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ABB INDUSTRIAL DRIVES

**ACS880-11, ACS880-31, ACS880-14,  
ACS880-34, ACS880-17, ACS880-37 drives**

Product note on DC voltage boost



# **ACS880-11, ACS880-31, ACS880-14, ACS880-34, ACS880-17, ACS880-37 drives**

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*Further information*

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# DC voltage boost

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## Introduction to this product note

This product note describes the use of DC voltage boost function in these drives:

- ACS880-11, ACS880-31 frames R3, R6, R8
- ACS880-14 and ACS880-34 frame R11
- ACS880-17 (45...400 kW) and ACS880-37 (45...400 kW) frames R8, R11.

## Description of the DC voltage boost function

The regenerative and ultra low harmonic drives can boost their DC link voltage. In other words, they can increase the operating voltage of the DC link from its default value.

The user can take the DC voltage boost function in use by:

1. adjusting the user-defined DC voltage reference value (94.22) and
2. selecting the user-defined reference (94.22) as the source for the drive DC voltage reference (94.21).

Benefits of the DC voltage boost function are:

- possibility to supply nominal voltage to the motor even when the supply voltage of the drive is below the motor nominal voltage level
  - compensation of voltage drop due to output filter, motor cable or input supply cables
  - increased motor torque in the field weakening area (ie, when the drive operates the motor in the speed range above the motor nominal speed)
  - possibility to use a motor with higher nominal voltage than the actual supply voltage of the drive. Example: A drive that is connected to 415 V can supply 460 V to a 460 V motor.
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## Parameters

This table lists relevant parameters to the DC voltage boost feature.

Number	Name	Range	Default	Description
94.20	DC voltage reference	0.0 ... 2000.0 V	0.0 V	Read-only parameter, to show what DC reference is sent to the line-side converter. 0 V value means that the line-side converter uses automatic DC voltage control.
94.21	DC voltage ref source	Zero User ref Other	User ref (94.22)	Selects the source of the DC voltage reference to be sent to the line-side converter. User ref points to parameter 94.22 <i>User DC voltage reference</i> .
94.22	User DC voltage reference	0.0 ... 2000.0 V	0.0 V	User-set DC voltage reference. See the table in section <a href="#">Limitations (page 11)</a>
97.04	Voltage reserve	-4% ... 50%	-2%	Defines the minimum allowed voltage reserve. When the voltage reserve has decreased to the set value, the drive enters the field weakening area. <b>Note:</b> This is an expert level parameter and should not be adjusted without appropriate skill.

## Use case examples

### ■ **Example 1: Full motor voltage regardless of supply voltage fluctuations**

Supply voltage is 380 V, motor nominal voltage is 400 V. To get motor nominal voltage at nominal speed regardless of the supply voltage fluctuations:

1. Calculate the required user DC voltage reference:  $400 \text{ V} \times \sqrt{2} = 567 \text{ V DC}$ .
2. Set the value of parameter 94.22 *User DC voltage reference* to 567 V.
3. Make sure that the value of parameter 99.07 *Motor nominal voltage* is set to 400 V.



### ■ **Example 2: Sine filter at the output of the drive**

The drive is equipped with a sine filter at the output. Motor cable length is 300 m. Estimated voltage loss across the filter and cable is 40 V. Motor nominal voltage is 400 V.

To compensate the 40 V voltage loss at the nominal speed:

1. Calculate the required voltage at the drive output before the sine filter to compensate the voltage drop:  $400\text{ V} + 40\text{ V} = 440\text{ V}$ .
2. Calculate the required user DC voltage reference:  $440\text{ V} \times \sqrt{2} = 622\text{ V}$ .
3. Set the value of parameter *94.22 User DC voltage reference* to 622 V.

If the drive is configured to operate in DTC motor control mode and the ID run is performed with the output filter and motor cable connected, no other configuration is needed. The DTC motor control will take care of the estimated losses and boost drive output voltage without getting limited by parameter *99.07 Motor nominal voltage*.

If the drive is configured to operate in the scalar motor control mode, change the value of parameter *99.07 Motor nominal voltage* to 440 V to allow the motor control to go up to 440 V at the drive output at nominal speed.

**Note:** In scalar motor control mode, the output voltage can alternatively be increased by adjusting the *U/f* curve: by setting parameter *97.07 User flux level*. The value of *97.07*, can be calculated as the ratio of the desired voltage and the nominal voltage. In this example, the ratio is  $440\text{ V} / 400\text{ V} = 110\%$ . Set the value of *97.07* to 110% and leave motor nominal voltage as 400 V.

