MAKING MODERN LIVING POSSIBLE

Harmonics mitigation

Requirements and Danfoss Drives' solutions

VLT®
THE REAL DRIVE

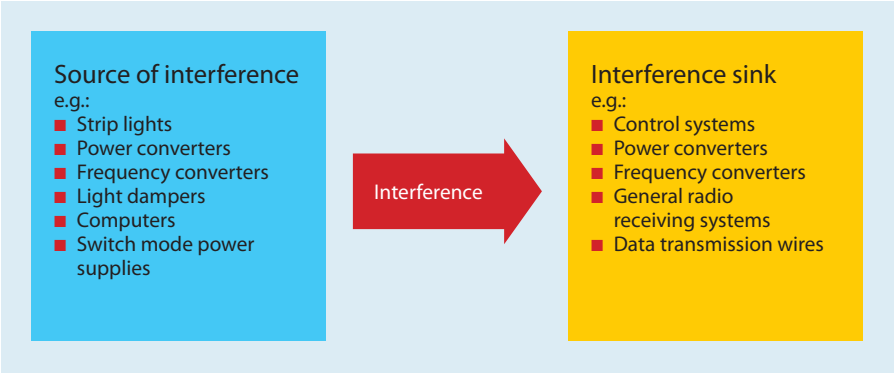
Harmonic distortion – an ever increasing problem

The mains voltage supplied by electricity utilities to homes, businesses and industry should be a uniform sinusoidal voltage with a constant amplitude and frequency.

This ideal situation is no longer found in any power grid. This is mainly because consumers take non-sinusoidal current from the grid or have a non-linear characteristic, e.g. strip lights, light dampers, energy-saving bulbs and frequency converters.

Because of the constantly increasing use of non-linear loads, deviations become increasingly serious.

Irregular power supplies influence the performance and operation of electrical equipment, so motors, frequency converters and transformers must be more highly rated to maintain proper operation.



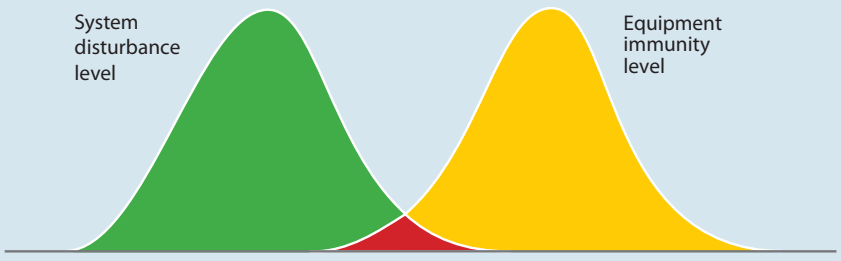
Statutory basis of assessment
The compatibility levels of the standards EN 50160/EN 61000 and, for industrial environments, EN 61000, apply within the scope of the EMC directives.

It is assumed, in principle, that when these levels are observed, all devices and systems fulfil their specified functions without disruption in electrical supply networks

How feedback occurs
The distortion of the sinusoidal curve shape of the supply network as a result of the intermittent use of electricity by the consumers connected to it is called "network feedback".

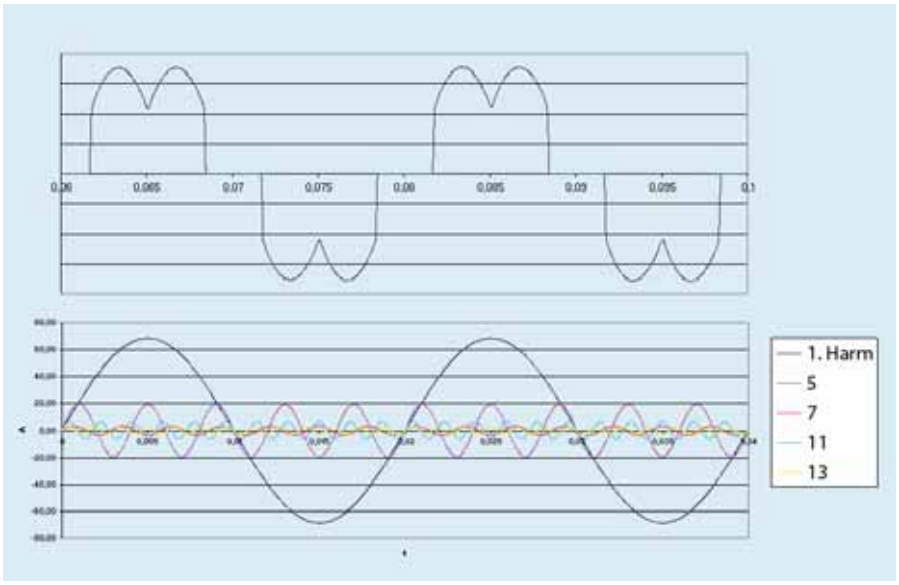
Experts refer to the relative harmonic content of a network on the basis of Fourier analysis and calculate it to 2.5 kHz for 50 Hz, corresponding to the 50th harmonic oscillation.

Relationship between compatibility, immunity and emission levels

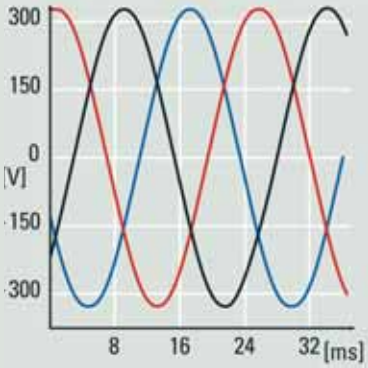


Normal distribution of disturbance and immunity level

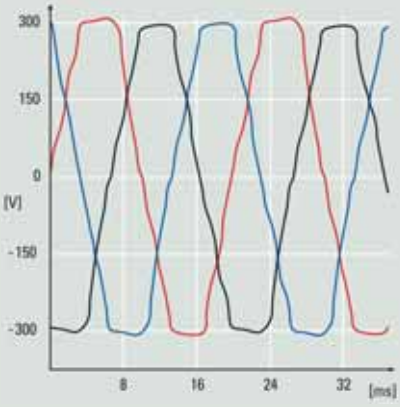
A satisfactory operating production system is obtained when each installed equipment has an immunity that's higher than the total allowed grid distortion. For EN 61000-2-4 the immunity level is a minimum of 10% where as the planned highest distortion level is 5 or 8% depending on the installation. This leaves very few parts (red scattered) of the installation with temporary problems.



