Variable Speed Drives

The Advantages of DC Chokes versus AC Line Reactors

Data Bulletin

This document compares the advantages and drawbacks of AC line reactors and DC chokes when used with variable speed drives.

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Introduction

Most low-power drives have a very simple AC to DC input converter based on an input diode rectifier and DC bus capacitors to reduce the DC voltage ripple. This topology leads to input current harmonics that increase the RMS value of the input current.

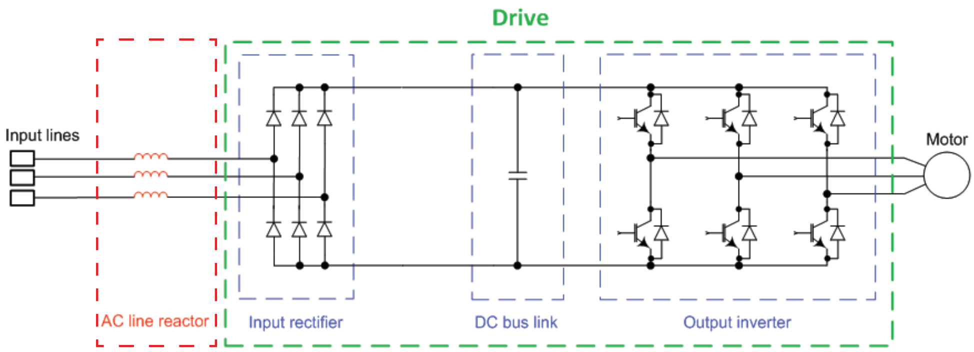
To maximize energy efficiency or to meet the requirements of applicable standards, some applications require reduction of the total harmonic distortion (THD) of the drive's input current.

Many solutions exist that make use of passive components or active systems. This data bulletin describes the differences between AC line reactors and DC chokes when used in combination with variable speed drives to reduce the mains input current's THD. Total harmonic distortion of the current is called THDi in this document.

AC line reactor

An AC line reactor is wired at the drive's mains inputs.

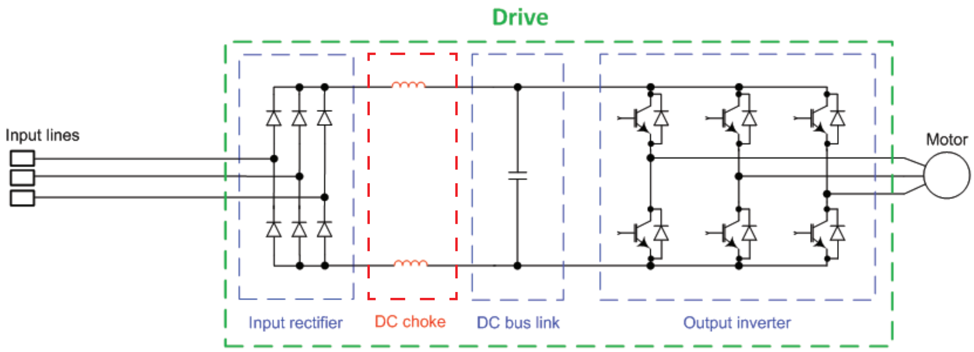
Figure 1 - AC line reactor wiring



DC choke

A DC choke can be split into two chokes, as shown in Figure 2, or kept as one part located in either the DC+ or DC- line of the drive.

Figure 2 - DC choke wiring



Definition

DC chokes and AC line reactors are usually defined by their impedance as a ratio $Z_{\%}$ commonly referred to per unit. To refer to this or any other number in this paper in percent, multiply by 100 and add the % symbol. Examples: 0.03 becomes 3% and 5% equals 0.05. If L is the inductance value of the choke and f is the frequency of the mains power supply, $Z_{\%}$ is defined by:

$$Z_{\%} = \frac{2\pi f L}{Z}$$

Z is a virtual impedance defined by:

$$Z = \frac{V}{I_1}$$

Where:

- V is the RMS value of the phase-to-neutral voltage of the mains power supply and
- I_1 is the RMS value of the fundamental current in one phase.

$Z_{\%}$ becomes:

$$Z_{\%} = \frac{2\pi f L I_1}{V}$$

For 3-phase drives, I_1 can be calculated using the active power P_{active} at the drive input:

$$P_{active} = \sqrt{3} U I_1 cos\varphi_1 \Rightarrow I_1 = \frac{P_{active}}{\sqrt{3} U cos\varphi_1}$$

Where:

- φ_1 is the phase shift angle of current I_1 to the phase-to-neutral voltage V of the mains power supply.
- $cos\varphi_1 \approx 1$ for drives
- U is the RMS value of the phase-to-phase voltage of the mains power supply:

  $$U = V\sqrt{3}$$

$Z_{\%}$ becomes:

$$Z_{\%} = \frac{2\pi f L P_{active}}{V\sqrt{3} U cos\varphi_1} = \frac{2\pi f L P_{active}}{U^2 cos\varphi_1} \approx \frac{2\pi f L P_{active}}{U^2}$$

P_{active} can be calculated by:

$$\frac{Rated\ motor\ power}{Motor\ efficiency \times Drive\ efficiency}$$

$Z_{\%}$ becomes:

$$Z_{\%} \approx \frac{2\pi f L}{U^2} \cdot \frac{Rated\ motor\ power}{Motor\ efficiency \times Drive\ efficiency}$$

A 3% choke is defined by $Z_{\%}$ = 3%, which means:

$$L \approx 0.03 \frac{Motor\ efficiency \times Drive\ efficiency \times U^2}{2\pi f \times Rated\ motor\ power}$$

AC line reactor or DC choke used with drives

Input current harmonics

To compare the drive's input current harmonics mitigation with AC line reactors and DC chokes, a variable speed drive designed to operate a 20 hp, 480 V, 60 Hz, 3-phase induction motor at rated torque is used as an example in this paper. The choke's impedance values range from 0–7%. The drive's internal main DC bus capacitor is 1500 μF.

Figure 3 illustrates the result obtained with an internal DC choke value of 1.52 mH, which is a 4.3% impedance at 480 V 60 Hz, taking into account a 20 hp (15 kW) motor with an efficiency of 0.91 and a drive efficiency of 0.95.

Figure 4 shows the result obtained by the same drive without an internal DC choke, but with an external AC line reactor of 1 mH, which is a 2.8% impedance at 480 V 60 Hz and gives the same input current THDi as the DC choke.

