Technical Data

VARIDYNE™ 2

Model sizes A to C and 2 to 6

AC variable speed drive for 3 phase induction motors

Part Number: 0472-0101-05
Issue: 5

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional parameters of the equipment or from mismatching the variable speed drive with the motor.

The contents of this guide are believed to be correct at the time of printing. In the interests of commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the content of the guide without notice.

Drive software version

This product is supplied with the latest version of user-interface and machine control software. If this product is to be used in a new or existing system with other drives, there may be some differences between their software and the software in this product. These differences may cause the product to function differently. This may also apply to drives returned from a Service Centre.

If there is any doubt, please contact the supplier of the drive.

Issue: 5

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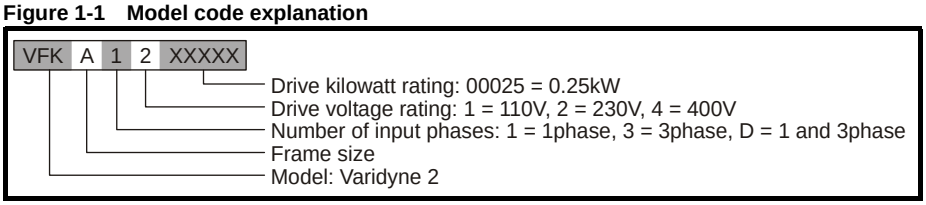
1 Technical data

1.1 VARIDYNE 2 size A to C

Figure 1-1 Model code explanation



1.1.1 VARIDYNE 2 110V size B units

Table 1-1 Ratings

MODEL	VFKB11	
	00075	00110
AC supply voltage and frequency	Single phase 100 to 120V ±10% 48Hz to 62Hz	
Input displacement factor (cos∅)	>0.97	
Nominal motor power (kW)	0.75	1.1
Nominal motor power (hp)	1.0	1.5
Output voltage and frequency	3 phase, 0 to drive rating (240), 0 to 1500Hz***	
100% RMS output current (A)	4.0	5.2
150% overload current for 60s (A)	6.0	7.8
Typical full load input current (A)	19.6	24.0
Maximum continuous input current (A)*		
Typical inrush current (A) (<10ms)	12.5	
Weight (kg)	1.356	
Weight (lb)	3	
Internal EMC filter	Yes	
DC bus terminals	Yes**	
Din rail mounting	Yes	

* For 3ph input only at 2% negative phase sequence.

** The -DC bus terminal is not connected to the power terminal.

*** The 110V size B uses a voltage doubler circuit on the input.

Table 1-2 Cables

MODEL		VFKB11	
		00075	00110
Recommended input supply fuse (A)	IEC gG	25	32
Control cable****	(mm^2)	≥0.5	
	(AWG)	20	
Recommended input cable*****	(mm^2)	4.0	
	(AWG)	10	
Recommended motor cable*****	(mm^2)	1.0	
	(AWG)	16	
Recommended brake resistor*****	(mm^2)	1.0	
	(AWG)	16	

**** The maximum size of wire for the control terminals is 2.5mm^2

***** The maximum size of wire for the power terminals is 2.5mm^2 (Size A) and 4mm^2 (Size B and C)

Table 1-3 Braking resistor

MODEL	VFKB11	
	00075	00110
Minimum braking resistor value (Ω)******	28	
Recommended braking resistor value (Ω)	100	
Resistor peak power rating (kW)	1.7	
Maximum braking current (A)	14.8	

****** Resistor tolerance ±10%

Table 1-4 Cooling fan

MODEL		VFKB11	
		00075	00110
Cooling fan fitted		Yes	
Air flow	($feet^3$/minute)	3.8	
	(m^3/minute)	0.4	

1.1.2 VARIDYNE 2 200V size A to C units

Table 1-5 Ratings

MODEL	VFKA12				VFKBD2				VFKCD2	
	00025	00037	00055	00075	00110		00150		00220	
					1ph	3ph	1ph	3ph	1ph	3ph
AC supply voltage and frequency	Single phase 200 to 240V ±10% 48Hz to 62Hz				Single or 3 phase 200 to 240V ±10% 48Hz to 62Hz					
Input displacement factor (cos∅)	>0.97									
Nominal motor power (kW)	0.25	0.37	0.55	0.75	1.1		1.5		2.2	
Nominal motor power (hp)	0.33	0.50	0.75	1.0	1.5		2.0		3.0	
Output voltage and frequency	3 phase, 0 to drive rating (240), 0 to 1500Hz									
100% RMS output current (A)	1.7	2.2	3.0	4.0	5.2		7.0		9.6	
150% overload current for 60s (A)	2.6	3.3	4.5	6	7.8		10.5		14.4	
Typical full load input current (A)	4.3	5.8	8.1	10.5	14.2	6.7	17.4	8.7	23.2	11.9
Maximum continuous input current (A)*						9.2		12.6		17
Typical inrush current (A) (<10ms)	17.0				27.4				18.3	
Weight (kg)	0.95		1.0		1.3		1.4		2.1	
Weight (lb)	2.1		2.2		2.9		3.1		4.6	
Internal EMC filter	Yes									
DC bus terminals	No				Yes					
Din rail mounting	Yes								No	

* For 3ph input only at 2% negative phase sequence.

Table 1-6 Cables

MODEL		VFKA12				VFKBD2				VFKCD2	
		00025	00037	00055	00075	00110		00150		00220	
						1ph	3ph	1ph	3ph	1ph	3ph
Recommended input supply fuse (A)	IEC gG	6	10		16	16	10	20	16	25	20
	Class CC	5	10		15	15	10	20	15	25	20
Control cable****	(mm^2)	≥0.5				≥0.5					
	(AWG)	20				20					
Recommended input cable*****	(mm^2)	1.0			1.5	2.5	1.5	2.5	1.5	4.0	2.5
	(AWG)	16			14	12	14	12	14	10	12
Recommended motor cable*****	(mm^2)	1.0				1.0				1.5	
	(AWG)	16				16				14	
Recommended brake resistor*****	(mm^2)	1.0				1.0				1.5	
	(AWG)	16				16				14	

**** The maximum size of wire for the control terminals is $2.5mm^2$

***** The maximum size of wire for the power terminals is $2.5mm^2$ (Size A) and $4mm^2$ (Size B and C)

Table 1-7 Braking resistor

MODEL	VFKA12				VFKBD2		VFKCD2
	00025	00037	00055	00075	00110	00150	00220
Minimum braking resistor value (Ω)******	68				28		28
Recommended braking resistor value (Ω)	200			150	100		50
Resistor peak power rating (kW)	0.9			1.1	1.7		3.4
Maximum braking current (A)	6.1				14.8		14.8

****** Resistor tolerance ±10%

Table 1-8 Cooling fan

MODEL		VFKA12				VFKBD2		VFKCD2
		00025	00037	00055	00075	00110	00150	00220
Cooling fan fitted		No				Yes		Yes
Air flow	($feet^3$/minute)					3.8		
	(m^3/minute)					0.4		

1.1.3 VARIDYNE 2 400V size A to C units

Table 1-9 Ratings

MODEL	VFKB34					VFKC34		
	00037	00055	00075	00110	00150	00220	00300	00400
AC supply voltage and frequency	3 phase 380 to 480V ±10% 48Hz to 62Hz							
Input displacement factor (cos∅)	>0.97							
Nominal motor power (kW)	0.37	0.55	0.75	1.1	1.5	2.2	3.0	4.0
Nominal motor power (hp)	0.5	0.75	1.0	1.5	2.0	3.0	3.0	5.0
Output voltage and frequency	3 phase, 0 to drive rating (480), 0 to 1500Hz							
100% RMS output current (A)	1.3	1.7	2.1	2.8	3.8	5.1	7.2	9.0
150% overload current for 60s (A)	2	2.6	3.2	4.2	5.7	7.7	10.8	13.5
Typical full load input current (A)	1.7	2.5	3.1	4	5.2	7.3	9.5	11.9
Maximum continuous input current (A)*	2.5	3.1	3.75	4.6	5.9	9.6	11.2	13.4
Typical inrush current (A) (<10ms)	17.0					11.3		
Weight (kg)	1.2			1.3		2.1		
Weight (lb)	2.7			2.9		4.6		
Internal EMC filter	Yes							
DC bus terminals	Yes							
Din rail mounting	Yes					No		

* For 3 phase input only at 2% negative phase sequence.

Table 1-10 Cables

MODEL		VFKB34					VFKC34		
		00037	00055	00075	00110	00150	00220	00300	00400
Recommended input supply fuse (A)	IEC gG	6				10	16		
	Class CC	5				10	15		
Control cable****	(mm^2)	≥0.5					≥0.5		
	(AWG)	20					20		
Recommended input cable *****	(mm^2)	1.0					1.5		2.5
	(AWG)	16					14		12
Recommended motor cable*****	(mm^2)	1.0					1.0		1.5
	(AWG)	16					16		14
Recommended brake resistor cable*****	(mm^2)	1.5					1.5		
	(AWG)	14					14		

**** The maximum size of wire for the control terminals is $2.5mm^2$

***** The maximum size of wire for the power terminals is $2.5mm^2$ (size A) and $4mm^2$ (size B and C)

Table 1-11 Braking resistor

MODEL	VFKB34					VFKC34		
	00037	00055	00075	00110	00150	00220	00300	00400
Minimum braking resistor value (Ω)******	100					100	55	
Recommended braking resistor value (Ω)	200					200	150	100
Resistor peak power rating (kW)	3.4					3.4	4.6	6.9
Maximum braking current (A)	8.3					8.3	15.1	

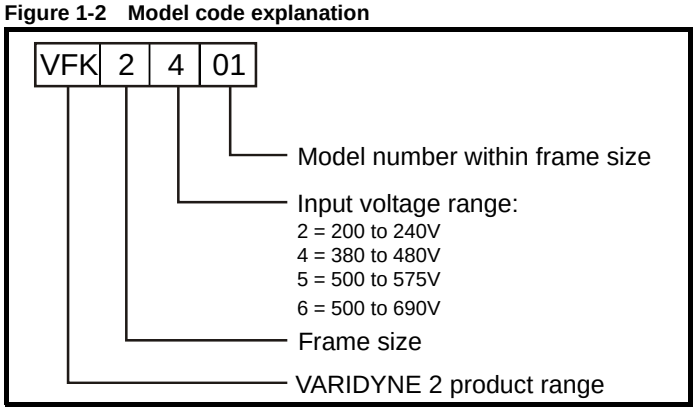
****** Resistor tolerance ±10%

Table 1-12 Cooling fan

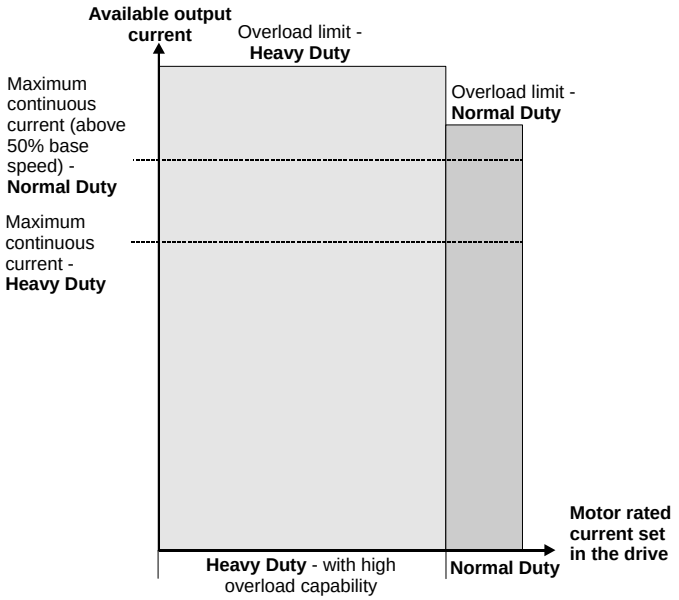
MODEL		VFKB34					VFKC34		
		00037	00055	00075	00110	00150	00220	00300	00400
Cooling fan fitted		No			Yes		Yes		
Air flow	($feet^3$/minute)				3.8				
	(m^3/minute)				0.4				

1.2 VARIDYNE 2 size 2 to 6

Figure 1-2 Model code explanation



The VARIDYNE 2 sizes 2 to 6 are dual rated.
The setting of the motor rated current determines which rating applies - Heavy Duty or Normal Duty.
The two ratings are compatible with motors designed to IEC60034.
The graph aside illustrates the difference between Normal Duty and Heavy Duty with respect to continuous current rating and short term overload limits.



