Description DC/DC Converters

# Definition of the Output Data

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

## Voltage Deviation in the Event of a Variation in Load (static)

Depending on the current load, there is a slight change in the voltage, the so-called control deviation, on all voltage regulators used.
It is specified in the data sheets as the maximum magnitude of a load variation of 0...100% of the nominal current.
Measurement is conducted directly on the female connector with sense leads connected at the measuring point.

## Voltage Deviation in the Event of a Variation in Input Voltage

If the input voltage is varied, the output voltage will also vary slightly.
The data sheets specify the maximum control deviation of the output voltage on changing the input voltage between $V_{INmin}$ and $V_{INmax}$.
Measurement is conducted directly on the female connector with sense leads connected at the measuring point.

## Switching Frequency Ripple

The output voltage of the power supply is characterized by a slight superimposed AC voltage component, the operating frequency ripple.
This results from charging and discharging of the secondary energy story mechanisms with the switching frequency of the power supply.
Measurement is conducted directly on the female connector with sense leads connected.
The value in the data sheet is the peak to peak value $V_{R\ PP}$ as shown in figure 1.

## Superimposed Switching Spikes

Fast current and voltage variations occur when the power transistors are switched on and off. This results in high-frequency transient impulses superimposed on the output voltage of the power supply.
These switching spikes are poor in energy.
The data sheet values are measured directly on the female connector without sense leads with a bandwidth of 20MHz.
They are peak to peak values $V_{S\ PP}$ as shown in figure 1.

## Dynamic Voltage Deviation and Regulation Time

Voltage overshoot and undershoot occur in the case of abrupt load variations of the output of the DC/DC converter. See figure 2.
Causes of the voltage deviation (ΔV) is the energy stored in the output circuit and the limited speed of the controller.
The regulation time (Δt) is defined as the time until the output voltage returns to remain within a tolerance band after a load variation. The tolerance band is defined as ± 20mV. The voltage and current characteristics as a function of time are shown in figure 2.
Measurement is conducted directly on the female connector with sense leads connected.

Fig. 1
Output voltage

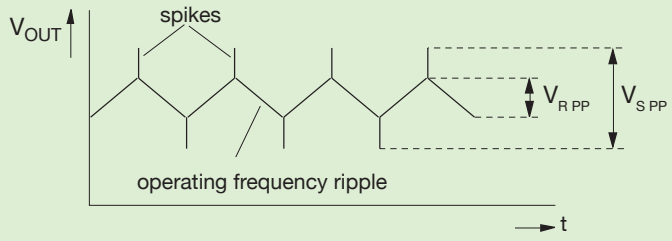
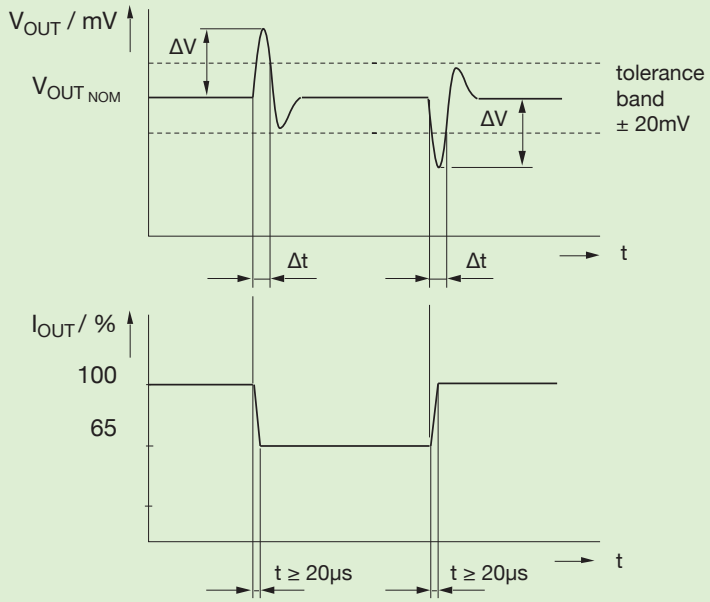



Fig. 2
Voltage variation of the output when subject to a defined sudden load variation



# Applications

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

CE
EMC + Safety tested

## Connection of the Load

Load lines and sense leads should be laid to the load twisted or screened.

**Load lines**

It is recommended that the load line is terminated on the load with a ceramic capacitor even if no sense leads are connected.

**Sense leads**

The power supplies are generally ready to operate even if sense leads are not connected.

