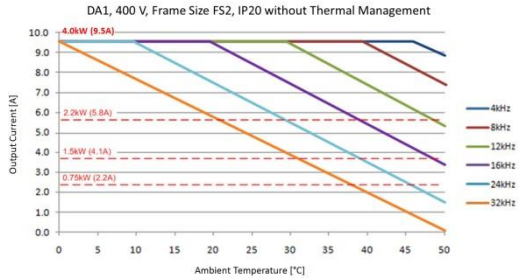
PowerXL™

DA1 Variable Frequency Drives
Dependency of the output current on switching frequency and ambient temperature



Level 3	1 – Fundamental – No previous experience necessary 2 – Basic – Basic knowledge recommended 3 – Advanced – Reasonable knowledge required 4 – Expert – Good experience recommended

Powering Business Worldwide

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Danger! - Dangerous electrical voltage!

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalization. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automatic control functions.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specification, otherwise this may cause malfunction and/or dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes. Unlatching of the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been properly installed and with the housing closed.
- Wherever faults may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (e.g. by means of separate limit switches, mechanical interlocks etc.).
- Frequency inverters may have hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may destroy the device and may lead to serious injury or damage.
- The applicable national safety regulations and accident prevention recommendations must be applied to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant electrical regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the frequency inverter (increased motor speed or sudden standstill of motor). These measures include: – Other independent devices for monitoring safety related variables (speed, travel, end positions etc.).
  – Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
  – Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be alive after disconnection. Consider appropriate warning signs.

Disclaimer

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1 General

In the development of variable frequency drives the thermal design plays an important role. With a given hardware (power semiconductors used, heat sinks, fan yes/no…) a reliable operation basically depends on three factors:

- the motor current
- the switching frequency in the power section
- the ambient temperature

In the technical data sheets one can find rating values, which correspond to a certain combination of the values above. In addition there is a possibility to use other combinations in an application. For example you can increase the switching frequency to reduce the noise, which is generated by switching the semiconductors in the power section. At the same time higher switching frequencies lead to increased losses. One can compensate these by reducing the current to make sure, that the thermal aspect is in balance. In some cases it may be necessary to select a variable frequency drive with a higher rating.

This application note describes the dependency of a possible output current on switching frequency and ambient temperature as well as the function “Auto Thermal Management”.

Some required parameters are inside Level 3 of the menu. This level has to be activated by prompting the „Password Level3“ (P6-30) into P1-14 (Password). Password Level3 is „201“ by default.

The functions described here, refer to an application software version 2.0 and above (see parameter P0-79).

2 The thermal management of the devices DA1

The most important parameter for a thermal balance is the heatsink temperature. The temperature is displayed with P0-21. The devices of the series DA1 have an internal thermal management, which reduces the switching frequency automatically in case of too high temperature. Hereby the likelihood of an overtemperature trip is minimized. The minimum switching frequency can be set with P6-02.

ATTENTION: In case a sine wave filter is used, the switching frequency has to be in the range which is permissible for the filter. In this case P2-24 has to be set to twice the switching frequency mentioned on the filter (e.g. sine wave filter for 4 kHz → P2-24 = 8 kHz). The switching frequency has to be kept constant to avoid resonances. In this case P2-24 and P6-02 have to be set to the same value. Equal values for P2-24 and P6-02 disable the thermal management and the switching frequency remains on the value set with these parameters.

Reasons for an excessive temperature could be:

- wrong selection of the variable frequency drive
- wrong mounting (cooling air cannot circulate properly)
- temporary increase of the ambient temperature e.g. on hot summer days
- breakdown of the cooling fan
- pollution of the heatsink

The table below shows the respective measures depending on the heat sink temperature (not ambient temperature!)

Heatsink temperature	Measure
70 °C	Automatic reduction of the switching frequency from 32 kHz to 24 kHz
75 °C	Automatic reduction of the switching frequency from 24 kHz to 16 kHz
80 °C	Automatic reduction of the switching frequency from 16 kHz to 12 kHz
85 °C	Automatic reduction of the switching frequency from 12 kHz to 8 kHz
90 °C	Automatic reduction of the switching frequency from 8 kHz to 4 kHz
97 °C	Overtemperature trip O-t

2.1 Switching Frequency (P2-24), Auto Thermal Management (P6-02), Heatsink Temperature (P0-21)

PNU	Parameter	Name	Range	Default
390.0	P2-24	Switching Frequency	0: 4 kHz 1: 8 kHz 2: 12 kHz 3: 16 kHz 4: 24 kHz 5: 32 kHz	f (I_e)
624.0	P6-02	Auto Thermal Management	0: 4 kHz 1: 8 kHz 2: 12 kHz 3: 16 kHz 4: 24 kHz 5: 32 kHz	0
822.0	P0-21	Heatsink Temperature	-29 … +100 °C	-

Hint: the maximum switching frequency depends on the device type.

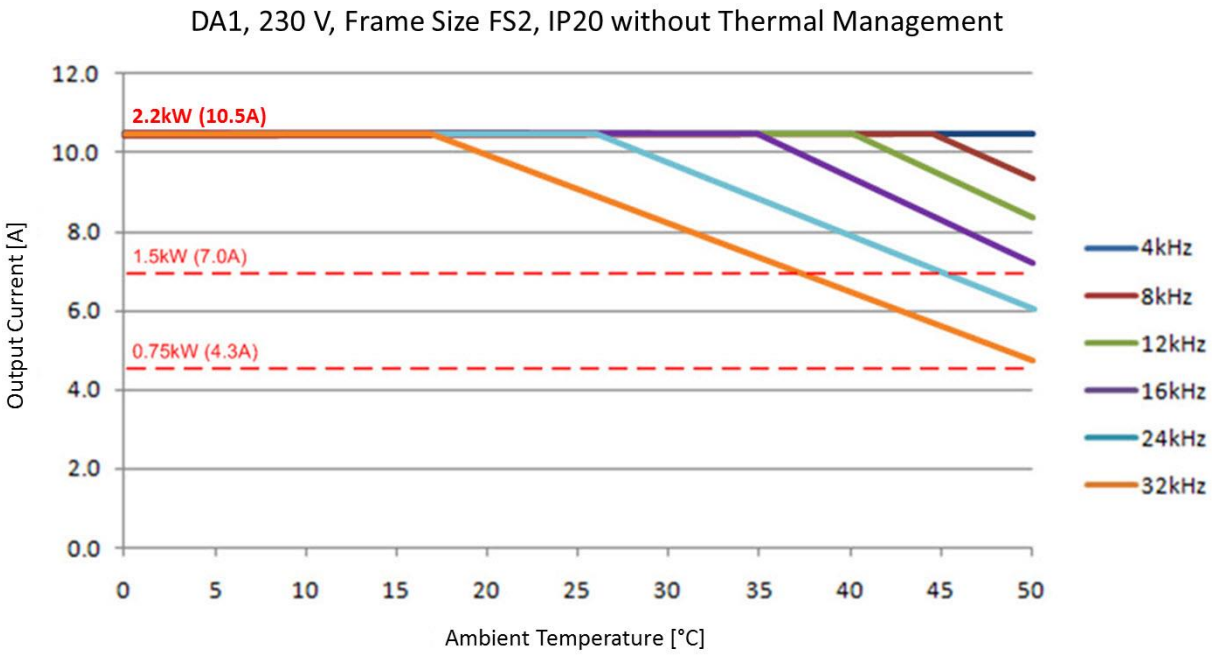
3 Current depending on switching frequency and temperature