Normal Duty

For applications which use self ventilated induction motors and require a low overload capability (e.g. fans, pumps).
Self ventilated induction motors require increased protection against overload due to the reduced cooling effect of the fan at low speed. To provide the correct level of protection the I^2t software operates at a level which is speed dependent. This is illustrated in the graph below.

NOTE

The speed at which the low speed protection takes effect can be changed by the setting of Pr **4.25**. The protection starts when the motor speed is below 15% of base speed when Pr **4.25** = 0 (default) and below 50% when Pr **4.25** = 1.
See the *VARIDYNE 2 Advanced User Guide*, Menu 4 for further details.

Heavy Duty (default)

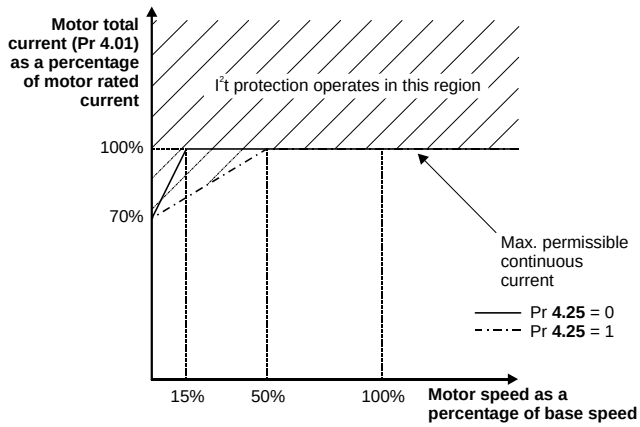
For constant torque applications or applications which require a high overload capability (e.g. cranes, hoists).
The thermal protection is set to protect force ventilated induction motors by default.

NOTE

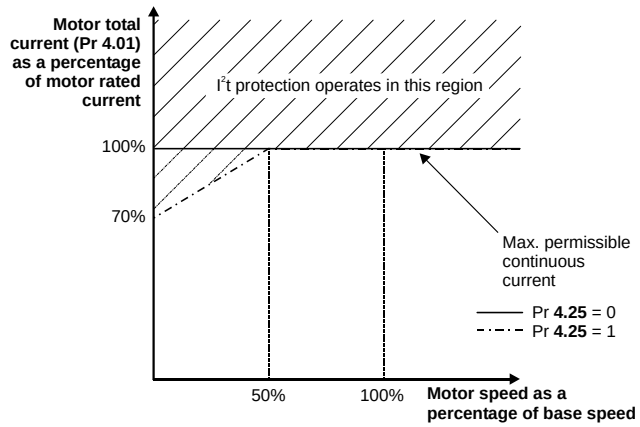
If the application uses a self ventilated motor and increased thermal protection is required for speeds below 50% base speed, then this can be enabled by setting Pr **4.25** = 1.
See the *VARIDYNE 2 Advanced User Guide*, Menu 4 for further details.

Operation of motor I^2t protection (It.AC trip)

Motor I^2t protection is fixed as shown below and is compatible with:
- Self ventilated induction motors



Motor I^2t protection defaults to be compatible with:
- Forced ventilation induction motors



1.2.1 Typical short term overload limits

The maximum percentage overload limit changes depending on the induction motor only. Variations in motor rated current, motor rated power factor and motor leakage inductance all result in changes in the maximum possible overload. The exact value for a specific motor can be calculated using the equations detailed in Menu 4 in the *VARIDYNE 2 Advanced User Guide*.

Table 1-13 Typical overload limits for size 2 to 5

	From cold	From 100% full load
Normal duty overload with motor rated current = drive rated current	110% for 215s	110% for 5s
Heavy duty overload with motor rated current = drive rated current	150% for 60s	150% for 8s
Heavy duty overload with a typical 4 pole motor	175% for 40s	175% for 5s

Table 1-14 Typical overload limits for size 6

	From cold	From 100% full load
Normal duty overload with motor rated current = drive rated current	110% for 165s	110% for 9s
Heavy duty overload with motor rated current = drive rated current	129% for 97s	129% for 15s

Generally the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting as illustrated by the example of a typical 4 pole motor.

The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

NOTE

The maximum overload level which can be attained is independent of the speed.

1.2.2 VARIDYNE 2 200V size 2 to 4 units

Key:

♦ Refer to Table 1-13 on page 9 for typical overload limits

* Typical input current

The values of typical input current are given to aid calculations for power flow and power loss (Normal Duty rating).
The values of typical input current are stated for a balanced supply.

** Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worse case condition with the unusual combination of a stiff supply with bad balance (Normal Duty rating). The value stated for the maximum continuous input current would only been seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated with a 2% negative phase-sequence imbalance and rated at the maximum supply fault current given in the following tables.

**** Resistor tolerance ±10%

^ Semi-conductor fuse in series with HRC fuse or circuit breaker

Table 1-15 Ratings

Model	VFK2			VFK3		VFK4		
	201	202	203	201	202	201	202	203
AC supply voltage and frequency	3 phase 200 to 240Vac ±10% 48 to 65Hz							
Input displacement factor (cos ∅)	>0.97							
Normal duty								
Nominal motor power at 220V (kW)	4.0	5.5	7.5	11	15	18.5	22	30
Nominal motor power at 230V (hp)	5.0	7.5	10	15	20	25	30	40
100% RMS output current (A)	15.5	22	28	42	54	68	80	104
Heavy Duty								
Nominal motor power (kW)	3.0	4.0	5.5	7.5	11	15	18.5	22
Nominal motor power (hp)	3.0	5.0	7.5	11	15	20	25	30
100% RMS output current (A)	12.6	17	25	31	42	56	68	80
Peak current (A) ♦	18.9	25.5	37.5	46.5	63	84	102	120
Typical full load input current (A) *	13.4	18.2	24.2	35.4	46.8	62.1	72.1	94.5
Maximum continuous input current (A) **	18.1	22.6	28.3	43.1	54.3	68.9	78.1	99.9
Typical inrush current (A)	12			8		73		
Maximum supply fault current (kA)	100							
Weight (kg)	7			15		30		
Weight (lb)	15.4			33.1		66.1		

Table 1-16 Size 2 and 3 fuses

Model		VFK2			VFK3	
		201	202	203	201	202
Recommended input supply fuse (A)	IEC gG	20	25	32	50	63
	Class CC	20	25			
	Class J			32	45	60

Table 1-17 Size 4 and 5 fuses

Model		VFK4					
		201	202	203	201	202	203
		Option 1			Option 2^		
Recommended input supply fuse (A)	IEC gR	100	100	125			
	Ferraz HSJ	90	100	125			
	IEC gG UL class J				90	100	125
	IEC class aR				160	160	200

Table 1-18 Cables

Model		VFK2			VFK3		VFK4		
		201	202	203	201	202	201	202	203
Control cable	(mm^2)	≥0.5							
	(AWG)	20							
Recommended input cable	(mm^2)	4.0	4.0	6.0	16	25	25	35	70
	(AWG)	12	10	8	6	4	3	3	1
Recommended motor cable	(mm^2)	2.5	4.0	6.0	16	25	25	35	70
	(AWG)	14	10	8	6	4	3	3	1
Recommended brake resistor	(mm^2)	2.5	4.0	6.0	16	25	25	35	70
	(AWG)	14	10	8	6	4	3	3	1

Table 1-19 Braking resistor (minimum resistance values and peak power rating for the braking resistor at 40ºC)

Model	VFK2			VFK3		VFK4		
	201	202	203	201	202	201	202	203
Minimum braking resistor value (Ω)****	18			5.0		5.0		
Resistor peak power rating (kW)	8.9			30.3		30.3		
Average power for 60s (kW)	6.0	8.0	8.9	13.1	19.3	22.5	27.8	30.3

1.2.3 VARIDYNE 2 400V size 2 to 6 units

Key:

♦ Refer to Table 1-13 and Table 1-14 on page 10 for typical overload limits

* Typical input current

The values of typical input current are given to aid calculations for power flow and power loss (Normal Duty rating).
The values of typical input current are stated for a balanced supply.

** Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worse case condition with the unusual combination of a stiff supply with bad balance (Normal Duty rating). The value stated for the maximum continuous input current would only been seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated with a 2% negative phase-sequence imbalance and rated at the maximum supply fault current given in the following tables.

*** VFK2404 Power and current ratings

VARIDYNE 2 size 2 to 6 are dual rated except for the VFK2404 which only has a Heavy Duty rating. However, if the current limit in Pr **4.07** is set to a maximum of 110% and the switching frequency is greater than 3kHz, then the drive can be used at a maximum continuous current higher than the Heavy Duty rating. Normal Duty ratings exist for the VFK2404 above 3kHz when the overload is reduced from the default value of 165% to 110%.

If the current limit in Pr **4.07** is set higher than 110% then the Heavy Duty current ratings are applicable.

**** Resistor tolerance ±10%

^ Semi-conductor fuse in series with HRC fuse or circuit breaker

^^ The minimum resistance value specified is for a stand-alone drive only. If the drive is part of a common DC bus system a different value must be used. Contact the supplier of the drive for more information

Table 1-20 Size 2 to 4 ratings

Model	VFK2				VFK3			VFK4		
	401	**402**	**403**	**404*** **	**401**	**402**	**403**	**401**	**402**	**403**
AC supply voltage and frequency	3 phase 380 to 480Vac ±10% 48 to 65Hz									
Input displacement factor (cos ∅)	>0.97									
Normal Duty										
Nominal motor power at 400V (kW)	7.5	11	15		18.5	22	30	37	45	55
Nominal motor power at 460V (hp)	10	15	20		25	30	40	50	60	75
100% RMS output current (A)	15.3	21	29		35	43	56	68	83	104
Heavy Duty										
Nominal motor power (kW)	5.5	7.5	11	15	15	18.5	22	30	37	45
Nominal motor power (hp)	10	10	20	20	25	30	30	50	60	75
100% RMS output current (A)	13	16.5	25	29	32	40	46	60	74	96
Peak current (A) ♦	19.5	24.7	34.5	43.5	48	60	69	90	111	144
Typical full load input current (A) *	15.7	20.2	26.6	26.6	34.2	40.2	51.3	61.2	76.3	94.1
Maximum continuous input current (A) **	17	21.4	27.6	27.6	36.2	42.7	53.5	62.3	79.6	97.2
Typical inrush current (A)	24				14			37	73	
Maximum supply fault current (kA)	100				100			100		
Weight (kg)	7				15			30		
Weight (lb)	15.4				33.1			66.1		

Table 1-21 Size 5 and 6 ratings

Model	VFK5		VFK6	
	401	402	401	402
AC supply voltage and frequency	3 phase 380 to 480Vac ±10% 48 to 65Hz			
Input displacement factor (cos ∅)	>0.97			
Normal Duty				
Nominal motor power (kW)	75	90	110	132
Nominal motor power (hp)	100	125	150	200
100% RMS output current (A)	138	168	205	236
Heavy Duty				
Nominal motor power (kW)	55	75	90	110
Nominal motor power (hp)	100	125	150	150
100% RMS output current (A)	124	156	180	210
Peak current (A) ♦	186	234	231	270
Typical full load input current (A) *	126	152	206	247
Maximum continuous input current (A) **	131	156	215	258
Typical inrush current (A)	110			
Maximum supply fault current (kA)	100			
Weight (kg)	55		75	
Weight (lb)	121.3		165.3	

