing function fails.

Key information that can be obtained via the display or the interface:
Input voltage
Output voltage
Output current
Output current
Charging voltage
Charging current
Min. input voltage
Max. output current
Accumulator running hours
Visualisation of all faults
Types of faults

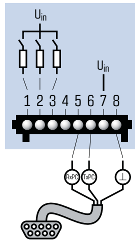
Communication with the user

❶ **Via the LEDs:** When the device is running without any errors, the green LED lights up. Non-critical statuses are indicated as warnings by the yellow LED, whilst critical situations are signalled by the red LED.



❷ **Via the display:** All currents and voltages are shown continuously on the display. Important parameter settings can be made with ease using the keys on the device. The device features an integrated fault memory for self-diagnostics in the event of a fault.

❸ **Via the signalling outputs:** The PVUA module has three active signal outputs and one isolated signal contact for watchdog functions. The active 24 V signal outputs do not need to be conditioned prior to processing as a digital signal. Signal output 1 is linked to an isolated signal contact. It can be user-defined with the free parameterisation software, e.g. for the purpose of generating a group signal for possible faults.



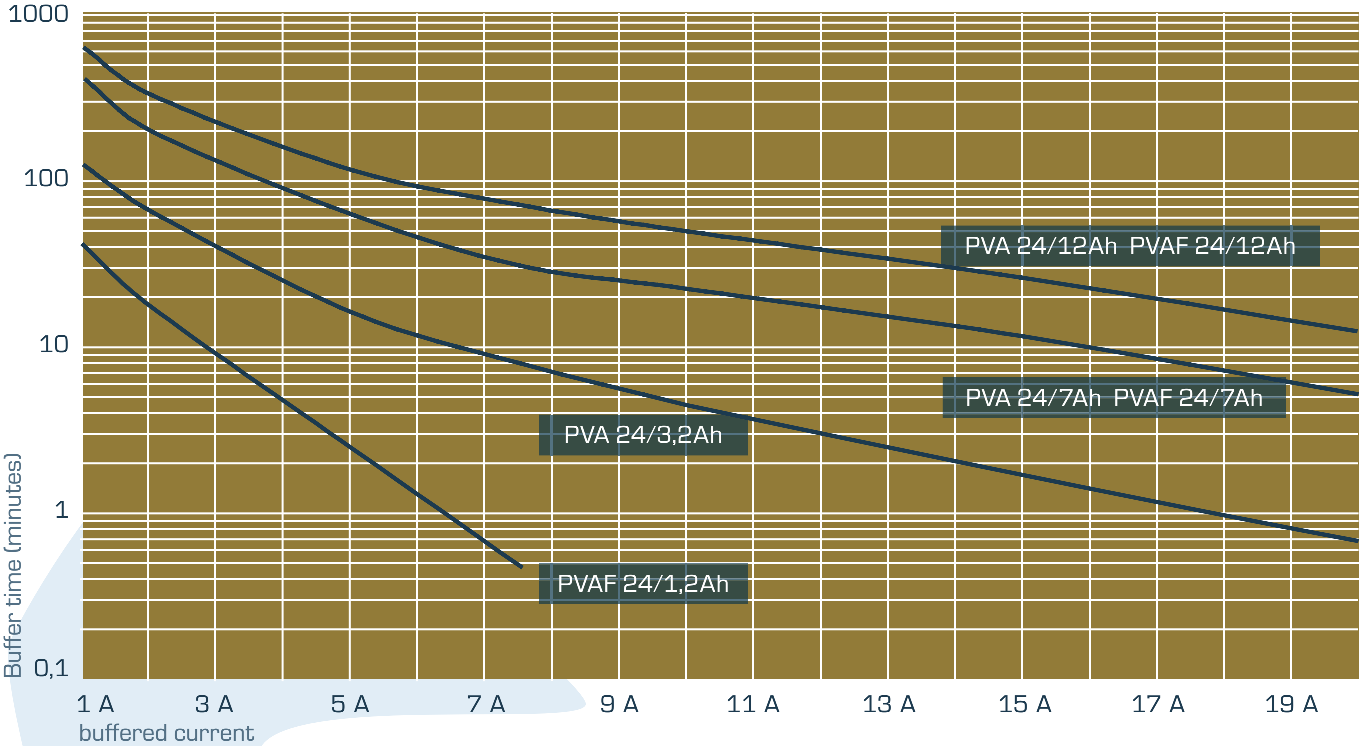
❹ **Via the interface:** The module can communicate with a PC or higher-level control system via the serial interface. Cyclic sending of information means that the user can both view relevant data and respond to faults. Parameter settings can also be made via this interface. The PowerVision software packages required for communication can be downloaded free of charge from www.block-trafo.de.

PVA / PVAF

Accumulator modules for PVUA

The accumulator module works in conjunction with the PVUA accumulator manager to provide a backup 24 V DC voltage in the event that the supply voltage fails. What is really special about this system is its integrated temperature meter. This is located in the accumulator housing, which can be placed in a specific location inside the wiring cabinet. Optimum accumulator charge and therefore long service life is assured.

Buffer times in relation to load current



the EU-Symbol (Communautés Européennes)

The CE mark

General Note

The technical explanations contained here represent points of departure for many areas of application, a number of rules apply in addition to special and exceptional cases. The intention here is to provide a brief introduction into the complex subject field.

CE mark

The Council of the European Union has issued some EC Directives based on the Treaty establishing the European Economic Community (EEC), and in particular Article 100. The purpose of these EC Directives is to harmonise the legal and administrative regulations within the various member states of the European Union (EU) in cases where differences between national regulations could result in trade restrictions or hinder the European single market in any other way. Legislative bodies on national levels are required to implement the Directives in the legislation of the country concerned within specified periods of time.
Manufacturers must attach the CE mark to products that fall within the scope of certain EC Directives as an indication of conformity. This affects products covered by Directives based on the "New Approach" (passed 07/05/1985), which outline requirements concerning the technical properties of products.

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EC Directives are legally binding regulations issued by the European Union. Consequently, these requirements must be met **in order for the products concerned to be marketed within Europe. They do not relate to trade markets in the rest of the world.** By attaching the CE mark to a product, the manufacturer is confirming that they are compliant with the relevant basic requirements of all the Directives which affect (i.e. are applicable to) that product. The CE mark is only intended to prove to supervisory authorities that the product concerned conforms to the relevant Directive(s). Despite this, it is often mistakenly seen as a mark of quality, which unfortunately leads to it being requested without any legal basis in many cases.

For this reason, we do not display the CE mark on the pages of our catalogues and brochures as part of our advertising strategy, since the mark fulfils a purely legal function for products and its requirements have to be adhered to by all manufacturers or importers.

Although the manufacturer's EC Declaration of Conformity only needs to be kept available for inspection by supervisory bodies (for a period of at least 10 years after the last product was put into circulation), customers are free to request copies of it from us.

The EC Declaration of Conformity for the product concerned contains information on which of the Directives apply to it. The Directives and their amending Directives which are most frequently applicable to the range of products we offer are:

1. The Low Voltage Directive (2006/95/EC) covering electrical equipment for use at a rated voltage of between 50 V_{AC} and 1000 V_{AC} and between 75 V_{DC} and 1500 V_{DC}.

