Data Bulletin

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Variable Frequency Drives and Short-Circuit Current Ratings

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Introduction

Short-circuit current ratings (SCCRs) for variable frequency drives (VFDs) is a topic that has been discussed often without clarity. Some manufacturers provide SCCRs based on testing only the output section of VFDs. While this method of test may be suitable for across-the-line starters used for motor control, Schneider Electric™ tests VFDs following the strictest interpretation of applicable standards and conducts SCCR tests based on the most likely failure points in the VFD, which is not the output section. Also, due to the electronic nature of VFDs, their characteristics may change depending on their electrical power system connection. The level of prospective short-circuit current (PSCC) available at the point where a VFD is connected to electrical power can have a significant impact on the safety, longevity, and cost of a VFD installation. Typical VFDs use diodes to convert AC electrical power to DC power. The DC power is stored in the VFD's capacitor bank, also called the DC bus. Insulated gate bipolar transistors (IGBTs) are then used to re-create an AC sine wave to provide power to AC induction motors. The PSCC level can have a significant thermal impact on the VFD's diodes and capacitor bank.

The following should be considered when specifying and installing a VFD:

- What is the level of PSCC specified?
- What type of overcurrent protective device (OCPD) will be used?
- What type of enclosure rating is required for the installation?
- What are the rated thermal characteristics of the VFD?
- Is a line reactor or DC choke required?
- What is the SCCR of the VFD?

This data bulletin clarifies the terms and standards used in the industry, explains the thermal impact of PSCC values on VFDs, and provides VFD installation ratings information. This bulletin also includes discussion on when to specify or install line reactors or DC chokes, and the aspects of installing a VFD without using an enclosure. In addition, the reader will understand how the cost of a VFD installation is directly proportional to the SCCR level specified. Considering these topics can lead to a robust, cost effective, and energy efficient VFD installation without over specifying rating requirements and adding unnecessary components and cost.

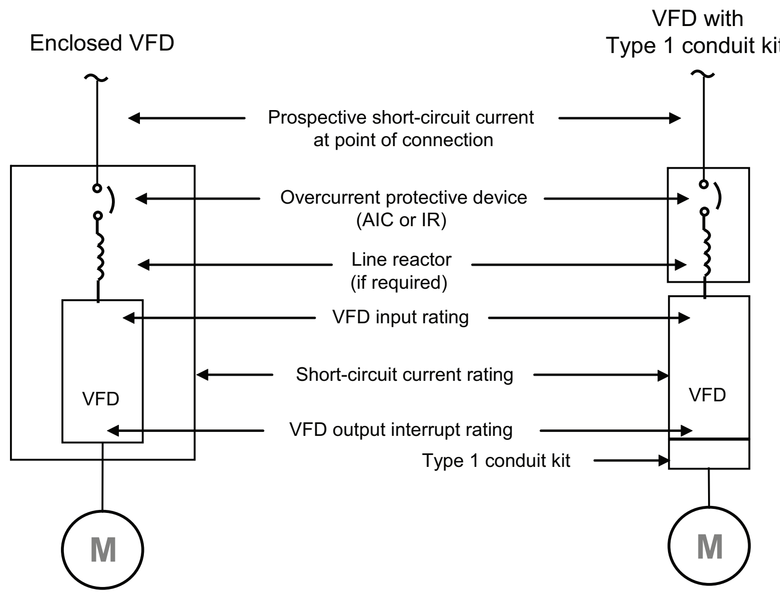
Terminology

To address these topics, an understanding is needed of the following terms:

- Prospective short-circuit current
- Overcurrent protective device, rated as ampere interrupting capacity (AIC) or interrupting rating (IR)
- VFD input rating
- Short-circuit current rating
- VFD output interrupt rating

Figure 1 shows a mapping of where the terms are applied in a one-line schematic of a VFD installed in an enclosure and of a VFD installed with a Type 1 conduit kit, without the use of an additional enclosure.

Figure 1: Terms Mapped to One-Line Schematic



Prospective Short-Circuit Current

The prospective short-circuit current (PSSC) refers to the amount of current that would flow at a given point on the electrical distribution system if a piece of bus bar were bolted across the phases and then the power was turned on. The amount of current that would flow would be limited by the impedance of the power system. The power system impedance is the result of the resistances and reactances of the transformers and the wiring. The PSCC is the symmetrical fault current that would flow, and does not include the asymmetrical component which could occur depending on the timing of the short circuit. PSCC is also referred to as the available fault current (AFC). Instead of specifying the system resistance and inductance, many specifications reference the PSCC level in kilo amperes. Common PSCC levels specified are 5, 10, 22, 42, 65, and 100 kA.

Overcurrent Protective Device

Circuit breakers and fuses are commonly used to meet code requirements for overcurrent protection. Circuit breakers have the ability to interrupt the high current that can flow in the event of a short circuit, and typically have a rating in kAIC, which stands for thousand amperes interrupting capacity. Fuses have a similar IR specification defined in rms symmetrical amperes. Although a VFD can detect a short on the output IGBTs and stop conducting very quickly, this provides no protection upstream of the IGBT output section. Therefore, the VFD cannot carry an AIC or IR rating in the same way that a fuse or circuit breaker can, nor can it be used to meet code requirements for an overcurrent protection device.

VFD Input Rating

The level of PSCC can have a significant thermal impact on the VFD’s input diodes and capacitor bank. The VFD’s input current increases significantly as the level of PSCC rises. This is caused by the input diodes conducting only when the input voltage is higher than the DC bus. The current is then limited only by the system impedance. Applying a VFD on an electrical system with a higher PSCC than the VFD input rating may cause overheating of the diodes and capacitor sections, and reduce the life expectancy of the VFD or damage the VFD. Figure 2 shows the effects of a power system with 5 kA PSCC on the input current of a 5 hp drive. The peak input current is around 30 A.

In Figure 3 the same model drive and output load are used as in Figure 2, but the input power system is modified to provide 100 kA PSCC. Note that the input current peaks now nearly reach 70 A.