Table 1-22 Size 2 and 3 fuses

Model		VFK2				VFK3		
		401	402	403	404	401	402	403
Recommended input supply fuse (A)	IEC gG	20	25	32	32	40	50	63
	Class CC	20	25					
	Class J			30	30	40	45	60

Table 1-23 Size 4 to 6 fuses

Model		VFK4						VFK5				VFK6			
		401	402	403	401	402	403	401	402	401	402	401	402	401	402
		Option 1			Option 2^			Option 1		Option 2^		Option 1		Option 2^	
Recommended input supply fuse (A)	IEC gR	80	110	125				200	250			250	315		
	Ferraz HSJ	80	110	125				175	225			250	300		
	IEC gG UL class J				80	100	125			160	200			250	300
	IEC class aR				160	200	200			200	250			315	350

Table 1-24 Size 2 to 4 cables

Model		VFK2				VFK3			VFK4		
		401	402	403	404	401	402	403	401	402	403
Control cable	(mm²)	≥0.5									
	(AWG)	20									
Recommended input cable	(mm²)	4.0	4.0	6.0	6.0	10	16	25	25	35	70
	(AWG)	12	10	8	8	6	6	4	3	2	1
Recommended motor cable	(mm²)	2.5	4.0	6.0	6.0	10	16	25	25	35	70
	(AWG)	14	10	8	8	6	6	4	3	2	1
Recommended brake resistor	(mm²)	2.5	4.0	6.0	6.0	10	16	25	25	35	70
	(AWG)	14	10	8	8	6	6	4	3	2	1

Table 1-25 Size 5 and 6 cables

Model		VFK5		VFK6	
		401	402	401	402
Control cable	(mm²)	≥0.5			
	(AWG)	20			
Recommended input cable	(mm²)	95	120	2 x 70	2 x 120
	(AWG)	2/0	4/0	2 x 2/0	2 x 4/0
Recommended motor cable	(mm²)	95	120	2 x 70	2 x 120
	(AWG)	2/0	4/0	2 x 2/0	2 x 4/0
Recommended brake resistor	(mm²)	95	120	2 x 70	2 x 120
	(AWG)	2/0	4/0	2 x 2/0	2 x 4/0

Table 1-26 Braking resistor (minimum resistance values and peak power rating for the braking resistor at 40ºC)

Model	VFK2				VFK3			VFK4^^			VFK5^^		VFK6	
	401	402	403	404	401	402	403	401	402	403	401	402	401	402
Minimum braking resistor value (Ω)****	19				18			11		9	7		5	
Resistor peak power rating (kW)	33.1				35.5			55.3		67.6	86.9		121.7	
Average power for 60s (kW)	9.6	13.1	19.3	22.5	22.5	27.8	33.0	45.0	53.0	67.5	82.5	86.9	90	110

1.2.4 VARIDYNE 2 575V size 3 to 6 units

Key:

♦ Refer to Table 1-13 and Table 1-14 on page 10 for typical overload limits

* Typical input current

The values of typical input current are given to aid calculations for power flow and power loss (Normal Duty rating).
The values of typical input current are stated for a balanced supply.

** Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worse case condition with the unusual combination of a stiff supply with bad balance (Normal Duty rating). The value stated for the maximum continuous input current would only been seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated with a 2% negative phase-sequence imbalance and rated at the maximum supply fault current given in the following tables.

**** Resistor tolerance ±10%

^ Semi-conductor fuse in series with HRC fuse or circuit breaker

^^ The minimum resistance value specified is for a stand-alone drive only. If the drive is part of a common DC bus system a different value must be used. Contact the supplier of the drive for more information

Table 1-27 Size 3 ratings

Model	VFK3						
	501	502	503	504	505	506	507
AC supply voltage and frequency	3 phase 500 to 575Vac ±10% 48 to 65Hz						
Input displacement factor (cos ∅)	>0.97						
Normal Duty							
Nominal motor power (kW)	3.0	4.0	5.5	7.5	11	15	18.5
Nominal motor power (hp)	3.0	5.0	7.5	10	15	20	25
100% RMS output current (A)	5.4	6.1	8.4	11	16	22	27
Heavy Duty							
Nominal motor power at 575V (kW)	2.2	3.0	4.0	5.5	7.5	11	15
Nominal motor power at 575V (hp)	2.0	3.0	5.0	7.5	10	15	20
100% RMS output current (A)	4.1	5.4	6.1	9.5	12	18	22
Peak current (A) ♦	6.1	8.1	9.1	14.2	18	27	33
Typical full load input current (A) *	5.0	6.0	7.8	9.9	13.8	18.2	22.2
Maximum continuous input current (A) **	6.7	8.2	11.1	14.4	18.1	22.2	26.0
Typical inrush current (A)	18						
Maximum supply fault current (kA)	100						
Weight (kg)	15						
Weight (lb)	33.1						

Table 1-28 Size 4 to 6 ratings

Model	VFK4				VFK5		VFK6	
	603	604	605	606	601	602	601	602
AC supply voltage and frequency	3 phase 500 to 575Vac ±10% 48 to 65Hz							
Input displacement factor (cos ∅)	>0.97							
Normal Duty								
Nominal motor power (kW)	22	30	37	45	55	75	90	110
Nominal motor power (hp)	30	40	50	60	75	100	125	150
100% RMS output current (A)	36	43	52	62	84	99	125	144
Heavy Duty								
Nominal motor power (kW)	18.5	22	30	37	45	55	75	90
Nominal motor power (hp)	25	30	40	50	60	75	100	125
100% RMS output current (A)	27	36	43	52	63	85	100	125
Peak current (A) ♦	40.5	54	64.5	78	93	126	128	160
Typical full load input current (A) *	32.9	39	46.2	55.2	75.5	89.1	128	144
Maximum continuous input current (A) **	35.1	41	47.9	56.9	82.6	94.8	139	155
Typical inrush current (A)	35				70			
Maximum supply fault current (kA)	100							
Weight (kg)	30				55		75	
Weight (lb)	66.1				121.3		165.3	

The power ratings above for model size 4 and larger are for the 690V drives when used on a 500V to 575V supply.

Table 1-29 Fuses

Model		VFK3						
		501	502	503	504	505	506	507
Recommended input supply fuse (A)	IEC gG	8	10	12	16	20	25	32
	Class CC	10	10	15	15	20	25	
	Class J							30

Table 1-30 Cables

Model		VFK3						
		501	502	503	504	505	506	507
Control cable	(mm²)	≥0.5						
	(AWG)	20						
Recommended input cable	(mm²)	1.0	1.0	1.5	2.5	4.0	4.0	6.0
	(AWG)	16	16	14	14	12	10	8
Recommended motor cable	(mm²)	1.0	1.0	1.0	1.5	2.5	4.0	6.0
	(AWG)	18	16	14	14	14	10	8
Recommended brake resistor	(mm²)	1.0	1.0	1.0	1.5	2.5	4.0	6.0
	(AWG)	18	16	14	14	14	10	8

Table 1-31 Braking resistor (minimum resistance values and peak power rating for the braking resistor at 40ºC)

Model	VFK3						
	501	502	503	504	505	506	507
Minimum braking resistor value (Ω)****	18						
Resistor peak power rating (kW)	50.7						
Average power for 60s (kW)	4.4	6.0	8.0	9.6	13.1	19.3	22.5

1.2.5 VARIDYNE 2 690V size 4 to 6 units

Key:

♦ Refer to Table 1-13 and Table 1-14 on page 10 for typical overload limits

* Typical input current

The values of typical input current are given to aid calculations for power flow and power loss (Normal Duty rating).
The values of typical input current are stated for a balanced supply.

** Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worse case condition with the unusual combination of a stiff supply with bad balance (Normal Duty rating). The value stated for the maximum continuous input current would only been seen in one of the input phases. The current in the other two phases would be significantly lower.

The values of maximum input current are stated with a 2% negative phase-sequence imbalance and rated at the maximum supply fault current given in the following tables.

**** Resistor tolerance ±10%

^ Semi-conductor fuse in series with HRC fuse or circuit breaker

^^ The minimum resistance value specified is for a stand-alone drive only. If the drive is part of a common DC bus system a different value must be used. Contact the supplier of the drive for more information

Table 1-32 Size 4 ratings

Model	VFK4					
	601	**602**	**603**	**604**	**605**	**606**
AC supply voltage and frequency	3 phase 500 to 690Vac ±10% 48 to 65Hz					
Input displacement factor (cos ∅)	>0.97					
Normal Duty						
Nominal motor power (kW)	18.5	22	30	37	45	55
Nominal motor power (hp)	25	30	40	50	60	75
100% RMS output current (A)	22	27	36	43	52	62
Heavy Duty						
Nominal motor power at 690V(kW)	15	18.5	22	30	37	45
Nominal motor power at 690V (hp)	20	25	30	40	50	60
100% RMS output current (A)	19	22	27	36	43	52
Peak current (A) ♦	27	33	40.5	54	64.5	78
Typical full load input current (A) *	23	26.1	32.9	39	46.2	55.2
Maximum continuous input current (A) **	26.5	28.8	35.1	41	47.9	56.9
Typical inrush current (A)	35					
Maximum supply fault current (kA)	100					
Weight (kg)	30					
Weight (lb)	66.1					

Table 1-33 Size 5 and 6 ratings

Model	VFK5		VFK6	
	601	**602**	**601**	**602**
AC supply voltage and frequency	3 phase 500 to 690Vac ±10% 48 to 65Hz			
Input displacement factor (cos ∅)	>0.97			
Normal Duty				
Nominal motor power at 690V(kW)	75	90	110	132
Nominal motor power at 690V (hp)	100	125	150	175
100% RMS output current (A)	84	99	125	144
Heavy Duty				
Nominal motor power (kW)	55	75	90	110
Nominal motor power (hp)	75	100	125	150
100% RMS output current (A)	63	85	100	125
Peak current (A) ♦	93	126	128	160
Typical full load input current (A) *	75.5	89.1	128	144
Maximum continuous input current (A) **	82.6	94.8	139	155
Typical inrush current (A)	70			
Maximum supply fault current (kA)	100			
Weight (kg)	55		75	
Weight (lb)	121.3		165.3	

Table 1-34 Size 4 fuses

Model		VFK4											
		601	602	603	604	605	606	601	602	603	604	605	606
		Option 1						Option 2^					
Recommended input supply fuse (A)	IEC gR	63					80						
	Ferraz HSJ	60											
	IEC gG UL class J							32	40	50	50	63	63
	IEC class aR							125	125	125	125	125	125

Table 1-35 Size 5 and 6 fuses

Model		VFK5				VFK6			
		601	602	601	602	601	602	601	602
		Option 1		Option 2^		Option 1		Option 2^	
Recommended input supply fuse (A)	IEC gR	125	125			160	160		
	Ferraz HSJ	100	100			175	175		
	IEC gG UL class J			90	125			150	160
	IEC class aR			160	160			315	315

Table 1-36 Cables

Model		VFK4						VFK5		VFK6	
		601	602	603	604	605	606	601	602	601	602
Control cable	(mm²)	≥0.5						≥0.5			
	(AWG)	20						20			
Recommended input cable	(mm²)	4	6	10	16	16	25	35	50	2 x 50	2 x 50
	(AWG)	10	8	8	6	6	4	2	1	2 x 1	2 x 1
Recommended motor cable	(mm²)	4	6	10	16	16	25	35	50	2 x 50	2 x 50
	(AWG)	10	8	8	6	6	4	2	1	2 x 1	2 x 1
Recommended brake resistor	(mm²)	4	6	10	16	16	25	35	50	2 x 50	2 x 50
	(AWG)	10	8	8	6	6	4	2	1	2 x 1	2 x 1

Table 1-37 Braking resistor (minimum resistance values and peak power rating for the braking resistor at 40ºC)

Model	VFK4^^						VFK5^^		VFK6	
	601	602	603	604	605	606	601	602	601	602
Minimum braking resistor value (Ω)****	13						10		10	
Resistor peak power rating (kW)	95.0						125.4		125.4	
Average power for 60s (kW)	19.3	22.5	27.8	33.0	45.0	55.5	67.5	82.5	112.5	125.4

2 Derating curves and losses

The derating curves are based on the results of heatruns that are carried out to measure temperatures of various components and at various key points within the drive at different switching frequencies, different loads and different ambient temperatures. The key components/points are:

- Heatsink
- Bridge rectifier
- IGBTs
- DC bus capacitors
- Various electrolytic capacitors
- Various resistors
- Various semiconductor components

It is not always the heatsink temperature that is the limiting factor for the de-rating curves.

