AMK AMKASYN

VARIABLE SPEED DRIVES

Application Note No. AP 2008_05-1e

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Author: KOJ

Topic:

Extended safety function for the operation on increased intermediate circuit voltage

Pertains the devices:

KWZ1(-EC) to KWZ5(-EC)	(Rev. 1.02)
KWD1(-0N) to KWD2 (-0N) and KWD5	(Rev. 3.14)
KW2 (-0N) to KW8	(Rev. 3.13)
KW10 and KW20	(Rev. 3.13)
KW40 and KW60	(Rev. 3.13)
KW100	(Rev. 4.00)
KW100 *AT*	(Rev. 3.12)

Contents

1 Glossary

DC - Operation	Inverter output frequency < $f_{out\ DC}$ $n\left[\frac{1}{\min}\right] = \frac{f(Hz)}{p} * 60$
p	Pole pair number of the motor
f_{out}	Output frequency of the inverter
$f_{out\ DC}$	Output frequency <f_{out} (crossover frequency $f_{out\ DC}$)
I²t	Safety from thermal overload in dependency of the output current frequency and the time t
$I_{max\ DC}$	Maximum current in DC - operation
KES	Compact rectifier unit with sinus shaped feedback
k_{red}	Reduction factor of the maximum current
KW	Compact inverter
PWM	Internal cycle frequency of the inverter
$T_{ol\ 800V}$	Maximum overload time for UZ 800 V
$T_{ol\ fout\ DC}$	DC overload time for UZ_{DC}
$T_{ol\ x}$	Overload time for variable intermediate circuit voltage
UZ_{DC}	Threshold intermediate circuit voltage where the linear reduction of the I²t limit value begins
UZ_x	Variable intermediate circuit voltage
I_{max}	Maximum current at crossover frequency $f_{out\ DC}$ without reduction
$I_{max\ (UZ)}$	Maximum current at crossover frequency $f_{out\ DC}$, reduction with UZ
UZ	Intermediate circuit voltage
(-EC)	KWZ EtherCAT version

2 Introduction

With the release of the rectifier unit KES the KW inverter can be operated on a permanently increased intermediate circuit voltage (UZ 600 V … 765 V).
With increasing intermediate circuit voltage the power loss in the KW inverter rises. To ensure a constant thermal protection against overload, the existing protective functions were extended depending on the device size. The following device-specific changes were made.

1. **Pertains the devices KW40, KW60 and KW100**
   Changes in the I^2t monitoring depending on the intermediate circuit voltage
   Changing the crossover frequency $f_{out\ DC}$
   (see chapter 4)

2. **Pertains the devices KW10 and KW20**
   Changes in the maximum current depending on the intermediate circuit voltage
   Changing the crossover frequency $f_{out\ DC}$
   (see chapter 5)

3. **Pertains to devices: KWD1 (-0N) to KWD2 (-0N) and KWD5**
   KW2 (-0N) to KW 8
   KW10 and KW 20
   KWZ1 to KWZ 5
   Changing the crossover frequency $f_{out\ DC}$
   (see chapter 6)

Note:	The extended protective function (item 1. I^2t monitoring) in case of increased intermediate circuit voltage is only effective in connection with the stated revision status and the firmware status as of KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545). If ignored, this can lead to device failure.

Note:	The extended protective function (item 2. maximum current reduction) in case of increased intermediate circuit voltage is only effective in connection with the stated revision status and the firmware status as of KW-R03 V3.16 2007/48 (part no. 201970) or KW-R03P V5.16 2007/48 (part no. 201971) If ignored, this can lead to device failure.

Note:	The extended protective function (item 3. maximum current reduction) changing the crossover frequency is only effective in connection with the stated revision status and the firmware status as of KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no.29919) and KWZ V1.00 2007/29 (T.-Nr. 201835) or KWZ-EC V1.00 2007/31 (T.-Nr. 201858). If ignored, this can lead to device failure.