Figure 2: Input Line Current on a 5 kA PSCC Power System

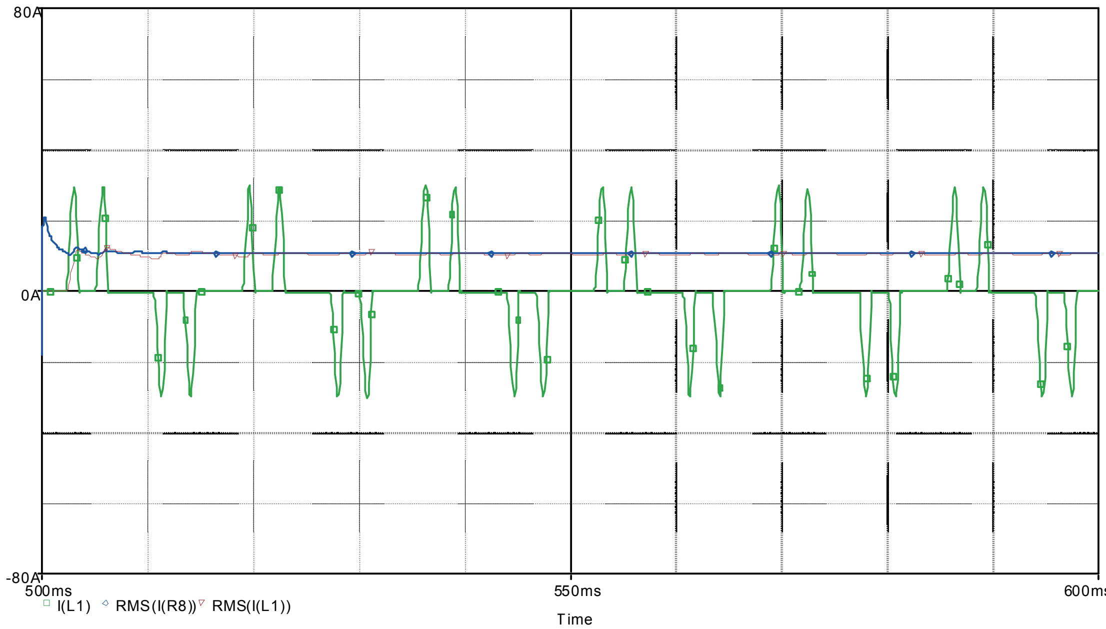
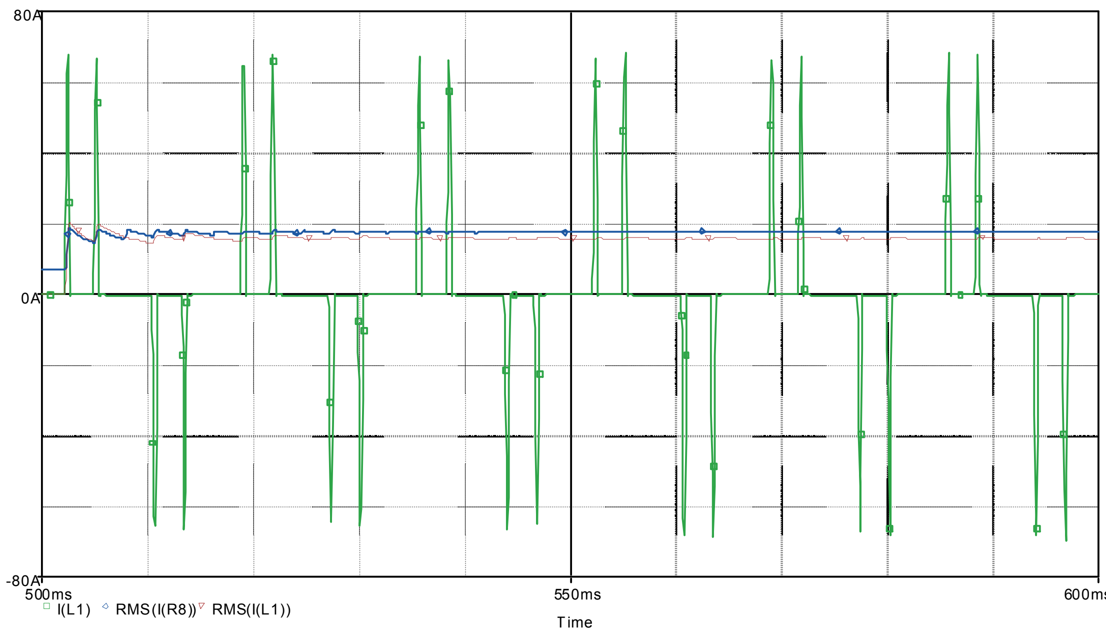


Figure 3: Input Line Current on a 100 kA PSCC Power System



When the PSCC is higher, the current peaks are much higher and the rms current is also higher. This is common for AC drives using a 6-pulse diode front-end. For more information see Schneider Electric Product Data Bulletin 8800DB0801, *The Effects of Available Short-Circuit Current on AC Drives*.

Because the higher current peaks occur on systems with higher PSCC, there is more heating in the input diodes and the DC bus capacitors. VFDs are designed for a specific expected “maximum PSCC.” The power component selection and the power section layout of the VFD design determines at what level of PSCC the product will be rated. This value is the VFD input rating. Schneider Electric publishes this rating under the column heading “maximum prospective line Isc” in VFD ratings tables. Schneider Electric also publishes line reactor requirements to use when the PSCC exceeds the VFD input rating in documentation that ships with each VFD.

Short-Circuit Current Rating

Short-circuit current rating (SCCR) refers to the amount of PSCC a device such as a VFD or an enclosed VFD is rated to withstand. The National Electrical Code® defines the SCCR as, “The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria.” The VFD or the enclosed VFD must not create a shock hazard and must contain any flame, fire, or explosion hazard during a short-circuit event. For example, an enclosed VFD with a 30 kA SCCR can be applied on a power system with a PSCC of 30 kA or less.

An enclosure’s SCCR is calculated from the SCCRs of the various components in the enclosure. Several papers and flow charts have been published showing how to establish the proper rating for an enclosure. The SCCR may also be determined by testing the complete assembled enclosure. Schneider Electric obtains ratings for our standard enclosed family of VFDs by testing the complete assembled enclosure in which the VFD is mounted. Testing a complete assembled enclosure is often not practical in low volume or highly customized enclosed VFDs. In these instances, the rating of the VFD itself and other products in the enclosure are used in determining the maximum SCCR of the enclosure.