At 3 and 6kHz, the limiting factor tends to be the capacitor temperatures. Operating outside the derating curves will cause some of the capacitors within the drive to run outside of their maximum operating temperature and this could lead to the drives design lifetime being reduced.

At 12 and 18kHz (18kHz where applicable) the limiting factor tends to be the heatsink temperatures. Operating outside the de-rating curves will cause the heatsink temperature to increase and may cause the drive to trip on O.ht2.

If the auto-switching frequency change is enabled (Pr **5.35** = 0 [by default]), the drive will automatically decrease the switching frequency when the heatsink temperature rises above pre-determined levels to reduce the heatsink temperature. When the drive switches down the switching frequency, the drives display will flash 'hot'.

NOTE

It is important that these de-rating curves are observed.

2.1 Size A

2.1.1 Derating curves

Figure 2-1 VARIDYNE 2 Size A 0.25kW derating curve

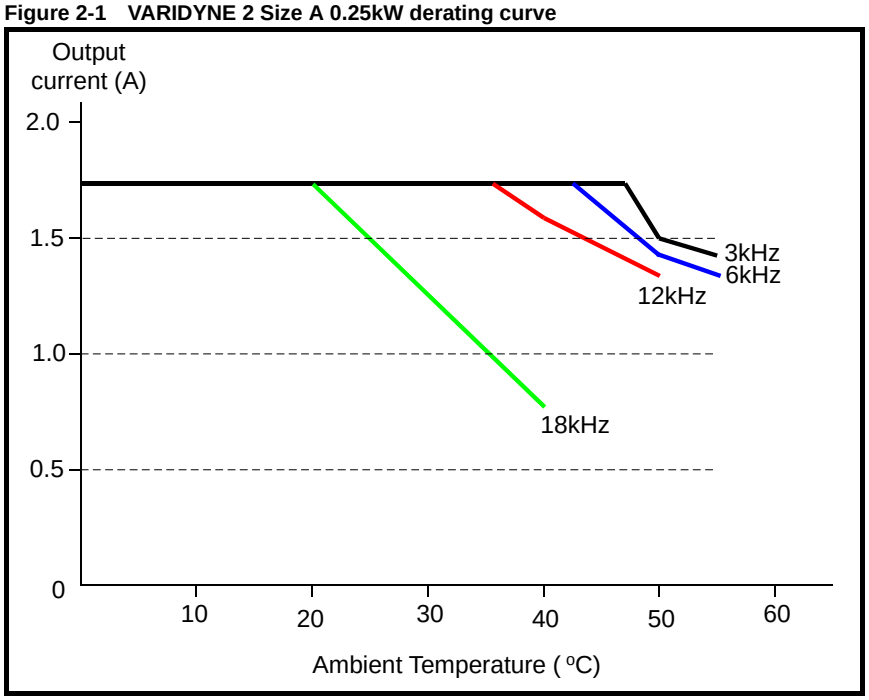


Figure 2-2 VARIDYNE 2 Size A 0.37kW derating curve

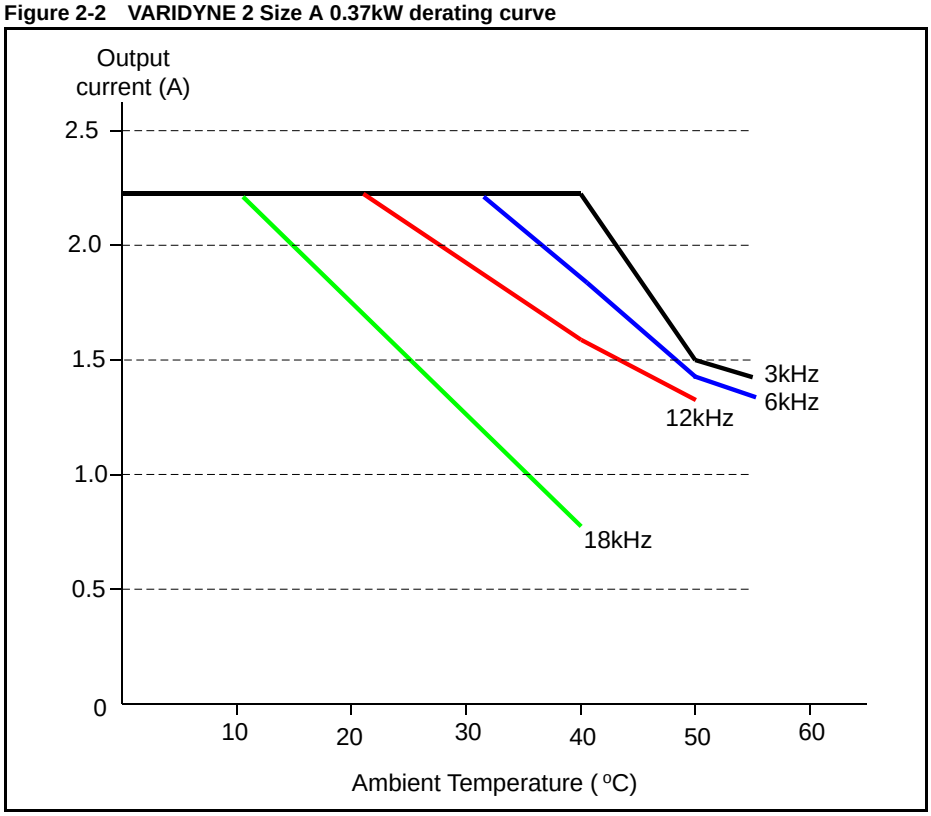


Figure 2-3 VARIDYNE 2 Size A 0.55kW derating curve

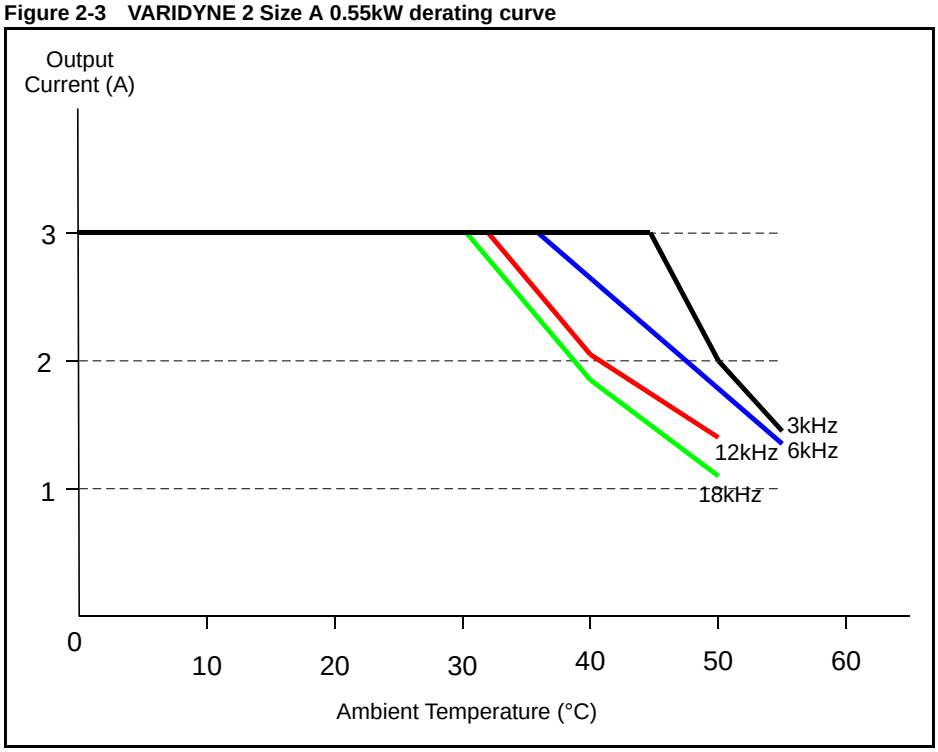
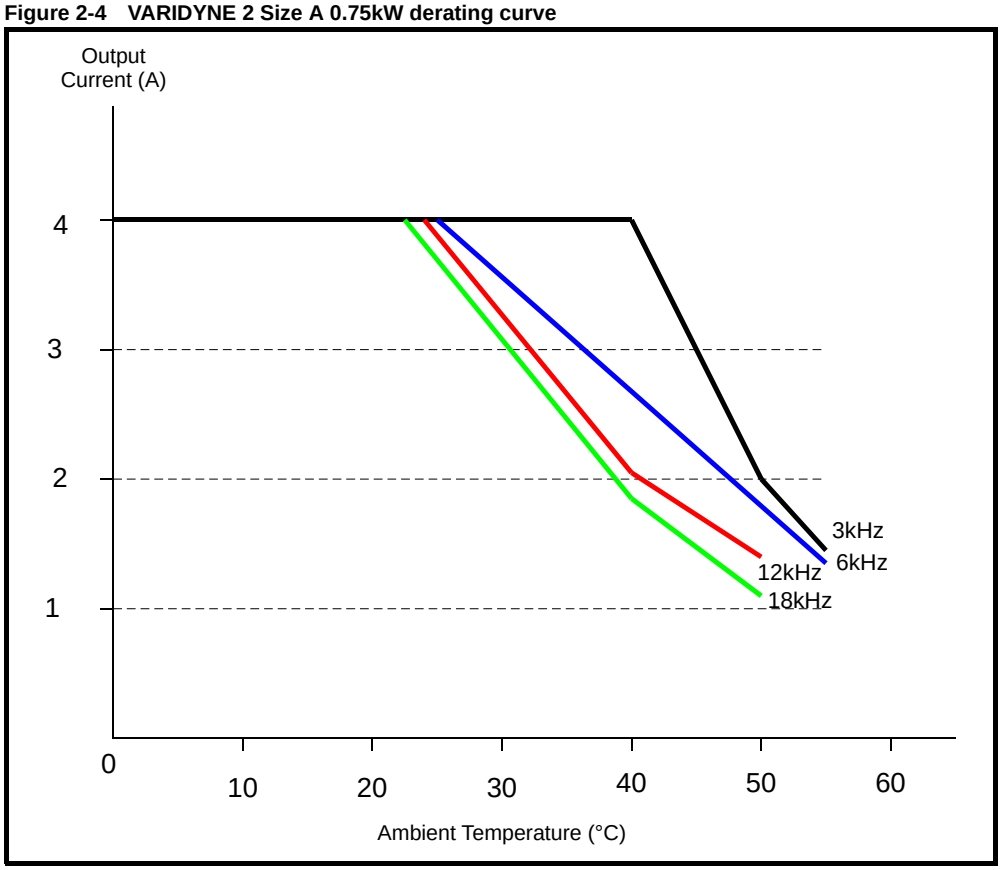


Figure 2-4 VARIDYNE 2 Size A 0.75kW derating curve



2.1.2 Drive losses

The following tables indicate the total drive losses at the de-rating curve points.