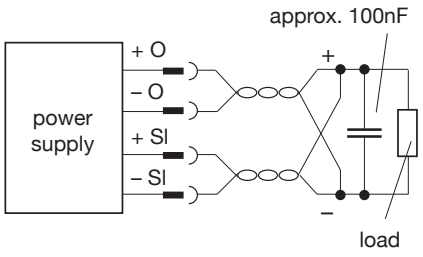
**External bridges do not have to be wired.**

In many practical applications, the devices are operated without sense leads being connected. E.g. in the case of short (low impedance) load lines or low load alternation.

The actual value of the voltage is measured directly at the load through the sense leads. Voltage drops through connectors and load lines are automatically compensated by the electronic regulation circuit. The stabilisation is designed for 0.25V voltage drop per load line.

To this end no changes are to be made to the power supply itself. Only the sense leads are externally connected to the load lines directly at the load.

**The load lines may not be disconnected before the sense leads, or the sense leads may not be connected before the load lines, as this will lead to the destruction of the device.**




## Input Voltage

The DC/DC-converters feature large smoothing capacitors at the input. External filtering of a rectified AC voltage is thus only required conditionally. The permitted superimposed AC voltage is 10% of the supply voltage.

If there is a higher superimposed AC voltage, we recommend additional smoothing capacitors.

The output voltage is only negligible influenced by the superimposed AC voltage. (Also see decoupling diode, page 6.)

## Input Transient Protection

On DC/DC-converters, a suppressor diode is used for transient protection. This limits overvoltages at the unit input caused, for example, by switching off inductive circuits.

## Starting Inrush Current

The power drain of DC/DC-converters at the switch-on time is determined by the input capacitors of the device.

In order to selectively protect DC/DC-converters, the user requires the specification of the starting inrush current which is characterised by the current integral and the maximum current surge.

Depending on the input voltage and performance class, some of our DC/DC-converters have built-in NTC resistors to limit the starting inrush current.

These NTC resistors are high ohmic in a cold state and thus limit the starting inrush current.

On reaching their operating temperature they become low ohmic and only become effective again after they have cooled down. This is why two values are specified in our data sheet (see technical data: "unit cold" and "worst case").

For device types without NTC resistors only the "worst case" specification is listed.

**Definition**

To measure the starting inrush current, for input voltages higher than 75V a network simulation with 0.5Ω (0.4Ω + j0.25Ω) and for input voltages lower than 75V a network simulation with 100mΩ and 150µH are used. The power line is 1m long and has a line cross section of 2.5mm$^2$.

**Note**

In order that the starting inrush current for "unit cold" is not exceeded, the power supply must remain switched off for about 5 minutes at a temperature of ≤ 25°C.

## Electronic Base Load

The multiple voltage units are equipped with an electronic base load as standard. This ensures that even if the main output of the power supply is unloaded, the other outputs still can deliver their nominal power.

If the main output is loaded again, the base load switches off continuously so that the full output power of the unit is available for the load.

For continuous operation however main output should be loaded with at least 5W.

## Extern ON/OFF

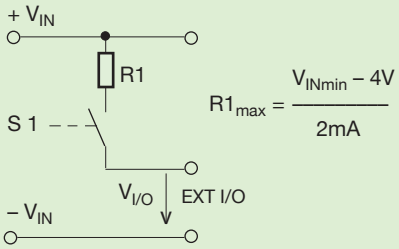
The unit can be switched on and off with an external control voltage.

The control voltage must be referred to input ground ($-V_{IN}$) and may also be derived from $+V_{IN}$ via a dropping resistor.

Voltage levels at the Extern ON/OFF-input

| | |
|---|---|
| Unit ON | ≤ 0,6V or not connected |
| Unit OFF | ≥ 4V to max. 36V |
| $V_{I/O}$ = 5V | $I_{I/O}$ ≤ 2mA |
| $V_{I/O}$ = 36V | $I_{I/O}$ ≤ 20mA |

External wiring for voltage level > 36V




S1 closed $\hat{=}$ unit off ($V_{I/O}$ ≥ 4V)

Any DC voltage referred to input ground can be used as the signal voltage.

# Applications

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

## Power Distribution

For multiple voltage units, the output power specified can be divided between the outputs as required within the maximal currents specified in the data sheet.