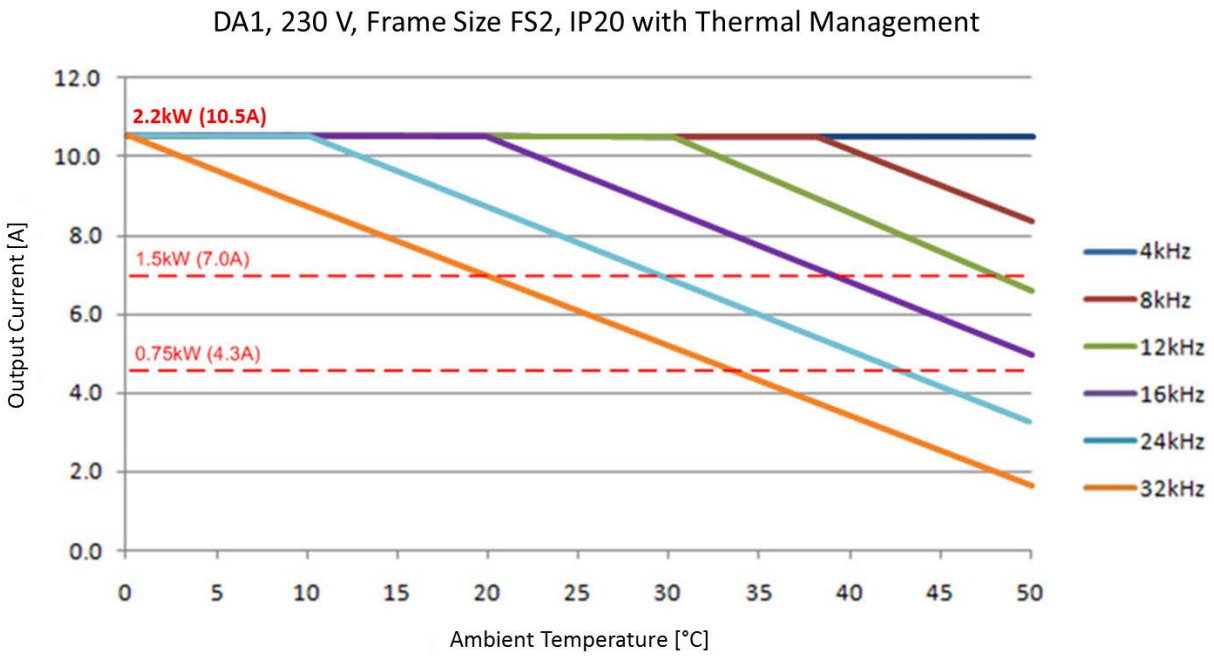
The following tables are splitted according the degree of protection (IP…), the mains voltage and the frame size (FS). As a voltage the so called “voltage class” is shown.

- 230 V → 200 V – 10 % … 240 V +10 % (values are true for single phase as well as for three phase supply)
- 400 V → 380 V – 10 % … 480 V + 10 %

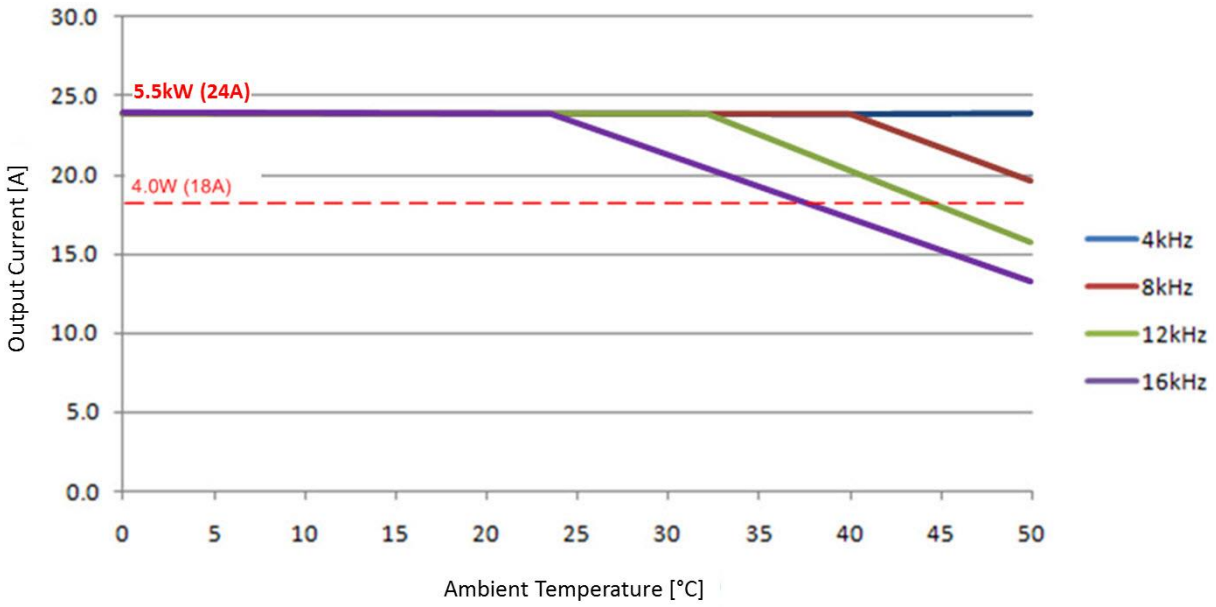
3.1 Devices DA1 with degree of protection IP20