Figure 3 - DC choke

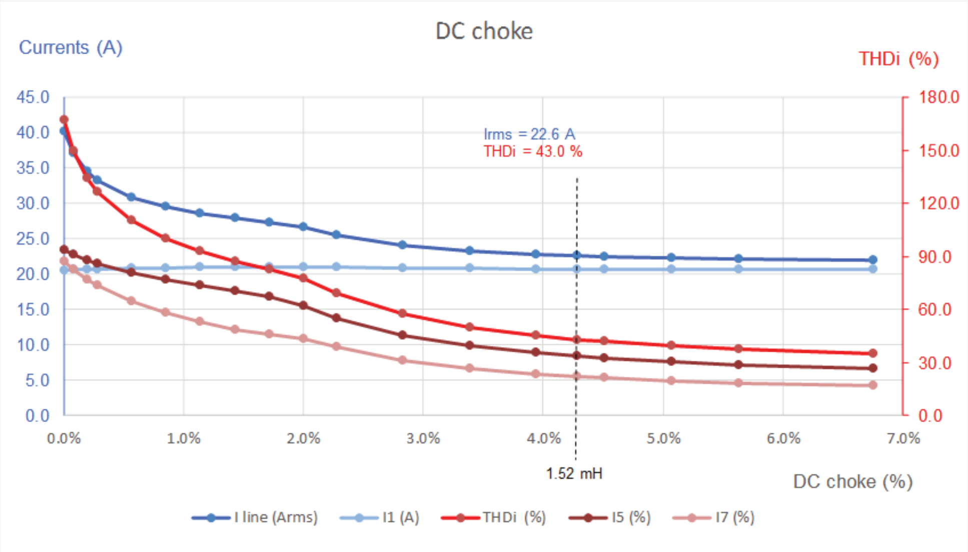
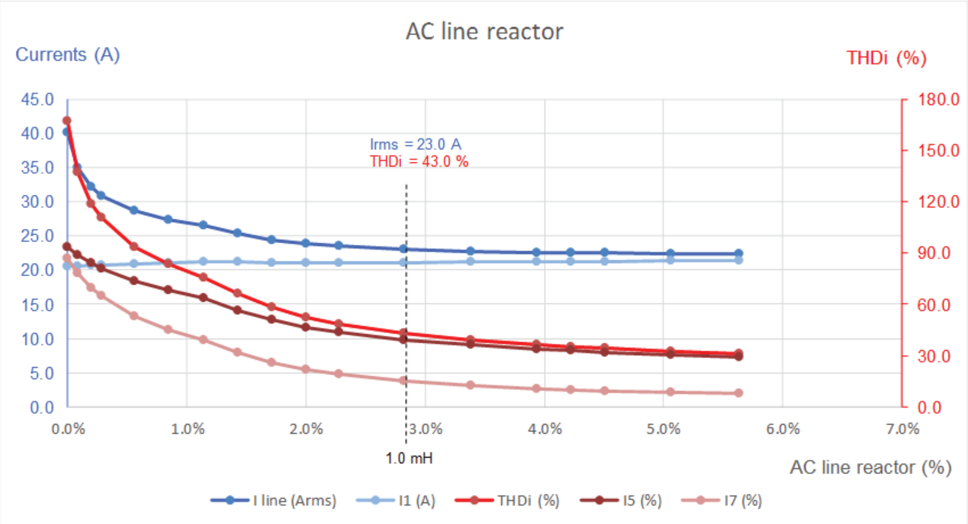


Figure 4 - AC line reactor



Figures 3 and 4 show for impedances from 0–7% of an AC line reactor or a DC choke:

- In blue, the evolution of the total RMS input current and the fundamental part I_1 in A (left Y-axis)
- In red, the THDi and the ratio of the 5th and 7th current harmonics to fundamental in % (right Y-axis)

ATV6xx/ATV9xx drives use an internal DC choke, whose impedance is about 4.0% on average over the full range at 480 V, 60 Hz. The DC choke was designed to reduce the input current THDi in order to meet IEC 61000-3-12 requirements listed in table 4 with Rsce ≥ 120, from which Table 1 is extracted. Rsce is the short circuit ratio—the short circuit apparent power divided by the equipment apparent power.

Table 1 - IEC 61000–3–12 Requirements for THDi with Rsce ≥ 120

TDH	I5/I1	I7/I1	I11/I1	I13/I1
≤ 48%	≤ 40%	≤ 25%	≤ 15%	≤ 10%

The table below shows that at 480 V 60 Hz, the 4.3% DC choke (1.52 mH) is able to reduce the input current THDi to 43.0% at rated load. To get the same input current THDi, an AC line reactor of 1 mH is needed, which is 2.8% impedance.

	Irms	I1	THDi	I5/I1	I7/I1	I11/I1	I13/I1
DC choke: 1.52 mH	22.6 A	20.7 A	43.0%	33.5%	21.9%	8.8%	7.6 %
AC line reactor: 1 mH	23.0 A	21.1 A	43.0%	39.2%	14.9%	7.5%	3.6%

At the same value of input current THDi there are differences between the AC line reactor and the DC choke:

- The RMS value of the input current is a little lower with the DC choke.
- The amplitude of the 5th harmonic of the current is lower with a DC choke.
- The amplitudes of the 7th, 11th, and 13th harmonics of the current are lower with an AC line reactor.

The majority of the THDi reduction is reached up to 5% impedance of a DC choke or up to 3% impedance of an AC line reactor. Above these values the THDi reduction is very low.

Both input AC line reactors and integrated DC chokes are valid solutions for reducing harmonics at the drive’s input terminals. Typically, installations have certain requirements that dictate which solution is required. For some applications, such as retrofits and applications with size constraints, our integrated DC chokes are ideal. It is important to note that with the use of Altivar™ Process Drives, the combination of integrated DC chokes with an external 3% input line reactor is acceptable and can achieve lower THDi levels. The advantages and disadvantages when using both an input line reactor and the integrated DC chokes hold true when examining the individual technologies. The following summaries provide the advantages and disadvantages of both types of solutions.

DC bus voltage drop

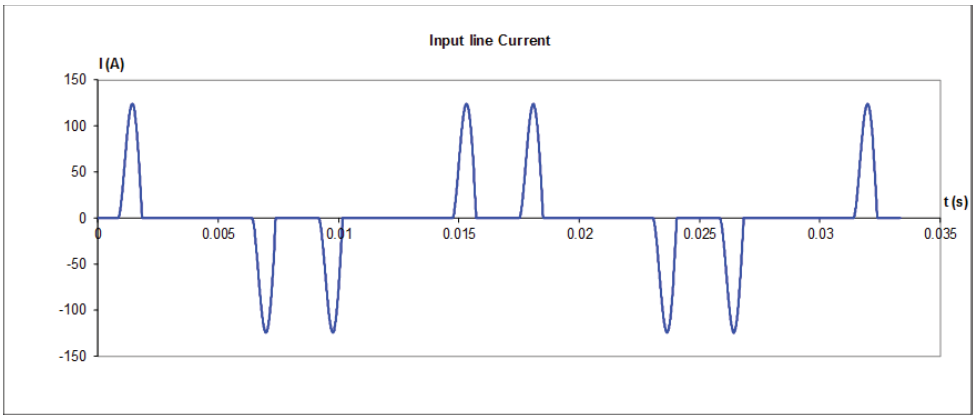
The additional impedance of an AC line reactor or DC choke in the circuit creates a voltage drop on the DC bus. It reduces the maximum voltage available to control the motor at rated speed and torque. If this voltage drop is too high, the motor will not get the full voltage at rated speed and rated load. This may increase the motor current and the motor slip, which can lead to additional losses in the motor.

DC bus average voltage reference

To compare an AC line reactor and a DC choke, the voltage drop is defined with a relative value to the average DC bus voltage obtained at rated load with a drive using no chokes or reactors at all. This drive should have 50% more capacitor value to keep the DC bus voltage ripple in an acceptable range. In these conditions, at 480 V, 60 Hz mains power supply and a 20 hp motor load, the DC bus average voltage is 672.5 V. The shape of the input current is shown in Figure 5.

The drive input current is: RMS value = 40.0 A, peak value = 122 A, THDi = 167%.

Figure 5 - DC bus average voltage reference



DC choke and voltage drop

The following sections show for an AC line reactor and a DC choke the relative DC bus voltage drop and the input current THDi as a function of the impedance of the chokes.