## Parallel Connection

Unit versions equipped with a PA connection can be connected in parallel.
Maximum 3 units may be operated in parallel in order to increase the power.
The individual PA contacts must be interconnected for this purpose so that the overvoltage protection circuit (output) integrated in the unit also switches off the power supplies operated in parallel in the event of a fault.
The load lines + and – should be interconnected in a balanced manner as possible. The sense leads should not be used.
We recommend redundancy operation in order to achieve even greater reliability.
**A connection in parallel is not suggested for multiple voltage units.**

## Electrical Isolation

On Kniel DC/DC-converters, all inputs and outputs are electrically isolated. This means that the output can be freely interconnected.
(Pay attention to the breach of security!)

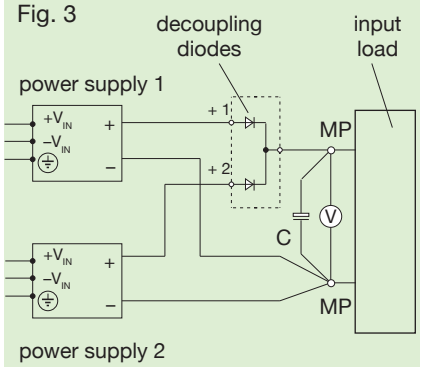
## Power Boost

The full output current of our units is available in ambient temperatures between – 25°C and + 70°C without derating. Additionally our units deliver even 20% more output power for a short time of peak loads. This is the power boost function.
The power boost can also be used as continuous power in ambient temperatures up to 45°C.

## Redundancy Operation

In order to increase the operational safety of the system the units can be switched to redundancy operation. See figure 3.
In the case of redundancy operation, the unit outputs must be decoupled by diodes.
In this operating mode, sense lead operation is impossible. Existing PA-contacts may not be interconnected.

Fig. 3




## Current Limitation

Kniel DC/DC-converters are protected against overload by a built-in current limitation circuit and are continuous short circuit proof.
The current limitation is factory set to the value specified in the data sheet. If this nominal value is exceeded the output current is limited to the maximal value and the voltage is reduced in accordance with the dimension of the overload.
The unit automatically returns to voltage control after the fault has been eliminated.
Also see thermal switch-off.

## Temperature Coefficient

The temperature coefficient indicates the maximum relative change of the output voltage per Kelvin of temperature change.

## Thermal Switch-off

In order to protect the power supply from thermal overload each device with an appropriate note in the data sheet is equipped with a thermal monitoring circuit. If the device overheats when the cooling is insufficient it switches itself off. After cooling down the power supply switches itself on again automatically.

## Overvoltage Protection (output)

The overvoltage protection feature (OVP) integrated as standard protects the connected electronic circuitry against inadmissibly high voltages. If an internal or external overvoltage occurs at the output of the power supply, a thyristor fires and shorts the output. At the same time, the DC/DC-converter is switched off. The residual voltage of the output is zero after switch-off of the DC-converter. In the case of external faults, the power supply can be placed back into operation by switching the input voltage off for approx. 1 minute, after the external fault has been remedied.

## Reverse Polarity Protection (input / output)

A reverse polarity protection circuit is installed as standard at the input and output in order to protect the unit against reverse polarity. Reverse polarity of the input circuit trips the internal fuse.
(See option decoupling diode for an alternative solution, page 5).

# Options

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

EMC + Safety tested

## PFS - Power-Fail Signal

This should always be activated if the power supply at the input of the load is at risk.
It is advisable to activate the Power-Fail Signal before the output voltage drops since this is the only way of storing important data or starting emergency routines. See figures 5 and 7.
The standard Power-Fail Signal response threshold is set to $V_{INNom}$ –20% (other settings available on request).
**On units with $V_{IN}$ = 36... 75V, the nominal operating voltage for setting the response threshold 48V or 60V must be specified by the customer**.
The power-fail signal is available separately and electrically isolated via optocouplers and can thus be freely connected.
(Pay attention to the breach of security! The spacing between optocoupler and output voltage is 0.5mm.)

### 1. PFS = f ($V_{IN}$)

- Brief mains voltage fades are bridged and no fault alarm is generated.
  Bridging time = $t_B$.
- If the input voltage remains below the response threshold for a time period longer than the "bridging time", the PFS is activated.
- After the PFS is triggered, the output voltage is still available for some time.
  This prewarning time = $t_P$ is sufficient to save data and start emergency routines.
- The total time, from input voltage failure to output voltage drop, is the buffering time : $t_{Buff} = t_B + t_P$ ;
  please refer to individual data specifications, buffering time.