Title: Directive 2006/95/EC of the European Parliament and of the Council of 12 December 2006 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits.

Almost all of the products we manufacture are affected by the Low Voltage Directive. The manufacturer is required to certify in the form of an EC Declaration of Conformity that each piece of electrical equipment, each device, each system and each installation conforms to the safety requirements of the Directive, and the EC conformity mark CE must be attached to the product or - in exceptional cases - the packaging.

2. The EMC Directive (2004/108/EC) for apparatus which is liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance.
Title: Directive 2004/108/EC of the European Parliament and of the Council of 14 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

Legal basis:
In the interest of harmonising the laws of the various member states, on 3 May 1989 the Council of the European Union issued a binding Directive for its members. In Germany, this was implemented in national legislation in the form of the Electromagnetic Compatibility Act (EMVG) on 9November 1992. The German Federal Network Agency (BNetzA) and its branches are responsible for enforcing (monitoring) the EMC Act.

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Definition according to an extract from Article 1:

Electromagnetic compatibility means the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment.

Scope of validity according to an extract from Article 2:
[Apparatus] which [is] liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance.

Note: "Apparatus" (as referred to in Article 1) denotes all electrical and electronic equipment, installations and systems that contain electrical and/or electronic components.

Basic process :
As of 1 January 1992 (transition period to 31 December 1995) electrical and electronic apparatus, systems and installations may only be placed on the market or put into service within the European Union if they conform to the EMC safety requirements outlined in the Directive. The manufacturer is required to certify in the form of an EC Declaration of Conformity that each piece of apparatus, each system and each installation conforms to the safety requirements of the Directive, and the EC conformity mark CE must be attached to the product.

Components that are not required to bear this mark:
For the purpose of the EMC Directive, a component is defined as any item which is installed in a piece of apparatus, but which does not itself have an intrinsic function and is not intended for use by the end consumer. According to Article 1 of the EMC Directive, components are therefore not apparatus and are excluded from this Directive from the outset.

Examples:

a) **Components (for printed circuit boards, apparatus, wiring cabinets)** which, as installation components, are not required to bear the CE mark. Examples: resistors, capacitors, inductors, integrated circuits.

b) Components which must bear the CE mark **(those with a housing and contact protection)**, which are to be operated independently and/or are sold to end consumers, such as plug-in power supplies, battery charging equipment, personal computers, testing and measuring equipment, isolating transformers for construction sites or service, transformers for halogen lamps.

Electromagnetic compatibility

Definition

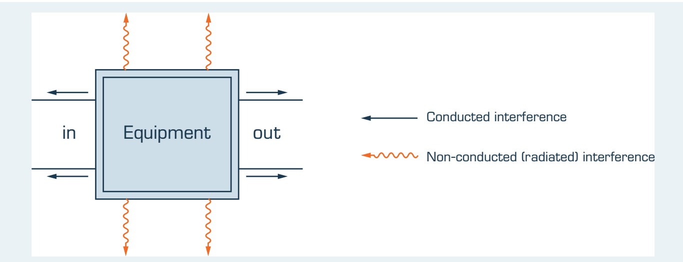
According to the definition in EMC Directive 2004/108/EC, electromagnetic compatibility means the ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to other equipment in that environment.

A distinction is drawn between
1. Electromagnetic interference (EMI)
2. Electromagnetic immunity (EMS)

Electromagnetic interference (EMI)

Electromagnetic interference (emitted interference) is any type of electromagnetic phenomenon (e.g. noise, unwanted signal), which could impair the function of a device, installation or system. The generic standards relating to emitted interference are:

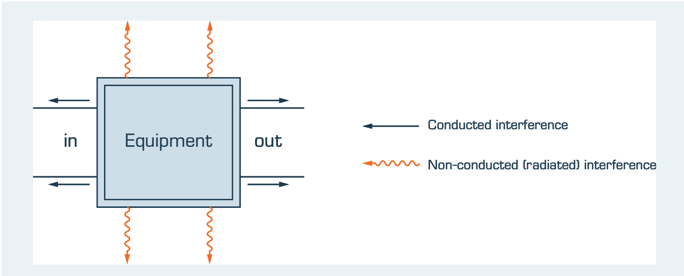
- EN 61000-6-3 (living areas, business and trade areas and small companies)
- EN 61000-6-4 (industrial areas)



Electromagnetic immunity (EMS)

The relevant testing standards are:

- EN 61000-4-2:1995 +A1:1998 +A2:2001
  Electrostatic discharge immunity test
- EN 61000-4-3:2006 +A1:2008
  Radiated, radio-frequency, electromagnetic field immunity test
- EN 61000-4-4:2004
  Electrical fast transient/burst immunity test
- EN 61000-4-5:2006
  Surge immunity test
- EN 61000-4-6:2007
  Immunity to conducted disturbances, induced by radio-frequency fields
- EN 61000-4-8:1993 + A1:2001
  Power frequency magnetic field immunity test
- EN 61000-4-11:2004
  Voltage dips, short interruptions and voltage variations immunity tests
- EN 61000-4-20:2003
  Emission and immunity testing in transverse electromagnetic (TEM) waveguides

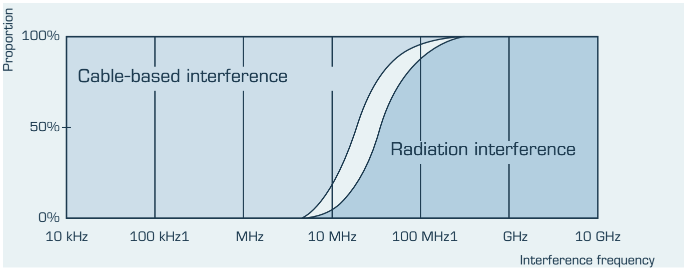


Shielding against interference

There are many ways in which interference can be transferred:

- Electrically in the form of current and voltage (conducted)
- As a magnetic field
- As an electrical field
- As an electromagnetic wave or radiation

Conducted and radiated interference is usually propagated as follows:

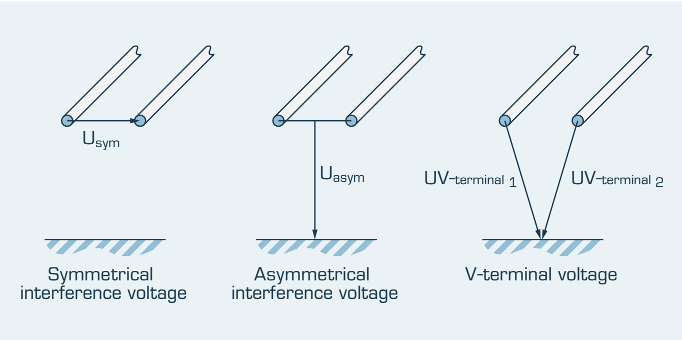


Interference can be attenuated by means of an EMC-compliant set-up using, for example, low-resistance earthing, filters, shielded lines, a metal housing and clearances. However, since the particular EMC measures to be put in place in each case are highly dependent on which components are being used and the operating parameters of the system, it is almost impossible to make any universally applicable statements concerning them.

