ENGINEERING TOMORROW

Danfoss

Design Guide

VLT® Advanced Harmonic Filter AHF 005/AHF 010

VLT® HVAC Drive FC 102 • VLT® Refrigeration Drive FC 103
VLT® AQUA Drive FC 202 • VLT® AutomationDrive FC 301/302

vlt-drives.danfoss.com

VLT®

Contents

1 Introduction

1.1 Purpose of the Design Guide

This design guide introduces important aspects of the VLT® Advanced Harmonic Filters AHF 005/AHF 010 (referred to as AHF) for VLT® FC Series frequency converters. It describes harmonics and how to mitigate them, and it provides installation instructions and guidance on how to program the frequency converter.

The technical data and information on the connection conditions are on the nameplate and in the documentation. Always observe the recommendations and instructions in this document.

Danfoss technical literature is also available online at *drives.danfoss.com/knowledge-center/technical-documentation/*.

1.2 Intended Use

The filters are components designed for installation in electrical systems or machinery.
When installing in machines, commissioning of the filters (that is starting of operation as directed) is prohibited until it is proven that the machine complies with the Machinery Directive 2006/42/EC. Observe EN 60204.

The VLT® Advanced Harmonic Filter AHF 005/AHF 010 is intended for use with:

- VLT® HVAC Drive FC 102.
- VLT® Refrigeration Drive FC 103.
- VLT® AQUA Drive FC 202.
- VLT® AutomationDrive FC 301/FC 302.

1.3 Organization of the Design Guide

Chapter 1 Introduction: The general purpose of the design guide and compliance with international directives.

Chapter 2 Introduction to Harmonics and Mitigation: An introduction to harmonics and how to mitigate them.

Chapter 3 Basic Operating Principle of the AHF: A description of the operating principles of harmonic filters.

Chapter 4 Requirements for Installation: Basic requirements for mechanical and electrical installation.

Chapter 5 Selection of Advanced Harmonic Filter: Information on how to calculate the correct filter size, ordering numbers, and accessories.

Chapter 6 Programming: Describes the necessary parameter settings for filter operation.

Chapter 7 Specifications: A compilation of technical data in table and graphics format.

Chapter 8 Spare Parts: Overview of all available spare parts, including ordering numbers.

Chapter 9 Appendix: A compilation of power loss tables.

1.4 Abbreviations, Symbols, and Conventions

1.4.1 Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
A	Ampere/AMP
AC	Alternating current
AHF	Advanced Harmonic Filter
AWG	American wire gauge
CDM	Complete drive module
DC	Direct current
DPF	Displacement power factor
EMC	Electromagnetic compatibility
$f_{M,N}$	Nominal motor frequency
FC	Frequency converter
g	Ground gravity
HCS	Harmonic calculation software
$I_{M,N}$	Nominal motor current
I_{INV}	Rated inverter output current
Hz	Hertz
kHz	Kilohertz
kVAr	Kilo-volt-ampere reactive
LCP	Local control panel
m	Meter
mA	Milliampere
MCT	Motion control tool
mH	Millihenry inductance
min	Minute
ms	Millisecond
nF	Nanofarad
Nm	Newton meters
P	Active power
PCC	Point of common coupling
PDS	Power drive system
PELV	Protective extra low voltage
PF	Power factor
$P_{M,N}$	Nominal motor power

PWHD	Partial weighted harmonic distortion
Q	Reactive power
R_{SCE}	Short circuit ratio
RPM	Revolutions per minute
S	Apparent power
s	Second
TDD	Total demand distortion
THD	Total harmonic distortion
THDi	Total harmonic current distortion
THDv	Total harmonic voltage distortion
TPF	True power factor
$U_{M,N}$	Nominal motor voltage
V	Volt

Table 1.1 Abbreviations

1.4.2 Conventions

Numbered lists indicate procedures.
Bullet lists indicate other information and description of illustrations.

Italicized text indicates:

- Cross-reference.
- Link.
- Footnote.
- Parameter name.
- Parameter group name.
- Parameter option.

All dimensions in drawings are in mm (in).
* Indicates a default setting of a parameter.

The following symbols are used in this guide:

WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

1.5 Document Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1.2 shows the document version.

Edition	Remarks
MG80C5xx	Editorial update

Table 1.2 Document Version

1.6 Approvals and Certifications

VLT® Advanced Harmonic Filters AHF 005/AHF 010 are designed in compliance with the directives described in this section.

More approvals and certifications are available. Contact a local Danfoss partner.

1.6.1 CE Conformity and Labeling

What is CE Conformity and Labeling?
The purpose of CE labeling is to avoid technical trade obstacles within EFTA and the EU. The EU has introduced the CE label as a simple way of showing whether a product complies with the relevant EU directives and standards. The CE label says nothing about the specifications or quality of the product.

1.6.2 CE Mark

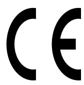

Illustration 1.1 CE

The CE mark (Communauté Européenne) indicates that the product manufacturer conforms to all applicable EU directives. The EU directives applicable to the design and manufacture of frequency converters are listed in *Table 1.3*.

NOTICE

The CE mark does not regulate the quality of the product. Technical specifications cannot be deduced from the CE mark.

EU Directive	Version
Low Voltage Directive	2014/35/EU
EMC Directive	2014/30/EU
Machinery Directive1)	2006/42/EC
ErP Directive	2009/125/EC
ATEX Directive	2014/34/EU
RoHS Directive	2011/65/EU

Table 1.3 EU Directives Applicable to Frequency Converters

1) Machinery Directive conformance is only required for frequency converters with an integrated safety function.

Declarations of conformity are available on request.

1.6.2.1 Low Voltage Directive

Frequency converters must be CE-labeled in accordance with the Low Voltage Directive of January 1, 2014. The Low Voltage Directive applies to all electrical equipment in the 50–1000 V AC and the 75–1500 V DC voltage ranges.

The aim of the directive is to ensure personal safety and avoid property damage when operating electrical equipment that is installed, maintained, and used as intended.

1.6.2.2 EMC Directive

The purpose of the EMC (electromagnetic compatibility) Directive is to reduce electromagnetic interference and enhance immunity of electrical equipment and installations. The basic protection requirement of the EMC Directive is that devices that generate electromagnetic interference (EMI), or whose operation could be affected by EMI, must be designed to limit the generation of electromagnetic interference. The devices must have a suitable degree of immunity to EMI when properly installed, maintained, and used as intended.

Electrical equipment devices used alone or as part of a system must bear the CE mark. Systems do not require the CE mark, but must comply with the basic protection requirements of the EMC Directive.

1.6.2.3 Machinery Directive

The aim of the Machinery Directive is to ensure personal safety and avoid property damage to mechanical equipment used in its intended application. The Machinery Directive applies to a machine consisting of an aggregate of interconnected components or devices of which at least 1 is capable of mechanical movement.

Frequency converters with an integrated safety function must comply with the Machinery Directive. Frequency converters without a safety function do not fall under the Machinery Directive. If a frequency converter is integrated into a machinery system, Danfoss can provide information on safety aspects relating to the frequency converter.

When frequency converters are used in machines with at least 1 moving part, the machine manufacturer must provide a declaration stating compliance with all relevant statutes and safety measures.

1.6.2.4 ErP Directive

The ErP directive is the European Ecodesign Directive for energy-related products. The directive sets ecodesign requirements for energy-related products, including frequency converters. The directive aims at increasing energy efficiency and the level of protection of the environment, while increasing the security of the energy supply. Environmental impact of energy-related products includes energy consumption throughout the entire product life cycle.

The RCM Mark label indicates compliance with the applicable technical standards for electromagnetic compatibility (EMC). An RCM Mark label is required for placing electrical and electronic devices on the market in Australia and New Zealand. The RCM Mark regulatory arrangements only deal with conducted and radiated emission. For frequency converters, the emission limits specified in EN/IEC 61800-3 apply. A declaration of conformity can be provided on request.

1.6.3 UL Compliance

UL listed

Illustration 1.2 UL

NOTICE

UL only covers 460 V/60 Hz and 600 V/60 Hz versions of the VLT® Advanced Harmonic Filter AHF 005/AHF 010.

The AHF filters have the following UL conformity:

- IP00: UL recognized.
- IP20: UL listed.

The frequency converter complies with UL 508C thermal memory retention requirements. For more information, refer to *chapter 4.2.3 Overtemperature Protection*.

1.7 Safety

1.7.1 General Safety Principles

If handled improperly, frequency converters have the potential for fatal injury as they contain high-voltage components. Only qualified personnel are allowed to install and operate the equipment. Do not attempt repair work without first removing power from the frequency converter and waiting the designated amount of time for stored electrical energy to dissipate.

Strict adherence to safety precautions and notices is mandatory for safe operation of the frequency converter.

1.7.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the filter. Only qualified personnel are allowed to install or operate this equipment.

Qualified personnel are defined as trained staff, who are authorized to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the qualified personnel must be familiar with the instructions and safety measures described in this manual.

⚠WARNING

IMPROPER INSTALLATION

Improper installation of the filter or the frequency converter may cause death, serious injury, or equipment failure.

- **Follow this design guide and install according to National and Local Electrical Codes.**

⚠WARNING

HIGH VOLTAGE

Filters contain high voltage when connected to AC mains input. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- **Only qualified personnel must perform installation, start-up, and maintenance.**
- **Never work on a filter in operation.**

⚠WARNING

DISCHARGE TIME

The VLT® Advanced Harmonic Filters AHF 005/AHF 010 contain capacitors. The capacitors can remain charged even when the filter is not powered. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Wait at least 10 minutes.**

⚠CAUTION

ELECTRICAL HAZARD

When measuring on live filters, observe the valid national regulations for the prevention of accidents (for example VBG 4).
The electrical installation must be carried out according to the appropriate regulations (for example cable cross-sections, fuses, and PE connection). When using the filters with frequency converters without safe separation from the supply line (to VDE 0100), include all control wiring in further protective measures (for example double insulated or shielded, grounded, and insulated).

⚠CAUTION

HOT SURFACE

When in use, the filter surface becomes hot.

- **Do NOT touch the filter during operation.**

⚠CAUTION

OVERTEMPERATURE

Overtemperature damages the filter chokes. To prevent overtemperature:

- **Use temperature switches, see *chapter 4.2.3 Overtemperature Protection*.**
- **Perform an immediate stop or a controlled ramp down within 30 s.**

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⚠CAUTION

PROTECTIVE DEVICES

Equip systems where filters are installed with extra monitoring and protective devices according to the valid safety regulations, for example rules on technical tools and regulations for the prevention of accidents.

⚠CAUTION

Non-authorized removal of required cover, inappropriate use, incorrect installation, or operation create the risk of severe injury to persons or damage to material assets.

- **To avoid the risk, only let authorized and qualified personnel handle the VLT® Advanced Harmonic Filter AHF005/AHF 010.**

NOTICE

The filters shown in this design guide are specially designed and tested for operation with Danfoss frequency converters, see *chapter 1.2.1 Intended Use*. Danfoss takes no responsibility for the use of the filters with third-party frequency converters.

NOTICE

REPAIR OF FILTER

Only Danfoss authorized, qualified personnel are allowed to repair the VLT® Advanced Harmonic Filter AHF005/AHF010. See *chapter 8 Spare Parts* for more details.

NOTICE

Commissioning is only allowed when there is compliance with the EMC Directive 2014/30/EU.
The filters meet the requirements of the Low Voltage Directive 2014/35/EU.

NOTICE

Protect the filter from inappropriate loads, particularly during transport and handling. Components are not allowed to be bent. Do not alter the distance in between isolation. Avoid touching electronic components and contacts.

2 Introduction to Harmonics and Mitigation

2.1 Harmonics and Mitigation

2.1.1 Linear Loads

On a sinusoidal AC supply, a purely resistive load (for example an incandescent light bulb) draws a sinusoidal current in phase with the supply voltage.

The power dissipated by the load is:
$P = U \times I$

For reactive loads (such as an asynchronous motor), the current is no longer in phase with the voltage. Instead, the current lags the voltage creating a lagging power factor with a value less than 1. In the case of capacitive loads, the current is ahead of the voltage, creating a leading power factor with a value less than 1.

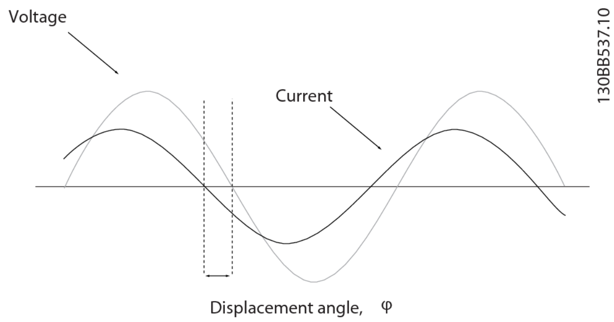


Illustration 2.1 Current Creating a True Power Factor

In this case, the AC power has 3 components:

- Real power, (P).
- Reactive power, (Q).
- Apparent power, (S).

The apparent power is:
$S = U \times I$
(where S=[kVA], P=[kW] and Q=[kVAR]).

In the case of a perfectly sinusoidal waveform, P, Q, and S can be expressed as vectors that form a triangle:
$S^2 = P^2 + Q^2$

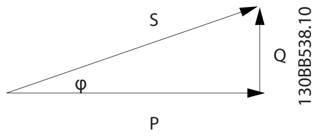


Illustration 2.2 Sinusoidal Waveform

The displacement angle between current and voltage is φ. The displacement power factor is the ratio between the active power (P) and apparent power (S):
$DPF = \frac{P}{S} = cos(\phi)$

2.1.2 Non-linear Loads

Non-linear loads (such as diode rectifiers) draw a non-sinusoidal current. *Illustration 2.3* shows the current drawn by a 6-pulse rectifier on a 3-phase supply.

A non-sinusoidal waveform can be decomposed in a sum of sinusoidal waveforms with periods equal to integer multiples of the fundamental waveform.
$f(t) = \sum a_h \times sin(h\omega_1 t)$
See *Illustration 2.3*.

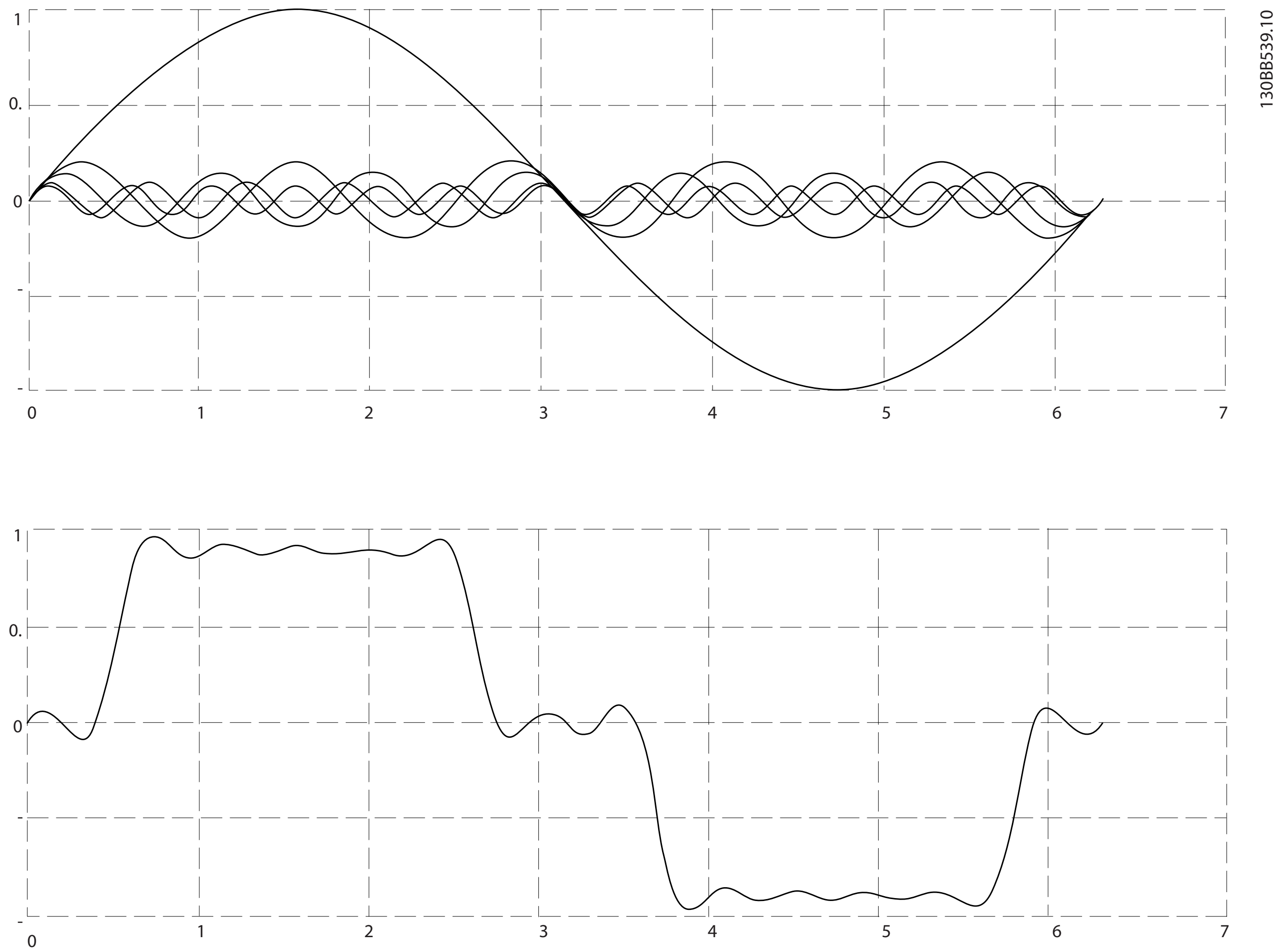


Illustration 2.3 Sinusoidal Waveforms

The integer multiples of the fundamental frequency ω1 are called harmonics. The RMS value of a non-sinusoidal waveform (current or voltage) is expressed as:

$$I_{RMS} = \sqrt{\sum_{h=1}^{h_{max}} I_{(h)}^2}$$

The number of harmonics in a waveform gives the distortion factor, or total harmonic distortion (THD). The THD is given by the ratio of RMS of the harmonic content to the RMS value of the fundamental quantity, expressed as a percentage of the fundamental:

$$THD = \sqrt{\sum_{h=2}^{h_{max}} \left(\frac{I_h}{I_1}\right)^2} \times 100\,\%$$

Using the THD, the relationship between the RMS current I_{RMS} and the fundamental current I_1 can be expressed as:

$$I_{RMS} = I_1 \times \sqrt{1 + THD^2}$$

The same applies for voltage.

The true power factor PF (λ) is:

$$PF = \frac{P}{S}$$

In a linear system, the true power factor is equal to the displacement power factor:

$$PF = DPF = cos(\phi)$$

In non-linear systems, the relationship between power factor and displacement power factor is:

$$PF = \frac{DPF}{\sqrt{1 + THD^2}}$$

Reactive power decreases the power factor and harmonic loads. A low power factor results in a high RMS current that produces higher losses in the supply cables and transformers.

In the power quality context, the total demand distortion (TDD) term is often encountered. The TDD does not characterize the load, but it is a system parameter. TDD expresses the current harmonic distortion in percentage of the maximum demand current I_L.

$$TDD = \sqrt{\sum_{h=2}^{h_{max}} \left(\frac{I_h}{I_L}\right)^2} \times 100\,\%$$

Another term often encountered is the partial weighted harmonic distortion (PWHD). PWHD is a weighted harmonic distortion that contains only the harmonics between the 14th and the 40th, as shown in the following definition.

$$PWHD = \sqrt{\sum_{h=14}^{40} \left(\frac{I_h}{I_1}\right)^2} \times 100\,\%$$

2.1.3 The Effect of Harmonics in a Power Distribution System

In *Illustration 2.4*, a transformer is connected on the primary side to a point of common coupling, PCC1, on the medium voltage supply. The transformer has an impedance Z_{xfr} and feeds several loads. PPC 2 is the point of common coupling where all loads are connected. Each load is connected through cables that have an impedance Z_1, Z_2, Z_3.

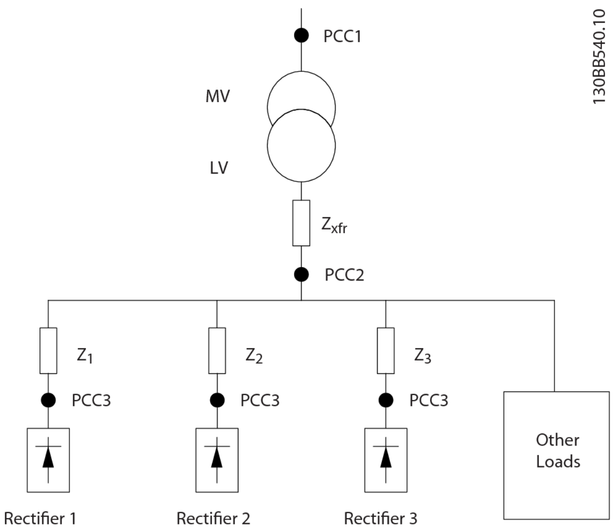


Illustration 2.4 Small Distribution System

Harmonic currents drawn by non-linear loads cause distortion of the voltage because of the voltage drop on the impedances of the distribution system. Higher impedances result in higher levels of voltage distortion.

Current distortion relates to apparatus performance, and it relates to the individual load. Voltage distortion relates to system performance. It is not possible to determine the voltage distortion in the PCC knowing only the harmonic performance of the load. To predict the distortion in the PCC, the configuration of the distribution system and relevant impedances must be known.

A commonly used term for describing the impedance of a grid is the short-circuit ratio R_{sce}. This ratio is defined as the ratio between the short circuit apparent power of the supply at the PCC (S_{sc}) and the rated apparent power of the load (S_{equ}).

$$R_{sce} = \frac{S_{ce}}{S_{equ}}$$

where $S_{sc} = \frac{U^2}{Z_{supply}}$ and $S_{equ} = U \times I_{equ}$

The negative effect of harmonics is twofold

- Harmonic currents contribute to system losses (in cabling and transformer).
- Harmonic voltage distortion causes disturbance to and increases losses in other loads.

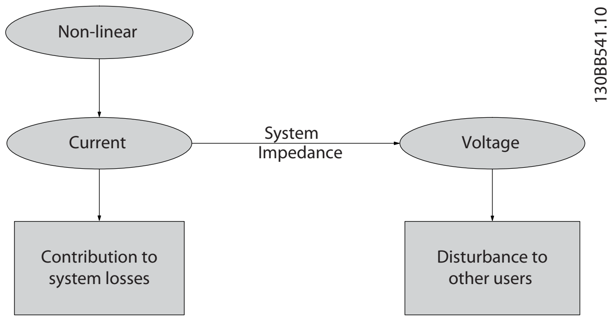


Illustration 2.5 The Negative Effect of Harmonics

2.2 Harmonic Mitigation Standards and Requirements

The requirements for harmonic limitation can be:

- Application-specific requirements.
- Requirements from standards that have to be observed.

2.2.1 Application-specific Requirements

The application-specific requirements are related to a specific installation where there are technical reasons for limiting the harmonics.

Example
Two 110 kW motors are connected to a 250 kVA transformer. One motor is connected direct online, and the other is supplied through a frequency converter. If the direct online motor should also be supplied through a frequency converter, the transformer is, in this case, undersized. To retrofit without changing the transformer, mitigate the harmonic distortion from the 2 frequency converters by using VLT® Advanced Harmonic Filters AHF 005/AHF 010.

2

2.2.2 Harmonic Mitigation Standards

There are various harmonic mitigation standards, regulations, and recommendations. Different standards apply in different geographical areas and industries. The following encountered standards are presented:

- IEC/EN 61000-3-2
- IEC/EN 61000-3-12
- IEC/EN 61000-3-4
- IEC 61000-2-2
- IEC61000-2-4
- IEEE 519
- G5/4

Number of standard	Title	Scope	Comments
IEC 61000-3-2	Limits for harmonic current emissions (equipment input current ≤16 A per phase).	Equipment connected to the public low-voltage distribution system having an input current up to and including 16 A per phase.	Danfoss frequency converters are in Class A. There are no limits for professional equipment with a total rated power >1 kW.
IEC 61000-3-12	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and ≤75 A.	Equipment connected to the public low-voltage distribution system having an input current >16 A and ≤75 A.	The emission limits are currently only for 230/400 V 50 Hz systems. There are requirements for individual harmonics (5th, 7th, 11th, and 13th) and for THD and PWHD. All frequency converters listed in *chapter 1.2 Intended Use* comply with these limits without extra filtering.
IEC 61000-3-4	Limits, limitation of emission of harmonic currents in low-voltage supply systems for equipment with rated current >16 A.	Equipment with rated current >75 A connected to the public low-voltage distribution system.	A 3-stage assessment procedure is described for the connection of equipment to the public supply. Equipment >75 A is limited to stage 3 *Connection based on the load's agreed power*. The supply authority may accept the connection of the equipment based on the agreed active power of the load's installation and local requirements of the supply authority apply. The manufacturer shall provide individual harmonics and the values for THD and PWHD.
IEC 61000-2-2/ IEC 61000-2-4	Compatibility levels for low-frequency conducted disturbances.	Stipulation of compatibility levels for low-frequency conducted disturbances in public low-voltage supply systems (IEC 61000-2-2) and industrial plants (IEC 61000-2-4).	Low-frequency disturbances include but are not limited to harmonics. Consider the values prescribed in the standards when planning installations.
IEEE 519	IEEE-recommended practices and requirements for harmonic control in electrical power systems.	Control of the voltage distortion at the PCC to a TDD of 5% and limitation of the maximum individual frequency voltage harmonic to 3%.	Establishment of goals for the design of electrical systems that include both linear and non-linear loads. Waveform distortion goals are established, and the interface between sources and loads is described as point of common coupling (PCC). The current distortion limits depend on the ratio I_{SC}/I_L where I_{SC} is the short circuit current at the utility PCC and I_L is the maximum demand load current. The limits are given for individual harmonics up to the 35th and total demand distortion (TDD). The most effective way to meet the harmonic distortion requirements is to mitigate at the individual loads and measure at the PCC.

Number of standard	Title	Scope	Comments
G5/4	Engineering recommendation, planning levels for harmonic voltage distortion, and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom.	Setting planning levels for harmonic voltage distortion to be used in the process of connecting non-linear equipment. A process for establishing individual customer emission limits based on these planning levels is described.	G5/4 is a system level standard. For 400 V, the voltage THD planning level is 5% at the PCC. Limits for odd and even harmonics in 400 V systems are given in Table 2 in the standard. The standard describes a 3-stage assessment procedure for the connection of non-linear equipment. The procedure aims at balancing the level of detail required by the assessment process with the degree of risk that the connection of particular equipment results in unacceptable voltage harmonic distortion. Compliance of a system containing VLT® frequency converters depends on the specific topology and population of non-linear loads. To meet the requirements of G5/4, employ VLT® Advanced Harmonic Filters AHF 005/AHF 010.

Table 2.1 Harmonics Mitigation Standards

2.3 Harmonic Mitigation

There are several ways of mitigating the harmonics caused by the frequency converter 6-pulse rectifier, and they all have their advantages and disadvantages.

Selecting the right solution depends on several factors:

- The grid (background distortion, mains unbalance, resonance, and type of supply - transformer/generator).
- Application (load profile, number of loads, and load size).
- Local/national requirements/regulations (for example IEEE 519, IEC, and ER G5/4).
- Total cost of ownership (for example initial cost, efficiency, and maintenance).

IEC standards are harmonized by various countries or supra-national organizations. All above-mentioned IEC standards are harmonized in the European Union with the prefix “EN”. For example, the European EN 61000-3-2 is the same as IEC 61000-3-2. The situation is similar in Australia and New Zealand, with the prefixes AS/NZS.

Categories of harmonic solutions:

- Passive.
- Active.

Passive solutions consist of capacitors, inductors, or a combination of the 2 in different arrangements.
The simplest solution is to add inductors/reactors of typically 3–5% in front of the frequency converter. This added inductance reduces the number of harmonic currents produced by the frequency converter. More advanced passive solutions combine capacitors and inductors in trap arrangement specially tuned to eliminate harmonics starting from, for example, the 5th harmonic.

The active solutions determine the exact current that cancels the harmonics present in the circuit and synthesizes and injects that current into the system. Thus, the active solution mitigates the real-time harmonic disturbances, which makes these solutions effective at any load profile. For more details on the Danfoss active solutions, refer to *VLT® Low Harmonic Drive Operating Instructions* and *VLT® Advanced Active Filter AAF 006 Operating Instructions*.

3 Basic Operating Principle of the AHF

3.1 Operating Principle

The VLT® Advanced Harmonic Filter AHF 005/AHF 010 consists of a main inductor L_0 and a 2-stage absorption circuit with the inductors L_1 and L_2, and the capacitors C_1 and C_2. The absorption circuit is specially tuned to eliminate harmonics starting with the 5th harmonic and is specific for the designed supply frequency. Therefore, the circuit for 50 Hz has different parameters than the circuit for 60 Hz.

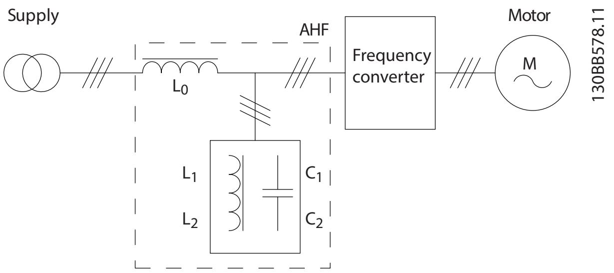


Illustration 3.1 Operating Principle

AHFs are available in 2 variants for 2 performance levels:

- AHF 005 with 5% THDi.
- AHF 010 with 10% THDi.

Each of the 2 variants is available with the following voltages:

- 380–415 V, 50 Hz.
- 380–415 V, 60 Hz.
- 440–480 V, 60 Hz.
- 600 V, 60 Hz.
- 500–690 V, 50 Hz.

The AHF 010 offers a performance similar to 12-pulse rectifiers, and the AHF 005 offers a performance similar to 18-pulse rectifiers.

The filter performance in terms of THDi varies as a function of the load. At nominal load, the filter performance is better than 10% THDi for AHF 010 and 5% THDi for AHF 005.

At part load, the THDi has higher values. However, the absolute value of the harmonic current is lower at part loads, even if the THDi has a higher value. Therefore, the negative effect of the harmonics at part loads is lower than at full load.

Example of part load

An 18.5 kW (25 hp) frequency converter is installed on a 400 V/50 Hz grid with a 34 A AHF 010 (type code AHF-DA-34-400-50-20-A).

The values in *Table 3.1* are measured for different load currents, using a harmonic analyzer:

I_{line} RMS	Basic current at 50 Hz I[1] RMS	THDi	Total harmonic current I_h RMS
[A]	[A]	[%]	[A][1]
9.6	9.59	5.45	0.52
15.24	15.09	13.78	2.07
20.24	20.08	12.46	2.5
25.17	25	11.56	2.89
30.27	30.1	10.5	3.15
34.2	34.03	9.95	3.39

Table 3.1 Example of Load Currents

1) The total harmonic current has been calculated. The THDi versus load plot is shown in Illustration 3.2.

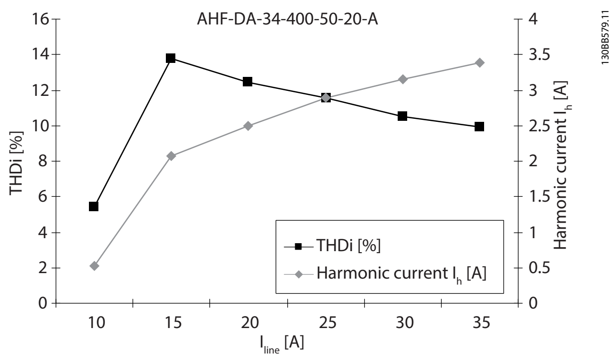


Illustration 3.2 THDi versus Load

At part load, 15 A, the THDi is approximately 14% compared to 10% at the nominal load of 34 A. At the same time, the total harmonic current is only 2.07 A at 15 A line current against 3.39 A harmonic current at 34 A line current. Thus, THDi is only a relative indicator of the harmonic performance. The harmonic distortion of the voltage is less at part load than at nominal load.

Background distortion

Factors such as background distortion and grid unbalance can affect the performance of AHF filters. The specific figures are different from filter to filter, and *Illustration 3.3* to *Illustration 3.6* show typical performance characteristics. For specific details, use a harmonic design tool such as MCT 31 or Harmonic Calculation Software (HCS).

The design of the filters aims to achieve 10%, respectively, 5% THDi levels with a background distortion of THDv = 2%. Practical measurements on typical grid conditions in frequency converter installations often show that the performance of the filter is slightly better with a 2% background distortion. However, the complexity of the grid conditions and the mix of specific harmonics does not provide a general rule about the performance on a distorted grid. *Illustration 3.3* and *Illustration 3.4* show worst-case performance deterioration characteristics with the background distortion.

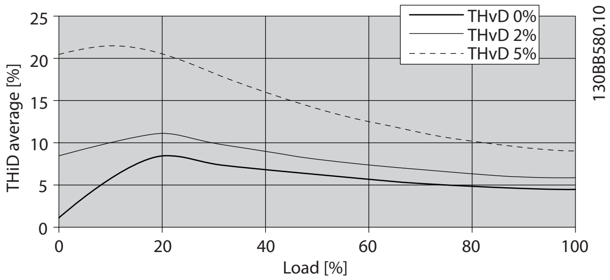


Illustration 3.3 AHF 005

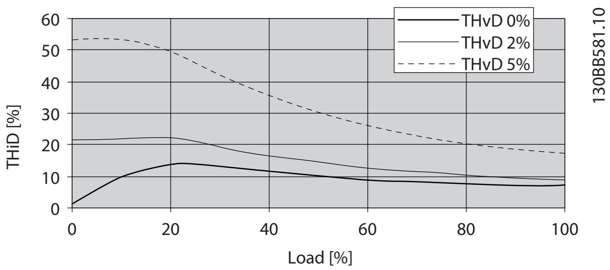


Illustration 3.4 AHF 010

Performance at 10% THDv has not been plotted. However, the filters have been tested and can operate at 10% THDv, but the filter performance can no longer be guaranteed.

The filter performance also deteriorates with the unbalance of the supply. Typical performance is shown in *Illustration 3.5* and *Illustration 3.6*.

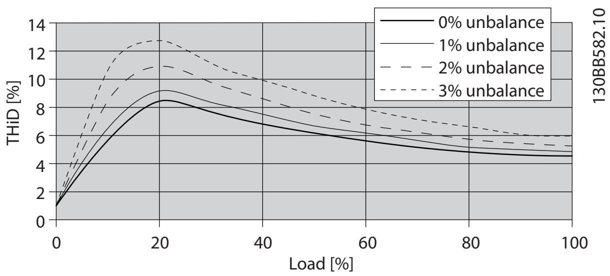


Illustration 3.5 AHF 005

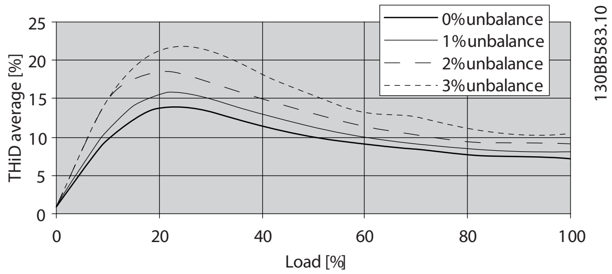


Illustration 3.6 AHF 010

3.1.1 Power Factor

In no-load conditions (the frequency converter is in stand-by), the frequency converter current is negligible, and the main current drawn from the grid is the current through the capacitors in the harmonic filter. Therefore, the power factor is close to 0, capacitive. The capacitive current is approximately 25% of the filter nominal current (depends on filter size, typical values of 20–25%). The power factor increases with the load. Because of the higher value of the main inductor L_0 in the VLT® Advanced Harmonic Filter AHF 005, the power factor is slightly higher than in the VLT® Advanced Harmonic Filter AHF 010.

Illustration 3.7 and *Illustration 3.8* show typical values for the true power factor on AHF 010 and AHF 005.

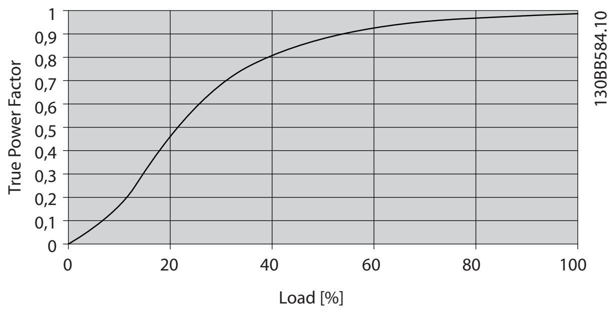


Illustration 3.7 AHF 005

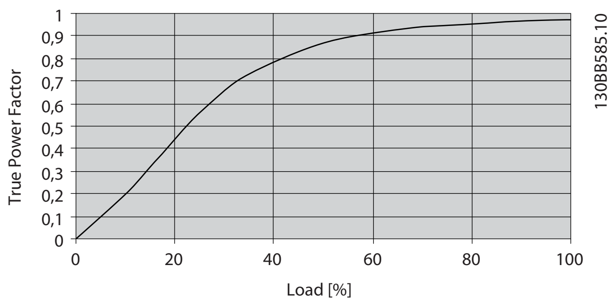


Illustration 3.8 AHF 010

3.1.2 Capacitive Currents

If the specific application requires a higher power factor at no-load and a reduction of the capacitive current in standby, use a capacitor disconnect. A contactor disconnects the capacitor at loads below 20%.

NOTICE

It is important to note that the capacitors must not be connected at full load or disconnected at no load.

It is important to consider the capacitive current in the design of applications where the harmonic filter is supplied by a generator. The capacitive current can cause overvoltage of the generator in no-load and low-load conditions. The overvoltage causes an increase of the voltage, which then may exceed the allowed voltage for the filter and the frequency converter. Therefore, always use a capacitor disconnect in generator applications and consider the design carefully. For more information about capacitive currents, refer to *chapter 4.2.1.1 Terminals for Capacitor Disconnect*.

Compared to multi-pulse rectifiers, passive harmonic filters (such as VLT® Advanced Harmonic Filter AHF 005/AHF 010) are more robust against background distortion and supply imbalance. However, the performance of passive filters is inferior to the performance of active filters when it comes to part load performance and power factor. For details about the performance positioning of the various harmonic mitigation solutions offered by Danfoss, consult the relevant harmonic mitigation manuals.

3.2 Energy Efficiency

3.2.1 Introduction to Energy Efficiency

The standard *EN 50598 Ecodesign for power drive systems, motor starters, power electronics, and their driven applications* provides guidelines for assessing the energy efficiency of frequency converters.

The standard provides a neutral method for determining efficiency classes and power losses at full load and at part load. The standard allows combination of any motor with any frequency converter.

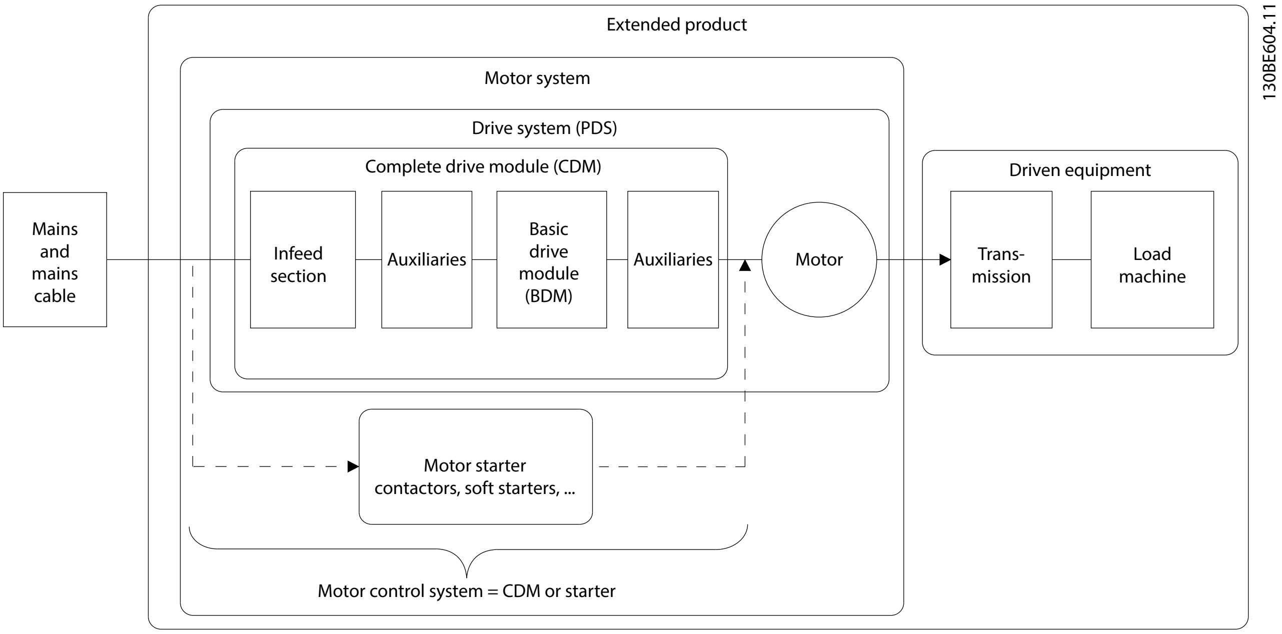


Illustration 3.9 Power Drive System (PDS) and Complete Drive Module (CDM)

Auxiliaries:

- VLT® Advanced Harmonic Filter AHF 005
- VLT® Advanced Harmonic Filter AHF 010
- VLT® Line Reactor MCC 103
- VLT® Sine-wave Filter MCC 101
- VLT® dU/dt Filter MCC 102

3.2.2 IE and IES Classes

Complete drive modules (CDM)
According to the standard EN 50598-2, the complete drive module comprises the frequency converter, its feeding section, and its auxiliaries.

Energy efficiency classes for the CDM:

- IE0 = below state of the art.
- IE1 = state of the art.
- IE2 = above state of the art.

Danfoss frequency converters fulfill energy efficiency class IE2. The energy efficiency class is defined at the nominal point of the CDM.

Power drive systems (PDS)
A power drive system consists of a complete drive module and a motor.

Energy efficiency classes for the PDS:

- IES0 = Below state of the art.
- IES1 = State of the art.
- IES2 = Above state of the art.

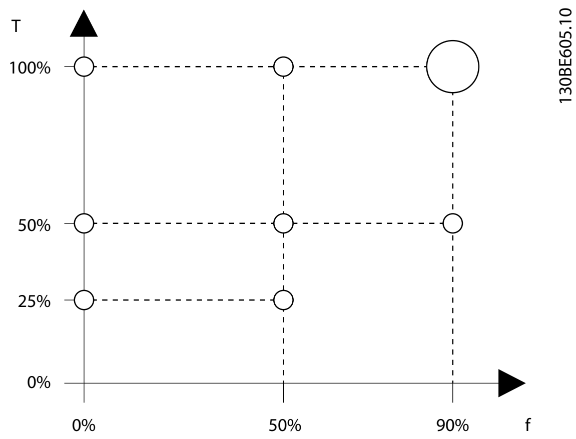
Depending on the motor efficiency, motors driven by a Danfoss VLT® frequency converter typically fulfill energy efficiency class IES2.

The energy efficiency class is defined at the nominal point of the PDS and can be calculated based on the CDM and the motor losses.

3.2.3 Power Loss Data and Efficiency Data

The power loss and the efficiency of a frequency converter depend on configuration and auxiliary equipment. To get a configuration-specific power loss and efficiency data, use the Danfoss ecoSmart tool.

The power loss data is provided in % of rated apparent output power and are determined according to EN 50598-2. When the power loss data are determined, the frequency converter uses the factory settings except for the motor data which is required to run the motor.



T	Torque-producing current [%]
f	Frequency [%]

Illustration 3.10 Frequency Converter Operating Points According to EN 50598-2

Refer to *www.danfoss.com/vltenergyefficiency* for the power loss and efficiency data of the frequency converter at the operating points specified in *Illustration 3.10*.

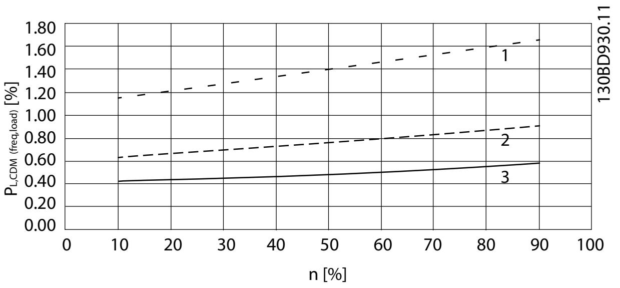
Use the Danfoss ecoSmart application to calculate IE and IES efficiency classes. The application is available at *ecosmart.danfoss.com*.

Example of available data

The following example shows power loss and efficiency data for a frequency converter with the following characteristics:

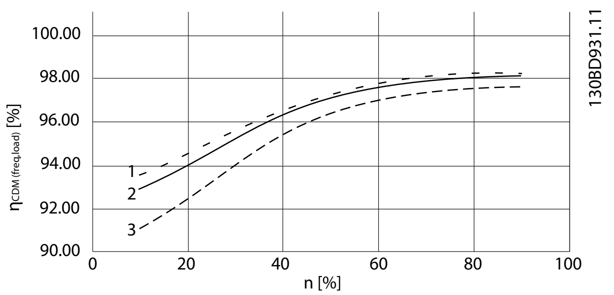
- Power rating 55 kW (75 hp), rated voltage at 400 V.
- Rated apparent power, Sr, 67.8 kVA.
- Rated output power, P_{CDM}, 59.2 kW (79.4 hp).
- Rated efficiency, η_r, 98.3%.

Illustration 3.11 and *Illustration 3.12* show the power loss and efficiency curves. The speed is proportional to the frequency.



1	100% load
2	50% load
3	25% load

Illustration 3.11 Frequency converter power loss data. CDM relative losses ($P_{L, CDM}$) [%] versus speed (n) [% of nominal speed].



1	100% load
2	50% load
3	25% load

Illustration 3.12 Frequency converter efficiency data. CDM efficiency ($\eta_{CDM(freq, load)}$) [%] versus speed (n) [% of nominal speed].

Interpolation of power loss
Determine the power loss at an arbitrary operating point using 2-dimensional interpolation.

3.2.4 Losses and Efficiency of a Motor

The efficiency of a motor running at 50–100% of the nominal motor speed and at 75–100% of the nominal torque is practically constant. This is valid both when the frequency converter controls the motor, or when the motor runs directly on mains.

The efficiency depends on the type of motor and the level of magnetization.

For more information about motor types, refer to the motor technology brochure at *www.vlt-drives.danfoss.com*.

3.2.5 Losses and Efficiency of a Power Drive System

To estimate the power losses at different operating points for a power drive system, sum the power losses at the operating point for each system component:

- Frequency converter.
- Motor.
- Auxiliary equipment.

3.2.6 Losses and Efficiency of a Power Drive System with Installed Filter

The power loss of the VLT® Advanced Harmonic Filter AHF005/AHF010 is specified in 5 different operating points as 0–100% load. The current load and power loss are specified in each operating point. See *Table 9.2* for power losses.

The power loss in the AHF depends on the operating point and is a function of the input current in the AHF. The identification point of operation of the AHF is based on the input current to the frequency converter. The input current of the frequency converter equals the input current to the AHF.
$I_{In,AHF}=I_{In,VLT}$

The output current of the frequency converter consists of the torque-producing component and the motor magnetization component. Different factors affect the relationship between the input current and output current of a frequency converter. For example, part load causes a significant difference between the 2 currents.
$I_{In,VLT} \neq I_{out,VLT}$

Calculate the input current of the frequency converter with this formula:
$I_{In,VLT}=I_{out,VLT}$ x cos(phi) x f_{motor} [%] x $load_{motor}$ [%] x 1.02

- $I_{out,VLT}$: Nominal output current from the frequency converter. Find the data in the frequency converter *design guide* or VLT® ecoSmart.
- Cos (phi): Motor power factor. Find the data on the motor nameplate. Alternatively, use a reference value from EN 50598, see *Table 3.2*.
- f_{motor} [%]: Percentage value of the nominal operating frequency in the motor in the range 0–1.
- $load_{motor}$ [%]: Percentage value of the torque-producing component or torque-producing current in the motor in the range 0–1. The value is typically from the design of the application.

The EN 50598 standard for *Ecodesign of Power Drive Systems* allows the use of reference values. Determine the motor cosine phi value by the motor nominal power rating as kVA and with linear interpolation from the reference values in *Table 3.2*.

Nominal power [kVA]	Current [%]	Cosine phi
0.278	100	0.73
1.29	100	0.79
7.94	100	0.85
56.9	100	0.86
245	100	0.87

Table 3.2 Motor Reference Values from EN 50598

3.2.6.1 Calculation Example

The frequency converter used in the example is a VLT® AutomationDrive FC 302, T5, 22 kW with Class A1/B RFI filter and enclosure protection rating IP20.

Frequency converter values

- $I_{out,VLT}$=44 A.
- Cos phi=0.85.
- f_{motor} [%]=25 Hz, resulting in 50%.
- $load_{motor}$ [%]=33 A, resulting in 75% (33 A/44 A x 100).

In the example, VLT® Advanced Harmonic Filter AHF 010 with ordering number 130B1111 is selected as filter. See *Table 5.3* for further specifications of the filter.

AHF values

- 40 A nominal current.
- AHF 010, THDi = 10%.
- IP20.

Calculating the frequency converter input current

$I_{In,VLT}=I_{out,VLT}$ x cos(phi) x f_{motor} [%] x $load_{motor}$ [%] x 1.02
$I_{In,VLT}$=44 x 0.85 x 0.50 x 0.75 x 1.02=14.3 A

Calculating the AHF input current

$I_{In,AHF}=I_{In,VLT}$=14.3 A

Calculating the power loss

Matching values from *Table 9.2*

- 127 W power loss at 10 A current loading.
- 177 W power loss at 20 A current loading.

Determining the power loss, $Loss_{OPT}$, in AHF point of operation $load_{OPT}$ using 2-dimensional interpolation

- $Loss_2$=177 W.
- $Loss_1$=127 W.
- $Load_2$=20 A.
- $Load_1$=10 A.
- $Load_{OPT}$ = $Load_{AHF}$ = Load of AHF in point of operation = 14.3 A.
- $Loss_{OPT}$ = $Loss_{AHF}$ = Loss in AHF in point of operation.

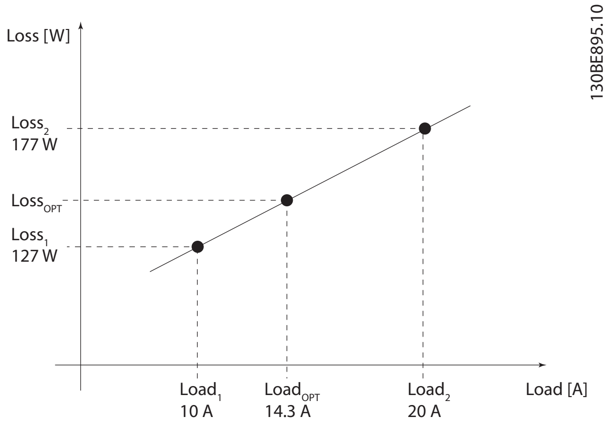


Illustration 3.13 Determining Power Loss with 2-dimensional Interpolation

$Loss_{OPT}$ = $Loss_1$ + ($Loss_2$ - $Loss_1$) x (($Load_{OPT}$ – $Load_1$) / ($Load_2$ – $Load_1$))
$Loss_{OPT}$ = $Loss_{AHF}$ = 127 + (177 - 127) x ((14.3 - 10) / (20 - 10)) = 149 W

The power loss of the frequency converter provided by VLT® ecoSmart:

- Power loss @ 50% motor frequency and 50% motor current = 249 W.
- Power loss @ 50% motor frequency and 100% motor current = 490 W.

The power loss of the frequency converter at 50% motor frequency and 75% torque-producing current are found by 2-dimensional interpolation as 370 W.
$Loss_{VLT}$ = 370 W.

Alternatively, identify the power loss of the frequency converter by entering the point of operation in VLT® ecoSmart as a user-defined operating point.

To determine the power loss of the CDM, sum up the power losses in the operating point of the AHF and the frequency converter:
$Loss_{CDM}$ = $Loss_{AHF}$ + $Loss_{VLT}$ = 149 W + 370 W = 519 W

4 Requirements for Installation

4

4.1 Mechanical Mounting

4.1.1 Safety Requirements of Mechanical Installation

NOTICE

Observe the filter weight and ensure that proper lifting equipment is used.

NOTICE

When installing the filter, use the lifting eyes on both sides to lift the filter.

4.1.2 Mounting Requirements

The filters are available in IP00 and IP20. During installation, follow the described recommendations for both IP ratings.

- Mount all filters vertically with the terminals at the bottom.
- Do not mount the filter close to other heating elements or heat-sensitive material (such as wood).

IP00

- The surface temperature of the IP00 filters can exceed 70 °C (158 °F), and a hot surface warning label is placed on the filter.
- To cool IP00 filters, use separate fans.
- Observe ventilation and cooling requirements.
- Ensure that the required airflow passes through the filter and not only the cabinet, see *chapter 4.1.4 Ventilation and Cooling Requirements* and *chapter 4.2.3 Overtemperature Protection*.

IP20

- Top and bottom clearances are minimum 150 mm (5.91 in).
- The surface temperature of the IP20 filters does not exceed 70 °C (158 °F).
- The filter can be mounted side by side with the frequency converter, and there is no spacing requirement between them.

4.1.3 Recommendations for Installation in Industrial Enclosures

To avoid high frequency noise coupling, keep a minimum distance of 150 mm (5.91 in) to:

- Mains supply wires.
- Motor wires of frequency converter.
- Control wires and signal wires (voltage range <48 V).

To obtain low impedance HF connections, grounding, shielding, and other metallic connections (for example mounting plates and mounted units) should have a surface as large as possible to metallic ground. Use grounding and potential equalization wires with a cross-section as wide as possible (minimum 10 mm^2 (8 AWG)) or thick grounding tapes. Use copper or tinned copper shielded wires only, as steel shielded wires are not suitable for high frequency applications. Connect the shield with metal clamps or metal glands to the equalization bars or PE connections.

Always equip inductive switching units such as relay and magnetic contactor with varistors, RC circuits, or suppressor diodes.

4.1.4 Ventilation and Cooling Requirements

The compact design of the filters is based on forced cooling, and the filters are cooled by circulating air. Therefore, ensure that air can circulate freely above and below the filter.

IP20 filters are cooled by built-in fans, and they have ventilation channels in the enclosure. The fans and ventilation channels provide the required airflow to prevent the filters from overheating.

IP00 filters are cooled by forced air supplied by separate fans. The fans are not part of the delivery. It is the responsibility of the installer to provide and install the fans. To avoid false airflow, it is sometimes also necessary to install air baffles to control the airflow.

NOTICE

IP00 - FORCED AIR REQURIED

When mounting IP00 versions, pay attention to the specific requirements for cooling and ventilation. Ensure that the minimum required forced air speed and air volume are observed as part of the installation of IP00 versions in panels. See *Table 4.2* and *Table 4.3* for details.

NOTICE

OVERHEATING OF FILTER

In wide and/or deep cabinets, there is a risk that the airflow bypasses the filter. The bypass overheats the filter, which can lead to equipment damage. To avoid bypassing of air:

- **Install air baffles to control the airflow when using IP00 filters.**

Observe the minimum required forced air speed and air volume, see *chapter 4.1.4.2 Requirements for IP00*.

When mounting the filters in panels or other industrial enclosures, ensure that there is a sufficient airflow through the filter to reduce the risk of overheating the filter and the surrounding components.

If other heat sources (such as frequency converters) are installed in the same enclosure, also consider the heat they generate when dimensioning the cooling of the enclosure.

4.1.4.1 Requirements for IP20

To guide air through the gap between the wall and the filter, mount the filters on a wall. In installations, for example panels, where the filter is mounted on rails, the filter is not sufficiently cooled because of false airflow. To overcome the false airflow, order a backplate (thickness: 2 mm (0.08 in)), shown in *Illustration 4.2*. See *Table 5.10* for ordering number.

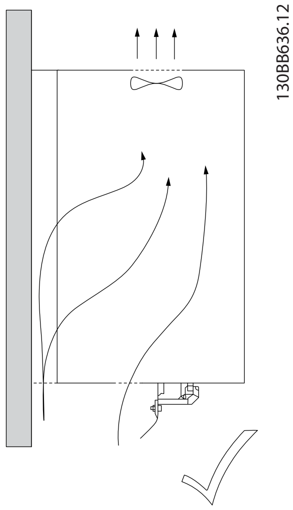
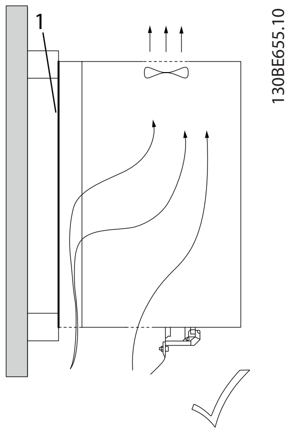
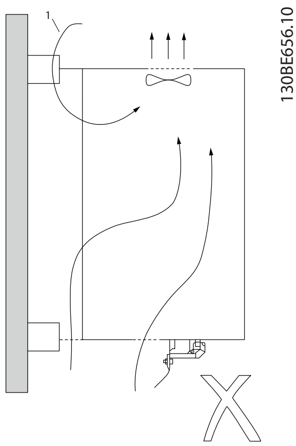


Illustration 4.1 Correct Airflow without Backplate



1	Backplate - 2 mm (0.08 in) thickness

Illustration 4.2 Correct Airflow with Backplate



1	False airflow

Illustration 4.3 False Airflow

Fan concept IP20

The IP20 versions of the VLT® Advanced Harmonic Filters AHF 005/AHF 010 use fans for cooling. The fans are supplied from mains supply and are mounted as either internal or external built-in fans.

The 690 V AHF filters are available in an extended input voltage range of 500–690 V, which requires a special fan. This fan has a built-in fan control circuitry matching the input voltage range. When mounting 690 V filters, observe the larger mechanical dimensions, see *chapter 7.2.7 Mechanical Dimensions* for further details.

There are 4 different fan types, see *Illustration 4.4* to *Illustration 4.7*:

- Internal fan type 1: Standard fan mounted inside the filter enclosure.
- External fan type 1: Standard fan mounted outside the filter enclosure.
- Internal fan type 2: Special fan mounted inside the filter enclosure. The fan supply circuitry is outside the enclosure. For 690 V only.
- External fan type 2: Special fan mounted outside the filter enclosure. The complete fan unit is outside the filter enclosure. For 690 V only.

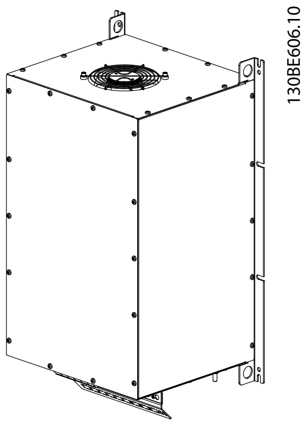


Illustration 4.4 Fan Concept, Internal Fan 1

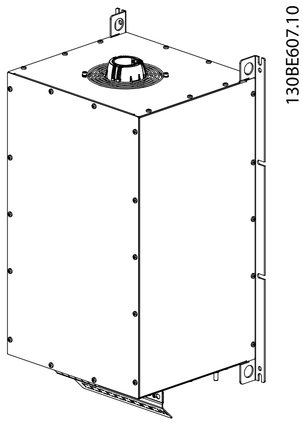


Illustration 4.5 Fan Concept, Internal Fan 2

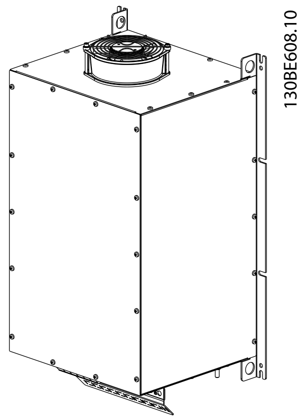


Illustration 4.6 Fan Concept, External Fan 1

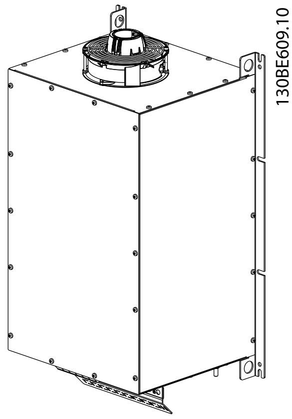


Illustration 4.7 Fan Concept, External Fan 2

Voltage [V]	Internal fan type 1	External fan type 1	Internal fan type 2	External fan type 2
380–415	✓	✓	–	–
440–480	✓	✓	–	–
600	✓	✓	–	–
500–690	–	–	✓	✓

Table 4.1 Overview of Voltage Sizes/Fan Types

NOTICE

IP21/NEMA 1 UPGRADE KIT

An IP21/NEMA 1 upgrade kit is available for the IP20 versions of the VLT® Advanced Harmonic Filter AHF 005/AHF 010. See *chapter 5.3.1 IP21/NEMA 1 Upgrade Kit* for further details.

4.1.4.2 Requirements for IP00

NOTICE

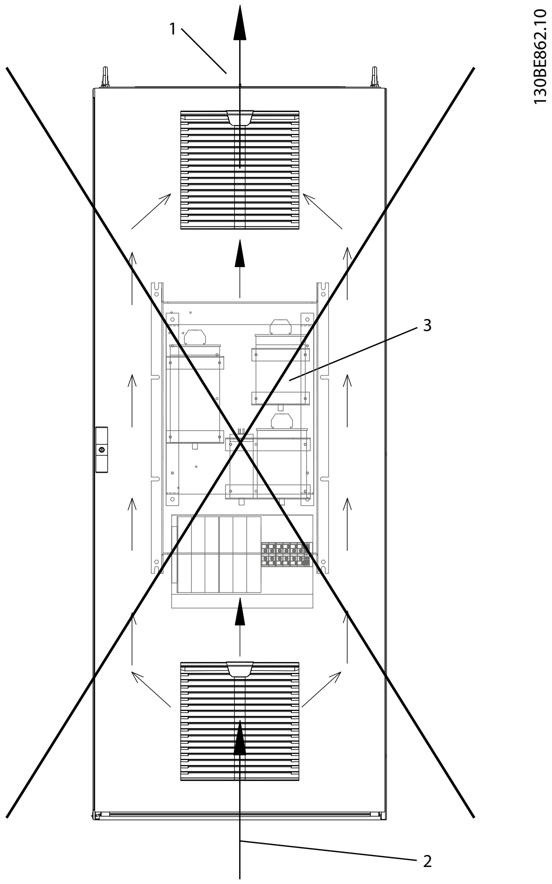
IP00 - FORCED AIR REQURIED

When mounting IP00 versions, pay attention to the specific requirements for cooling and ventilation. Ensure that the minimum required forced air speed and air volume are observed as part of the installation of IP00 versions in panels. See *Table 4.2* and *Table 4.3* for details.

The IP00 versions do not have integrated fans and ventilation channels. Thus, it is important that the airflow passes through the filter to avoid that the filter and other components in the cabinet overheat. When installing a filter in deep and/or wide enclosures, there is a high risk that the air bypasses the filter and therefore does not provide the required cooling. To control the airflow in wide/deep cabinets, mount air baffles at the top and at the bottom. See *Illustration 4.11* and *Illustration 4.12*.

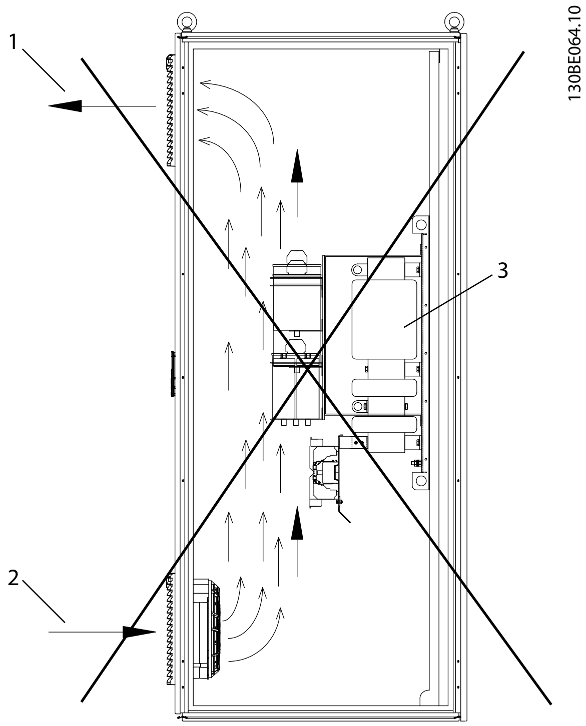
Wrong installations - air bypassing the filter

Illustration 4.8 and *Illustration 4.9* show a filter installed in a deep/wide cabinet without air baffles to control the airflow. The illustrations show that part of the airflow bypasses the filter, which results in an overheated filter.