### 2. PFS = f ($V_{OUT}$)

- In the event of unit overload (for multiple voltages O1), the PFS functions as a warning signal with no prewarning time.

Examples:

Wiring of the floating PFS outputs. See figures 4 and 6.

In the circuit examples below, a PF signal is generated, referred to – $V_{out}$. The signal voltage is derived from + $V_{out}$.

Fig. 4 PFS HIGH - ACTIVE

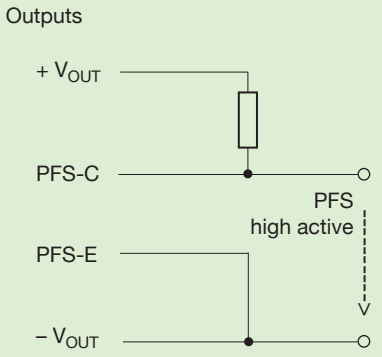
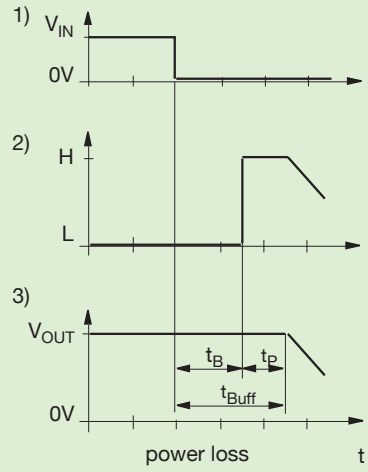



Fig. 5 Signal assignment
PFS High - Active




1) = input voltage $V_{IN}$
2) = power-fail signal
3) = output voltage $V_{OUT}$

Fig. 6 PFS LOW - ACTIVE

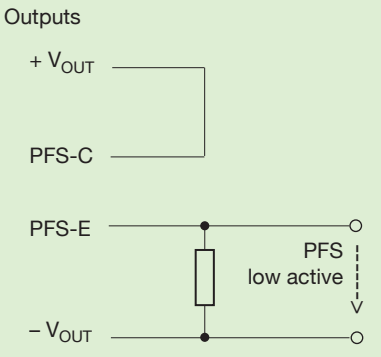
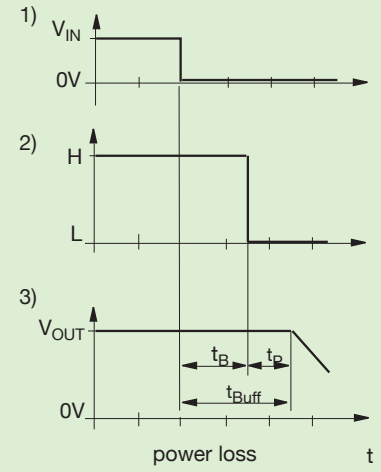



Fig. 7 Signal assignment
PFS Low - Active




1) = input voltage $V_{IN}$
2) = power-fail signal
3) = output voltage $V_{OUT}$

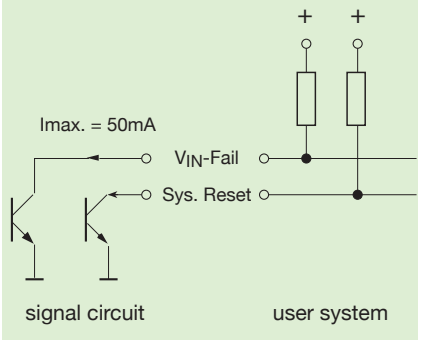
General

The maximum reverse voltage of the output transistor is 50V.
50mA can be switched at a residual voltage of 0.8V.

### VME Signals
(on request)

The two VME signals are always referred to the output voltage O1 and have open collector outputs.
In most cases the user circuitry has already got the required pull up resistors. When testing the signals without a connected user system, pull up resistors must be used.
The maximum blocking voltage $V_{CE}$ of the output transistor is 50V. A current of 50mA can be switched at a saturation voltage of ≤ 0.8V, see figure 8.
(Switching thresholds see option PFS.)