3 What's new - Overview

All devices of the KW series are affected

Devices	As of rev.	(new) function	Change	Supported from firmware version
KWZ1 (-EC) **… KWZ5(-EC)**	1.02	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz	Increase from 0.2 Hz to 1 Hz	KWZ V1.00 2007/29 (part no. 201835) und KWZ-EC V1.00 2007/31 (part no. 201858)
KWD1 (-ON)... KWD2 (-ON) and KWD5	3.14	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz	Increase from 0.2 Hz to 1 Hz	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no.29919)
KW2 (-ON) **…. KW8**	3.13	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz	Increase from 0.2 Hz to 1 Hz	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no.29919)
KW10 **KW20**	3.13	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz Maximum current reduction for an increased intermediate circuit voltage	Increase from 0.2 Hz to 1 Hz	KW-R03 V3.16 2007/48 (part no. 201970) and KW-R03P V5.16 2007/48 (part no. 201971)
KW40	3.13	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz Reduction of the I^2t time for DC operation with increased intermediate circuit voltage	Increase from 0.2 Hz to 0.4 Hz	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)
KW60	3.13	Crossover frequency $f_{out\ DC}$ for PWM 8 kHz Reduction of the I^2t time for DC operation with increased intermediate circuit voltage	Increase from 0.2 Hz to 0.8 Hz	
KW100 **KW100 *AT***	1.04 3.12	Crossover frequency $f_{out\ DC}$ for PWM 4 kHz and PWM 8 kHz Reduction of the I^2t time for DC operation with increased intermediate circuit voltage	Increase from 0.2 Hz to 0.8 Hz	
KW100 (-S3)	4.00	Crossover frequency $f_{out\ DC}$ for PWM 4 kHz and PWM 8 kHz Reduction of the I^2t time for DC operation with increased intermediate circuit voltage	Increase from 0.2 Hz to 0.5 Hz (for PWM 4 kHz) Increase from 0.2 Hz to 1.5 Hz (for PWM 8 kHz)	

4 Reduction of the I²t time for DC operation with an increased ZK-Spg (KW40-KW100)

The following chapter affects the devices KW40 and KW60 as of the rev. status 3.13 and KW100 *AT*rev. status 3.12 and KW100 rev. status 1.04 with the firmware status as of KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)

With the introduction of the KES devices new requirements are created for the I²t monitoring of the KW inverter, in particular in the DC operation (motor standstill).
The adjustable intermediate circuit voltage of the KES devices requires an evaluation of the I²t limit value dependant on the intermediate circuit voltage.

A permanently increased intermediate circuit voltage requires a linear reduction of the I²t limit value as of a specific intermediate circuit voltage UZ_{DC} (device specific), to ensure a continuous thermal protection of the inverter in DC operation.

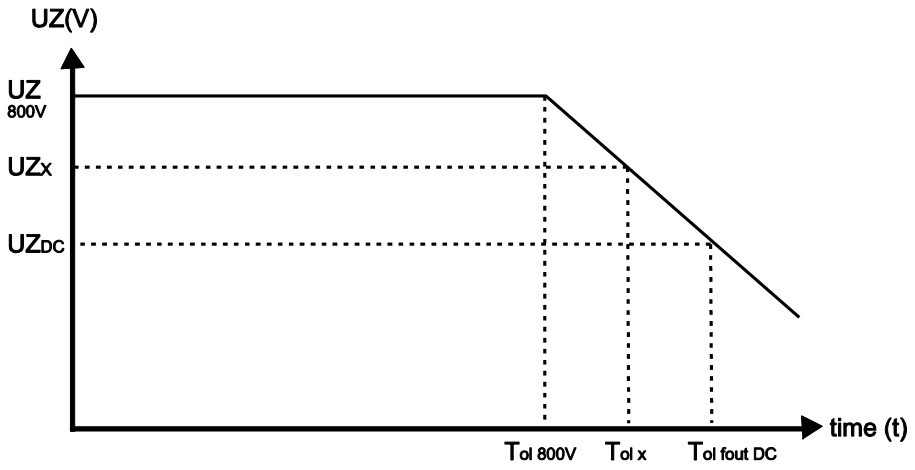
For the already named modules with the firmware status as of KW-R03 V3.13 2006/48 (part no. 201544) and. KW-R03P V5.13 2006/48 (part no. 201545) the following items should be observed:

Braking operation without feedback KE, KEN and network failure (for $f_{out} \leq f_{out\ DC}$)
Due to the reduction of the overload time above UZ_{DC} the braking behaviour (emergency stop) has to be inspected and reset if necessary during the replacement / employment of the KW devices (KW40, KW60, KW100) in existing systems.
Reason: The intermediate circuit voltage can increase above UZ_{DC} (up to 800 V) during braking operation, through which the overload time is reduced. (refer to the following diagrams)

Moving on block (stop) (for $f_{out} \leq f_{out\ DC}$)
Due to the reduction of the overload time above UZ_{DC} the maximum overload time is reduced during the replacement / employment of the KW devices (KW40, KW60, KW100) in existing systems.