1	Outlet for outgoing airflow
2	Inlet for ingoing airflow
3	AHF filter

Illustration 4.8 Wrong Installation - Airflow Bypassing the Filter - Front View

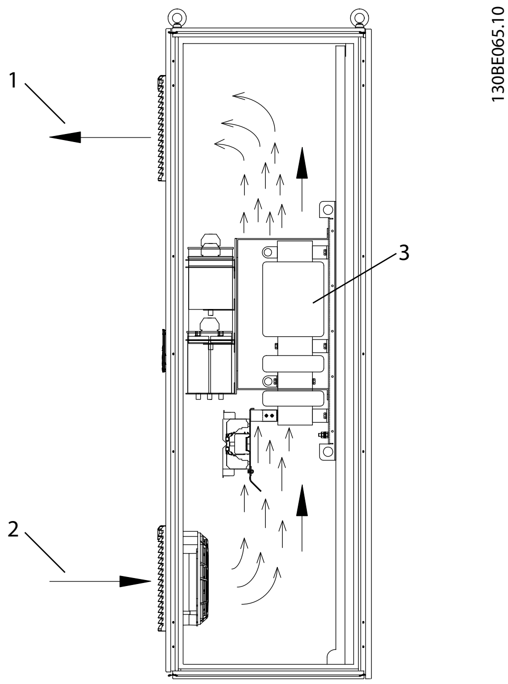


1	Outlet for outgoing airflow
2	Inlet for ingoing airflow
3	AHF filter

Illustration 4.9 Wrong Installation - Airflow Bypassing the Filter - Side View

Correct installation

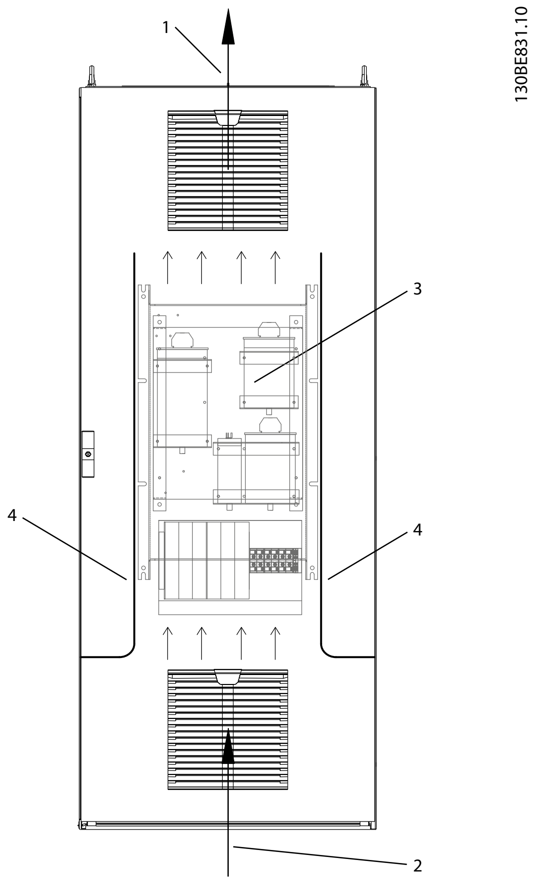
Illustration 4.10 shows a filter installed in a narrow cabinet. Here, the airflow is not able to bypass the filter, and air baffles are therefore not required.



1	Outlet for outgoing airflow
2	Inlet for ingoing airflow
3	AHF filter

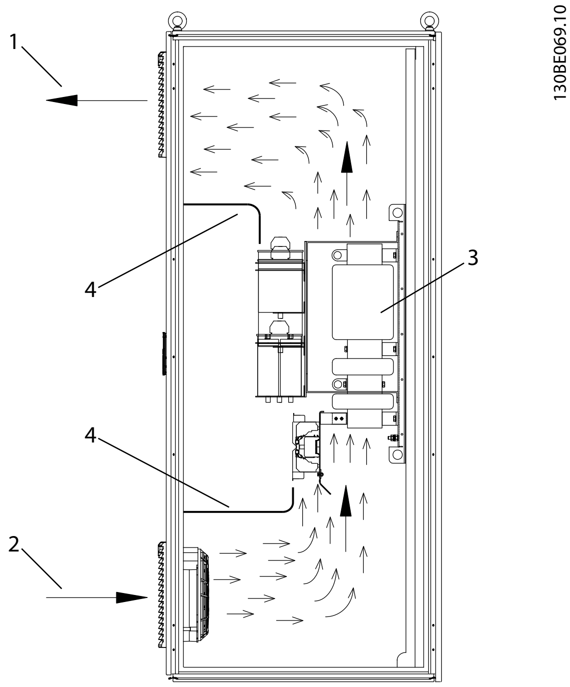
Illustration 4.10 Correct Installation in Narrow Cabinets - Airflow Passing Through the Filter

Illustration 4.11 and *Illustration 4.12* show correct installation in deep/wide cabinets. Here, the air baffles guide the airflow through the filter and provides cooling.



1	Outlet for outgoing airflow
2	Inlet for ingoing airflow
3	AHF filter
4	Air baffles guiding the airflow through the filter

Illustration 4.11 Correct Installation in Deep and/or Wide Cabinets - Air Baffles Force Airflow Through the Filter - Front View



1	Outlet for outgoing airflow
2	Inlet for ingoing airflow
3	AHF filter
4	Air baffles guiding the airflow through the filter

Illustration 4.12 Correct Installation in Deep and/or Wide Cabinets - Air Baffles Force Airflow Through the Filter - Side View

NOTICE

POSSIBLE INSUFFICIENT AIRFLOW

If the thermal switch activates repeatedly in IP00 installations, it is probably caused by insufficient airflow through the filter.

- **Evaluate the airflow and the installation conditions.**
- **Make the required changes to provide proper cooling.**

For more information about overtemperature protection, refer to *chapter 4.2.3 Overtemperature Protection*.

Minimum required air speed and air volume for IP00

Voltage and frequency		AHF 005			AHF 010		
380–415 V, 50 Hz 380–415 V, 60 Hz	440–480 V, 60 Hz	Power loss	Air speed	Air volume	Power loss	Air speed	Air volume
[A]	[A]	[W]	[m/s]	m^3/s	[W]	[m/s]	[m^3/s]
10	10	131	1)	1)	93	1)	1)
14	14	184	2	0.017	118	2	0.011
22	19	258	2	0.023	206	2	0.019
29	25	298	2	0.027	224	2	0.020
34	31	335	2	0.030	233	2	0.021
40	36	396	2	0.036	242	2	0.022
55	48	482	2	0.043	274	2	0.025
66	60	574	2	0.052	352	2	0.032
82	73	688	2	0.062	374	2	0.034
96	95	747	2	0.067	428	2	0.039
133	118	841	2	0.076	488	2	0.044
171	154	962	2	0.087	692	2	0.062
204	183	1080	2.5	0.097	743	2.5	0.067
251	231	1194	2.5	0.108	864	2.5	0.078
304	291	1288	2.5	0.116	905	2.5	0.082
325	355	1406	2.5	0.127	952	2.5	0.086
381	380	1510	2.5	0.136	1175	2.5	0.106
480	436	1852	2.5	0.167	1542	2.5	0.139

Table 4.2 Minimum Required Air Speed and Air Volume for IP00, 380–480 V, 50 Hz, and 60 Hz

1) Cooled by natural convection. No requirement for forced cooling.

Voltage and frequency		AHF 005			AHF 010		
600 V, 60 Hz	500–690 V, 50 Hz	Power loss	Air speed	Air volume	Power loss	Air speed	Air volume
[A]	[A]	[W]	[m/s]	(m^3/s)	[W]	[m/s]	[m^3/s]
15	15	298	2	0.027	224	2	0.020
20	20	335	2	0.030	233	2	0.021
24	24	396	2	0.036	242	2	0.022
29	29	482	2	0.043	274	2	0.025
36	36	574	2	0.052	352	2	0.032
50	50	688	2	0.062	374	2	0.034
58	58	747	2	0.067	428	2	0.039
77	77	841	2	0.076	488	2	0.044
87	87	962	2	0.087	692	2	0.062
109	109	1080	2	0.097	743	2	0.067
128	128	1194	2	0.108	864	2	0.078
155	155	1288	2.5	0.116	905	2.5	0.082
197	197	1406	2.5	0.127	952	2.5	0.086
240	240	1510	2.5	0.136	1175	2.5	0.106
296	296	1852	2.5	0.167	1288	2.5	0.116
366	366	–	–	–	1542	2.5	0.139
395	395	–	–	–	1852	2.5	0.167

Table 4.3 Minimum Required Air Speed and Air Volume for IP00, 500–690 V, 50 Hz, and 600 V, 60 Hz

4.2 Electrical Installation

4.2.1 Terminals - Short Overview

The VLT® Advanced Harmonic Filter AHF 005/AHF 010 contains the following terminals:

- X1.1–X1.3 are the mains terminals.
- X2.1–X2.3 are the output terminals to the frequency converter.
- X3.1–X4.3 are optional connection terminals for capacitor disconnect.
- A and B are the temperature switch connected to the frequency converter.
- PE for protective earth.

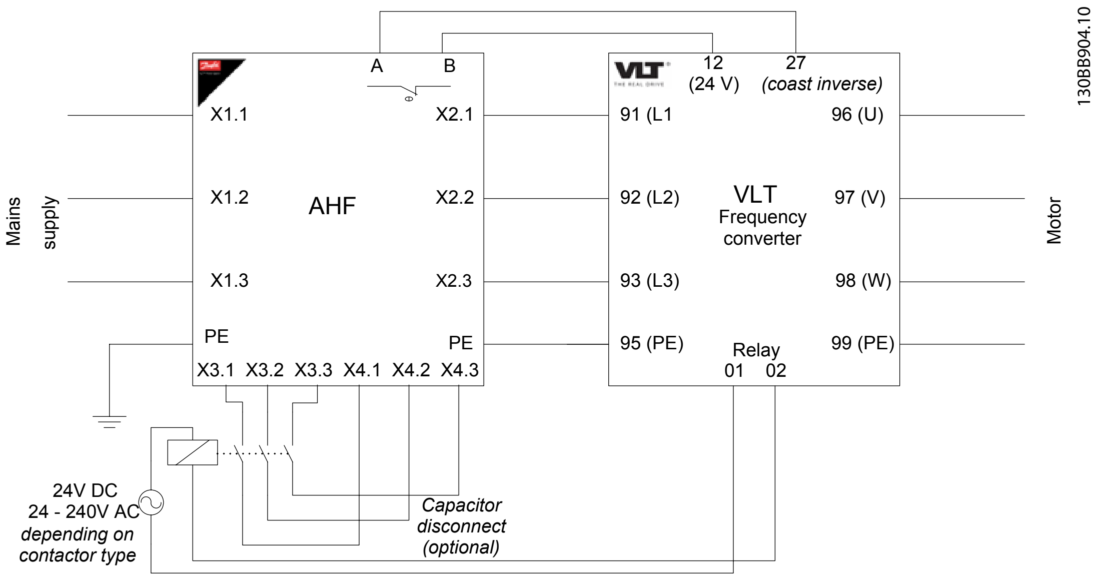


Illustration 4.13 Connection Diagram

4.2.1.1 Terminals for Capacitor Disconnect

From the factory, the terminals for the capacitor disconnect are bypassed or looped with jumpers. When using an external contactor, remove the jumper and use a relay. Refer to *chapter 5.2.2 Capacitor Disconnect Contactors*, *chapter 5.3.1.2 IP21/NEMA 1 Upgrade Kit with Built-in Capacitor Disconnect Circuitry*, and *Illustration 5.6* for more details.

NOTICE

A Danfoss frequency converter can be used for controlling the relay of an external contactor. See *chapter 6 Programming* for more information.

NOTICE

The capacitor disconnect feature does not apply to VLT® AutomationDrive FC 301.

The power factor of the VLT® Advanced Harmonic Filter AHF 005/AHF 010 decreases with decreasing load. At no load, the power factor is 0, and the capacitors produce leading current of approximately 25% of the rated filter current. In applications where this reactive current is not acceptable, disconnect the capacitor bank via terminals X3.1, X3.2, X3.3, and X4.1, X4, X4.3.

Per default (on delivery) the wiring shortens terminal X3.1 with X4.1, X3.2 with X4.2, and X3.3 with X.4.3. If no capacitor disconnect is required, do not change these shortened terminals.

If a disconnection of the capacitors is required, place a 3-phase contactor between terminals X3 and X4. Using AC3 contactors is recommended, see *chapter 5.2.2 Capacitor Disconnect Contactors*. An IP21/NEMA 1 upgrade kit with built-in capacitor disconnect circuitry is available as an option, see *chapter 5.3.1 IP21/NEMA 1 Upgrade Kit*.

Paralleling AHF

It is possible to run 2 filters in parallel and still use both the capacitor disconnect and the temperature switch. Wire according to *Illustration 4.14*.

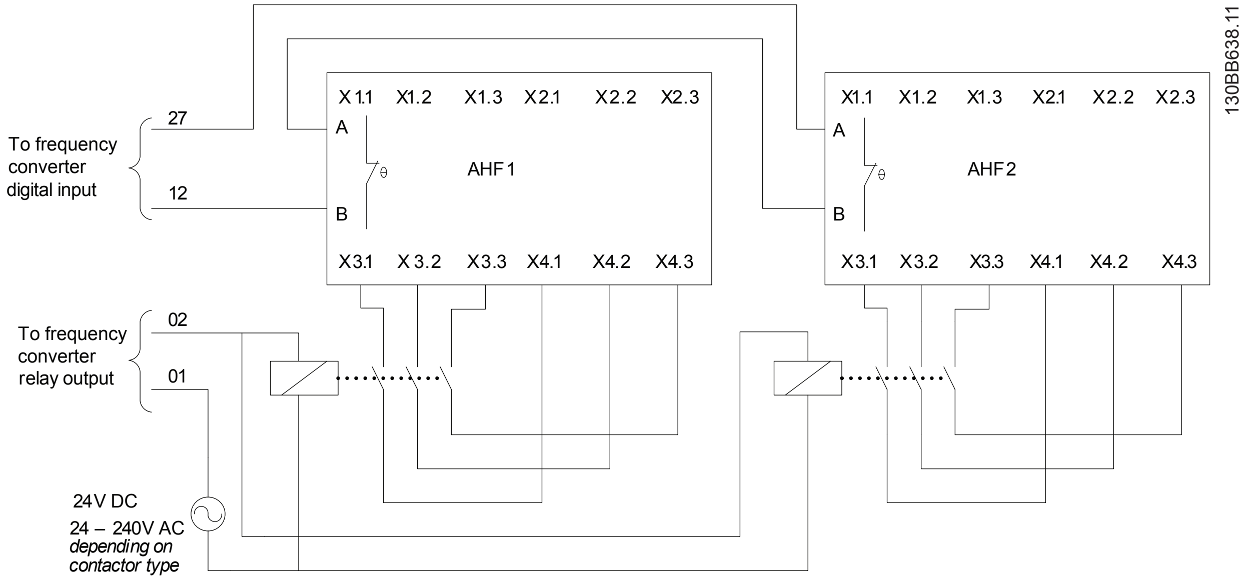


Illustration 4.14 Parallel Use of AHF Combined with Capacitor Disconnect

NOTICE

It is not allowed to use 1 common 3-poled contactor with several paralleled filters.

NOTICE

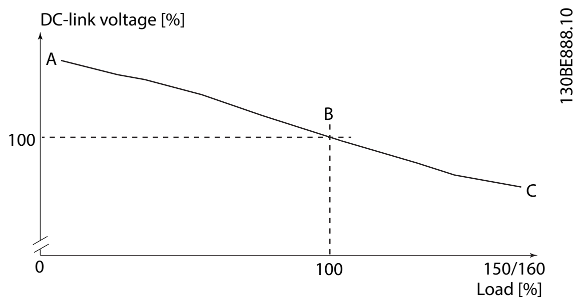
Keep the cable length between the filter and the capacitor disconnect contactor as short as possible to reduce the impedance influence on the cable. A maximum cable length of 2 m (6.6 ft) is allowed between filter and contactor.

Voltage boost

The AHF is designed to ensure the lowest possible insertion loss to provide full DC-link voltage in the frequency converter. The target of this design is to ensure full DC-link voltage at nominal load, see B in *Illustration 4.15*. Providing the full DC-link voltage at nominal load results in a minor voltage boost at low-load conditions and a minor voltage drop at overload conditions. The voltage boost at low load (A in *Illustration 4.15*) is approximately 5%, while the voltage drop at overload (C in *Illustration 4.15*) is a few percentages. *Illustration 4.15* shows the insertion loss in the frequency converter as a function of load.

NOTICE

The voltage boost causes the voltage at the frequency converter terminals to be up to 5% higher than the voltage at the input of the filter when the capacitors are not disconnected. Consider this situation when designing the installation. Take special care in 690 V applications where the voltage tolerance of the frequency converter is reduced to +5%, unless a capacitor disconnect is used.



A	Low-load condition or standby. Approximately 5% voltage boost occurs without the capacitors being disconnected. If the capacitors are disconnected, the voltage boost can be reduced.
B	Nominal load condition. The AHF is optimized for full DC-link voltage in the frequency converter at nominal load conditions.
C	Overload condition. A voltage drop of a few percentages occurs at high overload conditions.

Illustration 4.15 Insertion Loss in the Frequency Converter as a Function of Load

NOTICE

Only switch the contactor at less than 20% output power. Allow minimum 25 s for the capacitors to discharge before reconnecting. See more details in *chapter 6 Programming*.

NOTICE

Do not use the capacitor disconnect feature if several frequency converters are connected to the same filter.

4.2.2 Wiring

When wiring, also refer to *Illustration 4.13*.

1. Connect supply voltage to terminals X1.1, X1.2, and X1.3.
2. Connect the frequency converter supply terminals L1, L2, and L3 to the filter terminals X2.1, X2.2, and X2.3.

Wiring recommendations for paralleling of frequency converters
If connecting several frequency converters to 1 harmonic filter, the connection method is similar to the connection described above. Connect the supply terminals L1, L2, and L3 of the frequency converters to the filter terminals X2.1, X2.2, and X2.3.

NOTICE

Use cables complying with local regulations.

Wiring recommendations for paralleling of filters
If the mains input current of the frequency converter exceeds the nominal current of the largest harmonic filter, several harmonic filters can be paralleled to achieve the necessary current rating, see *Table 7.1*.

1. Connect supply voltage to terminals X1.1, X1.2, and X1.3 of the filters.
2. Connect the frequency converter supply terminals L1, L2, and L3 to the filters terminals X2.1, X2.2, and X2.3.

4.2.3 Overtemperature Protection

The VLT® Advanced Harmonic Filters AHF 005/AHF 010 are all equipped with a galvanically isolated switch (PELV). The switch is closed under normal operating conditions. If the filter is overheated, the switch opens.

Each filter contains 3 thermal switches mounted in series in each inductor group. At temperatures above 140 °C (284 °F), the switches open.

NOTICE

It is mandatory to use the integrated temperature switch to prevent damage of the filter caused by overtemperature. To prevent filter damage, perform an immediate stop or a controlled ramp down within maximum 30 s.

NOTICE

POSSIBLE INSUFFICIENT AIRFLOW

If the switch activates repeatedly in IP00 installations, it is probably caused by insufficient airflow through the filter.

- **Evaluate the airflow and the installation conditions.**
- **Make the required changes to provide proper cooling.**

4.2.3.1 Programming of Digital Inputs for Overtemperature Protection

The following describes the most commonly used programming examples. For more details, refer to *chapter 6 Programming*.

Example 1

1. Connect terminal A of the harmonic filter to terminal 12 or 13 (voltage supply digital input, 24 V) of the frequency converter.
2. Connect terminal B to terminal 27.
3. Program the digital input terminal 27 to *Coast Inverse*.

If an overtemperature is detected, the frequency converter coasts the motor and thus unloads the filter.

Example 2

1. Connect terminal A of the harmonic filter to terminal 12 or 13 (voltage supply digital input, 24 V DC) of the frequency converter.
2. Connect terminal B to terminal 33.
3. Set *parameter 1-90 Motor Thermal Protection*.
4. Set *parameter 1-93 Thermistor Resource*.

NOTICE

The maximum rating of the temperature switch is 250 V AC and 2 A.

4

5 Selection of Advanced Harmonic Filter

This chapter helps selecting the right filter size and contains calculation examples, electrical data, and ordering numbers for the filters.

5.1 Selecting the Correct AHF

For optimal performance, size the VLT® Advanced Harmonic Filter AHF 005/AHF 010 for the mains input current to the frequency converter. This current is the input current drawn based on the expected load of the frequency converter and not on the size of the frequency converter itself.

5

5.1.1 How to Calculate the Correct Filter Size

Calculate the mains input current of the frequency converter ($I_{FC,L}$). Use the nominal motor current ($I_{M,N}$) and the displacement factor (Cos φ) of the motor for the calculation. Both values are normally printed on the nameplate of the motor. If the nominal motor voltage ($U_{M,N}$) is unequal to the actual mains voltage (U_L), correct the calculated current with the ratio between these voltages, see the following equation:

$$I_{FC.L} = 1.1 \times I_{M,N} \times cos(\rho) \times \frac{U_{M,N}}{U_L}$$

The selected VLT® Advanced Harmonic Filter AHF 005/AHF 010 must have a nominal current ($I_{AHF,N}$) ≥ the calculated frequency converter mains input current ($I_{FC,L}$).

NOTICE

Do not oversize the AHF. The best harmonic performance is obtained at nominal filter load. Using an oversized filter most likely results in reduced THDi performance.

If connecting several frequency converters to the same filter, size the AHF according to the sum of the calculated mains input currents.

NOTICE

If the AHF is sized for a specific load, and the motor is changed, recalculate the current to avoid overloading the AHF.

5.1.2 Calculation Example

System mains voltage (U_L):	380 V
Motor nameplate power(P_M):	55 kW (75 hp)
Motor efficiency (η_M):	0.96
Frequency converter efficiency (η_{FC}):	0.97
AHF efficiency (η_{AHF})(worst-case estimate):	0.98

Table 5.1 Data for Calculation of Filter Size

Maximum line current (RMS):

$$\frac{P_M \times 1000}{U_L \times \eta_M \times \eta_{FC} \times \eta_{AHF} \times \sqrt{3}} = \frac{55 \times 1000}{380 \times 0.96 \times 0.97 \times 0.98 \times \sqrt{3}} = 91.57\,A$$

In this case, select a 96 A filter.

5.1.3 Voltage Boost

NOTICE

VOLTAGE BOOST

The voltage boost causes the voltage at the frequency converter terminals to be up to 5% higher than the voltage at the input of the filter when the capacitors are not disconnected. Consider this situation when designing the installation. Take special care in 690 V applications where the voltage tolerance of the frequency converter is reduced to +5%, unless a capacitor disconnect is used. For more information, see *chapter 4.2.1.1 Terminals for Capacitor Disconnect*.

5.2 Selection Tables

5.2.1 Terminology Used in Selection Tables

Table 5.2 explains in detail the terminology used in the selection tables, see *Table 5.3* to *Table 5.7*.

Value	Description
Power rating	Frequency converter kW power rating from the type code. The power ratings in the tables refer to the actual frequency converter operating conditions. Changing operating conditions between HO and NO changes the frequency converter operating conditions. The selection of the VLT® Advanced Harmonic Filter AHF 005/AHF 010 must match the actual operating conditions of the frequency converter.
Input current	The maximum input current ratings of the frequency converter in the specific mains supply voltage ranges.
T4, T5, T6, and T7	The frequency converter type code voltage class.
Current rating	Filter current rating at nominal load. Current ratings are combined values when paralleling filters.
AHF 005	Performance level of 5% THDi or better at system level with nominal load.
AHF 010	Performance level of 10% THDi or better at system level with nominal load.
Ordering numbers	AHF ordering numbers. The selected AHF must match the actual mains type.
Power loss	Maximum filter power losses during nominal loading.
Acoustic noise level	Maximum acoustic noise level from filters at 1 m (3.3 ft) distance.
Enclosure size, enclosure protection ratings, and fan concept: • [Enclosure size] IP20 if1. • [Enclosure size] IP20 ef1. • [Enclosure size] IP20 if2. • [Enclosure size] IP20 ef2.	Confirming the fan concepts and reference to mechanical drawings as: • [Enclosure size] IP20 with internal fan type 1. • [Enclosure size] IP20 with external fan type 1. • [Enclosure size] IP20 with internal fan type 2. • [Enclosure size] IP20 with external fan type 2.
IP00	Enclosure protection rating IP00. Forced cooling cools the AHF filters. IP00 types have no fans, and a minimum required airflow must be ensured separately during installation of the IP00 versions in panels. See *chapter 4.1.4 Ventilation and Cooling Requirements* for details.
IP20	Enclosure protection rating IP20. Built-in fans cool IP20 types as part of the mechanical design. IP21/ NEMA 1 upgrade kits are available for all IP20 types as separate options.

Table 5.2 Terminology Used in the Selection Tables

Selection table, 380–415 V, 50 Hz														
Frequency converter values		Filter values												
Power rating	Input current	Current rating	Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection rating, and fan concept				
T4/T5	380–440 V		AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010		
[kW][1)]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20	
0.37	1.2	10	130B1392	130B1229	130B1262	130B1027	131	93	<70	X1 IP00	X1 IP20 if1	X1 IP00	X1 IP20 if1	
0.55	1.6													
0.75	2.2													
1.1	2.7													
1.5	3.7													
2.2	5.0													
3.0	6.5													
4.0	9.0													
5.5	11.7	14	130B1393	130B1231	130B1263	130B1058	184	118	<70	X1 IP00	X1 IP20 ef1	X1 IP00	X1 IP20 ef1	
7.5	14.4													
11	22	22	130B1394	130B1232	130B1268	130B1059	258	206	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1	
15	29	29	130B1395	130B1233	130B1270	130B1089	298	224	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1	
18.5	34	34	130B1396	130B1238	130B1273	130B1094	335	233	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1	
22	40	40	130B1397	130B1239	130B1274	130B1111	396	242	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1	
30	55	55	130B1398	130B1240	130B1275	130B1176	482	274	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1	
37	66	66	130B1399	130B1241	130B1281	130B1180	574	352	<72	X4 IP00	X4 IP20 if1	X4 IP00	X4 IP20 if1	
45	82	82	130B1442	130B1247	130B1291	130B1201	688	374	<72	X4 IP00	X4 IP20 ef1	X4 IP00	X4 IP20 ef1	
55	96	96	130B1443	130B1248	130B1292	130B1204	747	428	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1	
75	133	133	130B1444	130B1249	130B1293	130B1207	841	488	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1	
90	171	171	130B1445	130B1250	130B1294	130B1213	962	692	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1	
110	204	204	130B1446	130B1251	130B1295	130B1214	1080	743	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1	
132	251	251	130B1447	130B1258	130B1369	130B1215	1194	864	<75	X7 IP00	X7 IP20 if1	X7 IP00	X7 IP20 if1	
160	304	304	130B1448	130B1259	130B1370	130B1216	1288	905	<75	X7 IP00	X7 IP20 if1	X7 IP00	X7 IP20 if1	
–	–	325	130B3153[2)]	130B3152[2)]	130B3151[2)]	130B3136[2)]	1406	952	<75	X8 IP00	X8 IP20 if1	X7 IP00	X7 IP20 if1	
200	381	381	130B1449	130B1260	130B1389	130B1217	1510	1175	<77	X8 IP00	X8 IP20 ef1	X7 IP00	X7 IP20 if1	
250	463	480	130B1469	130B1261	130B1391	130B1228	1852	1542	<77	X8 IP00	X8 IP20 ef1	X8 IP00	X8 IP20 ef1	

Selection table, 380–415 V, 50 Hz														
Frequency converter values		Filter values												
Power rating	Input current	Current rating	Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection rating, and fan concept				
T4/T5	380–440 V		AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010		
[kW][1)]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20	
315	590	608	2 x 130B1448	2 x 130B1259	2 x 130B1370	2 x 130B1216	2576	1810	<80	See individual filters				
355	647	650	2 x 130B3153	2 x 130B3152	2 x 130B3151	2 x 130B3136	2812	1904	<80					
400	684	685	130B1448 + 130B1449	130B1259 + 130B1260	130B1370 + 130B1389	130B1216 + 130B1217	2798	2080	<80					
450	779	762	2 x 130B1449	2 x 130B1260	2 x 130B1389	2 x 130B1217	3020	2350	<80					
500	857	861	130B1449 + 130B1469	130B1260 + 130B1261	130B1389 + 130B1391	130B1217 + 130B1228	3362	2717	<80					
560	964	960	2 x 130B1469	2 x 130B1261	2 x 130B1391	2 x 130B1228	3704	3084	<80					
630	1090	1140	3 x 130B1449	3 x 130B1260	3 x 130B1389	3 x 130B1217	4530	3525	<80					
710	1227	1240	2 x 130B1449 + 130B1469	2 x 130B1260 + 130B1261	2 x 130B1389 + 130B1391	2 x 130B1217 + 130B1228	4872	3892	<80					
800	1422	1440	3 x 130B1469	3 x 130B1261	3 x 130B1391	3 x 130B1228	5556	4626	<80					
1000	1675	1720	2 x 130B1449 + 2 x 130B1469	2 x 130B1260 + 2 x 130B1261	2 x 130B1389 + 2 x 130B1391	2 x 130B1217 + 2 x 130B1228	6724	5434	<80					

1) kW power ratings in selection table are the actual operating power and not necessarily the type code power rating. Changing operating conditions between HO and NO changes the actual operating conditions and the filter selection must reflect actual operating conditions.

2) Filters are used as paralleling for 355 kW frequency converters.

Table 5.3 380–415 V, 50 Hz

5

Selection table, 380–415 V, 60 Hz

Frequency converter values		Filter values											
Power rating	Input current	Current rating	Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T4/T5	380–440 V		AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
0.37	1.2	10	130B3095	130B2857	130B2874	130B2262	131	93	<70	X1 IP00	X1 IP20 if1	X1 IP00	X1 IP20 if1
0.55	1.6												
0.75	2.2												
1.1	2.7												
1.5	3.7												
2.2	5.0												
3.0	6.5												
4.0	9.0												
5.5	11.7	14	130B3096	130B2858	130B2875	130B2265	184	118	<70	X1 IP00	X1 IP20 ef1	X1 IP00	X1 IP20 ef1
7.5	14.4												
11	22	22	130B3097	130B2859	130B2876	130B2268	258	206	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1
15	29	29	130B3098	130B2860	130B2877	130B2294	298	224	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1
18.5	34	34	130B3099	130B2861	130B3000	130B2297	335	233	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
22	40	40	130B3124	130B2862	130B3083	130B2303	396	242	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
30	55	55	130B3125	130B2863	130B3084	130B2445	482	274	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
37	66	66	130B3126	130B2864	130B3085	130B2459	574	352	<72	X4 IP00	X4 IP20 if1	X4 IP00	X4 IP20 if1
45	82	82	130B3127	130B2865	130B3086	130B2488	688	374	<72	X4 IP00	X4 IP20 ef1	X4 IP00	X4 IP20 ef1
55	96	96	130B3128	130B2866	130B3087	130B2489	747	428	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
75	133	133	130B3129	130B2867	130B3088	130B2498	841	488	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
90	171	171	130B3130	130B2868	130B3089	130B2499	962	692	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1
110	204	204	130B3131	130B2869	130B3090	130B2500	1080	743	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1
132	251	251	130B3132	130B2870	130B3091	130B2700	1194	864	<75	X7 IP00	X7 IP20 if1	X7 IP00	X7 IP20 if1
160	304	304	130B3133	130B2871	130B3092	130B2819	1288	905	<75	X8 IP00	X8 IP20 if1	X7 IP00	X7 IP20 if1
–	–	325	130B3157[2)]	130B3156[2)]	130B3155[2)]	130B3154[2)]	1406	952	<75	X8 IP00	X8 IP20 if1	X7 IP00	X7 IP20 if1
200	381	381	130B3134	130B2872	130B3093	130B2855	1510	1175	<77	X8 IP00	X8 IP20 ef1	X7 IP00	X7 IP20 if1
250	463	480	130B3135	130B2873	130B3094	130B2856	1852	1542	<77	X8 IP00	X8 IP20 ef1	X8 IP00	X8 IP20 ef1

Selection table, 380–415 V, 60 Hz													
Frequency converter values		Filter values											
Power rating	Input current	Current rating	Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T4/T5	380–440 V		AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
315	590	608	2 x 130B3133	2 x 130B2871	2 x 130B3092	2 x 130B2819	2576	1810	<80	See individual filters			
355	647	650	2 x 130B3157	2 x 130B3156	2 x 130B3155	2 x 130B3154	2812	1904	<80				
400	684	685	130B3133 + 130B3134	130B2871 + 130B2872	130B3092 + 130B3093	130B2819 + 130B2855	2798	2080	<80				
450	779	762	2 x 130B3134	2 x 130B2872	2 x 130B3093	2 x 130B2855	3020	2350	<80				
500	857	861	130B3134 + 130B3135	130B2872 + 130B2873	130B3093 + 130B3094	130B2855 + 130B2856	3362	2717	<80				
560	964	960	2 x 130B3135	2 x 130B2873	2 x 130B3094	2 x 130B2856	3704	3084	<80				
630	1090	1140	3 x 130B3134	3 x 130B2872	3 x 130B3093	3 x 130B2855	4530	3525	<80				
710	1227	1240	2 x 130B3134 + 130B3135	2 x 130B2872 + 130B2873	2 x 130B3093 + 130B3094	2 x 130B2855 + 130B2856	4872	3892	<80				
800	1422	1440	3 x 130B3135	3 x 130B2873	3 x 130B3094	3 x 130B2856	5556	4626	<80				
1000	1675	1720	2 x 130B3134 + 2 x 130B3135	2 x 130B2872 + 2 x 130B2873	2 x 130B3093 + 2 x 130B3094	2 x 130B2855 + 2 x 130B2856	6724	5434	<80				

1) kW power ratings in selection table are the actual operating power and not necessarily the type code power rating. Changing operating conditions between HO and NO changes the actual operating conditions and the filter selection must reflect actual operating conditions.

2) Filters are used as paralleling for 355 kW frequency converters.

Table 5.4 380–415 V, 60 Hz

Selection table, 440–480 V, 60 Hz															
Frequency converter values			Filter values												
Power rating		441–500 V	Current rating		Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T4/T5			AHF 005	AHF 010	AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[hp][2)]	[A]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
0.37	0.50	1.0	10	10	130B1787	130B1752	130B1770	130B1482	131	93	<70	X1 IP00	X1 IP20 if1	X1 IP00	X1 IP20 if1
0.55	0.75	1.4													
0.75	1.0	1.9													
1.1	1.5	2.7													
1.5	2.0	3.1													
2.2	3.0	4.3													
3.0	4.0	5.7													
4.0	5.5	7.4													
5.5	7.5	9.9	14	14	130B1788	130B1753	130B1771	130B1483	184	118	<70	X1 IP00	X1 IP20 ef1	X1 IP00	X1 IP20 ef1
7.5	10	13													
11	15	19	19	19	130B1789	130B1754	130B1772	130B1484	258	206	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1
15	20	25	25	25	130B1790	130B1755	130B1773	130B1485	298	224	<70	X2 IP00	X2 IP20 ef1	X2 IP00	X2 IP20 if1
18.5	25	31	31	31	130B1791	130B1756	130B1774	130B1486	335	233	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
22	30	36	36	36	130B1792	130B1757	130B1775	130B1487	396	242	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
30	40	47	48	48	130B1793	130B1758	130B1776	130B1488	482	274	<72	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
37	50	59	60	60	130B1794	130B1759	130B1777	130B1491	574	352	<72	X4 IP00	X4 IP20 if1	X4 IP00	X4 IP20 if1
45	60	73	73	73	130B1795	130B1760	130B1778	130B1492	688	374	<72	X4 IP00	X4 IP20 ef1	X4 IP00	X4 IP20 ef1
55	75	95	95	95	130B1796	130B1761	130B1779	130B1493	747	428	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
75	100	118	118	118	130B1797	130B1762	130B1780	130B1494	841	488	<75	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
90	125	154	154	154	130B1798	130B1763	130B1781	130B1495	962	692	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1
110	150	183	183	183	130B1799	130B1764	130B1782	130B1496	1080	743	<75	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 if1
132	200	231	231	231	130B1900	130B1765	130B1783	130B1497	1194	864	<75	X7 IP00	X7 IP20 if1	X7 IP00	X7 IP20 if1
160	250	291	291	291	130B2200	130B1766	130B1784	130B1498	1288	905	<75	X8 IP00	X8 IP20 if1	X7 IP00	X7 IP20 if1
200	300	348	355	355	130B2257	130B1768	130B1785	130B1499	1406	952	<75	X8 IP00	X8 IP20 ef1	X7 IP00	X7 IP20 if1
–	–	–	380	380	130B3168[3)]	130B3167[3)]	130B3166[3)]	130B3165[3)]	1510	1175	<77	X8 IP00	X8 IP20 if1	X7 IP00	X7 IP20 if1
250	350	427	436	436	130B2259	130B1769	130B1786	130B1751	1852	1542	<77	X8 IP00	X8 IP20 ef1	X8 IP00	X8 IP20 ef1

Selection table, 440–480 V, 60 Hz															
Frequency converter values			Filter values												
Power rating		441–500 V	Current rating		Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T4/T5			AHF 005	AHF 010	AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[hp][2)]	[A]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
315	450	531	522	522	130B1900 + 130B2200	130B1765 + 130B1766	130B1783 + 130B1784	130B1497 + 130B1498	2576	1810	<80	See individual filters			
355	500	580	582	582	2 x 130B2200	2 x 130B1766	2 x 130B1784	2 x 130B1498	2812	1904	<80				
400	550	667	671	671	130B2200 + 130B3168	130B1766 + 130B3167	130B1784 + 130B3166	130B1498 + 130B3165	2798	2080	<80				
450	600	771	710	710	2 x 130B2257	2 x 130B1768	2 x 130B1785	2 x 130B1499	3020	2350	<80				
500	650	759	760	760	2 x 130B3168	2 x 130B3167	2 x 130B3166	2 x 130B3165	3362	2717	<80				
560	750	867	872	872	2 x 130B2259	2 x 130B1769	2 x 130B1786	2 x 130B1751	3704	3084	<80				
630	900	1022	1065	1065	3 x 130B2257	3 x 130B1768	3 x 130B1785	3 x 130B1499	4530	3525	<80				
710	1000	1129	1140	1140	3 x 130B3168	3 x 130B3167	3 x 130B3166	3 x 130B3165	4872	3892	<80				
800	1200	1344	1308	1308	3 x 130B2259	3 x 130B1769	3 x 130B1786	3 x 130B1751	5556	4626	<80				
1000	1350	1490	1582	1582	2 x 130B2257 + 2 x 130B2259	2 x 130B1768 + 2 x 130B1769	2 x 130B1785 + 2 x 130B1786	2 x 130B1499 + 2 x 130B1751	6724	5434	<80				

1) kW power ratings in selection table are the actual operating power and not necessarily the type code power rating. Changing operating conditions between HO and NO changes the actual operating conditions and the filter selection must reflect actual operating conditions.

2) Typical hp shaft output at 460 V.

3) Filters are used as paralleling for 500 kW and 710 kW frequency converters.

Table 5.5 440–480 V, 60 Hz

5

Selection table, 600 V, 60 Hz																	
Frequency converter values					Filter values												
Power rating			Input current		Current rating at 600 V		Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T6/T7	T6	T7	T6	T7													
			551–600 V	551–600 V	AHF 005	AHF 010	AHF 005		AHF 010		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[hp][2)]	[hp][2)]	[A]	[A]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
11	15	10	16	15	15	15	130B5261	130B5246	130B5229	130B5212	298	224	<70	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
15	20	15	20	19.5	20	20	130B5262	130B5247	130B5230	130B5213	335	233	<70	X3 IP00	X3 IP20 if1	X3 IP00	X3 IP20 if1
18.5	25	20	24	24	24	24	130B5263	130B5248	130B5231	130B5214	396	242	<70	X3 IP00	X3 IP20 ef1	X3 IP00	X3 IP20 ef1
22	30	25	31	29	29	29	130B5264	130B5249	130B5232	130B5215	482	274	<70	X4 IP00	X4 IP20 ef1	X4 IP00	X4 IP20 ef1
30	40	30	37	36	36	36	130B5265	130B5250	130B5233	130B5216	574	352	<70	X4 IP00	X4 IP20 ef1	X4 IP00	X4 IP20 ef1
37	50	40	47	49	50	50	130B5266	130B5251	130B5234	130B5217	688	374	<70	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
45	60	50	56	59	58	58	130B5267	130B5252	130B5235	130B5218	747	428	<70	X5 IP00	X5 IP20 ef1	X5 IP00	X5 IP20 ef1
55	75	60	75	74	77	77	130B5268	130B5253	130B5236	130B5219	841	488	<72	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 ef1
75	100	75	91	85	87	87	130B5269	130B5254	130B5237	130B5220	962	692	<72	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 ef1
90	125	100	119	106	109	109	130B5270	130B5255	130B5238	130B5221	1080	743	<72	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 ef1
110	–	125	–	124	128	128	130B5271	130B5256	130B5239	130B5222	1194	864	<72	X6 IP00	X6 IP20 ef1	X6 IP00	X6 IP20 ef1
132	–	150	–	151	155	155	130B5272	130B5257	130B5240	130B5223	1288	905	<72	X7 IP00	X7 IP20 ef1	X7 IP00	X7 IP20 ef1
160	–	200	–	189	197	197	130B5273	130B5258	130B5241	130B5224	1406	952	<72	X7 IP00	X7 IP20 ef1	X7 IP00	X7 IP20 ef1
200	–	250	–	234	240	240	130B5274	130B5259	130B5242	130B5225	1510	1175	<75	X8 IP00	X8 IP20 ef1	X7 IP00	X7 IP20 ef1
250	–	300	–	286	296	296	130B5275	130B5260	130B5243	130B5226	1852	1288	<75	X8 IP00	X8 IP20 ef1	X8 IP00	X8 IP20 ef1
315	–	350	–	339	394	366	2 x 130B5273	2 x 130B5258	130B5244	130B5227	2812	1542	<77	See individual filters		X8 IP00	X8 IP20 ef1
355	–	400	–	366	394	366	2 x 130B5273	2 x 130B5258	130B5244	130B5227	2812	1542	<77			X8 IP00	X8 IP20 ef1
400	–	400	–	395	394	395	2 x 130B5273	2 x 130B5258	130B5245	130B5228	2812	1852	<77			X8 IP00	X8 IP20 ef1
500	–	500	–	482	480	480	2 x 130B5274	2 x 130B5259	2 x 130B5242	2 x 130B5225	3020	2350	<80	See individual filters			
560	–	550	–	549	592	592	2 x 130B5275	2 x 130B5260	2 x 130B5243	2 x 130B5226	3704	2576	<80				
630	–	650	–	613	720	732	3 x 130B5274	3 x 130B5259	2 x 130B5244	2 x 130B5227	4530	3084	<80				
710	–	750	–	711	720	732	3 x 130B5274	3 x 130B5259	2 x 130B5244	2 x 130B5227	4530	3084	<80				
800	–	950	–	828	888	888	3 x 130B5275	3 x 130B5260	3 x 130B5243	3 x 139B5226	5556	3864	<80				
900	–	1050	–	920	960	960	4 x 130B5274	4 x 130B5259	3 x 130B5244	3 x 130B5227	6040	4626	<80				
1000	–	1150	–	1032	1184	1098	4 x 130B5275	4 x 130B5260	3 x 130B5244	3 x 130B5227	7408	4626	<80				

1) kW power ratings in selection table are the actual operating power and not necessarily the type code power rating. Changing operating conditions between HO and NO changes the actual operating conditions and the filter selection must reflect actual operating conditions.

2) Typical hp shaft output at 575 V.

Table 5.6 600 V, 60 Hz

Selection table, 500–690 V, 50 Hz																
Frequency converter values				Filter values												
Power rating	Input current			Current rating at 690 V		Ordering numbers				Power loss		Acoustic noise	Enclosure sizes, enclosure protection ratings, and fan concept			
T6/T7	T6 525–550 V	T7 525–550 V	T7 690 V	AHF 005	AHF 010	AHF 005[2)]		AHF 010[3)]		AHF 005	AHF 010		AHF 005		AHF 010	
[kW][1)]	[A]	[A]	[A]	[A]	[A]	IP00	IP20	IP00	IP20	[W]	[W]	[dB(A)]	IP00	IP20	IP00	IP20
11	17.2	15.0	14.5	15	15	130B5000	130B5088	130B5297	130B5280	298	224	<70	X3 IP00	X3 IP20 if2	X3 IP00	X3 IP20 if2
15	20.9	19.5	19.5	20	20	130B5017	130B5089	130B5298	130B5281	335	233	<70	X3 IP00	X3 IP20 if2	X3 IP00	X3 IP20 if2
18.5	25.4	24	24	24	24	130B5018	130B5090	130B5299	130B5282	396	242	<70	X3 IP00	X3 IP20 ef2	X3 IP00	X3 IP20 ef2
22	32.7	29	29	29	29	130B5019	130B5092	130B5302	130B5283	482	274	<70	X4 IP00	X4 IP20 ef2	X4 IP00	X4 IP20 ef2
30	39.0	36	36	36	36	130B5021	130B5125	130B5404	130B5284	574	352	<70	X4 IP00	X4 IP20 ef2	X4 IP00	X4 IP20 ef2
37	49.0	49	48	50	50	130B5022	130B5144	130B5310	130B5285	688	374	<70	X5 IP00	X5 IP20 ef2	X5 IP00	X5 IP20 ef2
45	59.0	59	58	58	58	130B5023	130B5168	130B5324	130B5286	747	428	<70	X5 IP00	X5 IP20 ef2	X5 IP00	X5 IP20 ef2
55	78.9	77	77	77	77	130B5024	130B5169	130B5325	130B5287	841	488	<72	X6 IP00	X6 IP20 ef2	X6 IP00	X6 IP20 ef2
75	95.3	89	87	87	87	130B5025	130B5170	130B5326	130B5288	962	692	<72	X6 IP00	X6 IP20 ef2	X6 IP00	X6 IP20 ef2
90	124.3	110	109	109	109	130B5026	130B5172	130B5327	130B5289	1080	743	<72	X6 IP00	X6 IP20 ef2	X6 IP00	X6 IP20 ef2
110	–	130	128	128	128	130B5028	130B5195	130B5328	130B5290	1194	864	<72	X6 IP00	X6 IP20 ef2	X6 IP00	X6 IP20 ef2
132	–	158	155	155	155	130B5029	130B5196	130B5329	130B5291	1288	905	<72	X7 IP00	X7 IP20 ef2	X7 IP00	X7 IP20 ef2
160	–	198	197	197	197	130B5042	130B5197	130B5330	130B5292	1406	952	<72	X7 IP00	X7 IP20 ef2	X7 IP00	X7 IP20 ef2
200	–	245	240	240	240	130B5066	130B5198	130B5331	130B5293	1510	1175	<75	X8 IP00	X8 IP20 ef2	X7 IP00	X7 IP20 ef2
250	–	299	296	296	296	130B5076	130B5199	130B5332	130B5294	1852	1288	<75	X8 IP00	X8 IP20 ef2	X8 IP00	X8 IP20 ef2
315	–	355	352	394	366	2 x 130B5042	2 x 130B5197	130B5333	130B5295	2812	1542	<77	See individual filters		X8 IP00	X8 IP20 ef2
355	–	381	366	394	395	2 x 130B5042	2 x 130B5197	130B5334	130B5296	2812	1852	<77			X8 IP00	X8 IP20 ef2
400	–	413	400	437	437	130B5042 + 130B5066	130B5197 + 130B5198	130B5330 + 130B5331	130B5292 + 130B5293	2916	2127	<80	See individual filters			
500	–	504	482	536	536	130B5066 + 130B5076	130B5198 + 130B5199	130B5331 + 130B5332	130B5293 + 130B5294	3362	2463	<80				
560	–	574	549	592	592	2 x 130B5076	2 x 130B5199	2 x 130B5332	2 x 130B5294	3704	2576	<80				
630	–	642	613	662	662	130B5076 + 2 x 130B5042	130B5199 + 2 x 130B5197	130B5332 + 130B5333	130B5294 + 130B5295	4664	2830	<80				
710	–	743	711	788	732	4 x 130B5042	4 x 130B5197	2 x 130B5333	2 x 130B5295	5624	3084	<80				
800	–	866	828	888	888	3 x 130B5076	3 x 130B5199	3 x 130B5332	3 x 130B5294	5556	3864	<80				
900	–	962	920	986	958	2 x 130B5076 + 2 x 130B5042	2 x 130B5199 + 2 x 130B5197	2 x 130B5332 + 130B5333	2 x 130B5294 + 130B5295	6516	4118	<80				

1) kW power ratings in selection table are the actual operating power and not necessarily the type code power rating. Changing operating conditions between HO and NO changes the actual operating conditions and the filter selection must reflect actual operating conditions.
2) Operating the AHF 005 at 525 V mains supply improves the harmonic performance level to a typical value of 3% THDi.
Operating the AHF 010 at 525 V mains supply improves the harmonic performance level to a typical value of 8%.

Table 5.7 500–690 V, 50 Hz

5.2.2 Capacitor Disconnect Contactors

Selection table for VLT® Advanced Harmonic Filters AHF 005/AHF 010 using separate Danfoss contactors.

AHF current rating										AHF enclosure size	Danfoss contactors	
380–415 V 50 Hz		380–415 V 60 Hz		440–480 V 60 Hz		600 V 60 Hz		500–690 V 50 Hz				
AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010		Description	Ordering number
[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	Type		
10 14	10 14	10 14	10 14	10 14	10 14	–	–	–	–	X1	CI 9	037H0021.32
22 29	22 29	22 29	22 29	19 25	19 25	–	–	–	–	X2	CI 16	037H0041.32
34 40 55	34 40 55	34 40 55	34 40 55	31 36 48	31 36 48	15 20 24	15 20 24	15 20 24	15 20 24	X3	CI 30	037H0055.32
66 82	66 82	66 82	66 82	60 73	60 73	29 36	29 36	29 36	29 36	X4	CI 45	037H0071.32
96 133	96 133	96 133	96 133	95 118	95 118	50 58	50 58	50 58	50 58	X5	CI 61	037H3061.32
171 204	171 204	171 204	171 204	154 183	154 183	77 87 109 128	77 87 109 128	77 87 109 128	77 87 109 128	X6	CI 98	037H3040.32
251 304	251 304 325 381	251	251 304 325 381	231	231 291 355 380	155 197	155 197 240	155 197	155 197 240	X7	CI 180	037H3082.31
325 381	–	304 325 381	–	291 355 380	–	240 296	296 366	240 296	296 366	X8	CI 180	037H3082.31
480	480	480	480	436	436	–	395	–	395	X8	CI 250	037H3267.32

Table 5.8 Selection Table, Capacitor Disconnect Contactors - Danfoss Types

5.2.2.1 Non-Danfoss Contactors

Non-Danfoss contactors are compatible with the VLT® Advanced Harmonic Filter AHF005/AHF 010. If using non-Danfoss contactors for capacitor disconnect, always select AC3-types. The current rating of the contactor must be equal to or higher than 50% of the nominal current rating of the AHF.

If the contactor is controlled by external equipment and not by a specific parameter in a Danfoss frequency converter, use contactors for capacitive switching.

5.3 Accessories

5.3.1 IP21/NEMA 1 Upgrade Kit

An upgrade kit is available for upgrading the VLT® Advanced Harmonic Filter AHF 005/AHF 010 from IP20 to IP21/NEMA 1.

The kits consist of 2 parts:

- A top plate that prevents dirt and vertically falling drops of water from entering the filter.
- A terminal box enclosing the terminals and connections, thus ensuring touch-safe terminals.

The terminal cover is prepared for installation of a contactor for capacitor disconnect.

Spacers must be used at IP21 top cover at enclosure sizes with:

- External fan type 1.
- External fan type 2.
- Internal fan type 2.

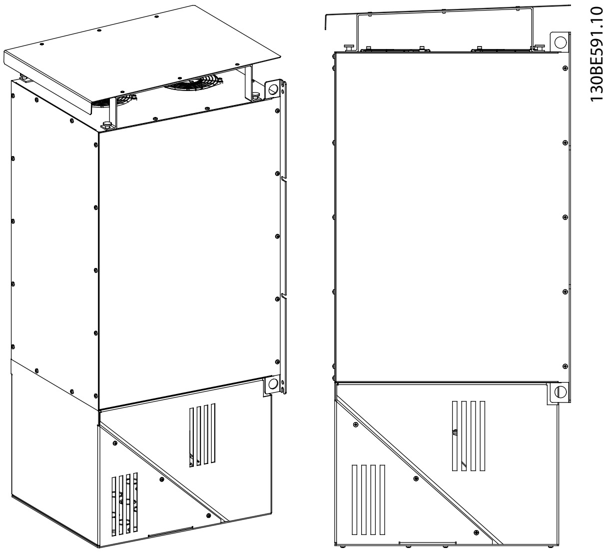


Illustration 5.1 IP21/NEMA 1 Kit, Internal Fan 1

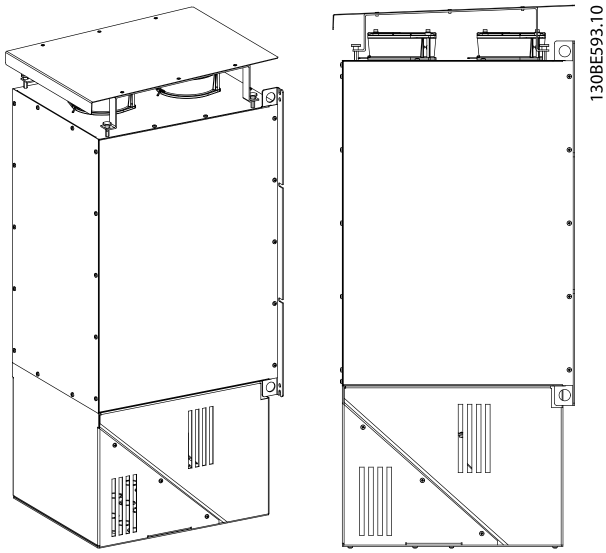


Illustration 5.3 IP21/NEMA 1 Kit, External Fan 1

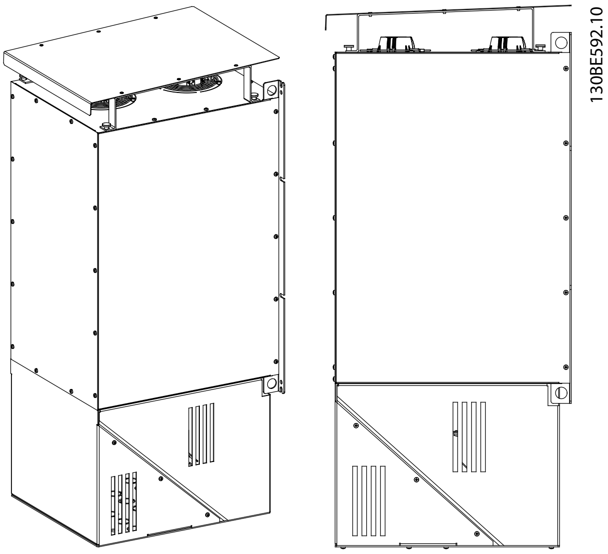


Illustration 5.2 IP21/NEMA 1 Kit, Internal Fan 2

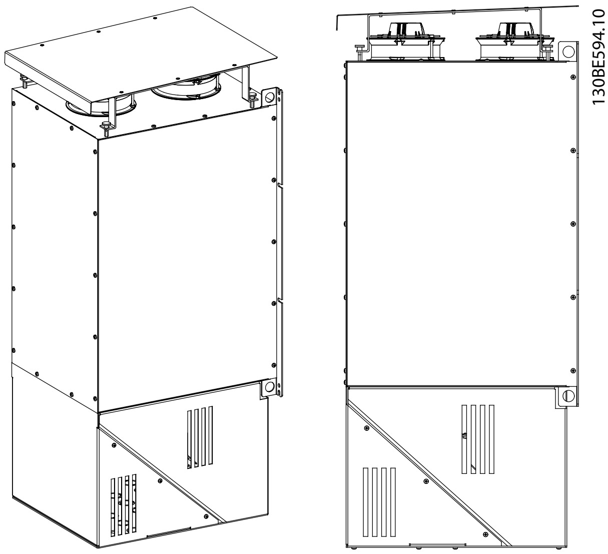


Illustration 5.4 IP21/NEMA 1 Kit, External Fan 2

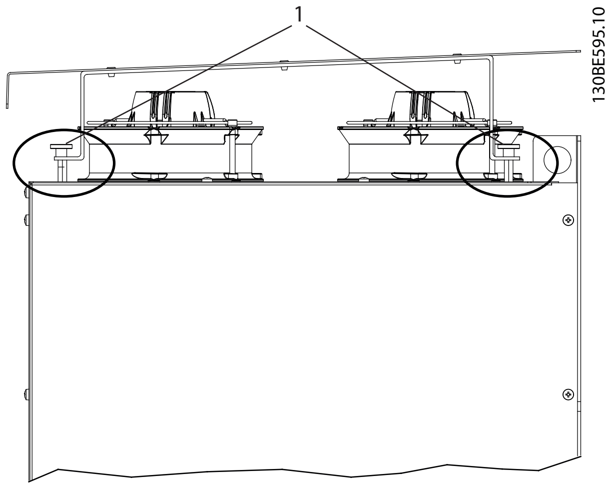
Furthermore, the kit is available in 2 versions:

- Without built-in capacitor disconnect circuitry.
- With built-in capacitor disconnect circuitry.

For further information on capacitor disconnect circuitry, refer to *chapter 4.2.1.1 Terminals for Capacitor Disconnect*.

NOTICE

When mounting the upgrade kit on an AHF filter with external fan, use the included spacers to ensure sufficient space between the filter and the top plate.



1	Spacers

Illustration 5.5 Spacers Required for External Fans

5.3.1.1 IP21/NEMA 1 Upgrade Kit without Built-in Capacitor Disconnect Circuitry

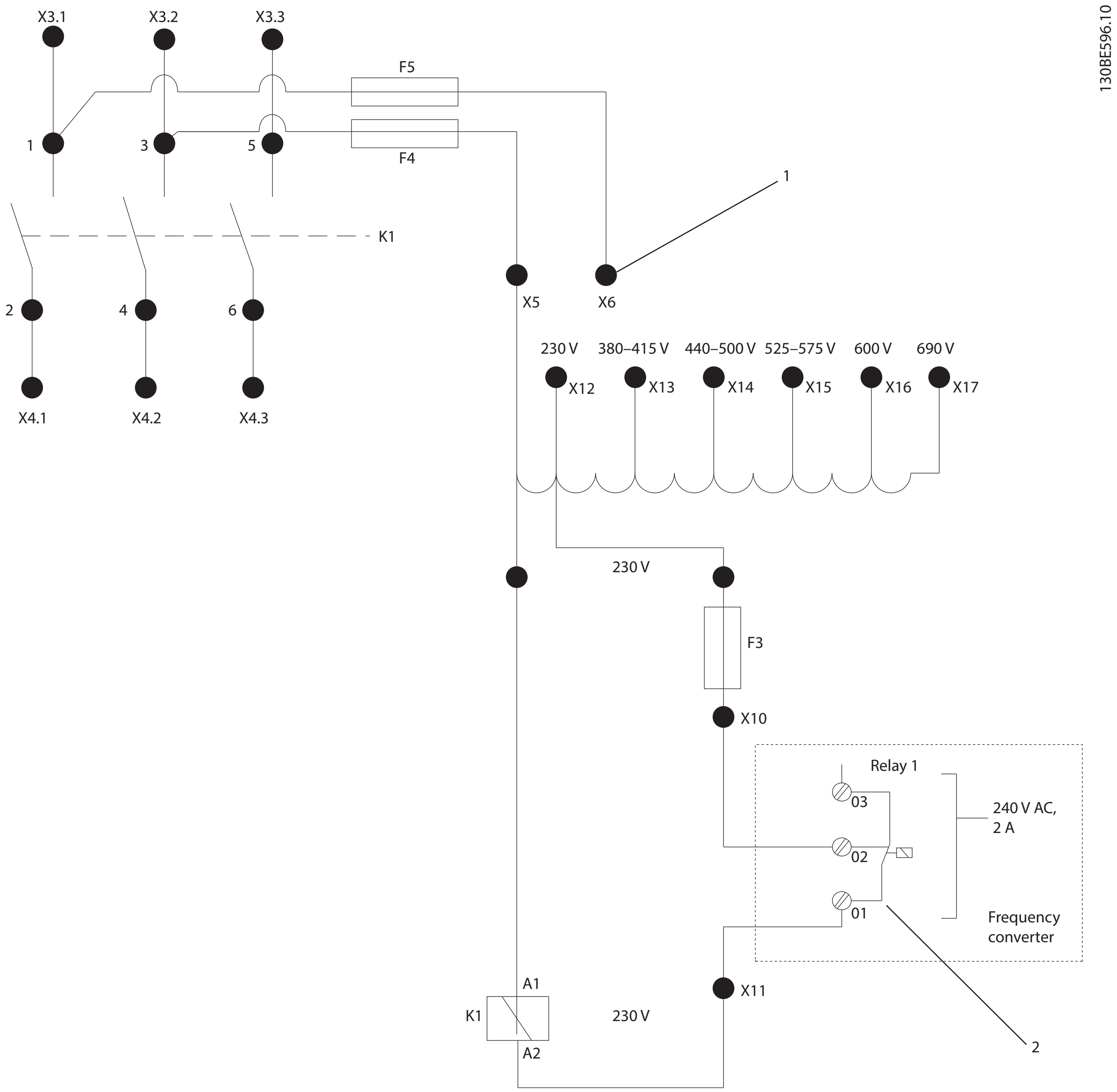
AHF current rating										AHF enclosure size	IP21/NEMA 1 Kit without capacitor disconnect circuitry for AHF IP20 enclosures	
380–415 V/50 Hz		380–415 V/60 Hz		440–480 V/60 Hz		600 V/60 Hz		500–690 V/50 Hz				
AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010		Description	Ordering number
[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]			
10 14	10 14	10 14	10 14	10 14	10 14	–	–	–	–	X1	IP21/NEMA 1 Kit for AHF X1 enclosure	130B3274
22 29	22 29	22 29	22 29	19 25	19 25	–	–	–	–	X2	IP21/NEMA1 Kit for AHF X2 enclosure	130B3275
34 40 55	34 40 55	34 40 55	34 40 55	31 36 48	31 36 48	15 20 24	15 20 24	15 20 24	15 20 24	X3	IP21/NEMA1 Kit for AHF X3 enclosure	130B3276
66 82	66 82	66 82	66 82	60 73	60 73	29 36	29 36	29 36	29 36	X4	IP21/NEMA1 Kit for AHF X4 enclosure	130B3277
96 133	96 133	96 133	96 133	95 118	95 118	50 58	50 58	50 58	50 58	X5	IP 21/NEMA1 Kit for AHF X5 enclosure	130B3278
171 204	171 204	171 204	171 204	154 183	154 183	77 87 109 128	77 87 109 128	77 87 109 128	77 87 109 128	X6	IP21/NEMA1 Kit for AHF X6 enclosure	130B3279
251 304	251 304 325 381	251	251 304 325 381	231	231 291 355 380	155 197	155 197 240	155 197	155 197 240	X7	IP21/NEMA1 Kit for AHF X7 enclosure	130B3281
325 381 480	480	304 325 381 480	480	291 355 380 436	436	240 296	296 366 395	240 296	296 366 395	X8	IP21/NEMA1 Kit for AHF X8 enclosure	130B3282

Table 5.9 Selection Table, Upgrade Kit without Built-in Capacitor Disconnect Circuitry

5.3.1.2 IP21/NEMA 1 Upgrade Kit with Built-in Capacitor Disconnect Circuitry

AHF current rating										AHF enclosure size	IP21/NEMA 1 Kit with capacitor disconnect circuitry for AHF IP20 enclosures	
380–415 V/50 Hz		380–415 V/60 Hz		440–480 V/60 Hz		600 V/60 Hz		500–690 V/50 Hz				
AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010	AHF 005	AHF 010		Description	Ordering number
[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]	[A]			
10 14	10 14	10 14	10 14	10 14	10 14	–	–	–	–	X1	IP21/NEMA 1 Kit for AHF X1 enclosure and contactor CI 9	130B5903
22 29	22 29	22 29	22 29	19 25	19 25	–	–	–	–	X2	IP21/NEMA1 Kit for AHF X2 enclosure and contactor CI 16	130B5904
34 40 55	34 40 55	34 40 55	34 40 55	31 36 48	31 36 48	15 20 24	15 20 24	15 20 24	15 20 24	X3	IP21/NEMA1 Kit for AHF X3 enclosure and contactor CI 30	130B5905
66 82	66 82	66 82	66 82	60 73	60 73	29 36	29 36	29 36	29 36	X4	IP21/NEMA1 Kit for AHF X4 enclosure and contactor CI 45	130B5906
96 133	96 133	96 133	96 133	95 118	95 118	50 58	50 58	50 58	50 58	X5	IP 21/NEMA1 Kit for AHF X5 enclosure and contactor CI 61	130B5907
171 204	171 204	171 204	171 204	154 183	154 183	77 87 109 128	77 87 109 128	77 87 109 128	77 87 109 128	X6	IP21/NEMA1 Kit for AHF X6 enclosure and contactor CI 98	130B5908
251 304	251 304 325 381	251	251 304 325 381	231	231 291 355 380	155 197	155 197 240	155 197	155 197 240	X7	IP21/NEMA1 Kit for AHF X7 enclosure and contactor CI 180	130B5909
325 381	–	304 325 381	–	291 355 380	–	240 296	296 366	240 296	296 366	X8	IP21/NEMA1 Kit for AHF X8 enclosure and contactor CI 180	130B6100
480	480	480	480	436	436	–	395	–	395	X8	IP21/NEMA1 Kit for AHF X8 enclosure and contactor CI 250	130B6101

Table 5.10 Selection Table, Upgrade Kit with Built-in Capacitor Disconnect Circuitry



1	The jumper connection wire is delivered looped at terminal X6 from the factory. Refer to *Table 5.11* for selecting the correct terminal for jumper connection.
2	Relay on the control card of the frequency converter.

Illustration 5.6 Control Voltage Setting

For more details on wiring of capacitor disconnect, refer to *chapter 4.2.1.1 Terminals for Capacitor Disconnect*.

AHF filter type	Terminals
Mains voltage AHF	Wire connctions to transformer
230 V	X6–X12
380–415 V	X6–X13
440–480 V	X6–X14
500 V	X6–X14
525–575 V	X6–X15
600 V	X6–X16
690 V	X6–X17

Table 5.11 Control Voltage Setting, IP21/NEMA1 Kit with Contactor

5.3.2 Backplate for IP20

To avoid false airflow when mounting the filter on rails, order a backplate. For more information, see *chapter 4.1.4 Ventilation and Cooling Requirements*.

Ordering number	Backplate
130B3283	X1
130B3284	X2
130B3285	X3
130B3286	X4
130B3287	X5 and X6
130B3288	X7 and X8

Table 5.12 Selection Table, Backplate

6 Programming

6.1 Parameter Descriptions

The parameters in this section are limited to those parameters that are required for operating the VLT® Advanced Harmonic Filter AHF 005/AHF 010. For reference to other parameters, refer to the frequency converter programming guide.