Fig. 8 Signal outputs



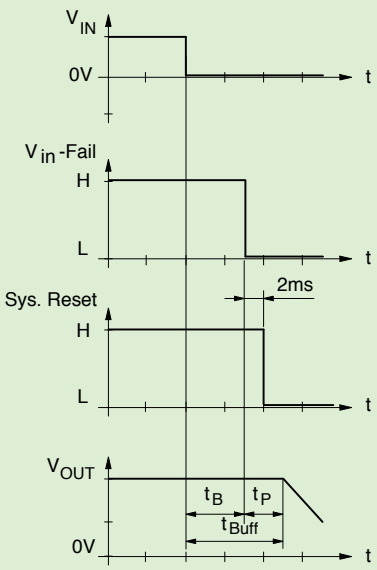

### $V_{IN}$-Fail = f ($V_{IN}$) (see figure 11)

- Brief mains voltage fades are bridged and no fault alarm is generated. Bridging time = $t_B$.
- If the input voltage remains below the response threshold for a time period longer than the "bridging time", the $V_{IN}$-Fail-signal is activated.
- After the $V_{IN}$-Fail-signal is triggered, the output voltage is still available for some time. This prewarning time = $t_P$ is sufficient to warrant the time specification according to the VME-standard (figure 9).
- The total time, from input voltage failure to output voltage drop, is the buffering time $t_{Buff} = t_B + t_P$, please refer to individual data specifications, buffering time.

### $V_{IN}$-Fail = f ($V_{OUT}$)

- In the event of unit overload (in case of multiple output only O1), the $V_{IN}$-Fail-signal functions as a warning signal with no prewarning time and without time sequence between $V_{IN}$-Fail-signal and Sys-Reset-signal.

Fig. 11




### Time Specifications According to VME Standards

Fig. 9

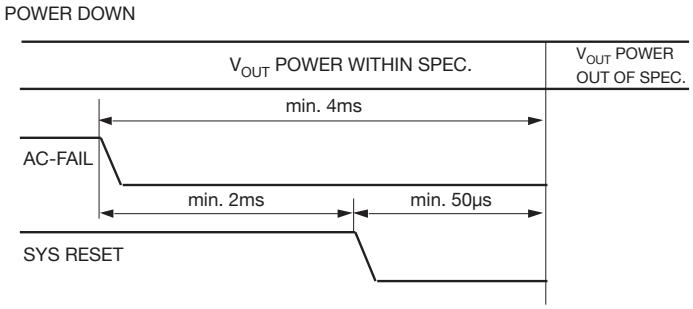
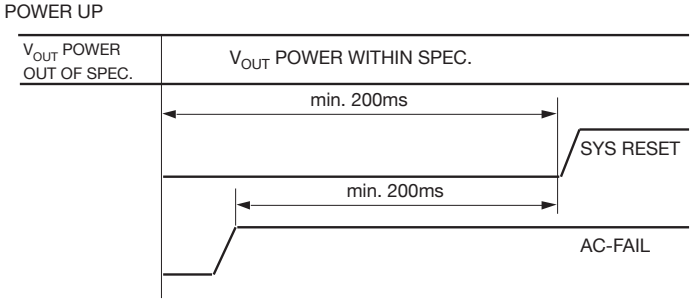



Fig. 10



# Options

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

EMC + Safety tested

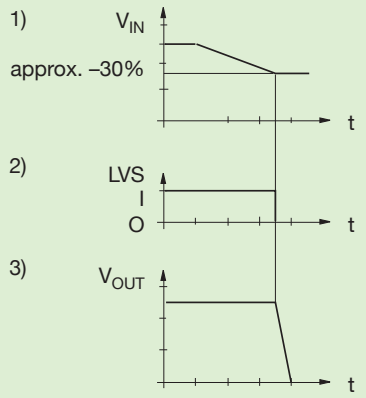
## LVS - Low-Voltage Shut-Down

DC/DC-converters are frequently powered by accumulators. The DC/DC-converter is switched off at an adjustable threshold in order to protect the accumulator against exhaustive discharge. If the input voltage is increased by approx. 10%, the unit switches back on. The switching threshold is set as standard to approx. $V_{INNOM}$ –30%, see figure 12 (other threshold settings are available on request).

**On units with $V_{INDC}$ = 36... 75V, the nominal operating voltage for setting the response threshold 48V or 60V must be specified by the customer.**

If the LVS signal is used in conjunction with the PF-(VME) signal, the time from activation of the power-fail signal through to switch-off of the DC/DC-converter (prewarning time) will depend on the capacity of the accumulator.