The Standard Technical Panel for UL 508C voted in late 2012 to clarify the wording to ensure that all VFD manufacturers conduct tests and provide consistent SCCR data across the industry. This action will benefit customers and installers by having more standardized information available when applying VFDs. These clarifications have been written into UL 61800-5-1, which is the new UL standard for VFDs. While the effectivity date for UL 61800-5-1 is three years away, Schneider Electric has tested VFDs according to the methods described in the new standard for over a decade.

Both UL 508C and UL 61800-5-1 specify product marking information. As the physical size of VFDs decreases, manufacturers are commonly supplying the product marking information in accompanying documents. For marking the SCCR, UL 508C 62.1 uses the following phrases:

- General marking:

  “Suitable For Use On A Circuit Capable Of Delivering Not More Than ___ rms Symmetrical Amperes, ___ Volts Maximum.”

- For protection by a fuse:

  “When Protected By ___ Class Fuses (with a maximum rating of ___).”

- For protection by a circuit breaker:

  “When Protected By A Circuit Breaker Having An Interrupting Rating Not Less Than ___ rms Symmetrical Amperes, ___ Volts Maximum.”

UL marking requirements may also include the manufacturer's name and the part number for the overcurrent protective device (OCPD). See UL 508C 62.2, May 16, 2016.

Schneider Electric determines the SCCR of the VFD based on containment testing. These ratings are obtained by performing containment tests that involve shorting internal components, such as the input diodes and DC bus capacitors, while connected to the specified PSCC level and using the specified OCPD. Not all manufacturers have published ratings based on containment tests. Some manufacturers have simply provided ratings based on shorting the VFDs output. This output test method is how across-the-line starters have been tested to obtain SCCRs and does not adequately test a VFD. Schneider Electric has provided SCCRs based on the VFD input rating and containment testing, following the strictest interpretation of UL 508C. This is the language that has been clarified in UL 61000-5-1, such that in the future, all VFD manufacturers will need to conduct containment tests that involve shorting internal components and not rely on obtaining ratings for the entire VFD based on testing the output section.

If the drive is mounted in an enclosure, the enclosure must contain any shock, flame, fire or explosion hazard. Refer to "Installing a VFD without an Enclosure" on page 7 for additional comments.

Most fuses clear faster than today's circuit breakers and allow less energy to enter the VFD during a short circuit. Therefore, containing the energy is easier with fuses than with circuit breakers or Type E manual motor protective devices, and typically allows a higher SCCR.

Schneider Electric publishes a document for each VFD detailing the specific SCCR depending on PSCC, VFD input rating, and what level of PSCC requires a line reactor.

VFD Output Interrupt Rating

The VFD output interrupt rating has been a point of confusion in the industry as some VFD manufacturers have published a VFD output interrupt rating leading customers and installers to think that this is the SCCR of the VFD. To determine the VFD output interrupt rating, an output short-circuit test is performed by shorting the output wires from the drive to the motor. Since the drive can detect a short circuit on the output and turn off the IGBTs in microseconds, the current never gets to a high level. This test is easily passed regardless of the PSCC. Because of this, some VFD manufacturers publish a 100 kA rating, but without clearly specifying any other ratings.

A VFD should be applied on a 100 kA power system only if the SCCR and the input rating are suitable for a 100 kA system.

When to Use a Line Reactor or a DC Choke

When the PSCC value at the point of the connection of the VFD is higher than the VFD input rating, a line reactor or DC choke must be used to reduce the PSCC and limit the current spikes discussed in Figure 2. Schneider Electric VFD installation manuals contain ratings tables that show the “maximum prospective line Isc” where Isc stands for “current short circuit” as shown in Figure 4. This Isc value is the same as the VFD input rating described in this data bulletin. This value is the highest PSCC that the VFD can be connected to without adding an external impedance such as a line reactor or DC choke. Long runs of cable and transformers also add impedance. In other rating documents this may be called an “input AFC rating” or an “input thermal rating.” These values are also provided in the installation material that ships with each VFD. A list of document numbers for each VFD can be found at the end of this bulletin.

Figure 4: Maximum Prospective Isc Column in a Typical VFD Ratings Table (Example Only)

Three-phase supply voltage: 380…480 V 50/60 Hz

Three-phase motor 380...480 V

Motor		Line supply (input)					Drive (output)			Altivar 61
Power indicated on plate (1)		Max. line current (2)		Max. prospective line Isc	Apparent power	Max. inrush current (3)	Max. available nominal current In (1)		Max. transient current (1) for 60 s	Catalog number (4)(5)
		at 380 V	at 480 V				at 380 V	at 460 V		
kW	HP	A	A	kA	kVA	A	A	A	A	
0.75	1	3.7	3	5	2.4	19.2	2.3	2.1	2.7	**ATV61H075N4**
1.5	2	5.8	5.3	5	4.1	19.2	4.1	3.4	4.9	**ATV61HU15N4**
2.2	3	8.2	7.1	5	5.6	19.2	5.8	4.8	6.9	**ATV61HU22N4**
3	-	10.7	9	5	7.2	19.2	7.8	6.2	9.3	**ATV61HU30N4**
4	5	14.1	11.5	5	9.4	19.2	10.5	7.6	12.6	**ATV61HU40N4**
5.5	7.5	20.3	17	22	13.7	46.7	14.3	11	17.1	**ATV61HU55N4**
7.5	10	27	22.2	22	18.1	46.7	17.6	14	21.1	**ATV61HU75N4**
11	15	36.6	30	22	24.5	93.4	27.7	21	33.2	**ATV61HD11N4**
15	20	48	39	22	32	93.4	33	27	39.6	**ATV61HD15N4**
18.5	25	45.5	37.5	22	30.5	93.4	41	34	49.2	**ATV61HD18N4**
22	30	50	42	22	33	75	48	40	57.6	**ATV61HD22N)**
30	40	66	56	22	44.7	90	66	52	79.2	**ATV61HD30N4**
37	50	84	69	22	55.7	90	79	65	94.8	**ATV61HD37N4**
45	60	104	85	22	62.7	200	94	77	112.8	**ATV61HD45N4**
55	75	120	101	22	81.8	200	116	96	139	**ATV61HD55N4**

Instead of providing an input thermal rating, some VFD manufacturers specify that if the transformer power rating is 10 times (or some other ratio) larger than the VFD power rating, then a line reactor must be used. VFD manufacturers may require a line reactor if there is low line impedance defined as less than 1% line reactance. While these methods can be applied to Schneider Electric VFDs also, we believe the information that we are providing is much clearer and easier for customers and installers to use.