Device related differences

The thresholds UZ_{DC} and $T_{ol\ fout\ DC}$ as well as $T_{ol\ 800V}$ are set and cannot be changed by the user.



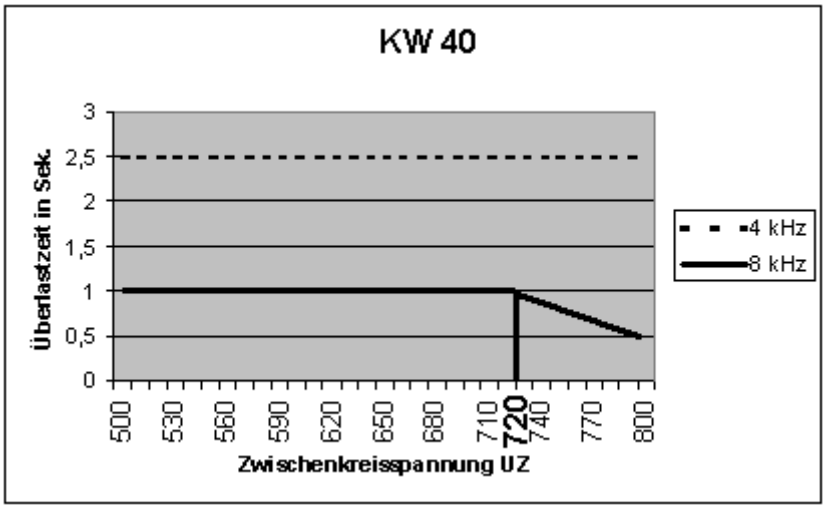
The following diagrams show the behaviour in DC operation ($f_{out} \leq f_{out\ DC}$)

KW 40

For **PWM = 4 kHz** the overload time $T_{ol\ fout\ DC}$ remains constant at 2.5 sec for the entire UZ range as before. The inverted is in DC operation, if the frequency is (f_{out}) ≤ 0.2 Hz.

For **PWM = 8 kHz** the overload time $T_{ol\ fout\ DC}$ is reduced linear from 720 V to 800 V from 1 sec. to 0.5 sec.
The inverter is in DC operation, if the frequency is (f_{out}) ≤ 0.4 Hz.

Diagram: 1 overload times in DC operation



Power data KW 40

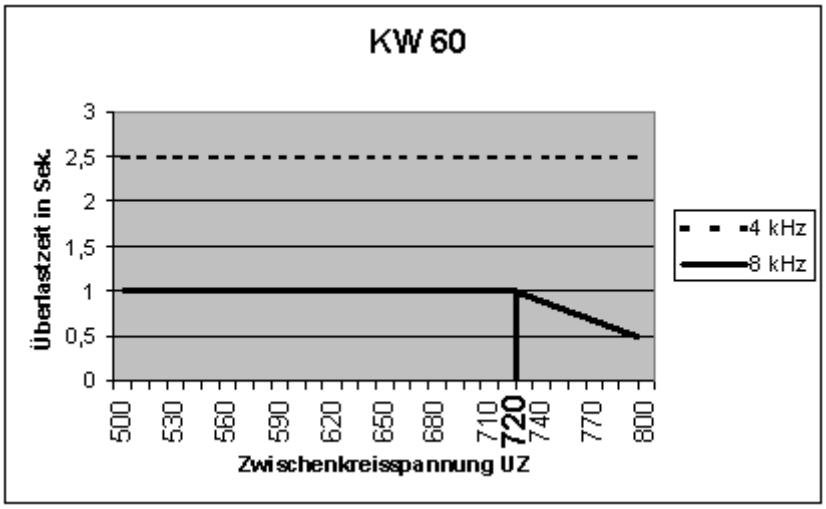
	KW 40 (46264) E770				
Rev. status	As of rev. 3.13				
Firmware	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)				
PWM frequency	4 kHz		8 kHz		
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 0.4$ Hz	$f_{Out} \leq 0.4$ Hz	
UZ voltage	540-800 V		540-800 V	≤ 720 V	800 V
Peak output	80 kVA		80 kVA		
Peak current	132 A		132 A		
Max perm. time	10s	2.5s	10s	1s	0.5s
Rated power	40 kVA				
Rated current	66 A				

KW 60

For **PWM = 4 kHz** the overload time $T_{ol\ fout\ DC}$ remains constant at 2.5 sec for the entire UZ range as before. The inverter is in DC operation, if the frequency is (f_{out}) ≤ 0.2 Hz.