Fig. 12




1) Input voltage $V_{IN}$
2) Low-voltage shut-down (internal shut-down)
3) Output voltage $V_{OUT}$

## Decoupling Diode

DC/DC-converters with the "Decoupling Diode" option have a forward-biased diode built into the input circuit. This means that, should a fault occur in the feeding system, e.g. in the event of short circuit, the energy of the input electrolytic capacitors is made available to the converter output and does not drain into the power system. This means that short voltage fades do not influence the output voltage. We are thus able to guarantee buffer times only with decoupling diode fitted.

The input fuse does not blow if the polarity of the fitted decoupling diode is reversed. The efficiency reduces between 1 and 5% owing to losses in the decoupling diode. Use of the decoupling diode is recommended in the case of a supply voltage with high superimposed AC voltage.

## Mechanical System

Kniel DC/DC-converters are compact, fully plug-in power supplies. They have been designed specifically for use in subracks according to IEC 60297-3-101 (19" standard).
The rugged mechanical structure consists of aluminum.
Specifically developed press-drawn sections for heat sinks and side walls form the basis for the finely tuned system between mechanical strength, protection against electromagnetic interference and optimum heat dissipation. The front panel projects beyond the body by approx. 1/2 HP at the right and left. This produces an air slot to the neighboring module in the subrack, ensuring adequate convection cooling up to +70°C ambient temperature. This prevents mutual heating.

Degree of protection:
IP 30 according to
EN 60529/IEC 529
when fitted at the front

Mechanical load rating:
Vibration:
0.15mm double amplitude
or 2g at 5 - 500Hz
according to DIN 40046
(same values in transportation packaging)

Shock:
10g; duration 11ms
according to DIN 40046
in transportation packaging
10g, duration 18ms.

## Environmental

Operating temperature range:
see data sheet.

Storage temperature:
see data sheet.

Humidity: 95% ,
without condensation.

## Safety

### RoHS
### EU Directive 2011/65/EU

The reduction of hazardous substances in electrical and electronic equipment is an important contribution to the protection of the environment and deserves the strongest possible support from all of us.
All Kniel products/power supplies delivered after 15 January 2006 comply with EU Directive 2011/65/EU except for some customer specific products. Products not compliant with said directive are noted as such in the delivery documents.

### WEEE
### EU Directive 2012/19/EU

Directive 2012/19/EU particularly applies to short-lived consumer goods for the mass market. Kniel products are generally used as capital goods over periods of many years or even decades. Therefore our products do not belong to the intended target group of the directive. Additionally said directive focusses on complete units or systems and thus does not cover our products. None of our products can be classified into one of the categories mentioned in said directive. Hence, Kniel does not plan to provide statistical information about when our products were placed on the market. We do not offer cost-free return of our products.

Description DC/DC Converters

# Safety

DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

CE
EMC + Safety tested

## Electrical Safety

The units are designed to cover a broad range of applications. The converters are being built according to **EN 60950 / IEC 950** for safety of data processing equipment, including electrical office machines, in order that the conventional regulations applicable to different fields of application are observed.

### Important Electrical Safety Features

All output circuits are electrically isolated, both with respect to each other and with respect to the input circuit.
Electrical isolation between primary and secondary circuits by adequate clearances and creepage distances.
Every unit is subject to a high-voltage test to ensure that safe electrical isolation is actually provided.

Test voltages (proof voltages) for :

$V_{IN}$ = 18V ... 36V:

| | | |
|---|---|---|
| primary | - secondary | 1 500 Vdc |
| primary | - PE | 1 000 Vdc |
| secondary | - PE | 700 Vdc |
| secondary | - secondary | 700 Vdc |

$V_{IN}$ = 36V ... 75V:

| | | |
|---|---|---|
| primary | - secondary | 2 500 Vdc |
| primary | - PE | 1 500 Vdc |
| secondary | - PE | 700 Vdc |
| secondary | - secondary | 700 Vdc |

$V_{IN}$ = 75V ... 300V:

| | | |
|---|---|---|
| primary | - secondary | 3 800 Vdc |
| primary | - PE | 2 400 Vdc |
| secondary | - PE | 700 Vdc |
| secondary | - secondary | 700 Vdc. |

**Note:**

On no account do we recommend a repeat test by the customer according to EN 60950/IEC 950 since this could damage semiconductors and insulation. If a further high-voltage test on each unit is mandatory, the test conditions must be coordinated with Messrs. Kniel. Otherwise, we are unable to accept warranty.

### SELV

Kniel power supplies with an output voltage of max. 55Vdc keeps to the requirements of SELV circuits. SELV circuits need a surely electric isolation to the mains.