3.1.1 Voltage class 230 V

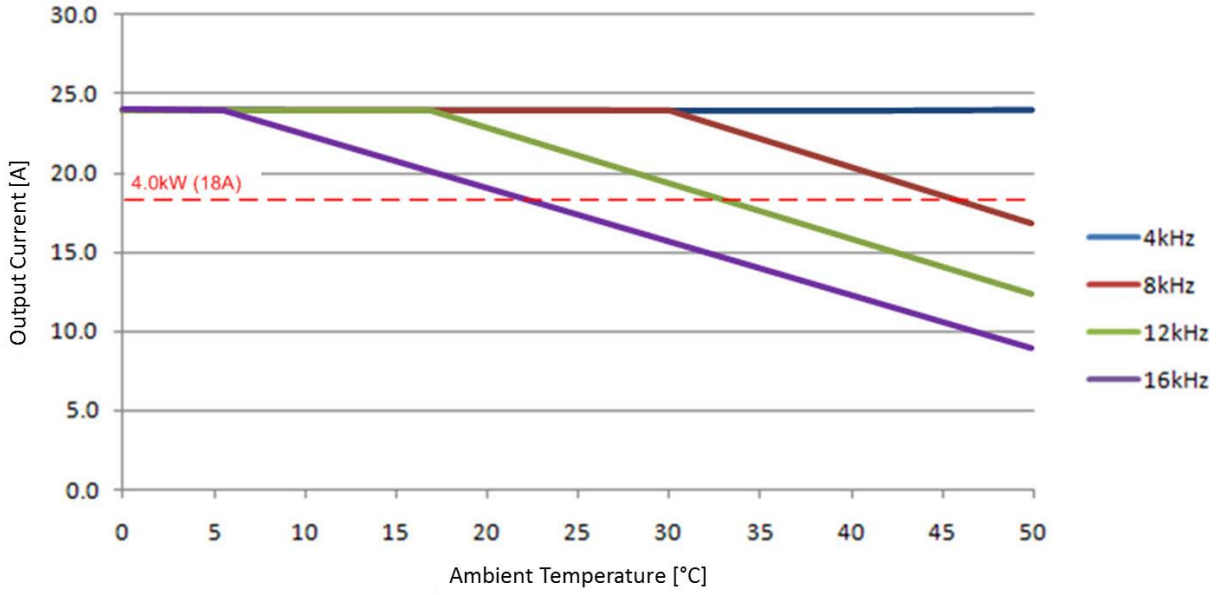




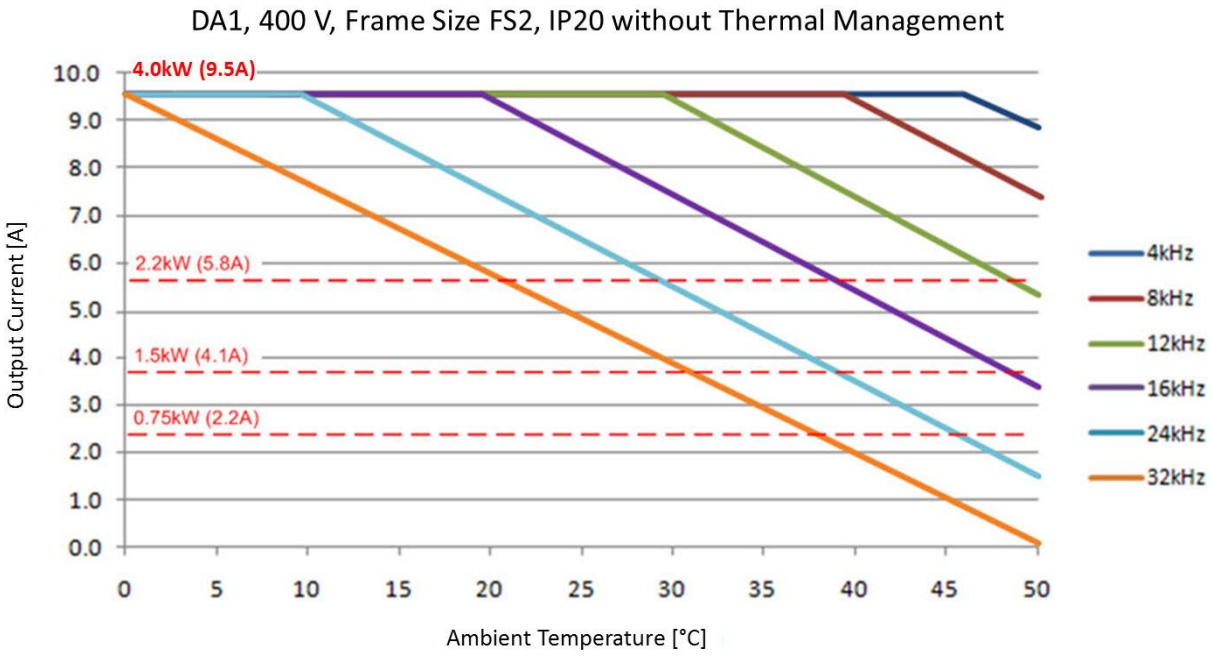
DA1, 230 V, Frame Size FS3, IP20 without Thermal Management