Conducted interference

On electrical lines, interference voltages occur between conductors as well as between conductors and earth, often up to a frequency of around 30 MHz. A distinction is made between symmetrical interference voltages, asymmetrical interference voltages and a combination of the two: V-terminal voltages.

Reactors, capacitors and filters as well as, indirectly, shielded lines are ideal ways of attenuating conducted interference. Additional protective measures (spark gaps, varistors) are usually required to combat high-energy interference (resulting from lightning strikes, for example).



EMC standards

The principles of EMC standardisation are mainly established by

- CISPR, founded in 1934 (International Special Committee on Radio Interference, Comité international Spécial des Perturbations Radioélectriques)

and

- IEC TC77, founded in 1974 (International Electrotechnical Commission Technical Committee 77, Comité d'études 77 de la Commission Electrotechnique Internationale)

in accordance with IEC Directive Guide 107 (EMC Guide to the drafting of electromagnetic compatibility publications).

The aim of Guide 107 is to ensure that the procedures and approaches taken towards EMC standardisation are consistent and to keep everything coherently organised. This takes into account both conducted and radiated phenomena in the frequency range from 0 to 400 GHz, in which it should be possible to achieve electromagnetic compatibility.

As a general rule, four categories of EMC standards are defined and each EMC standard usually falls into just one of these categories.

1. Basic standards, e.g.

- IEC 61000-2-2, -3-2, -4-1, -5-5 etc.,
- CISPR 11, 13, 14, 15, 16, 22

Basic standards may have the status of a standard, but they may also have the status of a technical report. They contain the relevant measurement procedures, ambient condition classifications and testing techniques for EMC. Generic standards, product family standards and product standards continually make reference to these basic standards. It must be possible to tell from the very title that the publication type is that of a basic standard.

2. Generic standards

- Living areas, business and trade areas and small companies: EN 61000-6-3 (emitted interference), EN 61000-6-1 (interference immunity)
- Industrial areas: EN 61000-6-4 (emitted interference), EN 61000-6-2 (interference immunity)

Generic standards are applied to products if there are no product family standards or product standards relating to them. A basic distinction is drawn between the environmental conditions of industrial areas (where power is supplied via an industrial network) and living areas, business and trade areas and small companies (where power is supplied via the public mains network). A limited number of EMC tests specify minimum interference immunity limit values and maximum emitted interference limit values, but do not deal with specific product features.

3. Product family standards, e.g.

- EN 55011 (emitted interference), industrial, scientific and medical (ISM) devices
- EN 55013 (emitted interference), EN 55020 (interference immunity), audio, TV, radio devices
- EN 55014 (emitted interference), EN 55104 (interference immunity), household appliances

Product family standards are tailored to specific product families and contain special guidelines (such as limit values, test set-up information, operating criteria and complaint criteria). Where measurement procedures are concerned, reference is made to basic standards and the limit values are often aligned with generic standards. A product family standard relating to EMC may be an entirely independent standard, or it may be one (independent) part of a series of standards regulating additional issues affecting a product family (e.g. electrical safety).

4. Product standards, e.g.

- EN 61800-3, frequency converters
- EN 50199, arc welding equipment

Product standards are aimed at specific products and have the highest priority in terms of application, which means they must be applied exclusively in order to ensure the product in question is EMC-compliant. The same rules apply to product standards as to product family standards in terms of how the information in basic standards and generic standards can be incorporated into them.

Classifications

Safety class

Safety class 0, I, II or III (see: VDE 0140/EN 61140/IEC 61140) is a **structural attribute** used to classify electrical equipment according to the degree of safety provided in respect of dangerous electric shock currents. For example:

- Safety class 0:
  Device with basic insulation as a precautionary measure to provide basic protection, but without any precautionary measures installed for fault protection purposes
- Safety class I:
  Device with protective conductor connection and (at the very least) basic insulation
- Safety class II:
  Device without protective conductor connection and with double or increased insulation
- Safety class III:
  Device with ELV (safety extra-low voltage) supply and in which no voltages higher than the ELV are generated

Electrical equipment which is intended for installation in devices does not have a safety class and may only be designated as "ready" to be used with the relevant class. Electrical equipment that is ready for use in safety class II devices may also be used in safety class I devices.

Degree of protection

The degree of protection specification (see: DIN VDE 0470, EN 60 529, IEC 60529) describes the **extent to which the electrical equipment is protected** by the housing, covers, casings and similar components.

The degree of protection is specified by an IP code, in which the **first digit** (0 to 6) provides information about the level of protection against contact and the ingress of foreign bodies, and the **second digit** (0 to 8) indicates the level of protection against the ingress of water.

Common degrees of protection:

- IP 00
  No special protection against accidental contact or the ingress of foreign bodies. No special protection against water. **"Open" designs are manufactured with degree of protection IP 00.**
- IP 20
  Protection against contact and against solid foreign bodies exceeding ø 12 mm in size. No special protection against water.
- IP 23
  Protection against contact and against solid foreign bodies exceeding ø 12 mm in size. Protection against spraying water; water falling as a spray at any angle up to 60° from the vertical must not have any harmful effects.
- IP 40
  Protection against contact and against solid foreign bodies exceeding ø 1 mm in size. No special protection against water.
- IP 44
  Protection against contact and against solid foreign bodies exceeding ø 1 mm in size. Protection against splashing water; water splashing against the equipment from any direction must not have any harmful effects.
- IP 54
  Full protection against contact. Protection against harmful dust deposits. The ingress of dust is not prevented altogether, but dust must not enter in sufficient quantities to prevent the equipment from operating satisfactorily. Protection against splashing water; water splashing against the equipment from any direction must not have any harmful effects.
- IP 65
  Full protection against contact. Protection against the ingress of dust. Protection against water jets. Water sprayed from a nozzle and aimed at the equipment from any direction must not have any harmful effects.
- IP 67
  Full protection against contact. Protection against the ingress of dust. Protection against the effects of temporary immersion in water. Water must not enter in harmful quantities when the housing is temporarily immersed in water under standardised pressure and time conditions.

Note: The degree of protection specified relates to the condition in which the device is delivered and is based on the stipulations regarding how the equipment is set up, or how it is usually set up. The actual degree of protection may change if it is set up or installed in some other way.

Class of insulation

The relevant regulations (see: VDE 0301/HD 566S1/IEC 60085 as well as: VDE 0304/HD 611.1S1/IEC 60216) describe, amongst other things, the **thermal resistance of electrical insulation materials**. Temperatures are assigned to the classes of insulation depending on their thermal resistance duration.

Commonly used classes of insulation:
A (105°C), E (120°C), B (130°C), F (155°C), H (180°C)

Unless otherwise agreed, transformers and line reactors are dimensioned for class of insulation B, F or H.

Insulation system (EIS)

An electrical insulation system (EIS) is an insulating arrangement which is made up of one or more types of insulation material (electrical insulation material) plus the associated conductive parts, and which is installed in a piece of electrical equipment (see VDE 0302 Part 1/EN 60505/IEC 60505 plus VDE 0302 Part 11/EN 61857-1/IEC 61857-1). Under thermal stress, an assessment is made concerning whether the **combination of insulating materials** is suitable for operation in accordance with the relevant class of insulation.