### Definition of the Ambient Conditions According to EN 60950/IEC 950

Pollution Severity II

Only non-conductive pollution occurs. Temporary conductivity as the result of condensation must be anticipated occasionally.

Overvoltage Category II

Equipment of overvoltage category II is intended for use in installations or parts thereof in which lightning overvoltage does not need to be taken into consideration. This includes, for instance, domestic electrical appliances. Overvoltages resulting from switching operations must be taken into consideration.

### Definition of the Safety Class

The DC/DC-converters are constructed in accordance with safety class I. With this safety class, all exposed parts must be connected to the PE wire with low resistance. Each unit is tested before delivery.

### Leakage Current

The maximum permitted leakage current of permanently installed equipment is 3.5mA. The actual leakage current on Kniel DC/DC-converters is well below this value.

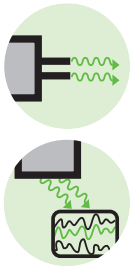
### More Tests

A fire resistance test, an overload test and a test of mechanical load capability are also conducted according to EN 60950/IEC 950.
A test designated "operation not as intended and incorrect operation" is conducted in order to allow us to assess the risks and dangers if the unit is operated not as intended.

## EMC

Kniel DC/DC-converters fully meet the legal requirements for emitted interference according to EN 55022/55011 as well as the interference immunity according to EN/IEC 61000-6-2.
To fully serve this wide application area the regulations for the domestic and commercial sectors apply for emitted interference, and the regulations for the industrial sector apply for the interference immunity. This means in each case, that a more stringent limit value is valid.

**Emitted Interference According to EN 55022/55011 (emission)**



DC/DC-converters generate radiated interference as the result of high-frequency, periodic switching operations. The higher the switching frequencies and the steeper the leading or trailing edges of currents and voltages are, the greater will be the high-frequency component of the noise spectrum.
The noise spectrum is considered over a bandwidth of 150KHz to 1 000MHz.
The noise voltage up to 30MHz on the lines is measured and weighted. Either as a mean value measurement*1 or as a quasi-peak measurement*2.
In the higher frequency band between 30MHz and 1 000MHz, the radiated interference fields are recorded at 10m distance.
The permitted limit values are intended to prevent neighboring electronic equipment being affected by interference. Corresponding limit values are stipulated in EN 55022.
Limit curve B must be observed if the DC/DC-converters are used on residential or commercial premises or in public facilities. See figure 13 and figure 14.
The limiting values for industrial applications are defined in EN 55011.

Fig. 13
Limit value class
150KHz to 30MHz

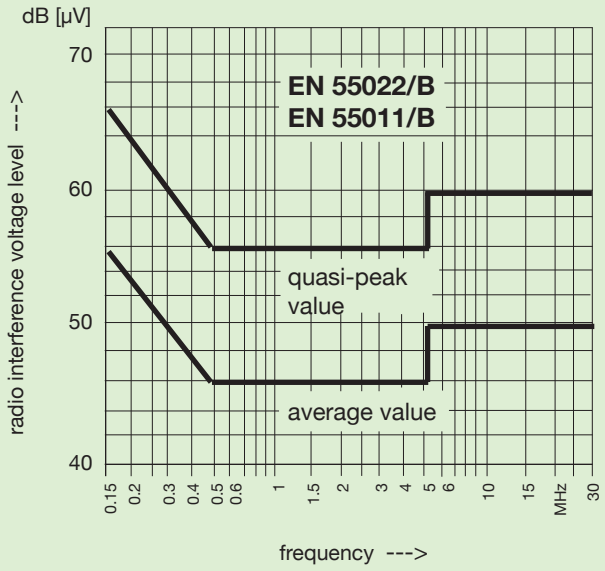
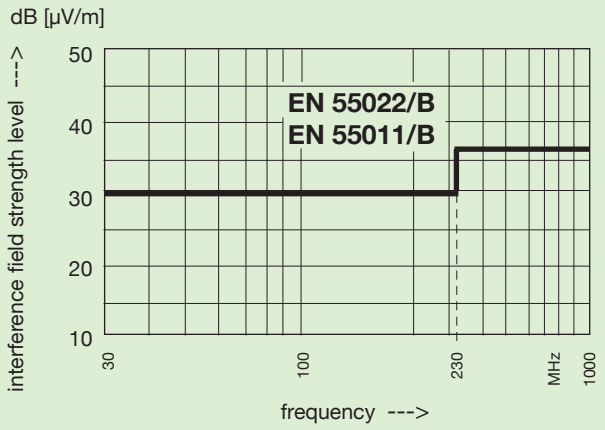



Fig. 14
Limit value class
30MHz to 1 000MHz




*1 = The mean value is the absolute mean value of a signal.