Any periodic function can be described as the sum of a series of sine-wave functions (called a "Fourier transformation") The figure shows the current drawn by a typical drive with dc coils. Underneath it is deconstructed into pure sinus curves. All but the blue curve represents distortion – unwanted and often harmful currents.



Normally the voltage in supply grids is not ideally sinusoidal.



Measurements show clear distortion of the mains voltage as the reaction to non-linear consumers.

The first indication of harmonic distortion is „flat-topped" voltage shape.

A Fourier analysis is a decomposition of the non-sinusoidal current wave-form into the sum of sinusoidal signals with various frequencies and amplitudes.

Harmonic current distortion is caused by the rectifier part of the variable speed drive, typically a 6-pulse diode rectifier. The harmonic currents can be described as reactive current adding to the active current.

The amount of harmonic current distortion is often described as a percentage of the fundamental current also known as total harmonic current distortion (THiD).

Consequences
Excessive distortion causes malfunctions. Most common is pre-aging of electronic control systems, computers and control devices.

The most common effect is not noticeable immediately but will, over time, increase the system cost as equipment has to be replaced more offen than otherwise.

High harmonic content causes an overall lower efficiency, loads idle compensating systems and may even cause their destruction. Harmonic current distortion is increasing the root mean square current and if not taken into account can result in overheating of components such as the supply transformer or cables.

Reducing feedback
Feedback from electronic power control systems can be reduced. In Danfoss frequency converters*, it is as standard limited by built-in filter elements.
If it is necessary to reduce the harmonic content in the mains network further, for example in the case of weak networks or emergency power operation, a network analysis can indicate appropriate measures, as described later in the brochure.

*(*Except VLT® Micro Drive)*

Prevent harmonic distortion of mains voltage and current

Built-in intermediate circuit coils reduce low-frequency mains feedback and increase the life of the drive.

Harmonic reduction techniques
To avoid potential problems or to comply with standards such as product standard EN 61000-3-12,system standard EN 61000-2-4 or recommendations such as IEEE 519-1992 or G5/4 several different harmonic reduction techniques for variable speed drives exist.

The most common solutions are:
- AC-coils
- DC-coils
- Multi-pulse (12- and 18-pulse)
- Active filtering
- Passive filtering

DC as standard
The VLT® HVAC Drive, AQUA Drive and AutomationDrive series have built-in chokes. This dramatically reduces network feedback and ensures the drives comply with the limits of EN 61000-3-12.

With this robustly designed intermediate circuit, these drives series operate in a stable and highly dynamic manner even during voltage disruption and under poor mains conditions.

AC-coils
The most common and easiest harmonic reduction technique is probably the use of AC-coils in front of the drive.

The AC-coils smoothes the line current drawn by the converter. Thereby, a significantly lower current distortion can be achieved compared to a basic frequency drive without coils. Similar effects can be obtained with DC-coils. Moreover, the DC-coils are, compared to AC-coils, smaller in size, have higher efficiency and no reduction of the DC-link voltage.

Passive Harmonic filtration
Many different passive harmonic filters exist. They are combinations of coils and capacitors tuned to the individual drive. The different passive filters are either tuned for individual harmonic cancellation or for reduction of a range of frequencies.

Passive harmonic filters offer a practical solution to harmonic mitigation on power systems with a large concentration of non-linear loads connected to the same distribution transformer. Like multi-pulse drives, passive filters have a performance depending on the loading, and grid stability.

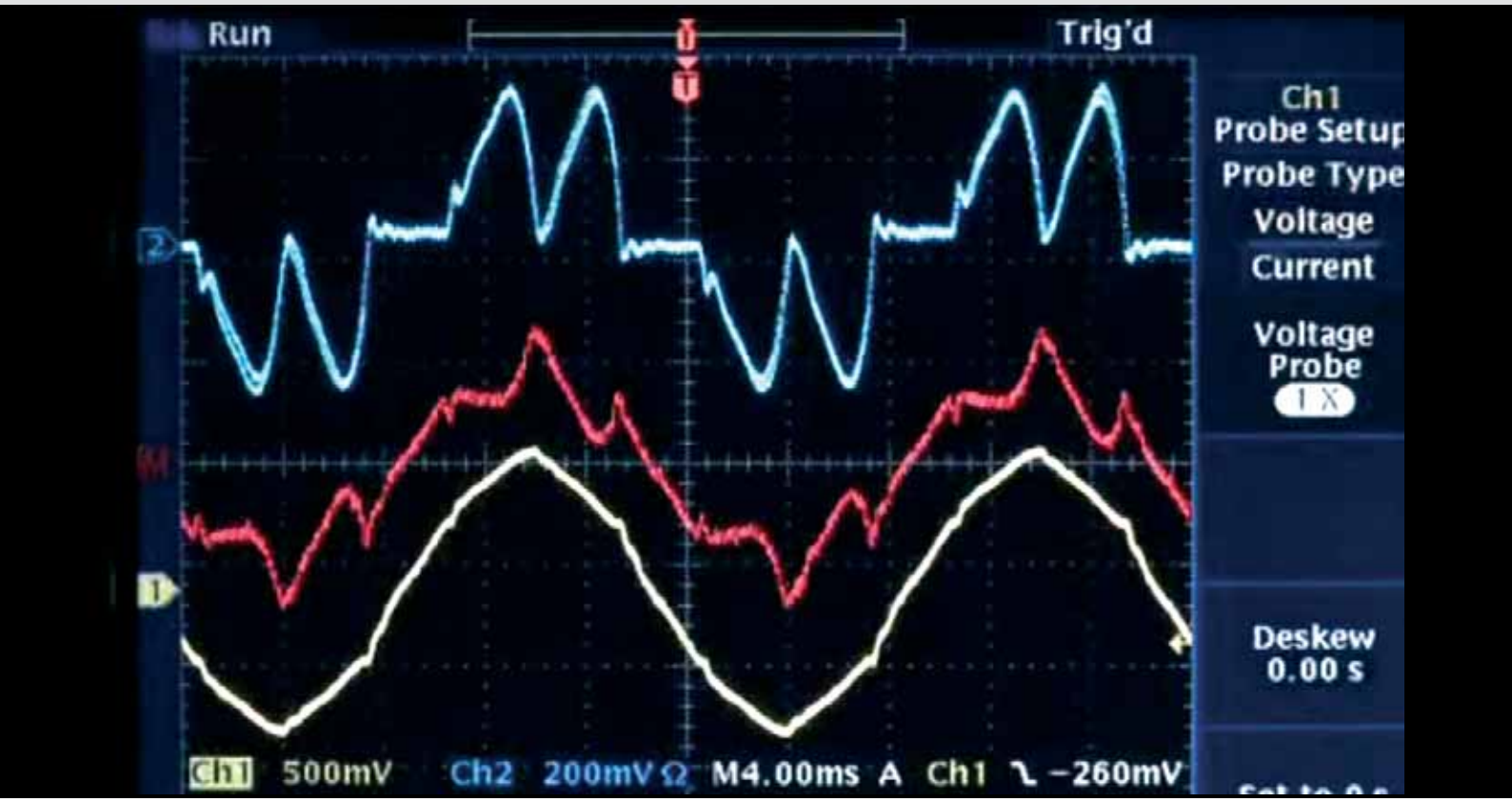
The mitigation performance of VLT® Advanced Harmonic Filter AHF 010 or AHF 005 are comparable to 12- or 18-pulse solutions respectively but have a higher immunity against loads changes, voltage imbalance and/or voltage pre-distortion.