5-00 Digital I/O Mode		
Option:		Function:
		NOTICE **Perform a power cycle to activate the parameter once it has been changed.** Digital inputs and programmed digital outputs are pre-programmable for operation either in PNP or NPN systems.
[0] *	PNP	Action on positive directional pulses (↕). PNP systems are pulled down to GND.
[1]	NPN	Action on negative directional pulses (↕). NPN systems are pulled up to +24 V, internally in the frequency converter.

5-01 Terminal 27 Mode		
Option:		Function:
		NOTICE **This parameter cannot be adjusted while the motor is running.**
[0] *	Input	Defines terminal 27 as a digital input.
[1]	Output	Defines terminal 27 as a digital output.

5-02 Terminal 29 Mode		
Option:		Function:
		NOTICE **This parameter is available for FC 302 only.**
[0] *	Input	Defines terminal 29 as a digital input.
[1]	Output	Defines terminal 29 as a digital output.

6.1.1 5-1* Digital Inputs

The digital inputs are used for selecting various functions in the frequency converter. All digital inputs can be set to the functions listed in *Table 6.1*.

Functions in group 1 have higher priority than functions in group 2.

Group 1	Reset, coast stop, reset, and coast stop, quick stop, DC brake, Stop, and the [Off] key.
Group 2	Start, pulse start, reversing, start reversing, jog, and freeze output.

Table 6.1 Function Groups

Digital input function	Select	Terminal
No operation	[0]	All, terminal 32, 33
Reset	[1]	All
Coast inverse	[2]	All, terminal 27
Coast and reset inverse	[3]	All
Quick stop inverse	[4]	All
DC brake inverse	[5]	All
Stop inverse	[6]	All
Start	[8]	All, terminal 18
Latched start	[9]	All
Reversing	[10]	All, terminal 19
Start reversing	[11]	All
Enable start forward	[12]	All
Enable start reverse	[13]	All
Jog	[14]	All, terminal 29
Preset reference on	[15]	All
Preset ref bit 0	[16]	All
Preset ref bit 1	[17]	All
Preset ref bit 2	[18]	All
Freeze reference	[19]	All
Freeze output	[20]	All
Speed up	[21]	All
Speed down	[22]	All
Set-up select bit 0	[23]	All
Set-up select bit 1	[24]	All
Precise stop inverse	[26]	18, 19
Precise start, stop	[27]	18, 19
Catch up	[28]	All
Slow down	[29]	All
Counter input	[30]	29, 33
Pulse input edge triggered	[31]	29, 33
Pulse input time based	[32]	29, 33
Ramp bit 0	[34]	All
Ramp bit 1	[35]	All
Latched precise start	[40]	18, 19
Latched precise stop inverse	[41]	18, 19
External interlock	[51]	–
DigiPot increase	[55]	All
DigiPot decrease	[56]	All
DigiPot clear	[57]	All
DigiPot hoist	[58]	All
Counter A (up)	[60]	29, 33

6

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Digital input function	Select	Terminal
Counter A (down)	[61]	29, 33
Reset Counter A	[62]	All
Counter B (up)	[63]	29, 33
Counter B (down)	[64]	29, 33
Reset counter B	[65]	All
Mech. brake feedb.	[70]	All
Mech. brake feedb. inv.	[71]	All
PID error inv.	[72]	All
PID reset I-part	[73]	All
PID enable	[74]	All
MCO specific	[75]	–
PTC card 1	[80]	All
PROFIdrive OFF2	[91]	–
PROFIdrive OFF3	[92]	–
Light-load detection	[94]	All
Mains Loss	[96]	32, 33
Mains loss inverse	[97]	32, 33
Start edge triggered	[98]	–
Safety option reset	[100]	Resets the safety option. Available only when the safety option is mounted.
Start homing	[110]	All
Activate touch	[111]	All
Relative position	[112]	All
Enable reference	[113]	All
Sync. to position mode	[114]	All
Home sensor	[115]	18, 32, 33
Home sensor inverse	[116]	18, 32, 33
Touch sensor	[117]	18, 32, 33
Touch sensor inverse	[118]	18, 32, 33

Table 6.2 Digital Input Function

VLT® AutomationDrive FC 301/FC 302 standard terminals are 18, 19, 27, 29, 32, and 33. Terminal 29 functions as an output only in FC 302.

Functions dedicated to only 1 digital input are stated in the associated parameter.

All digital inputs can be programmed to these functions:

[0]	No operation	No reaction to signals transmitted to the terminal.
[1]	Reset	Resets frequency converter after a trip/alarm. Not all alarms can be reset.
[2]	Coast inverse	(Default digital input 27): Coast stop, inverted input (NC). The frequency converter leaves the motor in free mode. Logic 0⇒coast stop.
[3]	Coast and reset inverse	Reset and coast stop inverted input (NC). Leaves motor in free mode and resets frequency converter. Logic 0⇒coast stop and reset.
[4]	Quick stop inverse	Inverted input (NC). Generates a stop in accordance with quick stop ramp time set in *parameter 3-81 Quick Stop Ramp Time*. When the motor stops, the shaft is in free mode. Logic 0⇒quick stop.
[5]	DC brake inverse	Inverted input for DC brake (NC). Stops motor by energizing it with a DC current for a certain time period. See *parameter 2-01 DC Brake Current* to *parameter 2-03 DC Brake Cut In Speed [RPM]*. The function is only active when the value in *parameter 2-02 DC Braking Time* is different from 0. Logic 0⇒DC brake.
[6]	Stop inverse	Stop inverted function. Generates a stop function when the selected terminal goes from logical level 1 to logical level 0. The stop is performed according to the selected ramp time: • *Parameter 3-42 Ramp 1 Ramp Down Time*, • *Parameter 3-52 Ramp 2 Ramp Down Time*, • *Parameter 3-62 Ramp 3 Ramp down Time*, and • *Parameter 3-72 Ramp 4 Ramp Down Time*. **NOTICE** **When the frequency converter is at the torque limit and has received a stop command, it may not stop by itself. To ensure that the frequency converter stops, configure a digital output to *[27] Torque limit and stop*. Connect this digital output to a digital input that is configured as coast.**
[8]	Start	(Default digital input 18): Select start for a start/stop command. Logic 1 = start, logic 0 = stop.
[9]	Latched start	If a pulse is applied for minimum 2 ms, the motor starts. The motor stops when stop inverse is activated, or a reset command (via DI) is given.
[10]	Reversing	(Default digital input 19). Change the direction of motor shaft rotation. Select logic 1 to reverse. The reversing signal only changes the direction of rotation. It does not activate the start function. Select both directions in *parameter 4-10 Motor Speed Direction*. The function is not active in process closed loop.
[11]	Start reversing	Used for start/stop and for reversing on the same wire. Signals on start are not allowed at the same time.
[12]	Enable start forward	Disengages the counterclockwise movement and allows clockwise direction.

[13]	Enable start reverse	Disengages the clockwise movement and allows counterclockwise direction.
[14]	Jog	(Default digital input 29): Activate jog speed. See *parameter 3-11 Jog Speed [Hz]*.
[15]	Preset reference on	Shifts between external reference and preset reference. It is assumed that *[1] External/preset* has been selected in *parameter 3-04 Reference Function*. Logic 0 = external reference active; logic 1 = 1 of the 8 preset references is active.
[16]	Preset ref bit 0	Preset reference bit 0, 1, and 2 enable a choice between 1 of the 8 preset references according to *Table 6.3*.
[17]	Preset ref bit 1	Same as *[16] Preset ref bit 0*.
[18]	Preset ref bit 2	Same as *[16] Preset ref bit 0*.

Preset ref. bit	2	1	0
Preset ref. 0	0	0	0
Preset ref. 1	0	0	1
Preset ref. 2	0	1	0
Preset ref. 3	0	1	1
Preset ref. 4	1	0	0
Preset ref. 5	1	0	1
Preset ref. 6	1	1	0
Preset ref. 7	1	1	1

Table 6.3 Preset Reference Bit

[19]	Freeze ref	Freezes the actual reference, which is now the point of enable/condition to be used for *[21] Speed up* and *[22] Speed down*. If speed up/speed down is used, the speed change always follows ramp 2 (*parameter 3-51 Ramp 2 Ramp Up Time* and *parameter 3-52 Ramp 2 Ramp Down Time*) in the range 0–*parameter 3-03 Maximum Reference*.
[20]	Freeze output	Freezes the actual motor frequency (Hz), which is now the point of enable/condition to be used for *[21] Speed up* and *[22] Speed down*. If speed up/speed down is used, the speed change always follows ramp 2 (*parameter 3-51 Ramp 2 Ramp Up Time* and *parameter 3-52 Ramp 2 Ramp Down Time*) in the range 0–*parameter 1-23 Motor Frequency*. **NOTICE** **When freeze output is active, the frequency converter cannot be stopped via a low *[8] Start* signal. Stop the frequency converter via a terminal programmed for *[2] Coasting inverse* or *[3] Coast and reset inverse*.**
[21]	Speed up	Select *[21] Speed up* and *[22] Speed down* for digital control of the up/down speed (motor potentiometer). Activate this function by selecting either *[19] Freeze ref* or *[20] Freeze output*. When speed up/speed down is activated for less than 400 ms, the resulting reference is increased/decreased by 0.1%. If speed up/speed down is activated for more than 400 ms, the resulting reference follows the setting in ramping up/down parameters 3-x1/3-x2.

	Shut down	Catch up
Unchanged speed	0	0
Reduced by %-value	1	0
Increased by %-value	0	1
Reduced by %-value	1	1

Table 6.4 Shut Down/Catch Up

[22]	Speed down	Same as *[21] Speed up*.
[23]	Set-up select bit 0	Select *[23] Set-up select bit 0* or select *[24] Set-up select bit 1* to select 1 of the 4 set-ups. Set *parameter 0-10 Active Set-up* to Multi Set-up.
[24]	Set-up select bit 1	(Default digital input 32): Same as *[23] Set-up select bit 0*.
[26]	Precise stop inv.	Sends an inverted stop signal when the precise stop function is activated in *parameter 1-83 Precise Stop Function*. Precise stop inverse function is available for terminals 18 or 19.
[27]	Precise start, stop	Use when *[0] Precise ramp stop* is selected in *parameter 1-83 Precise Stop Function*. Precise start, stop is available for terminals 18 and 19. Precise start ensures that the rotor turning angle from standing still to reference is the same for each start (for same ramp time, same setpoint). This function is the equivalent to the precise stop where the rotor turning angle from reference to standstill is the same for each stop. When using *parameter 1-83 Precise Stop Function* option *[1] Cnt stop with reset* or *[2] Cnt stop w/o reset*: The frequency converter needs a precise stop-signal before reaching the value of *parameter 1-84 Precise Stop Counter Value*. If this signal is not supplied, the frequency converter does not stop when the value in *parameter 1-84 Precise Stop Counter Value* is reached. Trigger precise start, stop by a digital input. The function is available for terminals 18 and 19.
[28]	Catch up	Increases reference value by percentage (relative) set in *parameter 3-12 Catch up/slow Down Value*.
[29]	Slow down	Reduces reference value by percentage (relative) set in *parameter 3-12 Catch up/slow Down Value*.
[30]	Counter input	Precise stop function in *parameter 1-83 Precise Stop Function* acts as counter stop or speed compensated counter stop with or without reset. The counter value must be set in *parameter 1-84 Precise Stop Counter Value*.

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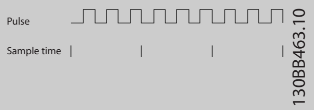
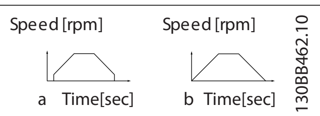
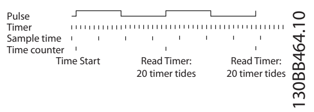
[31]	Pulse edge triggered	Counts the number of pulse flanks per sample time. This gives a higher resolution at high frequencies, but is not as precise at lower frequencies. Use this pulse principle for encoders with low resolution (for example 30 PPR).  **Illustration 6.1 Pulse Flanks per Sample Time**
[32]	Pulse time-based	Measures the duration between pulse flanks. This gives a higher resolution at lower frequencies, but is not as precise at higher frequencies. This principle has a cutoff frequency, which makes it unsuited for encoders with low resolutions (for example 30 PPR) at low speeds.  a: Low encoder resolution; b: Standard encoder resolution  **Illustration 6.2 Duration Between Pulse Flanks**
[34]	Ramp bit 0	Enables a selection between 1 of the 4 ramps available, according to *Table 6.5*.
[35]	Ramp bit 1	Same as *[34] Ramp bit 0*.

Preset ramp bit	1	0
Ramp 1	0	0
Ramp 2	0	1
Ramp 3	1	0
Ramp 4	1	1

Table 6.5 Preset Ramp Bit

[40]	Latched Precise Start	A latched precise start only requires a pulse of 3 ms on terminals 18 or 19. When using for *parameter 1-83 Precise Stop Function [1] Cnt stop with reset* or *[2] Cnt stop w/o reset*: When the reference is reached, the frequency converter internally enables the precise stop signal. This means that the frequency converter does the precise stop when the counter value of *parameter 1-84 Precise Stop Counter Value* is reached.
[41]	Latched Precise Stop inverse	Sends a latched stop signal when the precise stop function is activated in *parameter 1-83 Precise Stop Function*. The latched precise stop inverse function is available for terminals 18 or 19.
[51]	External interlock	This function makes it possible to give an external fault to the frequency converter. This fault is treated in the same way as an internally generated alarm.
[55]	DigiPot Increase	Increase signal to the digital potentiometer function described in *parameter group 3-9* Digital Pot. Meter*.
[56]	DigiPot Decrease	Decrease signal to the digital potentiometer function described in *parameter group 3-9* Digital Pot. Meter*.
[57]	DigiPot Clear	Clears the digital potentiometer reference described in *parameter group 3-9* Digital Pot. Meter*.
[60]	Counter A	(Terminal 29 or 33 only). Input for increment counting in the SLC counter.
[61]	Counter A	(Terminal 29 or 33 only). Input for decrement counting in the SLC counter.
[62]	Reset Counter A	Input for reset of counter A.
[63]	Counter B	(Terminal 29 or 33 only). Input for increment counting in the SLC counter.
[64]	Counter B	(Terminal 29 or 33 only). Input for decrement counting in the SLC counter.
[65]	Reset Counter B	Input for reset of counter B.
[70]	Mech. Brake Feedback	Brake feedback for hoisting applications: Set *parameter 1-01 Motor Control Principle* to *[3] Flux w/ motor feedback*; set *parameter 1-72 Start Function* to *[6] Hoist mech brake Ref.*
[71]	Mech. Brake Feedback inv.	Inverted brake feedback for hoisting applications.
[72]	PID error inverse	When enabled, this option inverts the resulting error from the process PID controller. Available only if *parameter 1-00 Configuration Mode* is set to *[6] Surface Winder*, *[7] Extended PID Speed OL*, or *[8] Extended PID Speed CL*.
[73]	PID reset I-part	When enabled, this option resets the I-part of the process PID controller. Equivalent to *parameter 7-40 Process PID I-part Reset*. Available only if *parameter 1-00 Configuration Mode* is set to *[6] Surface Winder*, *[7] Extended PID Speed OL*, or *[8] Extended PID Speed CL*.
[74]	PID enable	Enables the extended process PID controller. Equivalent to *parameter 7-50 Process PID Extended PID*. Available only if *parameter 1-00 Configuration Mode* is set *[7]*

		Extended PID Speed OL or *[8] Extended PID Speed CL*.
[80]	PTC Card 1	All digital inputs can be set to *[80] PTC Card 1*. However, only 1 digital input must be set to this option.
[91]	PROFIdrive OFF2	The functionality is the same as the corresponding control word bit of the PROFIBUS/PROFINET option.
[92]	PROFIdrive OFF3	The functionality is the same as the corresponding control word bit of the PROFIBUS/PROFINET option.
[94]	Light Load Detection	Evacuation mode for lifts or elevators. The function magnetizes the motor before opening the mechanical brake. The motion starts in the direction (up or down) defined by VLT® Lift Controller MCO 361 using the speed of *parameter 30-27 Light Load Speed [%]*. This motion continues for the time specified in *parameter 30-25 Light Load Delay [s]* while measuring the current. If the motor current exceeds the reference current in *parameter 30-26 Light Load Current [%]*, the lift is obstructed. The direction is reversed after the delay time specified in *parameter 30-25 Light Load Delay [s]*. For the feature to run, a start or start reverse command is needed, together with selecting this digital input. **NOTICE** **Flying start overrules light-load detection.**
[96]	Mains Loss	Select to improve kinetic back-up. When the mains voltage goes back to a level that is close to (but still lower than) the detection level, the output speed increases and kinetic back-up remains active. To avoid this situation, send a status signal to the frequency converter. When the signal on the digital input is low (0), the frequency converter forcibly turns off the kinetic back-up. **NOTICE** **Only available for pulse inputs at terminals 32/33.**
[97]	Mains Loss Inverse	When the signal on the digital input is high (1), the frequency converter forcibly turns off the kinetic back-up. For more details, see the description of *[96] Mains loss*. **NOTICE** **Only available for pulse inputs at terminals 32/33.**
[98]	Start edge triggered	Edge-triggered start command. Keeps the start command alive. It can be used for a start push key.
[100]	Safe Option Reset	Resets the safety option. Available only when the safety option is mounted.
[110]	Start Homing	Starts the homing function selected in *parameter 17-80 Homing Function*. Must remain high until homing is done, otherwise homing is aborted.
[111]	Activate Touch	Activates the monitoring of the touch sensor input.
[112]	Relative Position	This option selects between absolute and relative positioning. The option is valid for the next positioning command.
[113]	Enable Reference	Positioning mode: The frequency converter activates the selected positioning type and target and starts the motion towards the new target. The motion starts either immediately or when active positioning is completed, depending on settings in *parameter 17-90 Absolute Position Mode* and *parameter 17-91 Relative Position Mode*. Synchronization mode: High signal locks the actual follower position to the actual master position. The follower starts and catches up with the master. Low signal stops the synchronization and the follower makes a controlled stop.
[115]	Home Sensor	Normally open contact for defining the home position. The function is defined in *parameter 17-80 Homing Function*. Available only at digital inputs 18, 32, and 33.
[116]	Home Sensor Inv.	Normally closed contact for defining the home position. The function is defined in *parameter 17-80 Homing Function*. Available only at digital inputs 18, 32, and 33.
[117]	Touch Sensor	Normally open contact. Serves as a reference for touch probe positioning. Available only at digital inputs 18, 32, and 33.
[118]	Touch Sensor	Normally closed contact. Serves as a reference for touch probe positioning. Available only at digital inputs 18, 32, and 33.
[119]	Sync. to Pos. Mode	Select positioning in synchronization mode.

5-12 Terminal 27 Digital Input

Option:		Function:
[2] *	Coast inverse	Functions are described in *parameter group 5-1* Digital Inputs*.

5-13 Terminal 29 Digital Input

Option:		Function:
		NOTICE **This parameter is available for FC 302 only.**
		Select the function from the available digital input range and the additional options *[60] Counter A*, *[61] Counter A*, *[63] Counter B*, and *[64] Counter B*. Counters are used in smart logic control functions.

5–13 Terminal 29 Digital Input		
Option:		**Function:**
[14] *	Jog	Functions are described in *parameter group 5-1* Digital Inputs*.

6.1.2 5-3* Digital Outputs

The 2 solid-state digital outputs are common for terminals 27 and 29. Set the I/O function for terminal 27 in *parameter 5-01 Terminal 27 Mode* and set the I/O function for terminal 29 in *parameter 5-02 Terminal 29 Mode*.

NOTICE

These parameters cannot be adjusted while the motor is running.

5-30 Terminal 27 Digital Output

This manual only shows the option relevant for the VLT® Advanced Harmonic Filter AHF 005/AHF 010. Refer to the frequency converter programming guide for the complete list of options in this parameter.

Option:		Function:
[188]	AHF Capacitor Connect	***NOTICE*** **This function is not suitable when multiple frequency converters are connected to a single filter.** The capacitors are turned on at 20% (hysteresis of 50% gives an interval of 10–30%). The capacitors are disconnected below 10%. The off delay is 10 s and restarts if the nominal power goes above 10% during the delay. *Parameter 5-80 AHF Cap Reconnect Delay* is used to guarantee a minimum off-time for the capacitors.

5-40 Function Relay

This manual only shows the option relevant for the VLT® Advanced Harmonic Filter AHF 005/AHF 010. Refer to the frequency converter programming guide for the complete list of options in this parameter.

Option:		Function:
[188]	AHF Capacitor Connect	***NOTICE*** **This function is not suitable when multiple frequency converters are connected to a single filter.** The capacitors are turned on at 20% (hysteresis of 50% gives an interval of 10–30%). The capacitors are disconnected below 10%. The off delay is 10 s and restarts if the nominal power goes above 10% during the delay. *Parameter 5-80 AHF Cap Reconnect Delay* is used to guarantee a minimum off-time for the capacitors.

5-40 Function Relay

This manual only shows the option relevant for the VLT® Advanced Harmonic Filter AHF 005/AHF 010. Refer to the frequency converter programming guide for the complete list of options in this parameter.

5-80 AHF Cap Reconnect Delay		
Range:		**Function:**
25 s*	[1 - 120 s]	Guarantees a minimum off-time for the capacitors. The timer starts once the AHF capacitor disconnects and has to expire before the output is allowed to be on again. It only turns on again if the frequency converter power is 20–30%.

6.1.3 DC-link Compensation Disabling

NOTICE

To prevent resonances in the DC link, disable the dynamic DC-link compensation by setting *parameter 14-51 DC-Link Compensation* to *[0] Off*.

The FC series includes a feature which ensures that the output voltage is independent of any voltage fluctuation in the DC link, for example caused by fast fluctuation in the mains supply voltage. Sometimes, this dynamic compensation can produce resonances in the DC link and should then be disabled. Typical cases are where VLT® Advanced Harmonic Filter AHF 005/AHF 010 is used on supply grids with high short circuit ratio. Fluctuations can often be recognized by increased acoustic noise and, in extreme cases, by unintended tripping.

14-51 DC-Link Compensation		
Option:		**Function:**
		The rectified AC-DC voltage in the frequency converter's DC link is associated with voltage ripples. These ripples can increase in magnitude with increased load. These ripples are undesirable because they can generate current and torque ripples. A compensation method is used to reduce these voltage ripples in the DC link. In general, DC-link compensation is recommended for most applications, but pay attention when operating in field weakening as it can generate speed oscillations at the motor shaft. In field weakening, turn off DC-link compensation.
[0]	Off	Disables DC-link compensation.
[1]	On	Enables DC-link compensation.

7 Specifications

7.1 General Specifications

7.1.1 General Technical Data

Supply voltage	380 V/60 Hz
	400 V/50 Hz
	460 V/60 Hz
	600 V/60 Hz
	690 V/50 Hz
Nominal supply voltages	380–415 V/60 Hz
	380–415 V/50 Hz
	440–480 V/60 Hz
	600 V/60 Hz
	500–690 V/50 Hz
Supply voltage tolerance	±10%
Tolerances of the actual supply voltage	342–456 V/60 Hz
	342–456 V/50 Hz
	396–528 V/60 Hz
	540–660 V/60 Hz
	450–759 V/50 Hz
Supply frequency tolerance	+5% to -1.5%
Overload capability	160% for 60 s every 10 minutes
Efficiency	>0.98
THDi[1)]	AHF 005 <5%
	AHF 010 <10%
Cos φ of I_L	0.5 cap at 25% $I_{AHF,N}$
	0.8 cap at 50% $I_{AHF,N}$
	0.85 cap at 75% $I_{AHF,N}$
	0.99 cap at 100% $I_{AHF,N}$
	1.00 at 160% $I_{AHF,N}$
Power derating - temperature	5–45 °C (41–113 °F) without derating. 45–60 °C (113–140 °F) with derating 1.5% per °C. See *Illustration 7.1*.
Power derating - altitude above sea level	1000 m (3280 ft) without derating. 1000–4000 m (3280–13123 ft) with derating 5% per 1000 m (3280 ft).

Table 7.1 General Technical Data

1) THDi level is system level performance from the filter combined with the actual frequency converter.

NOTICE

The reduction of the low harmonic current emission to the rated THDi implies that the THDv of the non-influenced mains voltage is lower than 2%, and the ratio of short circuit power to installed load (R_{SCE}) is above 66. Under these conditions, the THDi of the mains current of the frequency converter is reduced to 10% or 5% (typical values at nominal load). If these conditions are not or only partially fulfilled, a significant reduction of the harmonic components can still be achieved, but the rated THDi values may not be observed.

7.1.2 Terminal Specifications

Table 7.2 to *Table 7.6* show the terminal types, cable cross-section, tightening torque, and more.

AHF version		AHF enclosure size	AHF terminal connections										
380–415 V 50 Hz			Terminals X1 and X2			Terminals X3 and X4			Terminals A and B			PE	
AHF 005 [A]	AHF 010 [A]	Type	Cable cross-sections [mm^2 (AWG/MCM)]	Termination	Torque [Nm (in-lb)]	Cable cross-sections [mm^2 (AWG/MCM)]	Termination	Torque [Nm (in-lb)]	Cable cross-sections [mm^2 (AWG/MCM)]	Termination	Torque [Nm (in-lb)]	Type	Torque [Nm (in-lb)]
10 14	10 14	X1	0.5–10 (20–8)	Cable end sleeve	1.6 (14.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
22 29	22 29	X2	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
34 40 55	34 40 55	X3	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
66 82	66 82	X4	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
96 133	96 133	X5	10–70 (8–2/0)	Cable end sleeve	5 (44.3) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
171 204	171 204	X6	2.5–95 (14–3/0)	Cable lug M8	10 (88.5) ±10%	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
251 304	251 304 325 381	X7	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%
325 381 480	480	X8	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%

Table 7.2 Terminal Specifications, 380–415 V, 50 Hz

AHF version		AHF enclosure size	AHF terminal connections										
380–415 V 60 Hz			Terminals X1 and X2			Terminals X3 and X4			Terminals A and B			PE	
AHF 005	AHF 010		Cable cross-sections [mm^2 (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm^2 (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm^2 (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Type	Torque [Nm (in-lb)]
[A]	[A]	Type											
10 14	10 14	X1	0.5–10 (20–8)	Cable end sleeve	1.6 (14.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
22 29	22 29	X2	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
34 40 55	34 40 55	X3	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
66 82	66 82	X4	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
96 133	96 133	X5	10–70 (8–2/0)	Cable end sleeve	5 (44.3) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
171 204	171 204	X6	2.5–95 (14–3/0)	Cable lug M8	10 (88.5) ±10%	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
251	251 304 325 381	X7	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%
304 325 381 480	480	X8	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%

Table 7.3 Terminal Specifications, 380–415 V, 60 Hz

AHF version		AHF enclosure size	AHF terminal connections										
440–480 V 60 Hz			Terminals X1 and X2			Terminals X3 and X4			Terminals A and B			PE	
AHF 005	AHF 010		Cable cross-sections [mm²] (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²] (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²] (AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Type	Torque [Nm (in-lb)]
[A]	[A]	Type											
10 14	10 14	X1	0.5–10 (20–8)	Cable end sleeve	1.6 (14.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
19 25	19 25	X2	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1)±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M6	4.5 (40) ±10%
31 36 48	31 36 48	X3	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
60 73	60 73	X4	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
95 118	95 118	X5	10–70 (8–2/0)	Cable end sleeve	5 (44.3) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
154 183	154 183	X6	2.5–95 (14–3/0)	Cable lug M8	10 (88.5) ±10%	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
231	231 291 355 380	X7	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%
291 355 380 436	436	X8	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%

Table 7.4 Terminal Specifications, 480–480 V, 60 Hz

AHF version		AHF enclosure size	AHF terminal connections										
600 V/60 Hz			Terminals X1 and X2			Terminals X3 and X4			Terminasl A and B			PE	
AHF 005	AHF 010		Cable cross-sections [mm²(AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²(AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²(AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Type	Torque [Nm (in-lb)]
[A]	[A]	Type											
15 20 24	15 20 24	X3	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
29 36	29 36	X4	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
50 58	50 58	X5	10–70 (8–2/0)	Cable end sleeve	5 (44.3) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
77 87 109 128	77 87 109 128	X6	2.5–95 (14–3/0)	Cable lug M8	10 (88.5) ±10%	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
155 197	155 197 240	X7	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%
240 296	296 366 395	X8	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%

Table 7.5 Terminal Specifications, 600 V, 60 Hz

AHF version		AHF enclosure size	AHF terminal connections										
500–690 V 50 Hz			Terminals X1 and X2			Terminals X3 and X4			Terminals A and B			PE	
AHF 005	AHF 010		Cable cross-sections [mm²(AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²(AWG(M CM)]	Termina-tion	Torque [Nm (in-lb)]	Cable cross-sections [mm²(AWG/ MCM)]	Termina-tion	Torque [Nm (in-lb)]	Type	Torque [Nm (in-lb)]
[A]	[A]	Type											
15 20 24	15 20 24	X3	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	1.5–16 (16–6)	Cable end sleeve	2.4 (21.2) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
29 36	29 36	X4	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
50 58	50 58	X5	10–70 (8–2/0)	Cable end sleeve	5 (44.3) ±10%	1.5–25 (16–4)	Cable end sleeve	3.5 (31) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
77 87 109 128	77 87 109 128	X6	2.5–95 (14–3/0)	Cable lug M8	10 (88.5) ±10%	1.5–50 (16–1-1/0)	Cable end sleeve	4 (35.4) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M8	10 (88.5) ±10%
155 197	155 197 240	X7	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%
240 296	296 366 395	X8	25–300 (4–600)	Cable lug M16	50 (442.5) ±10%	16–150 (6–300)	Cable end sleeve	18 (159.3) ±10%	0.5–4 (20–12)	Cable end sleeve	0.8 (7.1) ±10%	M12	40 (354) ±10%

Table 7.6 Terminal Specifications, 500–690 V, 50 Hz

7.1.3 Environmental Data

Ambient temperature during operation	5–45 °C (41–113 °F) without derating 5–60 °C (41–140 °F) with derating 1.5% per °C. See *Illustration 7.1*
Temperature during storage and transportation	Transport: -25 °C to +65 °C (-13 °F to +149 °F)
	Storage: -25 °C to +55 °C (-13 °F to 131 °F)
Maximum altitude above sea level	1000 m (3280 ft) without derating
	1000–4000 m (3280–13123 ft) with derating 5% per 1000 m (3280 ft)
Relative humidity	Humidity class F without condensation 5–85% - Class 3K3 (non-condensing) during operation
Insulation strength	Overvoltage category lll according to EN 61800-5-1
Resonance strength	Base standard: DIN EN 600068-2-6
	Test specification: 5 Hz, 150 Hz, 3 directions (0.5 g, 0.1 g, 0.5 g)
Sine vibration test	Base standard: DIN EN 600068-2-6
	Test specification: 5–13.2 Hz, 150 Hz (2 mm (0.08 in) peak to peak 0.7 g)
Packaging	DIN 55468 for transport packaging materials
Enclosure protection rating	IP00 and IP20
	Optional IP21/NEMA1 upgrade kits for IP20 versions
Approvals	CE
	The Low Voltage Directive
	UL1)

Table 7.7 Environmental Data

1) UL only for 460 V/60 Hz and 600 V/60 Hz versions.

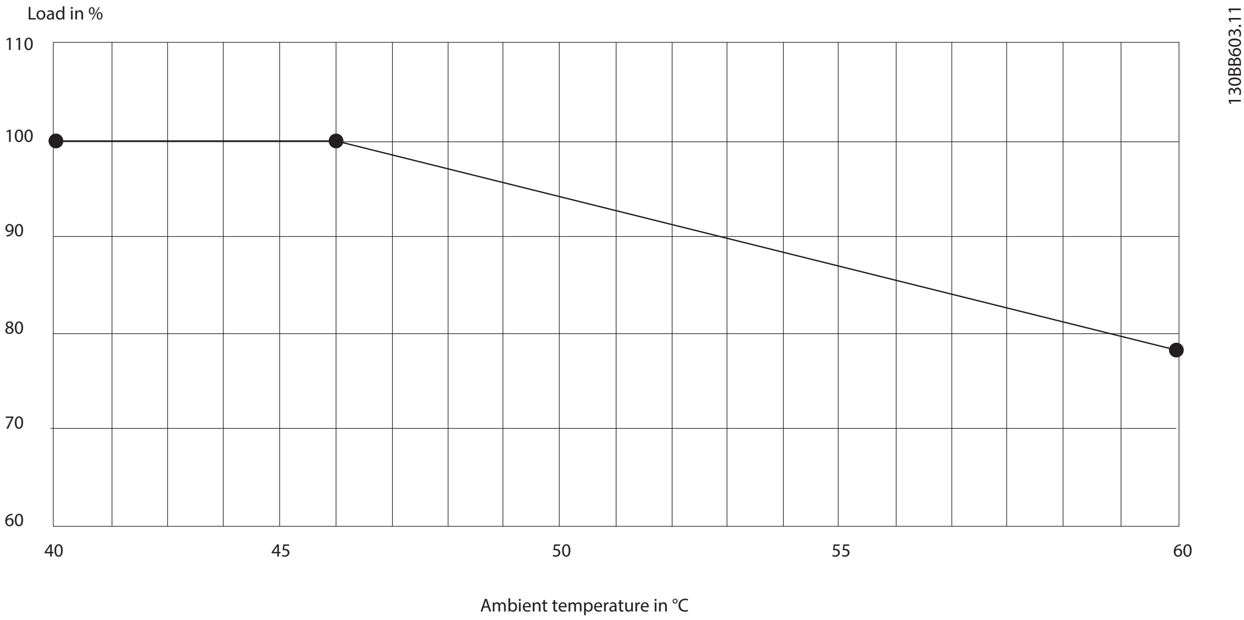


Illustration 7.1 Temperature Derating Curve

7.2 Mechanical Dimensions

7.2.1 Terminal Designations, IP20 and IP21

The terminals differ depending on the filter size. *Illustration 7.2* to *Illustration 7.3* show close-up views of the terminal designations for IP20/IP21 X1–X4, IP20/IP21 X5–X6, and IP20/IP21 X7–X8.