Table 2-1 VARIDYNE 2 size A 0.25kW losses

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	30	32	36	35
40	30	32	38	30
50	29	31	34	
55	29	30		

Table 2-2 VARIDYNE 2 size A 0.37kW losses

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	34	36	38	35
40	34	33	38	30
50	29	31	34	
55	29	30		

Table 2-3 VARIDYNE 2 size A 0.55kW losses

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	42	46	53	61
40	42	43	44	47
50	35	36	37	38
55	31	33		

Table 2-4 VARIDYNE 2 size A 0.75kW losses

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	48	50	59	62
40	48	43	44	47
50	35	36	37	38
55	31	33		

2.2 Size B

2.2.1 Derating curves

Figure 2-5 VARIDYNE 2 Size B, 200V, 1.1kW

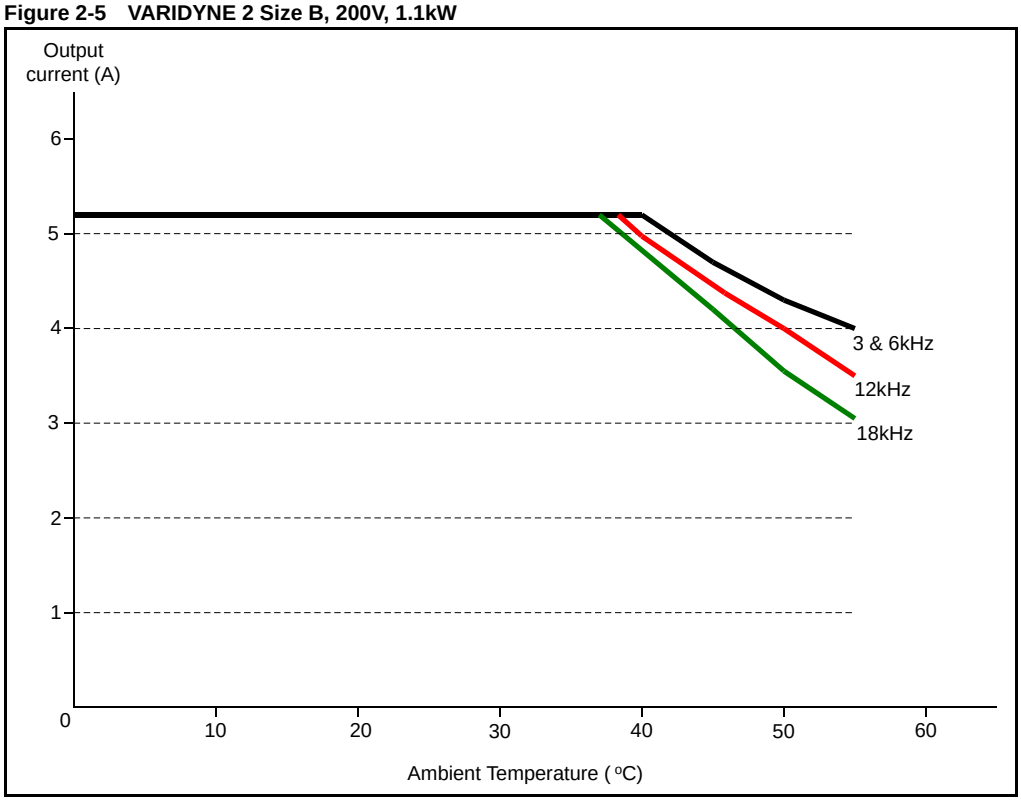
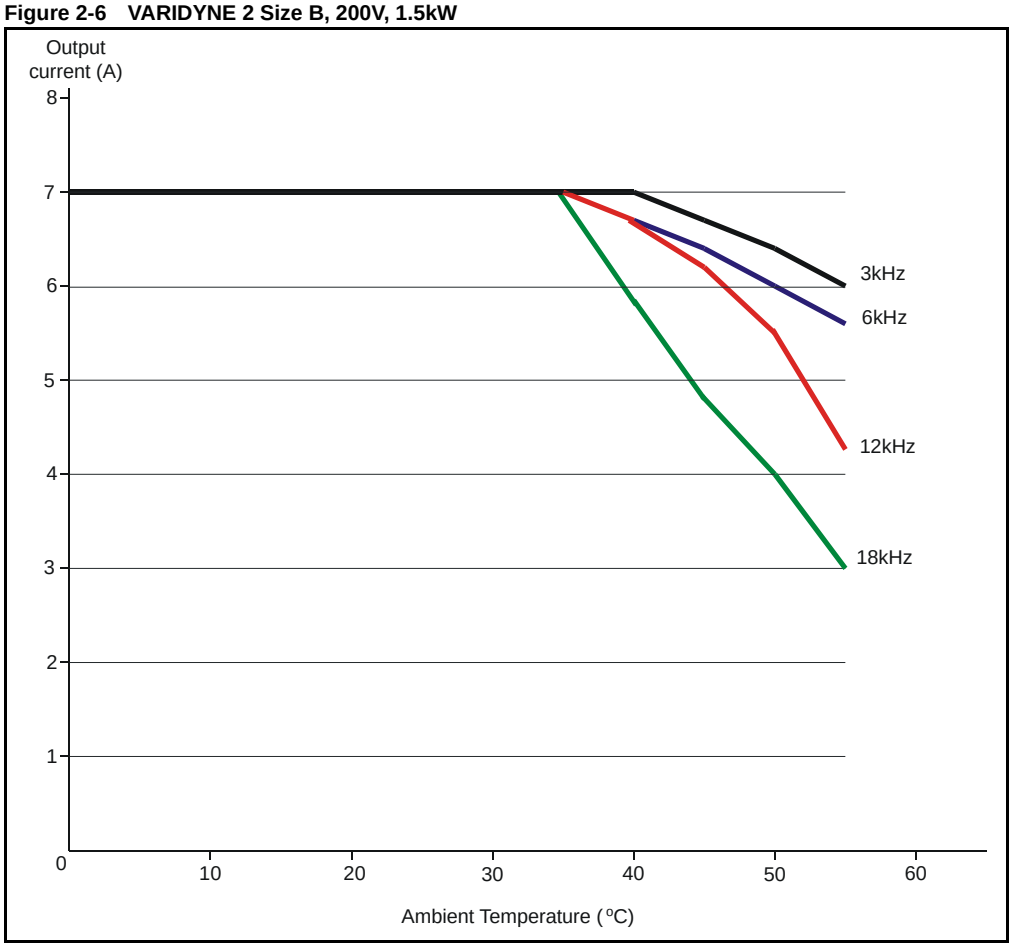


Figure 2-6 VARIDYNE 2 Size B, 200V, 1.5kW



With the 0.37, 0.55 & 0.75kW drives, no 12kHz derating information is shown on the graphs. This is because the losses at 12kHz is too great to run the drive continuously. Depending on the duty cycle etc. it is still possible to run the drive at 12kHz but if the heatsink gets too hot, the drive will automatically switch down the switching frequency to 6kHz. When the drive does this, the display will flash 'hot' to indicate that the drive has automatically switched down the switching frequency.