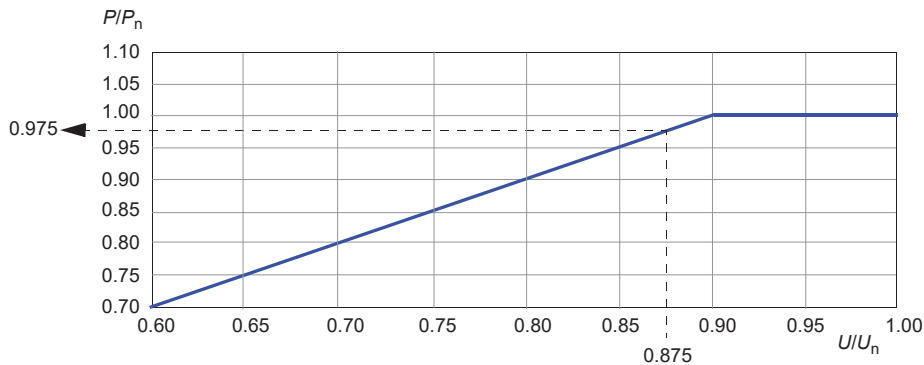
## Derating due to the output voltage boost

The drive can output a higher motor voltage than the supply voltage. This can require derating of the drive output power depending on the difference between the supply voltage and the output voltage to the motor for continuous operation. The graphs in this section are applicable for ACS880-11, ACS880-31, ACS880-14, ACS880-34, ACS880-17 and ACS880-37 drives. The symbols in the graphs are described in the table below.

$U$	Actual supply voltage to the drive. (Nominal values: for -3 types $U = 400\text{ V}$ , for -5 types $U = 500\text{ V}$ , for -7 types $U = 690\text{ V}$ but $575\text{ V}$ when $P_n$ refers to nominal power ratings in the UL (NEC) 575 V rating tables.)
$U_n$	Motor nominal voltage or the required drive output voltage
$P$	Derated output power of the drive
$P_n$	Nominal power rating of the drive

■ **400 V and 500 V drive types**

This graph shows the required derating for -3 and -5 (400 V and 500 V) drive types.



**Example 1:**  $P_n$  for ACS880-14-650A-3 is 355 kW. The supply voltage ( $U$ ) is 350 V.

$U/U_n = 350 \text{ V} / 400 \text{ V} = 0.875$ . From the graph we can see that  $P/P_n = 0.975$ .

The derated power  $P = 0.975 \times 355 \text{ kW} = 346 \text{ kW}$ .

To boost the output voltage to correspond the nominal supply voltage 400 V, increase the DC voltage to  $400 \text{ V} \times \sqrt{2} = 567 \text{ V}$ .

**Example 2:**  $P_n$  for ACS880-14-503A-5 is 355 kW. The supply voltage ( $U$ ) is 450 V.

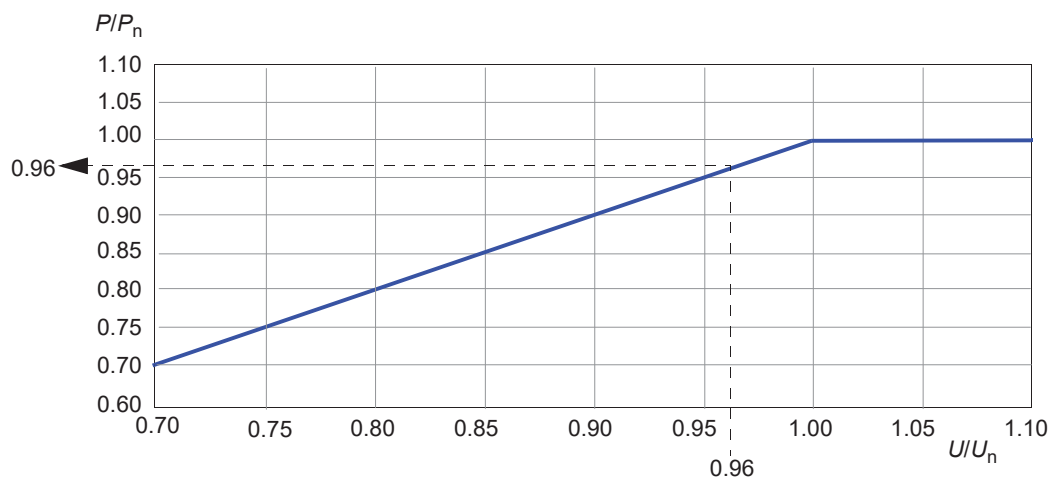
$U/U_n = 450 \text{ V} / 500 \text{ V} = 0.9$ . From the graph we can see that  $P/P_n = 1.00$ .