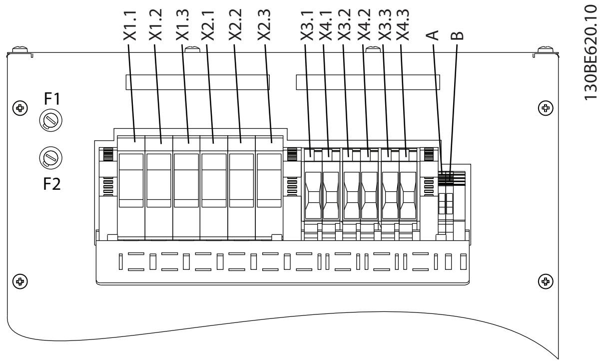


Illustration 7.2 Terminal Designations IP20/IP21 X1–X4

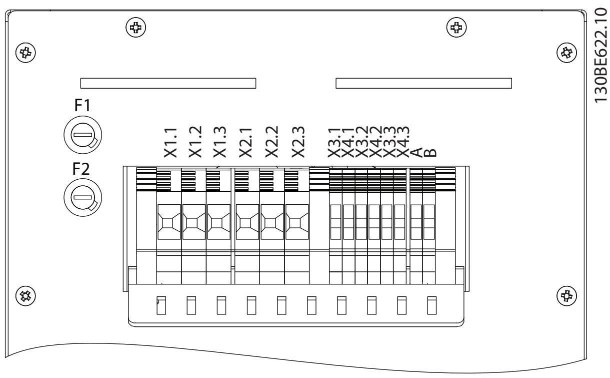


Illustration 7.3 Terminal Designations IP20/IP21 X5–X6

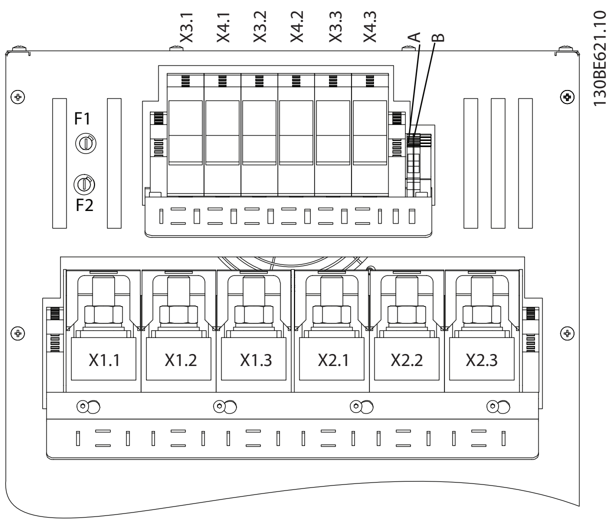


Illustration 7.4 Terminal Designations IP20/IP21 X7–X8

7.2.2 IP20 Enclosures

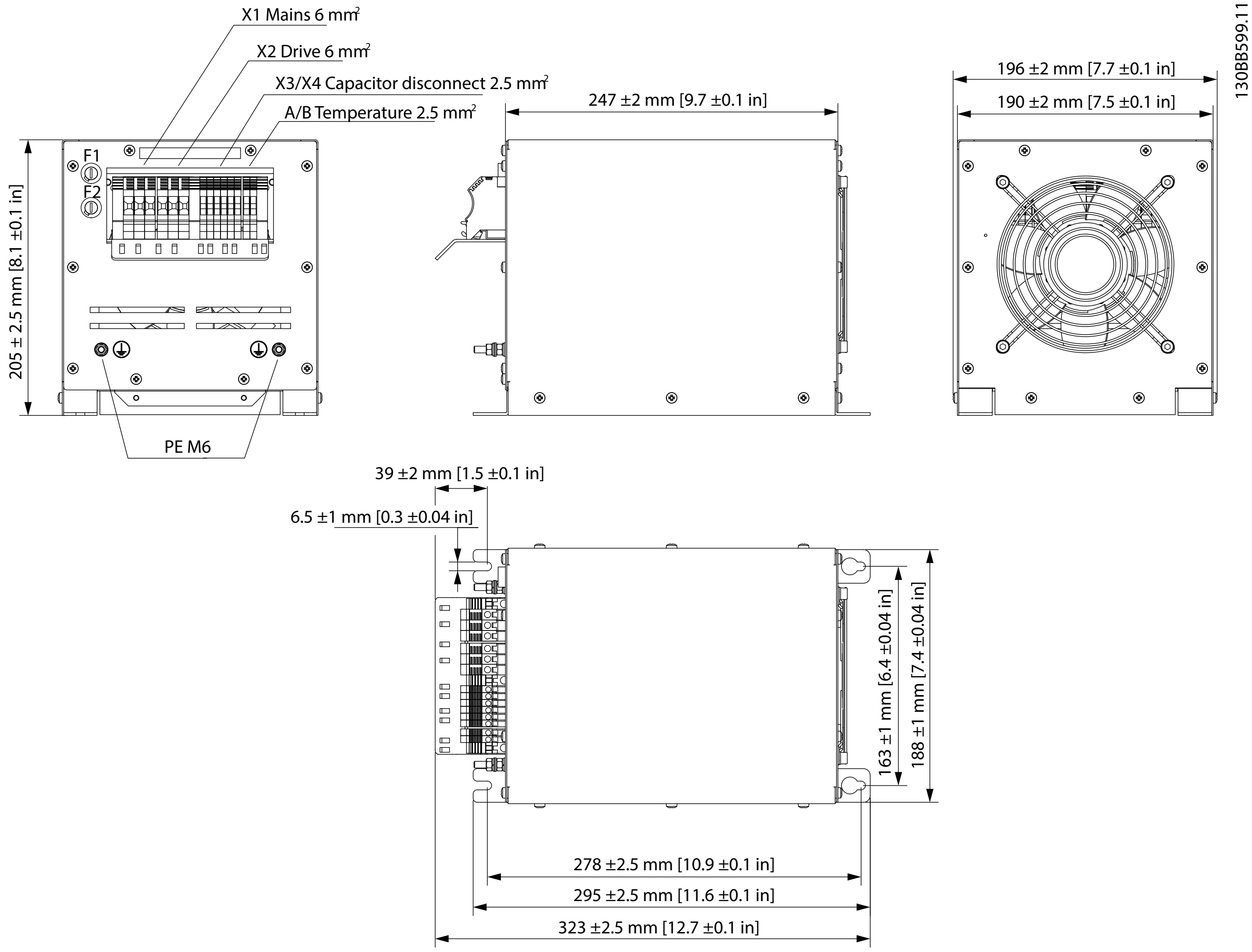


Illustration 7.5 IP20 X1 Internal Fan 1

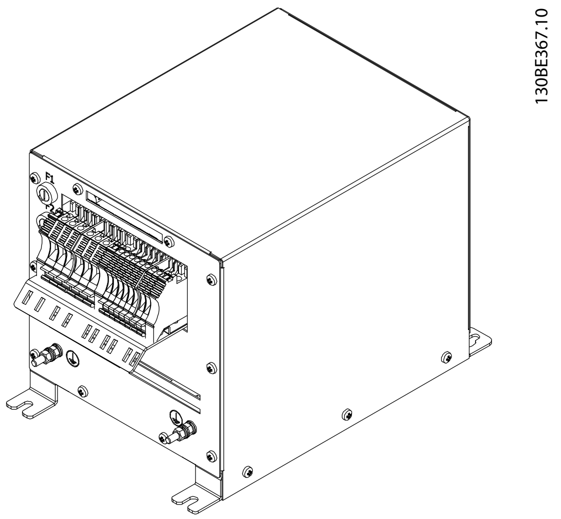


Illustration 7.6 IP20 X1 Internal Fan 1, 3D View

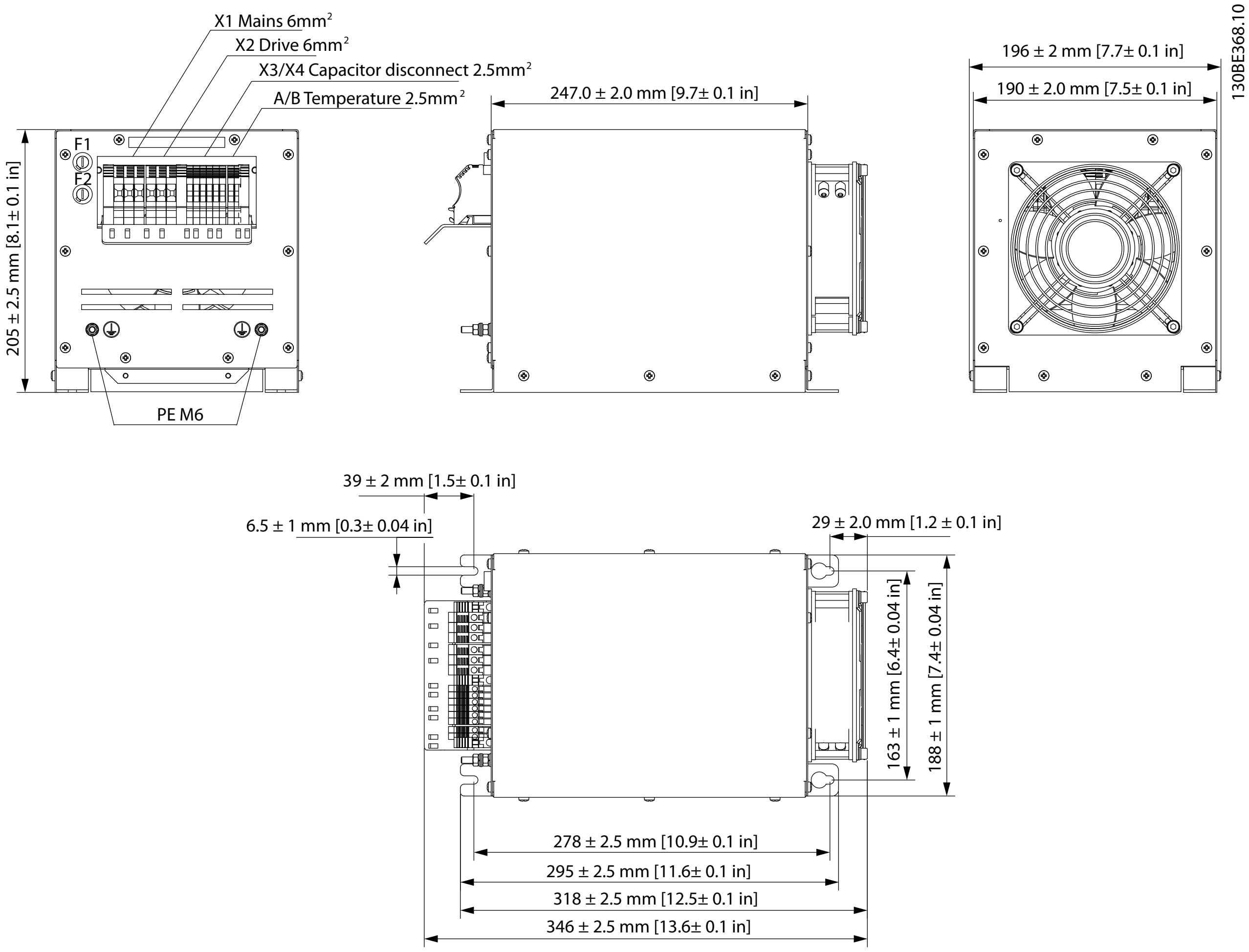


Illustration 7.7 IP20 X1 External Fan 1

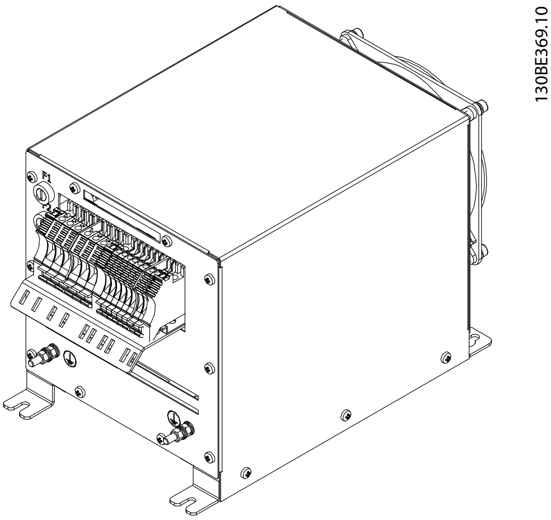


Illustration 7.8 IP20 X1 External Fan 1, 3D View

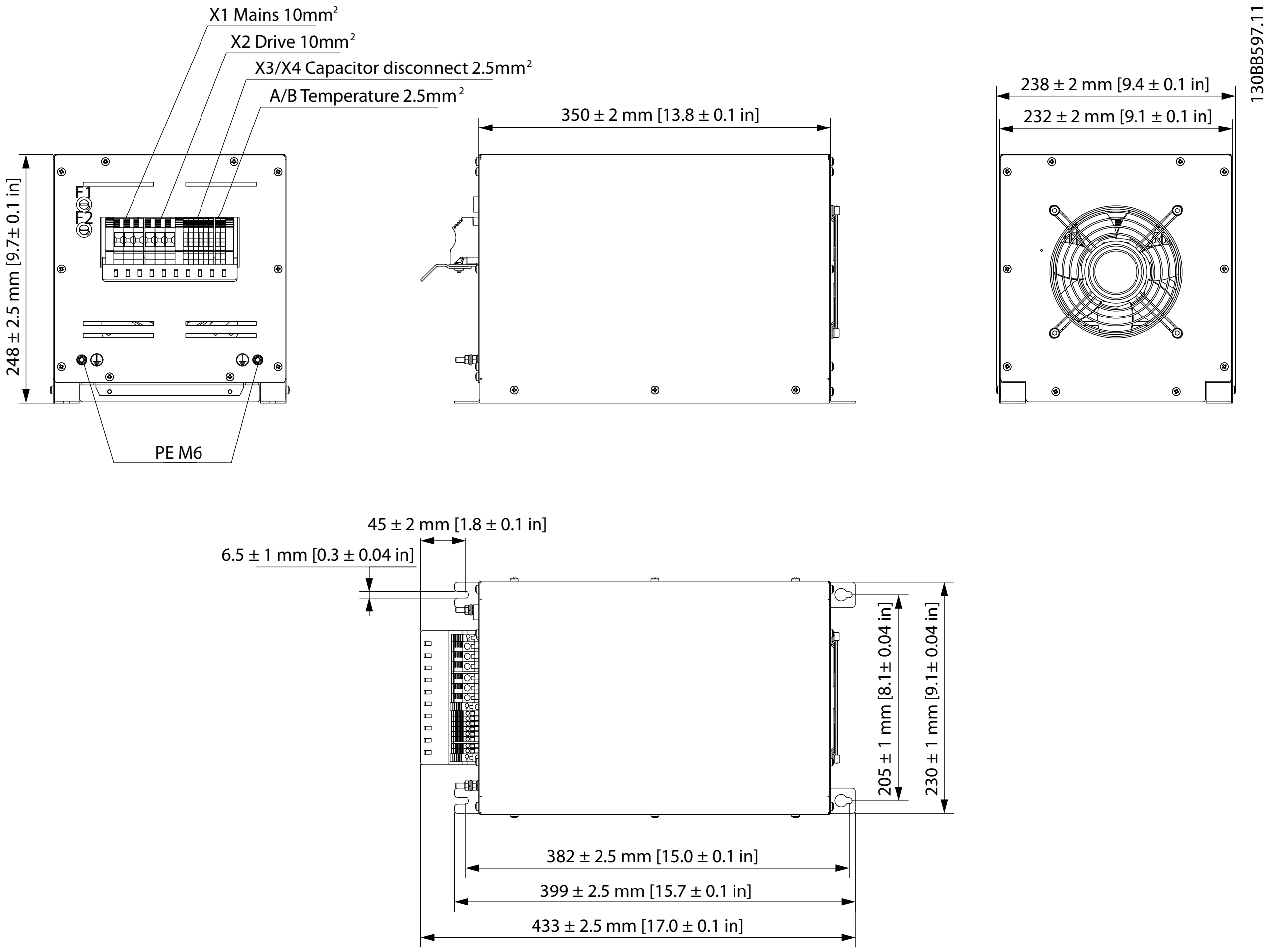


Illustration 7.9 IP20 X2 Internal Fan 1

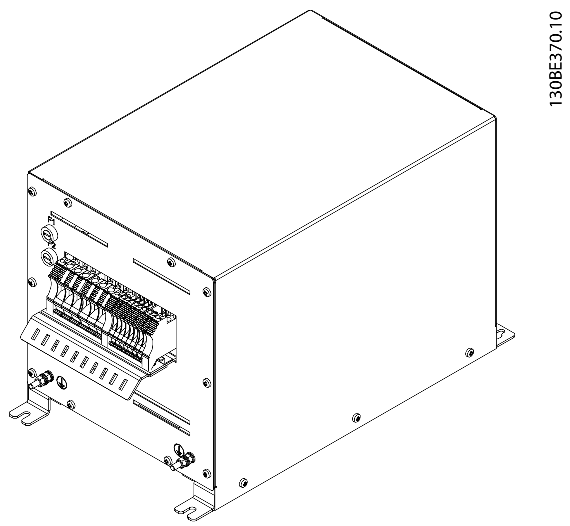


Illustration 7.10 IP20 X2 Internal Fan 1, 3D View

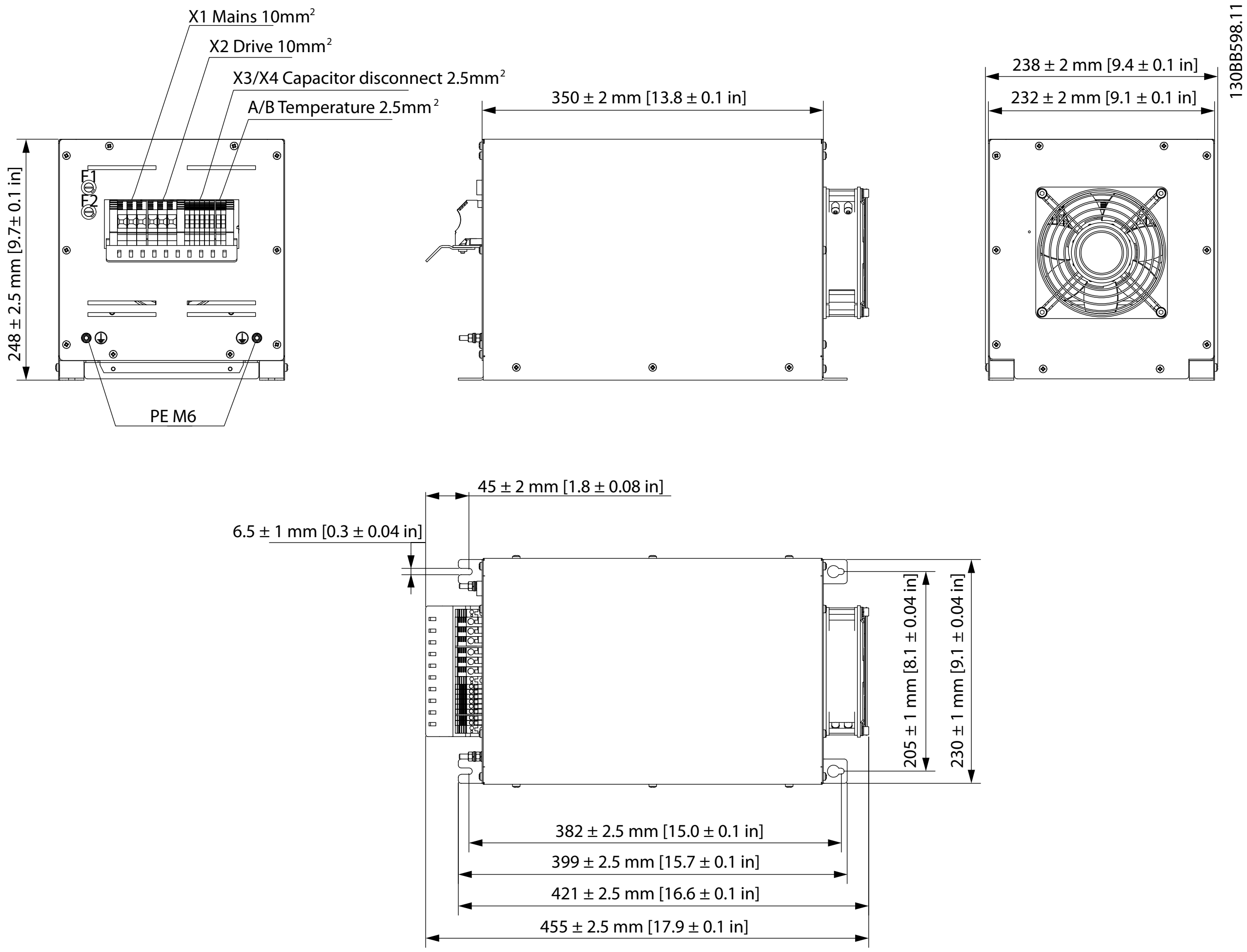


Illustration 7.11 IP20 X2 External Fan 1

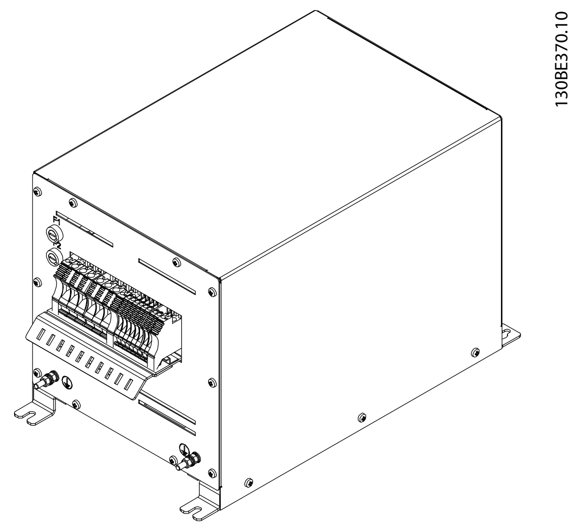


Illustration 7.12 IP20 X2 External Fan 1, 3D View

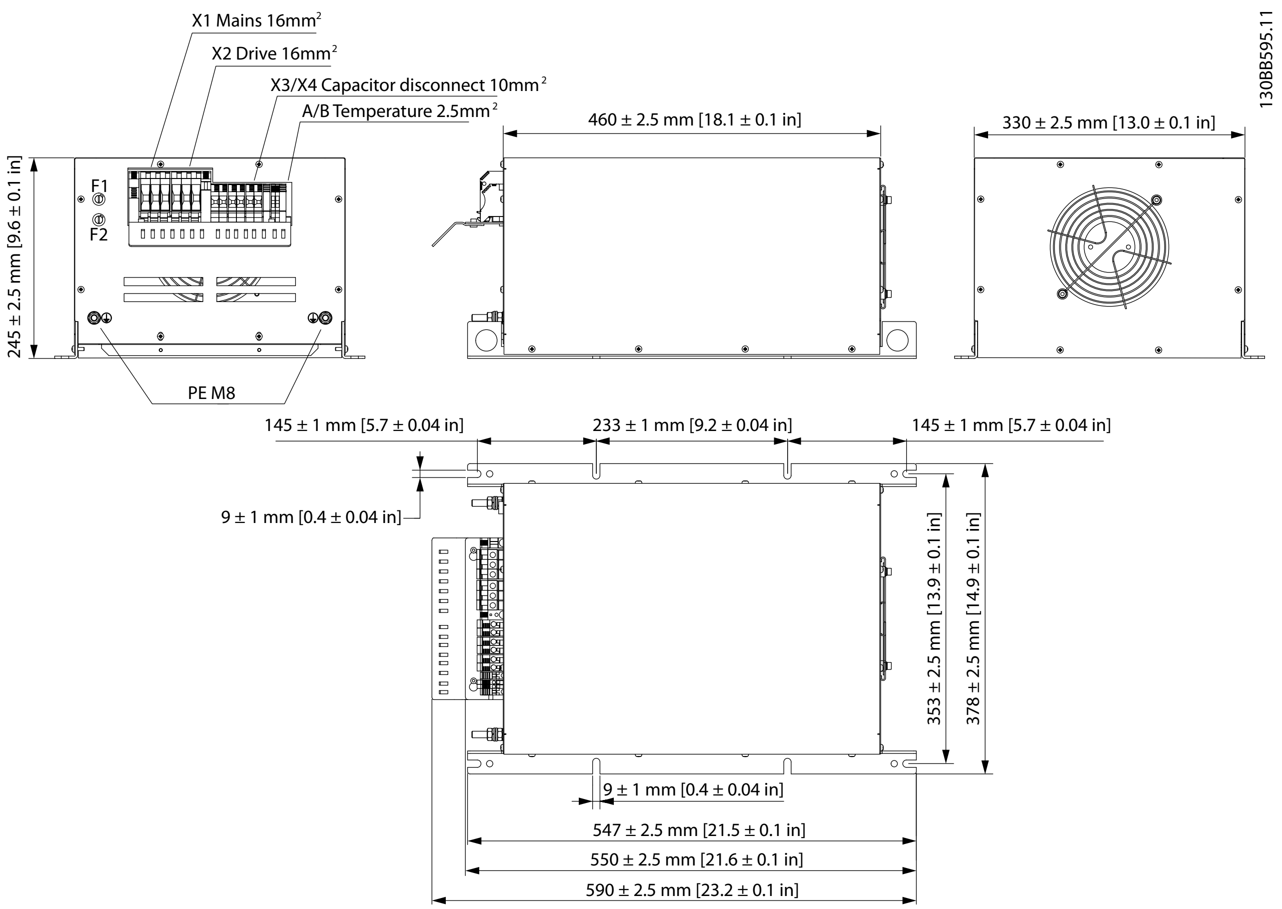


Illustration 7.13 IP20 X3 Internal Fan 1

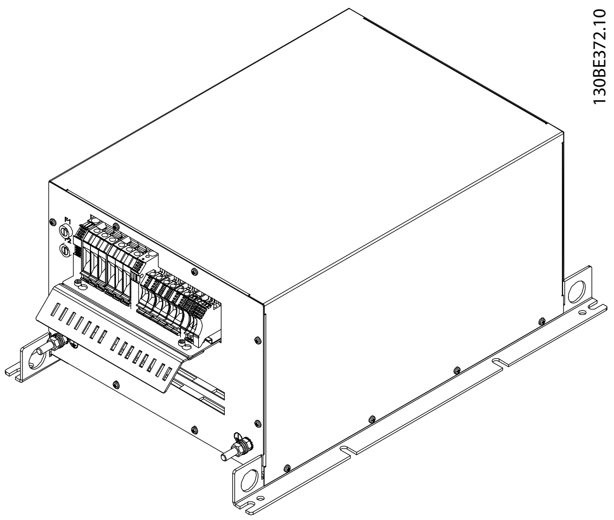


Illustration 7.14 IP20 X3 Internal Fan 1, 3D View

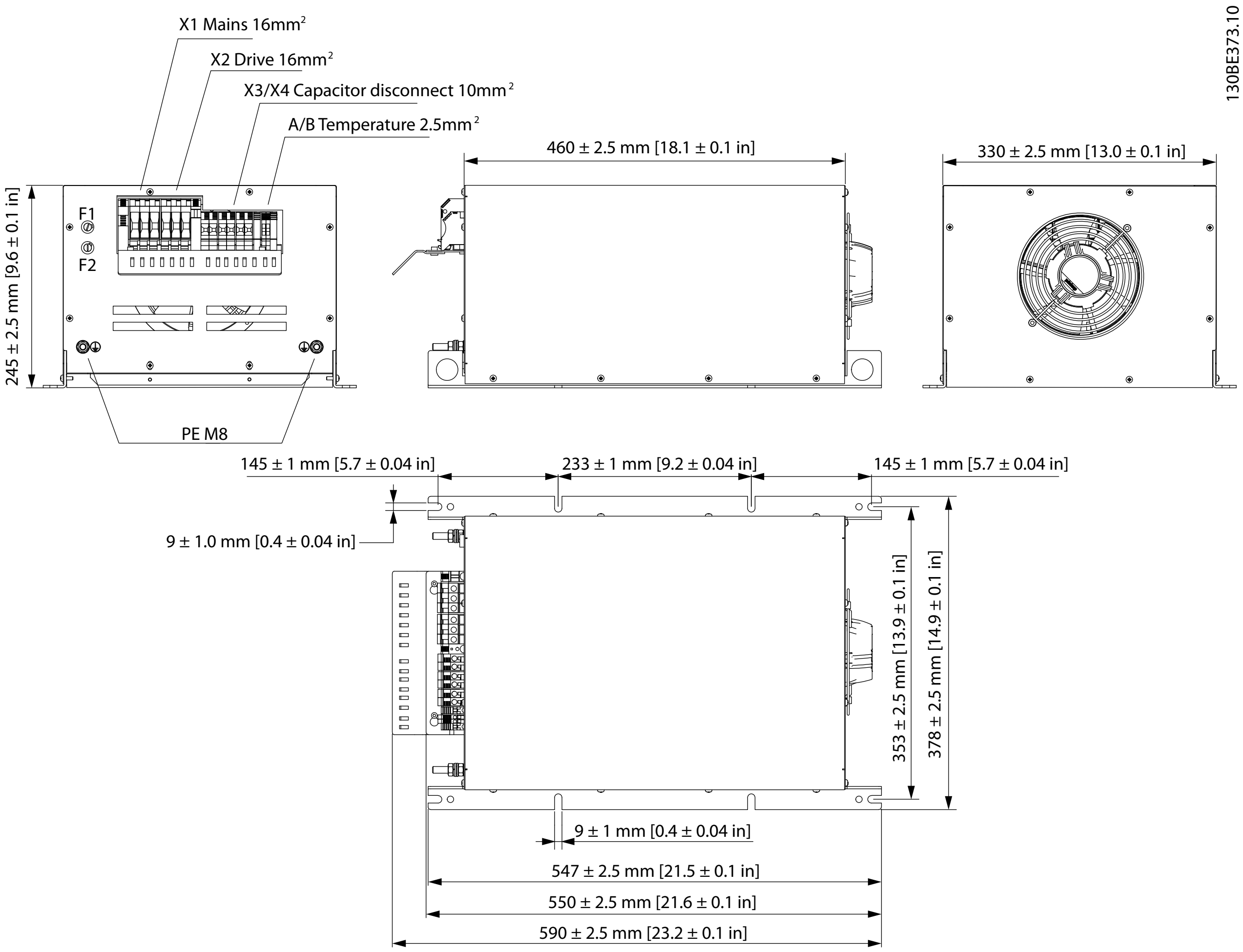


Illustration 7.15 IP20 X3 Internal Fan 2

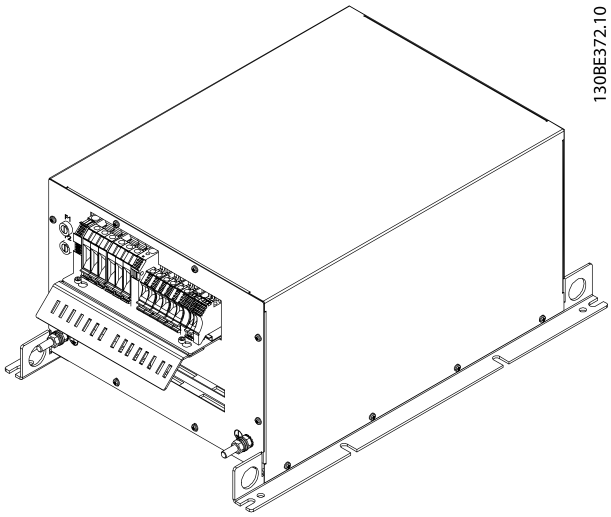


Illustration 7.16 IP20 X3 Internal Fan 2, 3D View

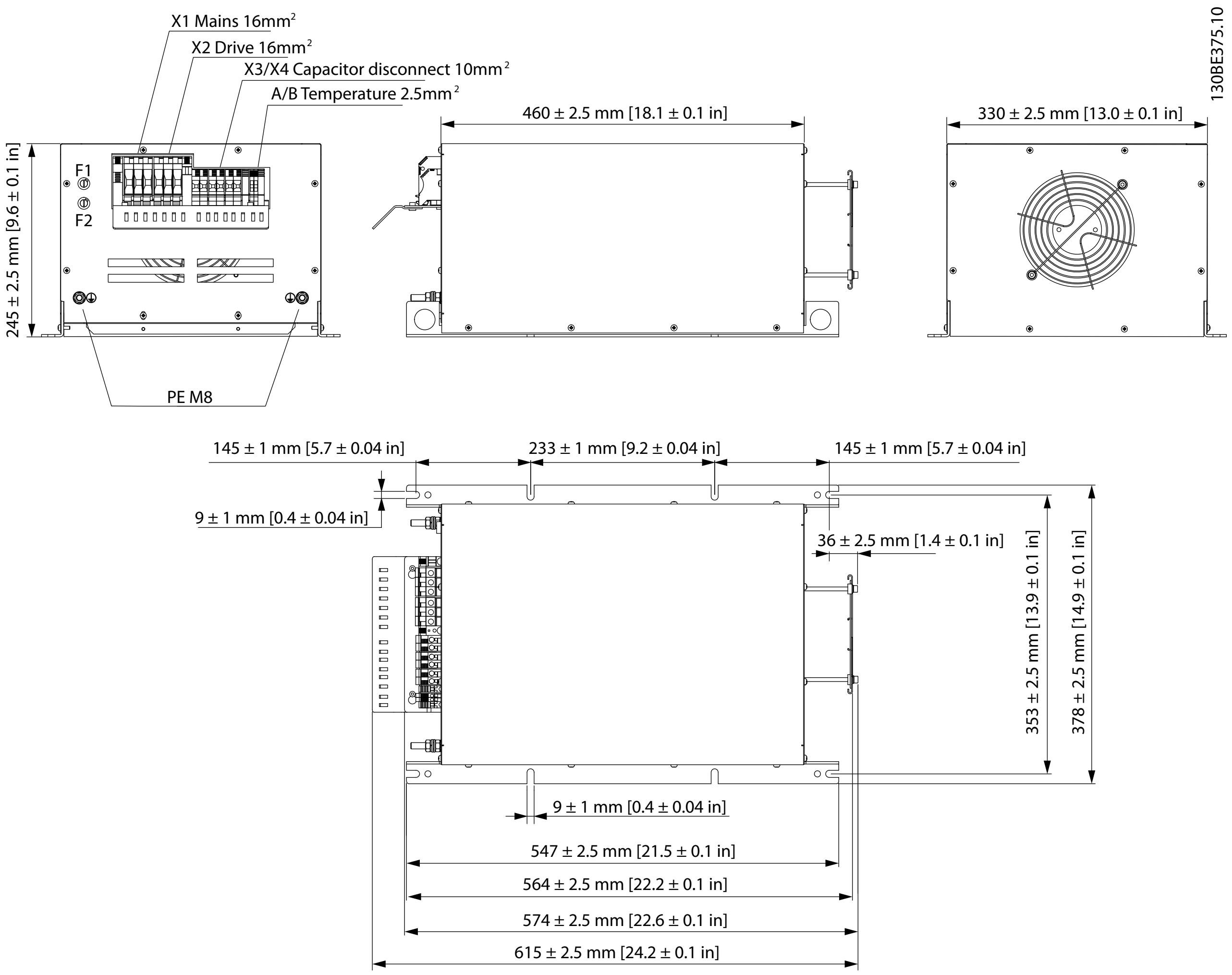


Illustration 7.17 IP20 X3 External Fan 1

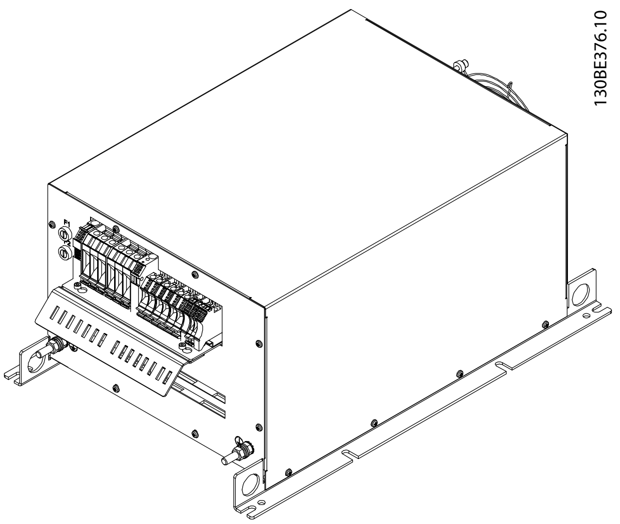


Illustration 7.18 IP20 X3 External Fan 1, 3D View

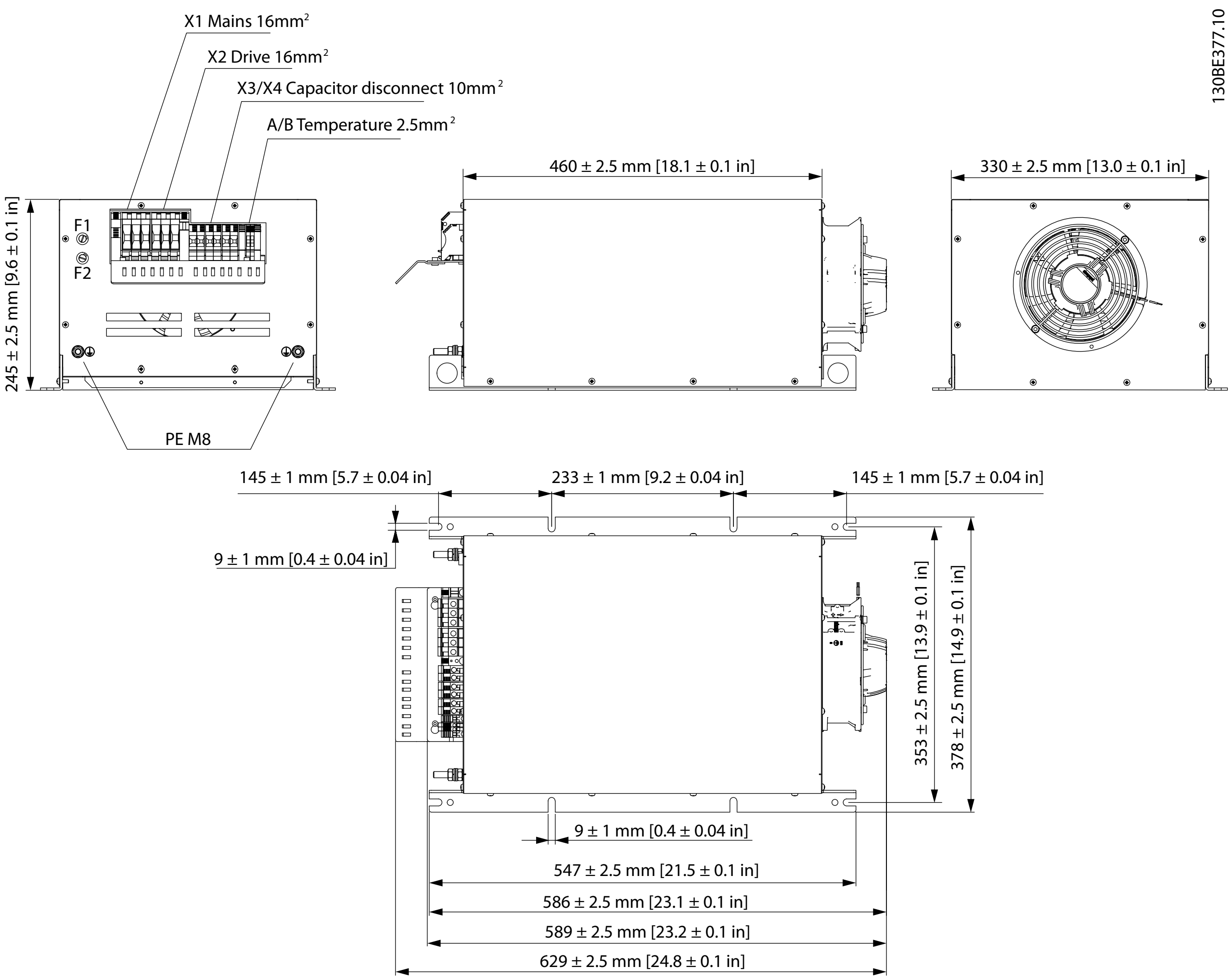


Illustration 7.19 IP20 X3 External Fan 2

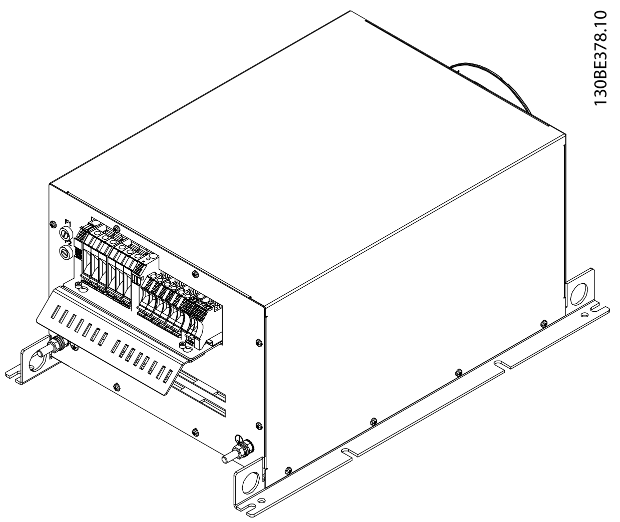


Illustration 7.20 IP20 X3 External Fan 2, 3D View

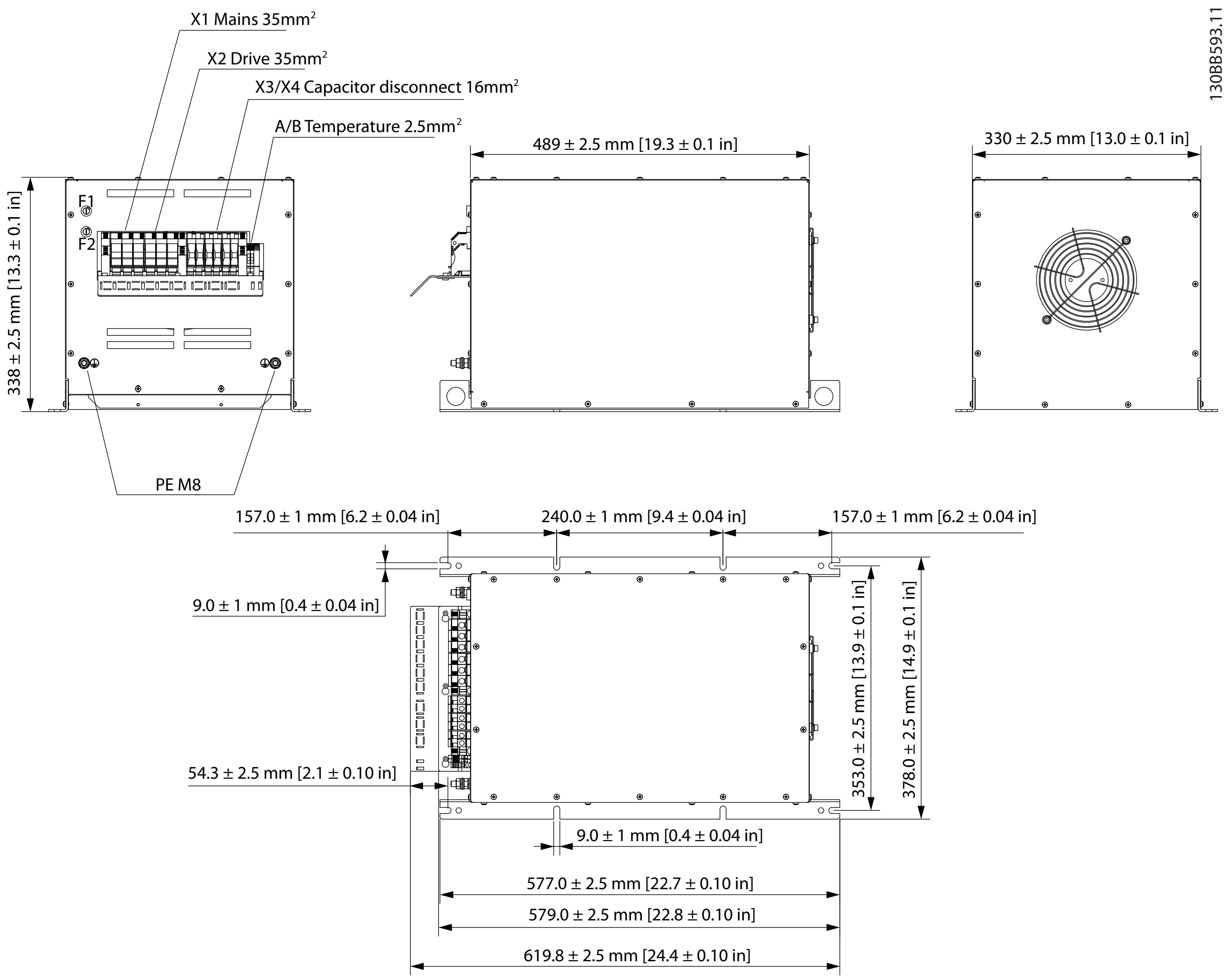


Illustration 7.21 IP20 X4 Internal Fan 1

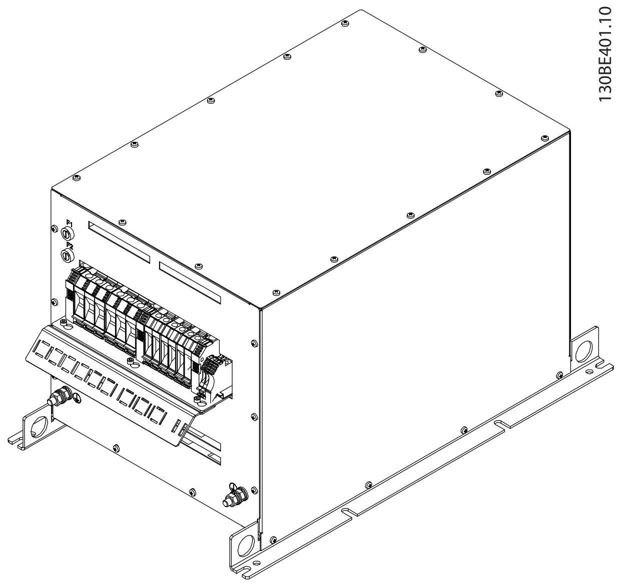


Illustration 7.22 IP20 X4 Internal Fan 1, 3D View

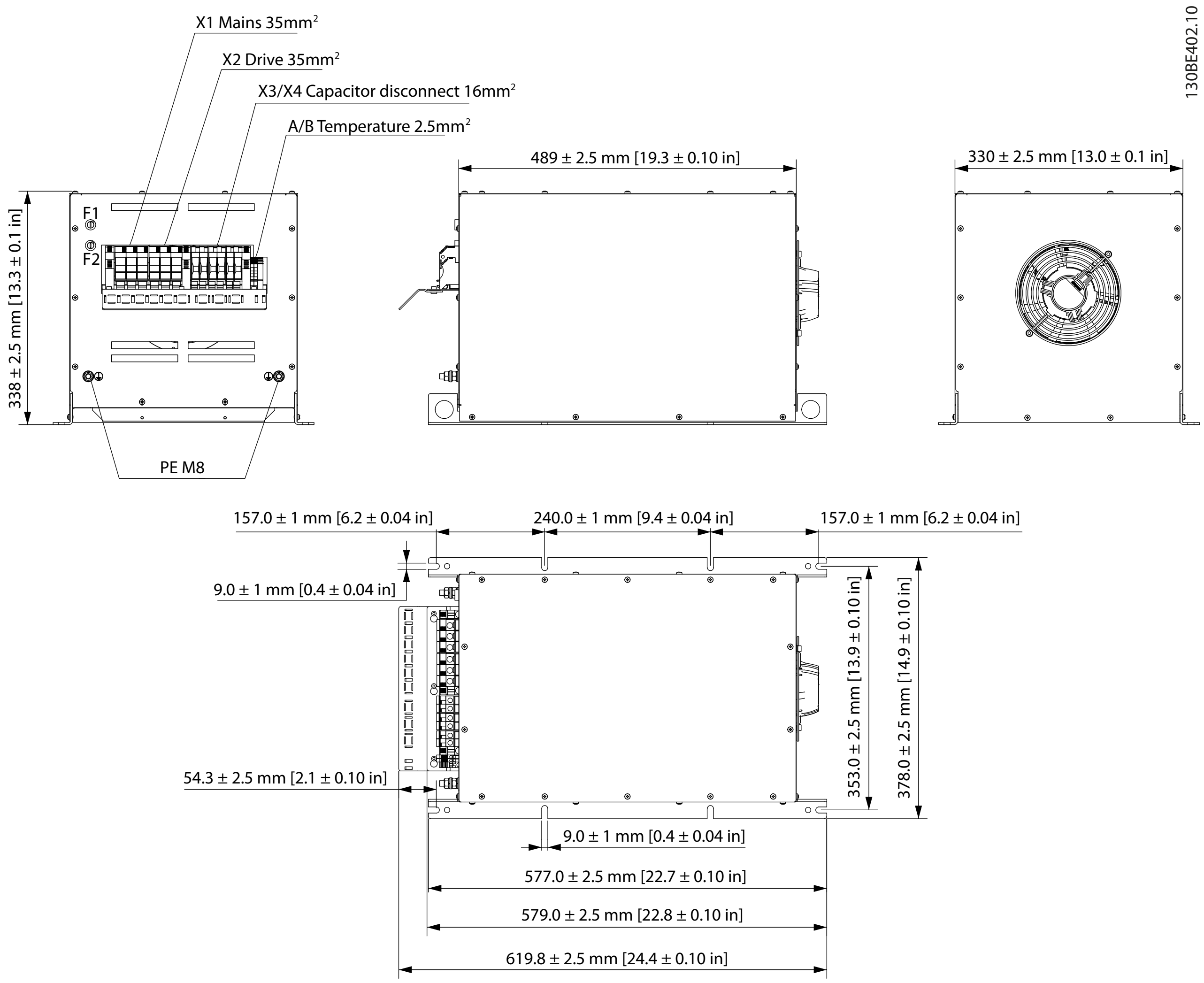


Illustration 7.23 IP20 X4 Internal Fan 2

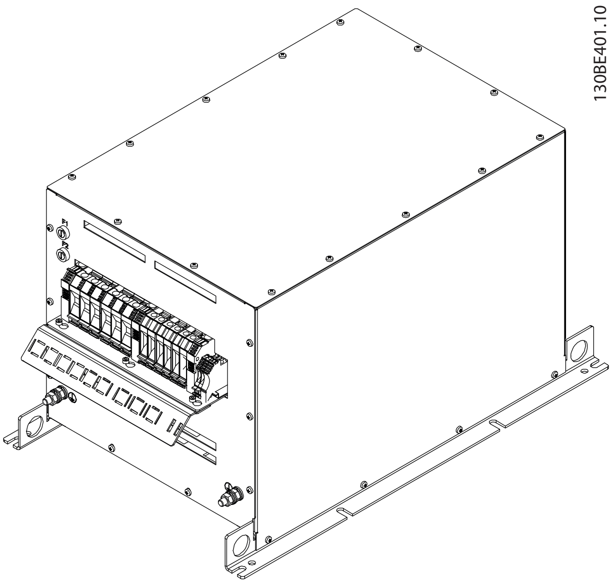


Illustration 7.24 IP20 X4 Internal Fan 2, 3D View

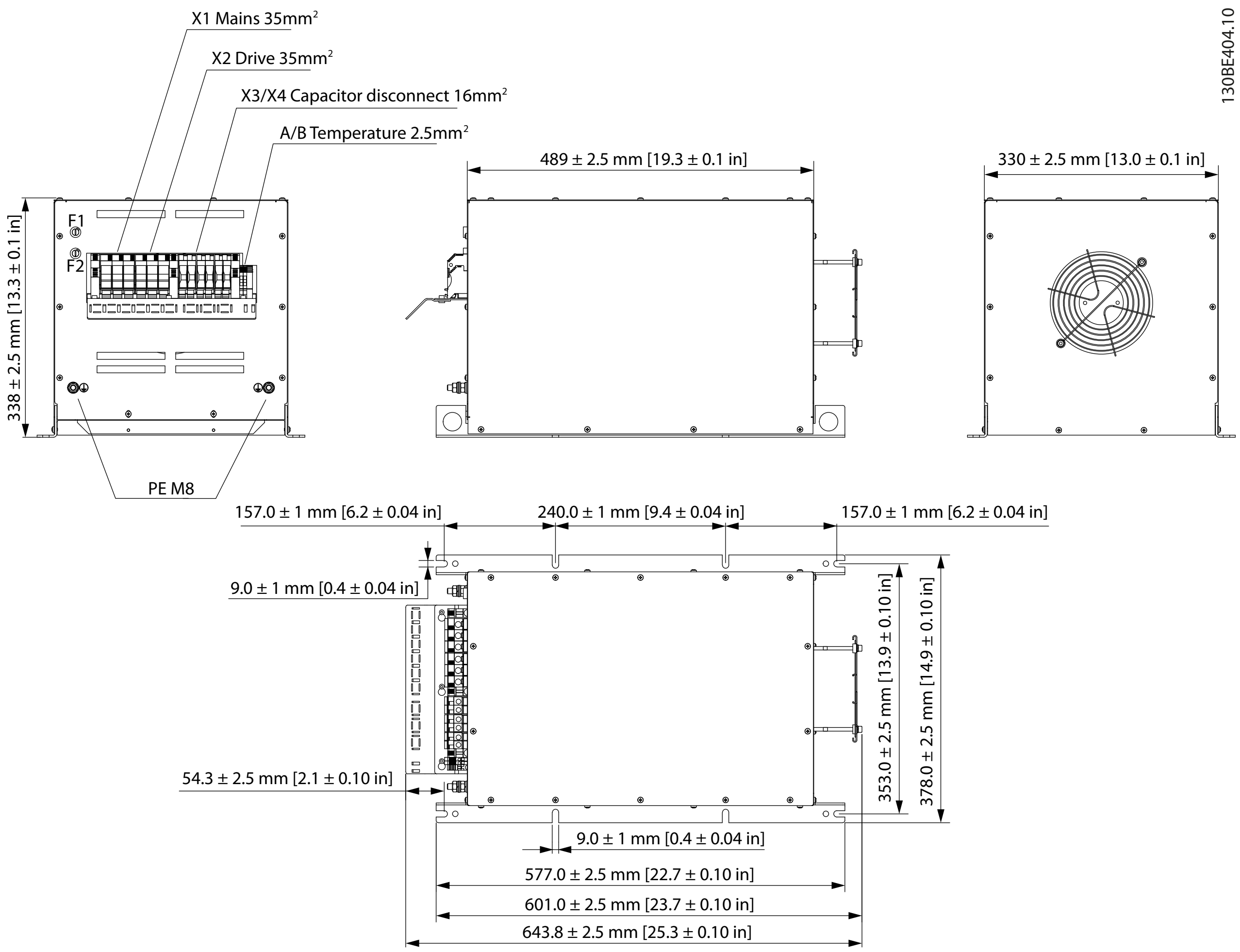


Illustration 7.25 IP20 X4 External Fan 1

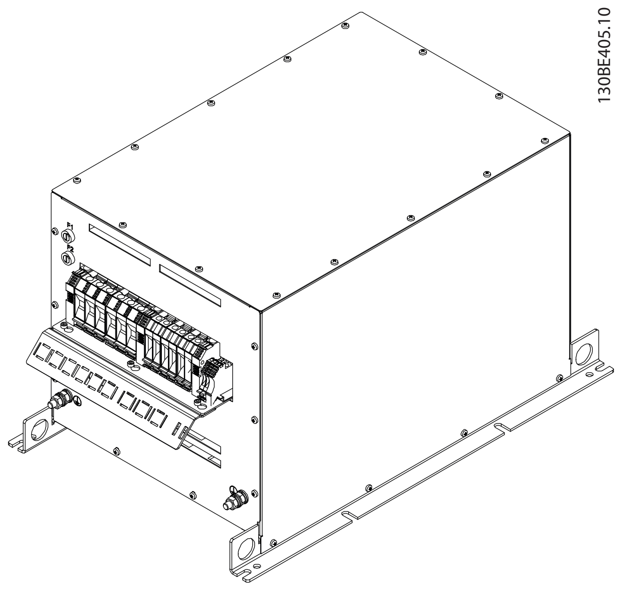


Illustration 7.26 IP20 X4 External Fan 1, 3D View

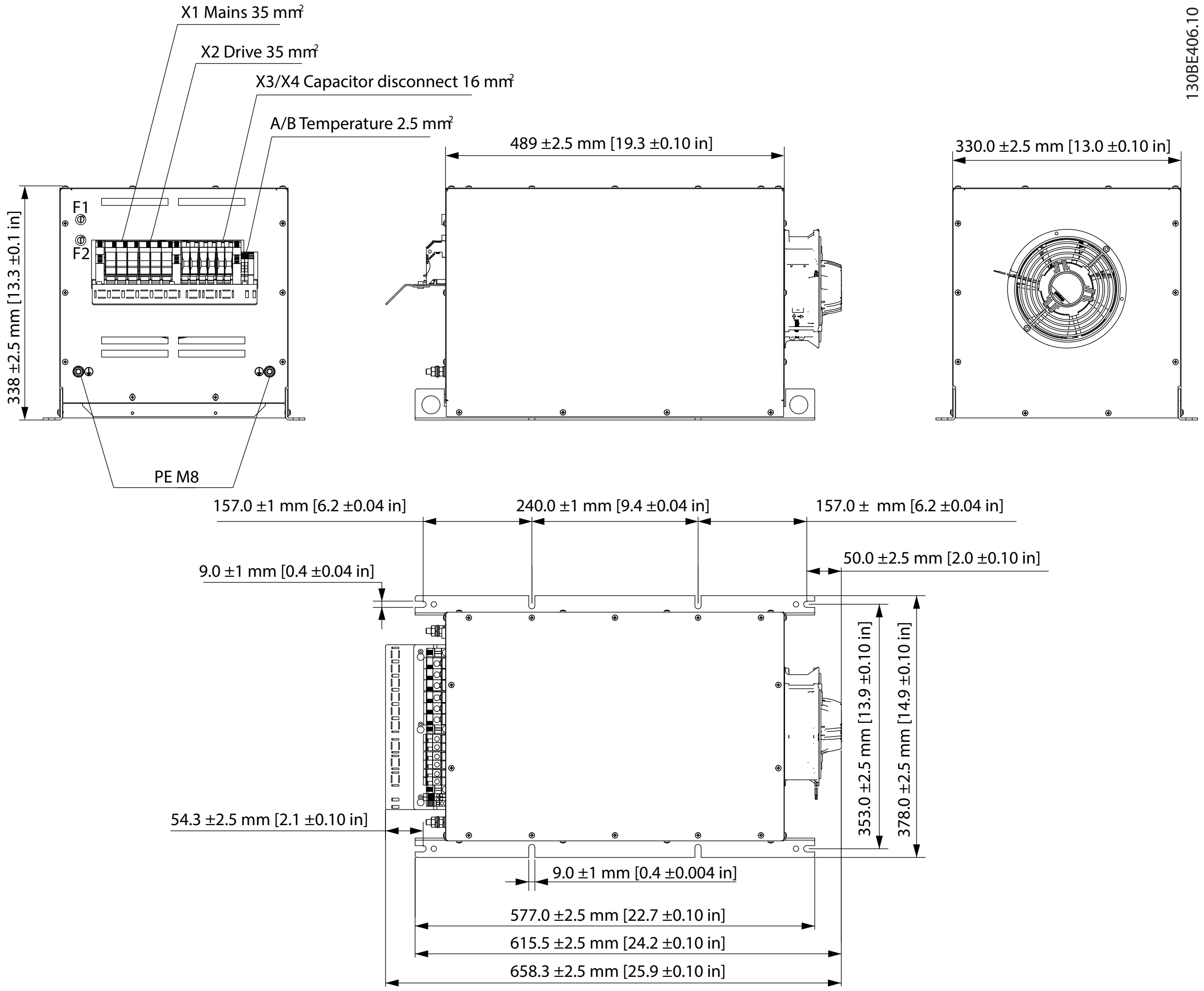


Illustration 7.27 IP20 X4 External Fan 2

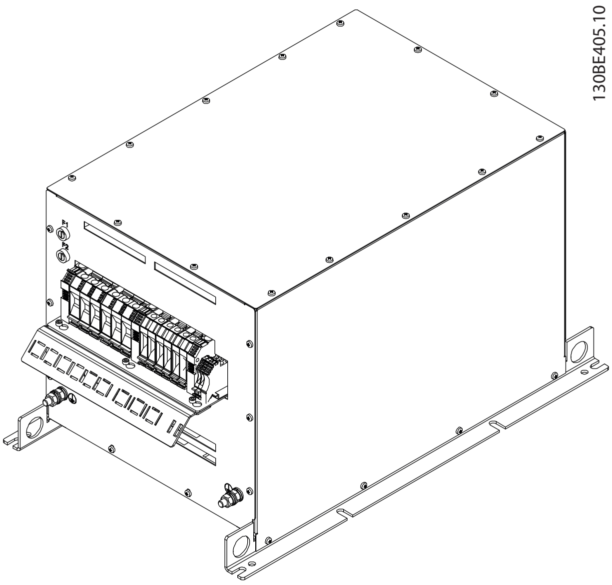


Illustration 7.28 IP20 X4 External Fan 2, 3D View

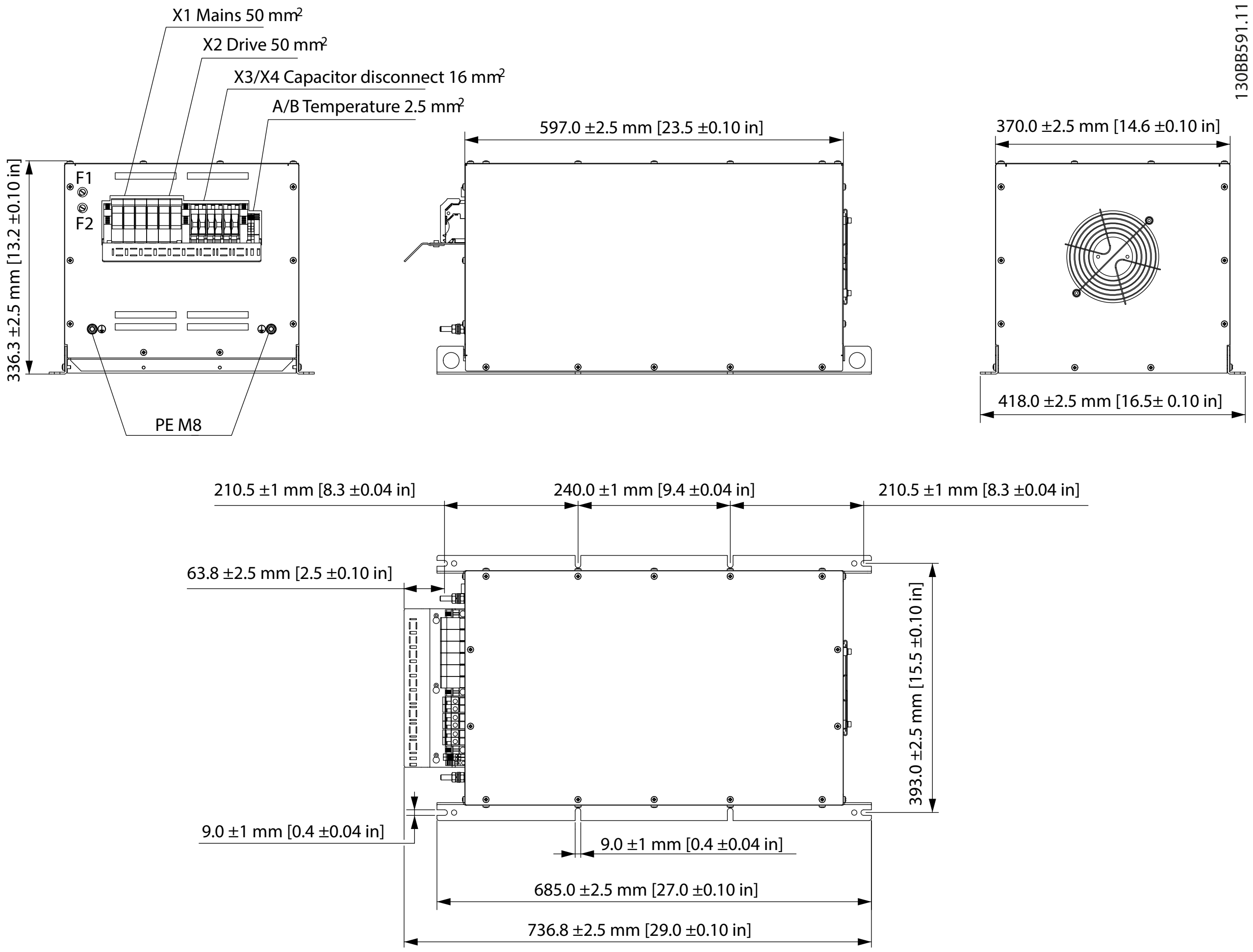


Illustration 7.29 IP20 X5 Internal Fan 1

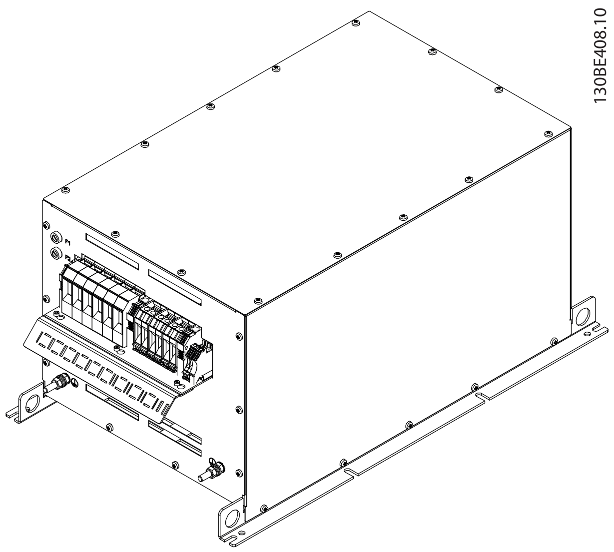


Illustration 7.30 IP20 X5 Internal Fan 1, 3D View

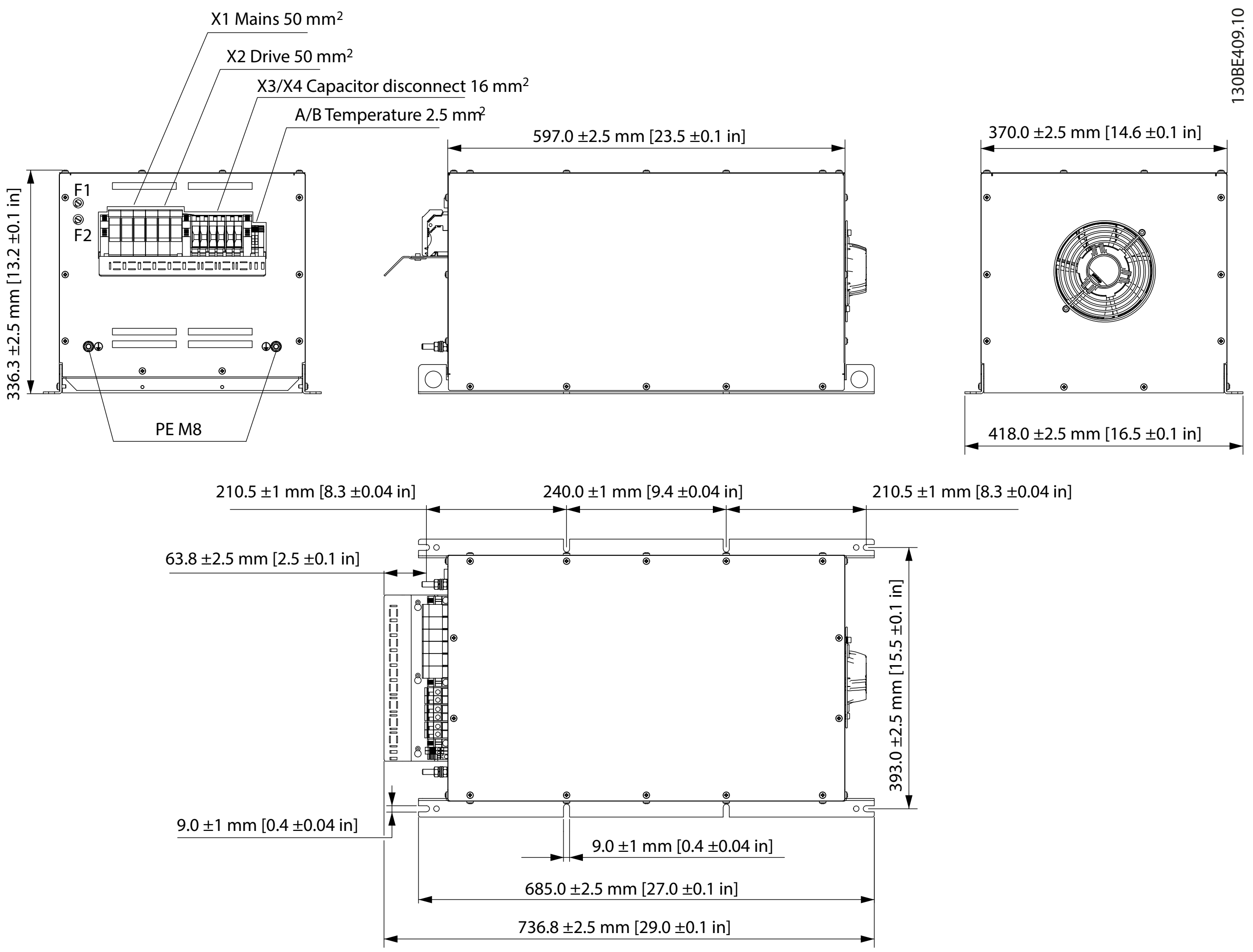


Illustration 7.31 IP20 X5 Internal Fan 2

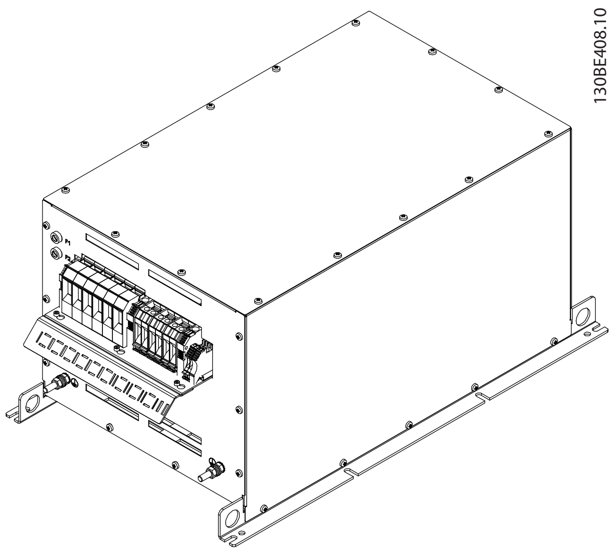


Illustration 7.32 IP20 X5 Internal Fan 2, 3D View

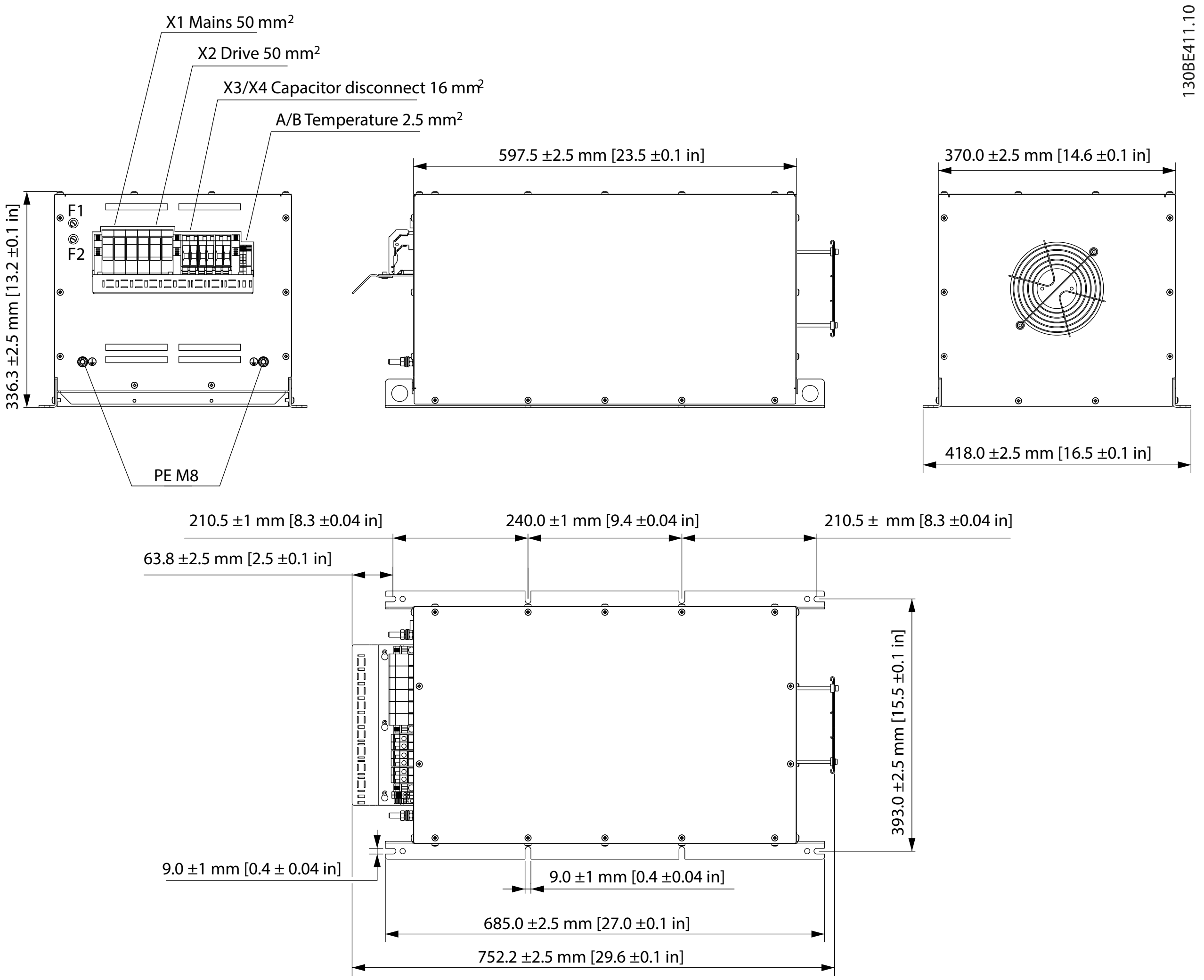


Illustration 7.33 IP20 X5 External Fan 1

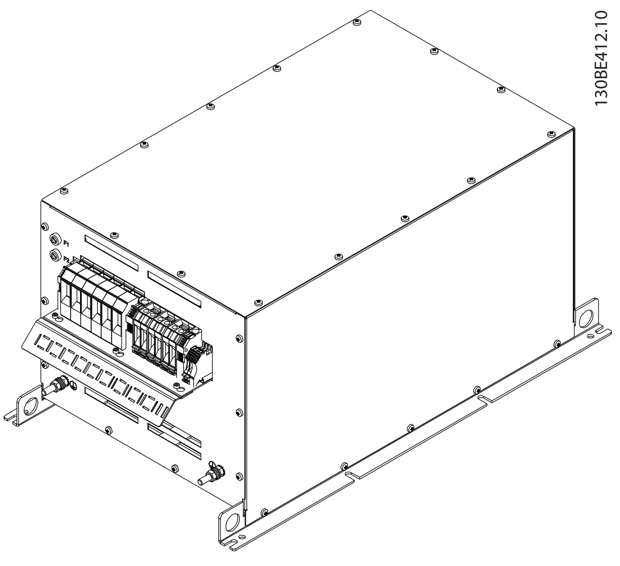


Illustration 7.34 IP20 X5 External Fan 1, 3D View

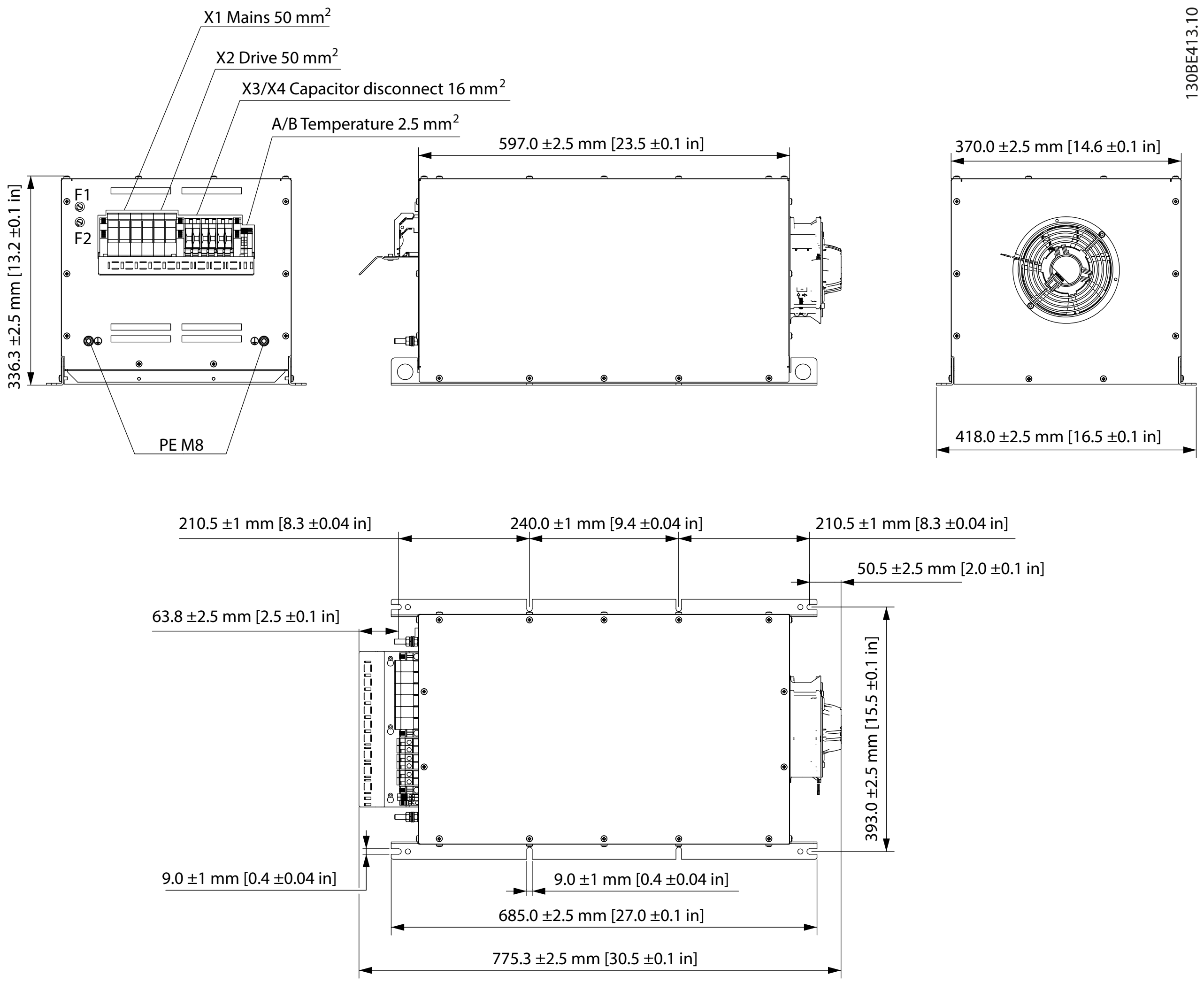


Illustration 7.35 IP20 X5 External Fan 2

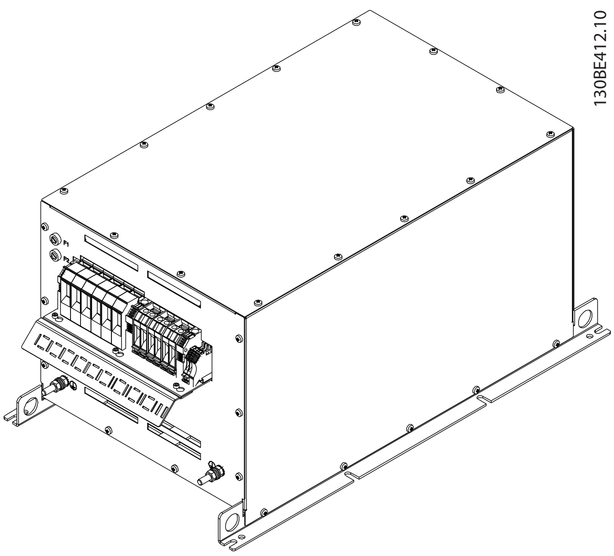


Illustration 7.36 IP20 X5 External Fan 2, 3D View

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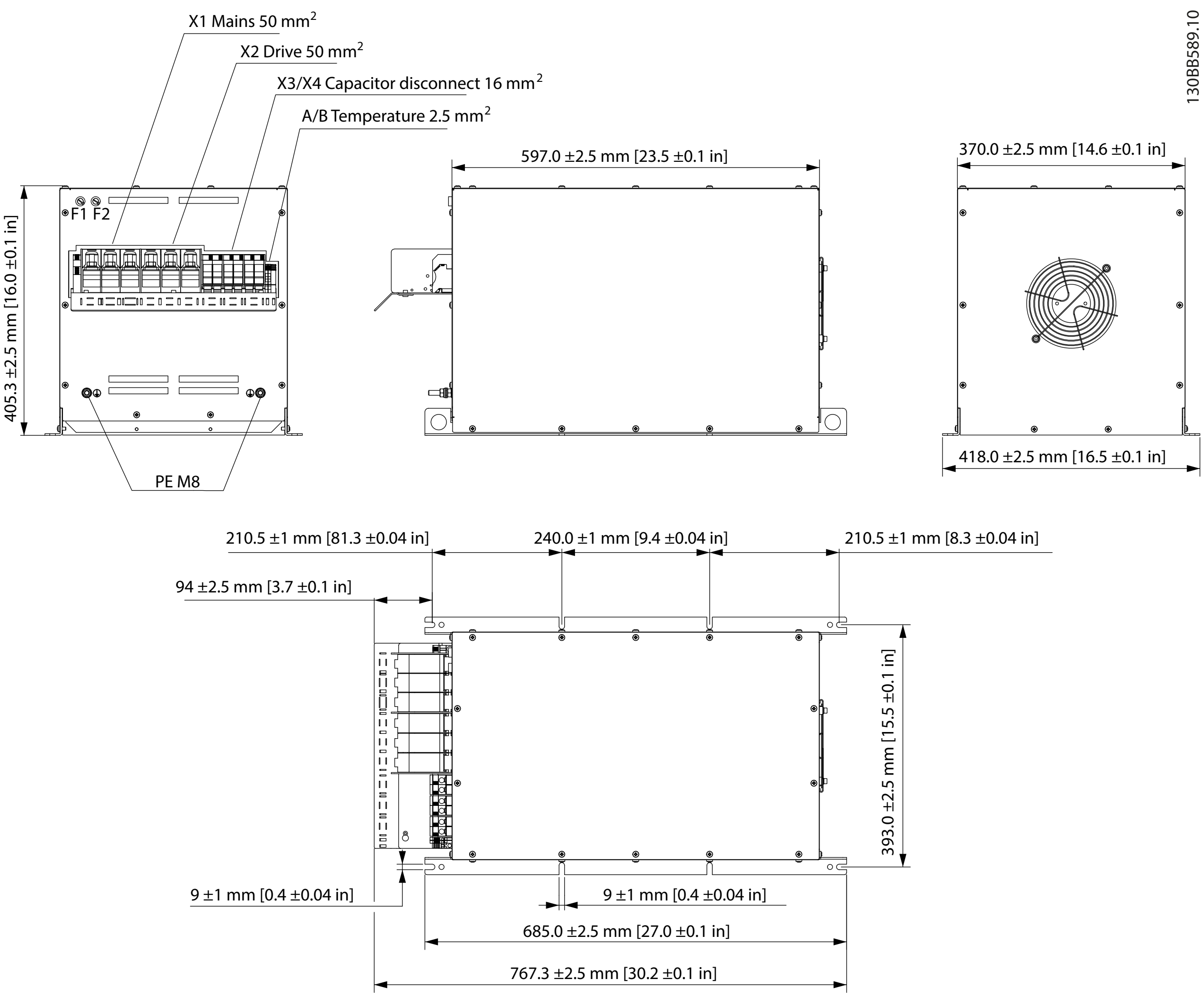