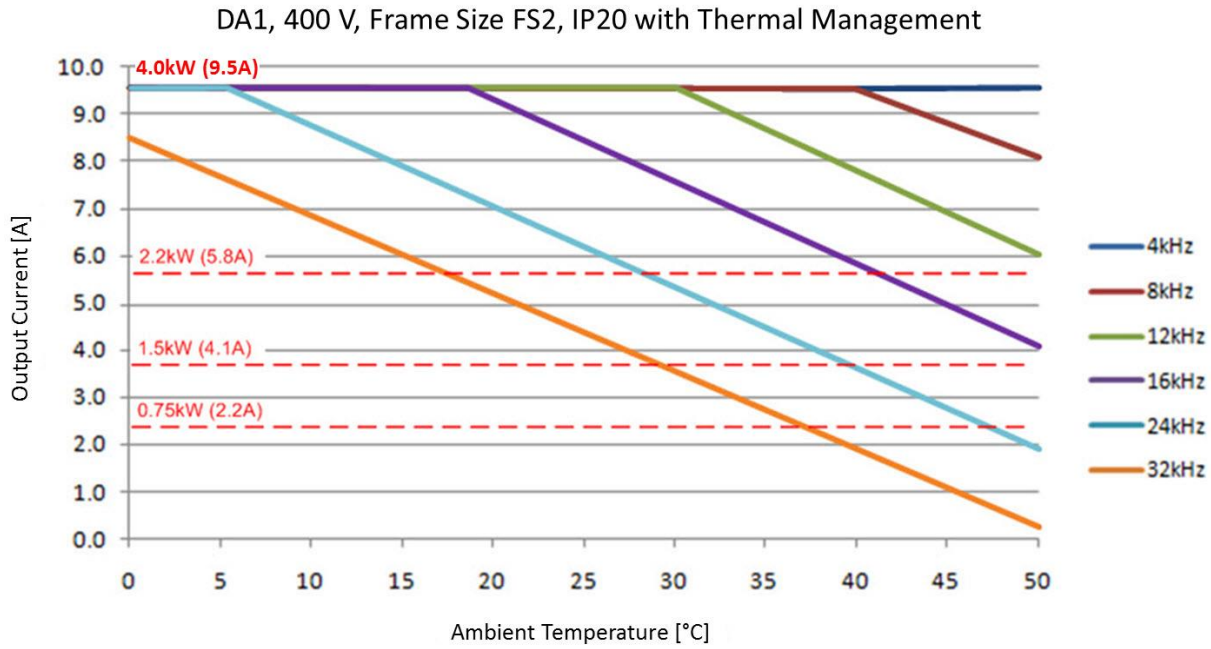


DA1, 230 V, Frame Size FS3, IP20 with Thermal Management

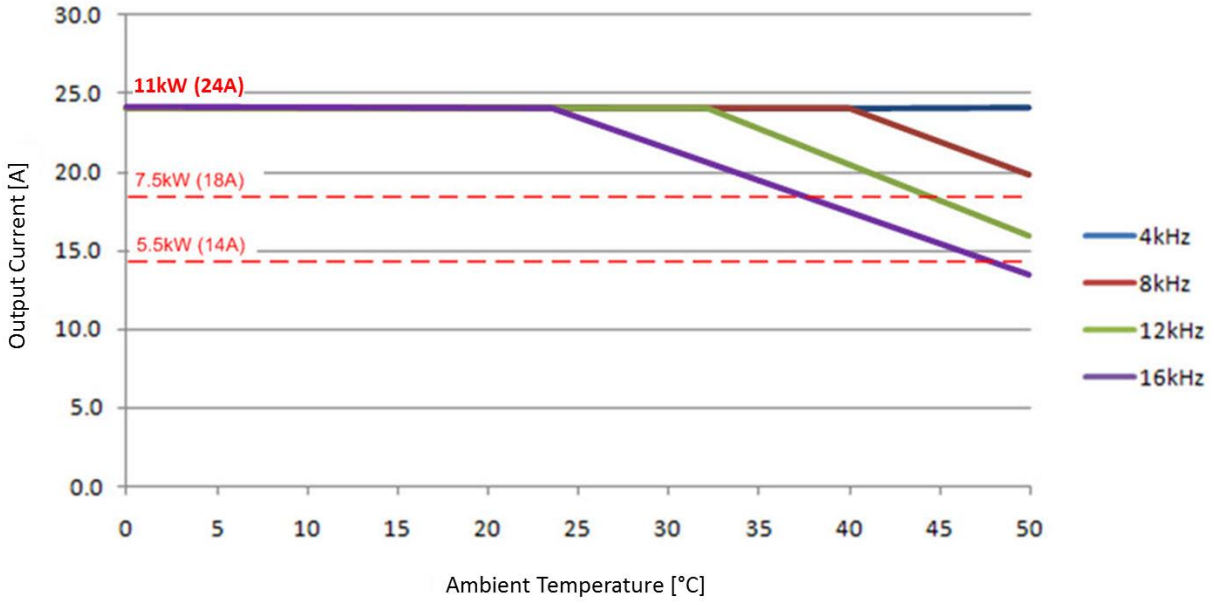


3.1.2 Voltage class 400 V

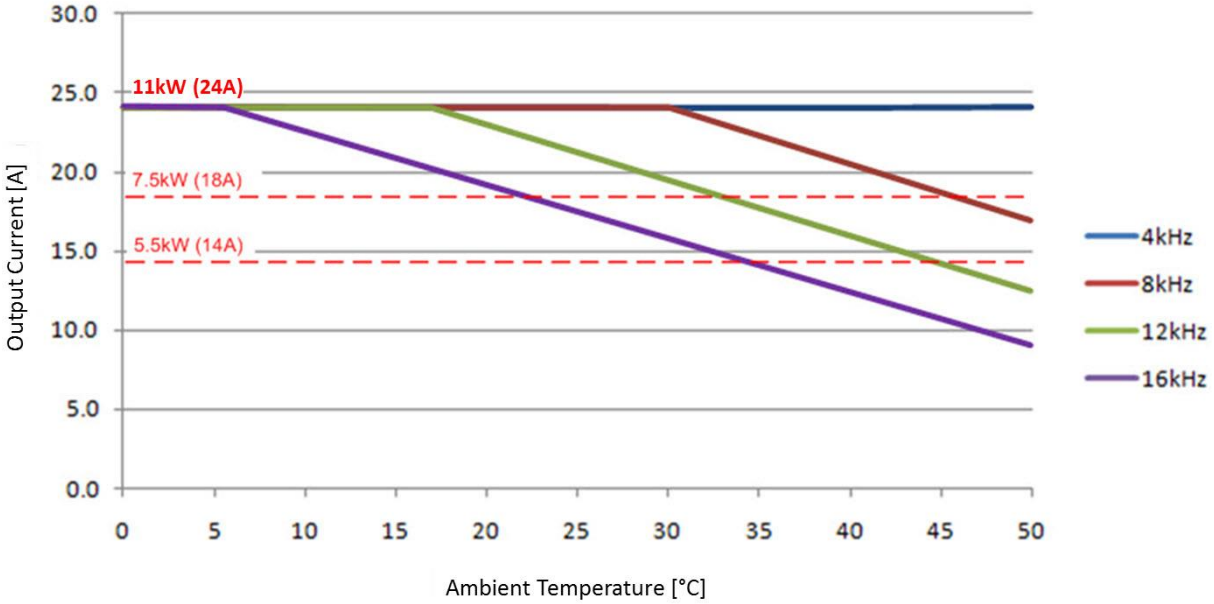




DA1, 400 V, Frame Size FS3, IP20 without Thermal Management

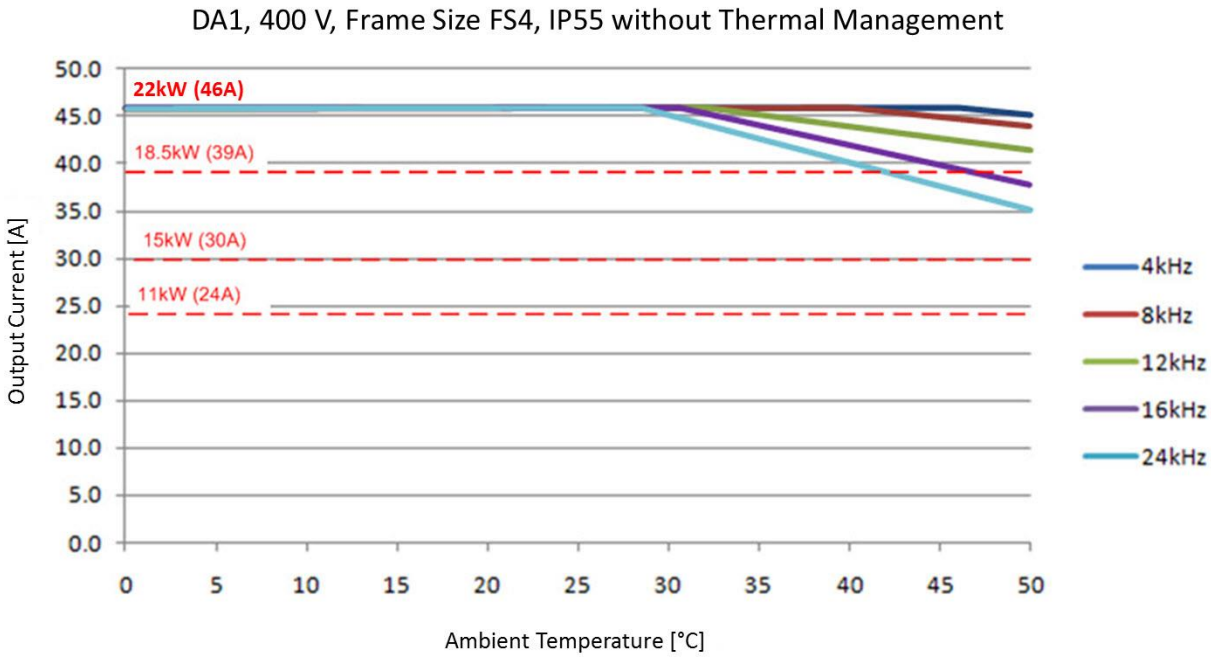


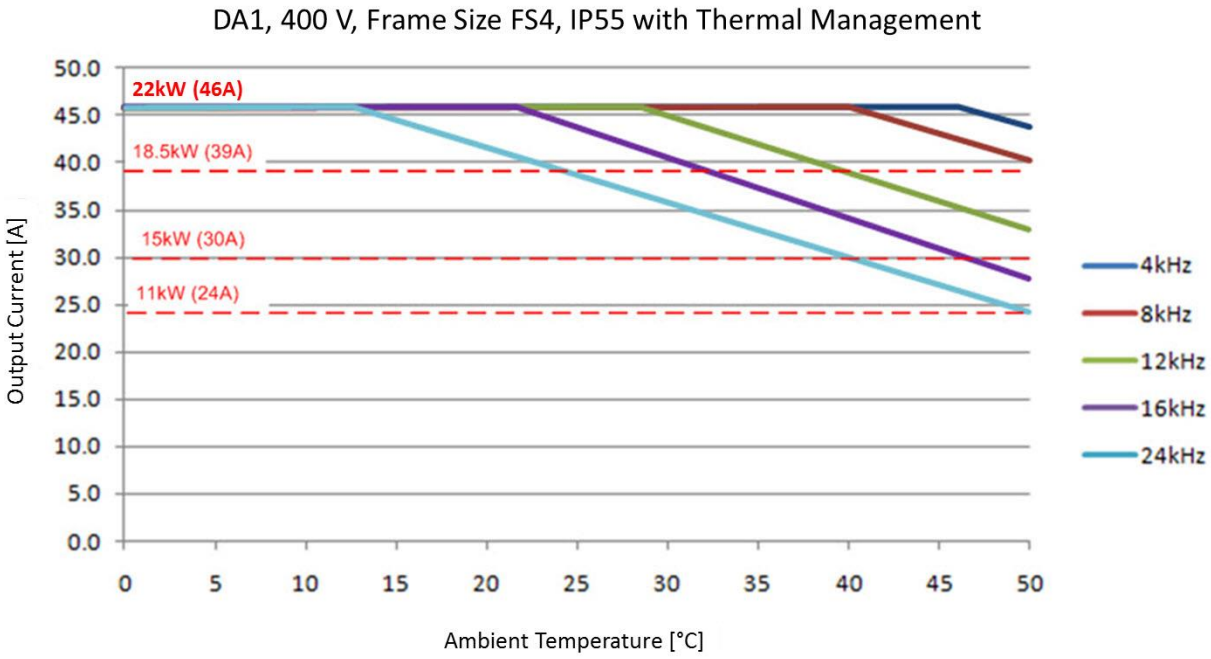
DA1, 400 V, Frame Size FS3, IP20 with Thermal Management



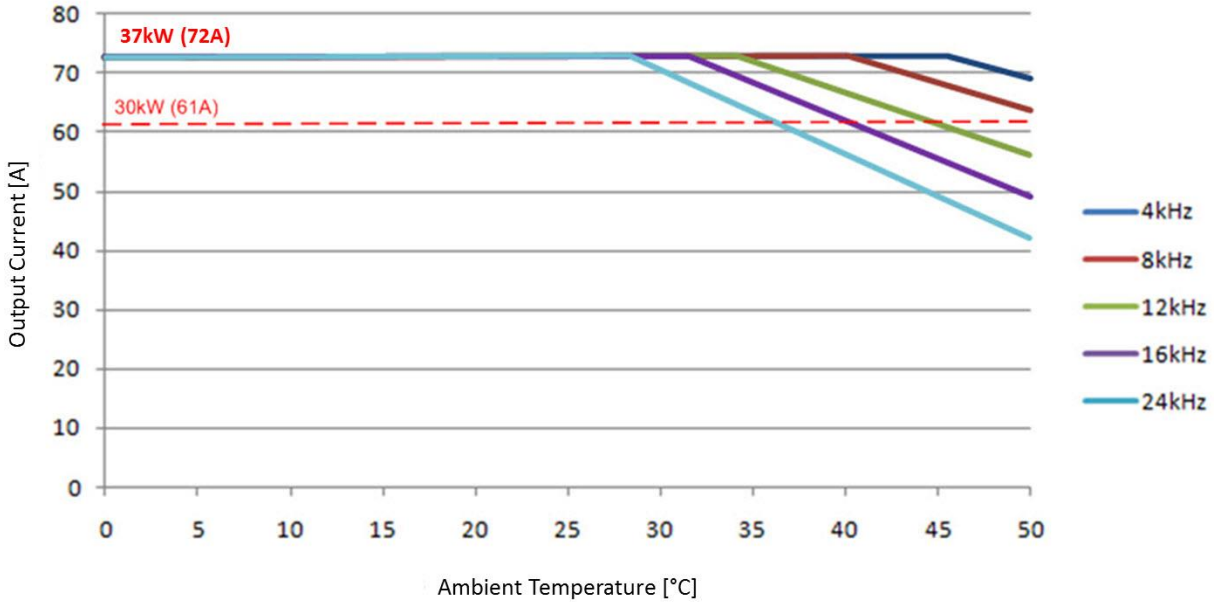
3.2 Devices DA1 with degree of protection IP55