For **PWM = 8 kHz** the overload time $T_{ol\ fout\ DC}$ is reduced linear from 720 V to 800 V from 1 sec. to 0.5 sec.
The inverter is in DC operation, if the frequency is (f_{out}) ≤ 0.8 Hz.

Diagram: 2 overload times in DC operation



Power data KW 60

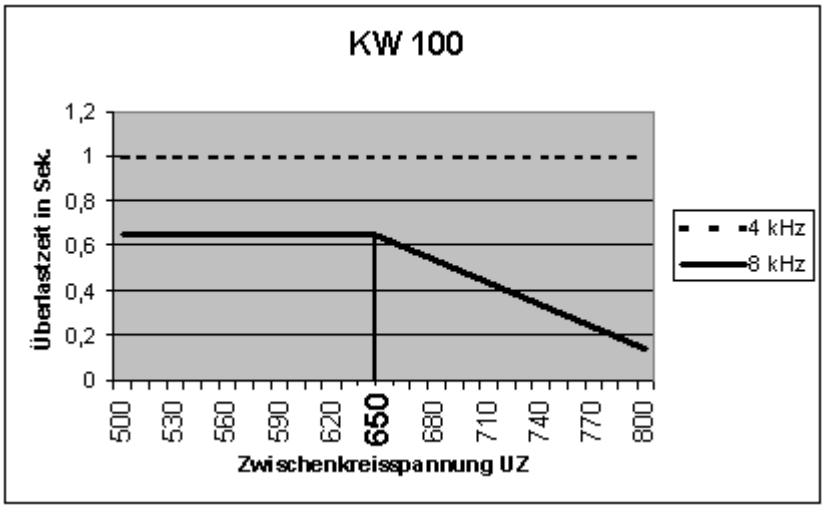
	KW 60 (46265) E771				
Rev. status	As of rev. 3.13				
Firmware	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)				
PWM frequency	4 kHz		8 kHz		
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 0.8$ Hz	$f_{Out} \leq 0.8$ Hz	
UZ voltage	540-800 V		540-800 V	≤ 720 V	800 V
Peak output	120 kVA		120 kVA		
Peak current	198 A		198 A		
Max perm. time	10s	2.5s	10s	1s	0.5s
Rated power	60 kVA				
Rated current	99 A				

KW 100

For **PWM = 4 kHz** the overload time $T_{ol\ fout\ DC}$ remains constant at 1 sec for the entire UZ range as before. The inverter is in DC operation, if the frequency is (f_{out}) ≤ 0.5 Hz.

For **PWM = 8 kHz** the overload time $T_{ol\ fout\ DC}$ is reduced linear from 650 V to 800 V from 0.65 sec. to 0.15 sec. The inverter is in DC operation, if the frequency is (f_{out}) ≤ 1.5 Hz.

Diagram: 3 overload times in DC operation



Power data KW 100

	KW 100 (46945) E855				
Rev. status	As of rev. 4.0				
Firmware	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)				
PWM frequency	4 kHz		8 kHz		
Inverter output frequency	$f_{Out} > 0.5$ Hz	$f_{Out} \leq 0.5$ Hz	$f_{Out} > 1.5$ Hz	$f_{Out} \leq 1.5$ Hz	
UZ voltage	540-800 V		540-800 V	≤ 650 V	800 V
Max. power output	200 kVA		165 kVA		
I_{max}	330 A		272 A		
Max perm. time	10s	1s	7.3s	0.65s	0.15s
Rated power	100 kVA				
Rated current	165 A				