*2 = In the case of a quasi-peak measurement, the peak value of noise voltage is evaluated in conjunction with the pulse frequency.

# Description DC/DC Converters

## EMC

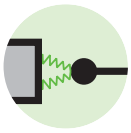
DC, DCD, DCM, DCQ, FDC, FDCD, FDCM, FDCQ

CE
EMC + Safety tested

**Interference Immunity According to EN/IEC 61000-6-2**

The immunity to electromagnetic interference, as occurs in practice as the result of static discharges, switching operations on inductive circuits and capacitors, as the result of lightning strike and as the result of high-frequency pick-up, is verified by a series of tests.
Limit values according to EN/IEC 61000-6-2 (industrial application) are taken as a basis for Kniel DC/DC converters.

**ESD - Immunity to Electrostatic Discharge According to EN/IEC 61000-4-2**

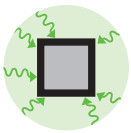


This test verifies the immunity to electrostatic discharge as may occur from the operator's body when touching the equipment. Static discharges as can arise between different objects are also covered with this test.
The required test voltage (proof voltage) is:

8kV - discharge in air
4kV - contact discharge.

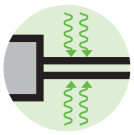
Evaluation criterion B.
Kniel DC/DC converters meet evaluation criterion A.

**Immunity to Electromagnetic Fields According to EN/IEC 61000-4-3**



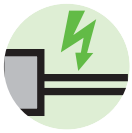
Electromagnetic fields are generated by radio-telephony equipment, radio broadcasting stations, TV stations and other industrial electromagnetic interference sources. The aim of this standard is to ensure immunity of equipment. The test covers the frequency band from 80MHz to 1 000MHz with a field strength of 10V/m.
The measurement is conducted in a booth.
No limit values or maximum permissible deviations are stipulated in the standard.
Our test criterion is:
During this test, the output voltage may not deviate more than 2% from the set value.

**Fast Electrical Transients Burst Test According to EN/IEC 61000-4-4**



Bursts occur during switching operations, e.g. disconnecting inductive loads and bounce of relay contacts, in all electrical power supply systems.
The burst test is intended to guarantee that the function of electrical loads is not impaired on a sustained basis as the result of these extremely brief voltage peaks.
The standard demands:
Assessment criterion B.
Kniel DC/DC converters comply with evaluation criterion A.

**Immunity to Surge Voltages According to EN/IEC 61000-4-5**

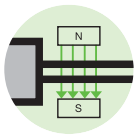


This type of surge voltage occurs in supply systems as the result of switching large inductive circuits or capacitor banks, as the result of short-circuits in the system or as the result of lightning strike.
A possible voltage amplitude of 500V is assumed for DC power systems.
As demanded, compliance to evaluation criterion B is given.

**Immunity to Conducted Interference Induced by High-Frequency Fields According to EN/IEC 61000-4-6**

In the frequency band 150kHz to 80MHz, the equipment is subject to modulated fields which induce noise voltages of 10V in the supply lead.
No limit values or maximum permissible deviations are stipulated in the standard.
Our test criterion is:
During this test, the output voltage may not deviate more than 2% from the set value.

**Magnetic Field with Energy Frequency According to EN/IEC 61000-4-8**




In the frequency range between 50Hz and 60Hz the device is applied with 30A/m. There must be no interference.
Kniel DC/DC-converters comply with assessment criterion A.

**Collapse of Voltage and/or Voltage Interruptions According to EN/IEC 61000-4-11**

The requirements demanded by EN/IEC 61000-4-11 for collapse of voltage and/or voltage interruptions are fully met.

**Note**

Compliance with the specified standards applies only to the Kniel power supplies.
If the power supply is integrated in an overall system, it is the user's obligation that the complete system meets the applicable standards.
Kniel is unable to assume warranty for this owing to the wide variety of applications.
Please consult Kniel regarding test conditions if the interference immunity tests are to be repeated.

Explanation Evaluation criterion

A : In this test the function may not be influenced in any way.

B : Partial loss of power or function. After completing the test the unit must operate within its specification again.