The derated power  $P = 1.00 \times 355 \text{ kW} = 355 \text{ kW}$ .

To boost the output voltage to correspond the nominal supply voltage 500 V, increase the DC voltage to  $500 \text{ V} \times \sqrt{2} = 707 \text{ V}$ .

■ **575 V and 690 V drives**

This graph shows the required derating for -7 (575 V and 690 V) drive types.



**Example 1:**  $P_n$  for ACS880-14-430A-7 is 400 kW. The supply voltage ( $U$ ) is 660 V.

$U/U_n = 660 \text{ V} / 690 \text{ V} = 0.96$ . from the graph we can see that  $P/P_n = 0.96$ .

The derated power  $P = 0.96 \times 400 \text{ kW} = 384 \text{ kW}$ .

To boost the output voltage to correspond the nominal supply voltage 690 V, increase the DC voltage to  $690 \text{ V} \times \sqrt{2} = 977 \text{ V}$ .

## Limitations

There are two types of limitations that you must take into account when you use the DC voltage boost function: limitations to the DC voltage reference and the limitation to the drive output voltage.

Drive calculates the minimum and maximum limits for the user-defined DC voltage reference (94.22). The calculation is based on the actual supply voltage, and the upper limit of the biggest supply voltage range selection available for the drive (95.01). Limits are:

1. Minimum limit: Internal DC voltage reference ( $U_{dc,int}$ ).
2. Maximum limit: Maximum DC voltage reference ( $U_{dc,max}$ ).

For more information, see the table below and sections [Internal DC voltage reference \( \$U\_{dc,int}\$ \)](#) and [Maximum DC voltage reference \( \$U\_{dc,max}\$ \)](#).

User defined voltage reserve parameter (97.04) limits the drive output voltage. For more information, see the table below and section [Maximum drive output voltage](#).

This table summarizes the limits to the user-defined DC voltage reference and to the drive output voltage.

Drive type	95.01 selection	Internal DC voltage reference ( $U_{dc,int}$ ) <sup>1)</sup>	Maximum DC voltage reference ( $U_{dc,max}$ )	Maximum drive output voltage with parameter 97.04 default value
xxxA-3	380...415 V	553 V	663 V	479 V
xxxA-5	380...415 V	553 V	799 V	576 V
	440...480 V	641 V		
	500 V	728 V		
xxxA-7	525...600 V	764 V	1102 V	795 V
	660...690 V	981 V		

1) See section [Internal DC voltage reference \( \$U\_{dc,int}\$ \)](#).

### ■ Internal DC voltage reference ( $U_{dc,int}$ )

$$U_{dc,int} = U_{ac,rms} \times \sqrt{2} \times 1.03$$

where

$U_{dc,int}$  Internal DC voltage reference

$U_{ac,rms}$  Actual input supply voltage.

If the user-defined reference (94.22) is lower than the internal reference value ( $U_{dc,int}$ ), the control program uses the internal reference as the drive DC voltage reference.

### ■ Maximum DC voltage reference ( $U_{dc,max}$ )

$$U_{dc,max} = U_{cat,hi} \times \sqrt{2} \times 1.13$$

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where

$U_{dc,max}$	Maximum DC voltage reference
$U_{cat,hi}$	Upper level of the selected voltage category in parameter <i>95.01 Supply voltage</i> .

If the user-defined reference (*94.22*) is higher than the maximum DC voltage reference ( $U_{dc,max}$ ), the control program uses the maximum value as the drive DC voltage reference.

### ■ Maximum drive output voltage

$$U_{ac,out} = (U_{dc} / \sqrt{2}) \times (1 - U_{res}),$$

where

$U_{ac,out}$	Maximum output voltage of the drive
$U_{dc}$	Actual DC voltage
$U_{res}$	Value of parameter <i>97.04 Voltage reserve</i> .

The voltage reserve setting (*97.04*) limits the maximum drive output voltage.

### ■ Limit calculation examples

#### **Example 1: Calculating the internal DC voltage reference and maximum DC voltage reference**

Voltage category 380...415 V and power line voltage 400 V.

The internal DC voltage reference  $U_{dc,int} = 400 \text{ V} \times \sqrt{2} \times 1.03 = 583 \text{ V}$ .

Maximum DC voltage reference  $U_{dc,max} = 415 \text{ V} \times \sqrt{2} \times 1.13 = 663 \text{ V}$ .

#### **Example 2: Calculating the maximum output voltage of the drive**

DC voltage is 650 V DC, and the voltage reserve setting (*97.02*) is -2%.

The maximum output voltage of the drive is  $U_{ac,out} = (650 / \sqrt{2}) \times (1 + 0.02) = 469 \text{ V}$ .

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# Further information

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