Power data KW 100 *AT*

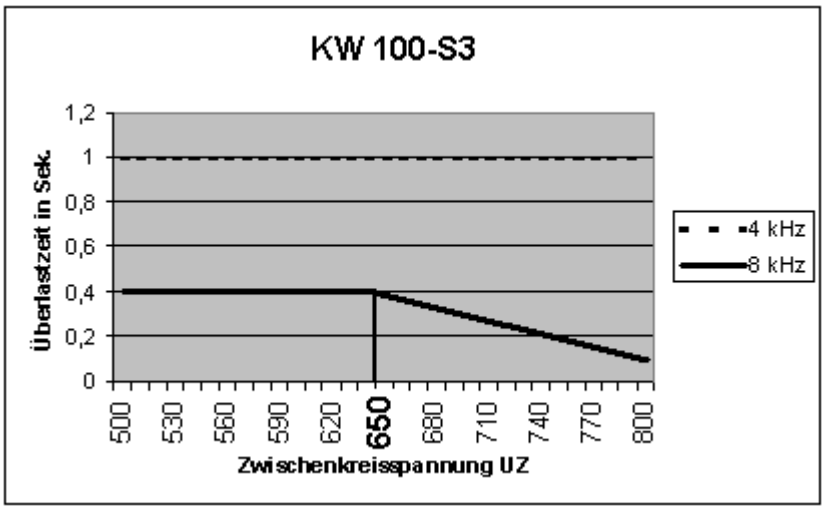
	KW 100 (46945) E855				
Rev. status	As of rev. 1.12				
Firmware	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)				
PWM frequency	4 kHz		8 kHz		
Inverter output frequency	$f_{Out} > 0.5$ Hz	$f_{Out} \leq 0.5$ Hz	$f_{Out} > 1.5$ Hz	$f_{Out} \leq 1.5$ Hz	
UZ voltage	540-800 V		540-800 V	≤ 650 V	800 V
Max. power output	200 kVA		165 kVA		
I_{max}	330 A		272 A		
Max perm. time	10s	1s	7.3s	0.65s	0.15s
Rated power	100 kVA				
Rated current	165 A				

KW100-S3

For **PWM = 4 kHz** the overload time $T_{ol\ fout\ DC}$ remains constant at 1 sec for the entire UZ range as before. The inverter is in DC operation, if the frequency is (f_{out}) ≤ 0.5 Hz.

For **PWM = 8 kHz** the overload time $T_{ol\ fout\ DC}$ is reduced linear from 650 V to 800 V from 0.4 sec. to 0.1 sec.
The inverter is in DC operation, if the frequency is (f_{out}) ≤ 1.5 Hz.

Diagram: 4 - overload times in DC operation



Power data KW100-S3

	KW 100-S3 (46951) E861				
Rev. status	As of rev. 4.0				
Firmware	KW-R03 V3.13 2006/48 (part no. 201544) and KW-R03P V5.13 2006/48 (part no. 201545)				
PWM frequency	4 kHz		8 kHz		
Inverter output frequency	$f_{Out} > 0.5$ Hz	$f_{Out} \leq 0.5$ Hz	$f_{Out} > 1.5$ Hz	$f_{Out} \leq 1.5$ Hz	
UZ voltage	540-800 V		540-800 V	≤ 650 V	800 V
Max. power output	200 kVA		200 kVA		
I_{max}	330 A		330 A		
Max perm. time	10s	1s	1.75s	0.4s	0.1s
Rated power	100 kVA				
Rated current	165 A				

5 Maximum current reduction for an increased intermediate circuit voltage (KW10 and KW20)

The following chapter affects the devices KW10 and KW20 the firmware status as of KW-R03 V3.16 2007/48 or KW-R03P V5.16 2007/48.
With the introduction of the KES series new requirements are created for the KW inverter, especially in DC operation. The adjustable intermediate circuit voltage of the KES series requires a reduction of the inverter maximum current depending on the intermediate circuit.