Illustration 7.37 IP20 X6 Internal Fan 1

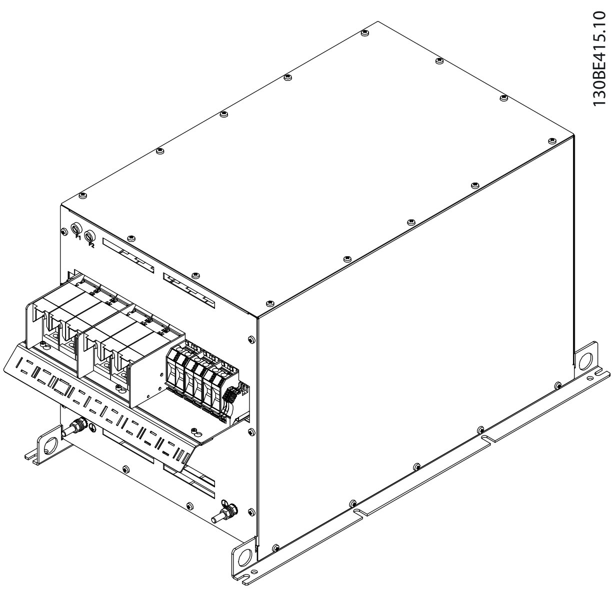

Illustration 7.38 IP20 X6 Internal Fan 1, 3D View

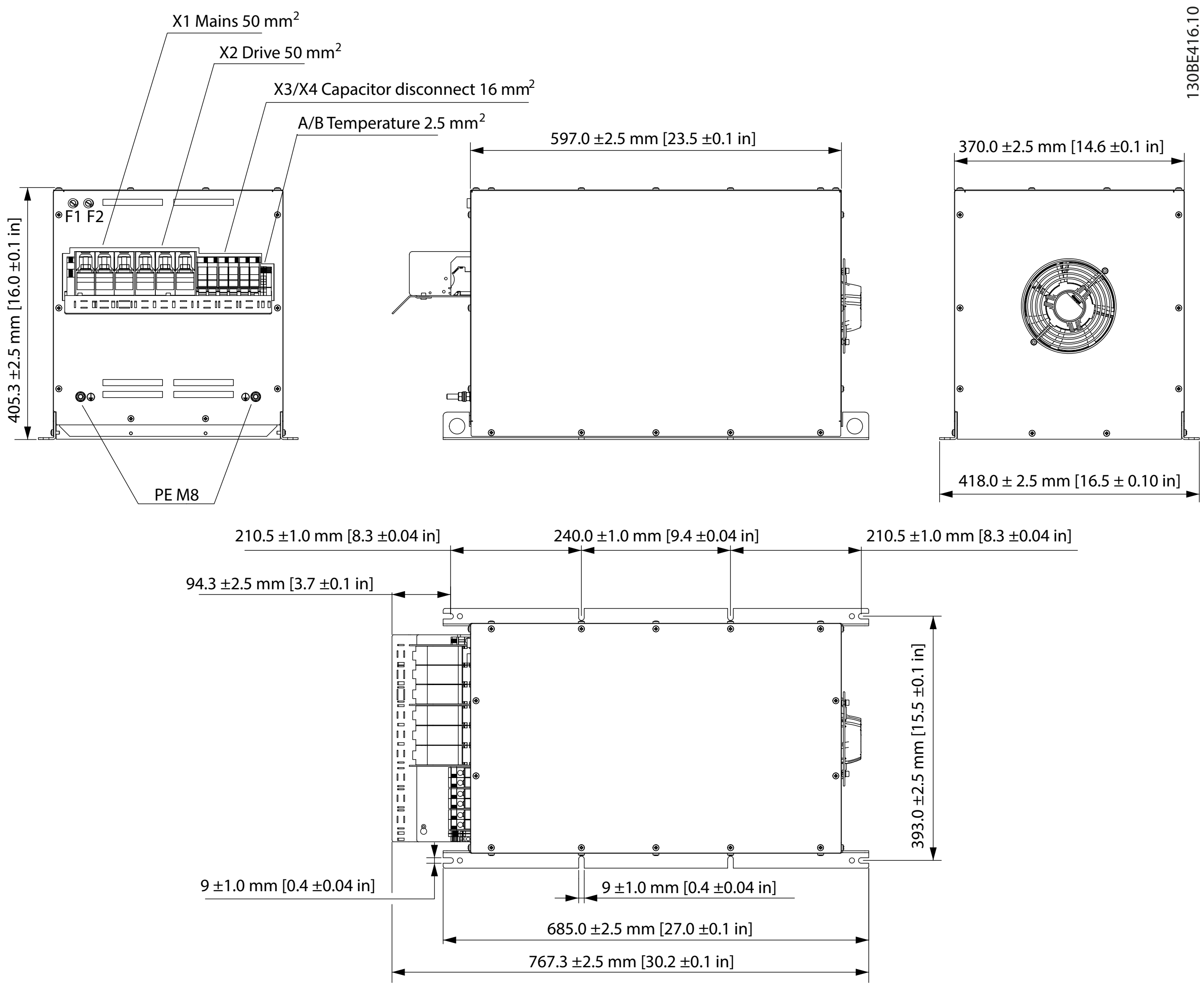

Illustration 7.39 IP20 X6 Internal Fan 2

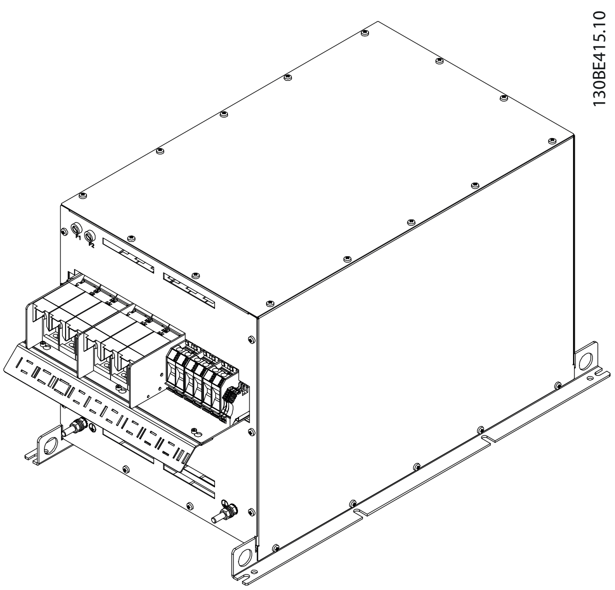

Illustration 7.40 IP20 X6 Internal Fan 2, 3D View

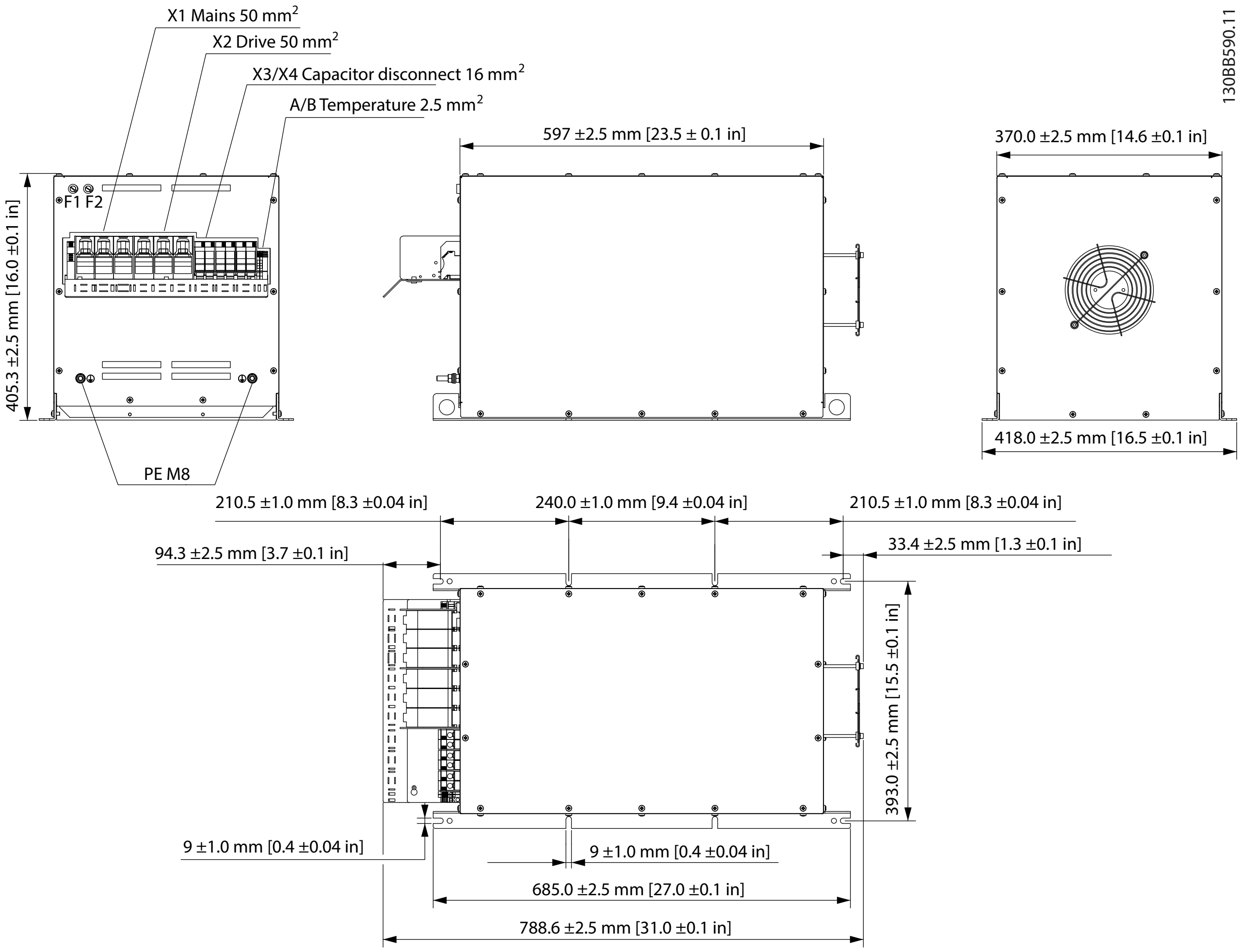

Illustration 7.41 IP20 X6 External Fan 1

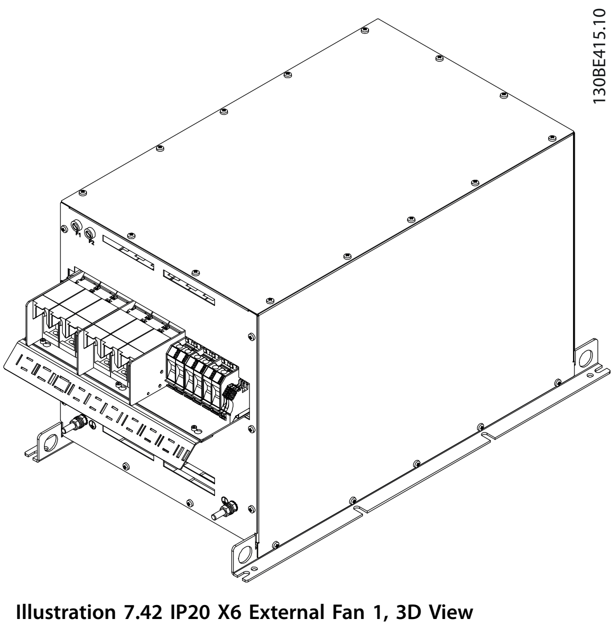

Illustration 7.42 IP20 X6 External Fan 1, 3D View

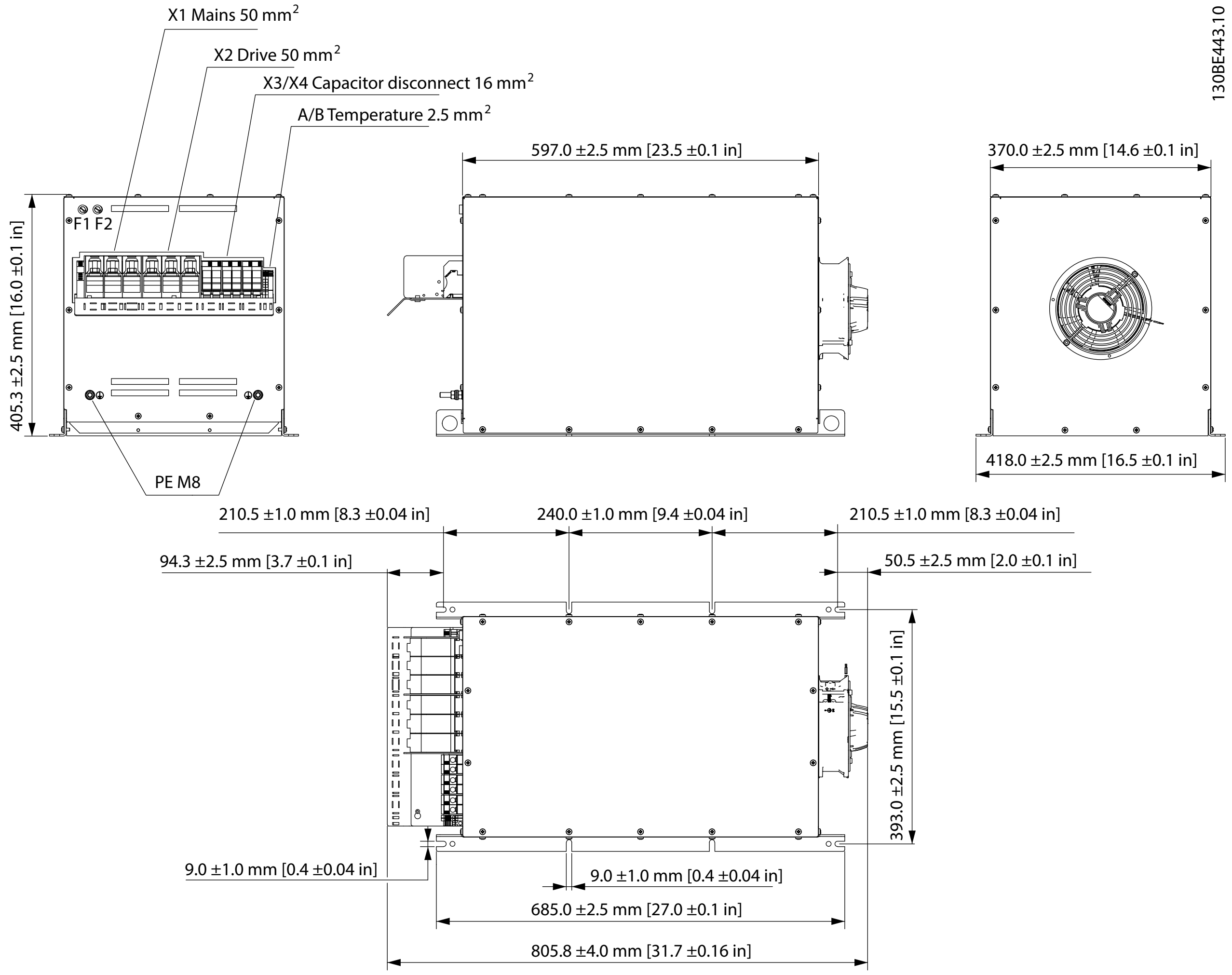

Illustration 7.43 IP20 X6 External Fan 2

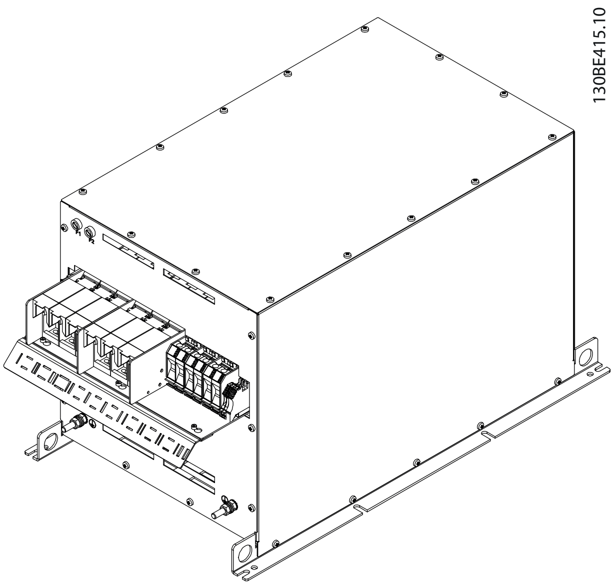

Illustration 7.44 IP20 X6 External Fan 2, 3D View

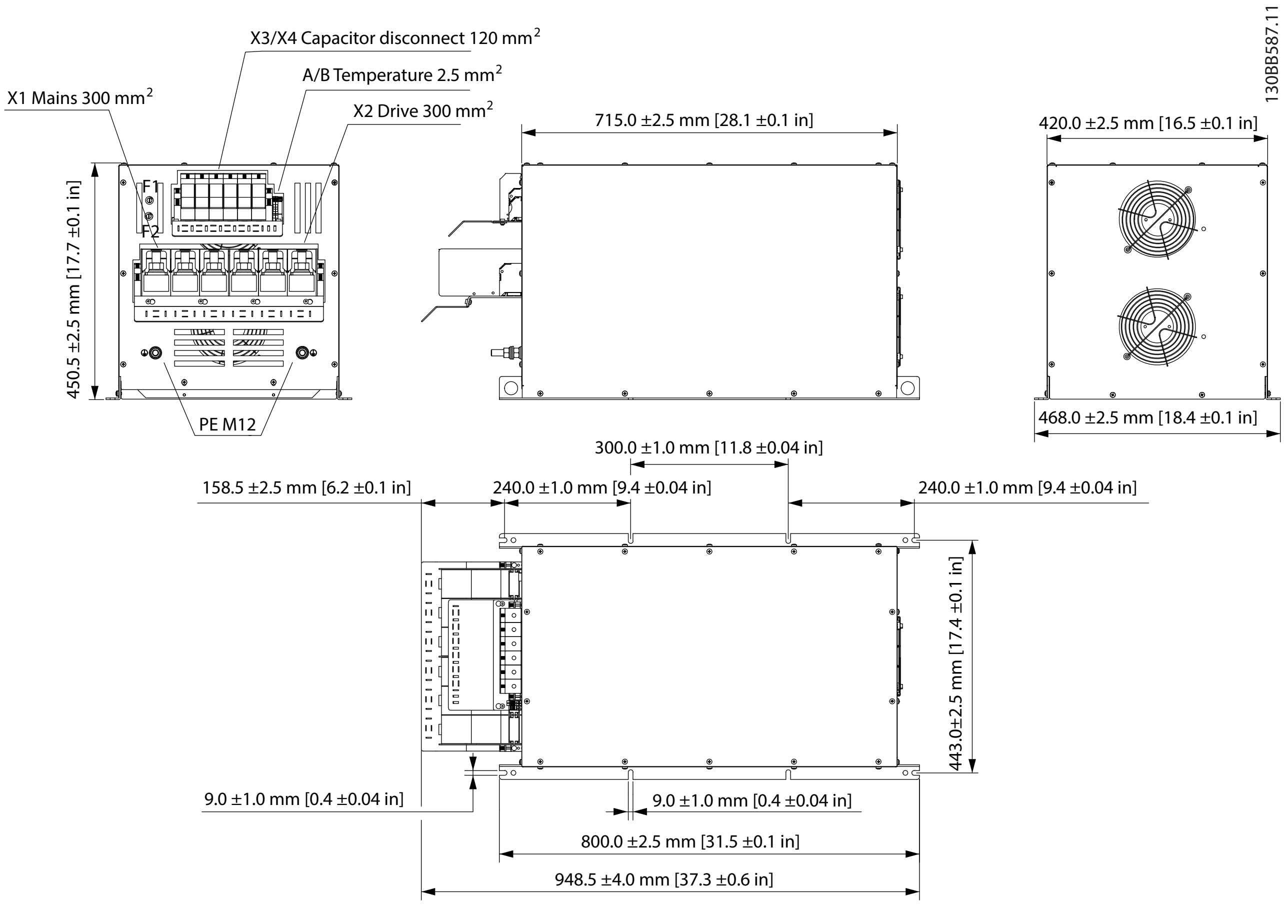

Illustration 7.45 IP20 X7 Internal Fan 1

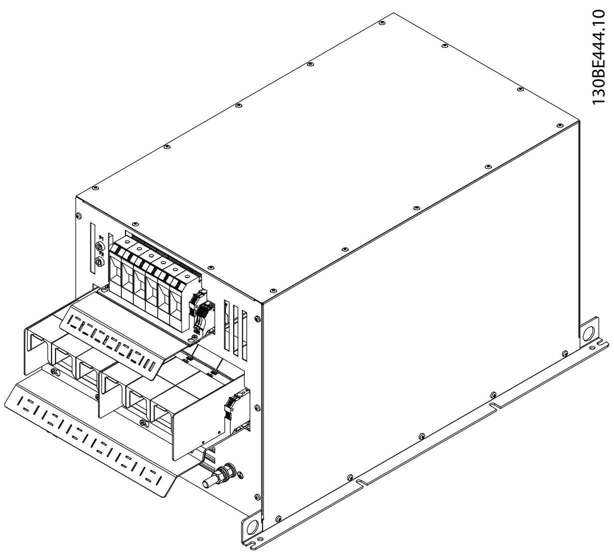

Illustration 7.46 IP20 X7 Internal Fan 1, 3D View

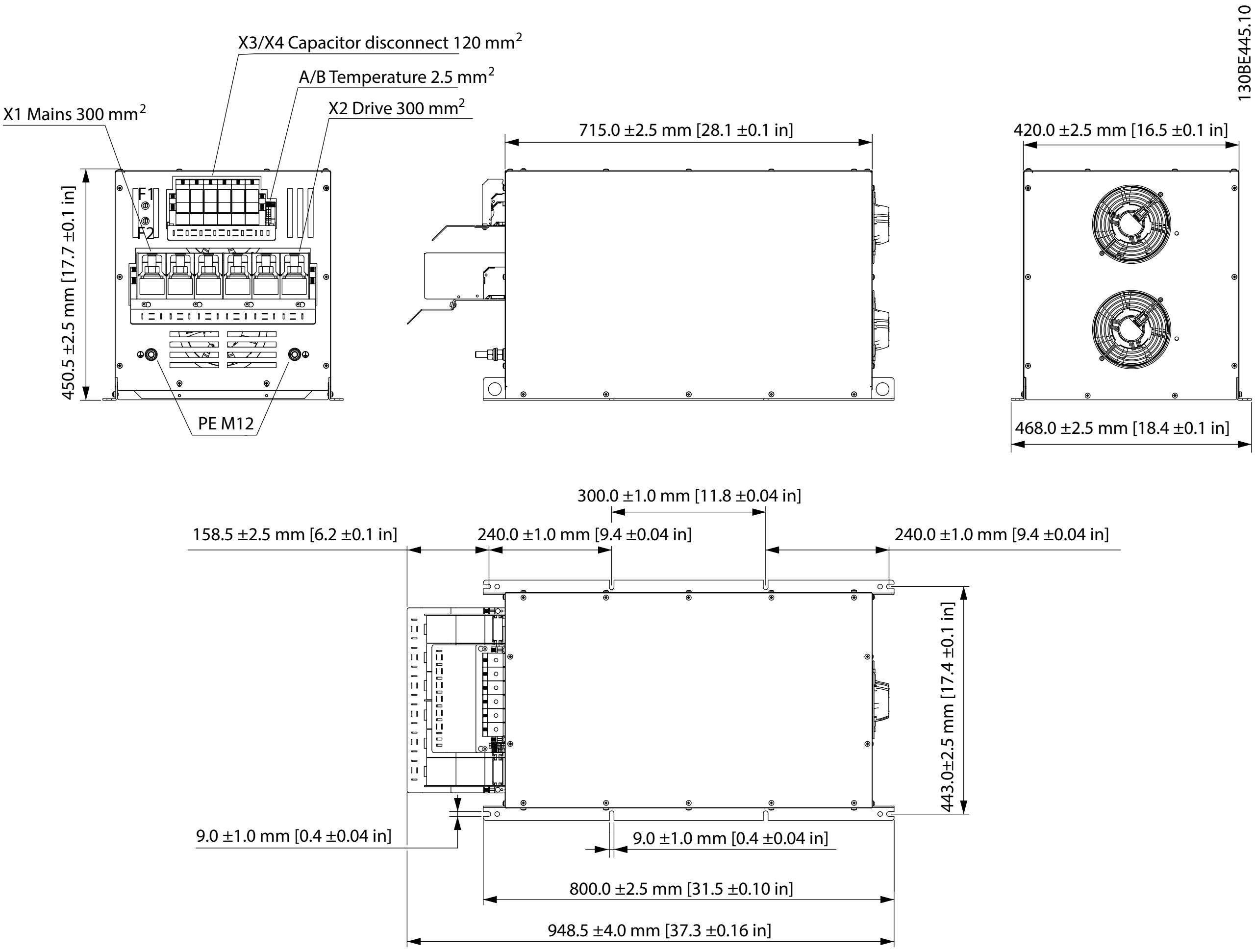

Illustration 7.47 IP20 X7 Internal Fan 2

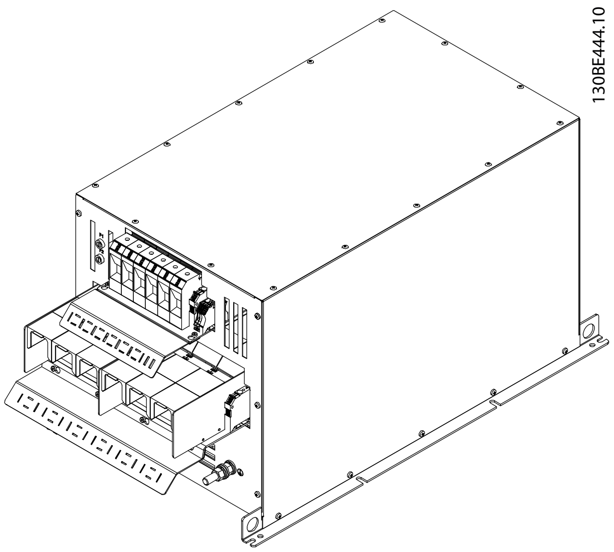

Illustration 7.48 IP20 X7 Internal Fan 2, 3D View

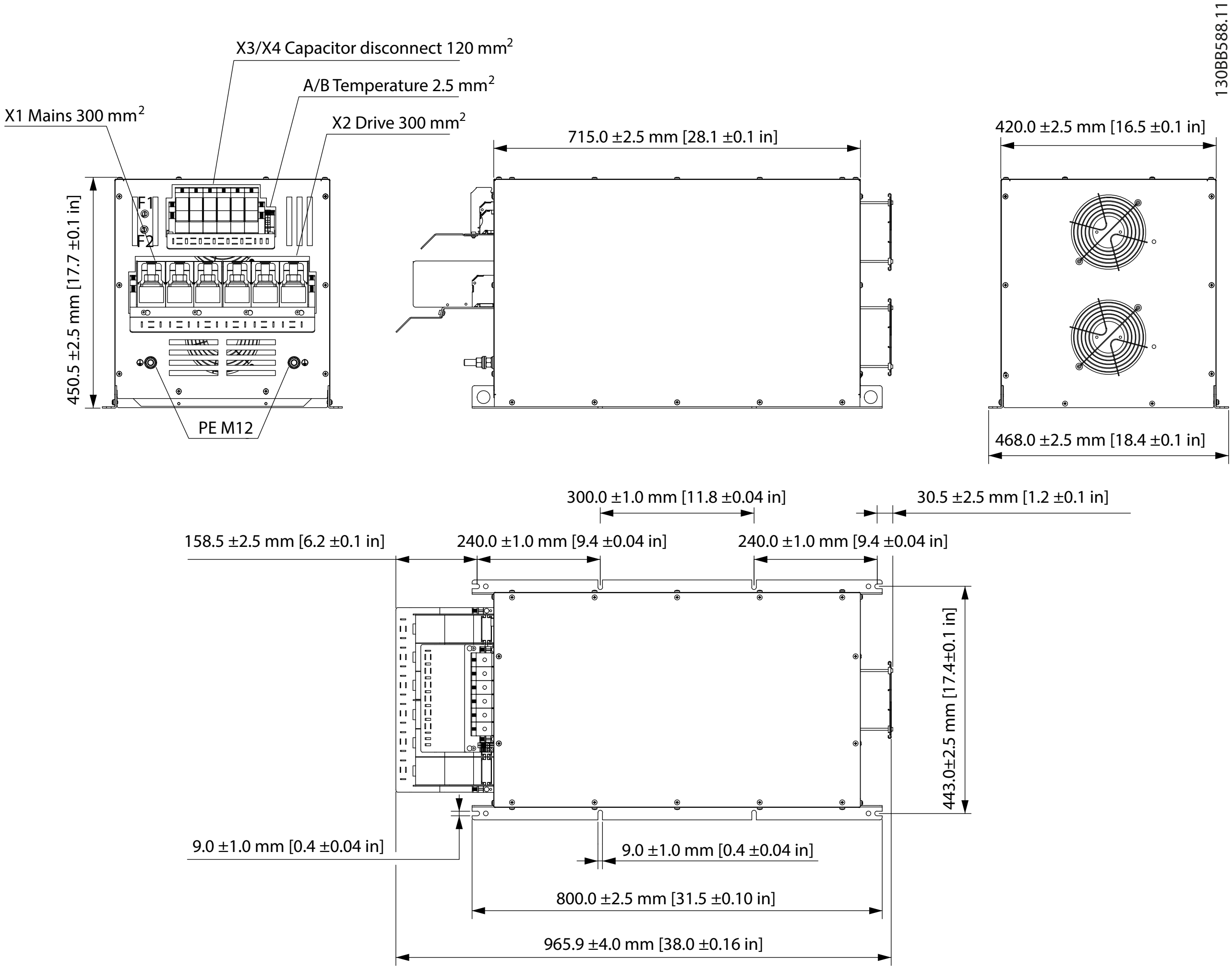

Illustration 7.49 IP20 X7 External Fan 1

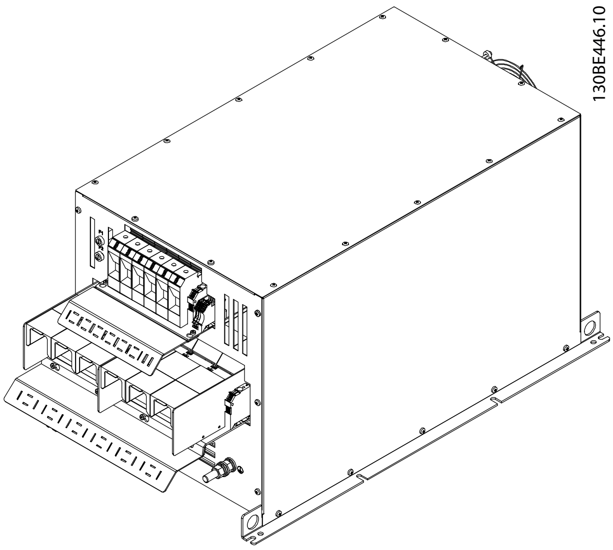

Illustration 7.50 IP20 X7 External Fan 1, 3D View

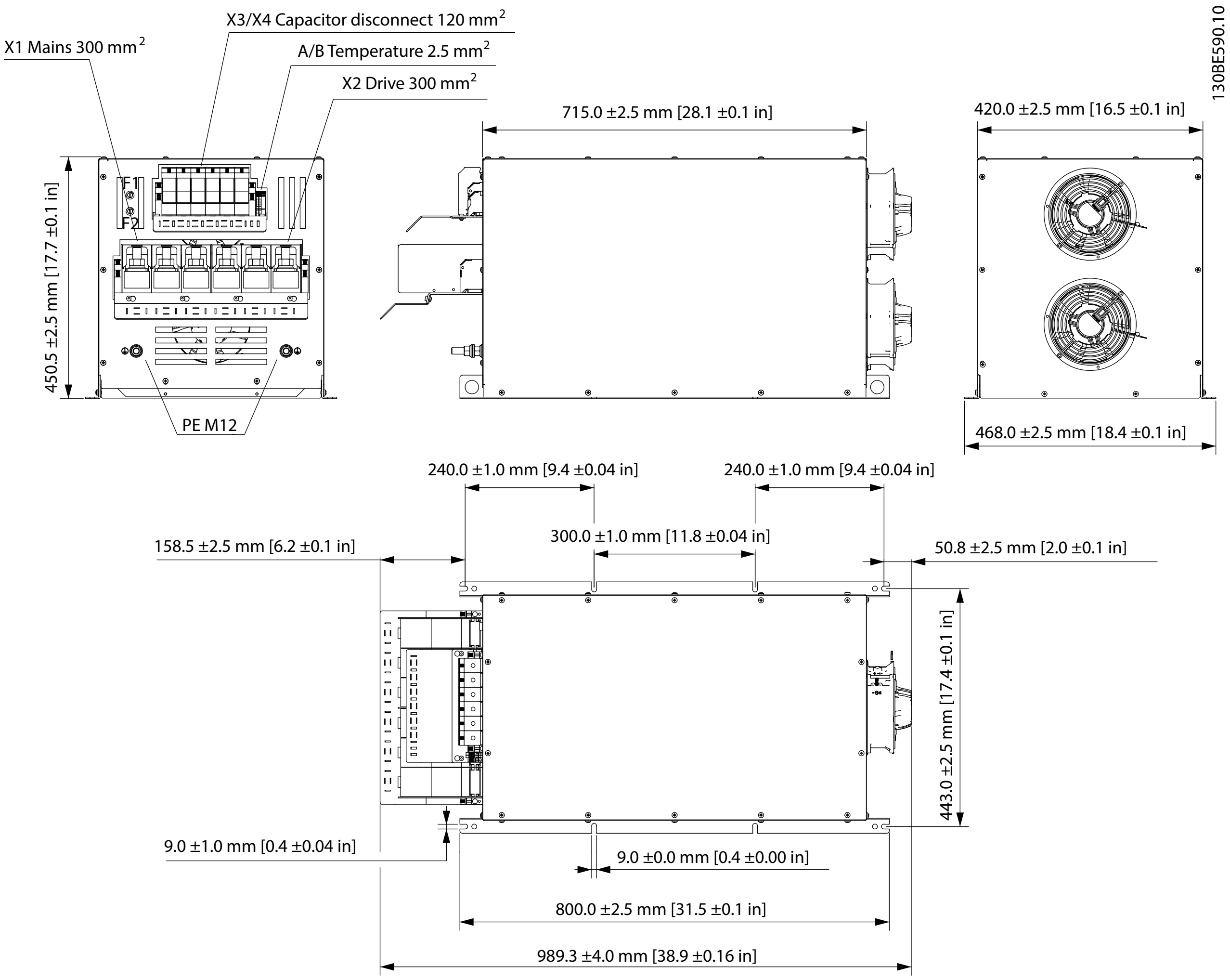

Illustration 7.51 IP20 X7 External Fan 2

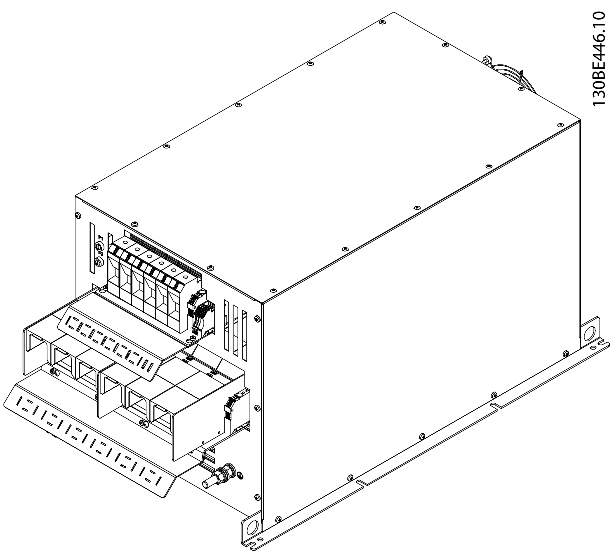

Illustration 7.52 IP20 X7 External Fan 2, 3D View

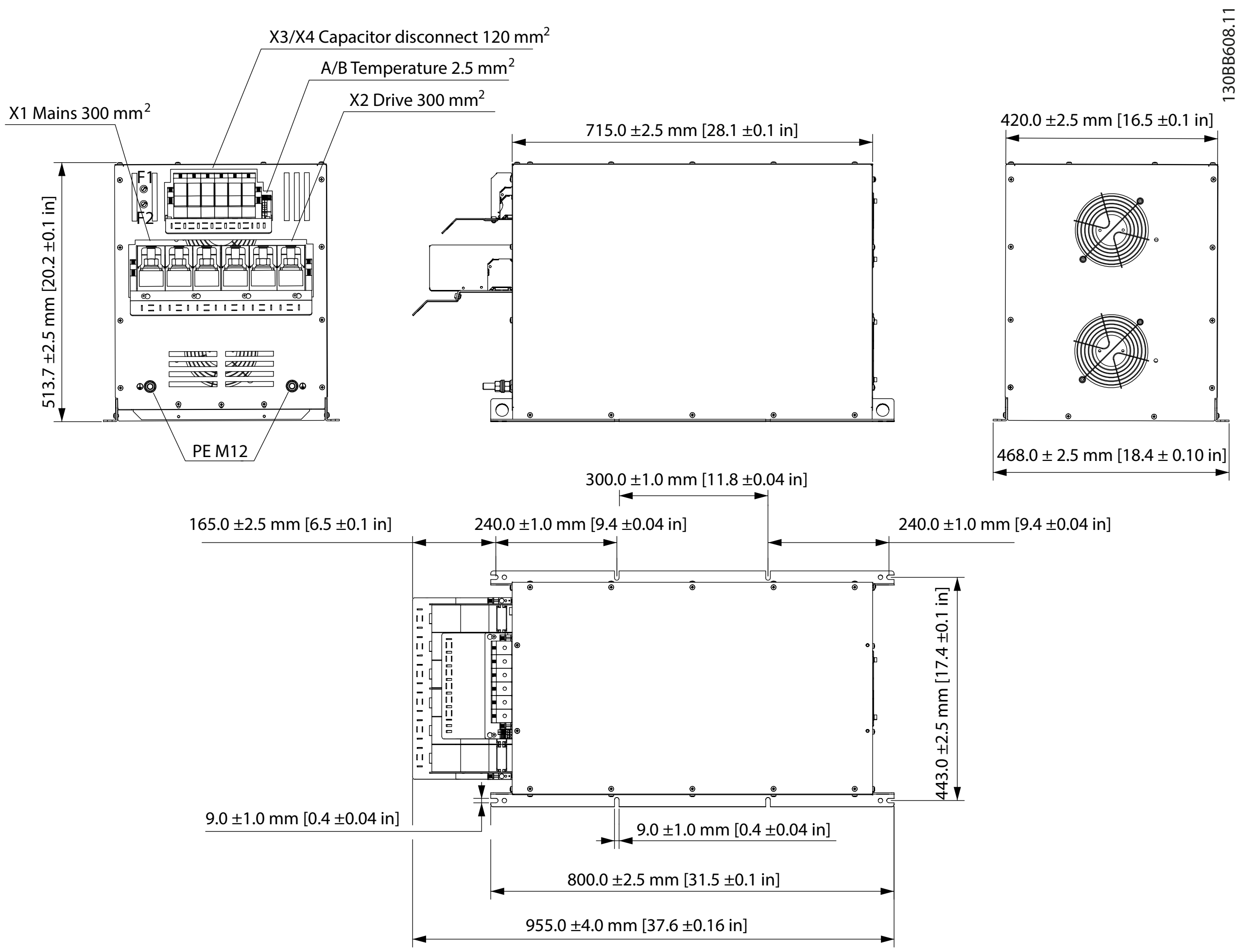

Illustration 7.53 IP20 X8 Internal Fan 1

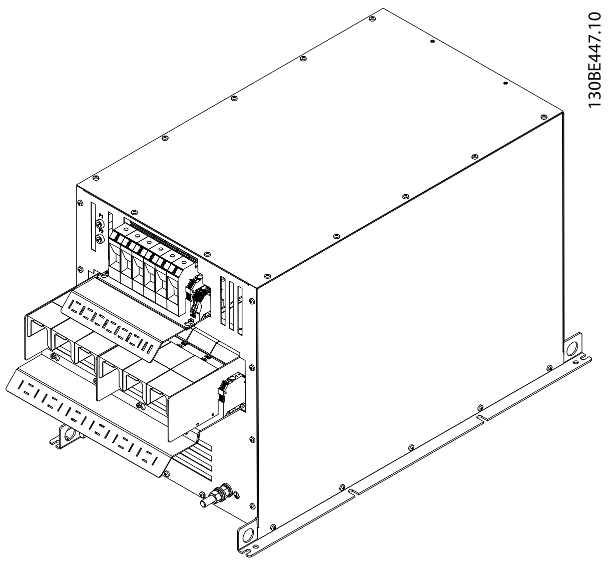

Illustration 7.54 IP20 X8 Internal Fan 1, 3D View

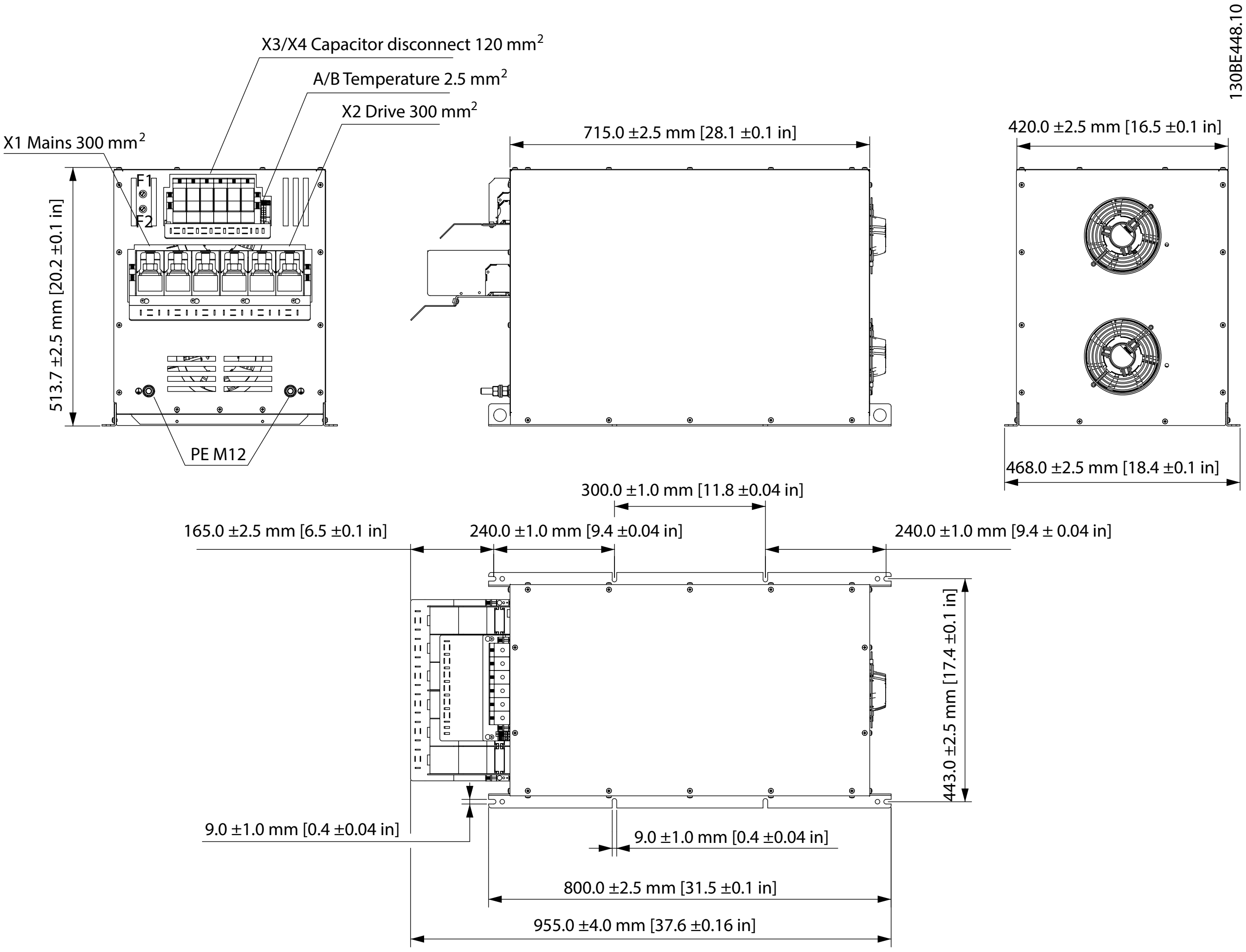

Illustration 7.55 IP20 X8 Internal Fan 2

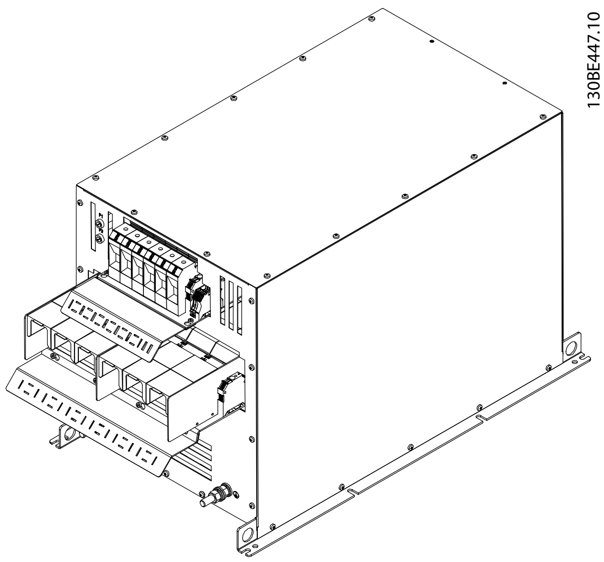

Illustration 7.56 IP20 X8 Internal Fan 2, 3D View

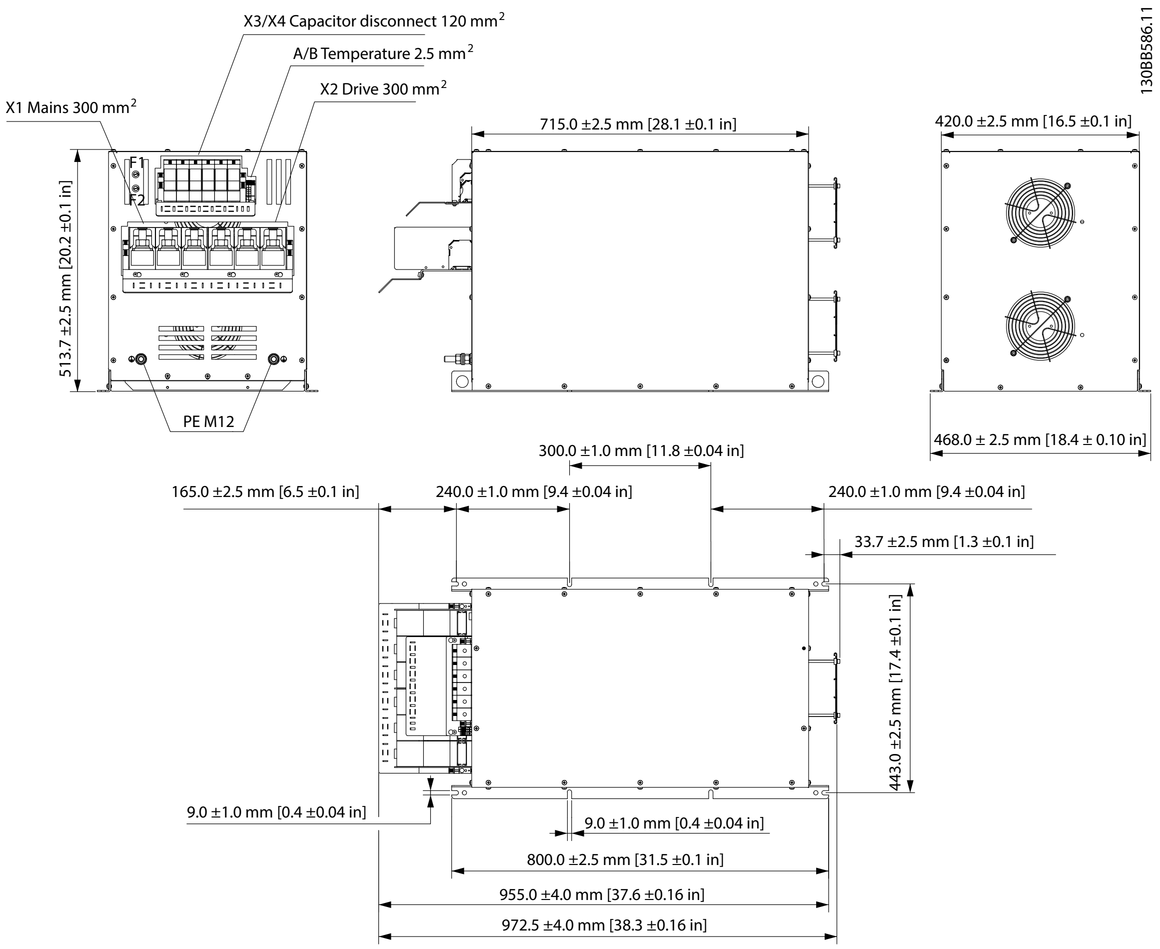

Illustration 7.57 IP20 X8 External Fan 1

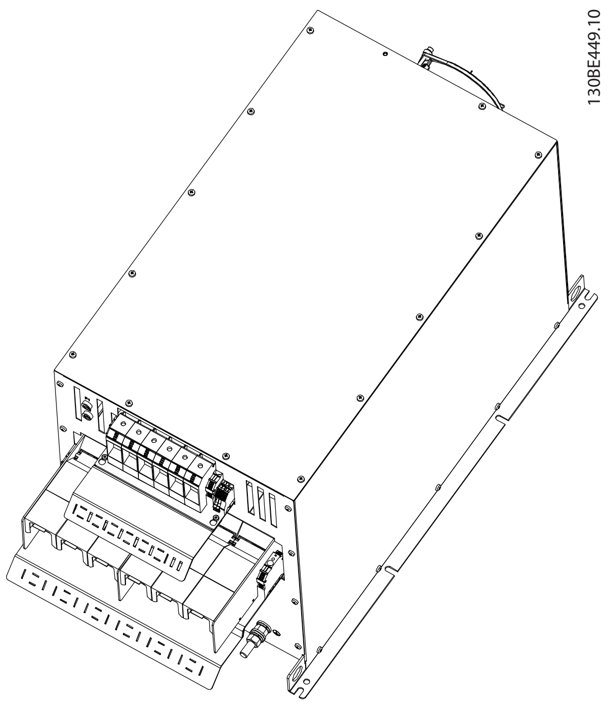

Illustration 7.58 IP20 X8 External Fan 1, 3D View

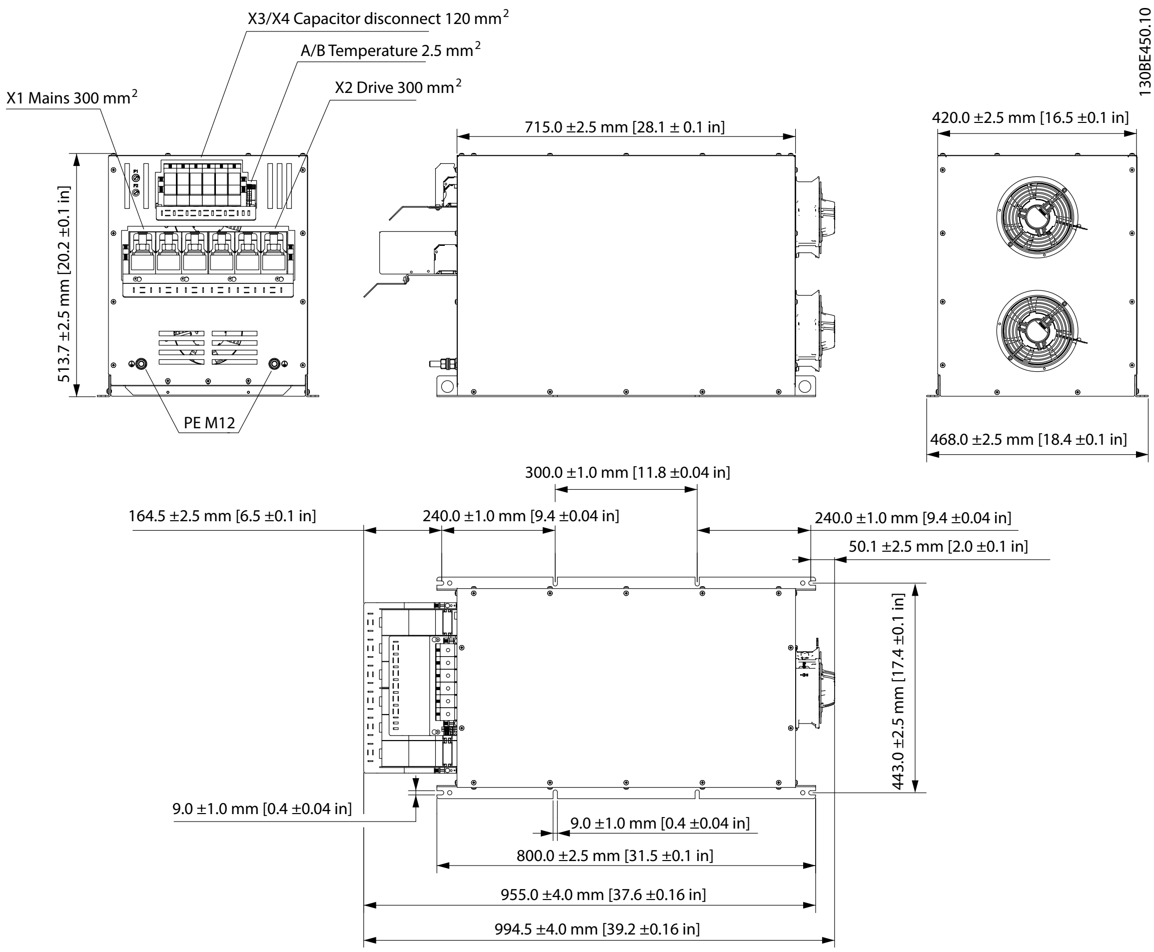

Illustration 7.59 IP20 X8 External Fan 2