Figure 2-7 VARIDYNE 2 Size B, 400V, 0.37kW

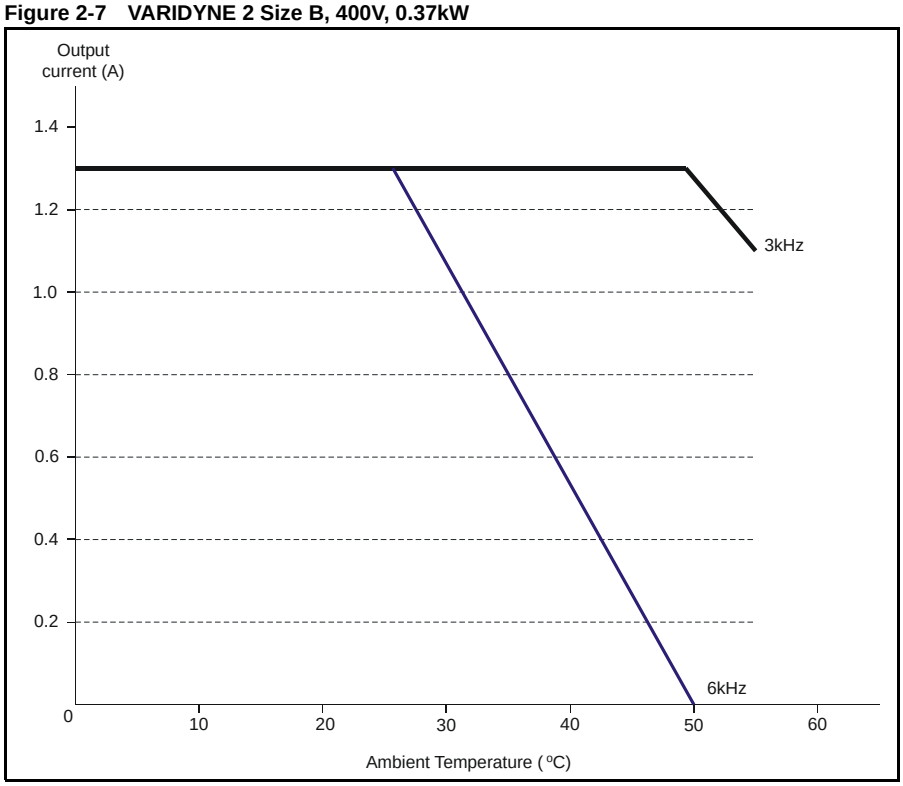


Figure 2-8 VARIDYNE 2 Size B, 400V, 0.55kW

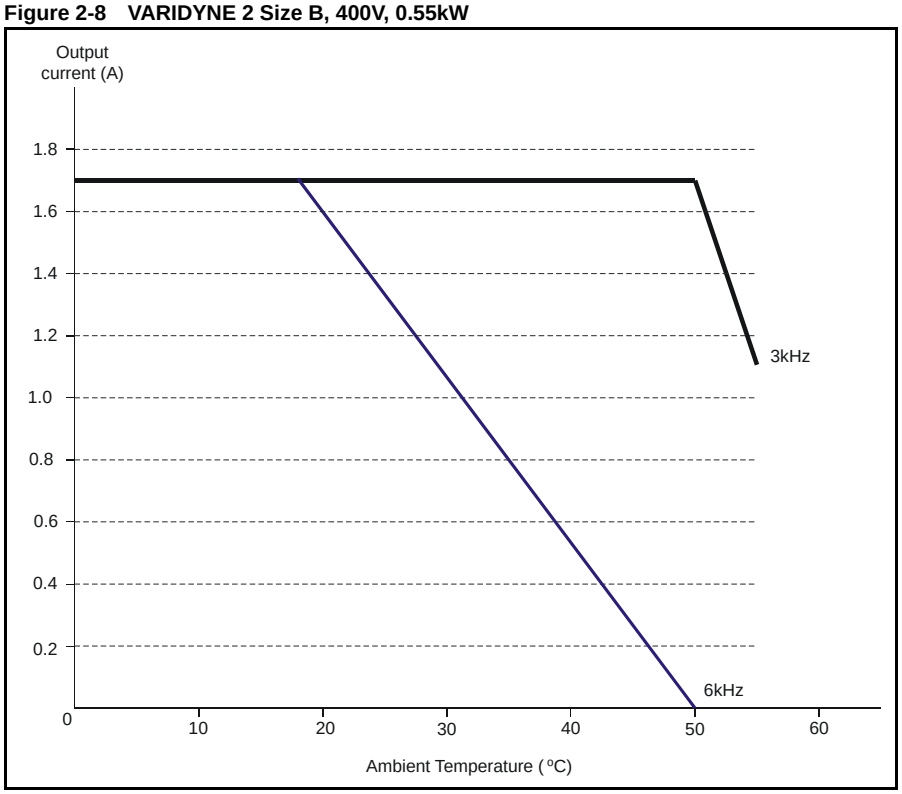


Figure 2-9 VARIDYNE 2 Size B, 400V, 0.75kW

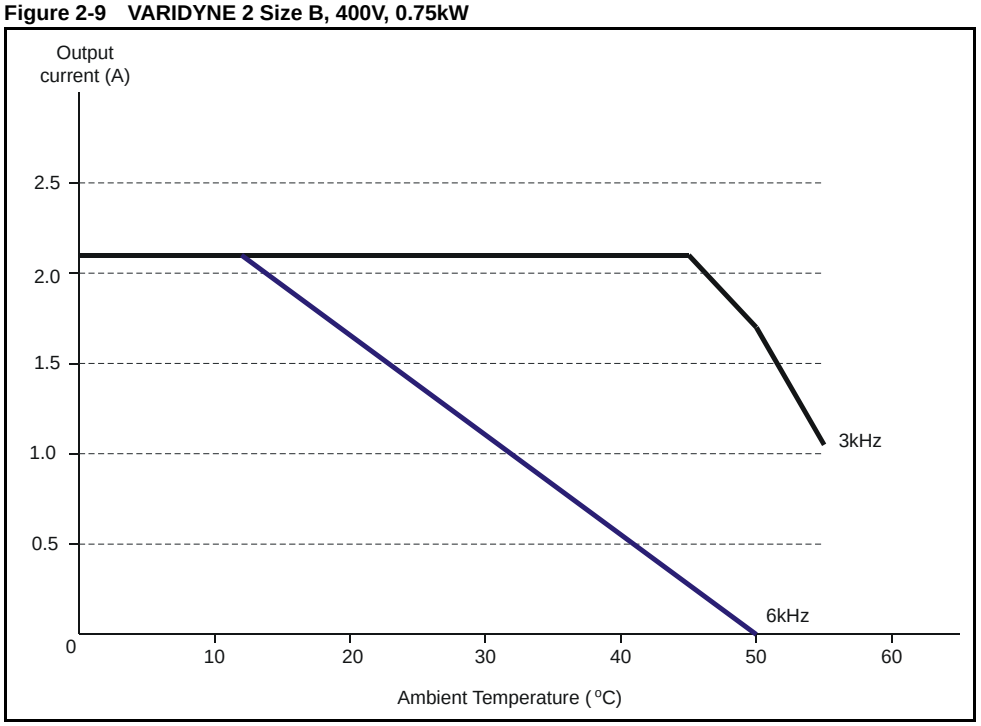


Figure 2-10 VARIDYNE 2 Size B, 400V, 1.1kW

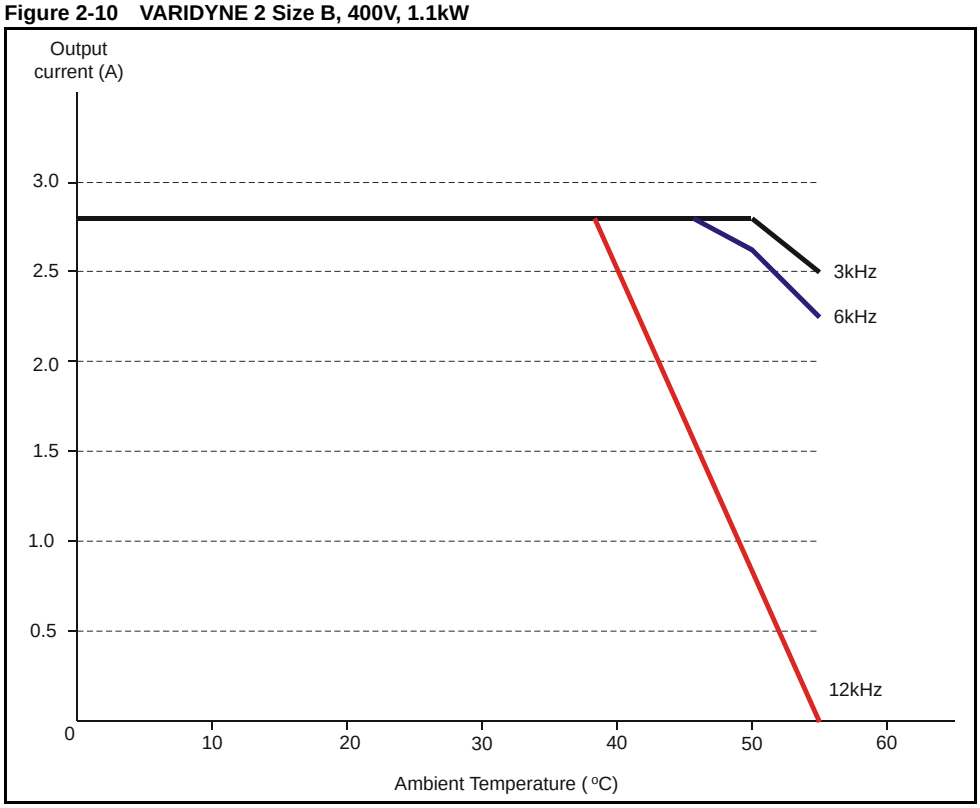
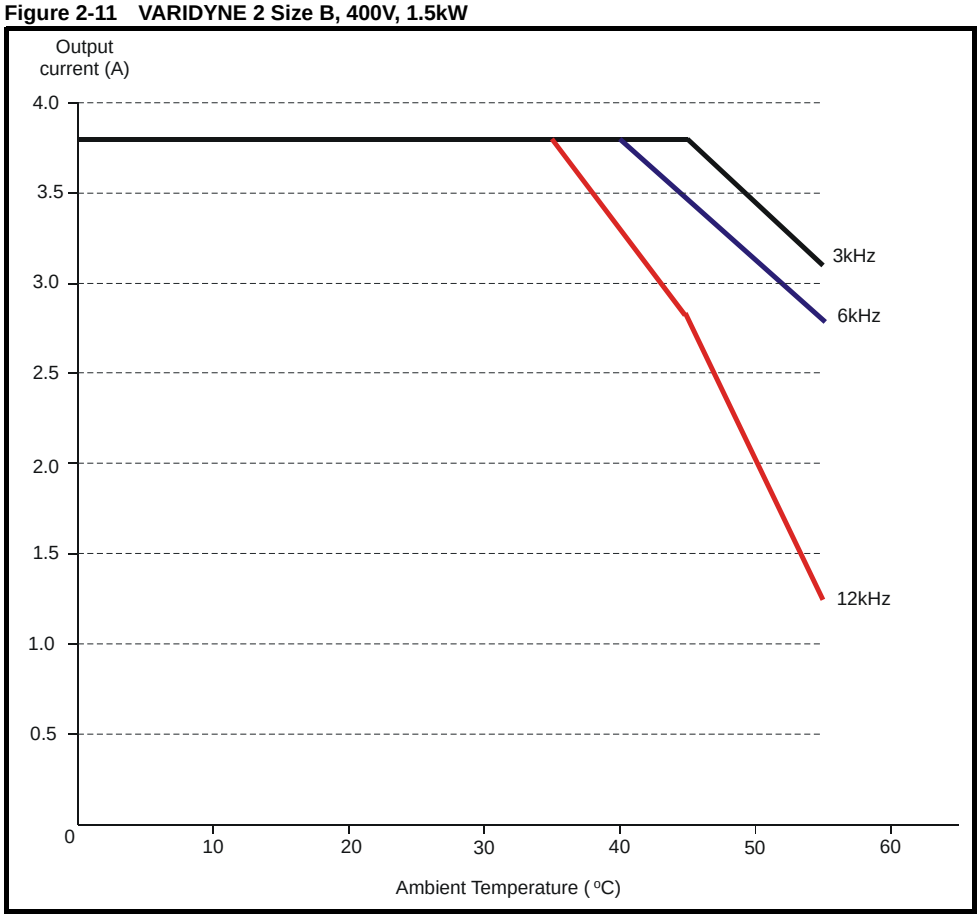


Figure 2-11 VARIDYNE 2 Size B, 400V, 1.5kW



2.2.2 Drive losses

The following tables indicate the total drive losses at the de-rating curve points.

Table 2-5 VARIDYNE 2 Size B, 200V, 1.1kW

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	58	63	73	84
40	58	63	70	78
50	51	55	60	62
55	48	51	54	57

Table 2-6 VARIDYNE 2 Size B, 200V, 1.5kW

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	72	79	85	92
40	72	76	82	80
50	66	69	71	59
55	63	65	57	50

Table 2-7 VARIDYNE 2 Size B, 400V, 0.37kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	24	27	
40	24	21	
50	24		
55	22		

Table 2-8 VARIDYNE 2 Size B, 400V, 0.55kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	27	26	
40	27	21	
50	27		
55	22		

Table 2-9 VARIDYNE 2 Size B, 400V, 0.75kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	31	27	
40	31	21	
50	26		
55	22		

Table 2-10 VARIDYNE 2 Size B, 400V, 1.1kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	43	51	68
40	43	51	62
50	43	49	35
55	40	44	

Table 2-11 VARIDYNE 2 Size B, 400V, 1.5kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	53	65	87
40	53	65	76
50	49	55	55
55	46	51	45