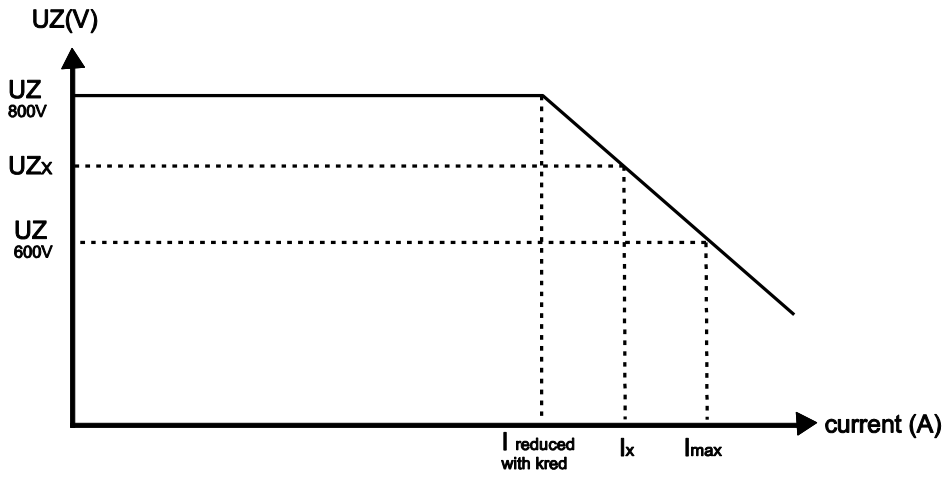
A permanently increased intermediate circuit voltage requires a linear reduction of the maximum current as of an intermediate circuit voltage > 600 V to ensure a continuous protection of the inverter in DC operation.
As of UZ 600 V the permissible maximum current of theses inverters (KW10 and KW20) are reduced linear.
The reduction is done with a reduction factor that is saved in the KW device-specific and cannot be changed by the user.
Additionally the threshold f_{out} between the standstill of the motor and the rotating operation is increased to 1 Hz.

Note:	For a PWM frequency of 4 kHz a reduction factor does not have to be taken into consideration.

As of device rev. 3.13 with the firmware status as of KW-R03 V3.13 2007/48 (part no. 201970) and KW-R03P V5.13 2007/48 (part no. 201971) the following items should be observed.

Braking operation without feedback (KEN) and network failure
Due to the reduction of I_{max} for UZ > 600 V the braking behaviour (emergency stop) has to be inspected and reset if necessary during the replacement / employment of the KW devices (KW10 and KW20) in existing systems.
Reason: The intermediate circuit voltage can increase above 600 V (up to 800 V) during braking operation, through which the maximum current is reduced up to 20%. (refer to the following diagrams)

Moving on block (stop)
The reduction of I_{max} for UZ > 600 V results in existing devices in a reduction of the maximum torque during the replacement / employment of the KW devices (KW10 and KW20).



Formula for the calculation on I_{max} for UZ_x

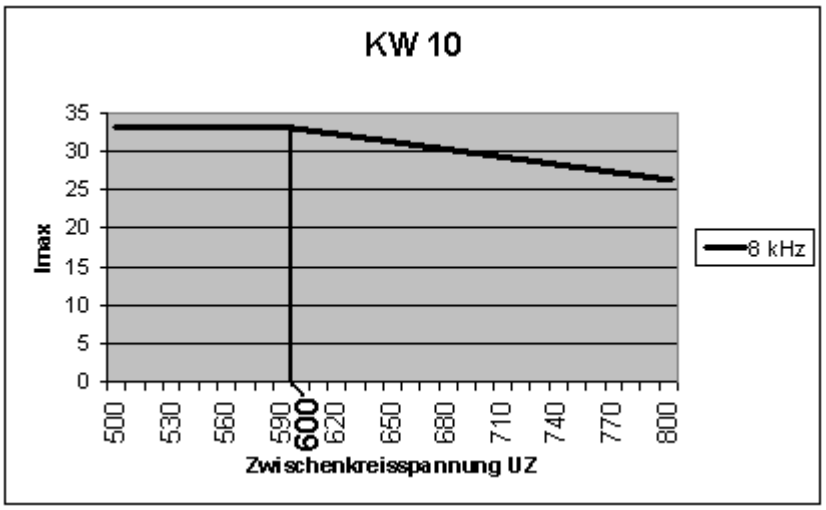
$$I_{\max}(UZ_x) = (1 - k_{red} * \frac{(UZ_x - 600V)}{(800V - 600V)}) * I_{\max}$$

KW 10

For PWM = 8 kHz the inverter is in DC operation, if the frequency is $f_{out} \leq 1$ Hz. The maximum overload time is 0.5 sec. in DC operation. The reduction of I_{max} begins at UZ = 600 V. I_{max} reduces by 20% at
UZ = 800 V.