3.2.1 Voltage class 400 V

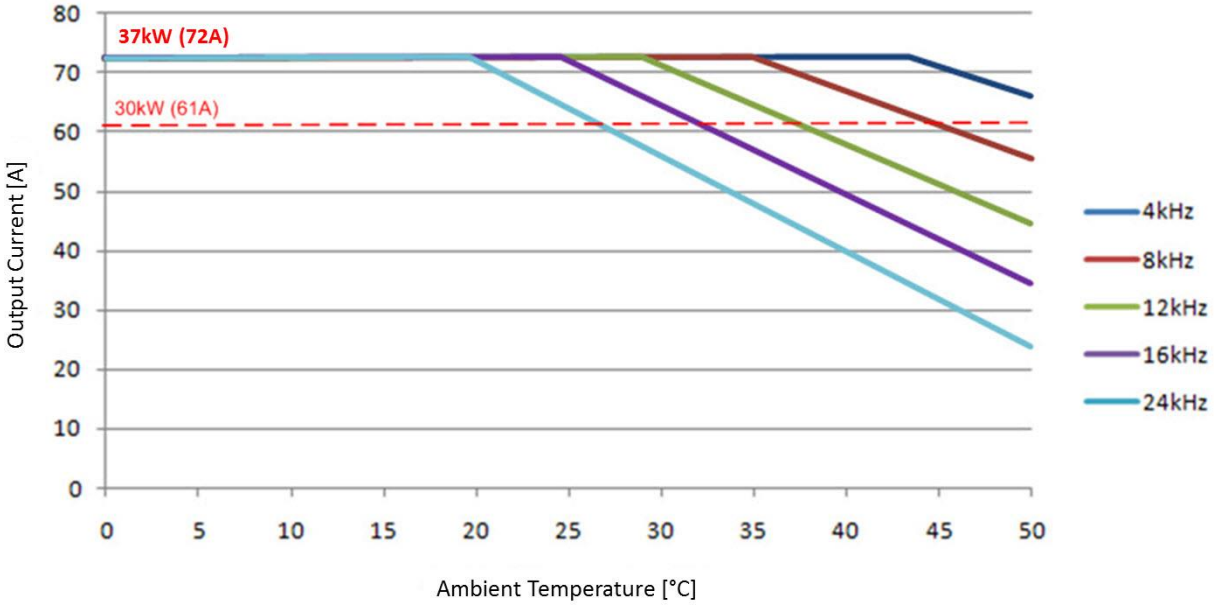




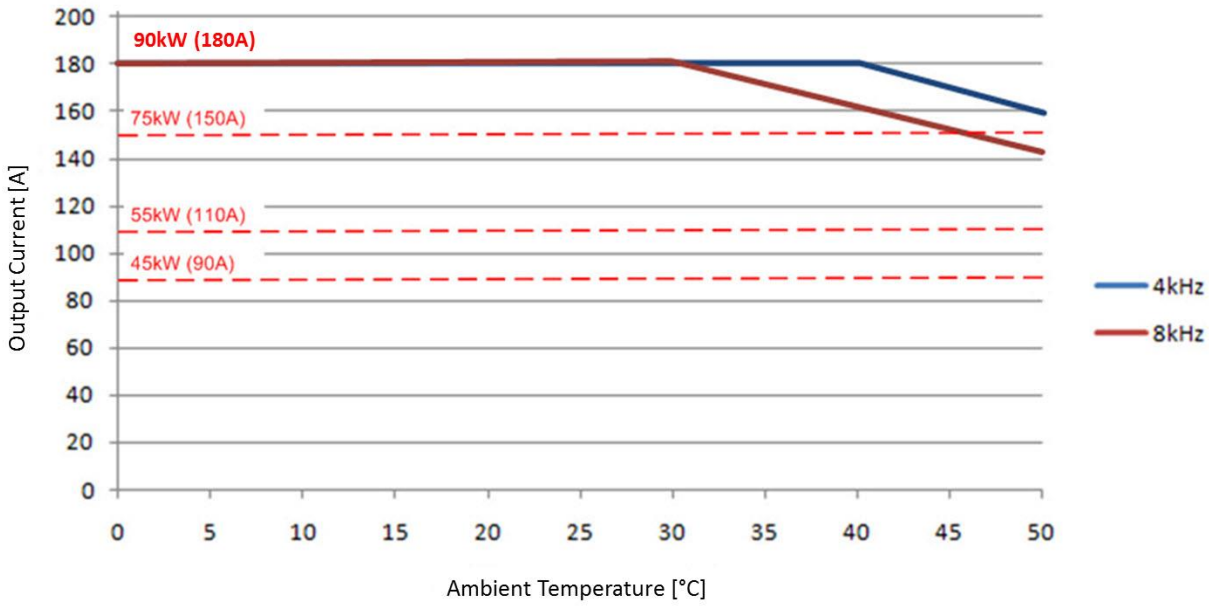
DA1, 400 V, Frame Size FS5, IP55 without Thermal Management



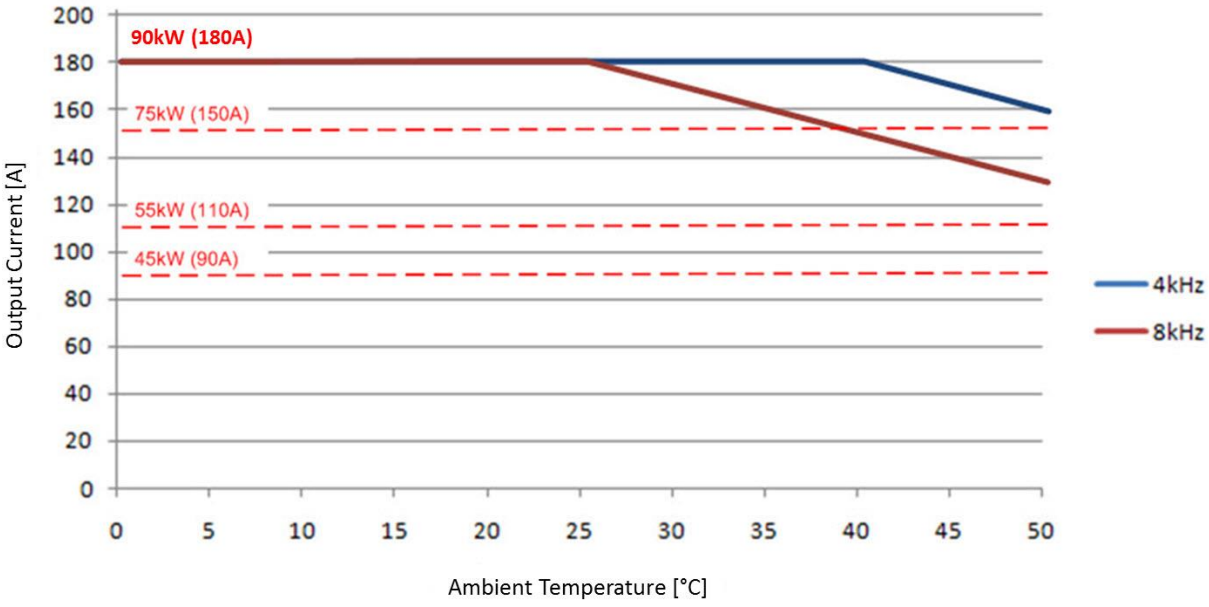
DA1, 400 V, Frame Size FS5, IP55 with Thermal Management