Rated ambient temperature

The rated ambient temperature is the highest ambient temperature at which a piece of electrical equipment, an electrical device or an installation component (e.g. transformer, reactor, filter) can be operated continuously under normal operating conditions. It is the **temperature of the air in the immediate surroundings**. Electrical values often refer to the rated ambient temperature and may change at different temperatures. Special attention must be paid to how components are installed in housings with a high degree of protection. Any potentially insufficient cooling measures may lead to impermissibly high temperatures in the housing. Under some circumstances, this may lead to a reduction in the expected service life of the component (see “Class of insulation”).

The rated ambient temperature is specified using an abbreviated format (see VDE 0570, EN 61558, IEC 61558).

Example:
t_a = 25°C or t_a = 40°C

Unless otherwise agreed, the rated ambient temperature used for designing components intended for installation is defined as at least 40°C; in the case of (table) devices which are to be operated independently it is 25°C.

Test class

The test class specifies the climate category (see: DIN EN 60068/EN 60068/IEC 60068) in the form of a code and indicates the climatic conditions in which the components can be used.

Example:

25/085/21

25 = –25°C, test A: cold, 085 = +85°C, test B: dry heat,

21 = 21 days, test Ca: constant damp heat

The individual tests are outlined in various parts of the relevant standard..

Marks and symbols

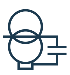
VDE 0570 Part 2–6/EN 61558-2-6/IEC 61558-2-6
Safety transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 50 V AC voltage (effective value) and/or 120 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–6/EN 61558-2-6/IEC 61558-2-6
Safety transformer, not short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 50 V AC voltage (effective value) and/or 120 V smoothed DC voltage, frequency max. 500 Hz

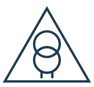
VDE 0570 Part 2–4/EN 61558-2-4/IEC 61558-2-4
Isolating transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V AC voltage or 708 V smoothed DC voltage, frequency max. 500 Hz.

VDE 0570 Part 2–4/EN 61558-2-4/IEC 61558-2-4
Isolating transformer, not short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V AC voltage or 708 V smoothed DC voltage, frequency max. 500 Hz.

VDE 0570 Part 2–15/EN 61558-2-15/IEC 61558-2-15
Isolating transformer for supplying medical areas, not short circuit-proof, double or increased insulation between PRI and SEC; windings installed one above the other; windings-core; windings-shield; shield-core; PRI max. 1000 V, SEC max. 250 V, frequency max. 500 Hz



VDE 0570 Part 2–12/EN 61558-2-12/IEC 61558-2-12
Magnetic voltage stabiliser acting as isolating transformer, short circuit-proof, double or increased insulation between PRI and SEC, PRI max. 1000 V, SEC max. 500 V, frequency max. 500 Hz (30 kHz internally)



VDE 0570 Part 2–2/EN 61558-2-2/IEC 61558-2-2
Control transformer, not short circuit-proof, basic insulation between PRI and SEC, PRI max. 1000 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–1/EN 61558-2-1/IEC 61558-2-1
Mains transformer, not short circuit-proof, basic insulation between PRI and SEC, PRI max. 1000 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–13/EN 61558-2-13/IEC 61558-2-13
Autotransformer, not short circuit-proof, no insulation between PRI and SEC, PRI max. 1100 V, SEC max. 1000 V AC voltage or 1415 V smoothed DC voltage, frequency max. 500 Hz

VDE 0570 Part 2–20/EN 61558-2-20/IEC 61558-2-20
Small reactor, not overload-free, max. 1000 V, frequency max. 1 MHz

6,3 AT

Specification for the fuse assigned in the case of transformers that are not short circuit-proof; here, 6.3 A time-lag

20 A

Thermal overcurrent release; here, 20 A miniature circuit breaker

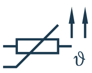
Temperature fuse

Temperature fuse

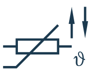
Self-resetting thermal relay
, e.g. thermal time delay switch

Non-self-resetting thermal relay Reset by switching off the mains connection, e.g. thermal time delay switch with locking function, PTC

Non-self-resetting thermal relay Manual reset (e.g. thermal overcurrent release, miniature circuit breaker)



PTC thermistor



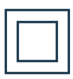
NTC thermistor

ta 40 °C
ta 40

Rated ambient temperature; here, 40°C

CL.B
CL.130
class 130

Class of insulation; here, B



Safety class II, total insulation

Protective conductor, earth

Connection for mount or core

Suitable for use with fitments whose flammability properties are not known, e.g. wood, furniture, intermediate ceilings. Sign in acc. with VDE 0710 Part 14.

Sign for domestic use, only for dry rooms, general

Voltage warning, general

Heat source warning: hot surface, general

~

AC current, also spelled A. C. or ac (alternating current)

⎓

DC current, also spelled D. C. or dc (direct current)

Marks of conformity

CE mark, legal mark of conformity in Europe (stands for Conformité Européenne)

ENEC mark of conformity, Europe; in Germany: certification by VDE (10), European Norms Electrical Certification

VDE mark of conformity, Germany, VDE Testing and Certification Institute

UL mark of conformity (recognized component), USA and Canada; in Germany: certification by UL, Underwriters Laboratories Inc.

transformer only

UL mark of conformity (recognized component), USA and Canada; in Germany: certification by UL, Underwriters Laboratories Inc., only relates to the integrated transformerr.

UL mark of conformity (recognized component), USA, Underwriters Laboratories Inc.

UL mark of conformity, (Listed) USA, Underwriters Laboratories Inc

CSA mark of conformity, Canada, Canadian Standards Association

GL mark of conformity, certification by Germanischer Lloyd

AS-Interface mark of conformity, certification by AS-International Association

Special signs by BLOCK

XtraDenseFill: XtraDenseFill from BLOCK, a casting technique that ensures cavity-free filling of the transformer's entire internal structure thanks to high vacuum and pressure phases. It significantly reduces creepage distances and clearances and enables the electrical equipment to enjoy long-term protection against the effects of its environment. A more compact design can also be used.

BLOCK ImpEx: Ensures the winding material is covered evenly, thus providing extensive protection against external influences. The resin developed specifically for BLOCKImpEx, together with our in-house-developed impregnation process, seals as many cavities as possible and creates a temperature reserve to ensure efficiency during long periods of operation.

The BLOCK logo: a sign of quality

The old BLOCK logo: our original logo

Power supplies

General technical information

A DC power supply is a static device with one or more inputs and one or more outputs. It uses electromagnetic induction to convert the AC voltage and AC current, and/or the DC current, into a system with DC voltage and DC current (usually at different values) for the purpose of transferring electrical energy.

Requirements

The ways in which the designs of DC power supplies differ mainly depend on their intended use. The relevant requirements are set out in installation and device standards (e.g. VDE 0100, VDE 0113/EN 60204/
IEC 60204, VDE 0700/EN 60335/
IEC 60335, VDE 0805/EN 60950/
IEC 60950) and in the standards available for DC power supplies with a general end use
(e.g. VDE 0570/EN 61558/IEC 61558, VDE 0557/EN 61204/IEC 61204)
.

An important selection criterion is the structure of the insulation between the input and output circuits (as already described in "Transformer requirements").