I_{max} = 33.0 A up to 600 V (Average value of the intermediate circuit at 400 V + 10%)
I_{max} = 29.3 A for 713 V (Average value of the intermediate circuit at 480 V + 10%)
I_{max} = 26.4 A for 800 V (Brake threshold)

Diagram: 5 overload times in DC operation



Power data KW10

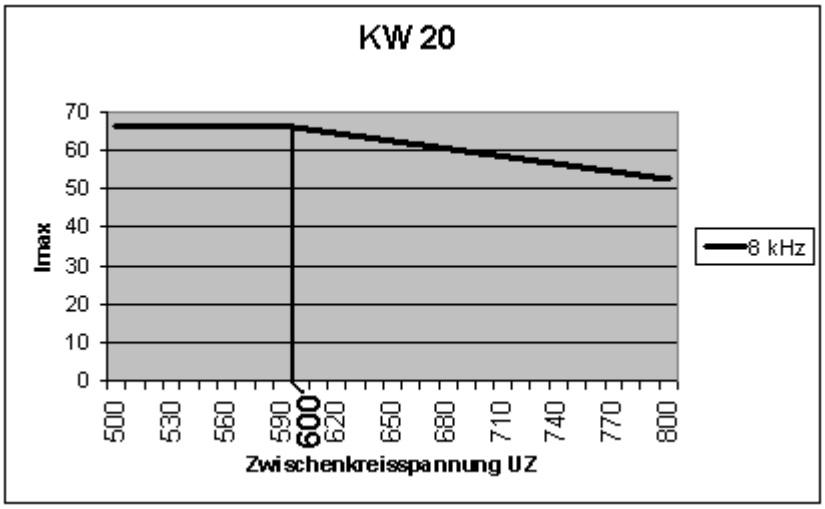
	KW 10 (46262) E768			
Rev. status	As of rev. 3.13			
Firmware	KW-R03 V3.16 2007/48 (T.-Nr. 201970) or KW-R03P V5.16 2007/48 (T.-Nr. 201971)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		<=600 V….800 V	
Max. power output	20 kVA		20 kVA….16 kVA	
I_{max}	33 A		33 A….26.4 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	10 kVA			
Rated current	16.5 A			

KW 20

For PWM = 8 kHz the inverter is in DC operation, if the frequency is $f_{out} \leq 1$ Hz. The maximum overload time is 0.5 sec. in DC operation. The reduction of I_{max} begins at UZ = 600 V. I_{max} reduces by 20% at UZ = 800 V.

$I_{max\ DC}$ = 66.0 A	for 600 V	Average value of the intermediate circuit at 400 V +10%)
$I_{max\ DC}$ = 58.5 A	for 713 V	(Average value of the intermediate circuit at 480 V +10%)
$I_{max\ DC}$ = 52.8 A	for 800 V	(Brake threshold)

Diagram: 6 - overload times in DC operation



Power data KW20

	KW 20 (46263) E769, KW 20-00S (46463) E761			
Rev. status	As of rev. 3.13			
Firmware	KW-R03 V3.16 2007/48 (T.-Nr. 201970) or KW-R03P V5.16 2007/48 (T.-Nr. 201971)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		<=600 V….800 V	
Max. power output	40 kVA		40 kVA….32 kVA	
I_{max}	66 A		66 A…52.8 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	20 kVA			
Rated current	33 A			

6 Increased crossover frequency $f_{out\ DC}$

Affects the series
KWD1 (-0N) to KWD2 (-0N)
and KWD5 (as of rev. 3.14)
KW2 (-0N) to KW8 (as of rev. 3.13)
KW10 and KW20 (as of rev. 3.13)
KWZ1 to KWZ5 (as of rev. 1.02)

With the introduction of the KES devices new requirements are created for the protective functions in the KW, in particular in the DC operation (motor standstill).
A permanently increased intermediate circuit voltage requires an increase of the crossover frequency $f_{out\ DC}$ for the devices stated above to ensure a continuous thermal protection of the inverter in DC operation.

Note: For a PWM frequency of 4 kHz the crossover frequency $f_{out\ DC}$ does not change.

During the replacement or employment of the KW devices in existing systems the inverter is in DC operation earlier because of the increase of the crossover frequency $f_{out\ DC}$, this can lead to a switching off with an overload error.