There are specific points on the graphics corresponding to different situations:

- Point A is the drive with increased capacitors and no chokes: this is the reference of the average DC bus voltage.
- At point B, there is an AC or DC choke with discontinuous conduction on the input rectifier.
- At point C the input current in the drive's input stage changes from discontinuous conduction to continuous conduction. This creates the slope change in the DC bus voltage drop.
- Point D is the drives' design point with the DC choke, to be compared with an AC choke which gives the same THDi.

Figure 6 - DC voltage drop and input current THDi versus impedance

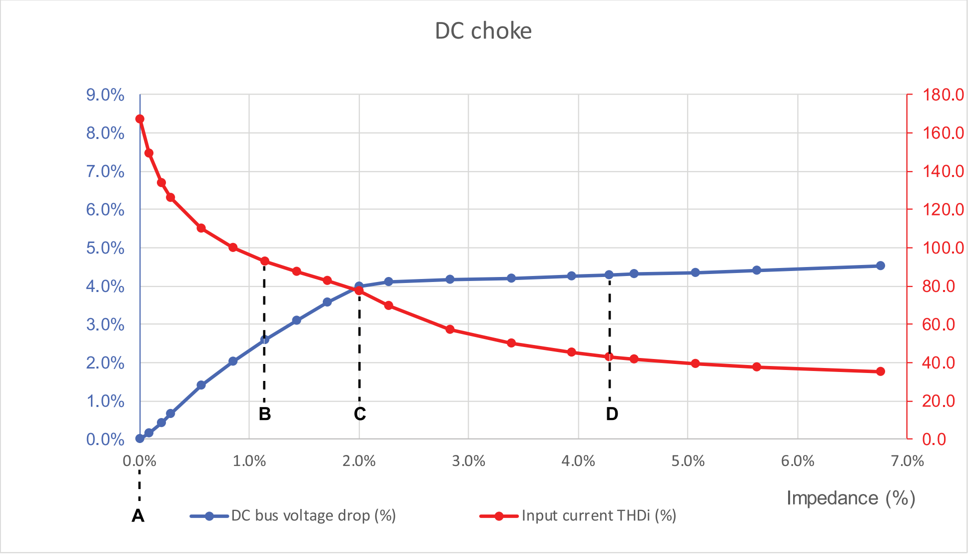
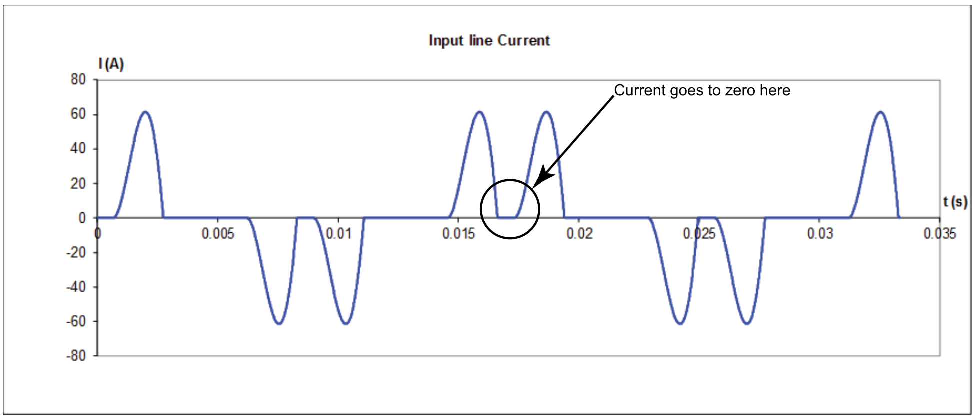
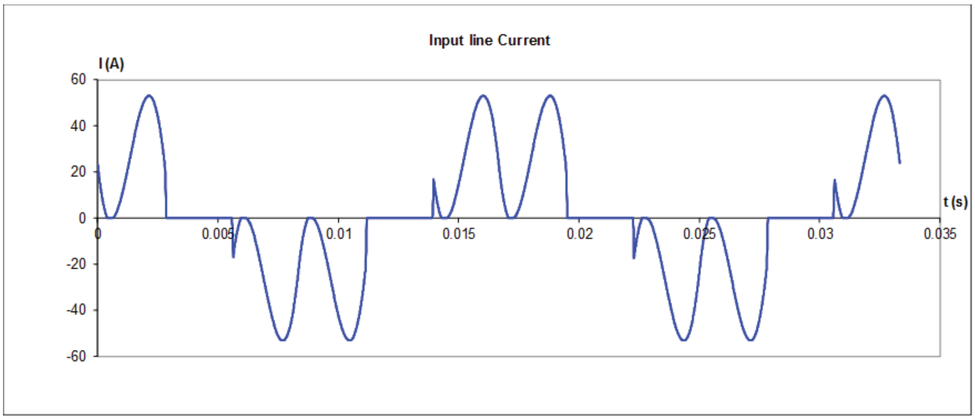


Figure 7 - Input current with input rectifier in discontinuous conduction mode



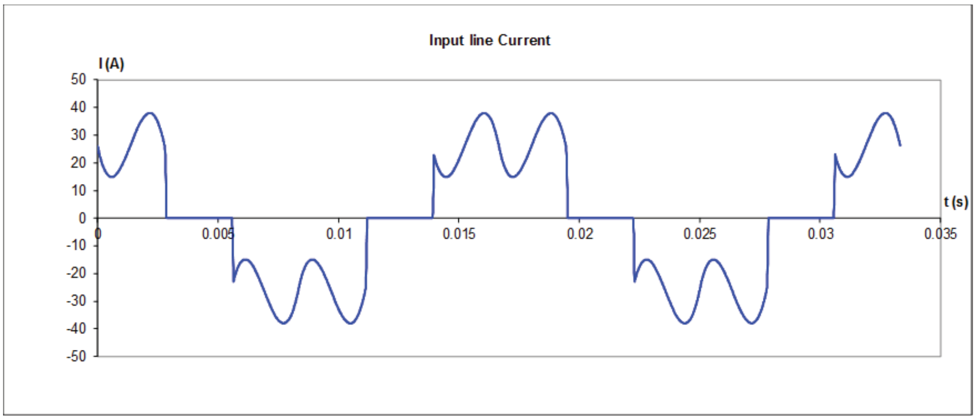
- Input current waveform at point B for DC choke: $L = 0.4\ mH,\ Z_{\%} = 1.1\%$.
- Drive input current RMS value = 28.6.4 A, peak value = 61.5 A, THDi = 93.0%

Figure 8 - Input current with input rectifier at transition from discontinuous to continuous conduction mode



- Input current waveform at point C for DC choke: $L = 0.7\ mH,\ Z_{\%} = 2.0\%$
- With this impedance value of the DC choke, the system is at the transition between continuous and discontinuous current in the input rectifier.
- Drive input current RMS value = 26.7 A, peak value = 53.1 A, THDi = 77.5%

Figure 9 - Input current with input rectifier in continuous conduction mode



- Input current waveform at point D for DC choke: $L = 1.52\ mH, Z_{\%} = 4.3\%$. This is the design point of the drive taken as reference.
- Drive input current RMS value 22.7 A, peak value = 38.0 A, THDi = 43.0%

The other drives of the range have the following impedance at 480 V, 60 Hz for the internal DC choke and the corresponding THDi of the input current at rated output load.