A further distinction is made based on how the AC voltage/AC current and DC voltage/DC current are converted:

- AC-DC converter
  AC voltage input, DC voltage output
- DC-DC converter
  DC voltage input, DC voltage output
- DC-AC converter
  DC voltage input, AC voltage output

Another important selection criterion is the stability and ripple levels of the DC output voltage. This results in the following categories:

- Unregulated DC power supplies
- Regulated DC power supplies

Standards

Unless otherwise agreed with the customer, we manufacture our devices according to the state of the art and the following standards:

Unregulated DC power supplies:

- VDE 0570: Sicherheit von Transformatoren, Netzgeräten und dergleichen Teil 1: Allgemeine Anforderungen und Prüfungen, in Verbindung mit dem jeweilig zutreffenden Teil 2.
  EN 61558, IEC 61558: Safety of power transformers, power supply units and similar, Part 1: General requirements and tests, in accordance with the relevant Part 2.

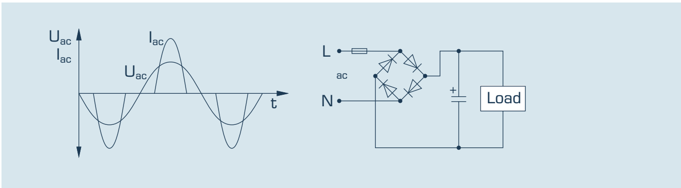
Regulated DC power supplies:

- VDE 0570: Sicherheit von Transformatoren, Netzgeräten und dergleichen, Teil 1: Allgemeine Anforderungen und Prüfungen, in Verbindung mit dem jeweilig zutreffenden Teil 2.
  EN 61558, IEC 61558: Safety of power transformers, power supply units and similar, Part 1: General requirements and tests, in accordance with the relevant Part 2-17.
- And/or:
  VDE 0557: Stromversorgungsgeräte für Niederspannung mit Gleichstromausgang
  EN 61204, IEC 61204: Low-voltage power supply devices, D. C. output – Performance characteristics and safety requirements.
- And:
  VDE 0805: Sicherheit von Einrichtungen der Informationstechnik, EN 60950, IEC 60950: Safety of information technology equipment

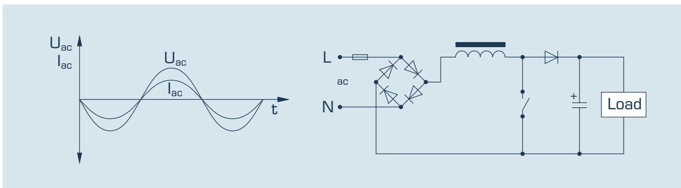
Power factor correction (PFC)

For financial reasons, energy providers strive to keep harmonic content and, consequently, the loads on their mains supplies to a minimum. EMC standards relating to this (see: EN 61000-3-2, for example) have already been brought into force. Efforts are centred around minimising harmonic currents whilst simultaneously correcting the power factor, which refers to the relationship between the active power consumed and the apparent power consumed by a consumer. A power factor of 1 with sinusoidal current consumption yields the lowest mains supply load.

Unfortunately, DC power supplies also cause the phenomena described here (amongst others) due to rectification of the (supply) input voltage with subsequent capacitor smoothing. If the DC voltage falls below the peak value of the feed AC voltage, then the capacitor will be recharged with brief, pulsating currents. In this case, it is less important whether this configuration is operated directly on the mains or with an upstream transformer.



The harmonic content can be reduced within certain limits by connecting a frequency-dependent resistor upstream (see “Line reactors” for information on this). However, correcting the power factor directly and in a way that is dependent on the load requires an electronic control system which ensures that the electrical current is drawn from the mains in a sinusoidal shape and in the same phase position as the voltage. The figure below shows a possible circuit concept:



A semiconductor switch, which is controlled by the magnitude of the load, clock pulse-controls the 50 Hz (supply) input current consumed using a high switching frequency (e.g. 20 kHz) and working in conjunction with the storage reactor. This is “modulated” in synchronism with the phase position of the (supply) input voltage in such a way that a power factor of almost 1 is produced.

Unregulated DC power supplies

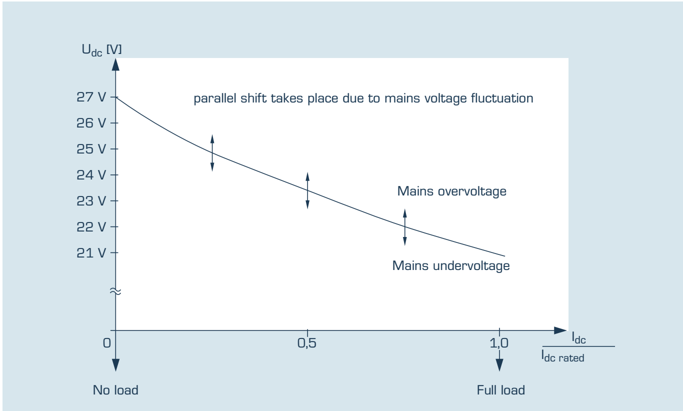
With unregulated DC power supplies, the DC output voltage is not regulated in relation to a specific value, but instead changes on the basis of the fluctuation in the (supply) input voltage and the load associated with this value.

The ripple is within the volt range and may depend on the load. Ripple is usually specified as a percentage value proportional to the DC output voltage level.

Even today, unregulated DC power supplies are still being used in applications thanks mainly to their robust, uncomplicated, stripped-down structure that is built to last.

Stability

The output characteristic below illustrates typical dimensioning of the DC output voltage relative to a rated voltage of 24 V_{DC}:



The rated voltage of 24 V_{DC} is set in relation to the rated input voltage at 50 – 75% of the load. This operational status generally corresponds to real-life requirements, such as a 24 V_{DC} control voltage in the system structure.

The “No load” and “Full load” limit values both determine the internal resistance of an unregulated DC power supply that is to be achieved by means of the structure. The more level the output characteristic is required to be, the more complex the component structure needed to achieve this level of “rigidity”. Limit value requirements are defined by the intended use of the application or in device standards

(e.g. VDE 0411 Part 500/EN 61131-2/IEC 61131-2):

Limit values VDE 0411 Part 500: Programmable controllers: Equipment requirements and tests		
DC voltage upper limit		
Peak value	≤ 30.0 V_S	With mains overvoltage and no load at output
Arithmetical mean	28.8 V	
DC voltage lower limit		
Peak value	≤ 19.2 V_S	At rated DC output current with mains undervoltage
Arithmetical mean	20.4 V	

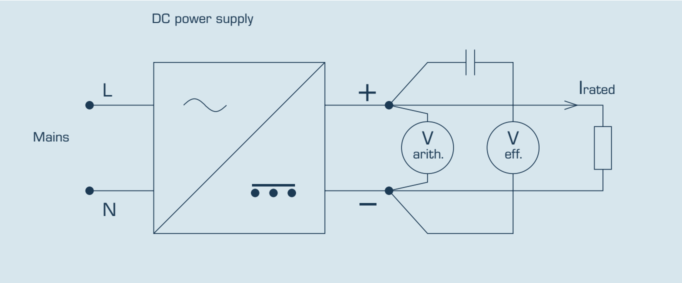
The values specified for the upper and lower voltage limits are adhered to consistently even in the case of mains overvoltage (+10%) and undervoltage (–10%) in accordance with VDE 0175/HD 475S1/IEC 60038, regardless of the load (0 – 100%) associated with our DC power supplies. Operation up to +10% of the mains voltage is permissible, as the DC power supplies are not thermally overloaded up to this point.