Care should be taken not to simply specify a line reactor for every installation to cover the possibility of a high PSCC. Elevated available fault currents—above 5 kA—are not present in many of the pump and fan applications in commercial, educational, healthcare, or lodging buildings. This presents a significant opportunity to reduce system costs in a majority of these facilities.

When you no longer need to specify or install a line reactor, the savings in installation costs are immediate. It eliminates the cost of purchasing a line reactor and decreases the mounting space requirements in mechanical rooms. This also lightens the weight of the installation. Also, since line reactors consume energy, their elimination removes a drag on efficiency and automatically makes a system consume less energy. In addition, line reactors give off heat. System designs without line reactors will require fewer measures for heat dissipation. Lastly, eliminating line reactors does away with the voltage drops that they cause. Unless line reactors are being specified for harmonic mitigation, line reactors or other impedance should only be specified when it has been determined that the PSCC is higher than the VFD input rating.

Installing a VFD without an Enclosure

It is becoming more common to mount and install a VFD without placing it in an enclosure. Two installation examples are:

1. Mounting the VFD on a mechanical room wall for controlling a pump or fan motor.
2. Mounting the VFD along a material handling conveyor to control the motor of a conveyor section.

Most VFDs have an option to attach a kit that accepts conduit connections and provide a Type 1 enclosure rating. When mounted in this fashion, the VFD itself must not create a shock hazard and contain any flame, fire, or explosion hazard during a short-circuit event. This is easier to achieve when the VFD is mounted in an enclosure, and more difficult to achieve when the VFD itself is mounted on a wall. It is common for a VFD to have a lower SCCR when mounted and installed without using an enclosure. In many cases, a wall-mounted VFD may not be able to obtain a SCCR with a circuit breaker. SCCRs with fuses are more attainable as fuses have greater energy limiting capabilities than circuit breakers on the market today.

Schneider Electric publishes SCCR information for VFDs that can be mounted in this fashion with a Type 1 enclosure rating in the information shipped with the VFD.

Example of Drive Ratings Table: Altivar™ 61 Family

Table 1 on page 8 provides short-circuit current ratings and branch circuit protection information for a portion of the Altivar™ 61 drive family.

- The combinations in the tables have been tested per UL 508C (Reference UL file E116875).
- These ratings are in addition to ratings on the nameplate of the product.
- The values for the overcurrent protection devices are the maximum allowable ampere size. Smaller ampere ratings may be used.
- Integral solid state short-circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- The devices are provided with software integral overload and overspeed protection for the motor. Protection at 110% of the full load motor current. The motor thermal protection current (ItH) must be set to the rated current indicated on the motor nameplate. (For details see the programming manual.)
- 167 °F (75 °C) copper conductor with the AWG wire size for all products, except ATV61HC16N4• to ATV61HC63N4•, ATV61HC11Y to ATV61HC80Y: 140 °F (60 °C) / 167 °F (75 °C) copper conductor with the AWG wire size.
- Suitable for use on a circuit capable of delivering not more than___X___rms symmetrical kiloAmperes,___Y___Volts maximum, when protected by___Z1___with a maximum rating of___Z2___.

Table 1: Short-Circuit Current Ratings and Branch Circuit Protection for the Altivar 61 Drive