2.3 Size C

2.3.1 Derating curves

Table 2-12 VARIDYNE 2 Size C, 200V, 2.2kW

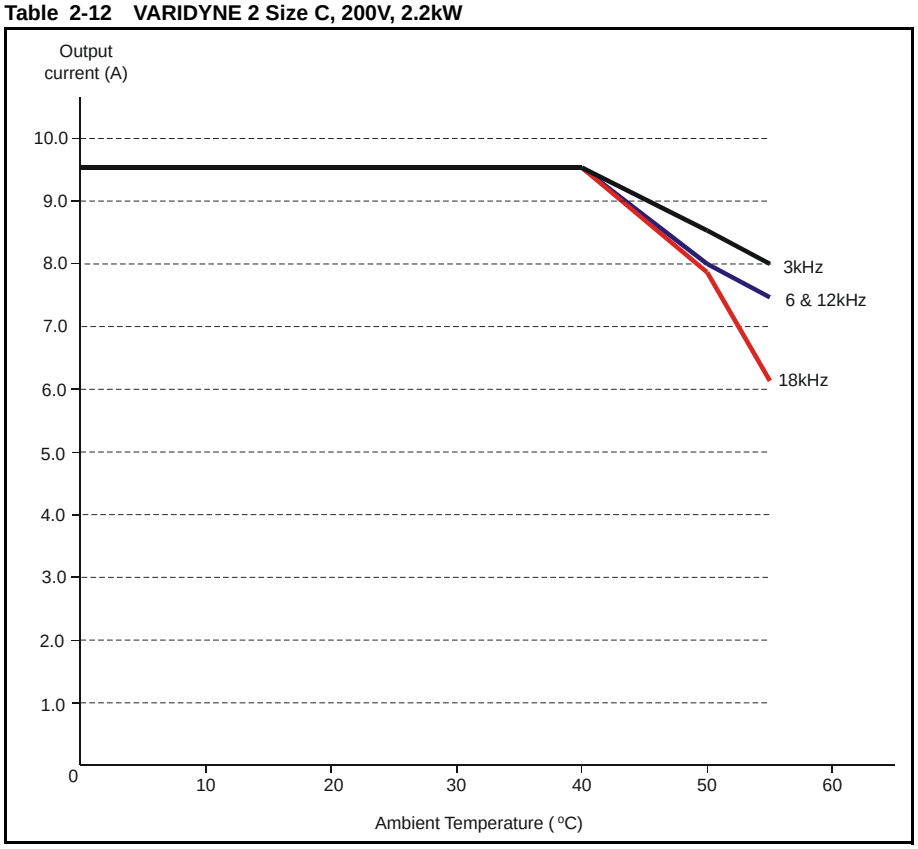


Table 2-13 VARIDYNE 2 Size C, 400V, 2.2kW

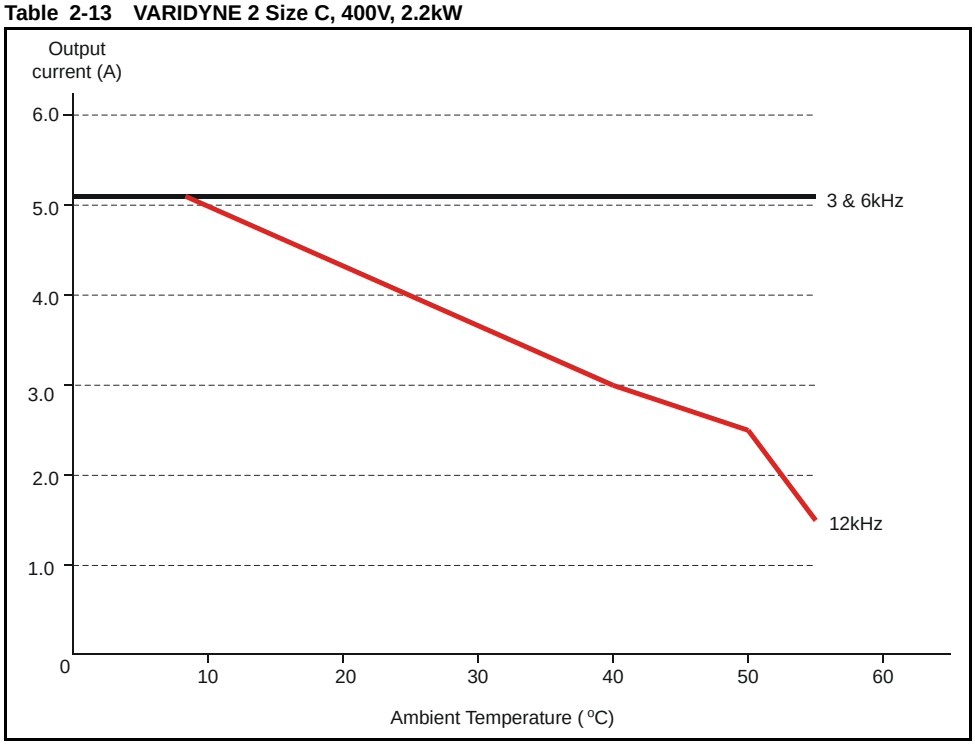


Table 2-14 VARIDYNE 2 Size C, 400V, 3.0kW

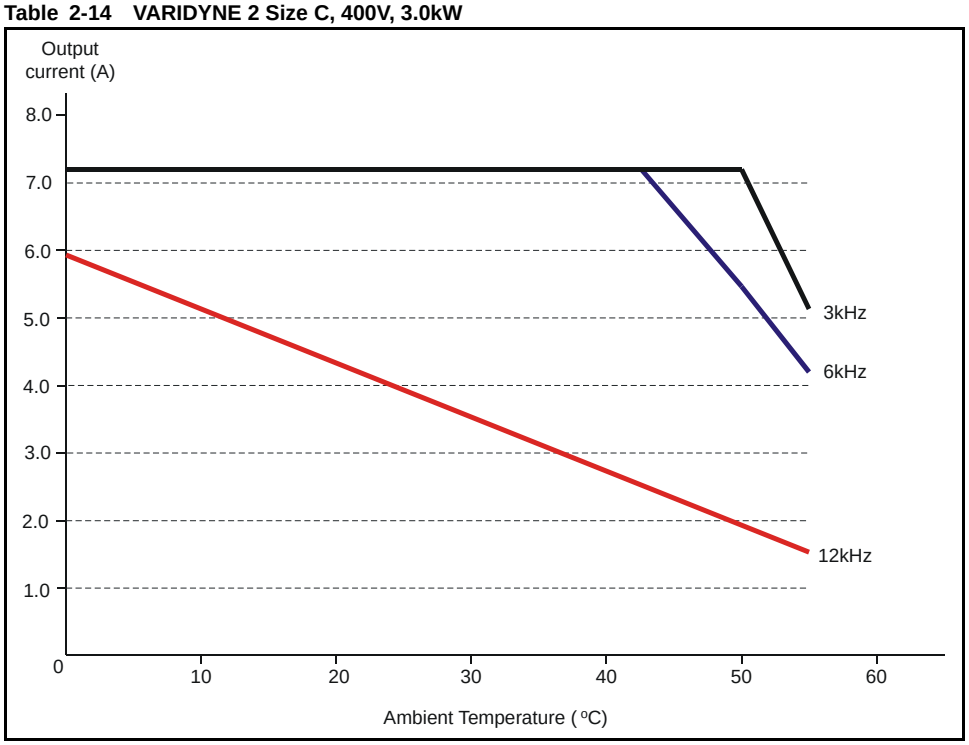
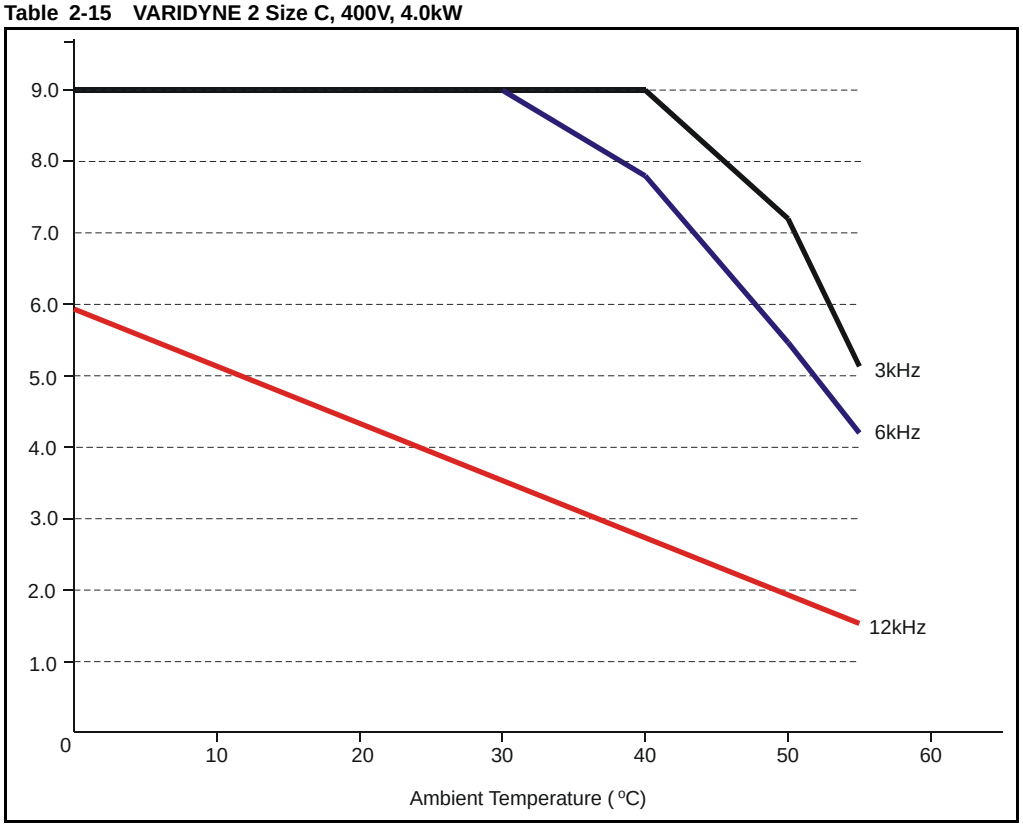


Table 2-15 VARIDYNE 2 Size C, 400V, 4.0kW



2.3.2 Drive losses

Table 2-16 VARIDYNE 2 Size C, 200V, 2.2kW

Ambient Temperature (°C)	Loss (W)			
	3kHz	6kHz	12kHz	18kHz
30	93	107	133	158
40	93	107	133	158
50	84	93	115	133
55	80	88	109	111

Table 2-17 VARIDYNE 2 Size C, 400V, 2.2kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	78	108	118
40	78	108	101
50	78	108	88
55	78	108	60

Table 2-18 VARIDYNE 2 Size C, 400V, 3.0kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	91	117	93
40	91	117	78
50	91	94	62
55	70	77	47

Table 2-19 VARIDYNE 2 Size C, 400V, 4.0kW

Ambient Temperature (°C)	Loss (W)		
	3kHz	6kHz	12kHz
30	116	149	99
40	116	132	84
50	96	100	69
55	75	83	54

2.4 Size 2

2.4.1 Power and current ratings (derating for switching frequency and temperature)

Table 2-20 Maximum permissible continuous output current @ 40ºC (104ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK2201	4.0	5.0	15.5			3.0	3.0	12.6		
VFK2202	5.5	7.5	22.0			4.0	5.0	17.0		
VFK2203	7.5	10	28.0		24.8	5.5	7.5	25.0	24.2	19.6
VFK2401	7.5	10	15.3		12.7	5.5	10	13.0		9.6
VFK2402	11	15	21.0	19.5	12.7	7.5	10	16.5	14.9	9.6
VFK2403	15	20	29.0	23.2	15.0	11	20	25.0	19.9	12.8
VFK2404*	15	20	29.0	26.6	16.5	15	20	29.0	20.5	12.1

Table 2-21 Maximum permissible continuous output current @ 40ºC (104ºF) ambient with IP54 insert and standard fan fitted

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK2201	4.0	5.0	15.5			3.0	3.0	12.6		
VFK2202	5.5	7.5	22.0		18.0	4.0	5.0	17.0		
VFK2203	7.5	10	24.5	22.0	17.9	5.5	7.5	24.2	21.8	17.7
VFK2401	7.5	10	15.3		10.1	5.5	10	13.0		9.4
VFK2402	11	15	20.1	15.6	10.1	7.5	10	16.5	14.9	9.3
VFK2403	15	20	21.7	16.4	10.2	11	20	21.6	16.4	10.2
VFK2404*	15	20	20.1	14.0	7.3	15	20	20.1	14.0	7.3

* See section **** VFK2404 Power and current ratings* on page 12.

Table 2-22 Maximum permissible continuous output current @ 50ºC (122ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK2201	4.0	5.0	15.5		13.5	3.0	3.0	12.6		
VFK2202	5.5	7.5	19.7	17.3	13.5	4.0	5.0	17.0		13.4
VFK2203	7.5	10	19.5	17.2	13.4	5.5	7.5	19.2	17.0	13.3
VFK2401	7.5	10	15.3	11.8	7.3	5.5	10	13.0	11.7	7.3
VFK2402	11	15	15.7	11.8	7.3	7.5	10	15.5	11.7	7.3
VFK2403	15	20	16.8	12.2	7.1	11	20	16.7	12.2	7.1
VFK2404*	15	20	22.3	15.8	8.6	15	20	22.3	14.0	7.3

* See section **** VFK2404 Power and current ratings* on page 12.