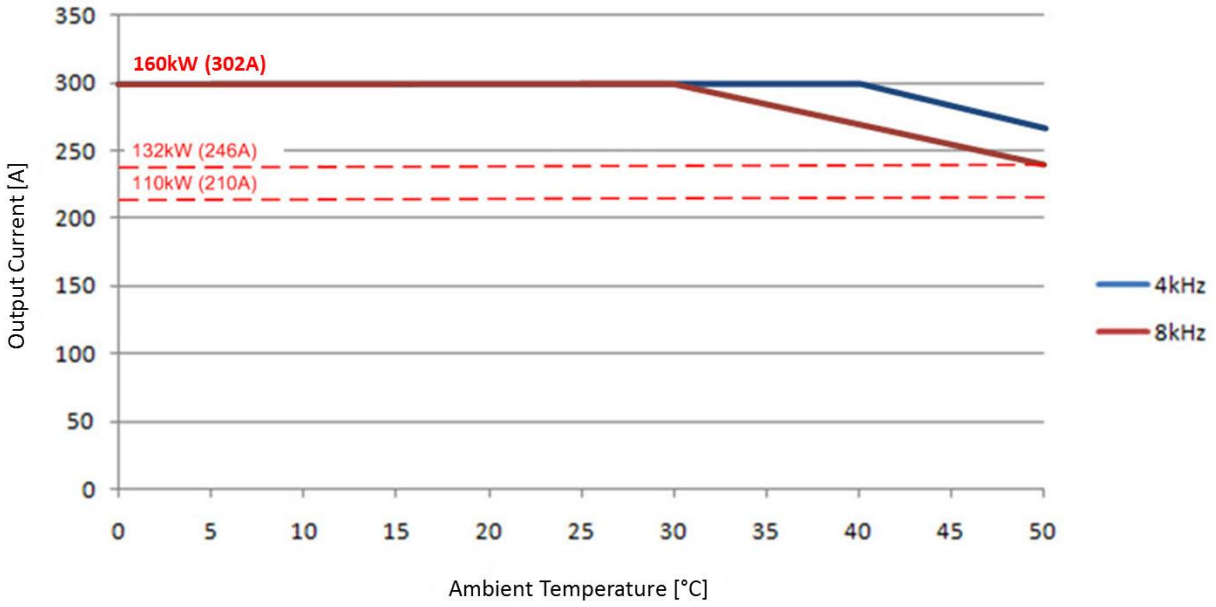
DA1, 400 V, Frame Size FS6, IP55 without Thermal Management



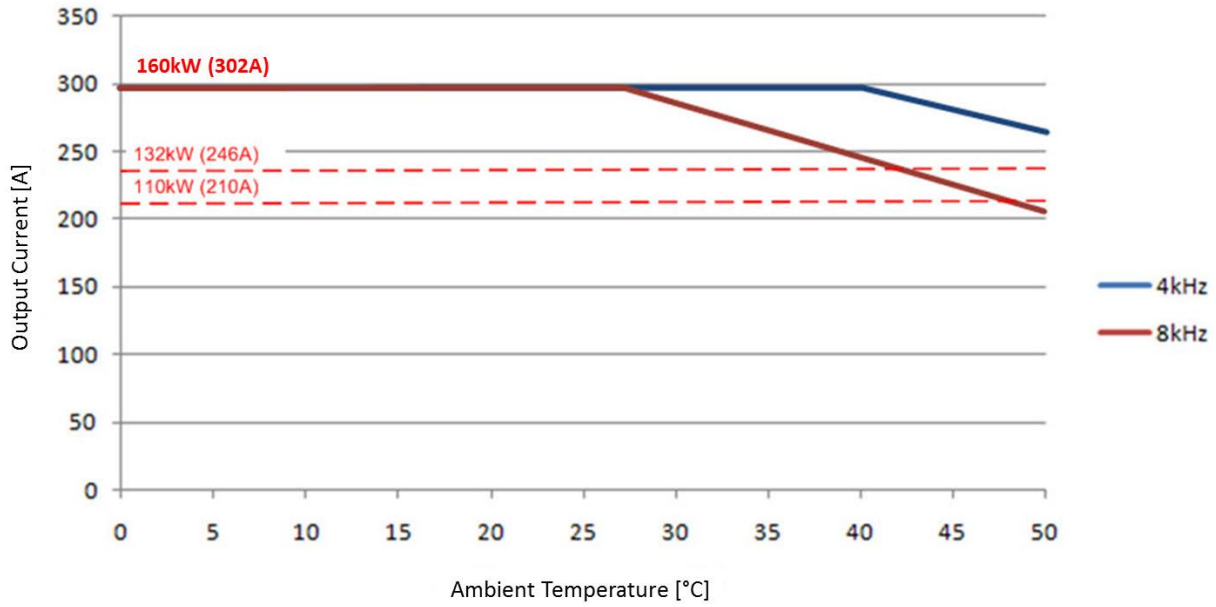
DA1, 400 V, Frame Size FS6, IP55 with Thermal Management



DA1, 400 V, Frame Size FS7, IP55 without Thermal Management

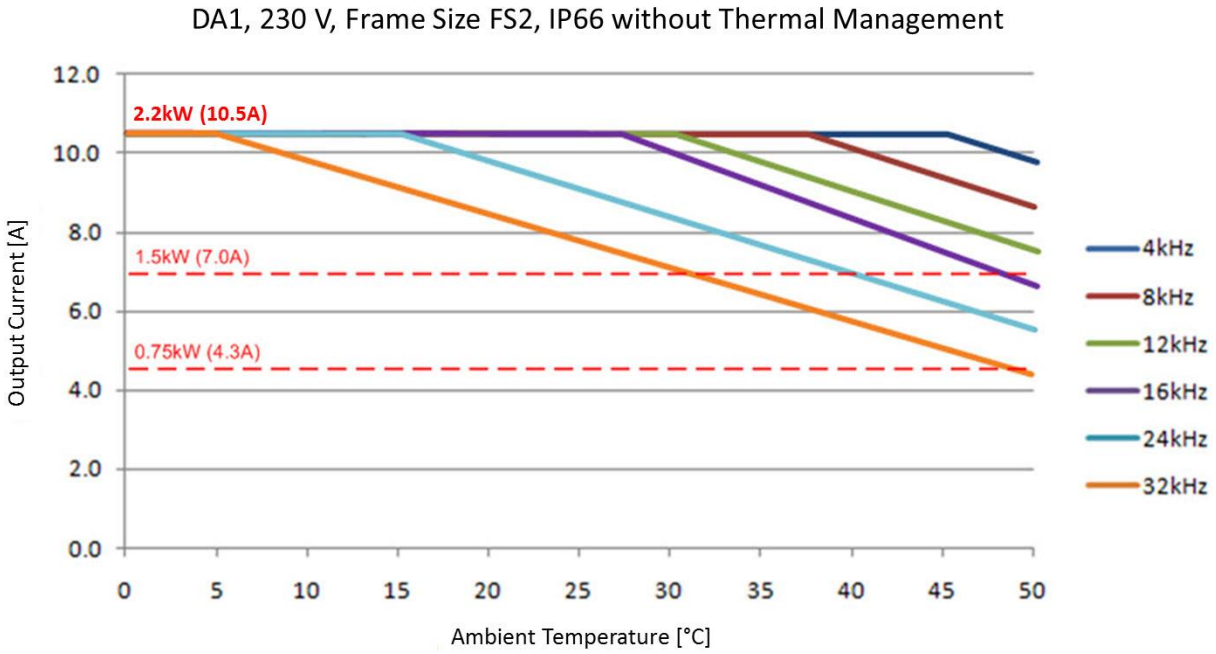


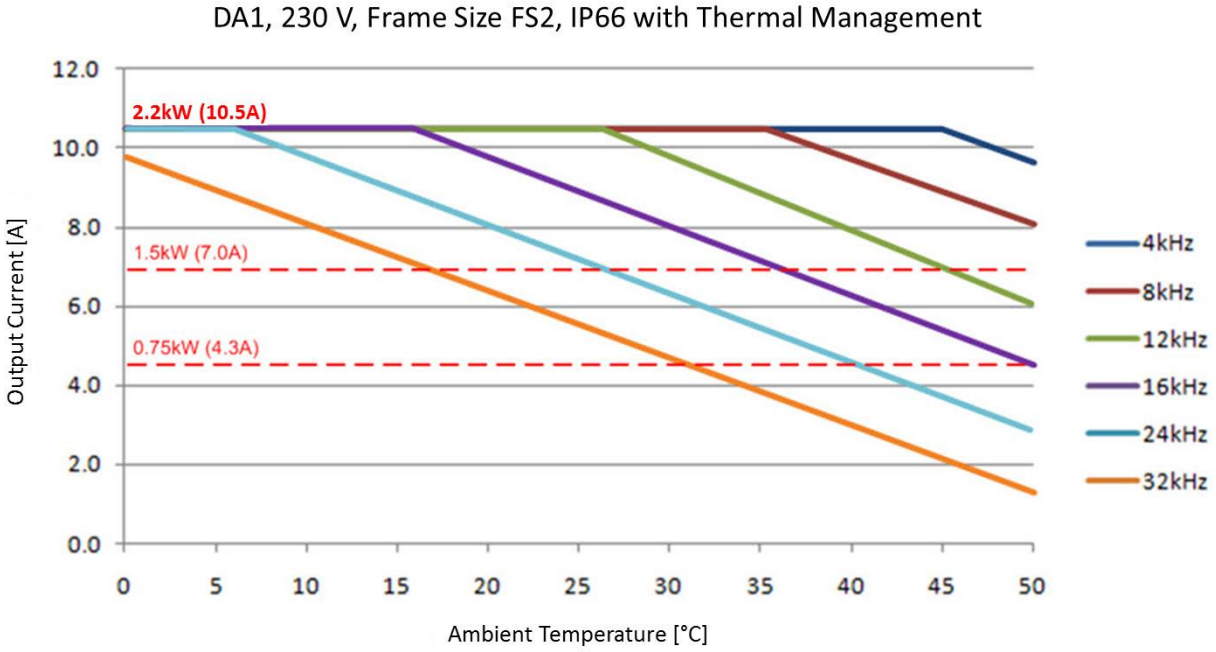
DA1, 400 V, Frame Size FS7, IP55 with Thermal Management