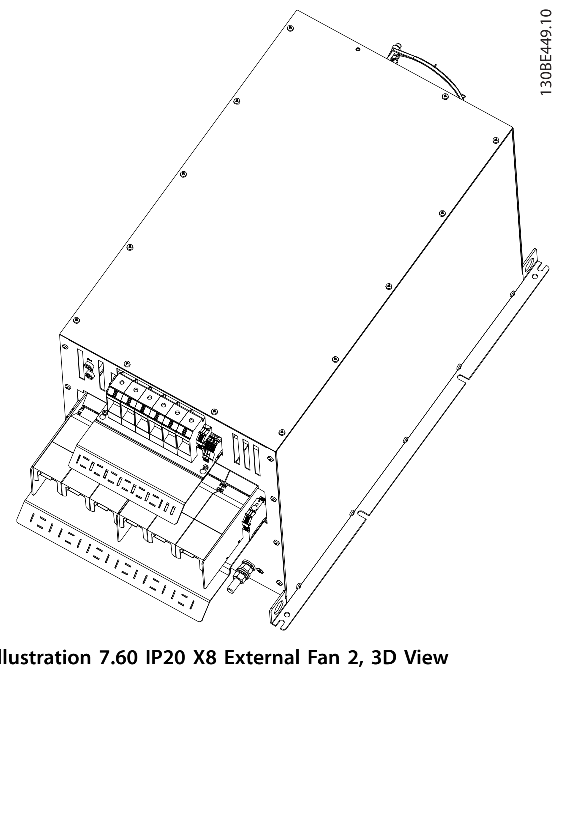

Illustration 7.60 IP20 X8 External Fan 2, 3D View

7.2.3 IP21 Enclosures

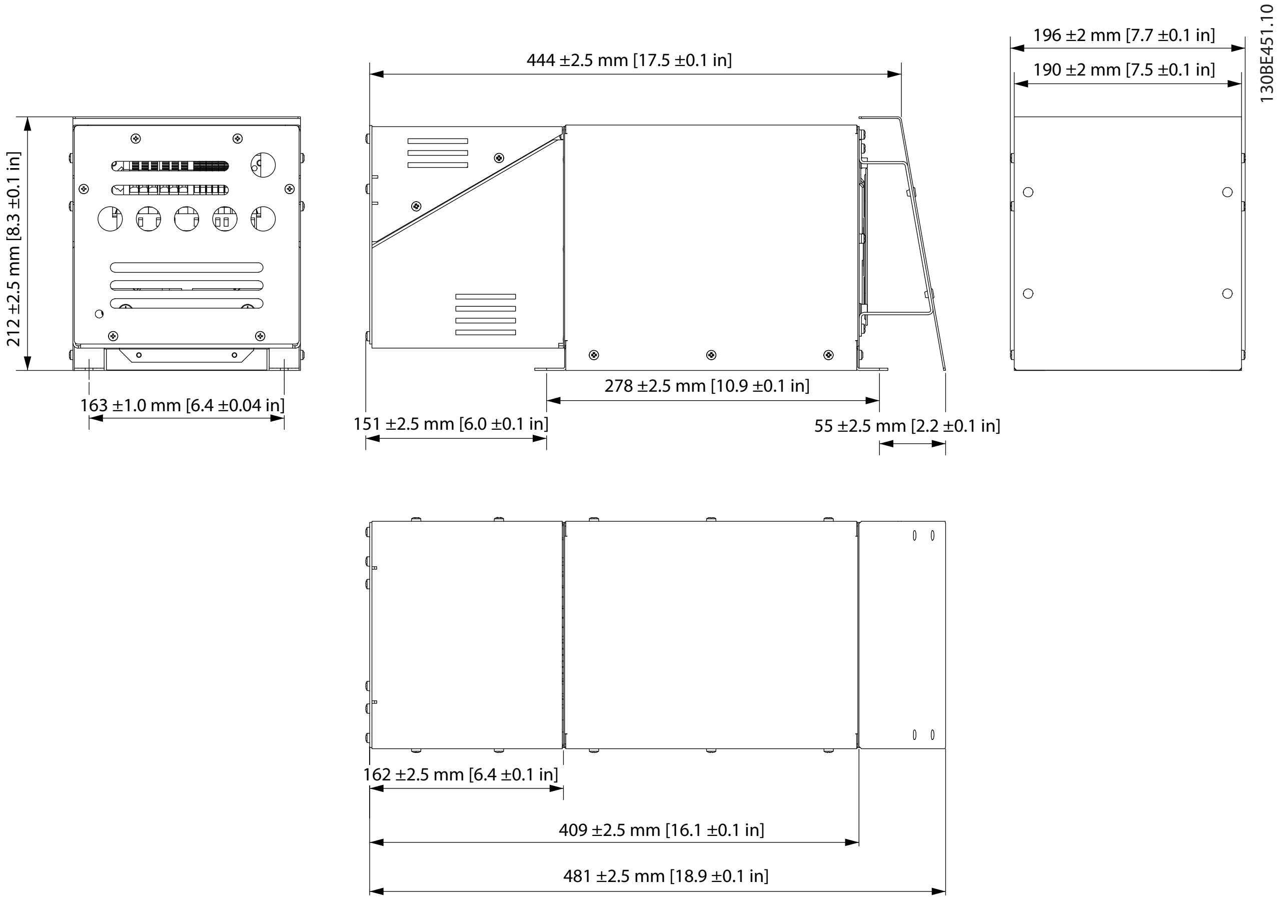

Illustration 7.61 IP21 X1 Internal Fan 1

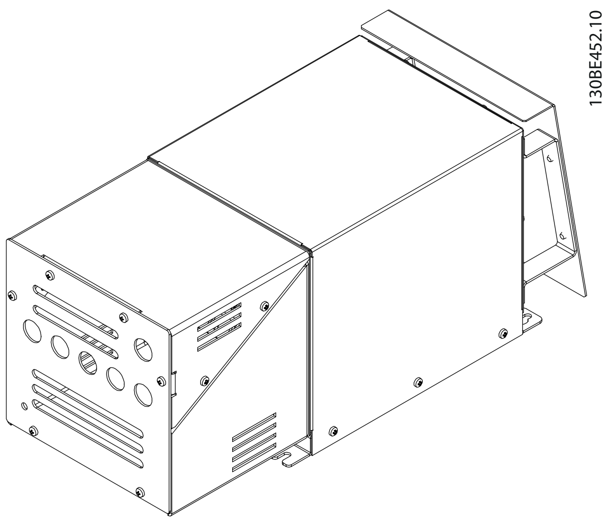

Illustration 7.62 IP21 X1 Internal Fan 1, 3D View

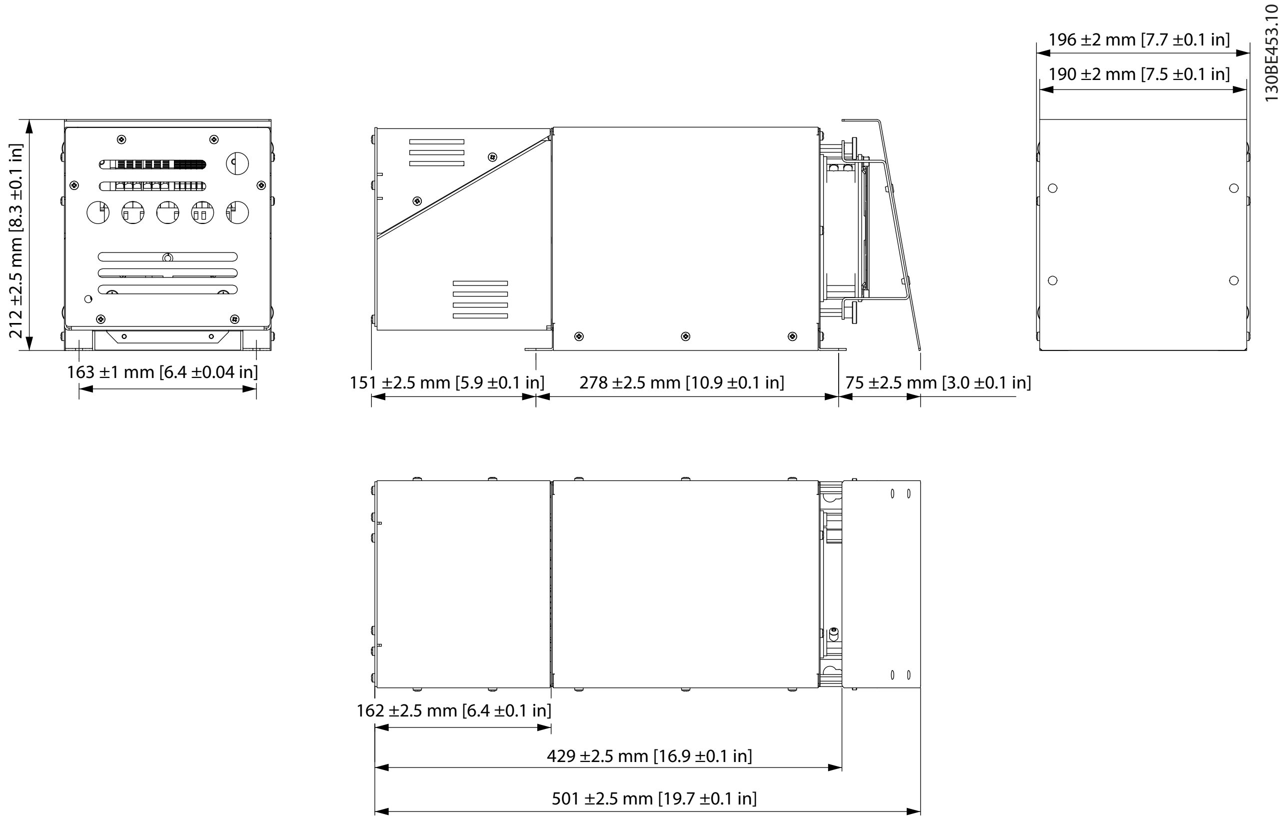

Illustration 7.63 IP21 X1 External Fan 1

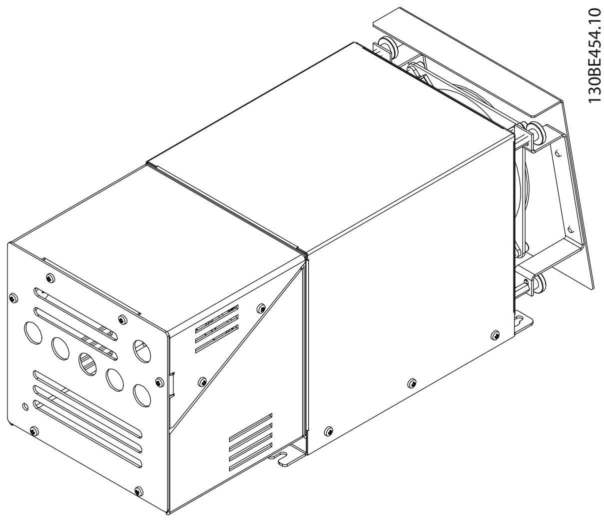

Illustration 7.64 IP21 X1 External Fan 1, 3D View

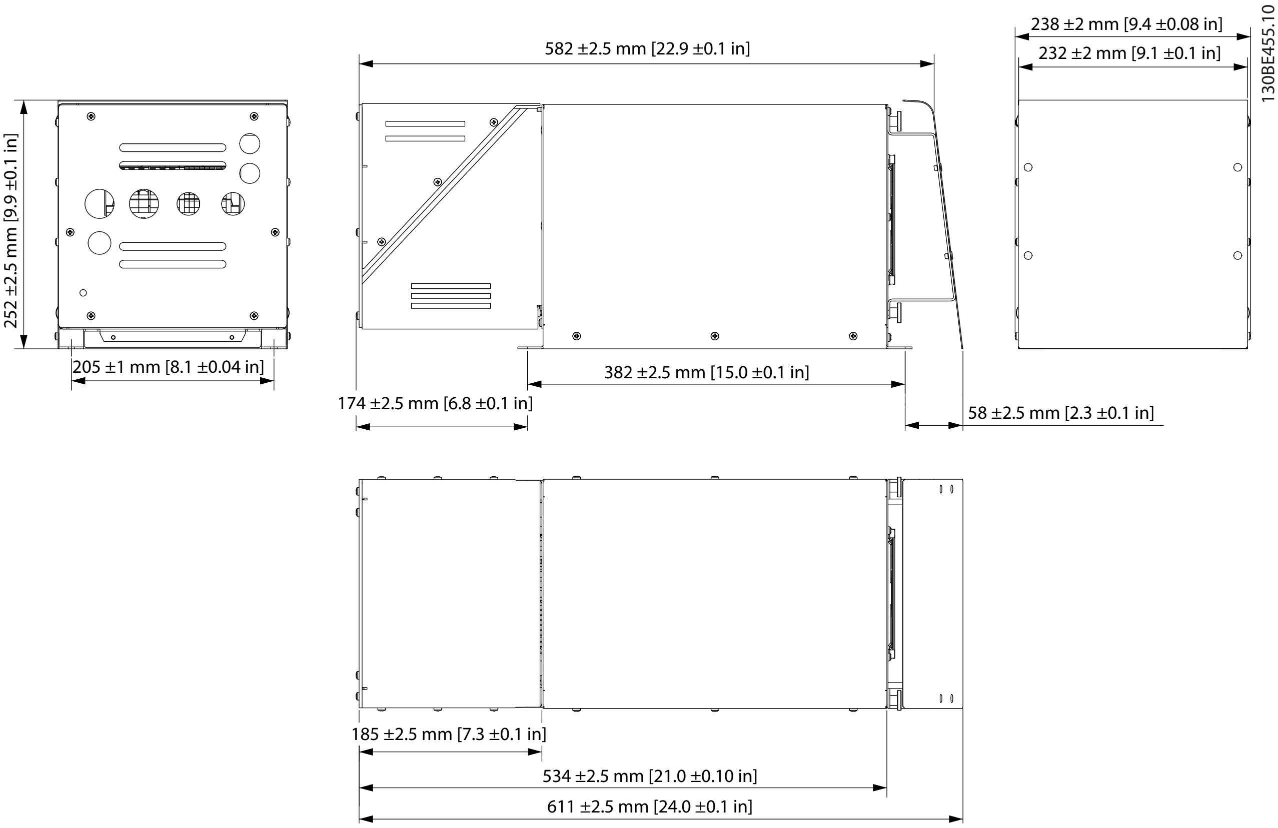

Illustration 7.65 IP21 X2 Internal Fan 1

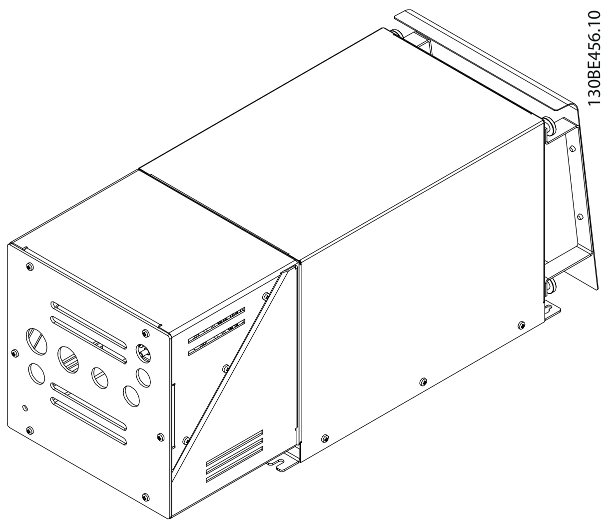

Illustration 7.66 IP21 X2 Internal Fan 1, 3D View

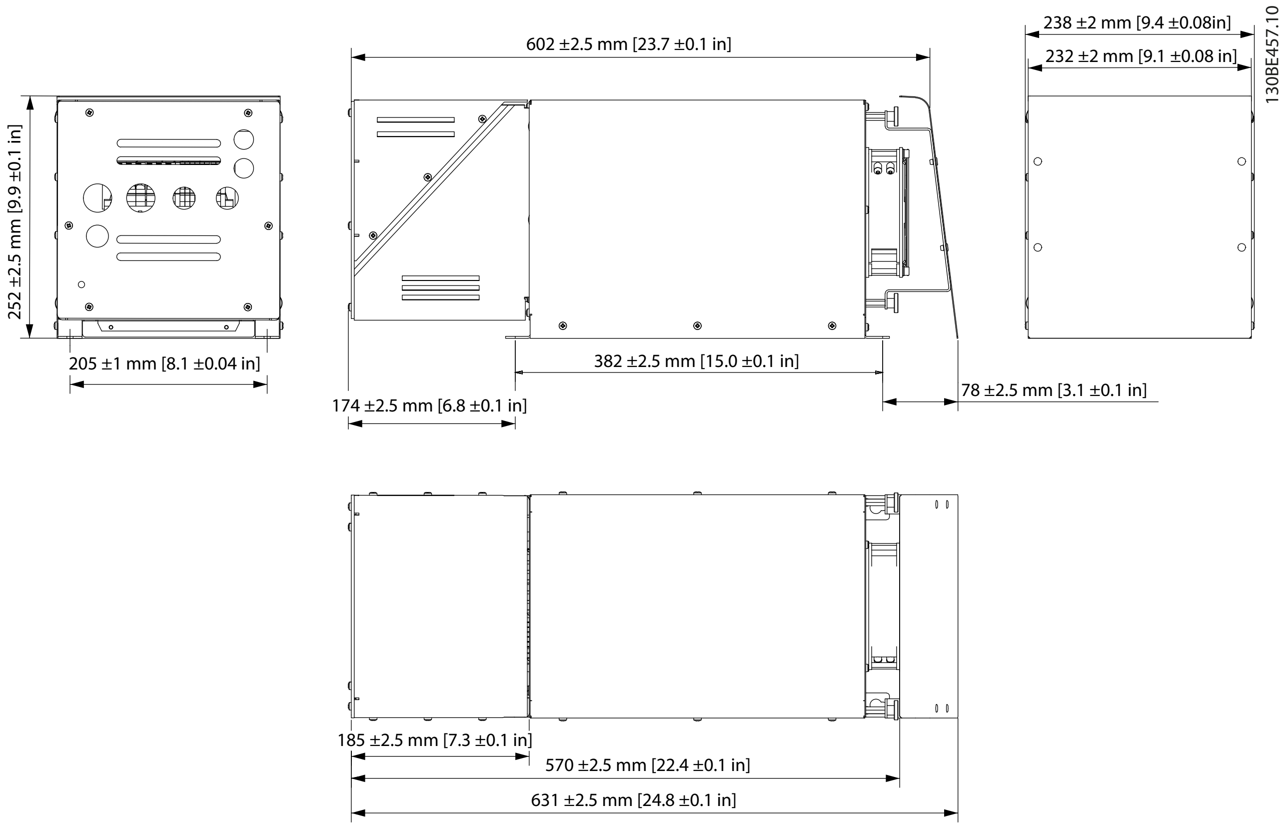

Illustration 7.67 IP21 X2 External Fan 1

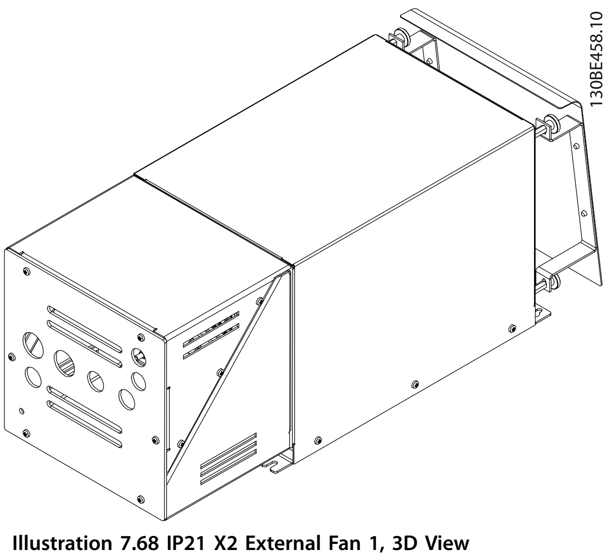

Illustration 7.68 IP21 X2 External Fan 1, 3D View

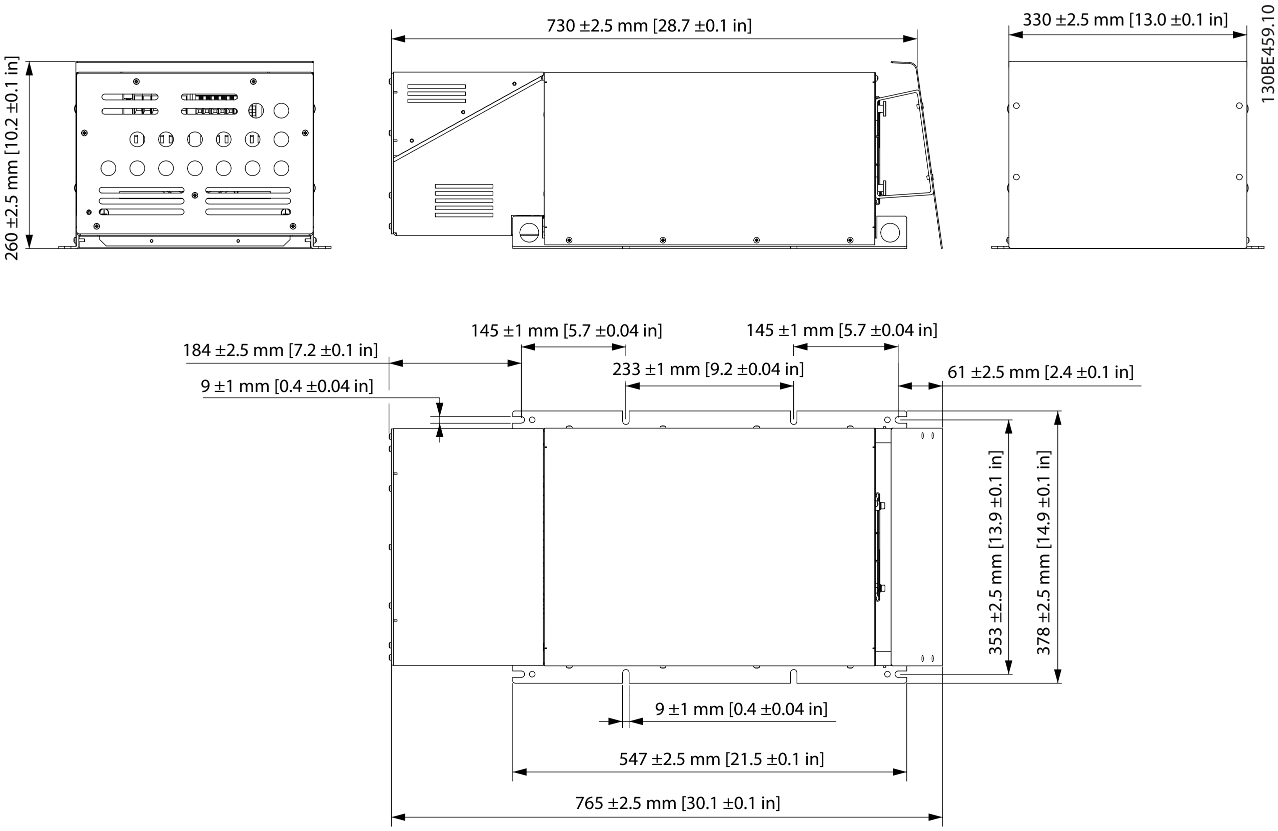

Illustration 7.69 IP21 X3 Internal Fan 1

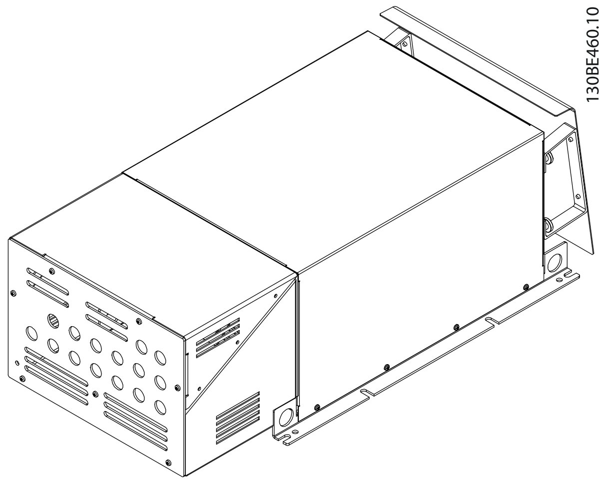

Illustration 7.70 IP21 X3 Internal Fan 1, 3D View

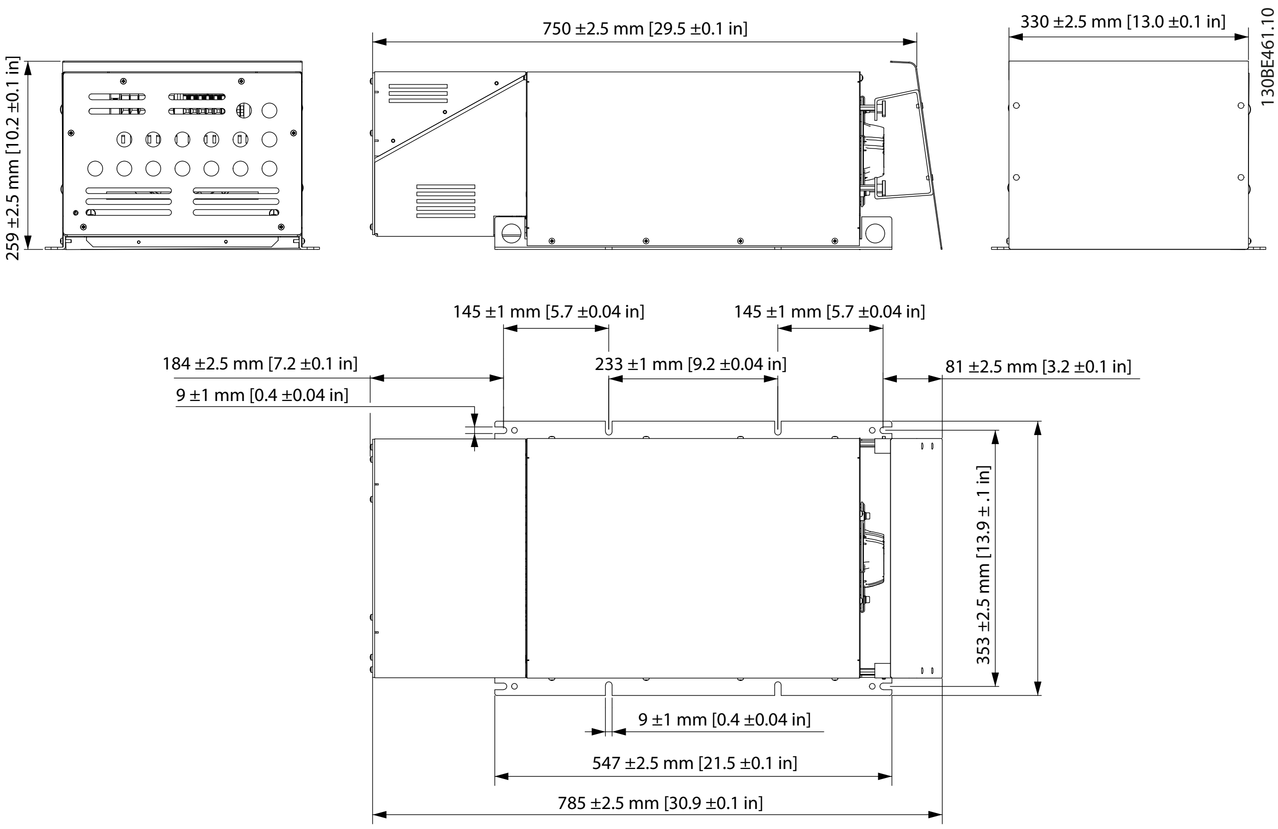

Illustration 7.71 IP21 X3 Internal Fan 2

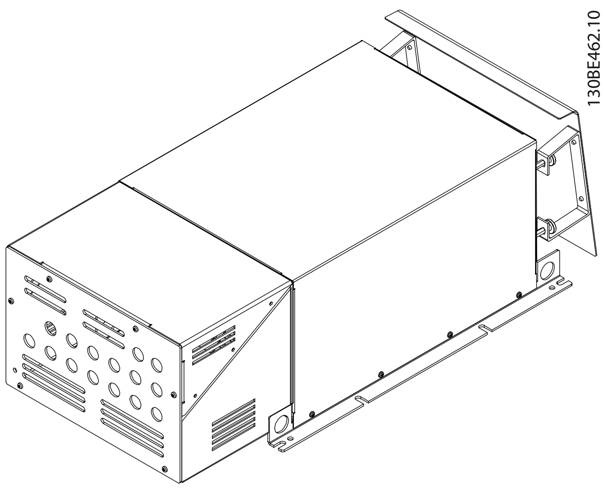

Illustration 7.72 IP21 X3 Internal Fan 2, 3D View

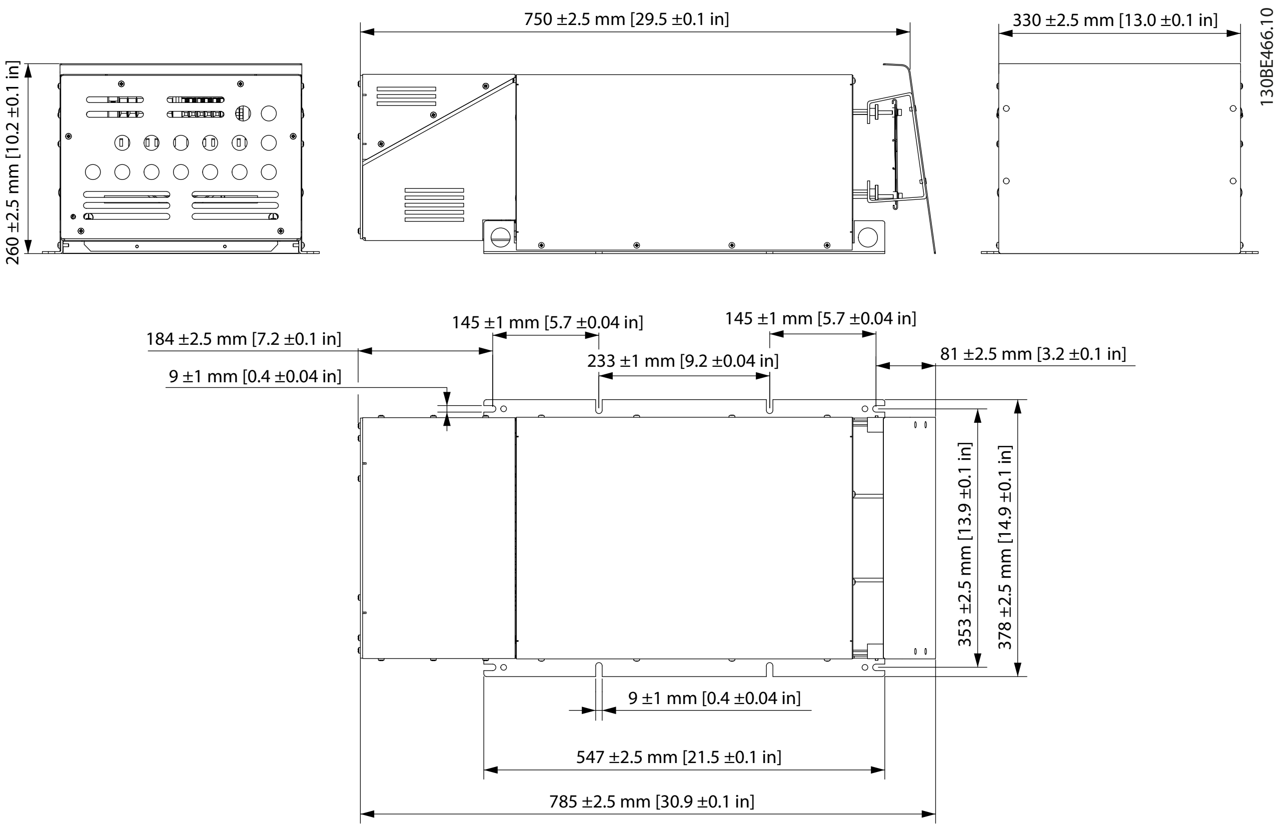

Illustration 7.73 IP21 X3 External Fan 1

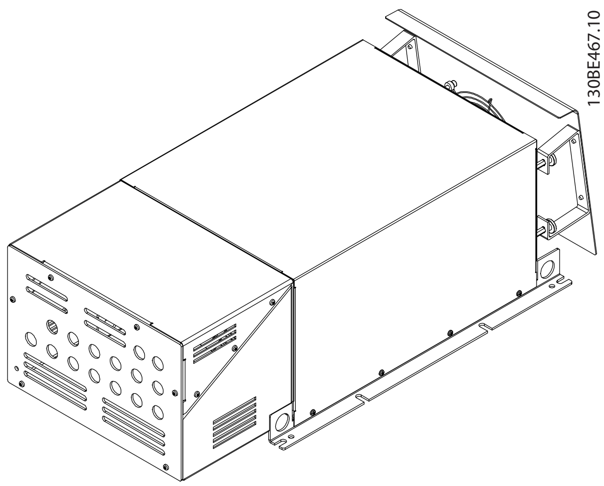

Illustration 7.74 IP21 X3 External Fan 1, 3D View

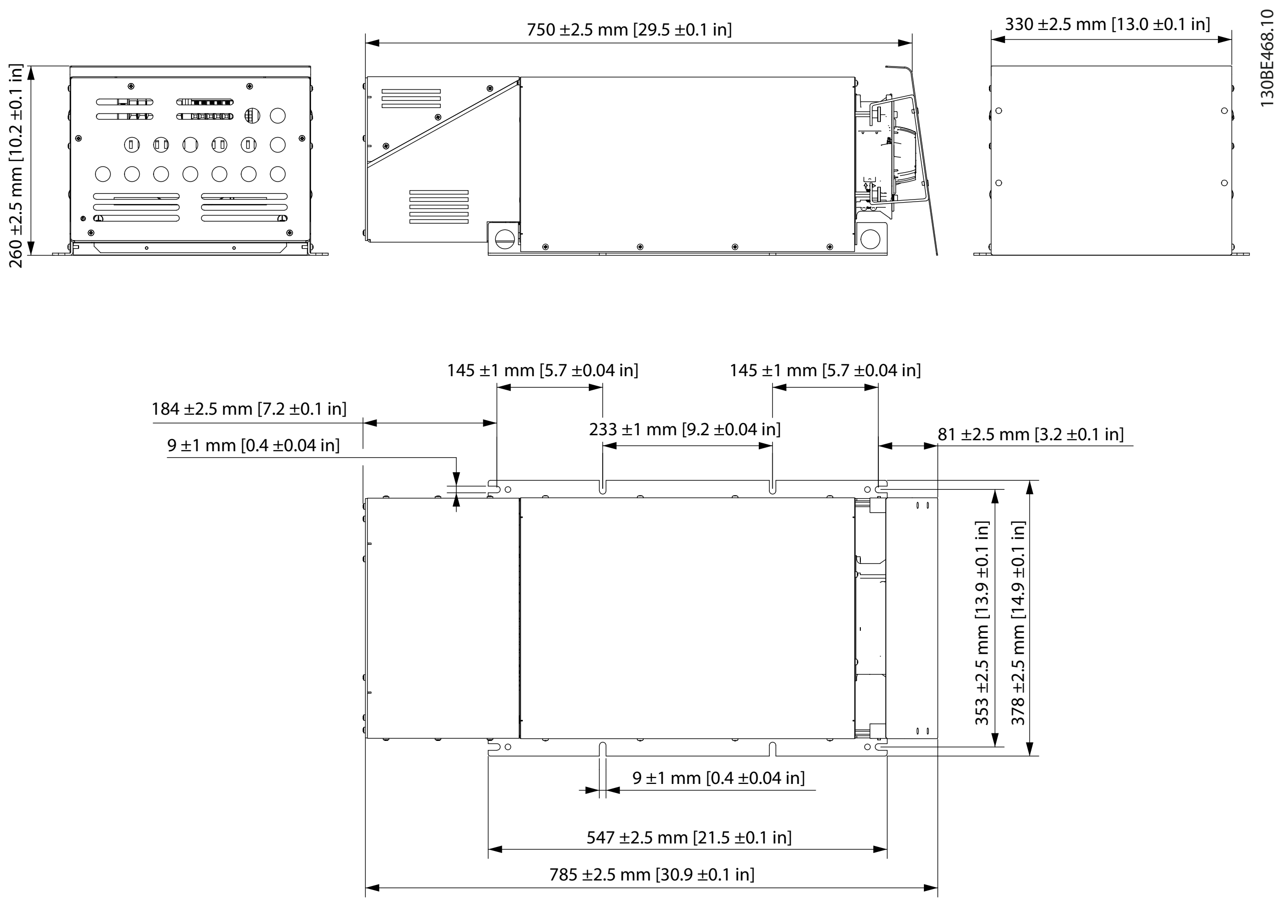

Illustration 7.75 IP21 X3 External Fan 2

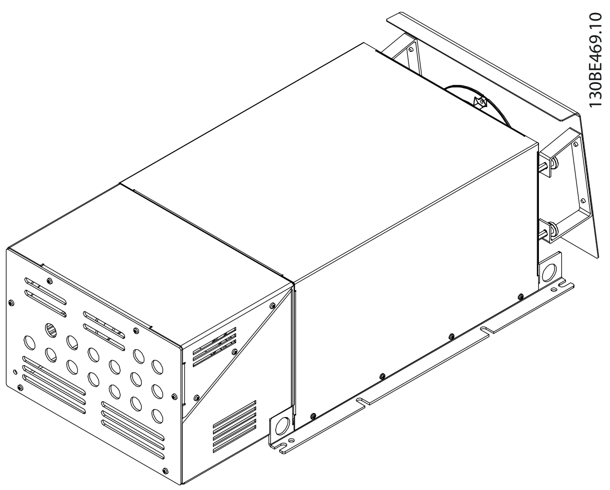

Illustration 7.76 IP21 X3 External Fan 2, 3D View

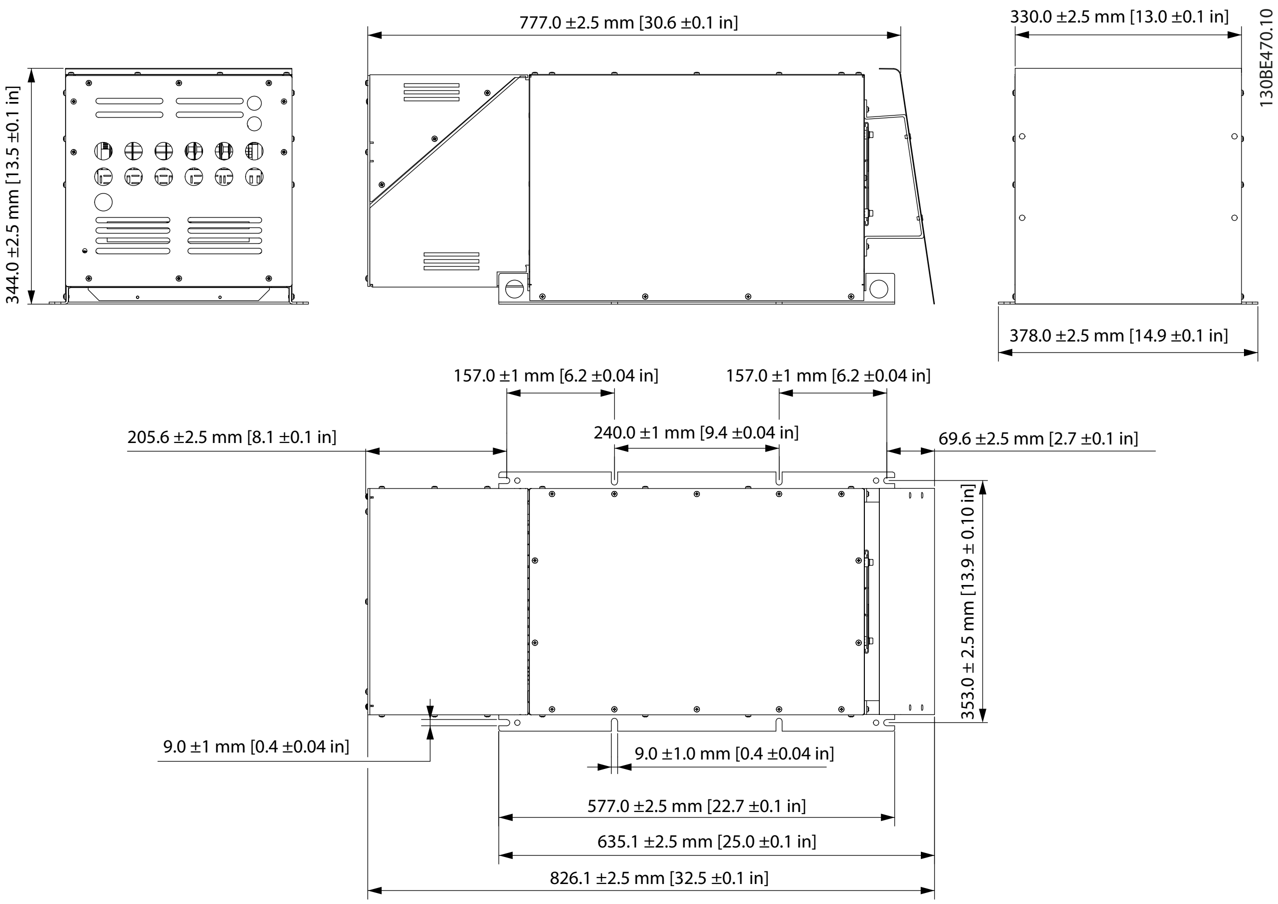

Illustration 7.77 IP21 X4 Internal Fan 1

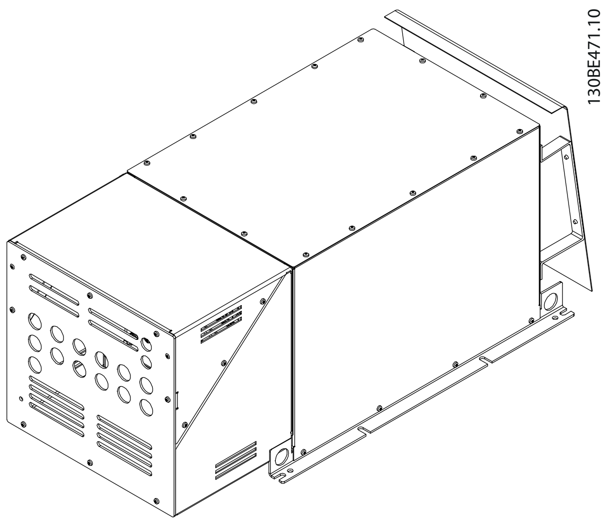

Illustration 7.78 IP21 X4 Internal Fan 1, 3D View

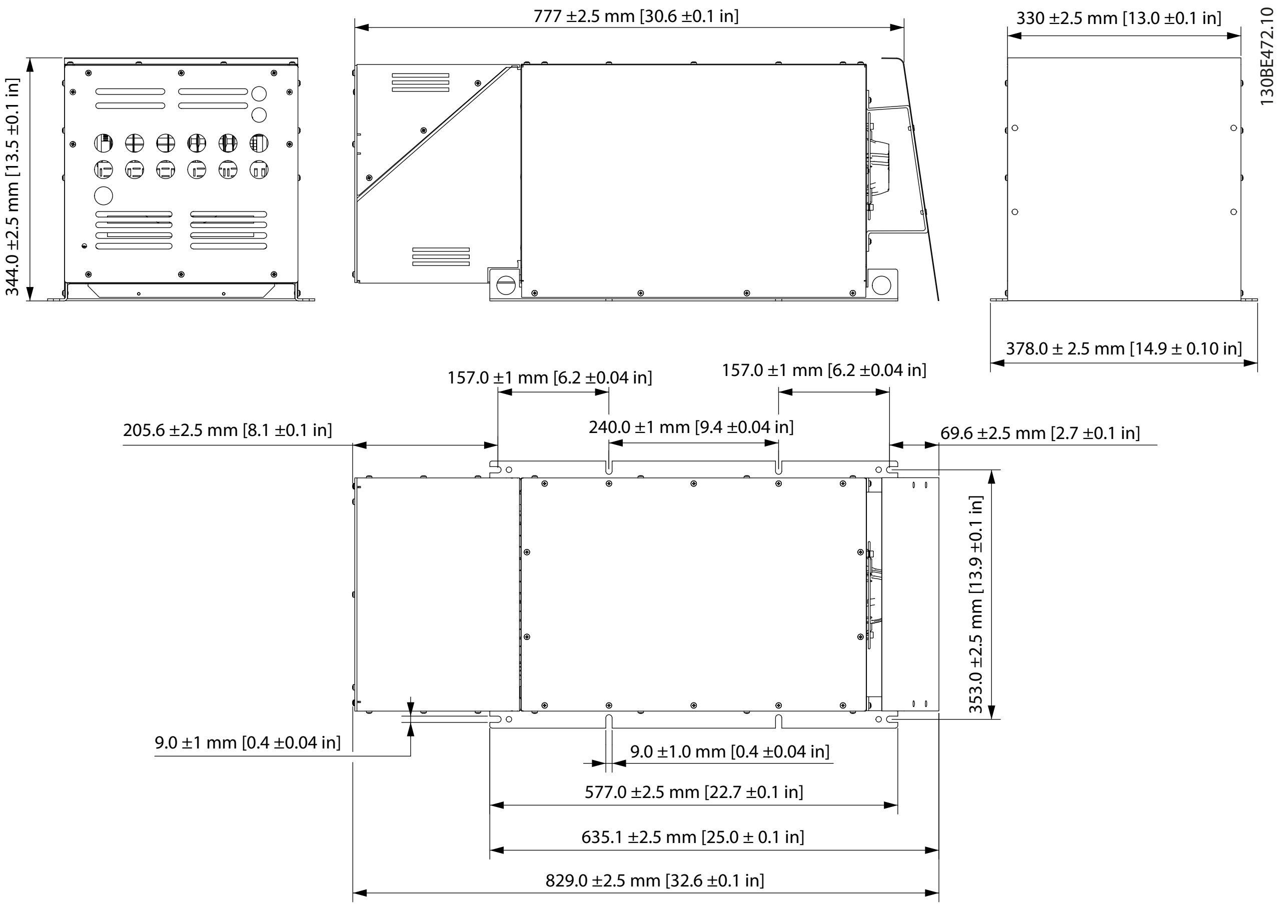

Illustration 7.79 IP21 X4 Internal Fan 2

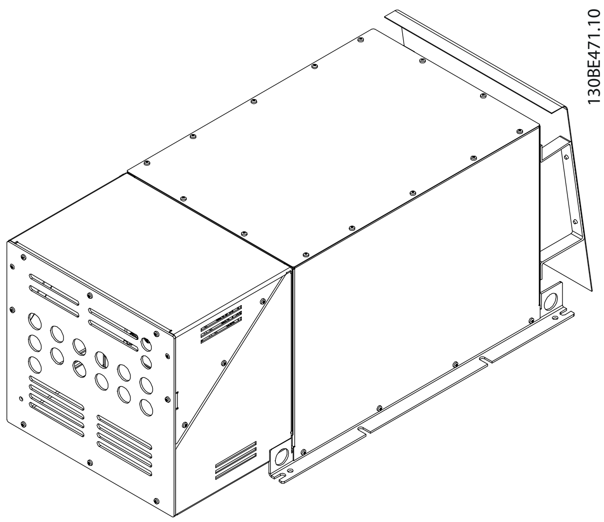

Illustration 7.80 IP21 X4 Internal Fan 2, 3D View

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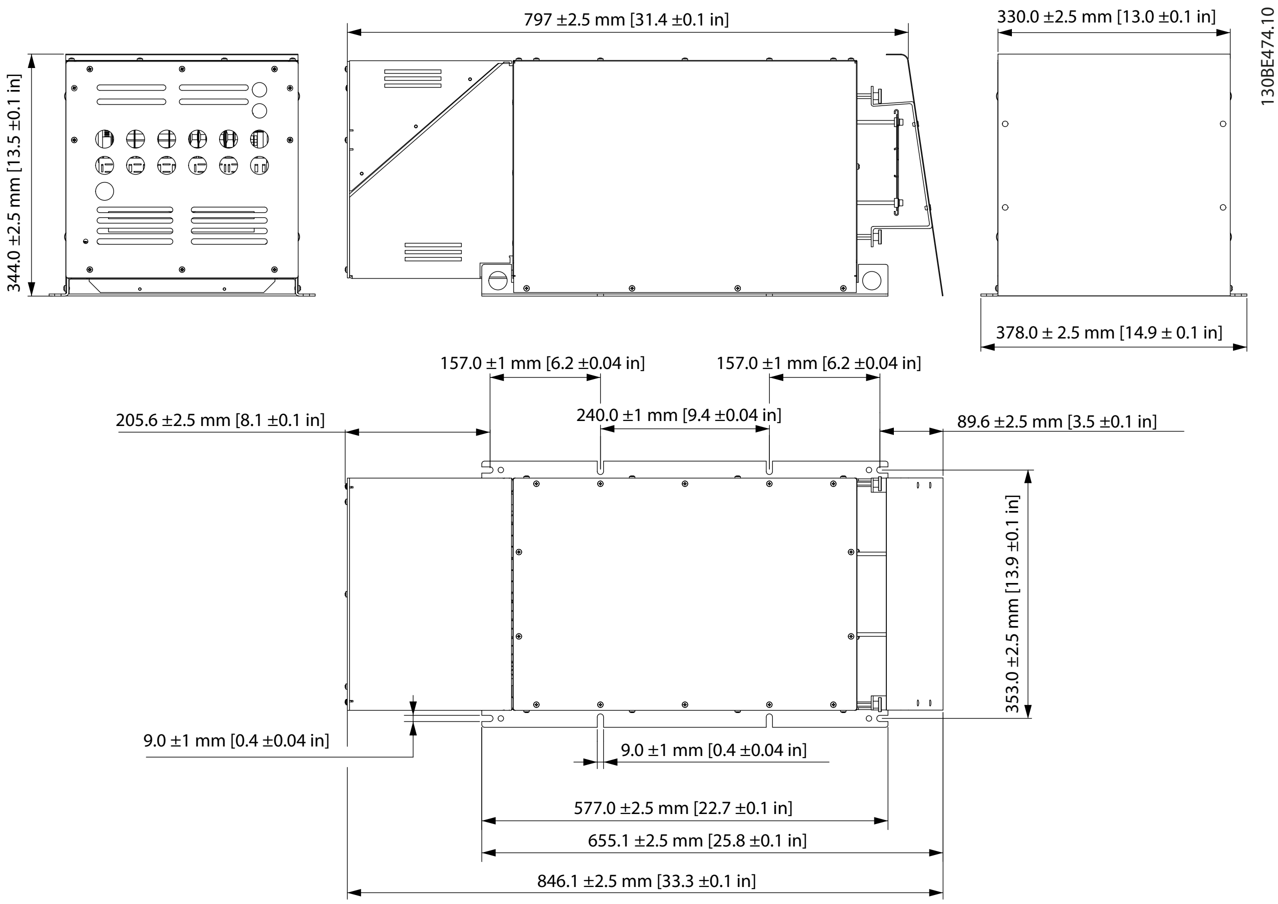