Especially at currents lower than 300 – 400 A, the Danfoss AHF filter offers a low cost alternative to 12-and 18-pulse drives even with improved harmonic performance.

Benefits for both AC and DC-coils
- Standard and often build-in
- RMS is dramatically reduced
- Practicable/Easy
- Cost included in drive

DC benefits
- Less frequency across coil giving lower losses then AC-coils (higher efficiency)
- More stable DC-voltage
  – longer capacitor life (smaller DC-ripple)
  – More stable motor control
- Smaller foot print

Prevent harmonic distortion of mains voltage and current



With active filtering the distortion is monitored and analysed. A corrective current is then injected in counter phase to eliminate the distortion.

Multi-pulse
12- and 18-pulse rectifiers have for many years been considered the standard solution to reduce harmonic distortion from drives. In theory, the 5th and 7th harmonic currents (for 18-pulse also the 11th and 13th) are cancelled by phase shifting transformers and the use of two (or three) six-pulse diode rectifiers.
However, a significant disadvantage of the multi-pulse harmonic reduction technique is the sensitivity to non-ideal supply voltage. Since some voltage imbalance or harmonic background distortion is always present, a complete cancellation of the 5th and 7th (11th and 13th) is never really achieved.

Active filtering
Active filters are very effective in reducing harmonic oscillations up to 2 kHz, and are used as an alternative to built-in DC or AC-coils or other passive filters.

For active filtering as for Low Harmonic Drives and for Active Front End drives, consideration must be given to the effects above 2 kHz, generated by these units themselves.

They make further measures necessary to keep the mains supply clean. Standard limits in this higher frequency range are still at the planning stage.

The switching frequencies of active filters will cause a peak at the switching frequency of the filter itself. This is above the range of current norms, but higher order disturbance is of equal importance.

Users should ask manufacturers specifically about emission values and counter-measures to secure the operational safety of their plant .

Low Harmonic Drive
Low harmonic drives are often Active front end drives where the diode rectifier of the drive is exchanged for a controlable IGBT module allowing energy to be injected back into the line.

The Danfoss Low Harmonic Drive however is a combination of an Active Filter and a standard AC-drive. It is designed with the fewest possible components in the main current path.

The active mitigation circuit is a parallel path that injects current in counter phase to the unwanted current components of the drive. With few components in the main current path, a high efficiency is achieved compared to other harmonic solutions. Although this solution, as AFE, also comes at a premium price, the return of investment is lower compared to traditional passive filters.

Active filtration keeps harmonics disturbance low for the full load range. The Low Harmonic Drives still have the side effect of increased EMC disturbance like other active solutions.

Harmonic Calculation Tool

Simulate the harmonic disturbance with and without filter

To avoid overloading and to secure mains voltage quality, a number of reduction, avoidance or compensation methods can be used with systems and devices producing harmonic currents.

You can use the VLT® Harmonic Calculation Tool MCT 31 to include specific counter-measures in the planning stage and therefore ensure the quality of your system. The network feedback of electronic devices can be estimated to within 2.5 kHz, depending on the system configuration and standard limits.

The analysis includes indication of norm compliance.

Calculate the harmonic disturbance
From www.danfoss.com you can download the free tool VLT® Harmonic Calculation MCT 31 – the most up-to-date version of the calculation software.

The Windows-like interface guarantees intuitive operation of the software.

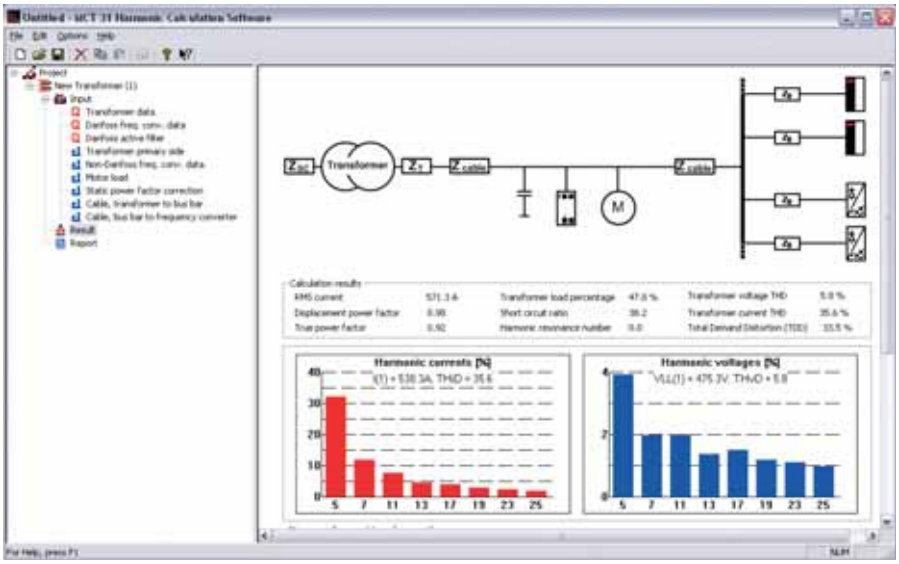
The software is built with a focus on user-friendliness and limited to involve only system parameters that are normally accessible.