Altivar 61								Short-Circuit Current Ratings [1]													
								with Circuit Breaker [2]			with GV•P [2]					with Fuses [2]			with Fuses and Type 1 kit [3]		
Input voltage 50/60 Hz				Catalog number	Input rating	Minimum inductance	Line reactor reference	PowerPact™ (Z1), (Z2) [5]	(X) SCCR	Minimum enclosure volume	GV•P Type E [6] (Z1), (Z2)	GV•P voltage rating	GV•P max. power	(X) SCCR	Minimum enclosure volume	Fuse ampere rating (Z1), (Z2)	(X) SCCR	Minimum enclosure volume	Fuse ampere rating (Z1), (Z2)	(X) SCCR	Minimum enclosure volume
Y	kW	HP	A		kA [4]	mH			kA	(in³)		V	HP	kA	(in³)	A	kA	(in³)	A	kA	(in³)
Three-phase input, without line reactor																					
200/240 V Three-phase	0.75	1	4.8	ATV61H075M3	5	—	—	HJL36015	5	4017	GV2P10	240	1.5	5	1600	15 [7, 8]	5	4017	15 [7, 8]	5	1078
	1.5	2	8	ATV61HU15M3	5	—	—	HJL36025	5	4017	GV2P14	240	3	5	1600	25 [7, 8]	5	4017	25 [7, 8]	5	1078
	2.2	3	11	ATV61HU22M3	5	—	—	HJL36040	5	4017	GV3P18	240	5	5	1920	40 [7]	5	4017	25 [7, 8]	5	1550
	3	—	13.7	ATV61HU30M3	5	—	—	HJL36040	5	4017	GV3P18	240	3/5	5	1920	40 [7]	5	4017	40 [7]	5	1550
	4	5	17.5	ATV61HU40M3	5	—	—	HJL36060	5	6528	GV3P25	240	7.5	5	1920	60 [7]	5	6528	45 [7]	5	1550
	6	7.5	27.5	ATV61HU55M3	22	—	—	HJL36070	22	6528	GV3P40	240	10	5	2880	70 [7]	22	6528	60 [7]	5	1987
	8	10	33	ATV61HU75M3	22	—	—	HJL36110	22	6528	GV3P50	240	10	5	4032	110 [7]	22	6528	70 [7]	5	2719
	11	15	54	ATV61HD11M3X	22	—	—	HJL36125	22	6528	GV3P50	240	10	5	5760	125 [7]	22	6528	90 [7]	5	4036
	15	20	66	ATV61HD15M3X	22	—	—	JJL36175	22	6528	GV3P65	240	15	5	5760	175 [7]	22	6528	110 [7]	5	4036
	18	25	75	ATV61HD18M3X	22	—	—	JJL36200	22	13215	—	—	—	—	—	200 [7]	22	13215	125 [7]	5	4900
	22	30	88	ATV61HD22M3X	22	—	—	JJL36250	22	13215	—	—	—	—	—	250 [7]	22	13215	150 [7]	5	4900
	30	40	120	ATV61HD30M3X	22	—	—	JJL36250	22	13215	—	—	—	—	—	250 [7]	22	13215	200 [7]	5	9640
	37	50	144	ATV61HD37M3X	22	—	—	JJL36250	22	13215	—	—	—	—	—	250 [7]	22	13215	225 [7]	5	9640
	45	60	176	ATV61HD45M3X	22	—	—	—	—	—	—	—	—	—	—	—	—	—	300 [7]	10	9640
380/480 V Three-phase	0.75	1	2.3	ATV61H075N4	5	—	—	HLL36015	5	4017	GV2P08	480Y/277	2	5	1600	15 [7, 8]	5	4017	6 [7, 8]	5	1078
	1.50	2	4.1	ATV61HU15N4	5	—	—	HLL36015	5	4017	GV2P10	480Y/277	4	5	1600	15 [7, 8]	5	4017	12 [7, 8]	5	1078
	2.20	3	5.8	ATV61HU22N4	5	—	—	HLL36015	5	4017	GV2P14	480Y/277	5	5	1600	15 [7, 8]	5	4017	15 [7, 8]	5	1078
	3	—	7.8	ATV61HU30N4	5	—	—	HLL36015	5	4017	GV2P14	480Y/277	5	5	1920	15 [7, 8]	5	4017	17.5 [7, 8]	5	1550
	4	5	10.5	ATV61HU40N4	5	—	—	HLL36025	5	4017	GV3P13	480Y/277	7.5	5	1920	25 [7, 8]	5	4017	25 [7, 8]	5	1550
	5.5	7.5	14.3	ATV61HU55N4	22	—	—	HLL36035	22	6528	GV3P25	480Y/277	15	5	2880	35 [7]	22	6528	40 [7]	5	1987
	7.5	10	17.6	ATV61HU75N4	22	—	—	HLL36050	22	6528	GV3P25	480Y/277	15	5	2880	50 [7]	22	6528	40 [7]	5	1987
	11	15	27.7	ATV61HD11N4	22	—	—	HLL36060	22	6528	GV3P40	480Y/277	25	5	4032	60 [7]	22	6528	60 [7]	5	2719
	15	20	33	ATV61HD15N4	22	—	—	HLL36080	22	6528	GV3P50	480Y/277	30	5	5760	80 [7]	22	6528	70 [7]	5	4036
	18	25	41	ATV61HD18N4	22	—	—	HLL36100	22	6528	GV3P50	480Y/277	30	5	8640	100 [7]	22	6528	70 [7]	5	4036
	22	30	48	ATV61HD22N4	22	—	—	HLL36125	22	6528	GV3P50	480Y/277	30	5	8640	125 [7]	22	6528	80 [7]	5	4900
	30	40	66	ATV61HD30N4	22	—	—	HLL36150	22	6528	GV3P65	480Y/277	40	5	10368	150 [7]	22	6528	90 [7]	5	7230
	37	50	79	ATV61HD37N4	22	—	—	JLL36175	22	13215	—	—	—	—	—	175 [7]	22	13215	110 [7]	5	7230
	45	60	94	ATV61HD45N4	22	—	—	JLL36225	22	13215	—	—	—	—	—	225 [7]	22	13215	150 [7]	10	12044
	55	75	116	ATV61HD55N4	22	—	—	JLL36250	22	13215	—	—	—	—	—	250 [7]	22	13215	175 [7]	10	12044
	75	100	160	ATV61HD75N4	22	—	—	JLL36250	22	38250	—	—	—	—	—	250 [7]	22	38250	225 [7]	10	12044
	75	100	160	ATV61HD75N4	22	—	—	KCL34250	22	38250	—	—	—	—	—	250 [7]	22	38250	225 [7]	10	12044
Three-phase input, with line reactor																					
200/240 V Three-phase	0.75	1	4.8	ATV61H075M3	5	3.00	RL00401	HJL36015	100	4017	GV2P10	240	1.5	65	1600	15 [7, 8]	100	4017	15 [7, 8]	5	1078
	1.5	2	8	ATV61HU15M3	5	1.50	RL00801	HJL36025	100	4017	GV2P14	240	3	65	1600	25 [7, 8]	100	4017	25 [7, 8]	5	1078
	2.2	3	11	ATV61HU22M3	5	1.25	RL01201	HJL36040	100	4017	GV3P18	240	5	65	1920	40 [7]	100	4017	25 [7, 8]	5	1550
	3	—	13.7	ATV61HU30M3	5	0.80	RL01801	HJL36040	100	4017	GV3P18	240	5	65	1920	40 [7]	100	4017	40 [7]	5	1550
	4	5	17.5	ATV61HU40M3	5	0.80	RL01801	HJL36060	100	6528	GV3P25	240	7.5	65	1920	60 [7]	100	6528	45 [7]	5	1550
	6	7.5	27.5	ATV61HU55M3	22	0.50	RL02501	HJL36070	100	6528	GV3P40	240	10	65	2880	70 [7]	100	6528	60 [7]	5	1987
	8	10	33	ATV61HU75M3	22	0.40	RL03501	HJL36110	100	6528	GV3P50	240	10	65	4032	110 [7]	100	6528	70 [7]	5	2719
	11	15	54	ATV61HD11M3X	22	0.30	RL04501	HJL36125	100	6528	GV3P50	240	10	65	5760	125 [7]	100	6528	90 [7]	5	4036
	15	20	66	ATV61HD15M3X	22	0.25	RL05501	JJL36175	100	6528	GV3P65	240	15	65	5760	175 [7]	100	6528	110 [7]	5	4036
	18	25	75	ATV61HD18M3X	22	0.20	RL08001	JJL36200	100	13215	—	—	—	—	—	200 [7]	100	13215	125 [7]	5	4900
	22	30	88	ATV61HD22M3X	22	0.15	RL10001	JJL36250	100	13215	—	—	—	—	—	250 [7]	100	13215	150 [7]	5	4900
	30	40	120	ATV61HD30M3X	22	0.10	RL13001	JJL36250	100	13215	—	—	—	—	—	250 [7]	100	13215	200 [7]	5	9640
	37	50	144	ATV61HD37M3X	22	0.075	RL16001	JJL36250	100	13215	—	—	—	—	—	250 [7]	100	13215	225 [7]	5	9640
	45	60	176	ATV61HD45M3X	22	0.055	RL20001	LAL36400	22	8640	—	—	—	—	—	400 [7]	22	8640	300 [7]	10	9640