ATV630•••N4	U07	U15	U22	U40	U55	U75	D11	D15	D18	D22	D30
Power rating (hp)	1	2	3	5	7.5	10	15	20	25	30	40
DC choke value (mH)	21.6	11.5	8.10	4.55	3.40	2.90	2.25	1.52	1.18	1.00	0.76
DC choke impedance (%)	3.4	3.5	3.6	3.3	3.7	4.2	4.8	4.3	4.2	4.2	4.2
Total effective input line impedance (%)[1]	2.2	2.3	2.4	2.2	2.4	2.7	3.1	2.8	2.7	2.7	2.8
THDi (%)	48.3	48.3	48.2	50.8	47.9	43.4	40.7	43.0	44.2	44.4	43.4
Voltage drop (%)	4.0	3.5	2.9	3.0	2.8	3.9	3.3	4.0	3.7	3.4	3.9

ATV630•••N4	D37	D45	D55	D75	D90	C11	C13	C16	C22	C25	C31
Power rating (hp)	50	60	75	100	125	150	200	250	350	400	500
DC choke value (mH)	0.59	0.49	0.37	0.31	0.23	0.16	0.16	0.16	0.105	0.095	0.069
DC choke impedance (%)	4.0	4.1	3.8	4.2	3.8	3.2	4.3	5.3	5.0	5.2	4.7
Total effective input line impedance (%)[1]	2.7	2.7	2.5	2.8	2.5	2.1	2.8	3.5	3.3	3.4	3.0
THDi (%)	45.1	44.6	45.2	42.4	44.6	47.9	41.0	37.4	37.3	36.7	36.9
Voltage drop (%)	3.8	3.8	3.6	3.5	3.3	3.1	3.0	2.9	2.1	1.9	1.2

1. With line reactors you have coils on two legs conducting at any one time as opposed to a single DC choke. In continuous conduction, the analysis shows that the DC choke inductance should be about 1.51 times larger than an input line reactor for the same harmonic reduction. The DC choke impedance values are divided by 1.51 in order to get the effective input line reactor impedance for comparison purposes.

AC line reactor and voltage drop

The same variable speed drive operating a 20 hp, 480 V, 60 Hz, 3-phase induction motor without the internal DC choke but with a 3-phase AC line reactor is used to perform the same simulations to compare the behavior of AC line reactors to DC chokes. The DC bus voltage drop and input current THDi are displayed as functions of the impedance. The input current waveforms are also displayed for different values of the impedance in the same way as for the DC choke.

Figure 10 - DC voltage drop and input current THDi versus impedance

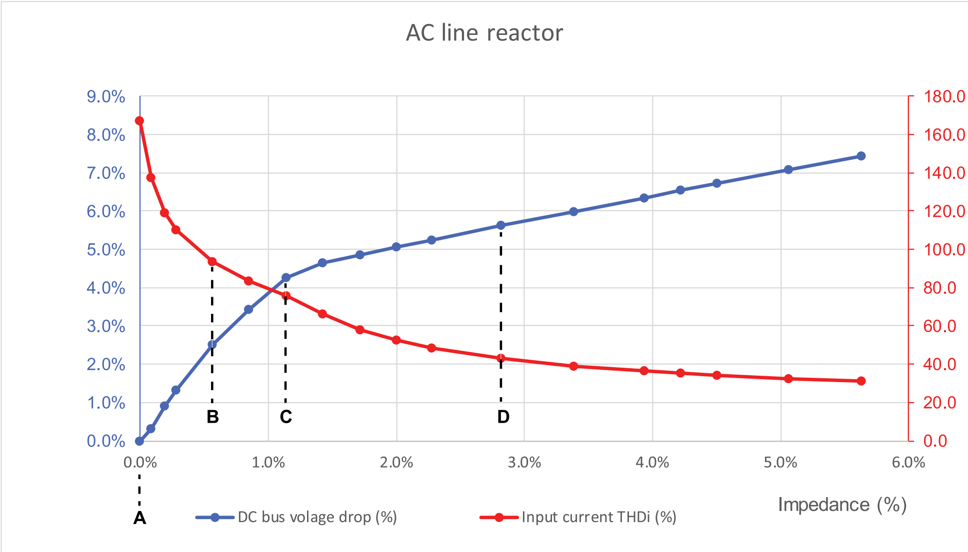
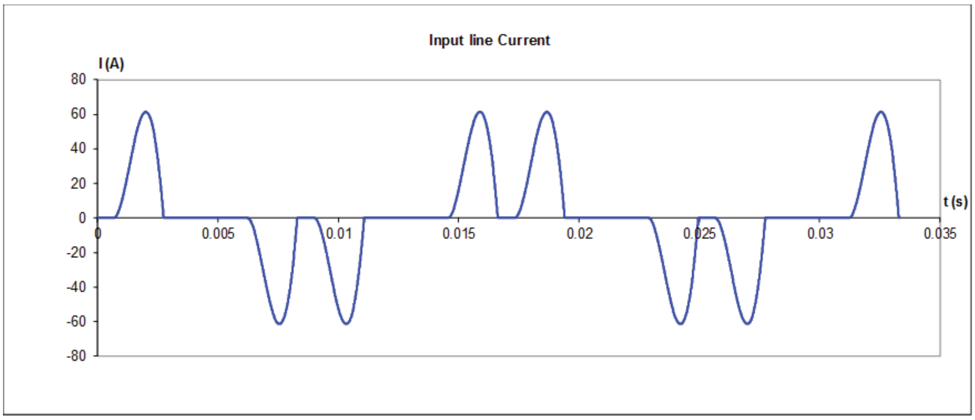
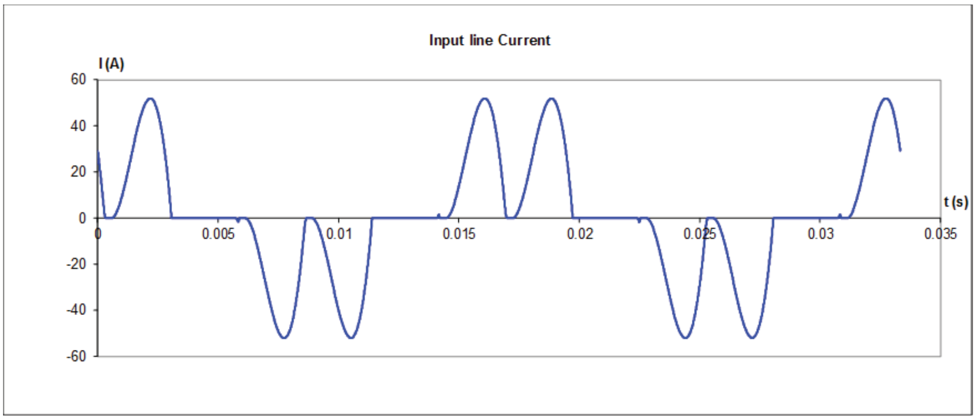