Example:
Conversion threshold $f_{out\ DC}$ into the motor speed n.

$$n\left[\frac{1}{\min}\right] = \frac{f\ [Hz]}{p} * 60$$

Example with 0.2 Hz and 1 Hz respectively and a motor with 2 pole pairs

$$n = \frac{0{,}2Hz}{2} * 60 = 6\left[\frac{1}{\min}\right] \qquad n = \frac{1Hz}{2} * 60 = 30\left[\frac{1}{\min}\right]$$

Power data KW2

	KW 2 (46304) E765, KW 2-0N (46270) E764			
Rev. status	As of 3.13			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	4 kVA		4 kVA	
I_{max}	6.6 A		6.6 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 kVA			
Rated current	3.3 A			

Power data KW3

	KW 3 (46756) E815			
Rev. status	As of 3.13			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	6 kVA		6 kVA	
I_{max}	10 A		10 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	3 kVA			
Rated current	5 A			

Power data KW5

	KW 5 (46303) E767, KW 5-0N (46358) E766			
Rev. status	As of 3.13			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Motor frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	10 kVA		10 kVA	
I_{max}	16.5 A		16.5 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	5 kVA			
Rated current	8.25 A			

Power data KW8

	KW 8 (46754) E813, KW 8-0N (46755) E814			
Rev. status	As of 3.13			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	16 kVA		16 kVA	
I_{max}	26.4 A		26.4 A	
Max perm. time:	10s	0.5s	10s	0.5s
Rated power	8 kVA			
Rated current	13.2 A			

Power data KWD1

	KWD 1 (46773) E759, KWD 1-0N (46771) E762			
Rev. status	As of 3.14			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 2 kVA		2 x 2 kVA	
I_{max}	2 x 3.3 A		2 x 3.3 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 1 kVA			
Rated current	2 x 1.65 A			

Power data KWD2

	KWD 2 (46774) E760, KWD 2-0N (46772) E763			
Rev. status	As of 3.14			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 4 kVA		2 x 4 kVA	
I_{max}	2 x 6.6 A		2 x 6.6 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 2 kVA			
Rated current	2 x 3.3 A			

Power data KWD5

	KWD 5 (46763) E818			
Rev. status	As of 3.14			
Firmware	KW-R03 V3.01 2003/12 (part no. 29918) and KW-R03P V5.01 2003/12 (part no. 29919)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 10 kVA		2 x 10 kVA	
I_{max}	2 x 16.5 A		2 x 16.5 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 5 kVA			
Rated current	2 x 8.25 A			

Power data KWZ1

	KWZ1 (46883) E841			
Rev. status	As of 1.02			
Firmware	KWZ V1.00 2007/29 (T.-Nr. 201835) KWZ-EC V1.00 2007/31 (T.-Nr. 201858)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 2 kVA		2 x 2 kVA	
I_{max}	2 x 3.3 A		2 x 3.3 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 1 kVA			
Rated current	2 x 1.65 A			

Power data KWZ2

	KWZ2 (46884) E842			
Rev. status	As of 1.02			
Firmware	KWZ V1.00 2007/29 (T.-Nr. 201835) KWZ-EC V1.00 2007/31 (T.-Nr. 201858)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 4 kVA		2 x 4 kVA	
I_{max}	2 x 6.6 A		2 x 6.6 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 2 kVA			
Rated current	2 x 3.3 A			

Power data KWZ5

	KWZ5 (46885) E843			
Rev. status	As of 1.02			
Firmware	KWZ V1.00 2007/29 (T.-Nr. 201835) KWZ-EC V1.00 2007/31 (T.-Nr. 201858)			
PWM frequency	4 kHz		8 kHz	
Inverter output frequency	$f_{Out} > 0.2$ Hz	$f_{Out} \leq 0.2$ Hz	$f_{Out} > 1$ Hz	$f_{Out} \leq 1$ Hz
UZ voltage	540-800 V		540-800 V	
Max. power output	2 x 10 kVA		2 x 10 kVA	
I_{max}	2 x 16.5 A		2 x 16.5 A	
Max perm. time	10s	0.5s	10s	0.5s
Rated power	2 x 5 kVA			
Rated current	2 x 8.25 A			