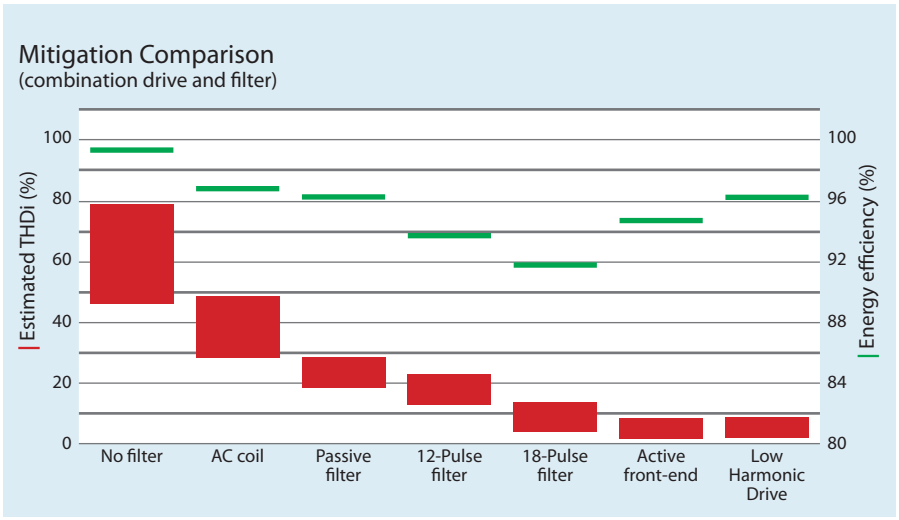
The Danfoss VLT® frequency converters are already embedded and speed date entry.

Convenient documentation
All the data entered may be sorted, stored and recalled and the software documents all the projects calculated in a detailed, clear way at the push of a button.

The results are shown in a table or bar chart for different measuring points within the configuration. The application indicates with warning signals where the limits are exceeded. In addition to the currents, the voltages of the harmonic oscillations are shown.

The documentation is completed by a general overview including a circuit diagram indicating the desired standards.





A comparison between different harmonic mitigation principles shows that low harmonic distortion is followed by low energy efficiency – except for active filtering, where the efficiency is relatively good.

Advanced Harmonic Filter

The Danfoss AHF 005 and AHF 010 are advanced harmonic filters, not to be compared with traditional harmonic trap filters. The Danfoss harmonic filters have been specially designed to match the Danfoss frequency converters.

By connecting the Danfoss harmonic filters AHF 005 or AHF 010 in front of a Danfoss frequency converter, the harmonic current distortion generated back to the mains is reduced to a minimum.

Danfoss Advanced Harmonic Filters offer cost effective and very robust solutions specifically for the low power range.

Product range
Line Voltage
- 380 – 415 V AC (50 and 60 Hz)
- 440 – 480 V AC (60 Hz)
- 500 – 525V (50 Hz)
- 690 V (50 Hz)

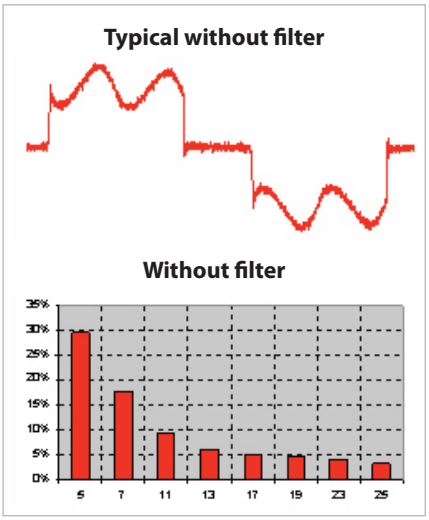
Filter current
- 10 A – 390 A
- (Modules can be paralleled for higher power)

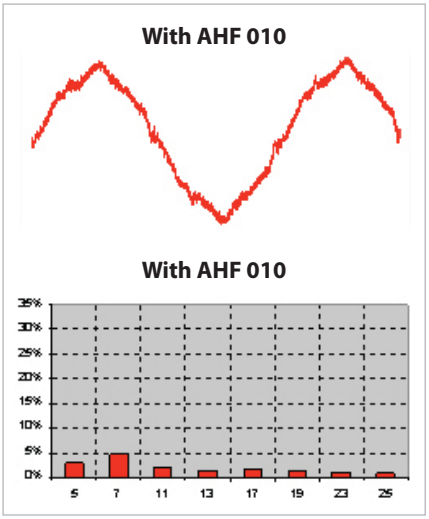
Enclosure degree
- IP 20

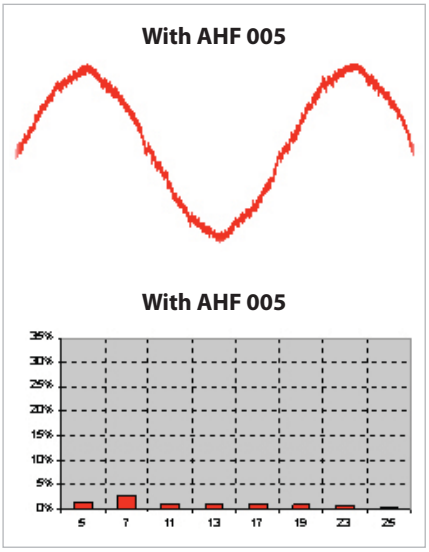
Features	Benefits
User-friendly	
Small compact housing	Fits into a panel
Easy to use in retrofit applications	High flexibility
One filter module can be used for several frequency converters	Lowers system cost
Complies with IEEE 519-1992 and stage 1 of EN 61000-3-12	Installation in harsh environments
Easy commissioning	No adjustment necessary
No routine maintenance required	No running expenses
Efficient	
AHF 005 reduces the total harmonic current distortion to 5% at 100% load	Reduces transformer load
AHF 010 reduces the total harmonic current distortion to 10% at 100% load	Reduces transformer load
Low filter losses	High efficiency (> 0.98)