Figure 11 - Input current with input rectifier in discontinuous conduction mode



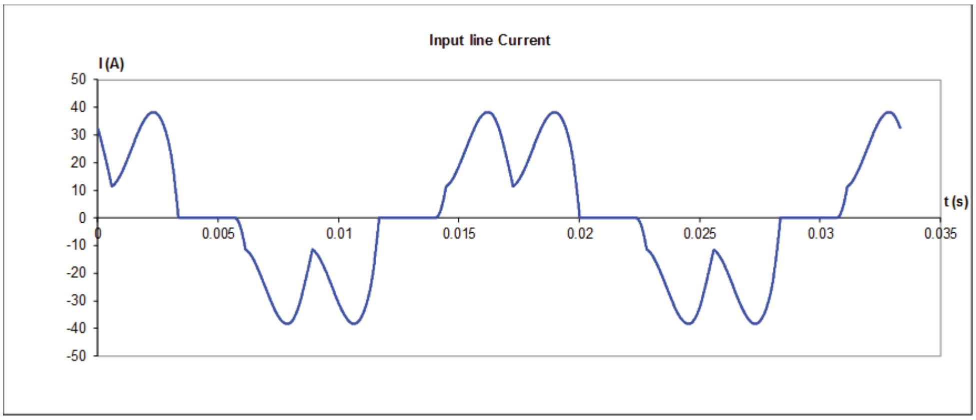
- Input current waveform at point B for AC line reactor: $L = 0.2\ mH, Z_{\%} = 0.6\%$.
- RMS value = 28.6 A, peak value = 61.4 A, THDi = 93.4 %.

Figure 12 - Input current with input rectifier at transition from discontinuous to continuous conduction mode



- Input current waveform at point C for AC line reactor: $L = 0.4\ mH, Z_{\%} = 1.4\%$
- RMS value 26.6 A, peak value = 52.0 A, THDi = 75.7%

Figure 13 - Input current with input rectifier in continuous conduction mode



- Input current waveform at point D for AC line reactor: $L = 1\ mH, Z_{\%} = 2.8\%$
- This value is selected to get the same THDi as at point D on the curve with the DC choke.
- RMS value 23.0 A, THDi = 43.0%, peak current 38.3 A

Conclusions

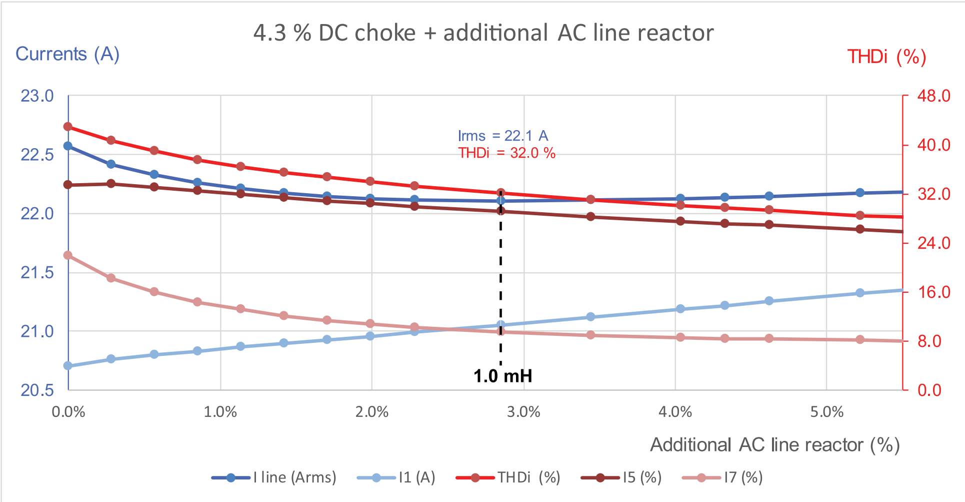
- Both DC Chokes and AC Line Reactors are effective methods to mitigate line harmonics.
- It is acceptable to use both DC Chokes and AC Line Reactors in order to achieve higher overall impedance, thus increasing the ability to mitigate harmonics.
- At the same level of input current THDi, the DC bus voltage drop created by the DC choke is less than with an AC line reactor.
- At 43% THDi—which is reached with a 4.3% impedance DC choke or a 2.8% impedance AC line reactor at 480 V, 60 Hz— the difference is about 30% more DC bus voltage drop with an AC line reactor.
- To increase DC choke or AC line reactor impedances over 4.5% or 3% respectively does not provide significant THDi and RMS input current reductions.

Using an AC line reactor with a DC choke

In this configuration, the 20 hp, 480 V, 60 Hz drive with its internal 4.3% impedance DC choke uses an additional external AC line reactor. Figure 14 shows that using an additional AC line reactor from 0 up to 5% impedance reduces:

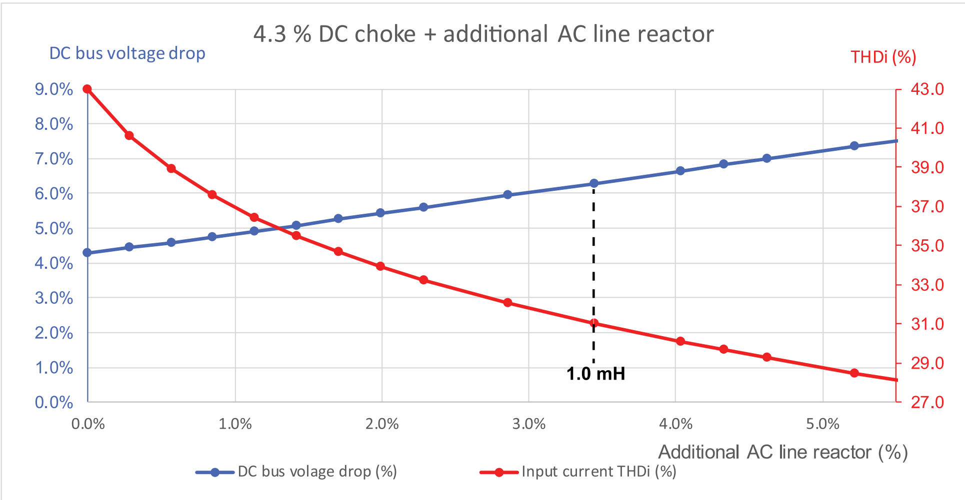
- THDi from 43.0% down to 28.5% when using 5% line reactor
- The 5th harmonic from 33.5% to 26.2% of the fundamental
- The 7th harmonic from 21.9% to 8.1% of the fundamental

Figure 14 - Using an AC line reactor with a DC choke



The total DC bus voltage drop and the input current THDi are shown in Figure 15.

Figure 15 - Total DC bus voltage drop and input current THDi



The total voltage drop starts at 0% impedance of the additional AC line reactor, with the value obtained with the internal DC choke only. It goes up to 7% with a 5% impedance of the additional AC line reactor. At the same time, the input current THDi is reduced from 43% down to 28.5%. For comparison, the input current THDi is also displayed.

A 3% impedance AC line reactor brings about 10% additional input current THDi reduction compared to what is reached with the 5% DC choke, with almost 2% additional voltage drop in the DC bus.

Performance Overview

An AC line reactor used in combination with a DC choke brings an additional reduction of the input current THDi, mainly by reduction of the 7th harmonic for which the AC line reactor was already better than the DC choke when either is used alone. This leads to an additional voltage drop on the DC bus. Using the 3% impedance AC line reactor from the MTE catalog in association with the ATV630 / ATV930 drives range gives the data shown in the table below. A 4.3% choke or a 3% line reactor provide effective harmonic mitigation. After these values, the addition of AC reactance begins to have diminishing returns at the expense of voltage drop.