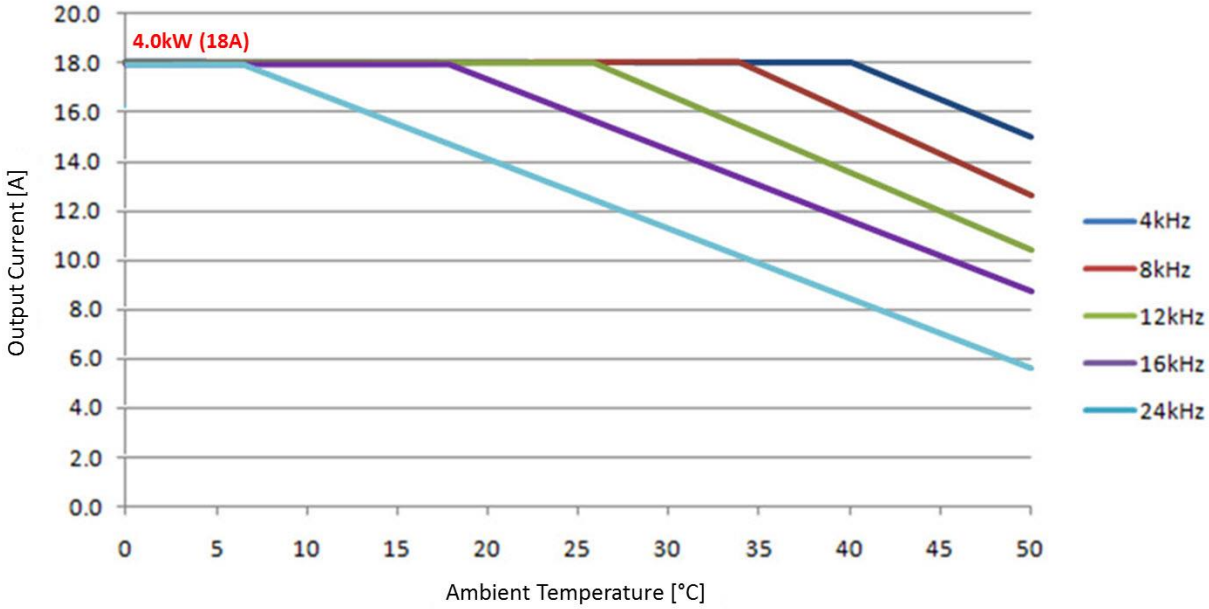
3.3 Devices DA1 with degree of protection IP66

3.3.1 Voltage class 230 V

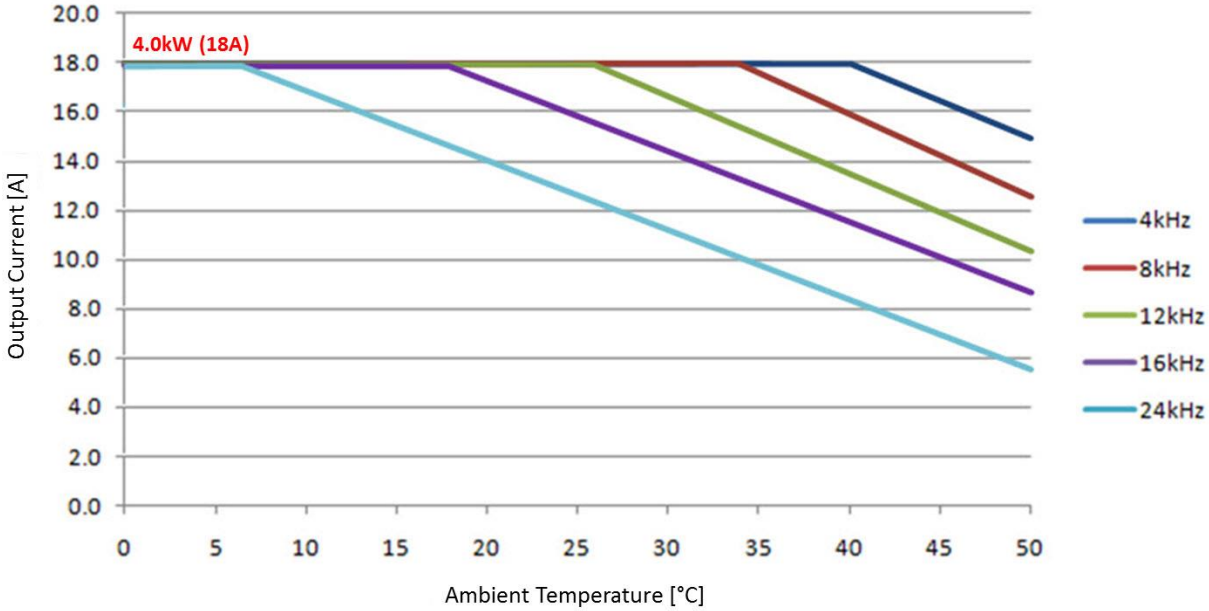




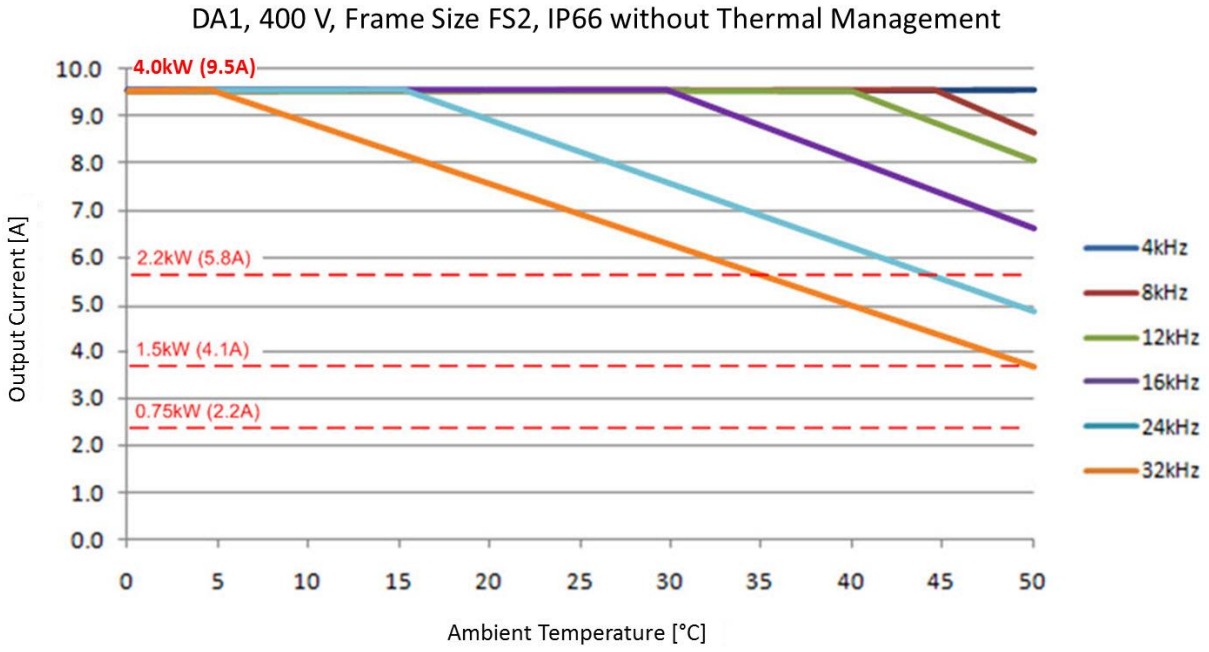
DA1, 230 V, Frame Size FS3, IP66 without Thermal Management