Continued on next page

Table 1: Short-Circuit Current Ratings and Branch Circuit Protection for the Altivar 61 Drive *(continued)*

Altivar 61								Short-Circuit Current Ratings [1]													
								with Circuit Breaker [2]			with GV•P [2]					with Fuses [2]			with Fuses and Type 1 kit [3]		
Input voltage 50/60 Hz				Catalog number	Input rating	Minimum inductance	Line reactor reference	PowerPact™ (Z1), (Z2) [5]	(X) SCCR	Minimum enclosure volume	GV•P Type E [6] (Z1), (Z2)	GV•P voltage rating	GV•P max. power	(X) SCCR	Minimum enclosure volume	Fuse ampere rating (Z1), (Z2)	(X) SCCR	Minimum enclosure volume	Fuse ampere rating (Z1), (Z2)	(X) SCCR	Minimum enclosure volume
Y	kW	HP	A		kA [4]	mH			kA	(in³)		V	HP	kA	(in³)	A	kA	(in³)	A	kA	(in³)
Three-phase input, with line reactor																					
380/480 V Three-phase	0.75	1	2.3	ATV61H075N4	5	12	RL00201	HLL36015	100	4017	GV2P08	480Y/277	2	65	1600	15 [7, 8]	100	4017	6 [7, 8]	100	1078
	1.50	2	4.1	ATV61HU15N4	5	6.5	RL00402	HLL36015	100	4017	GV2P10	480Y/277	4	65	1600	15 [7, 8]	100	4017	12 [7, 8]	100	1078
	2.20	3	5.8	ATV61HU22N4	5	6.5	RL00402	HLL36015	100	4017	GV2P14	480Y/277	5	65	1600	15 [7, 8]	100	4017	15 [7, 8]	100	1078
	3	-	7.8	ATV61HU30N4	5	3	RL00802	HLL36015	100	4017	GV2P14	480Y/277	5	65	1920	15 [7, 8]	100	4017	17.5 [7, 8]	100	1550
	4	5	10.5	ATV61HU40N4	5	3	RL00802	HLL36025	100	4017	GV3P13	480Y/277	7.5	65	1920	25 [7, 8]	100	4017	25 [7, 8]	100	1550
	5.5	7.5	14.3	ATV61HU55N4	22	2.5	RL01202	HLL36035	100	6528	GV3P25	480Y/277	15	65	2880	35 [7]	100	6528	40 [7]	100	1987
	7.5	10	17.6	ATV61HU75N4	22	1.5	RL01802	HLL36050	100	6528	GV3P25	480Y/277	15	65	2880	50 [7]	100	6528	40 [7]	100	1987
	11	15	27.7	ATV61HD11N4	22	1.2	RL02502	HLL36060	100	6528	GV3P40	480Y/277	25	65	4032	60 [7]	100	6528	—	—	—
	15	20	33	ATV61HD15N4	22	0.8	RL03502	HLL36080	100	6528	GV3P50	480Y/277	30	65	5760	80 [7]	100	6528	70 [7]	100	4036
	18	25	41	ATV61HD18N4	22	0.8	RL03502	HLL36100	100	6528	GV3P50	480Y/277	30	65	8640	100 [7]	100	6528	70 [7]	100	4036
	22	30	48	ATV61HD22N4	22	0.7	RL04502	HLL36125	100	6528	GV3P50	480Y/277	30	65	8640	125 [7]	100	6528	80 [7]	100	4900
	30	40	66	ATV61HD30N4	22	0.5	RL05502	HLL36150	100	6528	GV3P65	480Y/277	40	65	10368	150 [7]	100	6528	90 [7]	100	7230
	37	50	79	ATV61HD37N4	22	0.4	RL08002	JLL36175	100	13215	—	—	—	—	—	175 [7]	100	13215	110 [7]	100	7230
	45	60	94	ATV61HD45N4	22	0.4	RL08002	JLL36225	100	13215	—	—	—	—	—	225 [7]	100	13215	150 [7]	100	12044
	55	75	116	ATV61HD55N4	22	0.3	RL10002	JLL36250	100	13215	—	—	—	—	—	250 [7]	100	13215	175 [7]	100	12044
	75	100	160	ATV61HD75N4	22	0.2	RL13002	JLL36250	100	38250	—	—	—	—	—	250 [7]	100	38250	225 [7]	100	12044
	75	100	160	ATV61HD75N4	22	0.2	RL13002	KCL34250	100	38250	—	—	—	—	—	250 [7]	100	38250	225 [7]	100	12044

1 An ATV61 drive output short-circuit test was performed for 100 kA. In addition to providing a rating based on shorting the output of the drive, these short-circuit ratings have been obtained by shorting components internal to the Altivar 61 drive. These ratings allow proper coordination of short-circuit protection. The integral solid state short-circuit protection in the drive does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any local codes. The listed line reactor or minimum impedance is required to obtain ratings above the input rating.

2 Ratings apply to an Altivar 61 drive mounted in a non-ventilated Type 1, 3R, 4(X), or 12 rated enclosure. Use noted ratings when using a Type 1 conduit kit. Minimum enclosure volume allows for the specified SCCR. Your application specific thermal requirements may require a larger enclosure.

3 The fuse ratings in this column are for an Altivar 61 drive installed with a VW3A92•••• Type 1 conduit kit. These fuse ratings in this column can also apply to Altivar 61 drive installed in a Type 1, 3R, 4(X), or 12 rated enclosure that has a minimum volume listed in the table.

4 This column shows the maximum PSCC value that cannot be exceeded without adding input impedance. Electrical distribution systems with a higher PSCC will cause higher input currents in the front end of the drive. It is possible for the tested SCCR rating of the drive to be lower than this input rating. The tested SCCR rating can be higher than this input rating when a line reactor is used.