Ripple

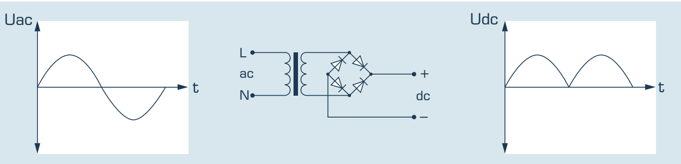
Ripple (see: DIN 41 755-1) is the ratio of the effective value of the superimposed AC voltage U_s to the value of the arithmetical DC voltage U_d and is specified as a percentage value

$$W = \frac{U_{s\ (\text{eff only ac})}}{U_{d\ (\text{arithm.})}} \times 100\ \%$$

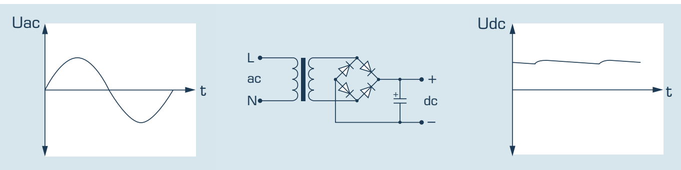
The test setup is identical for single-phase and three-phase DC power supplies:



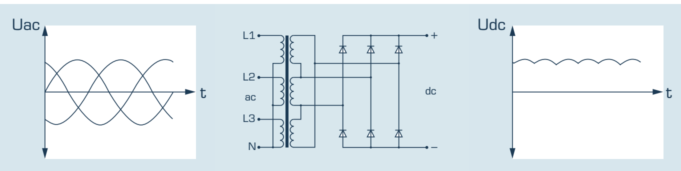
Unless otherwise specified, the ripple value refers to the load with rated DC current and an actual load impedance. The figures below show typical circuits for unregulated DC power supplies and the ripple levels associated with them:



Input 1-phase, 50 Hz **B4 circuit** **W = 48%** **Ripple = 100 Hz**



Input 1-phase, 50 Hz **B4 circuit with C ~1,5 mF/A** **W ~5%** **Ripple = 100 Hz**



Input 3-phase, 50 Hz **B6 circuit** **W = 4,2%** **Ripple = 300 Hz**

Mains buffering

Particularly where unregulated DC power supplies are concerned, it is often necessary to prevent mains interruptions that last just a few milliseconds (e.g. as a result of switching processes) from leading to control errors. An additional circuit containing a charging capacitor, which is connected in parallel to the DC output, is able to store energy and redeliver it in the event of a brief mains interruption. The capacitance of the additional charging capacitor can be determined as follows:

$$C = \frac{I_{dc} \times t}{dU_{dc}}$$

C	Capacitance of the capacitor charging (mF)
t	Power interruption (MS)
I_{dc}	removed DC (A)
dU_{dc}	permissible DC voltage reduction relative to the power failure duration (V)

Example: Switching processes in the mains lead to mains interruptions lasting 1.5 ms. The output voltage of an unregulated DC power supply is 22 V_{DC} at a rated DC current of 3 A_{DC} and the rated (supply) input voltage. What size does the additional charging capacitor need to be in order to prevent the output voltage dropping below 21 V_{DC}?

$$C = \frac{3\ A_{dc} \times 1{,}5\ ms}{1\ V_{dc}}$$

In this case, a circuit with 4700 µF (next-highest standard value) enables the required level of mains buffering.

Note:

1. When adding to a circuit at a later point, it is necessary to check whether the rectifier (in the existing DC power supply) is able to supply the additional energy required at the point when the system is switched on without the power supply being destroyed as a result.
2. In the case of DC power supplies with high ratings, it is often enough to simply equip the sensitive control component (which consumes a low amount of current) with an additional charging capacitor via a decoupling diode.

A side benefit of a circuit containing a supplementary charging capacitor is that it has a positive effect on ripple levels. In most applications, however, the benefits of mains buffering are far more significant than those associated with lower ripple levels.

Regulated DC power supplies

Regulated DC power supplies feature electronic regulation circuits in order to keep the DC output voltage (or, in special cases, the DC output current) at a particular value as consistently as possible. Influences such as (supply) input voltage fluctuations or variations in the output load are regulated electronically in the assigned functional area.

The DC output voltage ripple is in the millivolt range and is largely unaffected by the load at the output. The DC output voltage stability settles in the range of 1 - 3%, depending on the switching concept. In many cases, regulated DC power supplies also offer the advantage of electronic current limiting. This can provide protection both for the connected consumer and in the event of the DC power supply being overloaded.

There are two different concepts:

- Linearly regulated DC power supplies
- Clock pulse-controlled DC power supplies

Linearly regulated DC power supplies

These DC power supplies are often also referred to as linear regulators or longitudinal regulators.

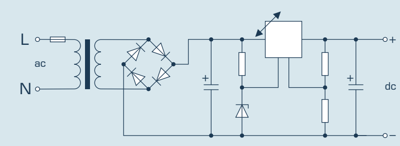
In many cases, the basic structure consists of a 50 Hz transformer (which meets the safety requirements for electrical isolation from the mains), rectification with filtering, and a regulator. This regulator chiefly consists of power transistors and behaves in the same way as a variable resistor. The electronics ensure a stable DC output voltage. The actual value of the DC output voltage is queried at the output by means of a voltage distributor and continually compared with the setpoint (reference voltage, frequently generated by a Zener diode). These two correcting variables permanently control the regulator and determine the DC output voltage level.

Benefits:

- No safety issues in terms of mains isolation by means of 50 Hz transformer
- Multiple input voltages can be implemented easily thanks to primary tapping
- Straightforward circuit concept
- Short settling times
- Extremely low ripple
- Very few EMC problems
- Inexpensive concept up to approx. 50 W

Drawbacks:

- Low level of efficiency
- Efficiency highly dependent on mains voltage fluctuations and the DC output voltage level; approx. 60% at 24 V_{DC}, 35% at 5 V_{DC}
- Pronounced heat build-up, particularly with high DC output currents
- High construction volume
- High weight



Linear regulator

Clock pulse-controlled DC power supplies

These power supplies are also often referred to as switched-mode regulators or switched mode power supplies. In contrast to linearly regulated DC power supplies, where the DC voltage and DC current are regulated continuously, these quantities are switched (chopped) in the case of clock pulse-controlled DC power supplies. As part of this concept, the **power semiconductors used are operated exclusively as switches**. Only slight switching and forward losses occur, which explains the high levels of efficiency that characterise these power supplies.

Regulation is carried out either by modifying the pulse duty ratio (switch-on time to switch-off time) with a constant frequency or by modifying the frequency with a constant pulse duty ratio. The **square-wave voltage** generated as a result can be transformed into practically any voltage level and rectified. A **high clock pulse frequency** ranging from around 20 kHz up to several MHz enables the **use of small ferrite transformers, inductors and capacitors**.