ATV630•••N4	U07	U15	U22	U40	U55	U75	D11	D15	D18	D22	D30
Power rating (hp)	1	2	3	5	7.5	10	15	20	25	30	40
+ MTE 3% AC line reactor (reference)	RL-00201	RL-00402	RL-00803	RL-00802	RL-01202	RL-01802	RL-02502	RL-03502	RL-03502	RL-04502	RL-05502
Line reactor current rating (A)	2	4	8	8	12	18	25	35	35	45	55
AC line reactor inductance (mH)	12.0	6.5	5.0	3.0	2.5	1.5	1.2	0.8	0.8	0.7	0.5
Line reactor impedance (%)	1.9	2.0	2.2	2.2	2.7	2.1	2.5	2.2	2.8	2.9	2.7
Total effective input line impedance (%)	4.1	4.3	4.6	4.4	5.1	4.9	5.7	5.0	5.5	5.6	5.5
THDi (%)	35.4	35.0	34.2	34.9	33.0	33.5	31.9	33.1	32.2	32.0	32.1
Voltage drop (%)	5.3	4.9	4.5	5.0	4.6	4.8	5.4	5.1	5.6	5.6	5.4

ATV630•••N4	D37	D45	D55	D75	D90	C11	C13	C16	C22	C25	C31
Power rating (hp)	50	60	75	100	125	150	200	250	350	400	500
+ MTE 3% AC line reactor (reference)	RL-08002	RL-10002	RL-10002	RL-13002	RL-16002	RL-20002-B14	RL-25002-B14	RL-32002-B14	RL-50002	RL-50002	RL-60002
Line reactor current rating (A)	80	100	100	130	160	200	250	320	500	500	600
AC line reactor inductance (mH)	0.4	0.3	0.3	0.2	0.15	0.11	0.09	0.075	0.05	0.05	0.04
Line reactor impedance (%)	2.7	3.3	3.1	2.7	2.5	2.2	2.4	2.5	2.3	2.7	2.7
Total effective input line impedance (%)	5.4	5.9	5.5	5.5	5.0	4.3	5.2	6.0	5.6	6.0	5.7
THDi (%)	32.4	31.3	31.9	32.1	32.9	34.5	32.3	31.0	31.2	30.4	30.4
Voltage drop (%)	5.5	5.5	5.8	5.4	5.2	4.9	4.4	4.4	4.4	3.5	3.5

Unbalanced mains power supply

All results defined in the previous sections are obtained with balanced 3-phase mains power supply. This section considers unbalanced mains power supply. The unbalanced power supply used by the drive are phase-to-phase voltages created by a star system where the phase shift is 120° with different amplitude values.

Unbalance definition

The original star system (v_1, v_2, v_3) is defined as follows:

$v_1 = V_1 \cos \omega t$ associated with the complex number $\underline{V_1} = V_1$

$v_2 = V_2 \cos(\omega t - \frac{2\pi}{3})$ $\underline{V_2} = V_2 e^{-j2\pi/3}$

$v_3 = V_3 \cos(\omega t - \frac{4\pi}{3})$ $\underline{V_3} = V_3 e^{-j4\pi/3}$

When the power supply is balanced $V_1 = V_2 = V_3$.

The resulting phase-to-phase system (u_{12}, u_{23}, u_{31}) that will be used by the drive as mains input power voltage is defined by:

$u_{12} = v_2 - v_1$ associated with the complex number $\underline{U_{12}} = \underline{V_2} - \underline{V_1}$

$u_{23} = v_3 - v_2$ $\underline{U_{23}} = \underline{V_3} - \underline{V_2}$

$u_{31} = v_1 - v_3$ $\underline{U_{31}} = \underline{V_1} - \underline{V_3}$

Using the operator

$$a = e^{j2\pi/3} = -\frac{1}{2} + j\frac{\sqrt{3}}{2}$$

This system can be broken down in 3 different balanced 3-phase systems:

- A direct system $(u_d, a^2 \cdot u_d, a \cdot u_d)$ defined by

$u_d = \frac{1}{3}(u_{12} + a \cdot u_{23} + a^2 \cdot u_{31})$ associated with the complex number $\underline{U_d} = \frac{1}{3}(\underline{U_{12}} + a\underline{U_{23}} + a^2\underline{U_{31}}) = U_d e^{-j\varphi_d}$

- A reverse system $(u_i, a \cdot u_i, a^2 \cdot u_i)$ defined by

$u_i = \frac{1}{3}(u_{12} + a^2 \cdot u_{23} + a \cdot u_{31})$ associated with the complex number $\underline{U_i} = \frac{1}{3}(\underline{U_{12}} + a^2\underline{U_{23}} + a\underline{U_{31}}) = U_d e^{-j\varphi_i}$

- And a zero sequence (homopolar) system (u_o, u_o, u_o) defined by

$$u_0 = \frac{1}{3}(u_{12} + u_{23} + u_{31})$$ associated with the complex number $$\underline{U_0} = \frac{1}{3}(\underline{U_{12}} + \underline{U_{23}} + \underline{U_{31}}) = U_0 e^{-j\varphi_0}$$

The unbalance factor τ is defined by the ratio of the module of the reverse component to the module of the direct component:

$$\tau = \frac{U_i}{U_d}$$

NEMA has defined an approximation of this unbalance factor by the following formula, which is valid for unbalance values up to about 10%.

$$\tau \approx \frac{MAX|U_{ij} - U_{average}|}{U_{average}}$$

Evaluation of input voltage unbalance on drives

To define an unbalanced phase-to-phase system, the original star system phase shift is kept constant to 120° and only the amplitudes are modified. The resulting delta system has amplitudes and phase modifications compared to a balanced system. There are many ways to get an increasing unbalance ratio. The method selected in this document is to modify the amplitudes of the original star system in the following way.

- V_2 is kept constant.
- V_1 is increased from its rated value up to +4% more, and then it is kept constant.
- V_3 is then decreased from its rated value down to –4%.

This creates an unbalance factor starting from 0 up to about 2%, increasing in a linear way, which allows us to use it on the X-axis of a graph to display how the DC bus voltage and the mains input current vary depending on it. The unbalance value obtained when V_1 stops increasing and V_3 starts decreasing is 1.2%. This can be seen on the graphs by a change in the slope of some curves.

For different values of the input unbalance factor, an electrical simulation of the input stage of the drive is performed with PSIM® software to get the values of the DC bus and input currents, which are copied in an Excel® file to get the graphs shown in this section.