5 Circuit breakers with lower interrupt ratings can be used within the same circuit breaker frame rating. For 200/240 Vac, replace with HGL or JGL for 65 kA interrupt rating. For 380/480 Vac, replace with HGL or JGL for 35 kA or HJL or JJL for 65 kA interrupt rating. For 500/600 Vac, replace with HJL for 25 kA or HGL for 18 kA, or HDL for 14 kA interrupt rating.

6 480 V ratings are for Wye connected electrical distribution systems only.
GV2P•• self-protected manual combination starter must be used with GV2GH7 insulating barrier to meet UL 508 Type E rating.
GV3P•• self-protected manual combination starter must be used with GV3G66 + GVAM11 insulating barrier to meet UL 508 Type E rating.

7 Use fast acting fuse or time delay Class J.

8 Fuse type Class CC.

Example of Drive Ratings Table: Altivar 320 Family

The combinations in Tables 2–4 have been tested per UL61800-5-1 (Reference UL file E116875).

ATV320 drives are provided with integral overload and overspeed protection for the motor after activation of the function [Mot THR memo] MtM. For more information refer to document number NVE41295, the ATV320 programming manual.

Protection at 100% of the full load motor current. The motor thermal protection current [Mot. therm. current] ItH must be set to the rated current indicated on the motor nameplate.

The values for the overcurrent protection devices are the maximum allowable ampere rating. Smaller ampere ratings may be used.The opening of the branch circuit protective device may be an indication that a fault current has been interrupted.

⚠ DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Current-carrying parts and other components of the controller should be examined and replaced if damaged.
- If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

Failure to follow these instructions will result in death or serious injury.

Table 2: Altivar 320 AC Drive Short-Circuit Current Ratings with Enclosure, No Line Reactor

Altivar 320 AC Drive Short-Circuit Current Ratings[1] with Enclosure, No Line Reactor				SCCR	Minimum Enclosure Volume		With Circuit Breaker	With GV•P			Fuses
							PowerPact™ CB Catalog Number[2]	GV2P/3P	GV•P		600 V Class J[3]
Input Voltage	Power Rating		Catalog Number[4]					Type E[5]	Voltage Rating	Power[6]	
	(kW)	(hp)		(kA)	(liter)	($inch^3$)			(V)	(hp)	(A)
480 V Three phase	0.37	1/2	ATV320U04N4•	5	53	3223	H•L36015	GV2P07	480Y/277	1	6
	0.55	3/4	ATV320U06N4•	5	53	3223	H•L36015	GV2P07	480Y/277	1	6
	0.75	1	ATV320U07N4•	5	53	3223	H•L36015	GV2P08	480Y/277	2	6
	1.1	1 1/2	ATV320U11N4•	5	53	3223	H•L36015	GV2P08	480Y/277	2	12
	1.5	2	ATV320U15N4•	5	53	3223	H•L36015	GV2P10	480Y/277	3	12
	2.2	3	ATV320U22N4•	5	53	3223	H•L36015	GV2P14	480Y/277	5	15
	3	4	ATV320U30N4•	5	53	3223	H•L36015	GV2P14	480Y/277	5	17.5
	4	5	ATV320U40N4•	5	53	3223	H•L36015	GV3P13[7]	480Y/277	7.5	25
	5.5	7.5	ATV320U55N4B	22	53	3223	H•L36020	GV3P18	480Y/277	10	40
	7.5	10	ATV320U75N4B	22	53	3223	H•L36030	GV3P25	480Y/277	15	40
	11	15	ATV320D11N4B	22	53	3223	H•L36040	GV3P32	480Y/277	20	60
	15	20	ATV320D15N4B	22	53	3223	H•L36050	GV3P40	480Y/277	25	60

1 This table shows the maximum short-circuit current rating the Altivar 320 drive can be installed on without adding impedance to the drive. Ratings apply to an Altivar 320 mounted in a Type 1, 3R, 4(X), or 12 rated enclosure. Minimum enclosure volume allows for specified SCCR. Thermal requirements may require a larger enclosure.

2 Circuit breaker part number designations: • = short circuit current rating.
For 208/230 V range, use: • = D for 25 kA, G for 65 kA, J for 65 kA, L for 65kA. For 480 V range, use: • = D for 18 kA, G for 35 kA, J for 65 kA, L for 65 kA.

3 Fuse type can be fast acting or time delay Class J, or Class CC.

4 Catalog Number designations: • = B for the book form factor drives and C for compact form factor drives.

5 For GV2P/3P use, 480 V and 600 V ratings are for Wye connected electrical distribution systems. GV2P•• self protected manual combination starter must be used with GV2GH7 insulating barrier to meet UL 508 Type E rating. GV3P•• self protected manual combination starter must be used with GV3G66 + GVAM11 insulating barrier and auxiliary contact to meet UL 508 Type E rating. The GVAM11 provides a visual indication if the GV3P has tripped.

6 UL508C Par. 57.1 & UL61800-5-1 Par. 6.3.7DV.2.1.1 require publishing the standard Type E combination motor controller power rating since this is a basic identification marking of the Type E devices. However, when applied as an input overcurrent protective device for a drive, the rated current of the Type E combination motor controller, not the rated power, is the key parameter for dimensioning (reference UL61800-5-1 Par. 5.2.3.6.2DV.4.1.11 & 5.2.3.6.2DV.4.1.12). Schneider Electric GV•P Type E combination motor controllers are adjustable, their current range is shown on the adjustment dial and their selection is based on the input current and not power rating of the drive.

7 GV2P products detailed below can be used in place of the GV3P products for obtaining the ratings listed in the SCCR column. GV2P16 for GV3P13, GV2P20 for GV3P18, GV2P22 for GV3P25.