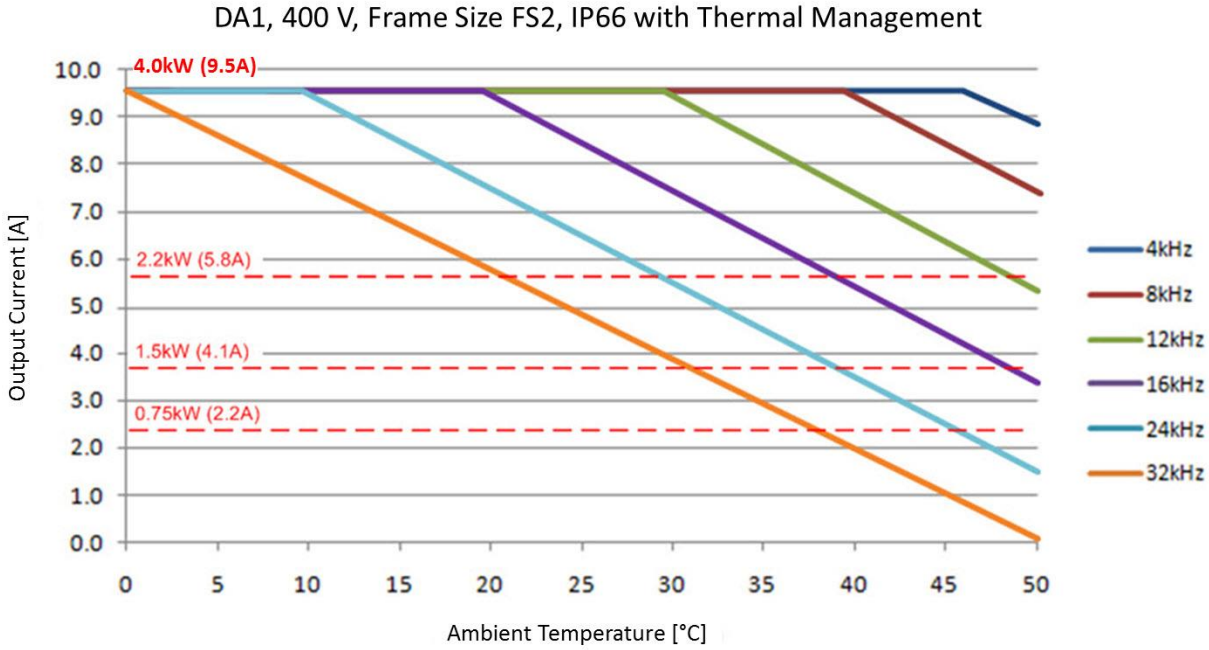


DA1, 230 V, Frame Size FS3, IP66 with Thermal Management

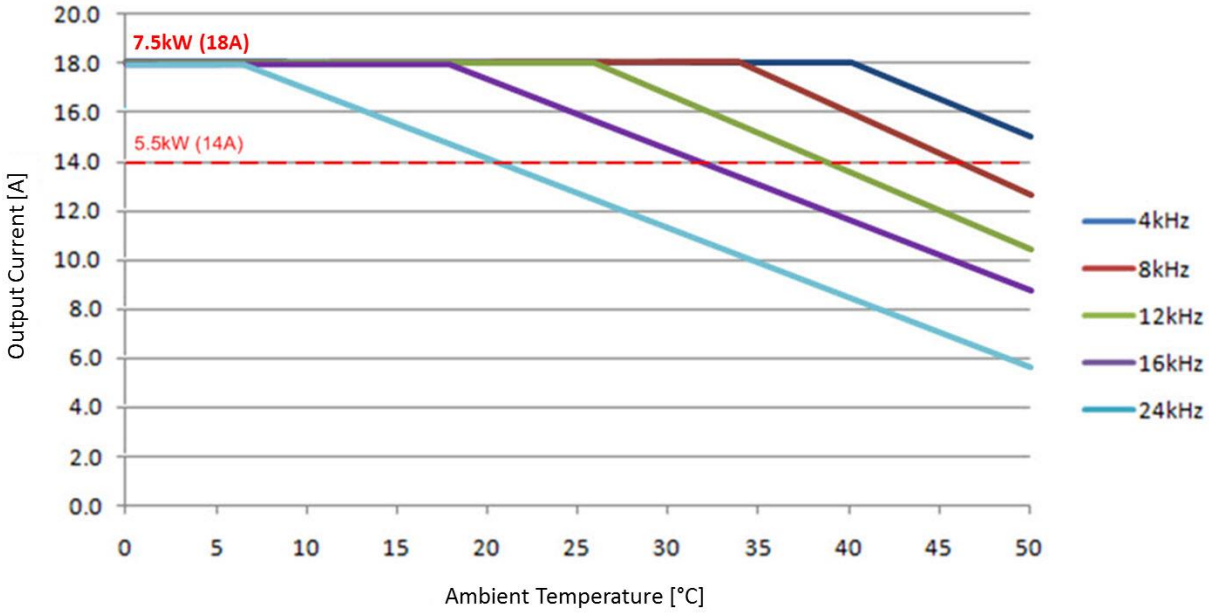
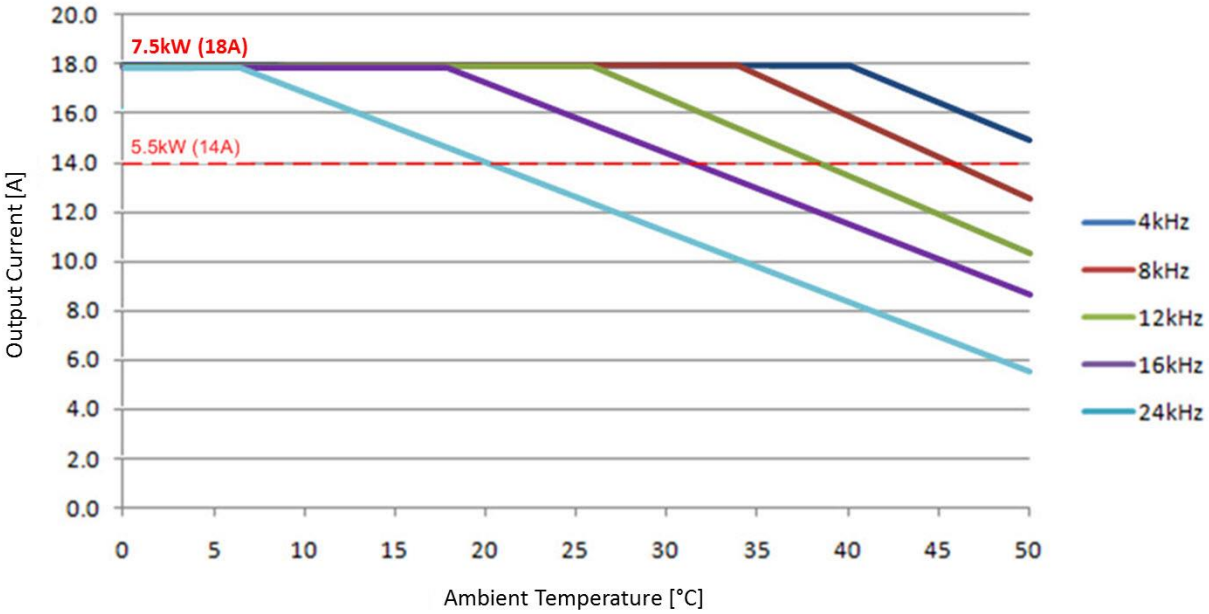


3.3.2 Voltage class 400 V





DA1, 400 V, Frame Size FS3, IP66 without Thermal Management



DA1, 400 V, Frame Size FS3, IP66 with Thermal Management