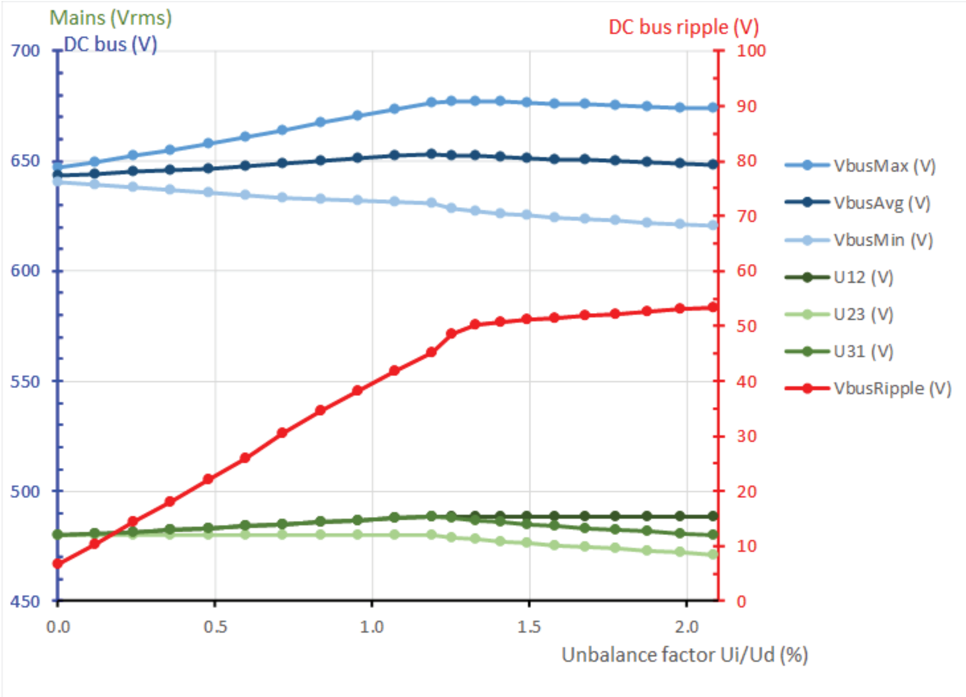
Drive with DC choke

The 20 hp drive with the integrated 4.3% DC choke is used as in the previous sections to make electrical simulations to display the impact of the input voltage unbalance.

Influence of DC choke on the drive DC bus voltage

Figure 16 shows the internal DC bus voltage (maximum, minimum, and average voltage) in blue, and its peak-to-peak ripple voltage in red. The frequency of the DC bus voltage ripple is twice the input line frequency. The drive’s mains input voltages resulting from the unbalanced star system are shown in green.

Figure 16 - Influence on the drive DC bus voltage

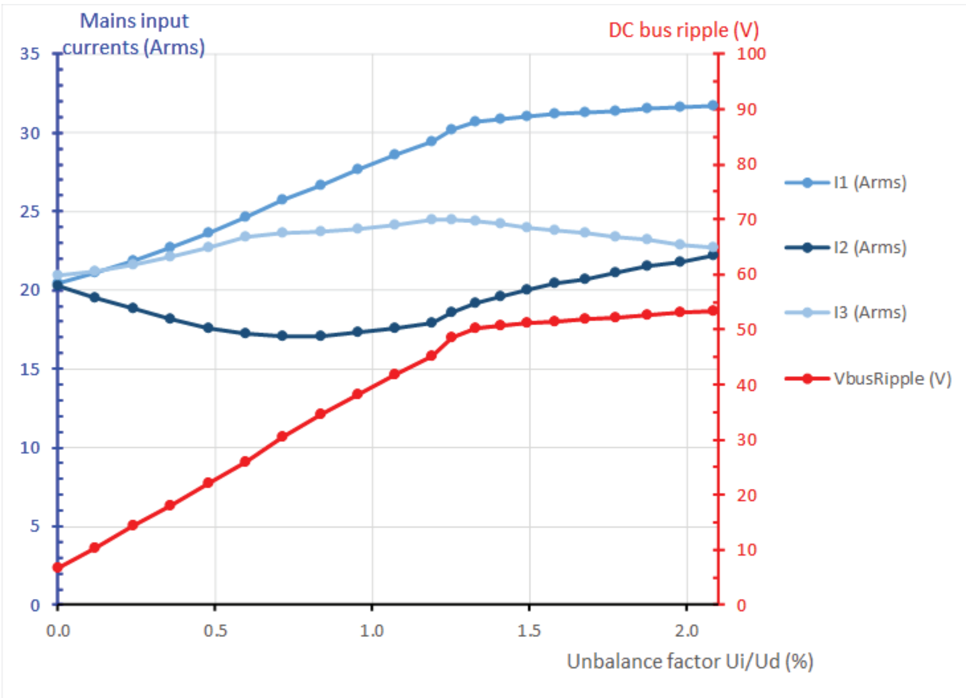


The DC bus voltage ripple starts at about 7 V with balanced mains input voltage and increases up to 53 V with 2% unbalance.

Influence of DC choke on the input line currents

Figure 17 shows the RMS values of the input current variation with the input voltage unbalance. The X-axis for the unbalance ratio and the auxiliary Y-axis for the DC bus voltage ripple are the same as in the previous graph.

Figure 17 - Influence of DC choke on the input line currents



Drive with AC line reactor

The same 20 hp, 480 V, 60 Hz drive, without its 4.3% internal DC choke but with the external 2.8% 3-phase AC line reactor, is used to perform the same electrical simulations to compare the results with the DC choke in case of unbalanced mains power supply.

Figure 18 - Influence of AC line reactor on the drive DC bus voltage

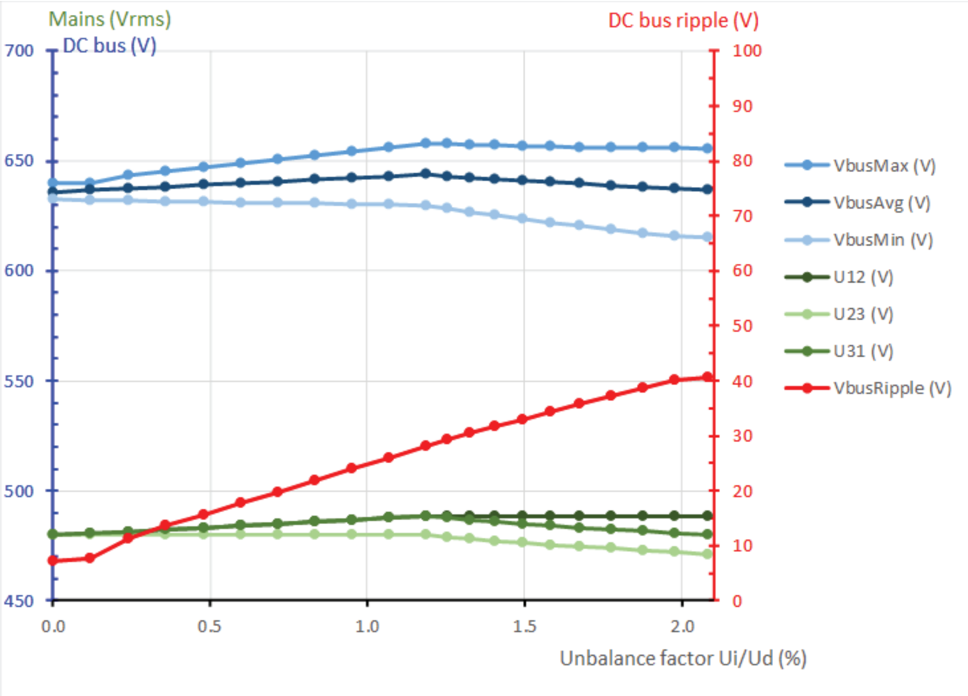
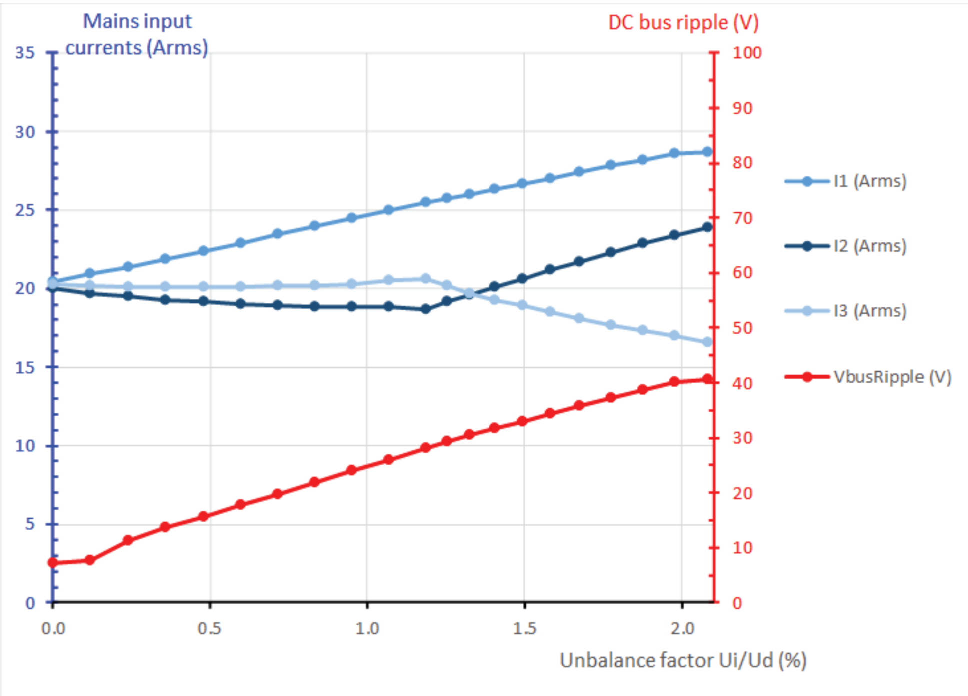