Table 3: Altivar 320 AC Drive Short-Circuit Current Ratings with Enclosure and Line Reactor

Altivar 320 AC Drive Short-Circuit Current Ratings[1] with Enclosure and Line Reactor				Line Reactor Min. Value	Minimum Enclosure Value		With Circuit Breaker (CB)		With GV•P					Fuses	
									GV2P/3P	GVG•P					
Input Voltage	Power Rating		Catalog Number[2]				PowerPact CB Catalog Number[3]	SCCR	Type E[4]	Voltage Rating	Power[5]	SCCR		600 V Class J[6]	SCCR
	(kW)	(hp)		(mH)	(liter)	(inch³)		(kA)		(V)	(hp)	(kA)		(A)	(kA)
480 V Three phase	0.37	1/2	ATV320U04N4•	12	53	3223	H•L36015	65	GV2P07	480Y/277	1	65		6	100
	0.55	3/4	ATV320U06N4•	12	53	3223	H•L36015	65	GV2P07	480Y/277	1	65		6	100
	0.75	1	ATV320U07N4•	12	53	3223	H•L36015	65	GV2P08	480Y/277	2	65		6	100
	1.1	1 1/2	ATV320U11N4•	6.8	53	3223	H•L36015	65	GV2P08	480Y/277	2	65		12	100
	1.5	2	ATV320U15N4•	6.8	53	3223	H•L36015	65	GV2P10	480Y/277	3	65		12	100
	2.2	3	ATV320U22N4•	5	53	3223	H•L36015	65	GV2P14	480Y/277	5	65		15	100
	3	–	ATV320U30N4•	3	53	3223	H•L36015	65	GV2P14	480Y/277	5	65		17.5	100
	4	5	ATV320U40N4•	3	53	3223	H•L36015	65	GV3P13[7]	480Y/277	7.5	65		25	100
	5.5	7.5	ATV320U55N4B	2.5	53	3223	H•L36020	65	GV3P18	480Y/277	10	65		40	100
	7.5	10	ATV320U75N4B	1.5	53	3223	H•L36030	65	GV3P25	480Y/277	15	65		40	100
	11	15	ATV320D11N4B	1.2	53	3223	H•L36040	65	GV3P32	480Y/277	20	65		60	100
	15	20	ATV320D15N4B	0.8	53	3223	H•L36050	65	GV3P40	480Y/277	25	65		60	100

1 Ratings apply to an Altivar 320 drive mounted in a Type 1, 3R, 4(X) or 12 rated enclosure. Minimum enclosure volume allows for specified SCCR. Thermal requirements may require a larger enclosure. The listed line reactor minimum inductance is required to get these higher ratings.

2 Catalog Number designations: • = B for the book form factor drives and C for compact form factor drives.

3 Circuit breaker part number designations: • = short circuit current rating.
For 208/230 V range, use: • = D for 25 kA, G for 65 kA, J for 65 kA, L for 65kA. For 480 V range, use: • = D for 18 kA, G for 35 kA, J for 65 kA, L for 65 kA.

4 For GV2P/3P use, 480 V and 600 V ratings are for Wye connected electrical distribution systems. GV2P•• self protected manual combination starter must be used with GV2GH7 insulating barrier to meet UL 508 Type E rating. GV3P•• self protected manual combination starter must be used with GV3G66 + GVAM11 insulating barrier and auxiliary contact to meet UL 508 Type E rating. The GVAM11 provides a visual indication if the GV3P has tripped.

5 UL508C Par. 57.1 & UL61800-5-1 Par. 6.3.7DV.2.1.1 require publishing the standard Type E combination motor controller power rating since this is a basic identification marking of the Type E devices. However, when applied as an input overcurrent protective device for a drive, the rated current of the Type E combination motor controller, not the rated power, is the key parameter for dimensioning (reference UL61800-5-1 Par. 5.2.3.6.2DV.4.1.11 & 5.2.3.6.2DV.4.1.12). Schneider Electric GV•P Type E combination motor controllers are adjustable, their current range is shown on the adjustment dial and their selection is based on the input current and not power rating of the drive.

6 Fuse type can be fast acting or time delay Class J, or Class CC.

7 GV2P products detailed below can be used in place of the GV3P products for obtaining the ratings listed in the SCCR column. GV2P16 for GV3P13, GV2P20 for GV3P18, GV2P22 for GV3P25

Table 4: Altivar 320 with Conduit Box (Type 1) AC Drive Short Circuit Current Ratings

Altivar 320 with Conduit Box (Type 1) AC Drive Short Circuit Current Ratings						
Input Voltage 60 Hz	Power Rating		Catalog Number	SCCR	Fuses[1]	Line Reactor Min. Value
	(kW)	(hp)		(kA)		(mH)
480 V Three phase	0.37	1/2	ATV320U04N4C	5	6	–
	0.55	3/4	ATV320U06N4C	5	6	–
	0.75	1	ATV320U07N4C	5	6	–
	1.1	1 1/2	ATV320U11N4C	5	12	–
	1.5	2	ATV320U15N4C	5	12	–
	2.2	3	ATV320U22N4C	5	15	–
	3	4	ATV320U30N4C	5	17.5	–
	4	5	ATV320U40N4C	5	25	–
	5.5	7.5	ATV320U55N4B	5	40	–
	7.5	10	ATV320U75N4B	5	40	–
	11	15	ATV320D11N4B	22	60	–
	15	20	ATV320D15N4B	22	60	–

1 Fuse type can be fast acting or time delay Class J, or Class CC.

Conclusion

Matching the drive input rating to the PSCC is not enough for proper drive installation. Careful consideration of both the containment rating and the input rating, along with their related OCPD, enclosure, and line reactor or DC choke requirements are essential.

Schneider Electric's experience with electric power distribution systems and VFDs products provides a unique position to understand the dynamics and interrelationships of these systems and products. Schneider Electric is leading the industry in providing information to allow end users, control panel builders, system integrators, and OEMs to make informed decisions with regard as to how to install a VFD, select the OCPD, and what SCCR rating can be obtained using various components. This information is available for all Altivar VFDs and can be found by a web search for the documents referred to below.

Document No.	Drive Product
S1A58684	Altivar 12
S1A73476	Altivar 212
S1B16328	Altivar 312
S1B39941	Altivar 32
S1B86981	Altivar 61
S1B86988	Altivar 71
NVE21777	Altivar 320
NVE37641	Altivar 340
EAV64300	Altivar 630
NHA61583	Altivar 930

Additional documents that are available from Schneider Electric:

Document No.	Document Title
8800DB0801	*The Effects of Available Short-Circuit Current on AC Drives*
8536DB0901	*Motor Control Solutions for the North American Market*
CPTG005	*Control Panel Technical Guide*

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