Specifications	
Line voltage	±10%
Frequency	+/- 5%
Overload current	160% for 60 s
Efficiency	0.98
True power factor	0.85 @ 50% load 0.99 @ 100% load 1.0 @ 150% load
Ambient temperature	5˚C – 40˚C without derating

Current and Distortion Spectrum at Full Load







Ordering numbers

380 V – 415 V (50 Hz)			
IAHF,N	Typical motor used (kW)	AHF 005	AHF 010
10 A	4, 5.5	175G6600	175G6622
19 A	7.5	175G6601	175G6623
26 A	11	175G6602	175G6624
35 A	15, 18.5	175G6603	175G6625
43 A	22	175G6604	175G6626
72 A	30, 37	175G6605	175G6627
101 A	45, 55	175G6606	175G6628
144 A	7.5	175G6607	175G6629
180 A	90	175G6608	175G6630
217 A	110	175G6609	175G6631
289 A	132, 160	175G6610	175G6632
324 A		175G6611	175G6633
370 A	200	175G6688	175G6691
434 A	250	2 x 175G6609	2 x 175G6631
578 A	315	2 x 175G6610	2 x 175G6632
613 A	350	175G6610 + 175G6611	175G6632 + 175G6633

380 V – 415 V (60 Hz)			
IAHF,N	Typical motor used (Hp)	AHF 005	AHF 010
10 A	6	130B2540	130B2541
19 A	10, 15	130B2460	130B2472
26 A	20	130B2461	130B2473
35 A	25, 30	130B2462	130B2474
43 A	40	130B2463	130B2475
72 A	50, 60	130B2464	130B2476
101 A	75	130B2465	130B2477
144 A	100	130B2466	130B2478
180 A	125	130B2467	130B2479
217 A	150	130B2468	130B2480
289 A	200	130B2469	130B2481
324 A	250	130B2470	130B2482
370 A	300	130B2471	130B2483
434 A	350	130B2468 + 130B2469	130B2480 + 130B2481
578 A	450	2 x 130B2469	2 x 130B2481
648 A	500	2 x 130B2470	2 x 130B2482

440 V – 480 V			
IAHF,N	Typical motor used (HP)	AHF 005	AHF 010
19 A	10, 15	175G6612	175G6634
26 A	20	175G6613	175G6635
35 A	25, 30	175G6614	175G6636
43 A	40	175G6615	175G6637
72 A	50, 60	175G6616	175G6638
101 A	75	175G6617	175G6639
144 A	100, 125	175G6618	175G6640
180 A	150	175G6619	175G6641
217 A	200	175G6620	175G6642
289 A	250	175G6621	175G6643
324 A	300	175G6689	175G6692
370 A	350	175G6690	175G6693
506 A	450	175G6620 + 175G6621	175G6642 + 175G6643
578 A	500	2 x 175G6621	2 x 175G6643

500 V – 525 V			
IAHF,N	Typical motor used (kW)	AHF 005	AHF 010
10 A	4, 5.5	175G6644	175G6656
19 A	7.5, 11	175G6645	175G6657
26 A	15, 18.5	175G6646	175G6658
35 A	22	175G6647	175G6659
43 A	30	175G6648	175G6660
72 A	37, 45	175G6649	175G6661
101 A	55, 75	175G6650	175G6662
144 A	90, 110	175G6651	175G6663
180 A	132	175G6652	175G6664
217 A	160	175G6653	175G6665
289 A	200	175G6654	175G6666
324 A	250	175G6655	175G6667
434 A	315	2 x 175G6653	2 x 175G6665
469 A	355	175G6652 + 175G6654	175G6664 + 175G6666
578 A	400	2 x 175G6654	2 x 175G6666

690 V			
IAHF,N	Typical motor used (kW)	AHF 005	AHF 010
43 A	37, 45	130B2328	130B2293
72 A	55, 75	130B2330	130B2295
101 A	90	130B2331	130B2296
144 A	110, 132	130B2333	130B2298
180 A	160	130B2334	130B2299
217 A	200	130B2335	130B2300
289 A	250	130B2331 + 130B2333	130B2301
324 A	315	130B2333 + 130B2334	130B2302
370 A	400	130B2334 + 130B2335	130B2304

VLT® 12-pulse drives
Reduced harmonics and increased network stability

When reduced harmonics and increased network stability are desired for high power applications, the Danfoss VLT® 12-pulse drive offers an excellent solution.

Two standard 6-pulse rectifiers are connected in parallel to a three-phase system, through a 30°-phase shifting transformer.

By phase shifting the secondary windings, the sum of the secondary currents in the primary eliminates the 5th, 7th, 17th and 19th harmonics.

This results in a THiD of approx.10 % compared with a THiD of 30% to 50% in a 6-pulse drive with coil mitigation.

The Danfoss VLT® 12-pulse drive provides harmonic reduction without adding capacitive, inductive or resistive components which often require extensive network analysis to avoid potential system resonance problems.

The VLT® 12-pulse is a high efficiency variable frequency converter which is built with the same modular design as the popular 6-pulse high power drives which provide exceptional flexibility, durability and reliability in demanding industry applications.

Power Range
- 250 kW – 1.4 MW

Voltage Range
- 380 - 690 Volts

Enclosure
- IP 21/NEMA Type 1
- IP 54/NEMA Type 12

Drive Platform
- VLT® HVAC Drive FC 102
- VLT® AQUA Drive FC 202
- VLT® AutomationDrive FC 302

The Perfect Solution for
- Soft Power Grids
- Reducing Network Harmonic Distortion
- Generator Powered Installations
- Step Down, Step Up Applications
- Drives to be isolated from the grid

Assists in Meeting Harmonic Standards
- IEEE-519 1992
- EN 61000-2-4
- G5/4

Features	Benefits
Common control platform with smaller drives	Ease of use; once you know one drive, you know them all
Proven power electronics	Reliable operation
Modular design	Components are accessible from the front for easy serviceability Quick and easy replacement
Back-channel cooling	Reduced maintenance requirements Longer drive lifetime
Rittal TS8 enclosure systems in IP 21 (NEMA1) or IP 54 (NEMA 12)	Allows easy expansion
Class A1 RFI filter	Reduced EMI/RFI without need for external filters
DC-link reactors	Reduced harmonics throughout the entire network. Low losses for high system efficiency
DC-link fuses	Independent protection of inverters
Coated PCB board	Protection against corrosive environments
Reduced Harmonic Impact	Reduced System Resonance Risk Reduced Erratic operation of installed equipment Reduced equipment malfunctions