For the sake of clarity, the figures below do not show the (mains) transformer or the rectifier connected downstream. This **intermediate circuit** usually forms the input for the **DC-DC converters**.

A fundamental distinction is drawn between two transformational converter principles on the basis of their transformation behaviour:

With a **feed forward converter**, energy is transported between the primary and the secondary circuit with a closed semiconductor switch.

Description: With the semiconductor switch closed, energy is delivered to the output via the first secondary diode (connected in series to the secondary winding). If the semiconductor switch is open, however, then this diode acts as a block, and the second secondary diode takes on the current (magnetically stored energy) from the storage reactor and delivers it to the output. The third winding and the diode connected in series limit the voltage level at the semiconductor switch. In addition, the energy stored in the ferrite transformer during the switch-on phase is delivered back to the input source (intermediate circuit) during the switch-off phase.

The flyback converter first stores the energy in the ferrite transformer whilst the semiconductor switch is closed, until it is ready to deliver it to the secondary circuit during the blocking phase.

Description: The ferrite transformer collects energy whilst the semiconductor switch is closed. The diode in the secondary circuit acts as a block and no energy is transferred to the output. It is only once the semiconductor switch is opened that the polarity is reversed, the diode becomes conducting and the energy stored in the ferrite transformer is transferred to the output in the secondary circuit.

The key benefits of the feed forward converter are a clean DC output voltage as well as higher performance, e.g. when acting as a push-pull feed forward converter in a half-bridge or full-bridge circuit. The flyback converter is a cheaper option by comparison, but its operating behaviour is less stable.

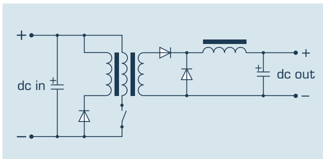
Two reactor converter principles are often used for applications **without electrical isolation** between the input (intermediate circuit) and output

The **step-down converter** is able to convert a higher DC input voltage into a lower DC output voltage (with a correspondingly higher DC output current).

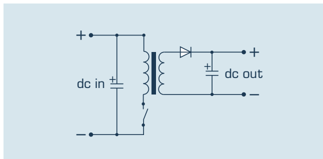
Description: When the semiconductor switch is closed, current flows to the output via the reactor. In the reactor, part of the current is converted into magnetic energy, which in turn is converted back into electrical energy during the blocking phase (with the semiconductor switch open). The polarity at the reactor reverses so that the current can flow to the output via the diode. This means that the DC output voltage is always lower than the DC input voltage.

With the **step-up converter**, it is possible to convert the DC input voltage into a higher DC output voltage (with a correspondingly lower DC output current).

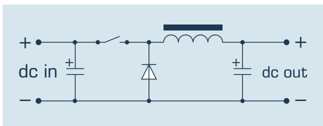
Description: When the semiconductor switch is open, current flows to the output via the reactor and the diode connected in a way that enables it to act as a feed-through. When the semiconductor switch is closed, electrical energy is converted into magnetic energy in the reactor and stored there. During this process, the diode prevents the output from being short-circuited. When the semiconductor switch is open, the magnetic energy is converted back into electrical energy and a DC voltage builds up in series to the output. This means that the DC output voltage is always higher than the DC input voltage..



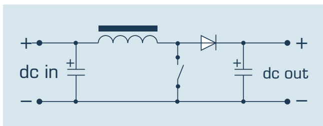
Feed forward converter



Flyback converter



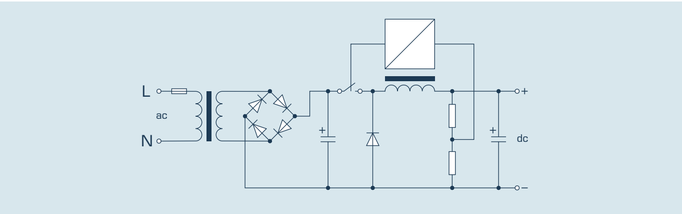
Step-down converter



Step-up converter

Secondary clock pulse-controlled DC power supplies

These DC power supplies are also referred to as secondary switched-mode regulators (amongst other things). Their main function is shown by the typical circuit concept below.



A **50 Hz transformer** which meets the safety requirements for electrical isolation is used for adaptation to the mains. Following rectification, an intermediate circuit DC voltage which is higher than the desired DC output voltage should be produced at the charging capacitor. A **step-down converter** with a typical **switching frequency of > 20 kHz** is connected downstream of the intermediate circuit. The regulator controls (clock pulse-controls) the semiconductor switch in a way that establishes a stable DC output voltage. As part of this, the reference voltage integrated into the regulator is compared with the actual value of the output (generated by the voltage distributor). These correcting variables are used to regulate the switch-on and switch-off times for the semiconductor switch.

Benefits:

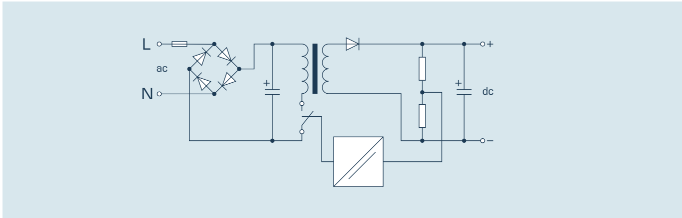
- No safety issues in terms of mains isolation by means of 50 Hz transformer
- Multiple input voltages can be implemented easily thanks to primary tapping
- Circuitry even easier to understand than before
- Relatively high efficiency level; largely unaffected by mains voltage fluctuations and the DC output voltage (approx. 70 – 80%)

Drawbacks:

- High construction volume
- High weight
- Relatively long settling times (compared to linearly regulated DC power supplies) which depend on the switching frequency
- Relatively unclean DC output voltage (spikes, wide-band spectrum)
- EMC problems due to clock pulse control, but a relatively low noise leve

Primary clock pulse-controlled DC power supplies

These DC power supplies are also referred to as primary switched-mode regulators (amongst other things). Their main function is shown by the circuit concept below, which is used in many applications



A **converter** with a typical **switching frequency of > 20 kHz** is connected downstream of the intermediate circuit. The regulator controls (clock pulse-controls) the semiconductor switch in a way that establishes a stable DC output voltage. As part of this, the reference voltage integrated into the regulator is compared with the actual value of the output (generated by the voltage distributor). These correcting variables are used to regulate the switch-on and switch-off times for the semiconductor switch.

With this type of circuit concept, the ferrite transformer must meet the safety requirements for electrical isolation from the mains; this also applies to the regulator (by using an optocoupler, for example).