Illustration 7.81 IP21 X4 External Fan 1

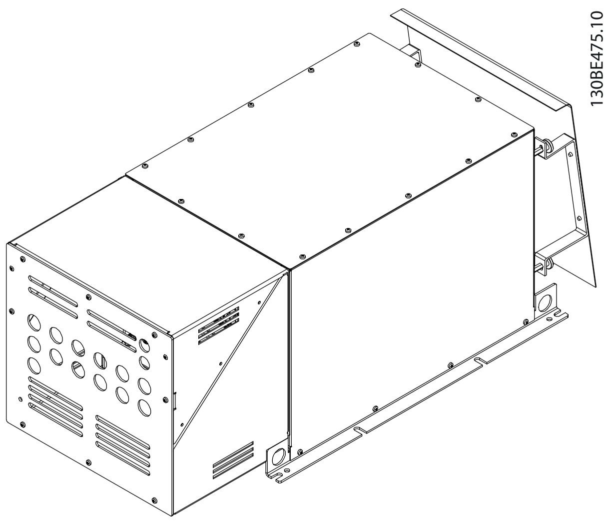

Illustration 7.82 IP21 X4 External Fan 1, 3D View

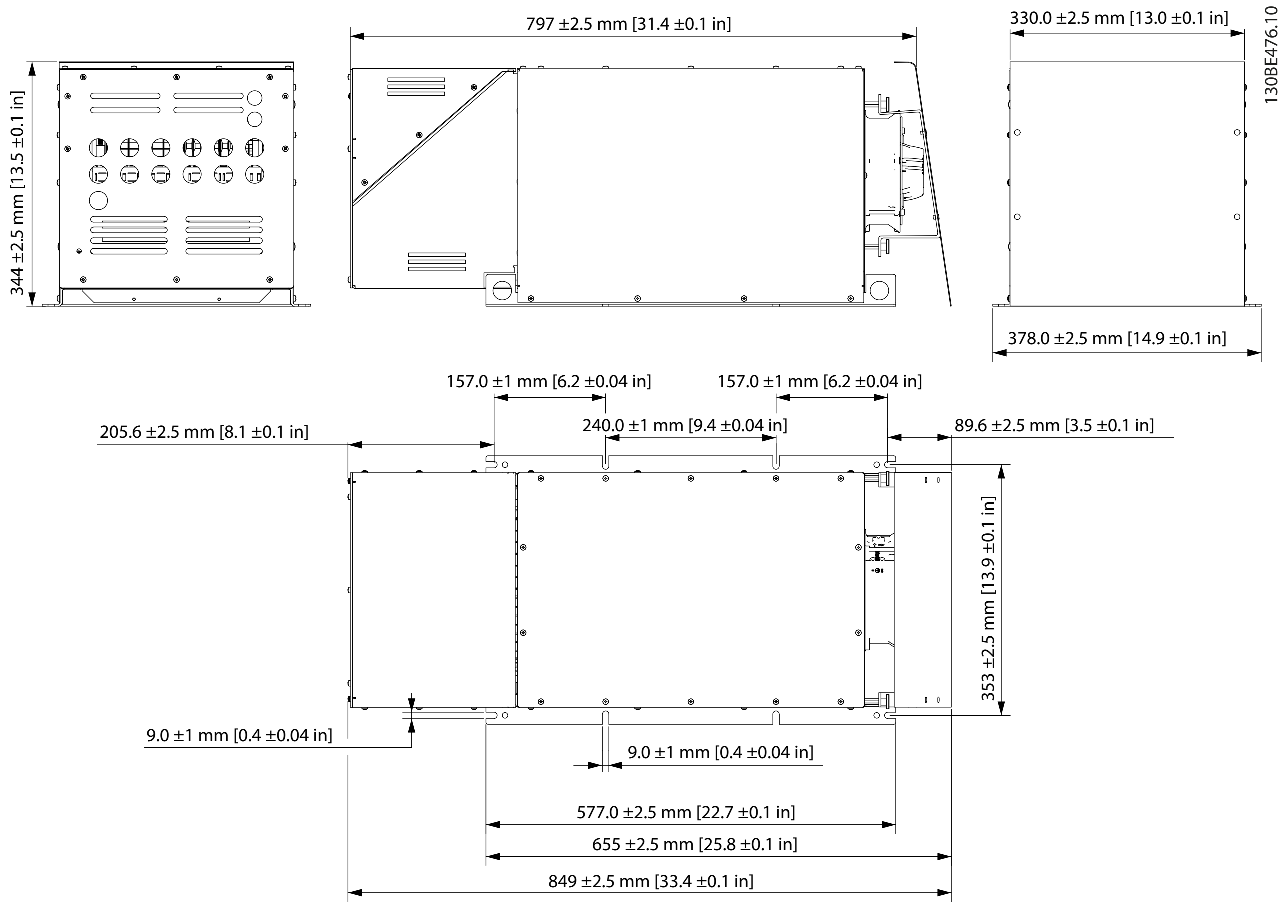

Illustration 7.83 IP21 X4 External Fan 2

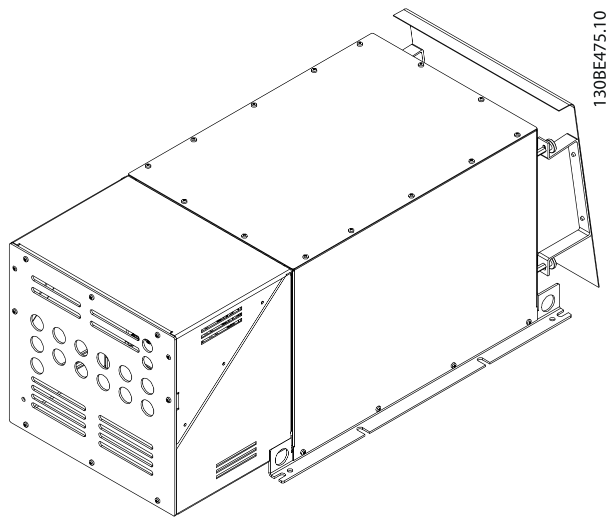

Illustration 7.84 IP21 X4 External Fan 2, 3D View

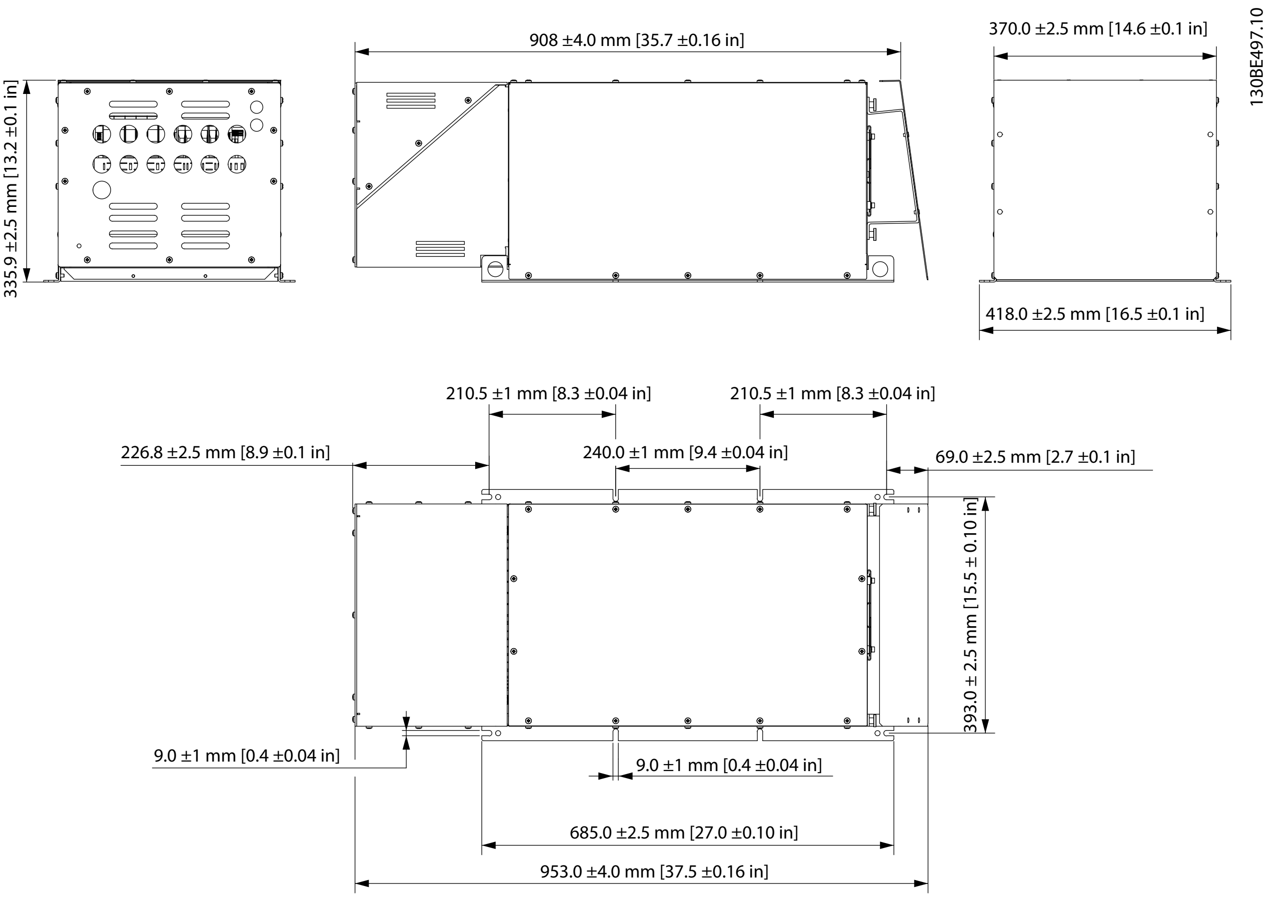

Illustration 7.85 IP21 X5 Internal Fan 1

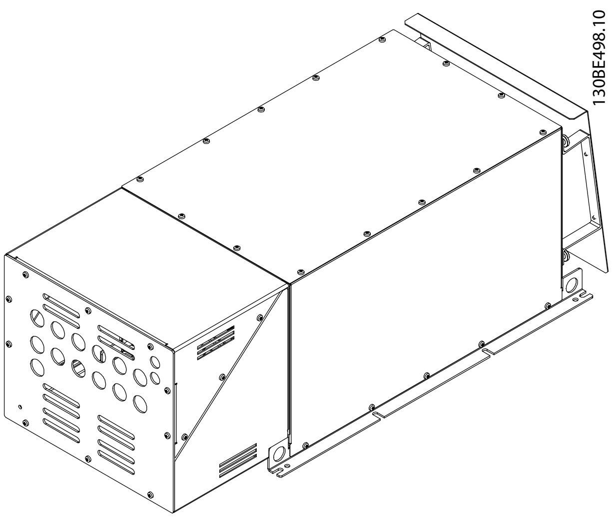

Illustration 7.86 IP21 X5 Internal Fan 1, 3D View

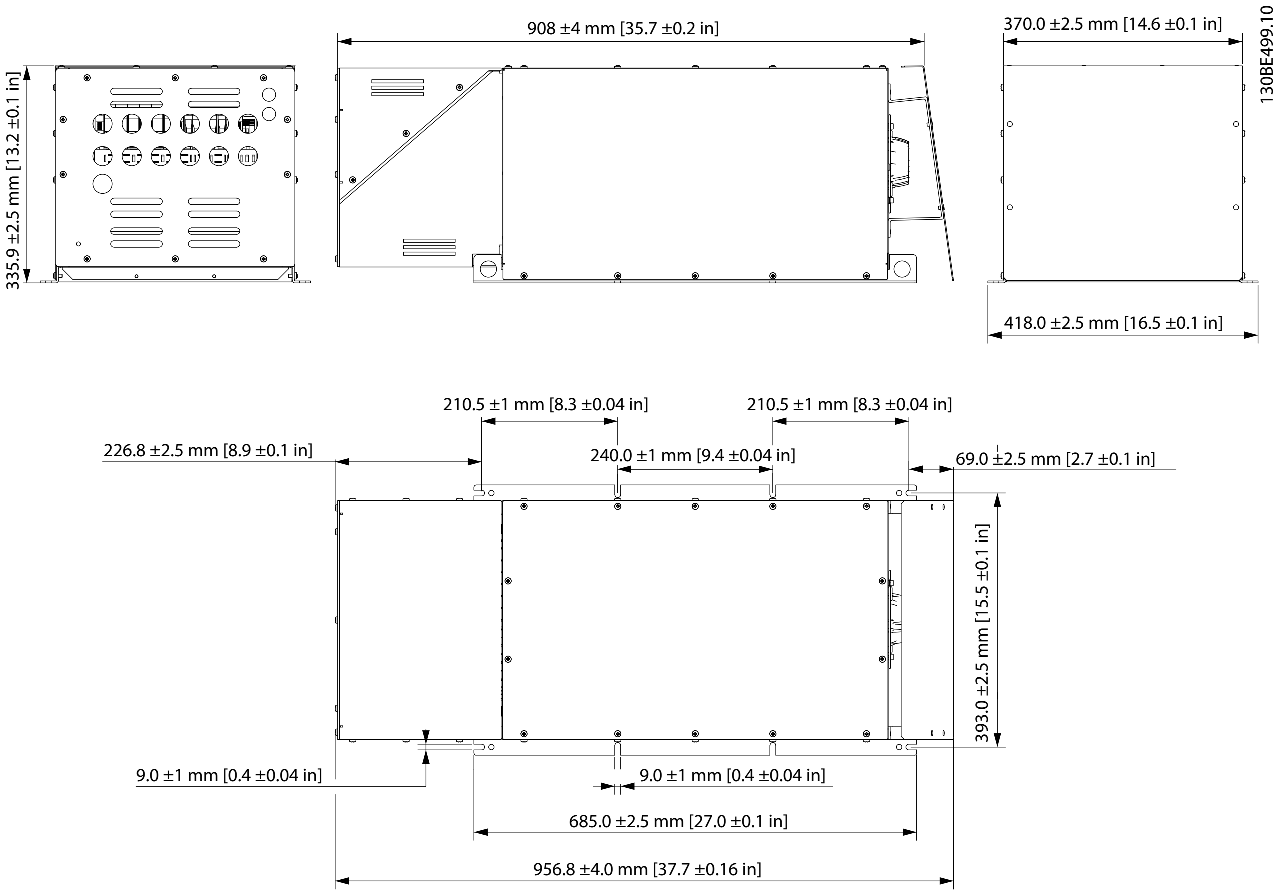

Illustration 7.87 IP21 X5 Internal Fan 2

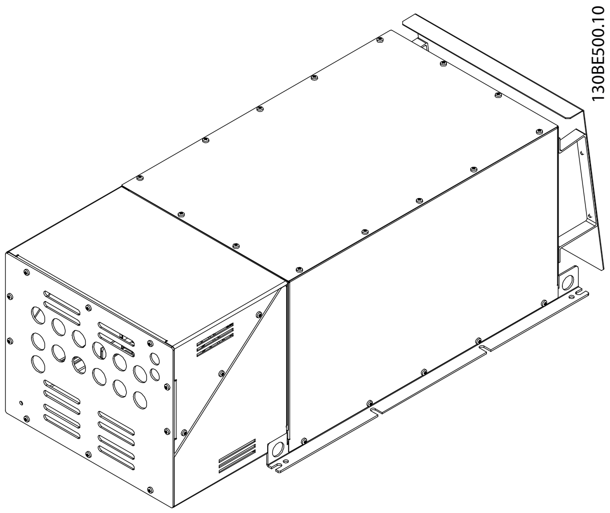

Illustration 7.88 IP21 X5 Internal Fan 2, 3D View

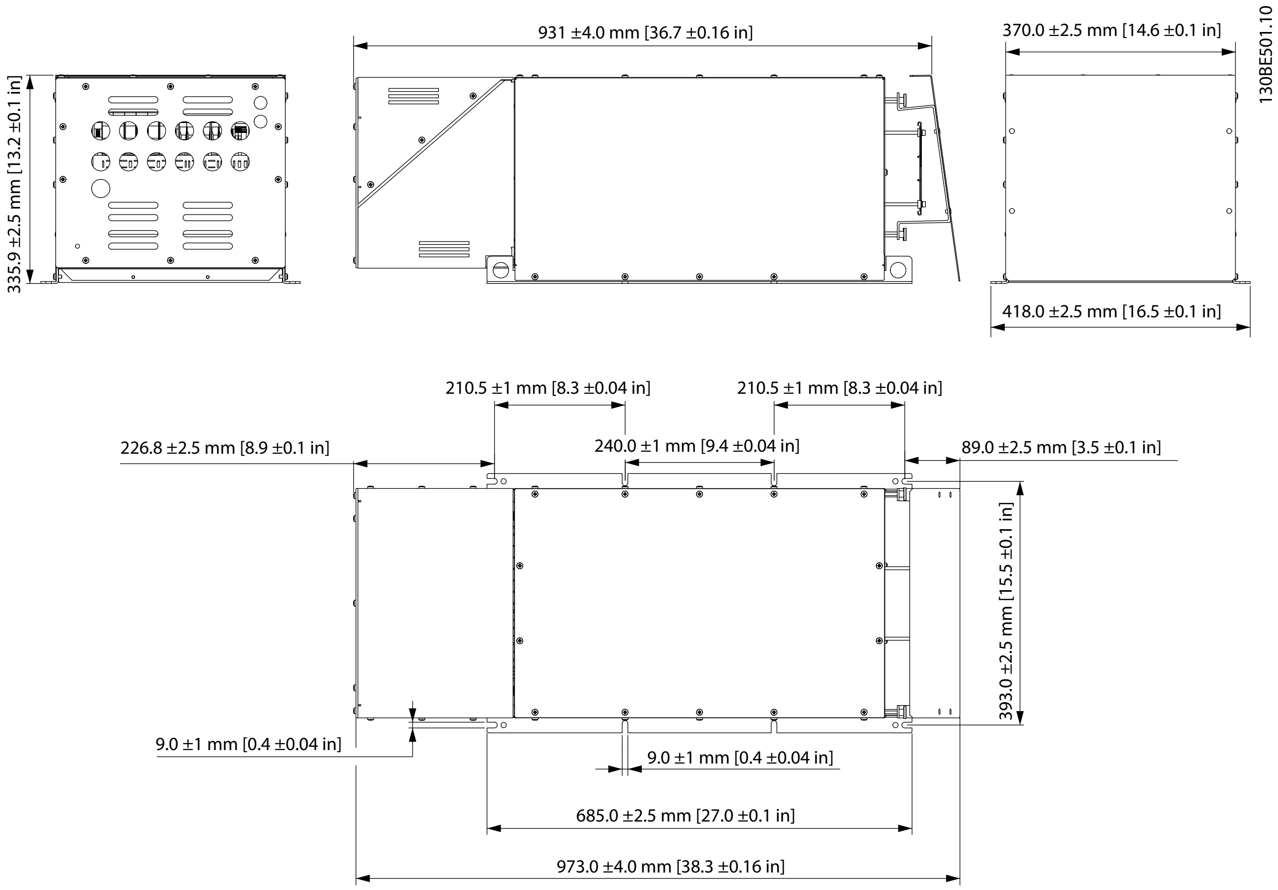

Illustration 7.89 IP21 X5 External Fan 1

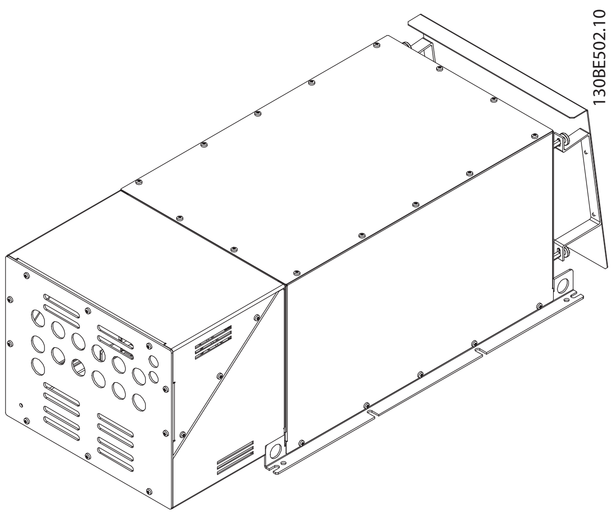

Illustration 7.90 IP21 X5 External Fan 1, 3D View

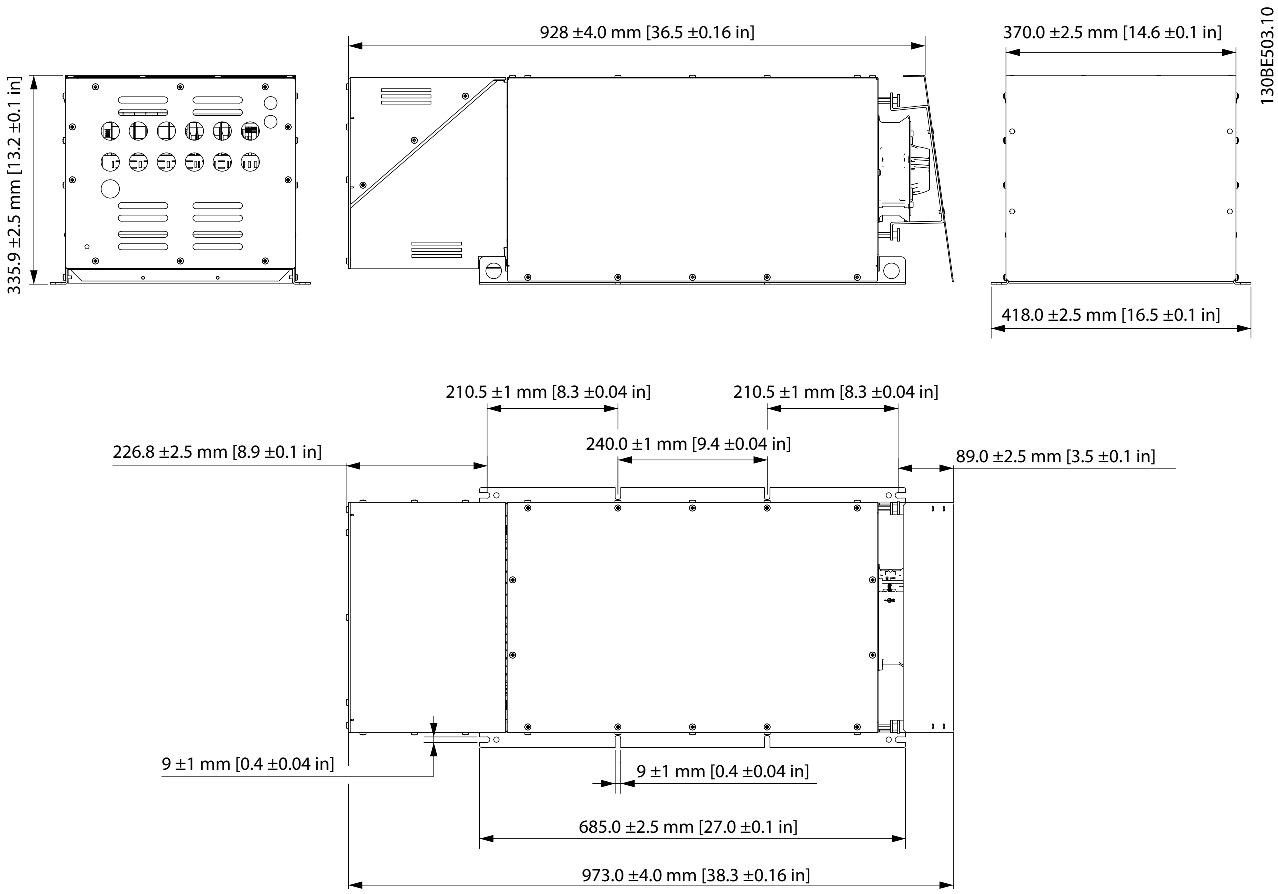

Illustration 7.91 IP21 X5 External Fan 2

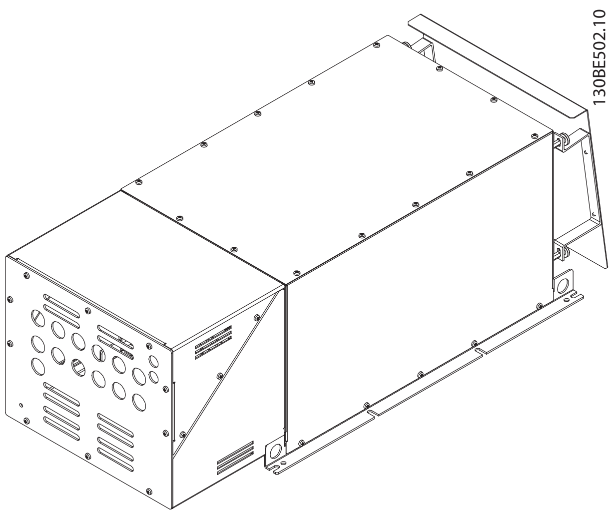

Illustration 7.92 IP21 X5 External Fan 2, 3D View

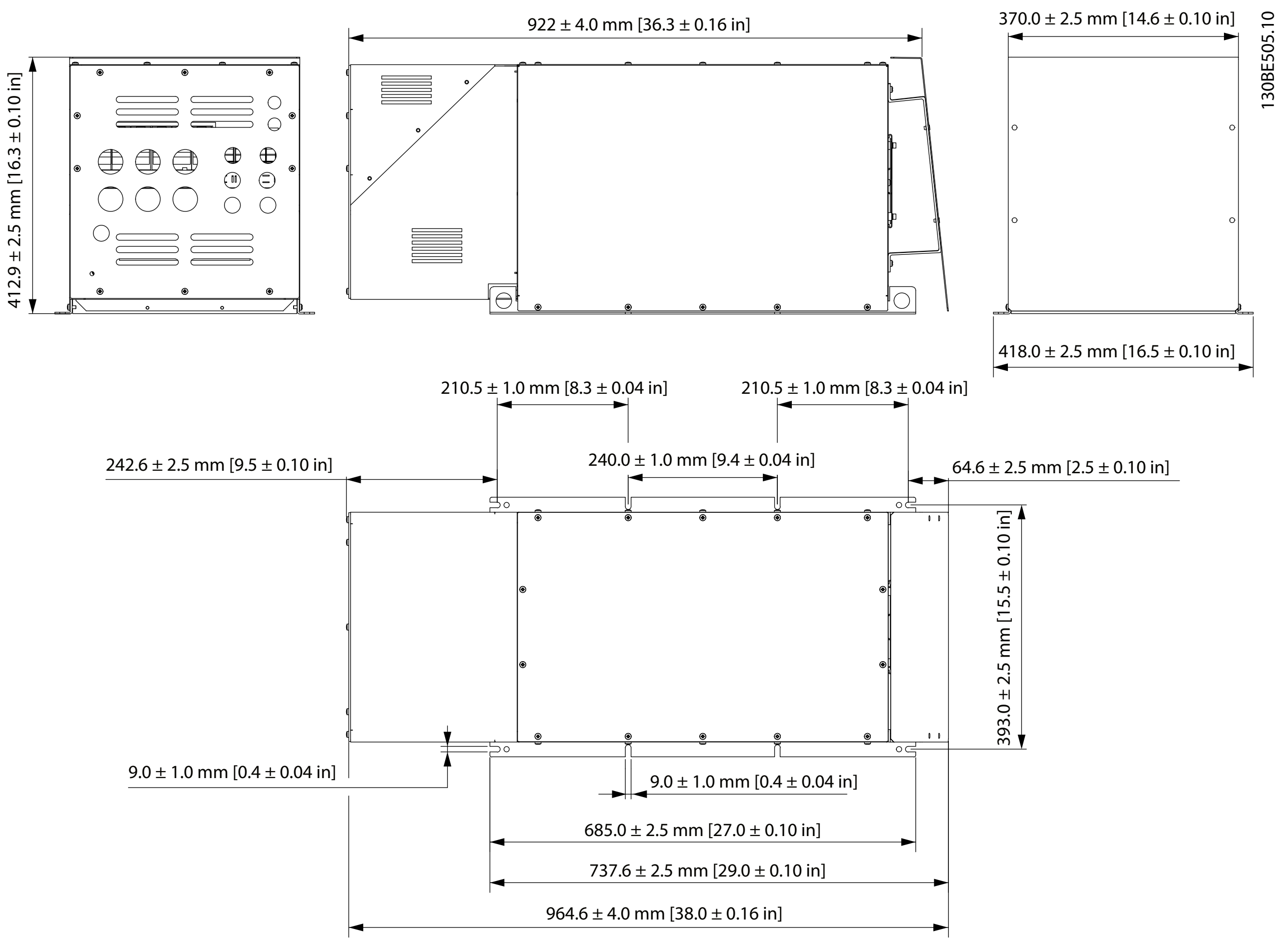

Illustration 7.93 IP21 X6 Internal Fan 1

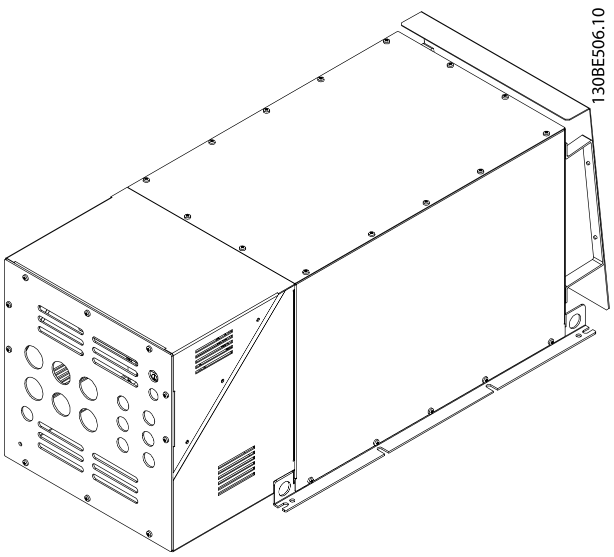

Illustration 7.94 IP21 X6 Internal Fan 1, 3D View

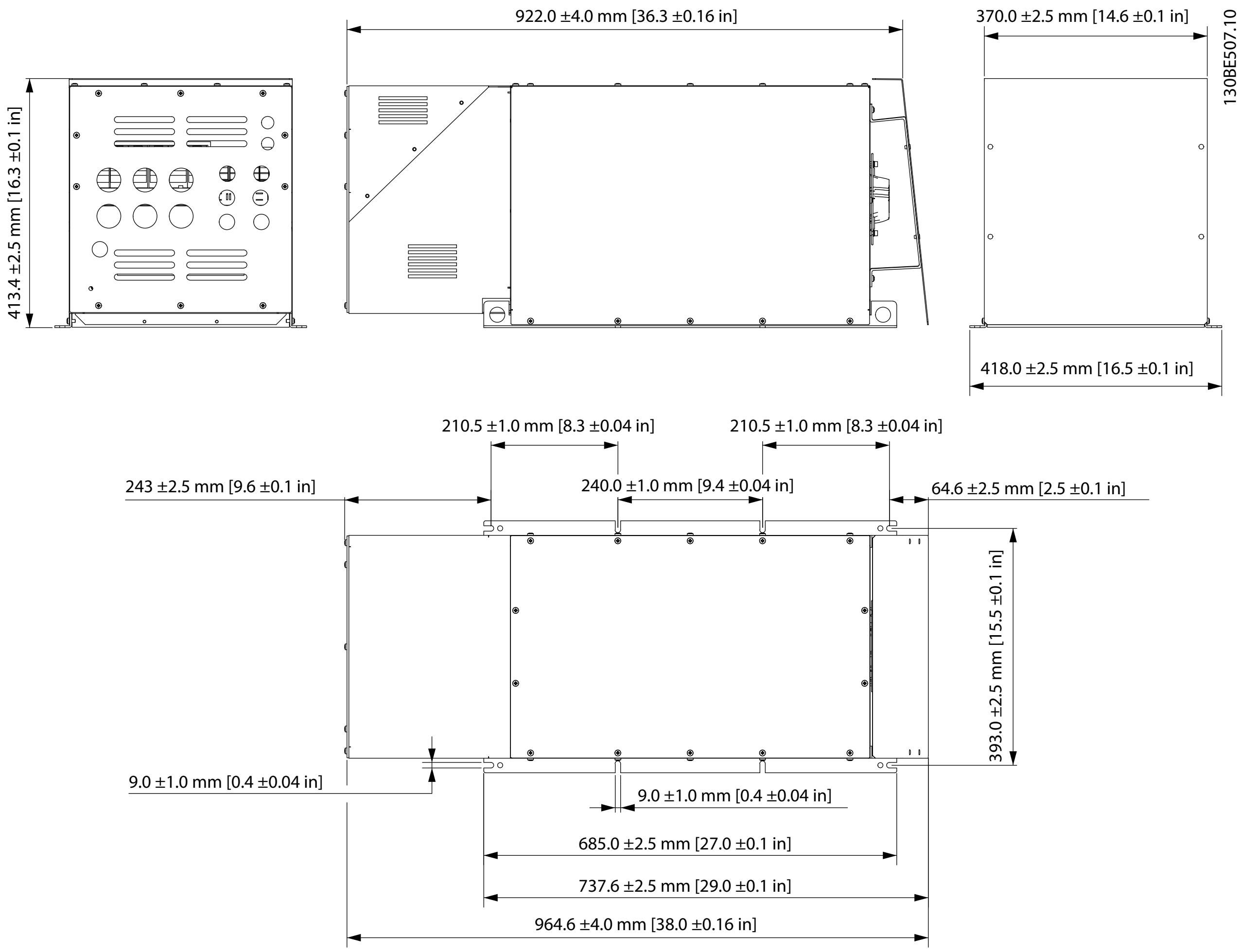

Illustration 7.95 IP21 X6 Internal Fan 2

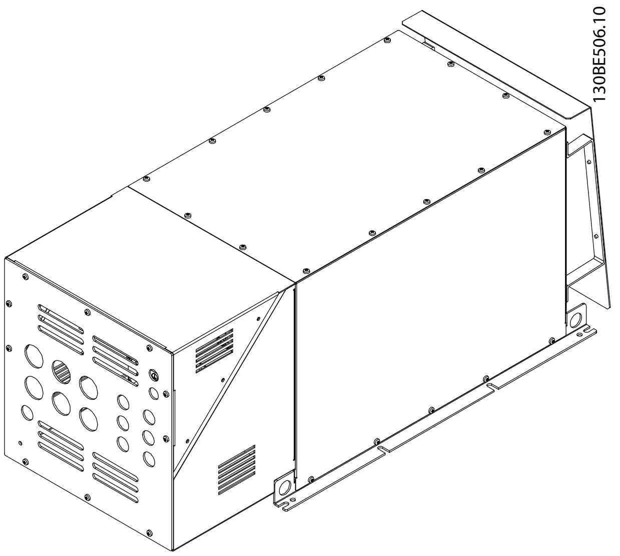

Illustration 7.96 IP21 X6 Internal Fan 2, 3D View

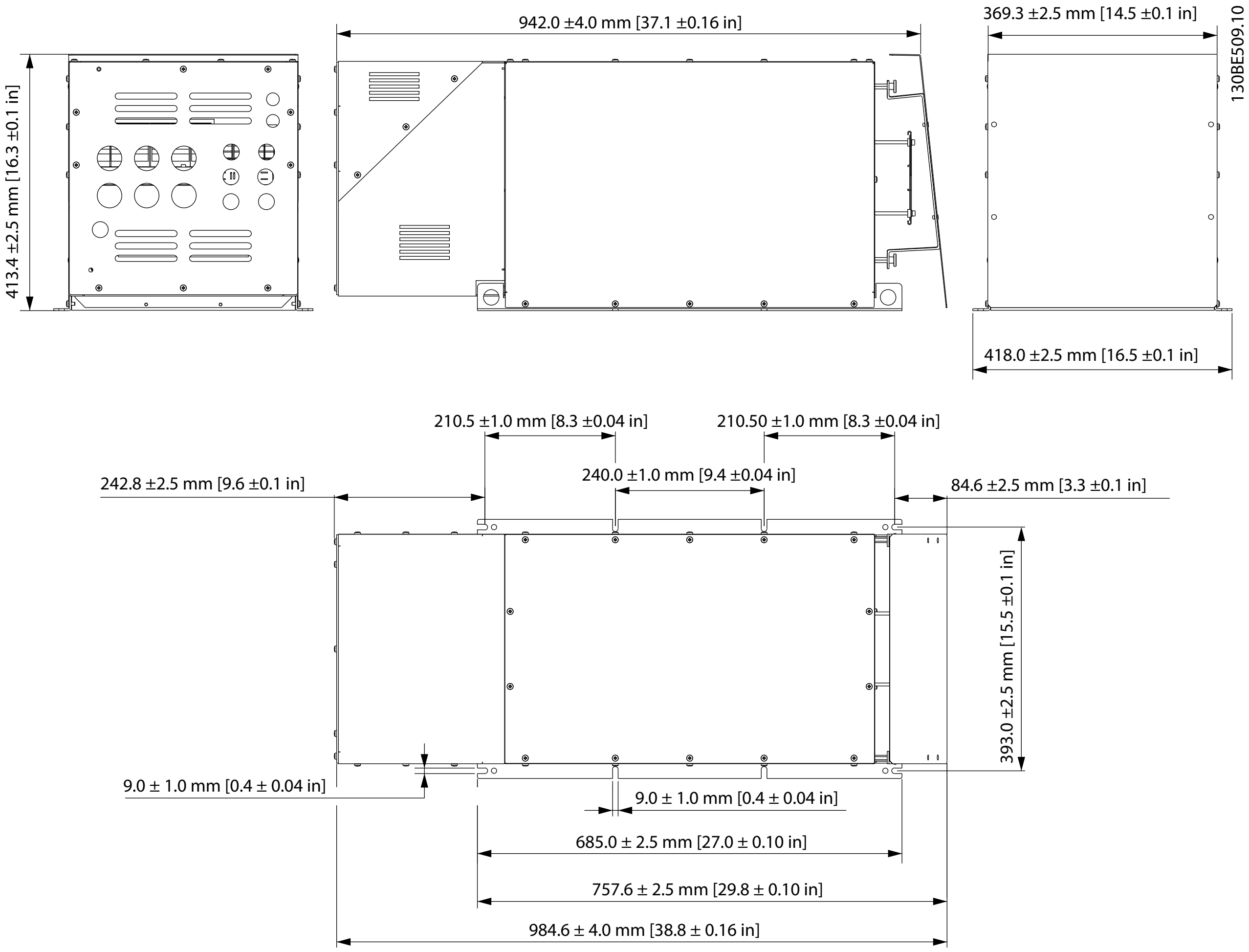

Illustration 7.97 IP21 X6 External Fan 1

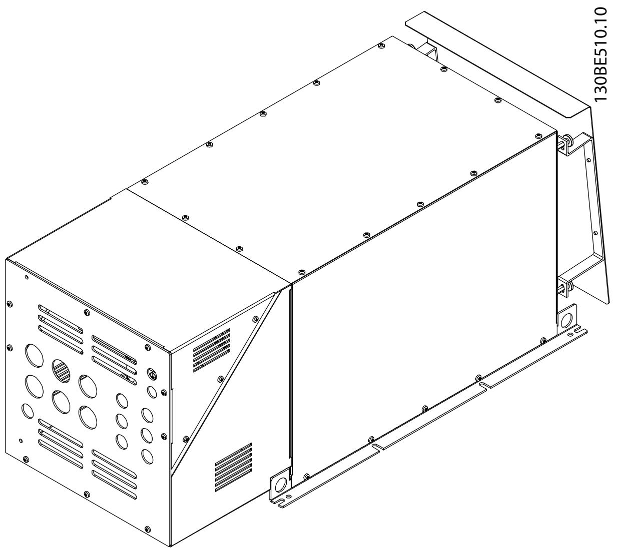

Illustration 7.98 IP21 X6 External Fan 1, 3D View

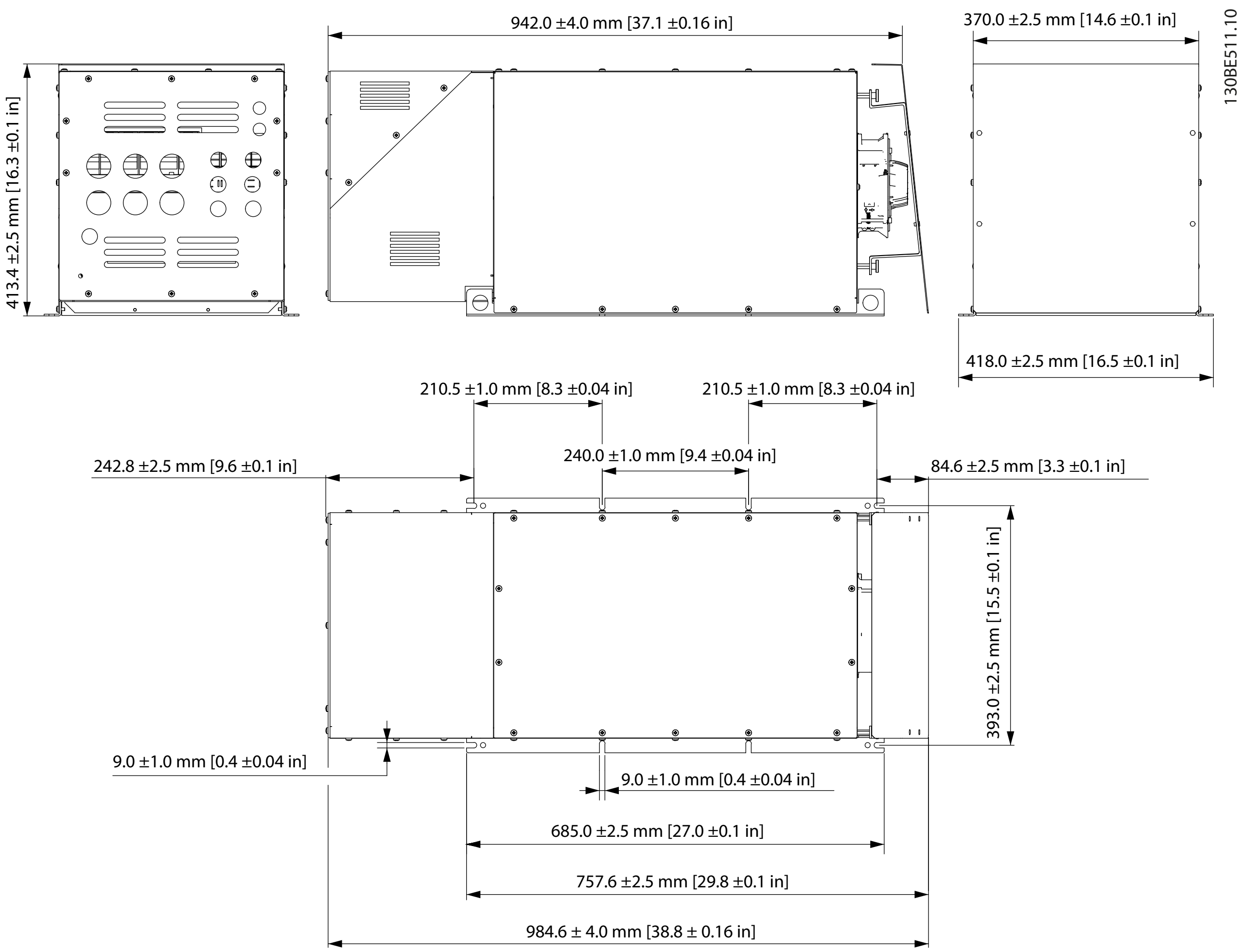

Illustration 7.99 IP21 X6 External Fan 2

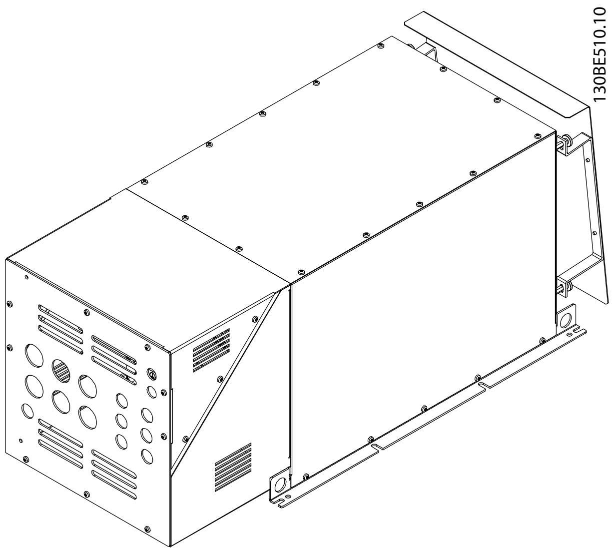

Illustration 7.100 IP21 X6 External Fan 2, 3D View

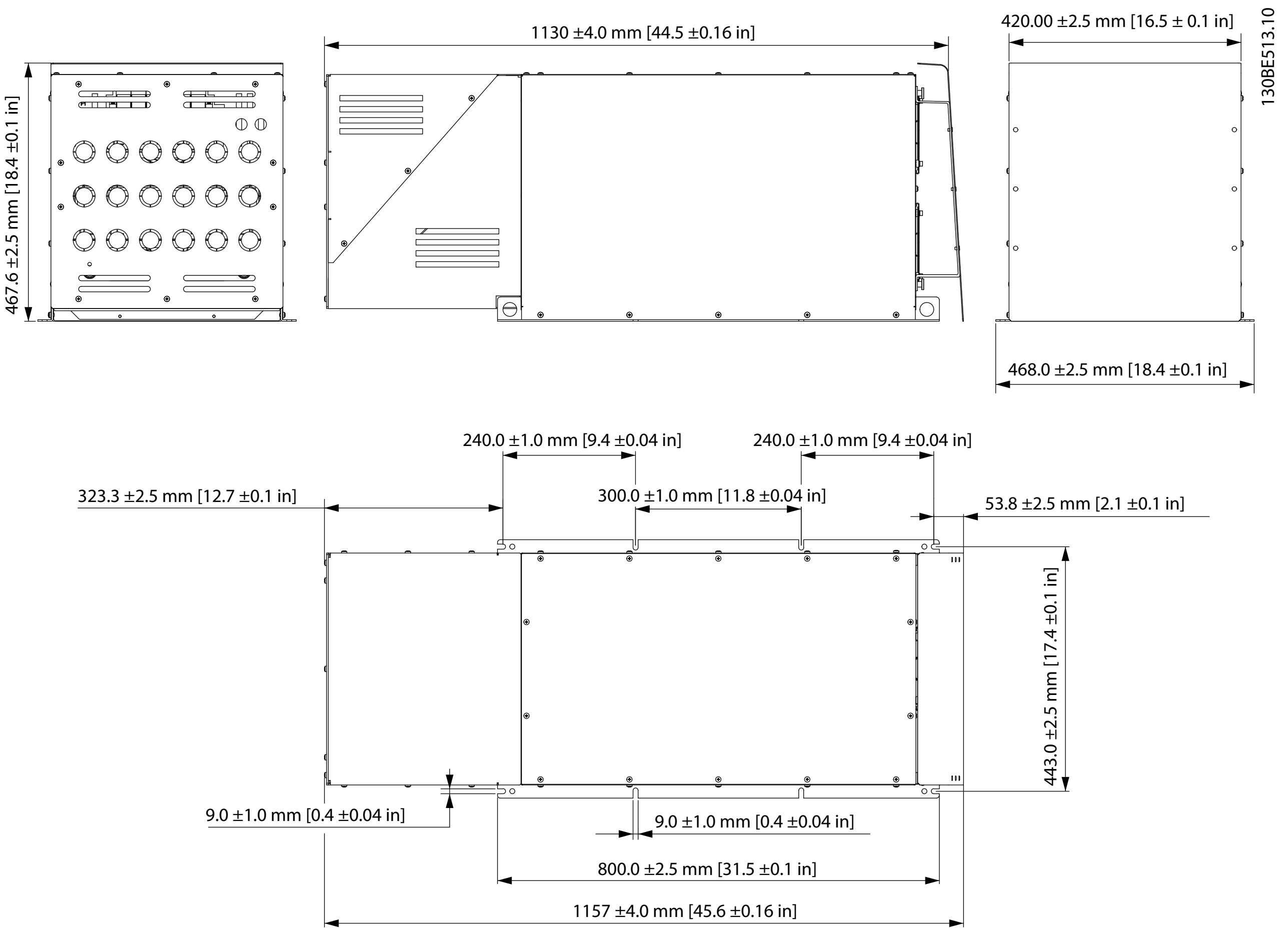

Illustration 7.101 X7 IP21 Internal Fan 1

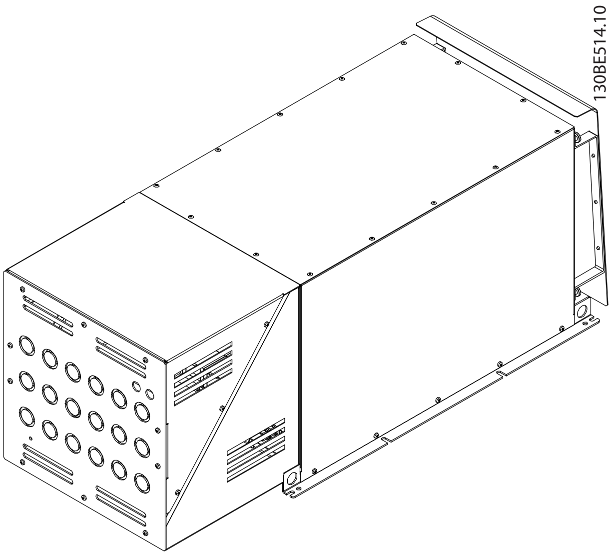

Illustration 7.102 X7 IP21 Internal Fan 1, 3D View

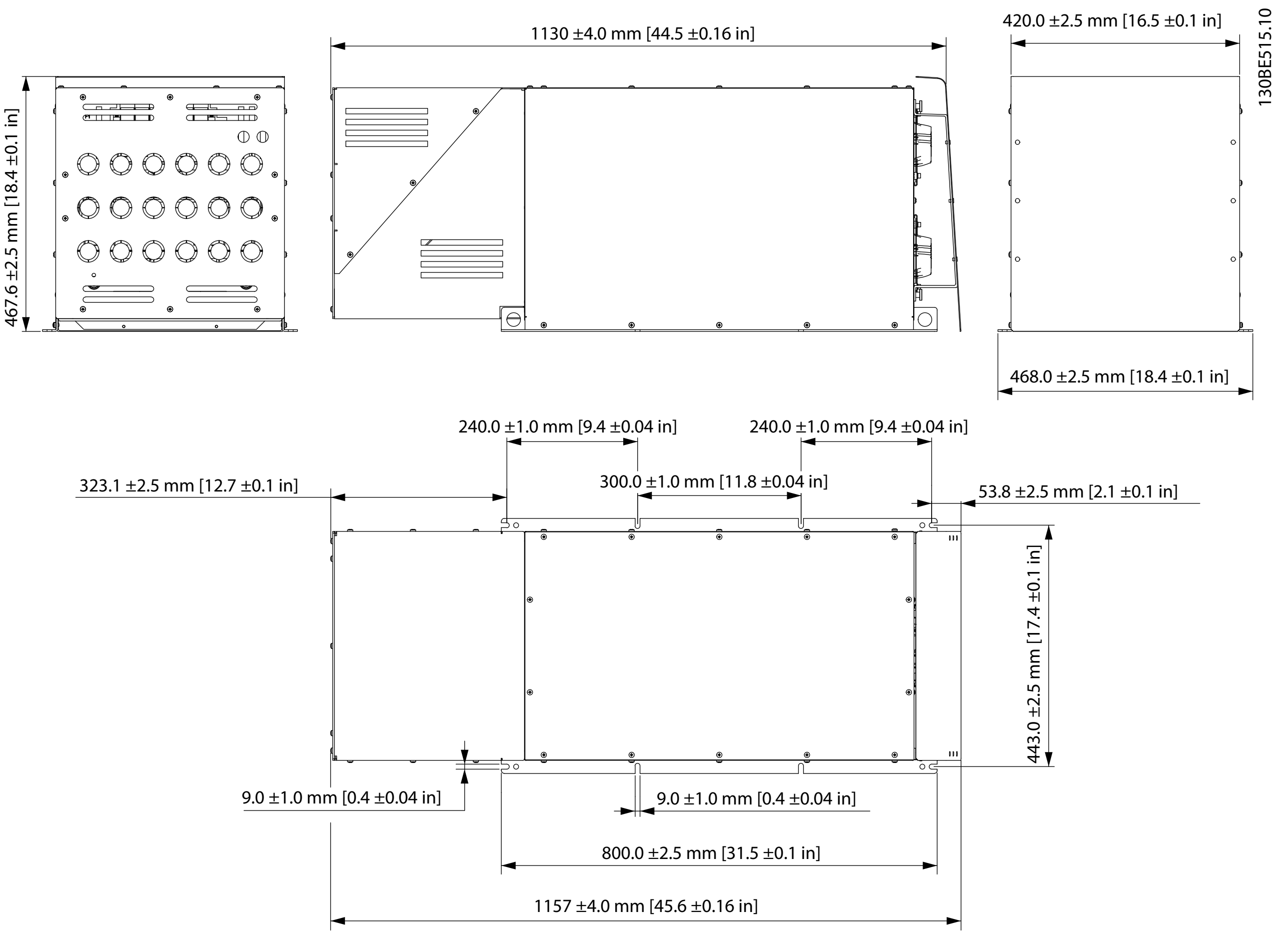

Illustration 7.103 X7 IP21 Internal Fan 2

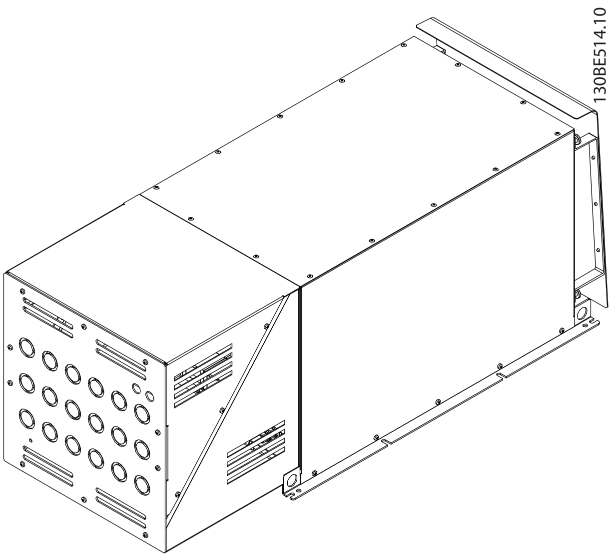

Illustration 7.104 X7 IP21 Internal Fan 2, 3D View

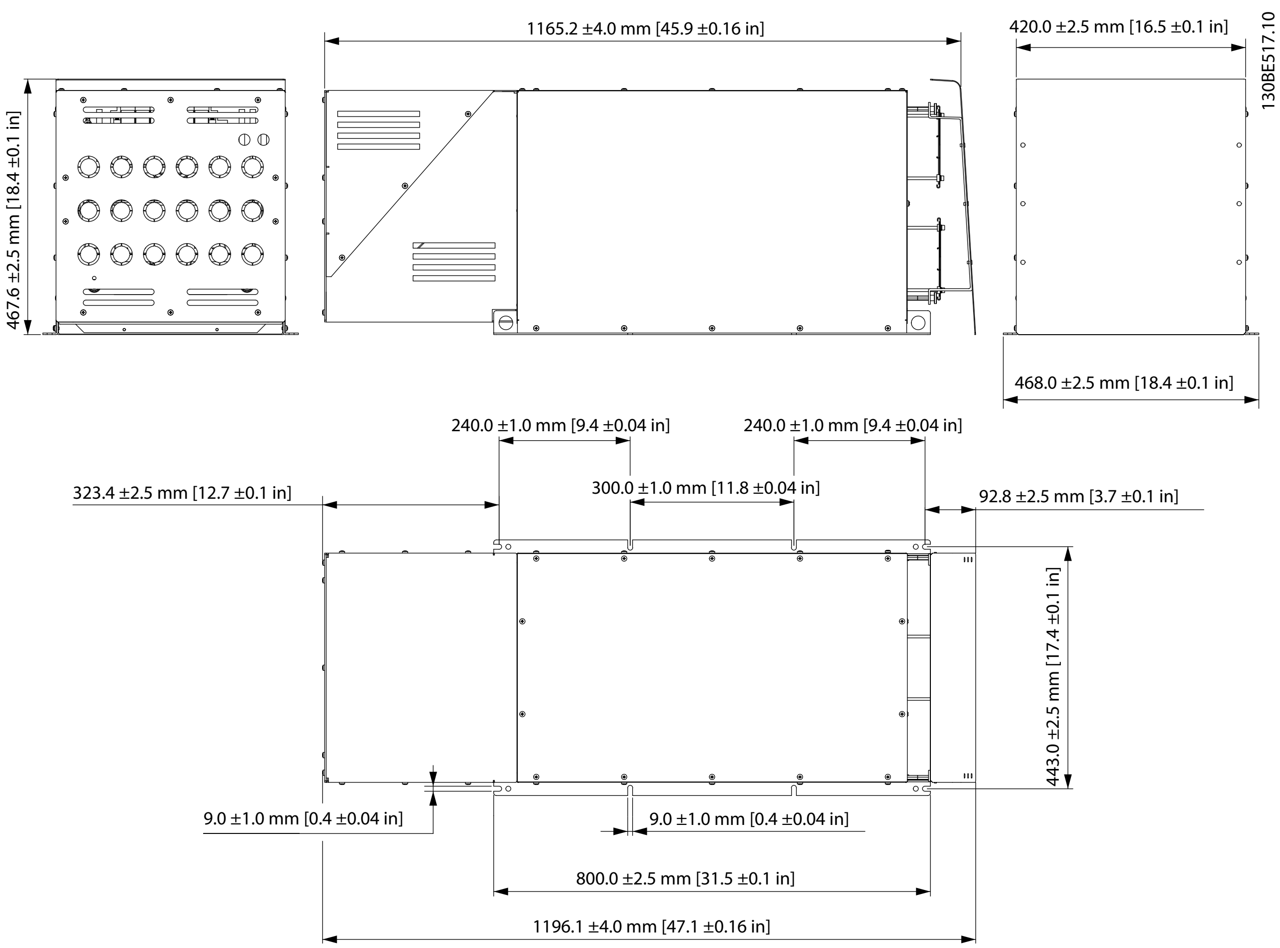

Illustration 7.105 X7 IP21 External Fan 1

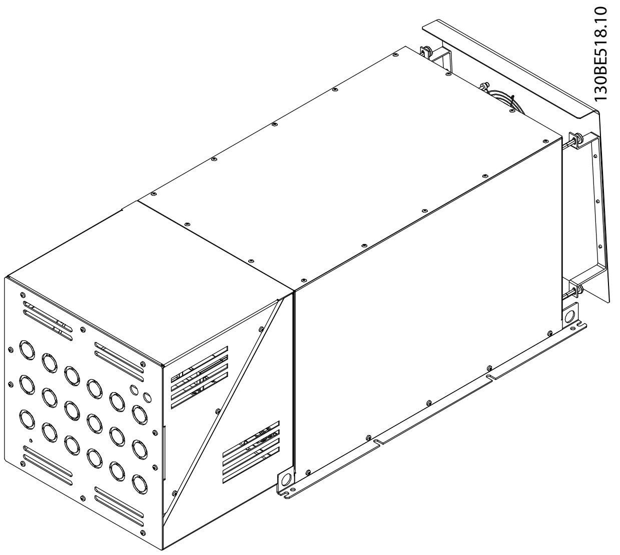

Illustration 7.106 X7 IP21 External Fan 1, 3D View

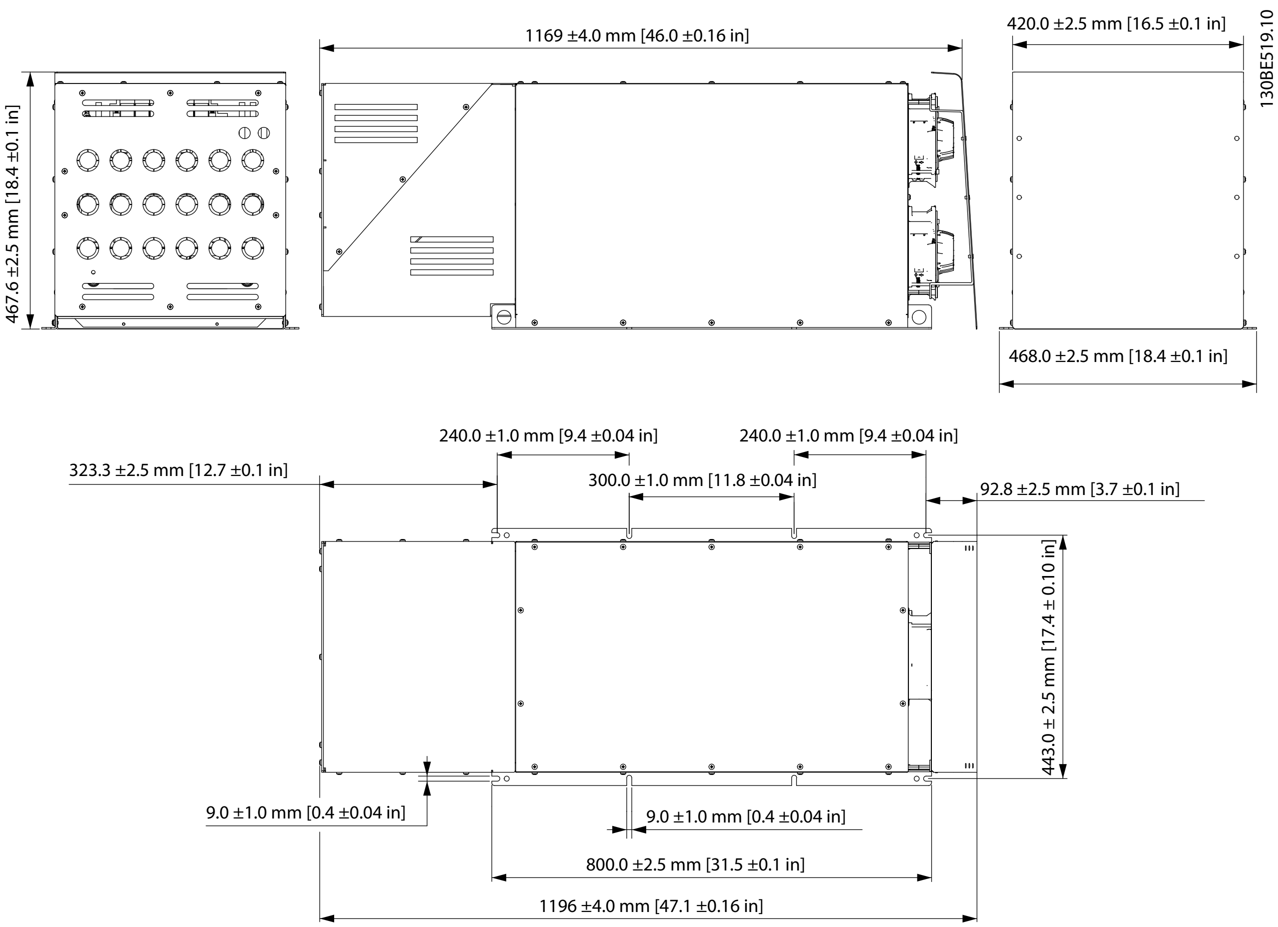

Illustration 7.107 X7 IP21 External Fan 2

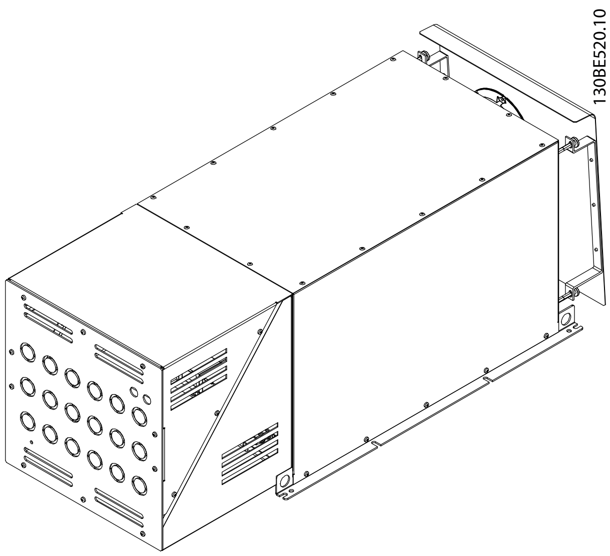

Illustration 7.108 X7 IP21 External Fan 2, 3D View

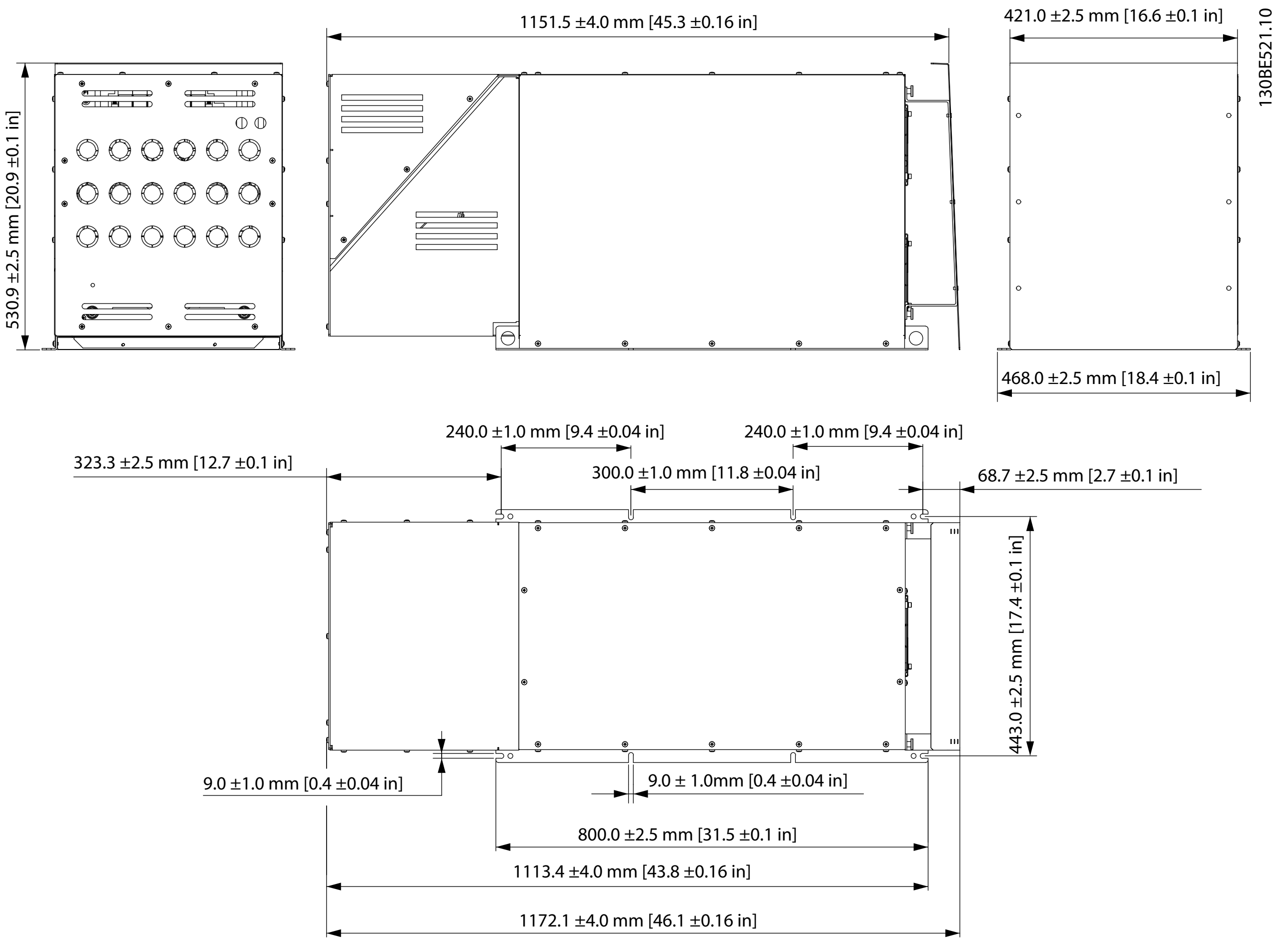

Illustration 7.109 X8 IP21 Internal Fan 1

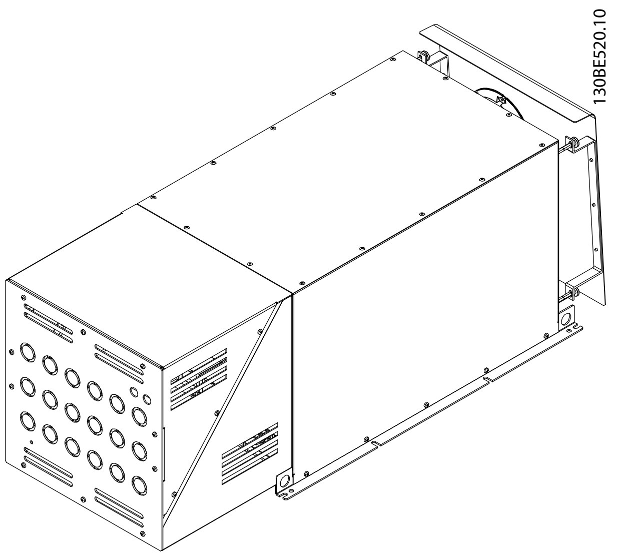

Illustration 7.110 X8 IP21 Internal Fan 1, 3D View

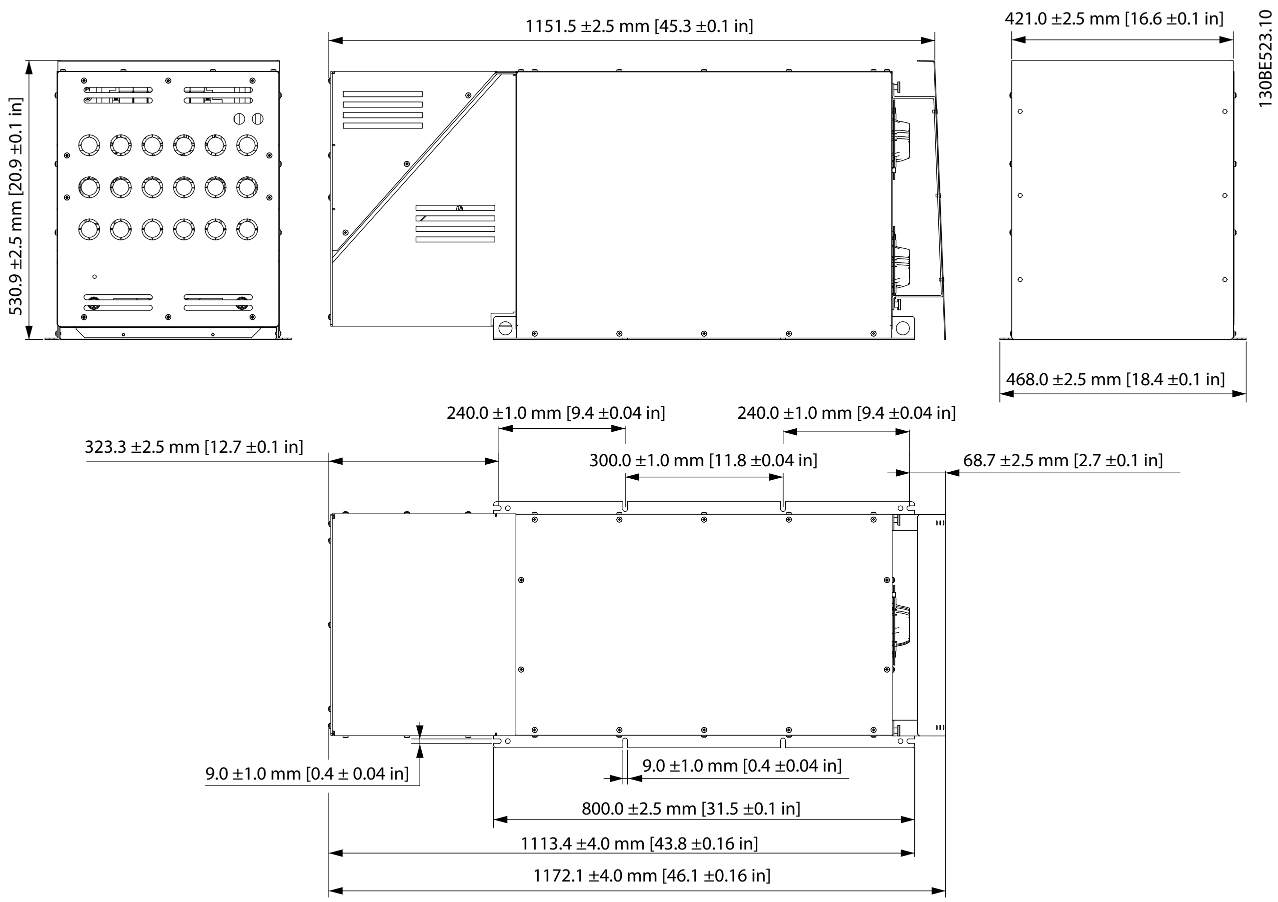

Illustration 7.111 X8 IP21 Internal Fan 2

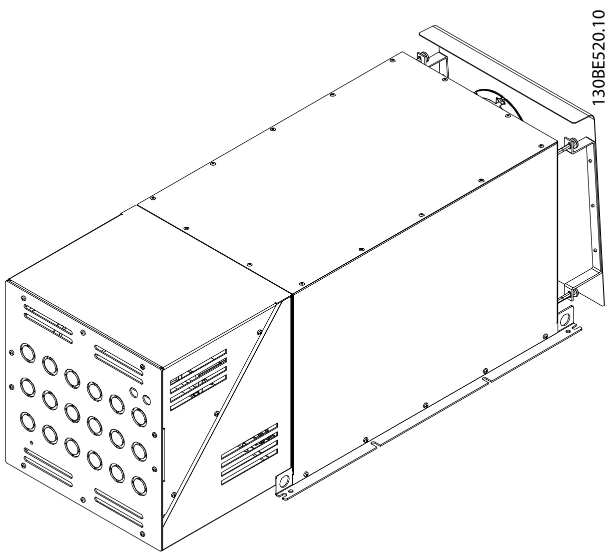

Illustration 7.112 X8 IP21 Internal Fan 2, 3D View

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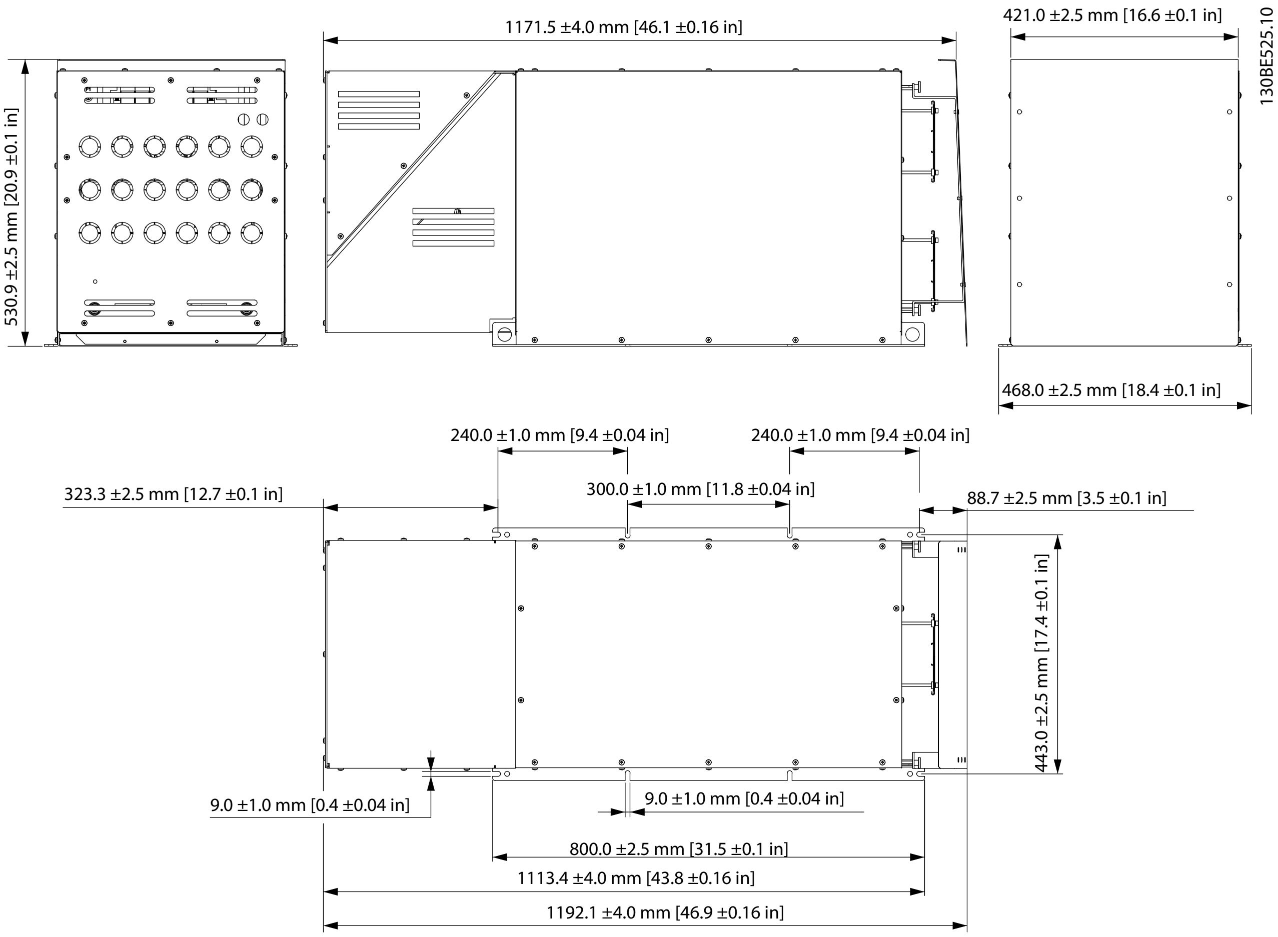

Illustration 7.113 X8 IP21 External Fan 1

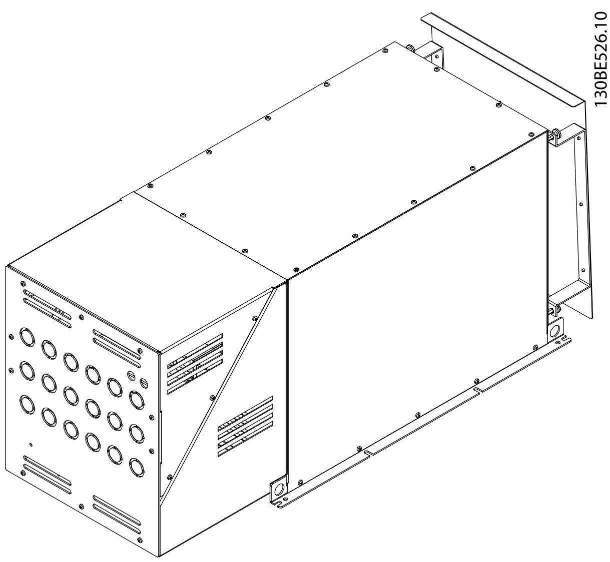

Illustration 7.114 X8 IP21 External Fan 1, 3D View

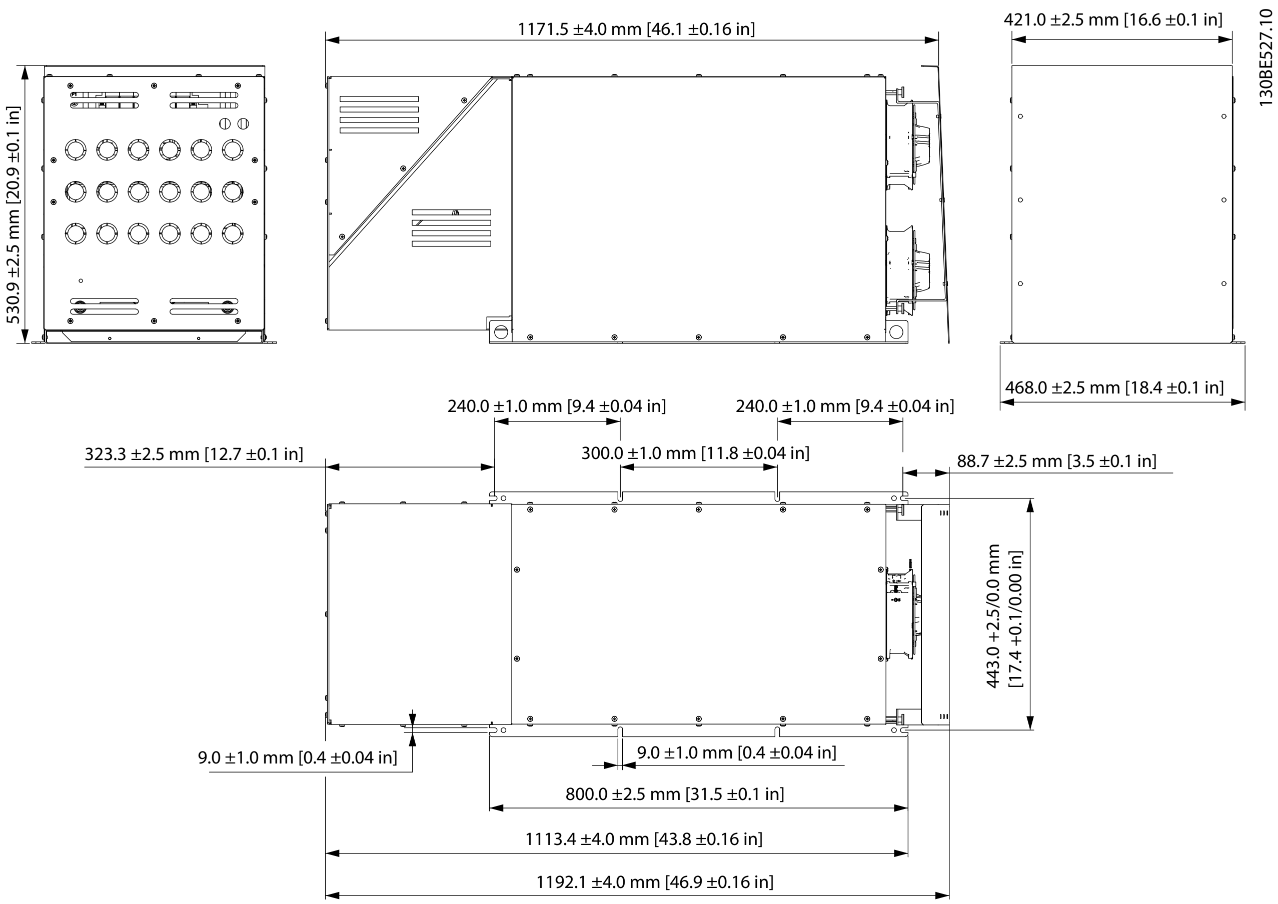

Illustration 7.115 X8 IP21 External Fan 2

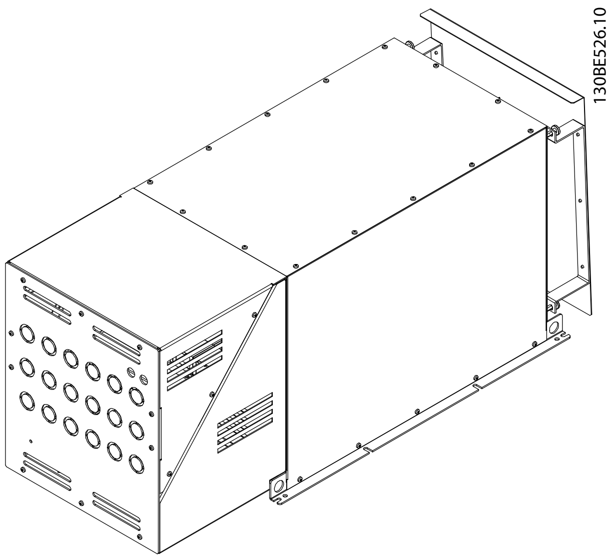

Illustration 7.116 X8 IP21 External Fan 2, 3D View

7.2.4 Terminal Designations, IP00

The terminals differ depending on the filter size. *Illustration 7.117* to *Illustration 7.119* show close-up views of the terminal designations for IP00 X1–X4, IP00 X5–X6, and IP00 X7–X8.