400 V AC				
Normal Overload		High Overload		Frame
Amps	kW	Amps	kW	
600	315	480	250	F0
648	355	600	315	
745	400	658	355	
800	450	695	400	
880	500	800	450	F5
990	560	880	500	
1120	630	990	560	
1260	710	1120	630	
1460	800	120	710	F6
1720	1000	140	800	

460 V				
Normal Overload		High Overload		Frame
Amps	HP	Amps	HP	
540	450	443	350	F0
590	500	540	450	
678	550	590	500	
730	600	678	550	
780	650	730	600	F5
890	750	780	650	
1050	900	890	750	
1160	1000	100	900	
1380	1200	110	1000	F6
1530	1350	1380	1200	

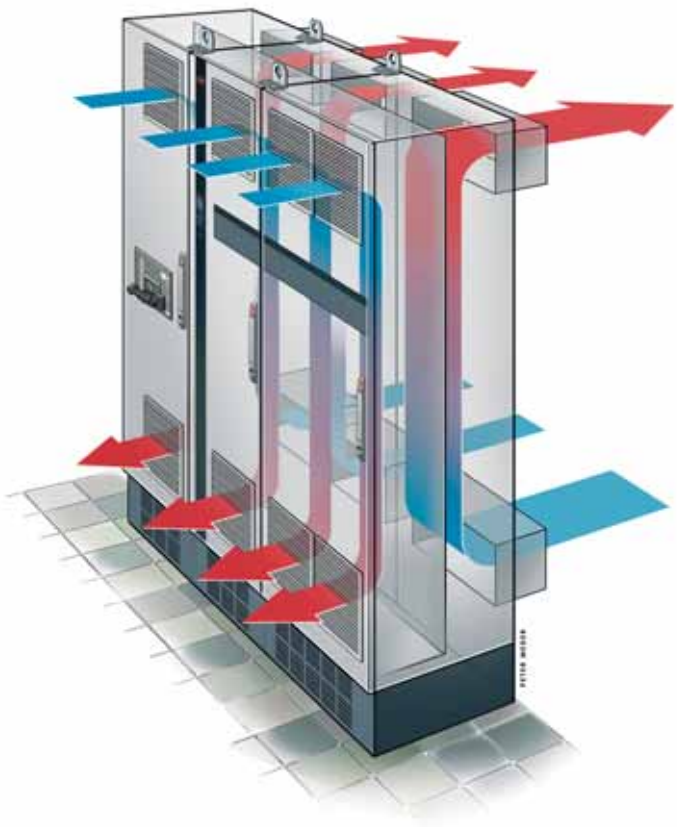
575 V				
Normal Overload		High Overload		Frame
Amps	HP	Amps	HP	
540	450	443	350	F0
590	500	540	450	
678	550	590	500	
730	600	678	550	
780	650	730	600	F5
890	750	780	650	
1050	900	890	750	
1160	1000	100	900	
1380	1200	110	1000	F6
1530	1350	1380	1200	

690 V				
Normal Overload		High Overload		Frame
Amps	kW	Amps	kW	
450	400	380	355	F0
500	500	410	400	
570	560	500	500	
630	630	570	560	
730	710	630	630	F5
850	800	730	710	
945	900	850	800	
1060	1000	945	900	
1260	1200	110	1000	F6
1415	1400	120	1200	

Cabinet Sizes [mm]			
Frame	Depth	Width	Height
F0	2280	800	607
F5		1600	
F6		2000	

Specifications

Control and convenience options	24 VDC regulated power supply 30A fuse protected circuit Manual motor starters NAMUR terminals
dU/dt filters	For providing motor insulation protection correction with options to program the task priorities
Sine filters	(LC filters): reduce motor noise
Enclosure options	Door interlocks Cabinet lights and Convenience power outlets Space heaters and thermostat
Modular application options	Plug-and-play cards facilitate drive upgrades, start-up and servicing
Monitoring options	RCD (Residual Current Devices) IRM (Insulation Resistance Monitor) Motor temperature monitoring
Power options	Class A2 RFI Disconnect (mains switch) (6) AC Semi-Conductor Fuses



Back-channel cooling

Our unique design uses a ducted back channel to pass cooling air over the heat sinks with minimal air passing through the electronics area.

This allows 85% of the heat losses to be exhausted directly outside of the enclosure, improving reliability and prolonging life by dramatically reducing temperature rise and contamination of the electronic components. There is an IP 54 seal between the back channel cooling duct and the electronics area of the VLT® Low Harmonic Drive.

VLT® Low Harmonic Drive

VLT® AQUA Drive, VLT® AutomationDrive and VLT® HVAC Drive are available in low harmonic versions

Where the performance of other low harmonic technologies depends on the stability of the grid and load or affect the controlled motor, the new Danfoss VLT® Low Harmonic Drives continuously regulate the network and load conditions without affecting the connected motor.

VLT® Low Harmonic Drives are motor friendly, with output impulse & shaft voltages compatible with motors conforming to IEC 60034-17/25 & NEMA-MG1-1998 part 31.4.4.2), as per standard VLT® Drives.

The VLT® Low Harmonic Drive has the same modular build-up as our standard high power drives and shares similar features: high energy efficiency, back-channel cooling and user-friendly operation.

The VLT® Low Harmonic Drive meets the toughest harmonic recommendations and gives the user full readout of the unit performance towards the grid, including graphical overview of grid behavior.