Benefits:

- Extremely high efficiency level; largely unaffected by mains voltage fluctuations and the DC output voltage (approx. 75% to over 90%)
- Low construction volume
- Low weight
- Option of wide input voltage range
- Option of AC and DC input voltage, depending on circuit concept

Drawbacks:

- Complex circuitry (number of components; likelihood of failure)
- Relatively long settling times, which also depend on the switching frequency
- Relatively unclean DC output voltage (spikes, wide-band spectrum)
- EMC problems due to clock pulse control, plus a high noise level

Stability

The stability of the DC output voltage of regulated DC power supplies is primarily determined by the **functional area** of the assigned requirements. This includes:

- **Line regulation**
  Defined between the permissible limit values for the lowest and highest input voltage, usually when the rated DC output current is at its maximum (but only with half the rated DC output current in accordance with VDE 0557/ EN 61204/IEC 61204). Line regulation is typically –15% to +10% relative to the rated input voltage, e.g. 230 V_{AC}.
- **Load regulation**
  Defined with the least favourable input voltage within the range where line regulation is taking place with load variations from 0 – 100% of the rated DC output current. Regulated DC power supplies without no-load-proof capability should be evaluated at the lower limit values of 10%, 25% or 50% and designated accordingly.
- **Effect of temperature**
  Often, it is particularly useful to look at how temperature affects the stability of the DC output voltage in the following worst-case scenarios:
  - Cold DC power supply at lower limit value of the assigned ambient temperature (e.g. 0°C) and minimum permissible load
  - DC power supply at operating temperature and in steady-state condition, at upper limit value of the assigned ambient temperature (e.g. 50°C) and maximum load.

In line with the relevant standards (see: VDE 0557/EN 61204/IEC 61204), the effect of temperature is represented as the temperature coefficient in % or °C.

Stability refers to the **potential variation in the DC output voltage** relative to the functional area of various parameters, such as line regulation, load regulation and temperature. The value assigned by the manufacturer is specified as a percentage **relative to the rated DC output voltage**.

Typical values:
0.5% for linearly regulated DC power supplies
2% for clock pulse-controlled DC power supplies

Tolerance

The DC output voltage of regulated DC power supplies **can normally be set** and referred to the rated value. The setting accuracy (resolution) depends on the circuit concept and the assigned setting range. Typical setting ranges (relative to a rated DC output voltage of 24 V_{DC}) are ±5% or 22 V_{DC} to 28.8 V_{DC}. It is important to remember that the **stability** of the DC output voltage may **change** if the rated value setting is different!

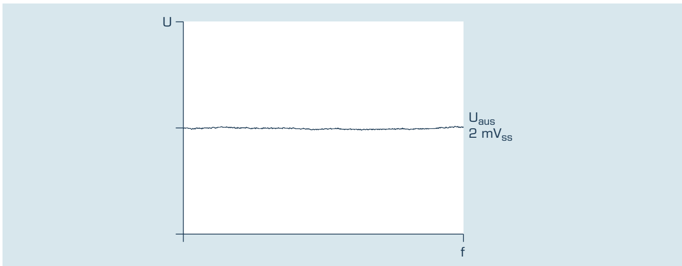
In the case of regulated DC power supplies which cannot be set, the DC output voltage tolerance is usually 2% or 5%, relative to the rated value

Ripple

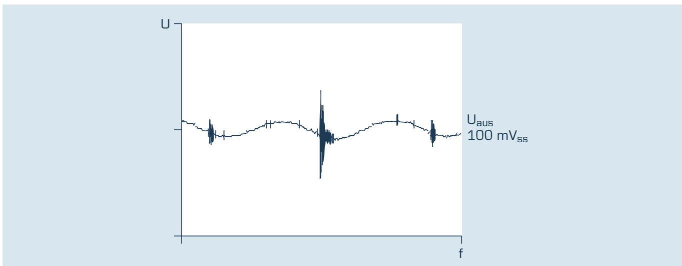
In contrast to unregulated DC power supplies with ripples in the volt range, regulated DC power supplies only demonstrate very low levels of ripple. For this reason, ripple is no longer specified as a percentage, but rather as an absolute voltage value in mV_{pp} (millivolt peak-to-peak). As far as possible, it is also independent of the DC output current level in the assigned functional area. Non-sinusoidal ripples (e.g. spikes) which exhibit wide-band frequency behaviour can occur as a result of regulating and switching procedures within the regulated DC power supply.

The quality of the DC output voltage ripple also differs depending on whether the DC power supply is linearly regulated or clock pulse-controlled.

If the supply DC voltage needs to be as “clean” as possible (as is the case in measurement and control technology, for example), then the linearly regulated DC power supply should be given preference over the other type of power supply..



Linearly regulated

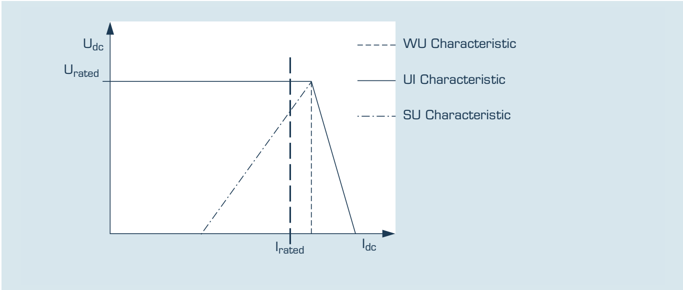


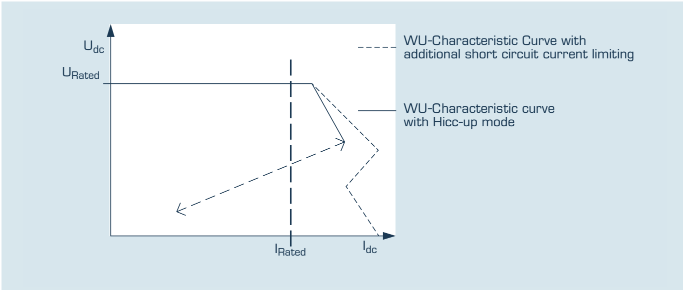
Clock pulse-controlled

Current limiting

Regulated DC power supplies usually feature an electronic current limiting function that acts on the output. This not only prevents the load (consumer) from becoming a source of danger (i.e. creating a risk of fire) as a result of excessive current consumption, but also protects the DC power supply itself from being destroyed due to a defective load (consumer).

Depending on the assigned requirements profile and the selected circuit concept, the following load characteristics (see: DIN 41 745, DIN 41 772) or combinations of these are often used:





Combination Example

Mains buffering

The mains buffer time - also known as the dwell time (see: VDE 0557/EN 61204/ IEC 61204) – is the time during which a regulated DC power supply is still able to supply the rated DC output current even though the (supply) input voltage has been switched off. In this case, the rated DC output voltage remains within the assigned tolerance range and the (supply) input voltage was at 90% of the rated value before it was switched off.

The most efficient way to increase the mains buffer time is when the**intermediate circuit charging capacitor** of the regulated DC power supply (see the “Primary clock pulse-controlled DC power supplies” wiring diagram, for example) has a **high capacitance** and is therefore able to store a large amount of energy. The charging capacitor which is connected in parallel to the output of a regulated DC power supply can, in principle, be increased in size as well in order to achieve a longer mains buffer time, although this may lead to undesirable effects on the regulating characteristics of the circuit. Furthermore, the DC output voltage may only build up slowly following switch-on, depending on the electronic current limiting concept selected.

In most cases, mains buffer times of 3 - 10 ms can be achieved; this may even be increased to 20 ms with some additional effort. To provide buffering for longer periods (e.g. for backing up data on storage media), a UPS (uninterruptible power supply) is usually required.


POWER
BLOCK
PSR 500/24-40
DC
OK
24 Vdc/40 A
Output
ADJ
Input
24Vdc/10A
Output