Figure 19 - Influence of AC line reactor on the input line currents



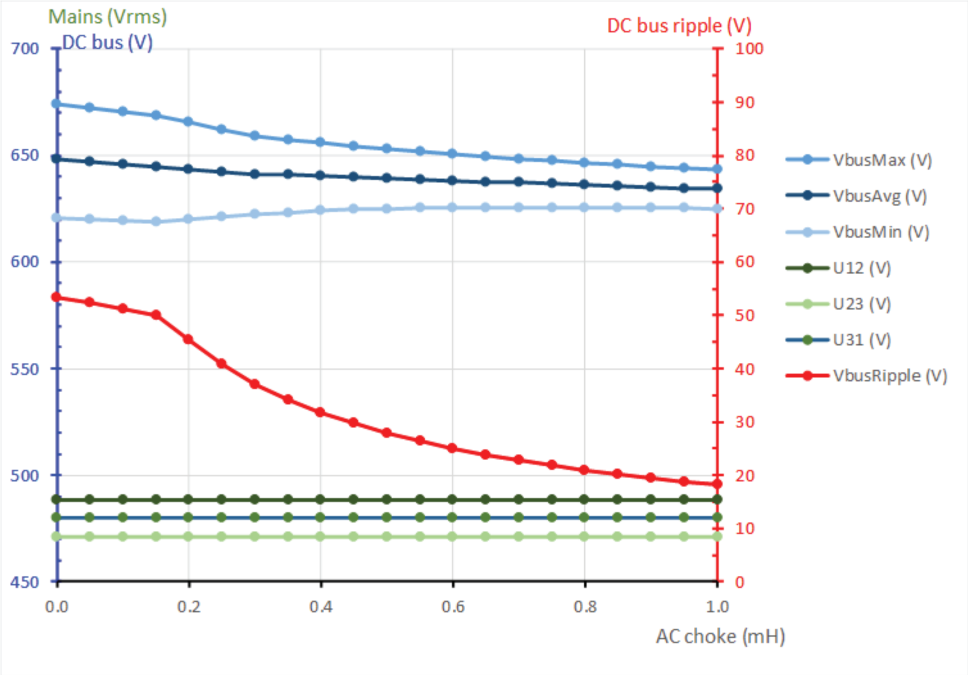
Figures 19 and 20 (next page) show the same voltage and current curves as with the DC choke, with the same input voltage unbalance. In the same input unbalance conditions, the internal DC bus of the drive has a little less ripple with an AC line reactor than with a DC choke. At the same time, the DC bus voltage ripple is also a little less with an AC line reactor.

Drive with DC choke and an additional AC line reactor

To evaluate the influence of an additional AC line reactor on a drive already equipped with a DC choke, the maximum input lines voltage unbalance of 2.1% is kept constant. The additional AC line reactor value is increased from 0 to the same value already used to compare the DC choke and AC line reactor in the previous section.

With the example of the 20 hp drive, the maximum value of the AC line reactor is 1 mH (corresponding to 2.8% impedance). Figure 20 shows that with an additional AC line reactor, the DC bus voltage ripple is reduced. The most important part of the reduction is reached at about half of the value of the AC line reactor.

Figure 20 - Drive with DC choke and an additional AC line reactor



Conclusions

In cases of voltage unbalance at the drive input, both a DC choke and an AC line reactor reduce DC bus voltage ripple. DC voltage harmonic rank 2 is created by the input voltage unbalance.

At the same time, input line current unbalance is also created at the drive input. If we consider the AC line reactor and the DC choke which give the same input current THDi in cases of balanced input voltage, the DC bus ripple voltage is a little less with the AC line reactor.

Using an additional AC line reactor with a drive already equipped with a DC choke helps to reduce the DC bus voltage ripple.

DC bus voltage ripple caused by the unbalance reduces the DC bus capacitors' life by increasing the RMS current through the DC bus capacitors at twice the input frequency.

It is clear that adding an input line reactor in combination with DC chokes reduces DC bus voltage ripple. This reduction of DC bus voltage ripple results in longer life of the DC bus capacitors in the drive.

Summary

Both AC line reactors and DC chokes are valid passive solutions for reducing harmonics impact.

AC line reactors advantages and drawbacks

Advantages

AC line reactors can be easily added in front of any drive since they are wired on the input lines. This can help reduce ripple voltage when the input voltage is unbalanced.

Since the AC line reactor is located in front of the input rectifier, it builds a low pass filter with the capacitors located on the DC bus at the output of the rectifier and the phase-to-phase capacitors included in the EMC filter. This provides protection for the input rectifier against overvoltage.

Drawbacks

AC line reactors are bigger and more expensive than a DC choke for the same drive input current THDi.

AC line reactors create more DC bus voltage drop than a DC choke for the same input current THDi.

A 3-phase AC line reactor built on the same magnetic core does not help in the drive's input EMC filter for high-frequency. The common mode inductance is canceled by the coils sharing the common core, making it not effective at blocking the higher frequency common mode noise.

DC chokes advantages and drawbacks

Advantages

DC chokes are smaller and less expensive than AC line reactors for the same input current THDi reduction.

DC chokes create less DC bus voltage drop than an AC line reactor for the same input current THDi.

Splitting the DC choke into two chokes, one on the DC+ and one on the DC-, allows it to work also in reducing high frequency noise. This helps the input EMI filter by filtering some high-frequency emissions coming from the output inverter switching.

Drawbacks

DC chokes do not provide protection of the input rectifier against mains power supply overvoltage.

If it is not integrated into the drive, additional terminals must be provided by the drive in order to insert an external DC choke.

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As standards, specifications, and design change from time to time, please ask for confirmation of the information given in this publication.

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