The perfect solution for

- Meeting the toughest harmonics recommendation/standards
- Generator-powered installations
- Installation with generator backup
- Soft power grids
- Installation of drives in grids with limited excess power capacity

Voltage range

- 380 – 480 V AC 50 – 60 Hz

Power Range

132 – 630 kW High Overload/
160 – 710 kW Normal Overload
(Matching drive frames D, E and F)

Enclosure degree

- IP 21 / NEMA 1, IP 54 Hybrid

Features	Benefits
Energy saving	**Lower operating costs**
Energy saving functions (e.g., sleep mode, standby mode). Variable switching frequency for lower switching losses High product efficiency network changes	Saves energy
Reduced harmonics	Improved power factor/reduced load on supply network Lower transformer, switchgear and cable losses
Back-channel cooling (85% heat dissipated via back channel)	Less control room cooling Less fan power consumption
Unequalled robustness	**Maximum up time**
Robust enclosure	Maintenance free
Unique cooling concept with no ambient airflow over electronics	Problem-free operation in harsh environment
Coated PCBs	Problem-free operation in harsh environment
100% factory test	Problem-free operation
Highest possible harmonic mitigation	**Save initial and operation cost**
Maximum 5% THiD	Meeting toughest harmonics recommendation/standards
Robust against voltage imbalance and grid predistortion	Optimized transformer/generator grid capacity, more drives on same transformer
Dynamic regulation to load changes	Energy optimization
All built-in	**Low investment**
Modular concept and a wide range of options	Low initial investment with maximum flexibility and possibility of future upgrades
Decentral I/O control via serial communication	Reduced cost for wiring and external I/O controller
Integrated EMC RFI filters	Meets EN 55011 (A1 optional, A2 standard)
User friendly	**Save commissioning and operation cost**
Award-winning graphical display, 27 languages	Effective commissioning and operation
Full overview of grid condition	Reduced test effort
Timely tracking of grid conditions	Reduced test effort

PC software

MCT 10

Ideal for commissioning, servicing, monitoring and performance logging.

RoHS compliant

VLT® Low Harmonic Drives are manufactured with respect for the environment and comply with the RoHS directive.

Options

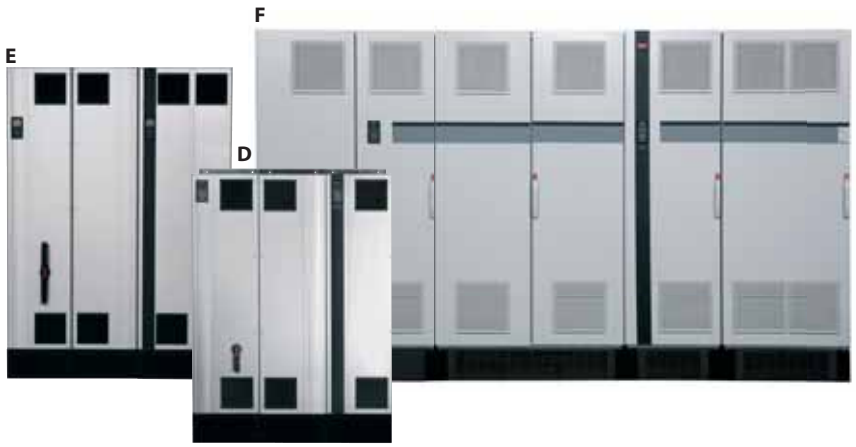
- **dU/dt filters**: Protect motor insulation
- **Sine filters** (LC filters): Reduce motor noise

Back-channel cooling

Our unique design uses a ducted back channel to pass cooling air over the heat sinks with minimal air passing through the electronics area. This allows 85% of the heat losses to be exhausted directly outside of the enclosure, improving reliability and prolonging life by dramatically reducing temperature rise and contamination of the electronic components. There is an IP 54 seal between the back channel cooling duct and the electronics area of the VLT® Low Harmonic Drive.

Specifications

Harmonic mitigation performance	< 5% THD Meet individual harmonic levels of IEEE 519 for ISC/IL>20 Meeting EN/IEC61000-3-4/IEC61000-3-12
True power factor	> 0.98
Displacement factor	> 0.98
PC software & user interface	Commissioning tool function Configuration and installation settings function User settings and information function Control panel function Data logger and event log function Network monitoring and measurement function Filter load and status function Software update function
LCP Regulation	UL-file. CE marking, cULus (UL508C) and c-tick (AS/NZS 2064) IEEE519 / EN 61000-3-xx harmonic mitigation guidelines IEEE587/ANSI C62.41/ EN61000-4-5 surge immunity EN 55011 electromagnetic compatibility EN 50178, EN 60146 safety/design
Ambient temperature	-10° C to +45° C, up to 3280 feet above sea level, with relative humidity of 5% – 85% RH, class 3K3 (functions to be maintained up to 95% RH not condensing)
Power fuses	Optional
RFI filtering	Class A2 RFI; Class A1 RFI optional
Cooling	Air cooled with primary cooling through back-channel



400 VAC (380 – 480 VAC)						
Normal Overload		High Overload		Frame	Dimensions	Weight
Power	Current	Power	Current		H x W x D	
kW	[A]	kW	[A]		IP 21 [mm]	kg
160	315	132	260	D	1740 x 1260 x 380	380
200	395	160	315			380
250	480	200	395			406
315	600	250	480	E	2000 x 1440 x 500	596
355	658	315	600			623
400	745	355	658			646
450	800	400	695			646
500	880	450	800	F	2200 x 3700 x 600	2009
560	990	500	880			2009
630	1120	560	990			2009
710	1260	630	1120			2009

VLT® Advanced Active Filter AAF 005

Danfoss Advanced Active Filters eliminate harmonic distortion from non-linear loads and improve system power factor.

Proven VLT® power electronics re-establish optimal sinusoidal power and unity power factor by generating and injecting counter phased harmonic and reactive currents.

The modular construction offers the same characteristics as our High Power VLT® family, including high energy efficiency, user-friendly operation, back channel cooling and high enclosure grades.

Danfoss Advanced Active Filters can compensate for individual VLT® drives as a compact integrated solution or can be installed as a compact stand-alone solution at a common point of coupling, compensating for several loads simultaneously. Danfoss Active Filters can operate at medium voltage level by means of step-down transformer.

The perfect solution for
- Restoring weak networks
- Increasing network capacity
- Increasing generator power
- Meeting compact retrofit demands
- Securing sensitive environments
- Utilising energy savings

Voltage range
- 380 – 480 V AC 50 – 60 Hz

Power Range
190 A, 250 A, 310 A, 400 A, 500 A.
Up to 4 units can be paralleled for higher power.