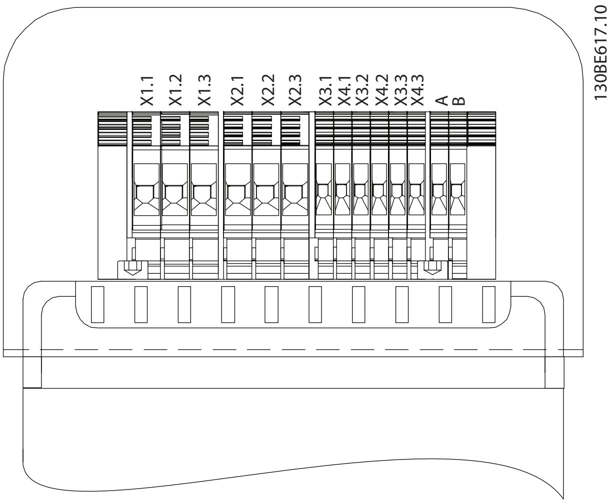

Illustration 7.117 Terminal Designations IP00 X1–X4

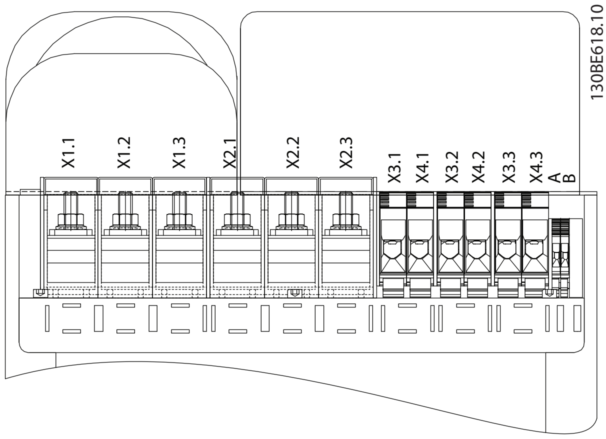

Illustration 7.118 Terminal Designations IP00 X5–X6

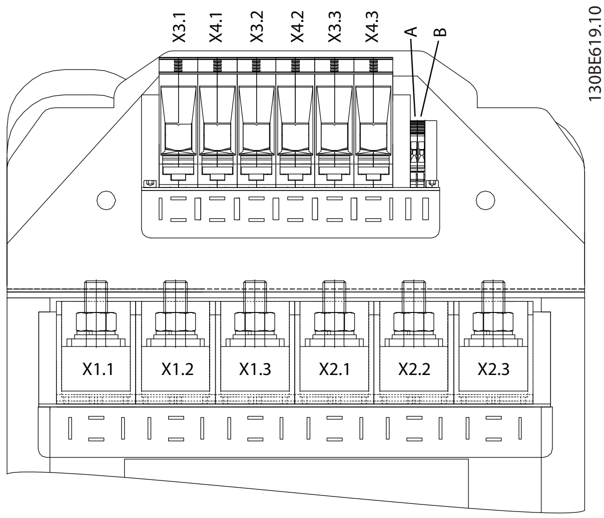

Illustration 7.119 Terminal Designations IP00 X7–X8

7.2.5 IP00 Enclosures

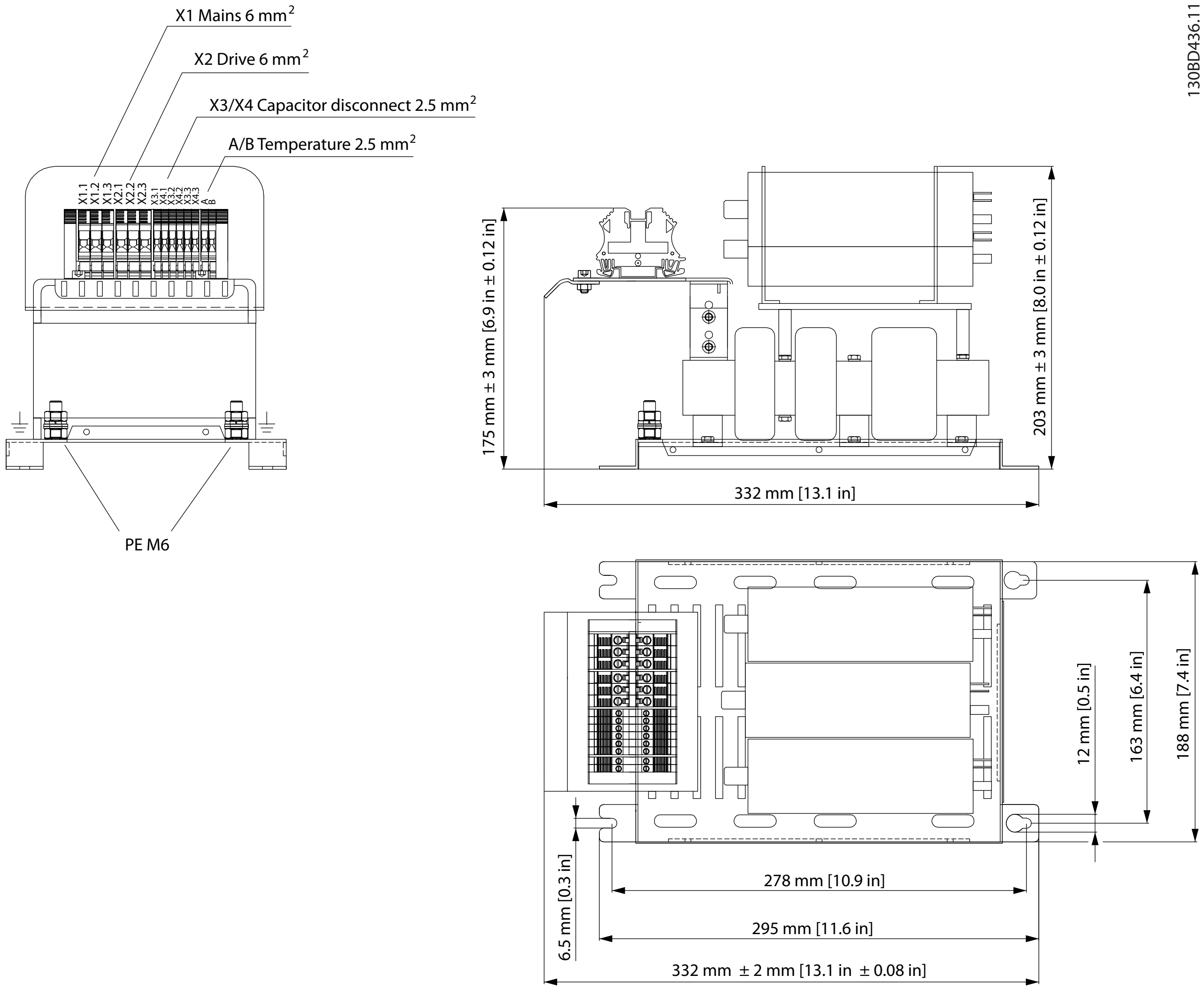

Illustration 7.120 IP00 X1

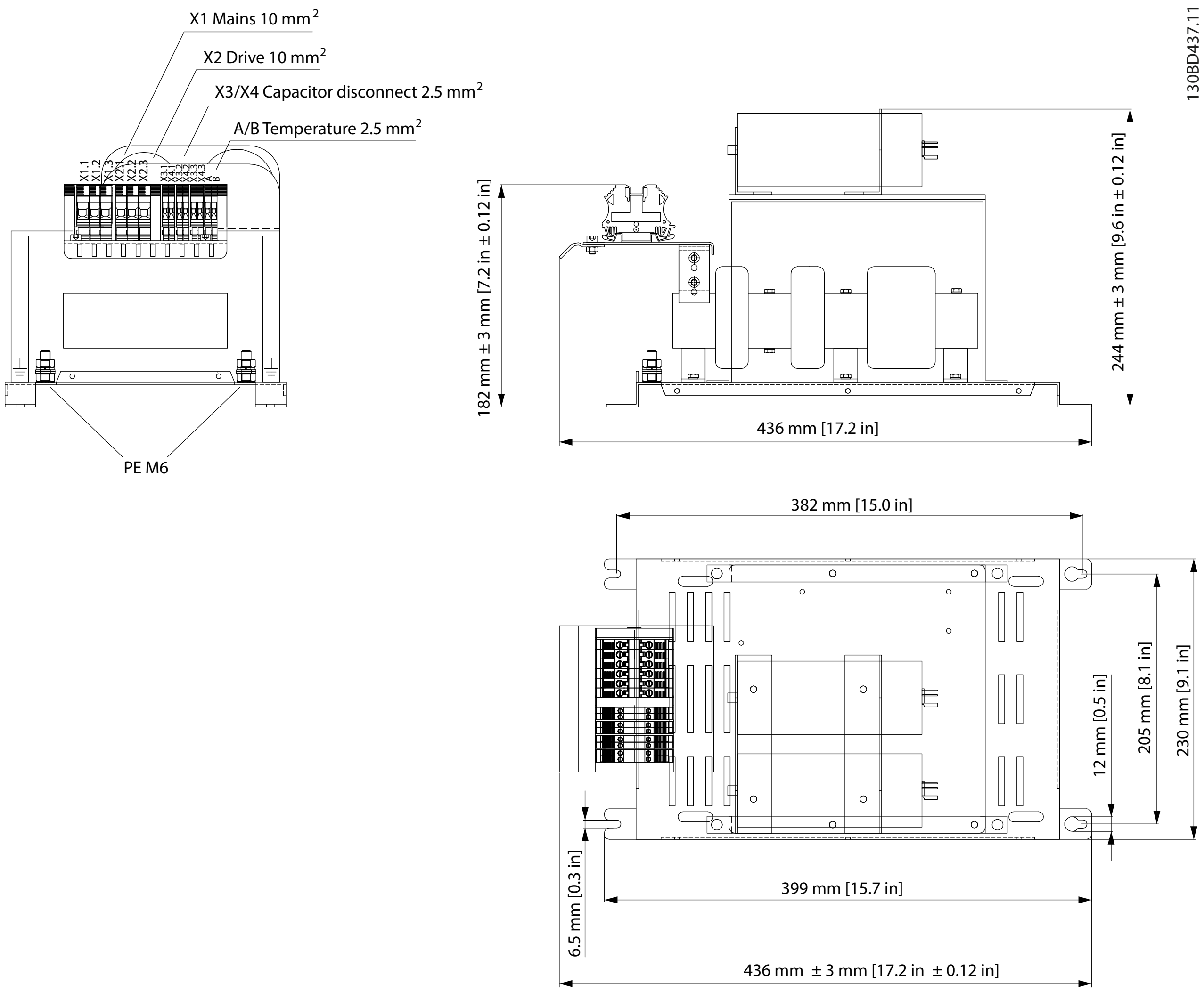

Illustration 7.121 IP00 X2

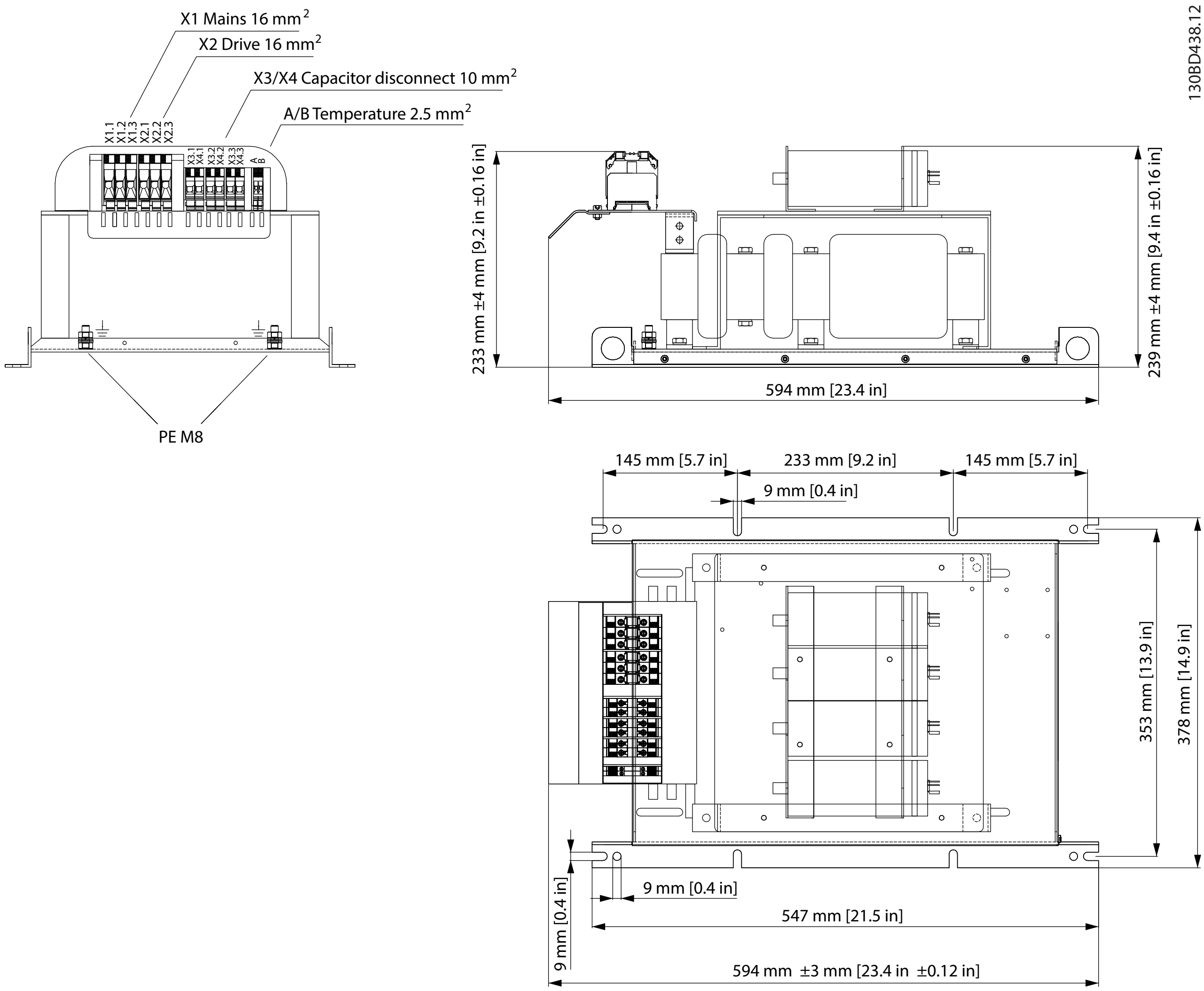

Illustration 7.122 IP00 X3

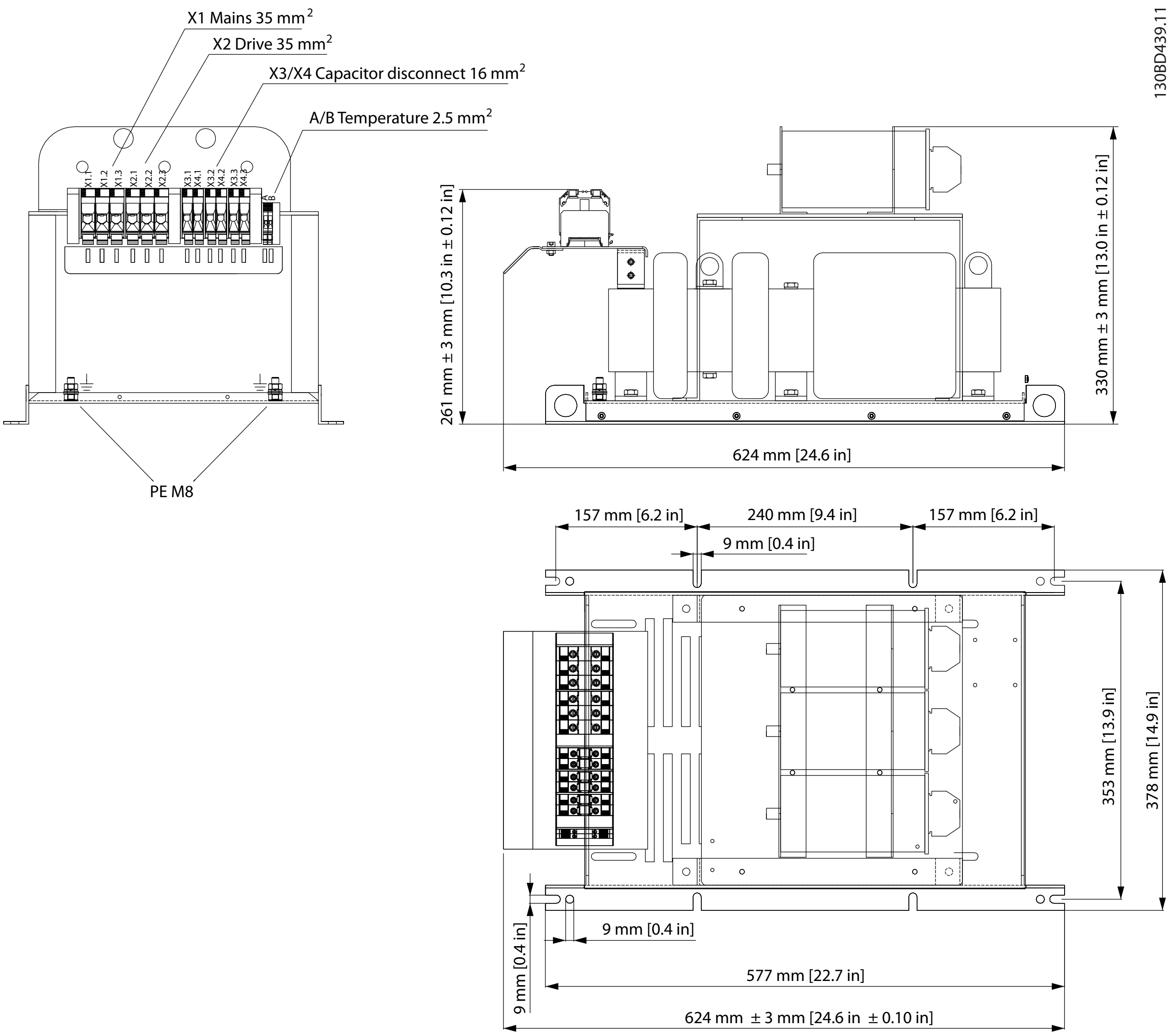

Illustration 7.123 IP00 X4

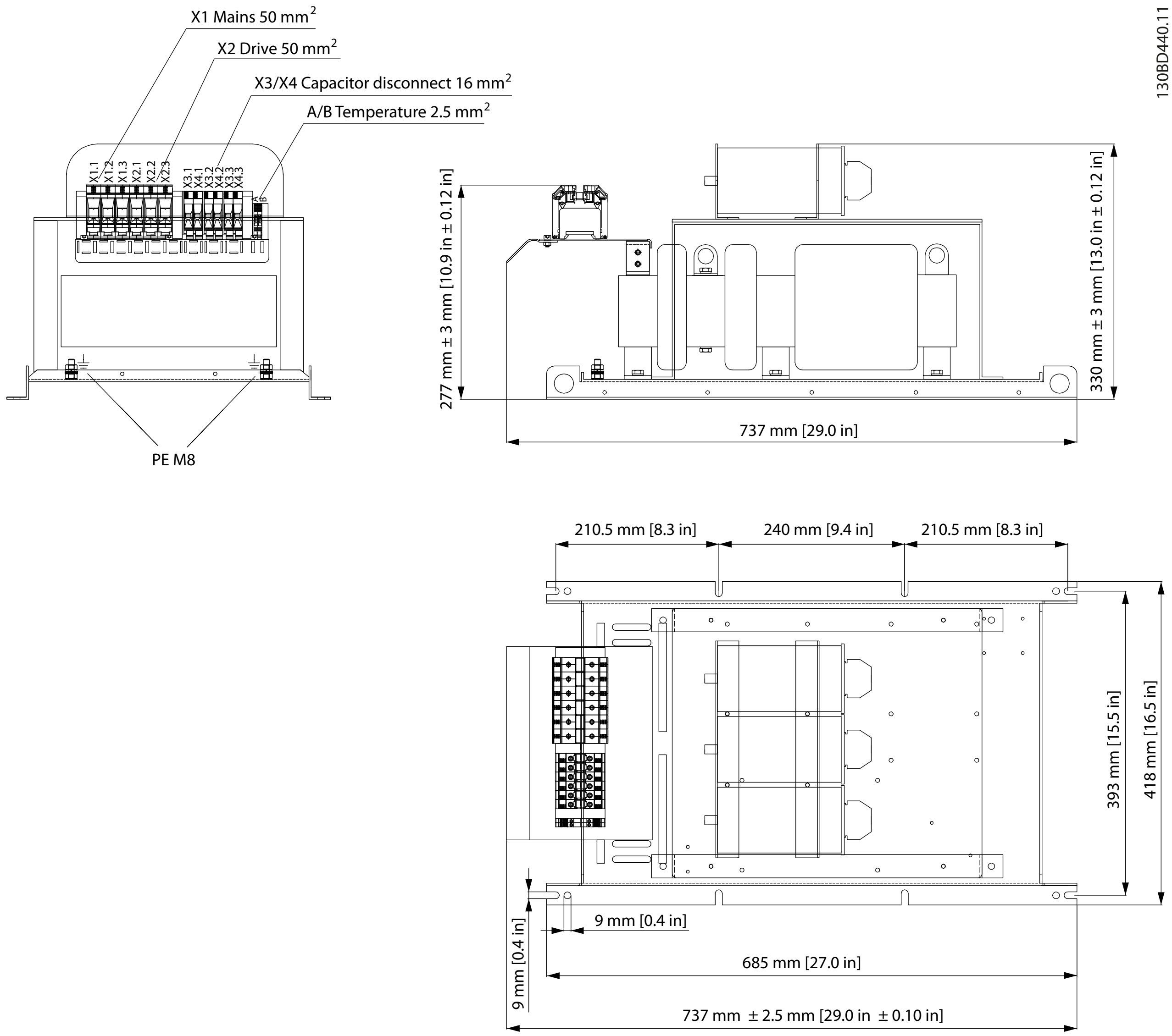

Illustration 7.124 IP00 X5

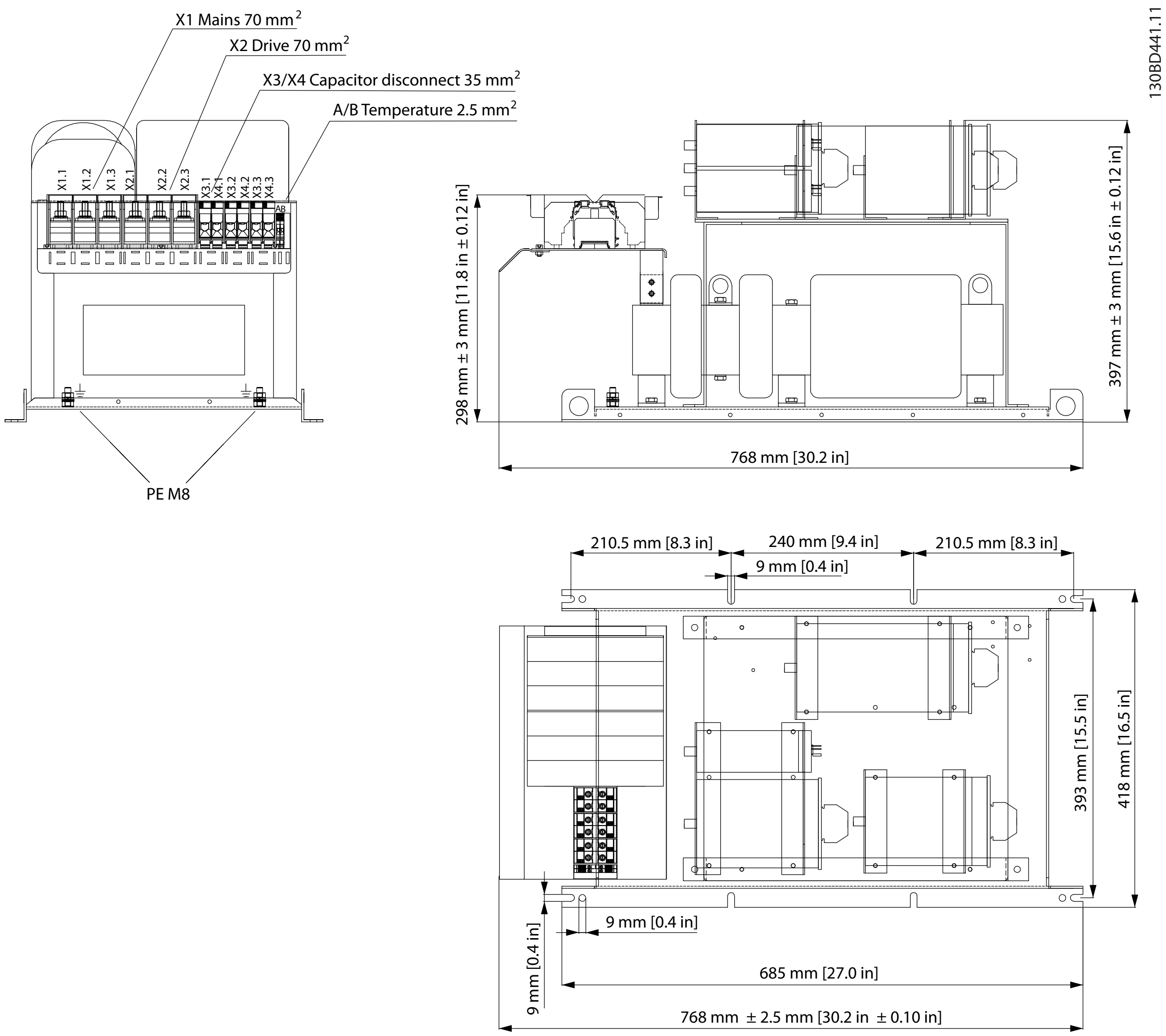

Illustration 7.125 IP00 X6

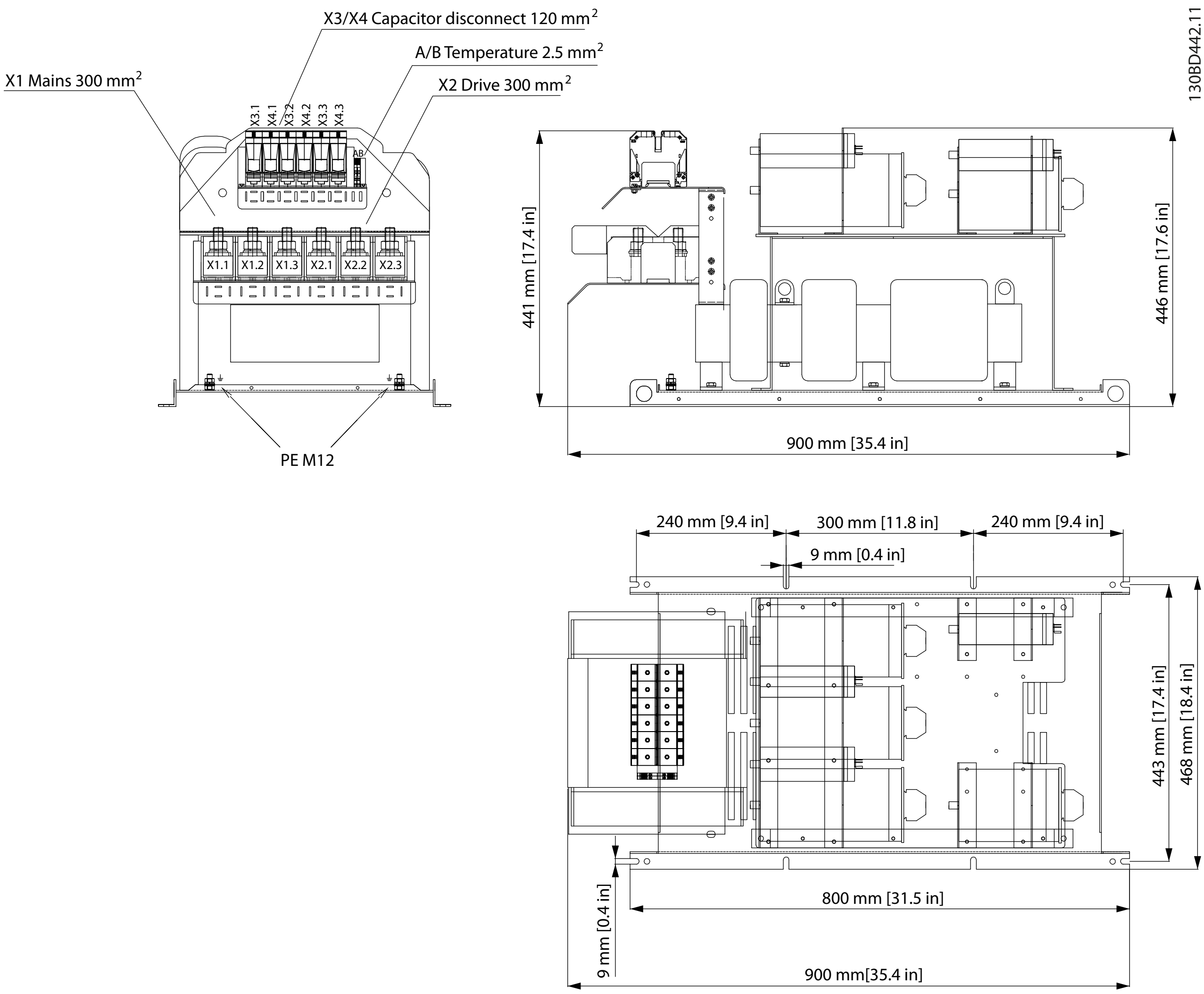

Illustration 7.126 IP00 X7

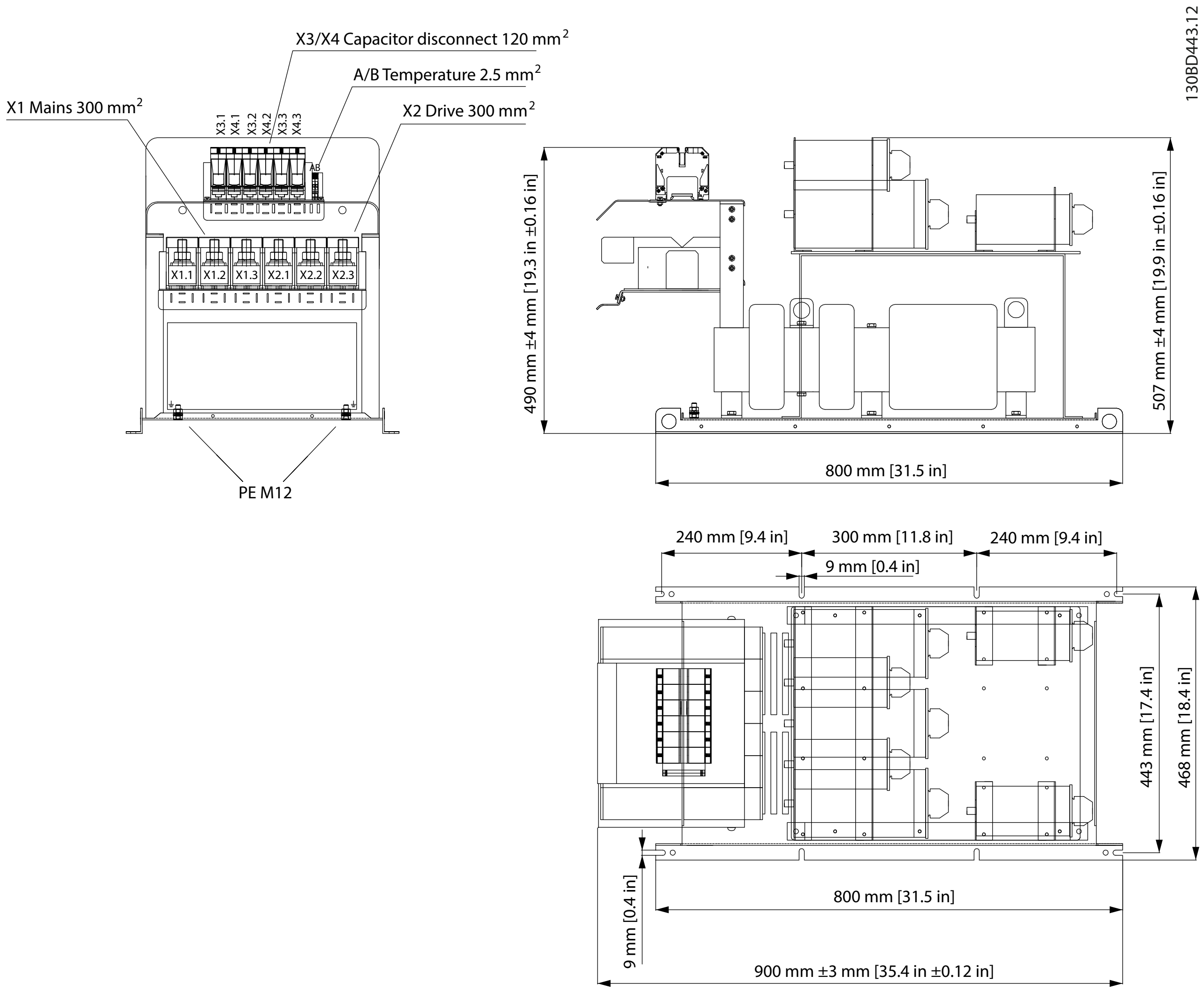

Illustration 7.127 IP00 X8

7.2.6 Terminology used in Mechanical Dimensions

Value	Description
if1	Internal fan 1
if2	Internal fan 2
ef1	External fan 1
ef2	External fan 2

Table 7.8 Terminology used in Mechanical Dimensions

See *chapter 4.1.4 Ventilation and Cooling Requirements* for further details on fan concepts.

7.2.7 Mechanical Dimensions

380–415 V 50 Hz	AHF 005 IP00					AHF 005 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	16 (35)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	18 (40)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	17 (38)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	20 (44)	X1 IP20 ef1
22	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	30 (66)	X2 IP20 ef1
29	433 (17)	238 (9.4)	248 (9.8)	30 (66)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	34 (75)	X2 IP20 ef1
34	590 (23.2)	378 (14.9)	245 (9.6)	45 (99)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	52 (115)	X3 IP20 if1
40	590 (23.2)	378 (14.9)	245 (9.6)	46 (101)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	53 (117)	X3 IP20 if1
55	590 (23.2)	378 (14.9)	245 (9.6)	51 (112)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	58 (128)	X3 IP20 if1
66	620 (24.4)	378 (14.9)	338 (13.3)	68 (150)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	76 (168)	X4 IP20 if1
82	620 (24.4)	378 (14.9)	338 (13.3)	89 (196)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	98 (216)	X4 IP20 ef1
96	737 (29)	418 (16.5)	333 (13.1)	94 (207)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	104 (229)	X5 IP20 ef1
133	737 (29)	418 (16.5)	333 (13.1)	96 (212)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	106 (234)	X5 IP20 ef1
171	767 (30.2)	418 (16.5)	405 (15.9)	115 (254)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	126 (278)	X6 IP20 ef1
204	767 (30.2)	418 (16.5)	405 (15.9)	124 (273)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	135 (298)	X6 IP20 ef1
251	949 (37.4)	468 (18.4)	451 (17.8)	159 (351)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	172 (379)	X7 IP20 if1
304	949 (37.4)	468 (18.4)	451 (17.8)	193 (425)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	206 (454)	X7 IP20 if1
325	949 (37.4)	468 (18.4)	515 (20.3)	208 (459)	X8 IP00	949 (37.4)	468 (18.4)	515 (20.3)	221 (487)	X8 IP20 if1
381	949 (37.4)	468 (18.4)	515 (20.3)	214 (472)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	230 (507)	X8 IP20 ef1
480	949 (37.4)	468 (18.4)	515 (20.3)	253 (558)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	272 (600)	X8 IP20 ef1

Table 7.9 380–415 V, 50 Hz, AHF 005

380–415 V 50 Hz	AHF 010 IP00					AHF 010 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	11.5 (25.4)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	13.5 (29.8)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	13 (29)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	16.3 (35.9)	X1 IP20 ef1
22	433 (17)	238 (9.4)	248 (9.8)	17 (38)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	22 (49)	X2 IP20 if1
29	433 (17)	238 (9.4)	248 (9.8)	21 (46)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP20 if1
34	590 (23.2)	378 (14.9)	245 (9.6)	26 (57)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	33 (73)	X3 IP20 if1
40	590 (23.2)	378 (14.9)	245 (9.6)	30 (66)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	37 (82)	X3 IP20 if1
55	590 (23.2)	378 (14.9)	245 (9.6)	32 (71)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	39 (86)	X3 IP20 if1
66	620 (24.4)	378 (14.9)	338 (13.3)	36 (79)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	44 (97)	X4 IP20 if1
82	620 (24.4)	378 (14.9)	338 (13.3)	47 (104)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	56 (123)	X4 IP20 ef1
96	737 (29)	418 (16.5)	333 (13.1)	52 (115)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	62 (137)	X5 IP20 ef1
133	737 (29)	418 (16.5)	333 (13.1)	62 (137)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	74 (164)	X5 IP20 ef1
171	767 (30.2)	418 (16.5)	405 (15.9)	74 (163)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	85 (187)	X6 IP20 if1
204	767 (30.2)	418 (16.5)	405 (15.9)	91 (201)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	102 (225)	X6 IP20 if1
251	949 (37.4)	468 (18.4)	451 (17.8)	106 (234)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	119 (262)	X7 IP20 if1
304	949 (37.4)	468 (18.4)	451 (17.8)	123 (271)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	136 (300)	X7 IP20 if1
325	949 (37.4)	468 (18.4)	451 (17.8)	129 (284)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	142 (313)	X7 IP20 if1
381	949 (37.4)	468 (18.4)	451 (17.8)	147 (324)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 if1
480	949 (37.4)	468 (18.4)	515 (20.3)	186 (410)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	205 (422)	X8 IP20 ef1

Table 7.10 380–415 V, 50 Hz, AHF 010

380–415 V 60 Hz	AHF 005 IP00					AHF 005 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	16 (35)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	18 (40)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	17 (38)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	20 (44)	X1 IP20 ef1
22	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	30 (66)	X2 IP20 ef1
29	433 (17)	238 (9.4)	248 (9.8)	30 (66)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	34 (75)	X2 IP20 ef1
34	590 (23.2)	378 (14.9)	245 (9.6)	45 (99)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	52 (115)	X3 IP20 if1
40	590 (23.2)	378 (14.9)	245 (9.6)	46 (101)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	53 (117)	X3 IP20 if1
55	590 (23.2)	378 (14.9)	245 (9.6)	51 (112)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	58 (128)	X3 IP20 if1
66	620 (24.4)	378 (14.9)	338 (13.3)	68 (150)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	76 (168)	X4 IP20 if1
82	620 (24.4)	378 (14.9)	338 (13.3)	89 (196)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	98 (216)	X4 IP20 ef1
96	737 (29)	418 (16.5)	333 (13.1)	94 (207)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	104 (229)	X5 IP20 ef1
133	737 (29)	418 (16.5)	333 (13.1)	96 (212)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	106 (234)	X5 IP20 ef1
171	767 (30.2)	418 (16.5)	405 (15.9)	115 (254)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	126 (278)	X6 IP20 ef1
204	767 (30.2)	418 (16.5)	405 (15.9)	124 (273)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	135 (298)	X6 IP20 ef1
251	949 (37.4)	468 (18.4)	451 (17.8)	159 (351)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	172 (379)	X7 IP20 if1
304	949 (37.4)	468 (18.4)	515 (20.3)	208 (459)	X8 IP00	949 (37.4)	468 (18.4)	515 (20.3)	221 (487)	X8 IP20 if1
325	949 (37.4)	468 (18.4)	515 (20.3)	214 (472)	X8 IP00	949 (37.4)	468 (18.4)	515 (20.3)	230 (507)	X8 IP20 if1
381	949(37.4)	468 (18.4)	515 (20.3)	214 (472)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	230 (507)	X8 IP20 ef1
480	949 (37.4)	468 (18.4)	515 (20.3)	253 (558)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	272 (600)	X8 IP20 ef1

Table 7.11 380–415 V, 60 Hz, AHF 005

380–415 V 60 Hz	AHF 010 IP00					AHF 010 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	11.5 (25.4)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	13.5 (29.8)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	13 (29)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	16.3 (35.9)	X1 IP20 ef1
22	433 (17)	238 (9.4)	248 (9.8)	17 (38)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	22 (49)	X2 IP20 if1
29	433 (17)	238 (9.4)	248 (9.8)	21 (46)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP20 if1
34	590 (23.2)	378 (14.9)	245 (9.6)	26 (57)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	33 (73)	X3 IP20 if1
40	590 (23.2)	378 (14.9)	245 (9.6)	30 (66)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	37 (82)	X3 IP20 if1
55	590 (23.2)	378 (14.9)	245 (9.6)	32 (71)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	39 (86)	X3 IP20 if1
66	620 (24.4)	378 (14.9)	338 (13.3)	36 (79)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	44 (97)	X4 IP20 if1
82	620 (24.4)	378 (14.9)	338 (13.3)	47 (104)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	56 (123)	X4 IP20 ef1
96	737 (29)	418 (16.5)	333 (13.1)	52 (115)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	62 (137)	X5 IP20 ef1
133	737 (29)	418 (16.5)	333 (13.1)	62 (137)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	74 (164)	X5 IP20 ef1
171	767 (30.2)	418 (16.5)	405 (15.9)	74 (163)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	85 (187)	X6 IP20 if1
204	767 (30.2)	418 (16.5)	405 (15.9)	91 (201)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	102 (225)	X6 IP20 if1
251	949 (37.4)	468 (18.4)	451 (17.8)	106 (234)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	119 (262)	X7 IP20 if1
304	949 (37.4)	468 (18.4)	451 (17.8)	129 (284)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	142 (313)	X7 IP20 if1
325	949 (37.4)	468 (18.4)	451 (17.8)	147 (324)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 if1
381	949 (37.4)	468 (18.4)	451 (17.8)	147 (324)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 if1
480	949 (37.4)	468 (18.4)	515 (20.3)	186 (410)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	205 (422)	X8 IP20 ef1

Table 7.12 380–415 V, 60 Hz, AHF 010

440–480 V 60 Hz	AHF 005 IP00					AHF 005 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	16 (35)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	18 (40)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	17 (38)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	20 (44)	X1 IP20 ef1
19	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	30 (66)	X2 IP20 ef1
25	433 (17)	238 (9.4)	248 (9.8)	30 (66)	X2 IP00	455 (17.9)	238 (9.4)	248 (9.8)	34 (75)	X2 IP20 ef1
31	590 (23.2)	378 (14.9)	245 (9.6)	45 (99)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	52 (115)	X3 IP20 if1
36	590 (23.2)	378 (14.9)	245 (9.6)	46 (101)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	53 (117)	X3 IP20 if1
48	590 (23.2)	378 (14.9)	245 (9.6)	51 (112)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	58 (128)	X3 IP20 if1
60	620 (24.4)	378 (14.9)	338 (13.3)	68 (150)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	76 (168)	X4 IP20 if1
73	620 (24.4)	378 (14.9)	338 (13.3)	89 (196)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	98 (216)	X4 IP20 ef1
95	737 (29)	418 (16.5)	333 (13.1)	94 (207)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	104 (229)	X5 IP20 ef1
118	737 (29)	418 (16.5)	333 (13.1)	96 (212)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	106 (234)	X5 IP20 ef1
154	767 (30.2)	418 (16.5)	405 (15.9)	115 (254)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	126 (278)	X6 IP20 ef1
183	767 (30.2)	418 (16.5)	405 (15.9)	124 (273)	X6 IP00	789 (31.1)	418 (16.5)	405 (15.9)	135 (298)	X6 IP20 ef1
231	949 (37.4)	468 (18.4)	451 (17.8)	159 (351)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	172 (379)	X7 IP20 if1
291	949 (37.4)	468 (18.4)	515 (20.3)	208 (459)	X8 IP00	949 (37.4)	468 (18.4)	515 (20.3)	221 (487)	X8 IP20 if1
355	949 (37.4)	468 (18.4)	515 (20.3)	214 (472)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	230 (507)	X8 IP20 ef1
380	949 (37.4)	468 (18.4)	515 (20.3)	248 (547)	X8 IP00	949 (37.4)	468 (18.4)	515 (20.3)	265 (584)	X8 IP20 if1
436	949 (37.4)	468 (18.4)	515 (20.3)	253 (558)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	272 (600)	X8 IP20 ef1

Table 7.13 440–480 V, 60 Hz, AHF 005

440–480 V 60 Hz	AHF 010 IP00					AHF 010 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
10	323 (12.7)	196 (7.7)	205 (8.1)	11.5 (25.4)	X1 IP00	323 (12.7)	196 (7.7)	205 (8.1)	13.5 (29.8)	X1 IP20 if1
14	323 (12.7)	196 (7.7)	205 (8.1)	13 (29)	X1 IP00	346 (13.6)	196 (7.7)	205 (8.1)	16.3 (35.9)	X1 IP20 ef1
19	433 (17)	238 (9.4)	248 (9.8)	17 (38)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	22 (49)	X2 IP20 if1
25	433 (17)	238 (9.4)	248 (9.8)	21 (46)	X2 IP00	433 (17)	238 (9.4)	248 (9.8)	25 (55)	X2 IP20 if1
31	590 (23.2)	378 (14.9)	245 (9.6)	26 (57)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	33 (73)	X3 IP20 if1
36	590 (23.2)	378 (14.9)	245 (9.6)	30 (66)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	37 (82)	X3 IP20 if1
48	590 (23.2)	378 (14.9)	245 (9.6)	32 (71)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	39 (86)	X3 IP20 if1
60	620 (24.4)	378 (14.9)	338 (13.3)	36 (79)	X4 IP00	620 (24.4)	378 (14.9)	338 (13.3)	44 (97)	X4 IP20 if1
73	620 (24.4)	378 (14.9)	338 (13.3)	47 (104)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	56 (123)	X4 IP20 ef1
95	737 (29)	418 (16.5)	333 (13.1)	52 (115)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	62 (137)	X5 IP20 ef1
118	737 (29)	418 (16.5)	333 (13.1)	62 (137)	X5 IP00	752 (29.6)	418 (16.5)	333 (13.1)	74 (164)	X5 IP20 ef1
154	767 (30.2)	418 (16.5)	405 (15.9)	74 (163)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	85 (187)	X6 IP20 if1
183	767 (30.2)	418 (16.5)	405 (15.9)	91 (201)	X6 IP00	767 (30.2)	418 (16.5)	405 (15.9)	102 (225)	X6 IP20 if1
231	949 (37.4)	468 (18.4)	451 (17.8)	106 (234)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	119 (262)	X7 IP20 if1
291	949 (37.4)	468 (18.4)	451 (17.8)	129 (284)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	142 (313)	X7 IP20 if1
355	949 (37.4)	468 (18.4)	451 (17.8)	147 (324)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 if1
380	949 (37.4)	468 (18.4)	451 (17.8)	156 (344)	X7 IP00	949 (37.4)	468 (18.4)	451 (17.8)	172 (379)	X7 IP20 if1
436	949 (37.4)	468 (18.4)	515 (20.3)	186 (410)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	205 (422)	X8 IP20 ef1

Table 7.14 440–480 V, 60 Hz, AHF 010

600 V 60 Hz	AHF 005 IP00					AHF 005 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
15	590 (23.2)	378 (14.9)	245 (9.6)	35 (77)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	42 (93)	X3 IP20 if1
20	590 (23.2)	378 (14.9)	245 (9.6)	43 (95)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	50 (110)	X3 IP20 if1
24	634 (25)	378 (14.9)	333 (13.1)	44 (97)	X3 IP00	615 (24.2)	378 (14.9)	245 (9.6)	52 (115)	X3 IP20 ef1
29	620 (24.4)	378 (14.9)	338 (13.3)	67 (148)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	75 (165)	X4 IP20 ef1
36	620 (24.4)	378 (14.9)	338 (13.3)	74 (164)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	82 (181)	X4 IP20 ef1
50	737 (29)	418 (16.5)	333 (13.1)	86 (190)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	96 (212)	X5 IP20 ef1
58	737 (29)	418 (16.5)	333 (13.1)	94 (207)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	104 (229)	X5 IP20 ef1
77	767 (30.2)	418 (16.5)	405 (15.9)	117 (258)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	130 (287)	X6 IP20 ef1
87	767 (30.2)	418 (16.5)	405 (15.9)	122 (269)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	135 (298)	X6 IP20 ef1
109	767 (30.2)	418 (16.5)	405 (15.9)	155 (342)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	168 (370)	X6 IP20 ef1
128	767 (30.2)	418 (16.5)	405 (15.9)	184 (406)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	197 (434)	X6 IP20 ef1
155	949 (37.4)	468 (18.4)	451 (17.8)	203 (448)	X7 IP00	966 (38)	468 (18.4)	451 (17.8)	220 (485)	X7 IP20 ef1
197	949 (37.4)	468 (18.4)	451 (17.8)	209 (461)	X7 IP00	966 (38)	468 (18.4)	451 (17.8)	228 (503)	X7 IP20 ef1
240	949 (37.4)	468 (18.4)	515 (20.3)	241 (531)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	260 (573)	X8 IP20 ef1
296	949 (37.4)	468 (18.4)	515 (20.3)	278 (613)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	297 (655)	X8 IP20 ef1
366	–	–	–	–	–	–	–	–	–	–
395	–	–	–	–	–	–	–	–	–	–

Table 7.15 600 V, 60 Hz, AHF 005

600 V 60 Hz	AHF 010 IP00					AHF 010 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
15	590 (23.2)	378 (14.9)	245 (9.6)	18 (40)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	25 (55)	X3 IP20 if1
20	590 (23.2)	378 (14.9)	245 (9.6)	29 (64)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	36 (79)	X3 IP20 if1
24	634 (25)	378 (14.9)	333 (13.1)	32 (71)	X3 IP00	615 (24.2)	378 (14.9)	245 (9.6)	40 (88)	X3 IP20 ef1
29	620 (24.4)	378 (14.9)	338 (13.3)	34 (75)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	42 (93)	X4 IP20 ef1
36	620 (24.4)	378 (14.9)	338 (13.3)	44 (97)	X4 IP00	644 (25.4)	378 (14.9)	338 (13.3)	52 (115)	X4 IP20 ef1
50	737 (29)	418 (16.5)	333 (13.1)	46 (101)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	56 (123)	X5 IP20 ef1
58	737 (29)	418 (16.5)	333 (13.1)	52 (115)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	62 (137)	X5 IP20 ef1
77	767 (30.2)	418 (16.5)	405 (15.9)	61 (134)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	74 (163)	X6 IP20 ef1
87	767 (30.2)	418 (16.5)	405 (15.9)	72 (159)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	85 (187)	X6 IP20 ef1
109	767 (30.2)	418 (16.5)	405 (15.9)	92 (203)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	105 (231)	X6 IP20 ef1
128	767 (30.2)	418 (16.5)	405 (15.9)	110 (243)	X6 IP00	789 (31)	418 (16.5)	405 (15.9)	123 (271)	X6 IP20 ef1
155	949 (37.4)	468 (18.4)	451 (17.8)	119 (262)	X7 IP00	966 (38)	468 (18.4)	451 (17.8)	136 (300)	X7 IP20 ef1
197	949 (37.4)	468 (18.4)	451 (17.8)	125 (276)	X7 IP00	966 (38)	468 (18.4)	451 (17.8)	142 (313)	X7 IP20 ef1
240	949 (37.4)	468 (18.4)	451 (17.8)	144 (317)	X7 IP00	966 (38)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 ef1
296	949 (37.4)	468 (18.4)	515 (20.3)	186 (410)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	205 (452)	X8 IP20 ef1
366	949 (37.4)	468 (18.4)	515 (20.3)	209 (461)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	228 (503)	X8 IP20 ef1
395	949 (37.4)	468 (18.4)	515 (20.3)	241 (531)	X8 IP00	966 (38)	468 (18.4)	515 (20.3)	260 (573)	X8 IP20 ef1

Table 7.16 600 V, 60 Hz, AHF 010

500–690 V 50 Hz	AHF 005 IP00					AHF 005 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
15	590 (23.2)	378 (14.9)	245 (9.6)	35 (77)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	42 (93)	X3 IP20 if2
20	590 (23.2)	378 (14.9)	245 (9.6)	43 (95)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	50 (110)	X3 IP20 if2
24	634 (25)	378 (14.9)	333 (13.1)	44 (97)	X3 IP00	629 (24.8)	378 (14.9)	245 (9.6)	52 (115)	X3 IP20 ef2
29	620 (24.4)	378 (14.9)	338 (13.3)	67 (148)	X4 IP00	658 (25.9)	378 (14.9)	338 (13.3)	75 (165)	X4 IP20 ef2
36	620 (24.4)	378 (14.9)	338 (13.3)	74 (164)	X4 IP00	658 (25.9)	378 (14.9)	338 (13.3)	82 (181)	X4 IP20 ef2
50	737 (29)	418 (16.5)	333 (13.1)	86 (190)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	96 (212)	X5 IP20 ef2
58	737 (29)	418 (16.5)	333 (13.1)	94 (207)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	104 (229)	X5 IP20 ef2
77	767 (30.2)	418 (16.5)	405 (15.9)	117 (258)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	130 (287)	X6 IP20 ef2
87	767 (30.2)	418 (16.5)	405 (15.9)	122 (269)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	135 (298)	X6 IP20 ef2
109	767 (30.2)	418 (16.5)	405 (15.9)	155 (342)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	168 (370)	X6 IP20 ef2
128	767 (30.2)	418 (16.5)	405 (15.9)	184 (406)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	197 (434)	X6 IP20 ef2
155	949 (37.4)	468 (18.4)	451 (17.8)	203 (448)	X7 IP00	989 (38.9)	468 (18.4)	451 (17.8)	220 (485)	X7 IP20 ef2
197	949 (37.4)	468 (18.4)	451 (17.8)	209 (461)	X7 IP00	989 (38.9)	468 (18.4)	451 (17.8)	228 (503)	X7 IP20 ef2
240	949 (37.4)	468 (18.4)	515 (20.3)	241 (531)	X8 IP00	989 (38.9)	468 (18.4)	515 (20.3)	260(573)	X8 IP20 ef2
296	949 (37.4)	468 (18.4)	515 (20.3)	278 (613)	X8 IP00	989 (38.9)	468 (18.4)	515 (20.3)	297 (655)	X8 IP20 ef2
366	–	–	–	–	–	–	–	–	–	–
395	–	–	–	–	–	–	–	–	–	–

Table 7.17 500–690 V, 50 Hz, AHF 005

500–690 V 50 Hz	AHF 010 IP00					AHF 010 IP20				
Current rating	Dimensions			Weight	Enclosure size	Dimensions			Weight	Enclosure size
[A]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP00	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]	[kg (lb)]	IP20
15	590 (23.2)	378 (14.9)	245 (9.6)	18 (40)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	25 (55)	X3 IP20 if2
20	590 (23.2)	378 (14.9)	245 (9.6)	29 (64)	X3 IP00	590 (23.2)	378 (14.9)	245 (9.6)	36 (79)	X3 IP20 if2
24	634 (25)	378 (14.9)	333 (13.1)	32 (71)	X3 IP00	629 (24.8)	378 (14.9)	245 (9.6)	40 (88)	X3 IP20 ef2
29	620 (24.4)	378 (14.9)	338 (13.3)	34 (75)	X4 IP00	658 (25.9)	378 (14.9)	338 (13.3)	42 (93)	X4 IP20 ef2
36	620 (24.4)	378 (14.9)	338 (13.3)	44 (97)	X4 IP00	658 (25.9)	378 (14.9)	338 (13.3)	52 (115)	X4 IP20 ef2
50	737 (29)	418 (16.5)	333 (13.1)	46 (101)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	56 (123)	X5 IP20 ef2
58	737 (29)	418 (16.5)	333 (13.1)	52 (115)	X5 IP00	775 (30.5)	418 (16.5)	333 (13.1)	62 (137)	X5 IP20 ef2
77	767 (30.2)	418 (16.5)	405 (15.9)	61 (134)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	74 (163)	X6 IP20 ef2
87	767 (30.2)	418 (16.5)	405 (15.9)	72 (159)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	85 (187)	X6 IP20 ef2
109	767 (30.2)	418 (16.5)	405 (15.9)	92 (203)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	105 (231)	X6 IP20 ef2
128	767 (30.2)	418 (16.5)	405 (15.9)	110 (243)	X6 IP00	806 (31.7)	418 (16.5)	405 (15.9)	123 (271)	X6 IP20 ef2
155	949 (37.4)	468 (18.4)	451 (17.8)	119 (262)	X7 IP00	989 (38.9)	468 (18.4)	451 (17.8)	136 (300)	X7 IP20 ef2
197	949 (37.4)	468 (18.4)	451 (17.8)	125 (276)	X7 IP00	989 (38.9)	468 (18.4)	451 (17.8)	142 (313)	X7 IP20 ef2
240	949 (37.4)	468 (18.4)	451 (17.8)	144 (317)	X7 IP00	989 (38.9)	468 (18.4)	451 (17.8)	163 (359)	X7 IP20 ef2
296	949 (37.4)	468 (18.4)	515 (20.3)	186 (410)	X8 IP00	989 (38.9)	468 (18.4)	515 (20.3)	205 (452)	X8 IP20 ef2
366	949 (37.4)	468 (18.4)	515 (20.3)	209 (461)	X8 IP00	989 (38.9)	468 (18.4)	515 (20.3)	228 (503)	X8 IP20 ef2
395	949 (37.4)	468 (18.4)	515 (20.3)	241 (531)	X8 IP00	989 (38.9)	468 (18.4)	515 (20.3)	260 (573)	X8 IP20 ef2

Table 7.18 500–690 V, 50 Hz, AHF 010

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7.2.8 IP21/NEMA 1 Kit

IP20 unit		IP20 with IP21/NEMA 1 upgrade kit	Height	Width	Depth
Type	Fan concept	Concept and drawing	[mm (in)]	[mm (in)]	[mm (in)]
X1	Internal fan type 1	X1 IP21 internal fan type 1	486.2 (19.1)	196 (7.7)	212 (8.3)
	External fan type 1	X1 IP21 external fan type 1	507 (20)		
X2	Internal fan type 1	X2 IP21 internal fan type 1	616.3 (24.3)	238 (9.4)	252 (9.9)
	External fan type 1	X2 IP21 external fan type 1	637.1 (25.1)		
X3	Internal fan type 1	X3 IP21 internal fan type 1	768 (30.2)	378 (14.9)	260 (10.2)
	External fan type 1	X3 IP21 external fan type 1	788 (31)		
	Internal fan type 2	X3 IP21 internal fan type 2	788 (31)	378 (14.9)	260 (10.2)
	External fan type 2	X3 IP21 external fan type 2	788 (31)		
X4	Internal fan type 1	X4 IP21 internal fan type 1	829.2 (32.6)	378 (14.9)	344 (13.5)
	External fan type 1	X4 IP21 external fan type 1	849.2 (33.4)		
	Internal fan type 2	X4 IP21 internal fan type 2	829.2 (32.6)	378 (14.9)	344 (13.5)
	External fan type 2	X4 IP21 external fan type 2	849.2 (33.4)		
X5	Internal fan type 1	X5 IP21 internal fan type 1	956.8 (37.7)	418 (16.5)	335.9 (13.2)
	External fan type 1	X5 IP21 external fan type 1	976.8 (38.5)		
	Internal fan type 2	X5 IP21 internal fan type 2	956.8 (37.7)	418 (16.5)	335.9 (13.2)
	External fan type 2	X5 IP21 external fan type 2	976.8 (38.5)		
X6	Internal fan type 1	X6 IP21 internal fan type 1	968.6 (38.1)	418 (16.5)	413.4
	External fan type 1	X6 IP21 external fan type 1	968.6 (38.1)		
	Internal fan type 2	X6 IP21 internal fan type 2	968.6 (38.1)	418 (16.5)	413.4 (16.3)
	External fan type 2	X6 IP21 external fan type 2	988.4 (38.9)		
X7	Internal fan type 1	X7 IP21 internal fan type 1	1157 (45.6)	468 (18.4)	467.6 (18.4)
	External fan type 1	X7 IP21 external fan type 1	1157 (45.6)		
	Internal fan type 2	X7 IP21 internal fan type 2	1157 (45.6)	468 (18.4)	467.6 (18.4)
	External fan type 2	X7 IP21 external fan type 2	1157 (45.6)		
X8	Internal fan type 1	X8 IP21 internal fan type 1	1172.1 (46.1)	468 (18.4)	530.9 (20.9)
	External fan type 1	X8 IP21 external fan type 1	1192.1 (46.9)		
	Internal fan type 2	X8 IP21 internal fan type 2	1172.1 (46.1)	468 (18.4)	530.9 (20.9)
	External fan type 2	X8 IP21 external fan type 2	1192.1 (46.9)		

Table 7.19 Mechanical Dimensions Including IP21/NEMA 1 Upgrade Kit

7.3 Fuses

To protect the installation against electrical and fire hazards, all filters in an installation must be protected against short-circuiting and overcurrent according to national and international regulations.

To protect both frequency converter and filter, select the type of fuses recommended in the frequency converter *design guide*. The maximum fuse rating per filter size is listed in *Table 7.20* to *Table 7.24*.

Filter current rating	Maximum fuse size	Fuses
[A]	[A]	(type)
10	16	gRL 690 V AC
14	35	gRL 690 V AC
22	35	gRL 690 V AC
29	50	gRL 690 V AC
34	50	gRL 690 V AC
40	63	gRL 690 V AC
55	80	gRL 690 V AC
66	125	gRL 690 V AC
82	160	gRL 690 V AC
96	250	gRL 690 V AC
133	250	gRL 690 V AC
171	315	gRL 690 V AC
204	350	gRL 690 V AC
251	400	gRL 690 V AC
304	500	gRL 690 V AC
325	630	gRL 690 V AC
381	630	gRL 690 V AC
480	800	gRL 690 V AC

Table 7.20 380–415 V, 50 Hz

Filter current rating	Maximum fuse size	Fuses
[A]	[A]	(type)
10	16	gRL 690 V AC
14	35	gRL 690 V AC
22	35	gRL 690 V AC
29	50	gRL 690 V AC
34	50	gRL 690 V AC
40	63	gRL 690 V AC
55	80	gRL 690 V AC
66	125	gRL 690 V AC
82	160	gRL 690 V AC
96	250	gRL 690 V AC
133	250	gRL 690 V AC
171	315	gRL 690 V AC
204	350	gRL 690 V AC
251	400	gRL 690 V AC
304	500	gRL 690 V AC
325	630	gRL 690 V AC
381	630	gRL 690 V AC
480	800	gRL 690 V AC

Table 7.21 380–415 V, 60 Hz

Filter current rating	Maximum fuse size	Fuses[1)]
[A]	[A]	(type)
10	20	Class J, 600 V AC, rated breaking capacity 100 kA
14	35	Class J, 600 V AC, rated breaking capacity 100 kA
19	35	Class J, 600 V AC, rated breaking capacity 100 kA
25	50	Class J, 600 V AC, rated breaking capacity 100 kA
31	50	Class J, 600 V AC, rated breaking capacity 100 kA
36	60	Class J, 600 V AC, rated breaking capacity 100 kA
48	80	Class J, 600 V AC, rated breaking capacity 100 kA
60	125	Class J, 600 V AC, rated breaking capacity 100 kA
73	150	Class J, 600 V AC, rated breaking capacity 100 kA
95	250	Class J, 600 V AC, rated breaking capacity 100 kA
118	250	Class J, 600 V AC, rated breaking capacity 100 kA
154	300	Class J, 600 V AC, rated breaking capacity 100 kA
183	350	Class J, 600 V AC, rated breaking capacity 100 kA
231	400	Class J, 600 V AC, rated breaking capacity 100 kA
291	600	Class J, 600 V AC, rated breaking capacity 100 kA
355	600	Class J, 600 V AC, rated breaking capacity 100 kA
380	600	Class J, 600 V AC, rated breaking capacity 100 kA
436	600	Class J, 600 V AC, rated breaking capacity 100 kA

Table 7.22 440–480 V, 60 Hz

1) Specified type is a UL requirement.

Filter current rating	Maximum fuse size	Fuses[1)]
[A]	[A]	(type)
15	35	Class J, 600 V AC, rated breaking capacity 100 kA
20	35	Class J, 600 V AC, rated breaking capacity 100 kA
24	50	Class J, 600 V AC, rated breaking capacity 100 kA
29	50	Class J, 600 V AC, rated breaking capacity 100 kA
36	60	Class J, 600 V AC, rated breaking capacity 100 kA
50	80	Class J, 600 V AC, rated breaking capacity 100 kA
58	100	Class J, 600 V AC, rated breaking capacity 100 kA
77	125	Class J, 600 V AC, rated breaking capacity 100 kA
87	150	Class J, 600 V AC, rated breaking capacity 100 kA
109	200	Class J, 600 V AC, rated breaking capacity 100 kA
128	250	Class J, 600 V AC, rated breaking capacity 100 kA
155	300	Class J, 600 V AC, rated breaking capacity 100 kA
197	350	Class J, 600 V AC, rated breaking capacity 100 kA
240	400	Class J, 600 V AC, rated breaking capacity 100 kA
296	500	Class J, 600 V AC, rated breaking capacity 100 kA
366	600	Class J, 600 V AC, rated breaking capacity 100 kA
395	600	Class J, 600 V AC, rated breaking capacity 100 kA

Table 7.23 600 V, 60 Hz

1) Specified type is a UL requirement.

Filter current rating	Maximum fuse size	Fuses
[A]	[A]	(type)
15	35	gRL 690 V AC
20	35	gRL 690 V AC
24	50	gRL 690 V AC
29	50	gRL 690 V AC
36	63	gRL 690 V AC
50	80	gRL 690 V AC
58	125	gRL 690 V AC
77	160	gRL 690 V AC
87	250	gRL 690 V AC
109	250	gRL 690 V AC
128	250	gRL 690 V AC
155	315	gRL 690 V AC
197	350	gRL 690 V AC
240	400	gRL 690 V AC
296	500	gRL 690 V AC
366	630	gRL 690 V AC
395	630	gRL 690 V AC

Table 7.24 500–690 V, 50 Hz

In applications where filters are paralleled, it might be necessary to install fuses in front of each filter and in front of the frequency converter.

8 Spare Parts

⚠WARNING

DISCHARGE TIME

The VLT® Advanced Harmonic Filters AHF 005/AHF 010 contain capacitors. The capacitors can remain charged even when the filter is not powered. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Wait at least 10 minutes.**

⚠WARNING

HAZARDOUS VOLTAGE

- **Observe and respect the discharge time.**
- **When the discharge time has elapsed, ensure that the voltage is 0 between the filter terminals X3.1, X3.2, and X3.3, and between X4.1, X4.2, and X4.3.**

Failure to follow recommendations could result in death or serious injury.

8.1 Selection Tables

8.1.1 Capacitor Kits

Items supplied, capacitor kits

The spare part capacitor kits are complete kits including cabling and accessories for replacement.

The spare part capacitor kits support the following filters:

- VLT® Advanced Harmonic Filter AHF 005 IP00.
- VLT® Advanced Harmonic Filter AHF 005 IP20.
- VLT® Advanced Harmonic Filter AHF 010 IP00.
- VLT® Advanced Harmonic Filter AHF 010 IP20.

380–415 V, 50 Hz	Capacitor kit	
Current rating [A]	Ordering number	Description
10	175U0134	Capacitor bank AHF DA/B 400V-50Hz-010A
14	175U0135	Capacitor bank AHF DA/B 400V-50Hz-014A
22	175U0136	Capacitor Bank AHF DA/B 400V-50Hz-022A
29	175U0137	Capacitor Bank AHF DA/B 400V-50Hz-029A
34	175U0138	Capacitor Bank AHF DA/B 400V-50Hz-034A
40	175U0139	Capacitor Bank AHF DA/B 400V-50Hz-040A
55	175U0140	Capacitor Bank AHF DA/B 400V-50Hz-055A
66	175U0141	Capacitor Bank AHF DA/B 400V-50Hz-066A
82	175U0142	Capacitor Bank AHF DA/B 400V-50Hz-082A
96	175U0143	Capacitor Bank AHF DA/B 400V-50Hz-096A
133	175U0144	Capacitor Bank AHF DA/B 400V-50Hz-133A
171	175U0145	Capacitor Bank AHF DA/B 400V-50Hz-171A
204	175U0146	Capacitor Bank AHF DA/B 400V-50Hz-204A
251	175U0147	Capacitor Bank AHF DA/B 400V-50Hz-251A
304	175U0148	Capacitor Bank AHF DA/B 400V-50Hz-304A
325	175U0149	Capacitor Bank AHF DA/B 400V-50Hz-325A
381	175U0150	Capacitor Bank AHF DA/B 400V-50Hz-381A
480	175U0151	Capacitor Bank AHF DA/B 400V-50Hz-480A

Table 8.1 Capacitor Kits, 380–415 V, 50 Hz

380–415 V, 60 Hz	Capacitor kit	
Current rating [A]	Ordering number	Description
10	175U0278	Capacitor Bank AHF DA/B 380V-60Hz-010A
14	175U0279	Capacitor Bank AHF DA/B 380V-60Hz-014A
22	175U0280	Capacitor Bank AHF DA/B 380V-60Hz-022A
29	175U0281	Capacitor Bank AHF DA/B 380V-60Hz-029A
34	175U0282	Capacitor Bank AHF DA/B 380V-60Hz-034A
40	175U0283	Capacitor Bank AHF DA/B 380V-60Hz-040A
55	175U0284	Capacitor Bank AHF DA/B 380V-60Hz-055A
66	175U0285	Capacitor Bank AHF DA/B 380V-60Hz-066A
82	175U0286	Capacitor Bank AHF DA/B 380V-60Hz-082A
96	175U0287	Capacitor Bank AHF DA/B 380V-60Hz-096A
133	175U0288	Capacitor Bank AHF DA/B 380V-60Hz-133A
171	175U0289	Capacitor Bank AHF DA/B 380V-60Hz-171A
204	175U0290	Capacitor Bank AHF DA/B 380V-60Hz-204A
251	175U0291	Capacitor Bank AHF DA/B 380V-60Hz-251A
304	175U0292	Capacitor Bank AHF DA/B 380V-60Hz-304A
325	175U0295	Capacitor Bank AHF DA/B 380V-60Hz-325A
381	175U0293	Capacitor Bank AHF DA/B 380V-60Hz-381A
480	175U0294	Capacitor Bank AHF DA/B 380V-60Hz-480A

Table 8.2 Capacitor Kits, 380–415 V, 60 Hz

440–480 V, 60 Hz	Capacitor kit	
Current rating [A]	Ordering number	Description
10	175U0152	Capacitor Bank AHF DA/B 460V-60Hz-010A
14	175U0153	Capacitor Bank AHF DA/B 460V-60Hz-014A
19	175U0154	Capacitor Bank AHF DA/B 460V-60Hz-019A
25	175U0155	Capacitor Bank AHF DA/B 460V-60Hz-025A
31	175U0156	Capacitor Bank AHF DA/B 460V-60Hz-031A
36	175U0158	Capacitor Bank AHF DA/B 460V-60Hz-036A
48	175U0159	Capacitor Bank AHF DA/B 460V-60Hz-048A
60	175U0160	Capacitor Bank AHF DA/B 460V-60Hz-060A
73	175U0161	Capacitor Bank AHF DA/B 460V-60Hz-073A
95	175U0162	Capacitor Bank AHF DA/B 460V-60Hz-095A
118	175U0163	Capacitor Bank AHF DA/B 460V-60Hz-118A
154	175U0164	Capacitor Bank AHF DA/B 460V-60Hz-154A
183	175U0165	Capacitor Bank AHF DA/B 460V-60Hz-183A
231	175U0166	Capacitor Bank AHF DA/B 460V-60Hz-231A
291	175U0167	Capacitor Bank AHF DA/B 460V-60Hz-291A
355	175U0168	Capacitor Bank AHF DA/B 460V-60Hz-355A
380	175U0169	Capacitor Bank AHF DA/B 460V-60Hz-380A
436	175U0170	Capacitor Bank AHF DA/B 460V-60Hz-436A

Table 8.3 Capacitor Kits, 440–480 V, 60 Hz

600 V, 60 Hz	Capacitor kit	
Current rating [A]	Ordering number	Description
15	175U0205	Capacitor Bank AHF DA/B 600V-60Hz-015A
20	175U0206	Capacitor Bank AHF DA/B 600V-60Hz-020A
24	175U0207	Capacitor Bank AHF DA/B 600V-60Hz-024A
29	175U0208	Capacitor Bank AHF DA/B 600V-60Hz-029A
36	175U0209	Capacitor Bank AHF DA/B 600V-60Hz-036A
50	175U0211	Capacitor Bank AHF DA/B 600V-60Hz-050A
58	175U0212	Capacitor Bank AHF DA/B 600V-60Hz-058A
77	175U0213	Capacitor Bank AHF DA/B 600V-60Hz-077A
87	175U0214	Capacitor Bank AHF DA/B 600V-60Hz-087A
109	175U0215	Capacitor Bank AHF DA/B 600V-60Hz-109A
128	175U0217	Capacitor Bank AHF DA/B 600V-60Hz-128A
155	175U0218	Capacitor Bank AHF DA/B 600V-60Hz-155A
197	175U0219	Capacitor Bank AHF DA/B 600V-60Hz-197A
240	175U0245	Capacitor Bank AHF DA/B 600V-60Hz-240A
296	175U0254	Capacitor Bank AHF DA/B 600V-60Hz-296A
366	175U0255	Capacitor Bank AHF DA 600V-60Hz-366A
395	175U0256	Capacitor Bank AHF DA 600V-60Hz-395A

Table 8.4 Capacitor Kits, 600 V, 60 Hz

500–690 V, 50 Hz	Capacitor kit	
Current rating [A]	Ordering number	Description
15	175U0173	Capacitor bank AHF DA/B 500V/690V-50Hz-015A
20	175U0174	Capacitor bank AHF DA/B 500V/690V-50Hz-020A
24	175U0175	Capacitor bank AHF DA/B 500V/690V-50Hz-024A
29	175U0176	Capacitor bank AHF DA/B 500V/690V-50Hz-029A
36	175U0177	Capacitor bank AHF DA/B 500V/690V-50Hz-036A
50	175U0178	Capacitor bank AHF DA/B 500V/690V-50Hz-050A
58	175U0180	Capacitor bank AHF DA/B 500V/690V-50Hz-058A
77	175U0190	Capacitor bank AHF DA/B 500V/690V-50Hz-077A
87	175U0193	Capacitor bank AHF DA/B 500V/690V-50Hz-087A
109	175U0195	Capacitor bank AHF DA/B 500V/690V-50Hz-109A
128	175U0196	Capacitor bank AHF DA/B 500V/690V-50Hz-128A
155	175U0197	Capacitor bank AHF DA/B 500V/690V-50Hz-155A
197	175U0198	Capacitor bank AHF DA/B 500V/690V-50Hz-197A
240	175U0199	Capacitor bank AHF DA/B 500V/690V-50Hz-240A
296	175U0201	Capacitor bank AHF DA/B 500V/690V-50Hz-296A
366	175U0202	Capacitor bank AHF DA 500V/690V-50Hz-366A
395	175U0203	Capacitor bank AHF DA 500V/690V-50Hz-395A

Table 8.5 Capacitor Kits, 500–690 V, 50 Hz

8.1.2 Terminals

Items supplied, terminal kits

- Terminal X1–X2: Each kit contains 3 terminal blocks, including labels for matching designations.
- Terminal X3–X4: Each kit contains 3 terminal blocks, including labels for matching designations.
- Terminal A+B: Each kit contains 3 terminal blocks, including labels for matching designations.

The spare part terminal kits support the following filters:

- VLT® Advanced Harmonic Filter AHF 005 IP00.
- VLT® Advanced Harmonic Filter AHF 005 IP20.
- VLT® Advanced Harmonic Filter AHF 010 IP00.
- VLT® Advanced Harmonic Filter AHF 010 IP20.

380–415 V 50 Hz	Terminals X1+X2		Terminals X3+X4		Terminals A+B	
Current rating	Ordering number	Description	Ordering number	Description	Ordering number	Description
[A]		Mains input and output terminals		Capacitor disconnect terminals		Thermal switch terminals
10	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
14	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
22	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
29	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
34	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
40	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
55	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
66	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
82	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
96	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
133	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
171	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
204	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
251	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
304	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
325	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
381	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
480	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A

Table 8.6 Terminal Kits, 380–415 V 50 Hz

380–415 V 60 Hz	Terminals X1+X2		Terminals X3+X4		Terminals A+B	
Current rating [A]	Ordering number	Description [Mains input and output terminals]	Ordering number	Description [Capacitor disconnect terminals]	Ordering number	Description [Thermal switch terminals]
10	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
14	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
22	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
29	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
34	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
40	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
55	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
66	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
82	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
96	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
133	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
171	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
204	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
251	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
304	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
325	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
381	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
480	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A

Table 8.7 Terminal Kits, 380–415 V 60 Hz

440–480 V 60 Hz	Terminals X1+X2		Terminals X3+X4		Terminals A+B	
Current rating [A]	Ordering number	Description [Mains input and output terminals]	Ordering number	Description [Capacitor disconnect terminals]	Ordering number	Description [Thermal switch terminals]
10	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
14	175U0258	WDU 6 600 V 50 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
19	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
25	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A	175U0257	WDU 2.5 600 V 25 A
31	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
36	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
48	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
60	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
73	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
95	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
118	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
154	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
183	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
231	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
291	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
355	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
380	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
436	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A

Table 8.8 Terminal Kits, 440–480 V 60 Hz

600 V 60 Hz	Terminals X1+X2		Terminals X3+X4		Terminals A+B	
Current rating [A]	Ordering number	Description [Mains input and output terminals]	Ordering number	Description [Capacitor disconnect terminals]	Ordering number	Description [Thermal switch terminals]
15	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
20	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
24	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
29	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
36	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
50	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
58	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
77	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
87	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
109	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
128	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
155	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
197	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
240	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
296	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
366	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
395	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A

Table 8.9 Terminal Kits, 600 V 60 Hz

500–690 V 50 Hz	Terminals X1+X2		Terminals X3+X4		Terminals A+B	
Current rating [A]	Ordering number	Description [Mains input and output terminals]	Ordering number	Description [Capacitor disconnect terminals]	Ordering number	Description [Thermal switch terminals]
15	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
20	175U0260	WDU 16 600 V 85 A	175U0259	WDU 10 600 V 65 A	175U0257	WDU 2.5 600 V 25 A
24	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
29	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
36	175U0261	WDU 35 1000 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
50	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
58	175U0262	WDU 50N 600 V 150 A	175U0260	WDU 16 600 V 85 A	175U0257	WDU 2.5 600 V 25 A
77	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
87	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
109	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
128	175U0263	WFF70N/AH 1000 V 183 A	175U0261	WDU 35 1000 V 150 A	175U0257	WDU 2.5 600 V 25 A
155	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
197	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
240	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
296	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
366	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A
395	175U0265	WFF300/AH 1000 V 500 A	175U0264	WDU 95N 1000 V 228 A	175U0257	WDU 2.5 600 V 25 A

Table 8.10 Terminal Kits, 500–690 V 50 Hz

8.1.3 Fans

Items supplied, fan kits and accessories

- Fan: The spare part fan kit contains 1 fan.
- Fan fence: The spare part fan fence kit contains 1 fence.
- Transformer: The spare part transformer kit contains 1 transformer.

The spare part fan kits support:

- VLT® Advanced Harmonic Filter AHF 005 IP20.
- VLT® Advanced Harmonic Filter AHF 010 IP20.

380–415 V 50 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
10[1)]	–	–	–	175U0113	1	AHF2 Fan fence size 10	–	–	–
14	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
22	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
29	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
34	175U0111	1	AHF2 Fan 380–400 V 34–480A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
40	175U0111	1	AHF2 Fan 380–400V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
55	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
66	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
82	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
96	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V

380–415 V 50 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
133	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
171	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
204	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
251	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
304	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
325	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
381	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
480	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V

Table 8.11 Fan Kits and Accessories, 380–415 V, 50 Hz

1) 10 A version is cooled by natural convections.

380–415 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
10[1)]	–	–	–	175U0113	1	AHF2 Fan fence size 10	–	–	–
14	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
22	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
29	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
34	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
40	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
55	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
66	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
82	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
96	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
133	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
171	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
204	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V

380–415 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
251	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
304	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
325	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
381	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V
480	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0267	1	Transformer for AHF2 400 V–2x230 V

Table 8.12 Fan Kits and Accessories, 380–415 V, 60 Hz

1) 10 A version is cooled by natural convections.

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440–480 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
10[1)]	–	–	–	175U0113	1	AHF2 Fan fence size 10	–	–	–
14	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
19	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer for AHF2 400 V/460–230 V
25	175U0110	1	AHF2 Fan 380–400 V 10–29 A	175U0113	1	AHF2 Fan fence size 10	175U0268	1	Transformer. for AHF2 400 V/460–230 V
31	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
36	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
48	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
60	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
73	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
95	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
118	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
154	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V
183	175U0111	1	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0268	1	Transformer for AHF2 400 V/460–230 V

440–480 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
231	175U0111	2	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0268	2	Transformer for AHF2 400 V/460–230 V
291	175U0111	2	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0268	2	Transformer for AHF2 400 V/460–230 V
355	175U0111	2	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0268	2	Transformer for AHF2 400 V/460–230 V
380	175U0111	2	AHF2 Fan 380–400 V 34–480 A 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0268	2	Transformer for AHF2 400V/460–230 V
436	175U0111	2	AHF2 Fan 380–400 V 34–48 0A 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0268	2	Transformer for AHF2 400 V/460–230 V

Table 8.13 Fan Kits and Accessories, 440–480 V, 60 Hz

1) 10 A version is cooled by natural convections.

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600 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
15	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
20	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
24	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
29	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
36	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
50	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
58	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
77	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
87	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
109	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
128	175U0111	1	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	1	AHF2 Fan fence size 20	175U0269	1	Transformer for AHF2 600 V/690–230 V
155	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V

600 V 60 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
197	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V
240	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V
296	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V
366	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V
395	175U0111	2	AHF2 Fan 380–400 V 34–480 A/ 460 V 10–436 A	175U0112	2	AHF2 Fan fence size 20	175U0269	2	Transformer for AHF2 600 V/690–230 V

Table 8.14 Fan Kits and Accessories, 600 V, 60 Hz

500–690 V 50 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
15	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
20	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
24	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
29	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
36	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
50	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
58	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
77	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
87	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
109	175U0266	1	AHF2 Fan 600–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
128	175U0266	1	AHF2 Fan 600-–690 V	175U0323	1	AHF2 Fan fence size 30	175U0269	1	Transformer for AHF2 600 V/690–230 V
155	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V
197	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V
240	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V
296	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V
366	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V

500–690 V 50 Hz	Fan			Fan fence			Fan transformer		
Current rating [A]	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description	Ordering number	Quantity required	Description
395	175U0266	2	AHF2 Fan 600–690 V	175U0323	2	AHF2 Fan fence size 30	175U0269	2	Transformer for AHF2 600 V/690–230 V

Table 8.15 Fan Kits and Accessories, 500–690 V, 50 Hz

8.1.4 Fuses

Items supplied, fuse kits and accessories
Fan fuses: The spare fuse kits contain 10 fuses.
Fuse holder: 1 item.
Cover for fuse holder: 1 item.

The spare part fuse kits support the following filters:

- VLT® Advanced Harmonic Filter AHF 005 IP20.
- VLT® Advanced Harmonic Filter AHF 010 IP20.

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380–415 V 50 Hz	380–415 V 60 Hz	440–480 V 60 Hz	600 V 60 Hz	500–690 V 50 Hz	Fuse		Fuse holder		Fuse cover	
Current rating [A]					Ordering number	Description	Ordering number	Description	Ordering number	Description
10[1)]	10	10	–	–	–	–	–	–	–	–
14	14	14	15	15	175U0114	AHF2 Fuse for fan 380–690 V 2 A	175U0115	AHF2 Fuse holder 380–690 V	175U0117	AHF2 Cover for fuse holder 380–690 V
22	22	19	20	20						
29	29	25	24	24						
34	34	31	29	29						
40	40	36	36	36						
55	55	48	50	50						
66	66	60	58	58						
82	82	73	77	77						
96	96	95	87	87						
133	133	118	109	109						
171	171	154	128	128						
204	204	183	155	155						
251	251	231	197	197						
304	304	291	240	240						
325	325	355	296	296						
381	381	380	366	366						
480	480	436	395	395						

Table 8.16 Fuse Kits and Accessories

1) 10 A version is cooled by natural convections.

9 Appendix

9.1 Power Loss Tables

Value	Description
Current rating	Filter nominal current rating.
Type	Harmonic type as AHF 005 or AHF 010 with THDi levels of 5% or 10%, respectively.
IP class	Enclosure protection rating as IP00 or IP20. The IP20 versions have higher losses due to the built-in fans. The IP00 versions require forced cooling by separate fans in the installation.
Load	AHF current loading in point of operation.
Loss	AHF power loss in point of operation.

Table 9.1 Abbreviations and Explanations to *Table 9.2*

AHF values			Load and loss									
Current rating	Type	IP class	0%		25%		50%		75%		100%	
			Load	Loss	Load	Loss	Load	Loss	Load	Loss	Load	Loss
[A]	[THDi]		[A]	[W]	[A]	[W]	[A]	[W]	[A]	[W]	[A]	[W]
10	10	IP00	0	17	2	22	5	38	7	54	10	86
		IP20		17		22		38		54		86
	5	IP00		28		36		66		91		142
		IP20		28		36		66		91		142
14	10	IP00	0	21	4	33	7	50	11	84	14	114
		IP20		63		74		90		124		155
	5	IP00		26		41		64		113		159
		IP20		64		80		103		150		195
22	10	IP00	0	40	6	58	11	90	17	146	22	211
		IP20		79		97		128		183		247
	5	IP00		47		69		109		185		269
		IP20		86		108		147		220		304
29	10	IP00	0	51	8	70	15	105	23	167	29	229
		IP20		92		111		145		206		266
	5	IP00		64		92		147		245		342
		IP20		102		130		183		277		375
34	10	IP00	0	47	9	68	17	108	26	177	34	271
		IP20		104		124		164		238		320
	5	IP00		68		99		161		272		407
		IP20		123		153		224		331		460
40	10	IP00	0	46	10	72	20	121	30	195	40	297
		IP20		101		127		177		249		352
	5	IP00		70		110		184		293		439
		IP20		125		163		237		346		492
55	10	IP00	0	47	14	76	28	141	42	243	55	373
		IP20		103		133		195		294		422
	5	IP00		59		101		196		346		527
		IP20		117		158		252		396		576
60	10	IP00	0	57	17	102	33	182	50	317	66	497
		IP20		115		158		236		369		547
	5	IP00		80		148		267		462		704
		IP20		140		204		323		513		752

AHF values			Load and loss									
Current rating	Type	IP class	0%		25%		50%		75%		100%	
			Load	Loss	Load	Loss	Load	Loss	Load	Loss	Load	Loss
[A]	[THDi]		[A]	[W]	[A]	[W]	[A]	[W]	[A]	[W]	[A]	[W]
82	10	IP00	0	74	21	113	41	179	62	284	82	429
		IP20		127		166		232		337		482
	5	IP00		91		159		278		473		715
		IP20		144		212		331		526		768
96	10	IP00	0	95	24	144	48	233	72	360	96	537
		IP20		152		198		289		420		589
	5	IP00		103		163		286		462		684
		IP20		161		218		340		512		734
133	10	IP00	0	105	34	170	66	290	100	481	133	737
		IP20		161		226		342		528		772
	5	IP00		115		197		341		569		873
		IP20		171		252		391		616		908
171	10	IP00	0	137	43	220	85	362	128	580	171	882
		IP20		191		271		406		617		911
	5	IP00		155		265		480		810		1259
		IP20		212		315		523		852		1295
204	10	IP00	0	132	51	224	102	364	153	574	204	869
		IP20		185		277		417		627		922
	5	IP00		157		258		461		771		1187
		IP20		210		311		514		824		1240
251	10	IP00	0	189	63	293	125	468	188	750	251	1158
		IP20		295		399		574		856		1264
	5	IP00		176		298		520		860		1330
		IP20		282		404		626		966		1436
304	10	IP00	0	222	71	337	152	548	223	844	304	1316
		IP20		328		443		654		950		1422
	5	IP00		274		383		626		955		1469
		IP20		380		489		732		1061		1575
325	10	IP00	0	234	81	343	162	557	243	885	325	1349
		IP20		340		449		663		991		1455
	5	IP00		209		354		633		1047		1628
		IP20		330		477		749		1153		1726
381	10	IP00	0	273	95	388	190	640	285	1036	381	1581
		IP20		379		494		746		1142		1687
	5	IP00		162		316		682		1229		1973
		IP20		268		422		788		1335		2079
480	10	IP00	0	384	120	615	240	1013	360	1580	480	2311
		IP20		490		721		1119		1686		2417
	5	IP00		390		577		1010		1812		2587
		IP20		496		683		1116		1918		2693

Table 9.2 Power Loss, 400 V, 50 Hz

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