Enclosure degree
- IP 21, IP 54 Hybrid

Features	Benefits
Energy saving	**Lower operating costs**
Power factor correction and control priority dedication Automatically adapts to network changes	Saves energy
Reduced harmonics	Increased transformer efficiency Reduced cable losses
Back-channel cooling (85% heat dissipated via back channel)	Less control room cooling Less fan power consumption
Reliable	**Maximum up time**
Continues operation if overloaded High robustness against background distortion and voltage imbalance Self protection features	More up-time
Optional, mains disconnect switch and fuses	No need of external switches
Back-channel cooling	Lower panel temperature Longer lifetime
Coated PCB board	Increased resistance against dust
Retrofit without dismounting existing equipment	Saves time and cost
User friendly	**Save initial and operation cost**
Standard award-winning control panel (LCP)	Effective commissioning and operation
Same compact wall mount cabinet as drive	Well known and easy installation in small installation spaces
Modular design	Enables fast installation
High component commonality with our drives	Fast and easy service
Automatic current sensor adaptation	Less commissioning effort
Complies with VLT® software	Save commissioning time Enables analysis support

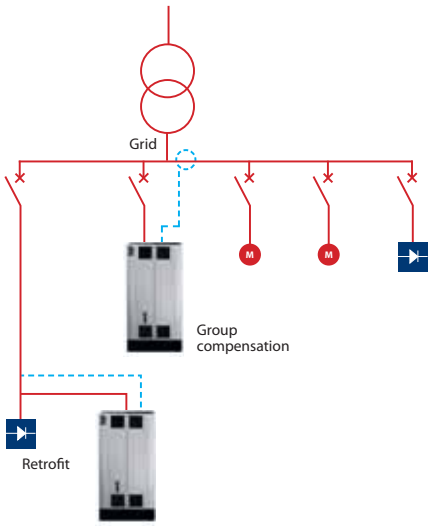
PC software

MCT 10

Ideal for commissioning, servicing, monitoring and performance logging.

RoHS compliant

The VLT® Active Filter is manufactured with respect to the environment, and it complies with the RoHS directive.



Specifications

CT requirements	Three standard current transformers (CT's), connected during installation at phases L1, L2 and L3
Operation modes	Mode 1: Harmonic mitigation Mode 2: Harmonic mitigation and power factor correction with options to program the task priorities
Harmonic mitigation performance	< 5% THD of the rated non-linear load current at the PCC
Harmonics Control	Individual harmonic control of odd harmonic 5th to 25th excl. tripplens. Full compensation of all harmonics 2nd to 25th and power factor correction.
Compatibility	Equipment is compatible for field installation with existing active filters
PC Software & user interface	Commissioning tool function Configuration and installation settings function. User settings and information function. Control panel function. Data logger and event log function. Network monitoring and measurements function. Filter load and status function. Software update function.
LCP Regulation	UL-file. CE marking, cULus (UL508C) and c-tick (AS/NZS 2064). IEEE519 / EN61000-3-xx Harmonic Mitigation Guidelines IEEE587/ANSI C62.41/ EN61000-4-5 Surge Immunity EN55011 Electromagnetic compatibility EN50178, EN60146 Safety/Design
Ambient temperature	-10° C to +45° C, up to 1000 metres above sea level, with relative humidity of 5% – 85% RH, class 3K3 (functions to be maintained up to 95% RH not condensing)
Power fuses	Optional
RFI filtering	Class A2 RFI; Class A1 RFI optional
Cooling	Air cooled with primary cooling through back channel
Standard Current Transducer	Rated secondary current 1 A and 5 A Rated apparent power > 5 VA Accuracy class 0.5 or better

D

E

F

400 VAC (380 – 480 VAC)														
Total Current [A]	Order No.	Frame	Dimensions H*W*D	Weight	Max. Reactive [A]	Max. Harmonic [A]	Max. individual harmonic compensation [A]							
	RFI A2, IP 21, T4		IP 21, IP 54				I_5	I_7	I_{11}	I_{13}	I_{17}	I_{19}	I_{23}	I_{25}
190	AAF005A190T4E21H2GCxx	D	1740*840*380 mm	293 kg	190	170	133	95	61	53	38	34	30	27
250	AAF005A250T4E21H2GCxx	E	2000*840*500 mm	352 kg	250	225	175	125	80	70	50	45	40	35
310	AAF005A315T4E21H2GCxx				310	280	217	155	99	87	62	56	50	43
400	AAF005A400T4E21H2GCxx	F	2200*2300*600 mm	1004 kg	400	360	280	200	128	112	80	72	64	56
500	AAF005A500T4E21H2GCxx				500	450	350	250	160	140	100	90	80	70

Environmentally responsible

VLT® products are manufactured with respect for the safety and well-being of people and the environment.

All activities are planned and performed taking into account the individual employee, the work environment and the external environment. Production takes place with a minimum of noise, smoke or other pollution and environmentally safe disposal of the products is pre-prepared.

UN Global Compact
Danfoss has signed the UN Global Compact on social and environmental responsibility and our companies act responsibly towards local societies.

EU Directives
All factories are certified according to ISO 14001 standard. All products fulfil the EU Directives for General Product Safety and the Machinery directive. Danfoss Drives is, in all product series, implementing the EU Directive concerning Hazardous Substances in Electrical and Electrical Equipment (RoHS) and is designing all new product series according to the EU Directive on Waste Electrical and Electronic Equipment (WEEE).

Impact on energy savings
One year's energy savings from our annual production of VLT® drives will save the energy equivalent to the energy production from a major power plant. Better process control at the same time improves product quality and reduces waste and wear on equipment.

What VLT® is all about

Danfoss Drives is the world leader among dedicated drives providers – and still gaining market share.

Dedicated to drives
Dedication has been a key word since 1968, when Danfoss introduced the world's first mass produced variable speed drive for AC motors – and named it VLT®.

Twenty five hundred employees develop, manufacture, sell and service drives and soft starters in more than one hundred countries, focused only on drives and soft starters.

Intelligent and innovative
Developers at Danfoss Drives have fully adopted modular principles in development as well as design, production and configuration.

Tomorrow's features are developed in parallel using dedicated technology platforms. This allows the development of all elements to take place in parallel, at the same time reducing time to market and ensuring that customers always enjoy the benefits of the latest features.

Rely on the experts
We take responsibility for every element of our products. The fact that we develop and produce our own features, hardware, software, power modules, printed circuit boards, and accessories is your guarantee of reliable products.

Local backup – globally
VLT® motor controllers are operating in applications all over the world and Danfoss Drives' experts located in more than 100 countries are ready to support our customers with application advice and service wherever they may be.

Danfoss Drives experts don't stop until the customer's drive challenges are solved.