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

2.4.2 Drive losses

Table 2-23 Losses @ 40ºC (104ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK2201	4.0	5.0	155	173	210	3.0	3.0	133	150	182
VFK2202	5.5	7.5	210	234	282	4.0	5.0	170	190	229
VFK2203	7.5	10	272	302	320	5.5	7.5	245	263	259
VFK2401	7.5	10	186	234	283	5.5	10	164	206	229
VFK2402	11	15	248	291	283	7.5	10	201	230	229
VFK2403	15	20	313	320	315	11	20	272	279	279
VFK2404	15	20	311	376		15	20	311	301	302

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

Table 2-24 Losses @ 40ºC (104ºF) ambient with IP54 insert and standard fan fitted

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK2201	4.0	5.0	155	173	210	3.0	3.0	133	150	182
VFK2202	5.5	7.5	210	234	237	4.0	5.0	170	190	229
VFK2203	7.5	10	237			5.5	7.5	237		
VFK2401	7.5	10	186	234	237	5.5	10	164	206	226
VFK2402	11	15	237			7.5	10	201	230	224
VFK2403	15	20	237			11	20	237		
VFK2404	15	20	225			15	20	225		

Table 2-25 Losses @ 50ºC (122ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK2201	4.0	5.0	155	173	190	3.0	3.0	133	150	182
VFK2202	5.5	7.5	190			4.0	5.0	170	190	
VFK2203	7.5	10	190			5.5	7.5	190		
VFK2401	7.5	10	186	190		5.5	10	164	190	
VFK2402	11	15	190			7.5	10	190		
VFK2403	15	20	190			11	20	190		
VFK2404	15	20	245			15	20	245		

2.5 Size 3

2.5.1 Power and current ratings (derating for switching frequency and temperature)

Table 2-26 Maximum permissible continuous output current @ 40ºC (104ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK3201	11	15	42.0			7.5	10	31.0		
VFK3202	15	20	54.0		48.5	11	15	42.0		41.3
VFK3401	18.5	25	35.0		26.3	15	25	32.0		22.0
VFK3402	22	30	43.0		28.6	18.5	30	40.0	38.3	24.5
VFK3403	30	40	56.0	44.6	28.6	22	30	46.0	38.3	24.4
VFK3501	3.0	3.0	5.4			2.2	2.0	4.1		
VFK3502	4.0	5.0	6.1			3.0	3.0	5.4		
VFK3503	5.5	7.5	8.4			4.0	5.0	6.1		
VFK3504	7.5	10	11.0			5.5	7.5	9.5		
VFK3505	7.5	10	11.0			5.5	7.5	9.5		
VFK3506	15	20	22.0	18.2		11	15	18.0		
VFK3507	18.5	25	27.0	21.6		15	20	22.0	18.4	

Table 2-27 Maximum permissible continuous output current @ 50ºC (122ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK3201	11	15	42.0		38.2	7.5	10	31.0		
VFK3202	15	20	54.0	52.8	38.2	11	15	42.0		37.2
VFK3401	18.5	25	35.0	33.5	21.5	15	25	32.0	30.7	19.7
VFK3402	22	30	43.0	34.2	21.0	18.5	30	40.0	34.1	20.7
VFK3403	30	40	46.0	34.2	21.0	22	30	46.0	33.6	20.8
VFK3501	3.0	3.0	5.4			2.2	2.0	4.1		
VFK3502	4.0	5.0	6.1			3.0	3.0	5.4		
VFK3503	5.5	7.5	8.4			4.0	5.0	6.1		
VFK3504	7.5	10	11.0			5.5	7.5	9.5		
VFK3505	7.5	10	16.0			5.5	7.5	12.0		
VFK3506	15	20	22.0	17.8		11	15	18.0	16.8	
VFK3507	18.5	25	24.6	17.8		15	20	22.0	16.7	

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

2.5.2 Drive losses

Table 2-28 Losses @ 40ºC (104ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK3201	11	15	331	380	477	7.5	10	260	297	370
VFK3202	15	20	431	492	551	11	15	349	398	486
VFK3401	18.5	25	364	449	477	15	25	337	415	408
VFK3402	22	30	437	540	514	18.5	30	411	485	452
VFK3403	30	40	567	552	510	22	30	474	485	452
VFK3501	3.0	3.0	127	168		2.2	2.0	112	148	
VFK3502	4.0	5.0	135	180		3.0	3.0	127	168	
VFK3503	5.5	7.5	163	218		4.0	5.0	135	180	
VFK3504	7.5	10	197	263		5.5	7.5	178	237	
VFK3505	7.5	10	267	354		5.5	7.5	212	281	
VFK3506	15	20	362	475		11	15	300	396	
VFK3507	18.5	25	448	477		15	20	365	406	

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

Table 2-29 Losses @ 50ºC (122ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK3201	11	15	331	380	436	7.5	10	260	297	370
VFK3202	15	20	431	480	439	11	15	349	398	439
VFK3401	18.5	25	364	430	399	15	25	337	399	373
VFK3402	22	30	437	435	399	18.5	30	411	435	396
VFK3403	30	40	474	429	397	22	30	474	429	397
VFK3501	3.0	3.0	127	168		2.2	2.0	112	148	
VFK3502	4.0	5.0	135	180		3.0	3.0	127	168	
VFK3503	5.5	7.5	163	218		4.0	5.0	135	180	
VFK3504	7.5	10	197	263		5.5	7.5	178	237	
VFK3505	7.5	10	267	354		5.5	7.5	212	281	
VFK3506	15	20	362	390		11	15	300	372	
VFK3507	18.5	25	405	390		15	20	365	369	

2.6 Size 4

2.6.1 Power and current ratings (derating for switching frequency and temperature)

Table 2-30 Maximum permissible continuous output current @ 40ºC (104ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK4201	18.5	25	68.0			15	20	56.0		
VFK4202	22	30	80.0			18.5	25	68.0		
VFK4203	30	40	104			22	30	80.0		
VFK4401	37	50	68.0			30	50	60.0	51.9	
VFK4402	45	60	83.0	74.0		37	60	74.0	50.9	
VFK4403	55	75	104	95.1		45	75	96.0	66.6	
VFK4601	18.5	25	22.0			15	20	19.0		
VFK4602	22	30	27.0			18.5	25	22.0		
VFK4603	30	40	36.0			22	30	27.0		
VFK4604	37	50	43.0	41.3		30	40	36.0		
VFK4605	45	60	52.0	41.2		37	50	43.0	41.3	
VFK4606	55	75	62.0	48.4		45	60	52.0	44.7	

Table 2-31 Maximum permissible continuous output current @ 50ºC (122ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK4201	18.5	25	68.0			15	20	56.0		
VFK4202	22	30	80.0			18.5	25	68.0		
VFK4203	30	40	87.4			22	30	80.0		
VFK4401	37	50	68.0	66.8		30	50	60.0	46.7	
VFK4402	45	60	83.0	66.5		37	60	68.2	46.0	
VFK4403	55	75	86.5	71.3		45	75	86.5	60.1	
VFK4601	18.5	25	22.0			15	20	19.0		
VFK4602	22	30	27.0			18.5	25	22.0		
VFK4603	30	40	36.0	30.7		22	30	27.0		
VFK4604	37	50	43.0	30.7		30	40	36.0	30.7	
VFK4605	45	60	45.6	30.7		37	50	43.0	30.7	
VFK4606	55	75	51.9	34.7		45	60	51.9	34.7	

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

2.6.2 Drive losses

Table 2-32 Losses @ 40ºC (104ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK4201	18.5	25	517	589		15	20	428	488	
VFK4202	22	30	611	694		18.5	25	517	589	
VFK4203	30	40	810	916		22	30	611	694	
VFK4401	37	50	714	914		30	50	629	704	
VFK4402	45	60	882	995		37	60	780	690	
VFK4403	55	75	1070	1217		45	75	976	854	
VFK4601	18.5	25	409	590		15	20	360	519	
VFK4602	22	30	496	712		18.5	25	409	590	
VFK4603	30	40	660	941		22	30	496	712	
VFK4604	37	50	798	1083		30	40	660	941	
VFK4605	45	60	985	1080		37	50	798	1083	
VFK4606	55	75	1060	1130		45	60	873	1042	

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

Table 2-33 Losses @ 50ºC (122ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK4201	18.5	25	517	589		15	20	428	488	
VFK4202	22	30	611	694		18.5	25	517	589	
VFK4203	30	40	671	761		22	30	611	694	
VFK4401	37	50	714	898		30	50	629	638	
VFK4402	45	60	882	894		37	60	716	629	
VFK4403	55	75	877	912		45	75	876	775	
VFK4601	18.5	25	409	590		15	20	360	519	
VFK4602	22	30	496	712		18.5	25	409	590	
VFK4603	30	40	660	805		22	30	496	712	
VFK4604	37	50	798	805		30	40	660	805	
VFK4605	45	60	850	805		37	50	798	805	
VFK4606	55	75	871	816		45	60	871	816	

2.7 Size 5

2.7.1 Power and current ratings (derating for switching frequency and temperature)

Table 2-34 Maximum permissible continuous output current @ 40ºC (104ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK5401	75	100	138	118		55	100	124	82.4	
VFK5402	90	125	168	129		75	125	156	109	
VFK5601	75	100	84			55	75	63		
VFK5602	90	125	99			75	100	85		

Table 2-35 Maximum permissible continuous output current @ 50ºC (122ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK5401	75	100	138	105.9		55	100	112.7	74.5	
VFK5402	90	125	141	112		75	125	140	99.0	
VFK5601	75	100				55	75			
VFK5602	90	125				75	100			

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

2.7.2 Drive losses

Table 2-36 Losses @ 40ºC (104ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK5401	75	100	1471	1640		55	100	1311	1150	
VFK5402	90	125	1830	1781		75	125	1681	1508	
VFK5601	75	100				55	75			
VFK5602	90	125				75	100			

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

Table 2-37 Losses @ 50ºC (122ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK5401	75	100	1471	1462		55	100	1186	1047	
VFK5402	90	125	1500	1543		75	125	1500	1366	
VFK5601	75	100				55	75			
VFK5602	90	125				75	100			

2.8 Size 6

2.8.1 Power and current ratings (derating for switching frequency and temperature)

Table 2-38 Maximum permissible continuous output current @ 40ºC (104ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK6401	110	150	202	164.1		90	150	180	134.5	
VFK6402	132	200	236	157.7		110	150	210	129.7	
VFK6601	110	150	125			90	125	100		
VFK6602	132	175	144			110	150	125		

Table 2-39 Maximum permissible continuous output current @ 50ºC (122ºF) ambient for wall mounted drives

Model	Normal Duty					Heavy Duty				
	Nominal rating		Maximum continuous output current (A) @ each switching frequency			Nominal rating		Maximum continuous output current (A) @ each switching frequency		
	kW	hp	3kHz	6kHz	12kHz	KW	hp	3kHz	6kHz	12kHz
VFK6401	110	150	191.5	147.6		90	150	180	121.5	
VFK6402	132	200	198.4	138.1		110	150	190	116.2	
VFK6601	110	150				90	125			
VFK6602	132	175				110	150			

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

2.8.2 Drive losses

Table 2-40 Losses @ 40ºC (104ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK6401	110	150	2058	2153		90	150	1817	1772	
VFK6402	132	200	2477	2255		110	150	2192	1888	
VFK6601	110	150				90	125			
VFK6602	132	175				110	150			

NOTE

For the definition of ambient temperature, see section 5.4.4 *Cubicle design and drive ambient temperature* on page 63.

Table 2-41 Losses @ 50ºC (122ºF) ambient for wall mounted drives

Model	Drive losses (W) taking into consideration any current derating for the given conditions									
	Normal Duty					Heavy Duty				
	Nominal rating		3kHz	6kHz	12kHz	Nominal rating		3kHz	6kHz	12kHz
	kW	hp				kW	hp			
VFK6401	110	150	1942	1939		90	150	1817	1610	
VFK6402	132	200	2068	1997		110	150	1979	1715	
VFK6601	110	150				90	125			
VFK6602	132	175				110	150			

For through-panel mounting losses see Table 5-3 on page 53.

2.9 Derating with glanding box and Cover kit (size A to C only)

Table 2-42 Size A derating with glanding box and Cover kit fitted to drive

Model	Output current
VFKA1200037	1.7A
VFKA1200055	2.2A
VFKA1200075	3.0A

For sizes B and C there is no derating due to forced ventilation from fan.

3 Drive voltage levels

Condition	110V drives	200V drives	400V drives	575V drives	690V drives
OV trip level	415 Vdc	415 Vdc	830 Vdc	990 Vdc	1190 Vdc
Braking level	390 Vdc	390 Vdc	780 Vdc	930 Vdc	1120Vdc
Rated upper level (AC mains +10% x 1.4142)	373 Vdc	373 Vdc	747 Vdc	895 Vdc	1073 Vdc
Rated lower level (AC mains -10% x 1.4142)	255 Vdc	255 Vdc	484 Vdc	636 Vdc	636 Vdc
*UV reset level	215 Vdc	215 Vdc	425 Vdc	590 Vdc	590 Vdc
UV trip level	175 Vdc	175 Vdc	330 Vdc	435 Vdc	435 Vdc
Standard ramp voltage	375 Vdc	375 Vdc	Eur: 750 Vdc USA: 775 Vdc	895 Vdc	1075 Vdc

* These are the absolute minimum DC voltages that the drive can be supplied with. If the drive is not supplied with at least this voltage, it will not reset out of a UV trip at power up.

Output frequency: 0 to 1500Hz

Output voltage: 3 phase, 0 to drive rating (240, 480, 575 or 690 Vac maximum set by Pr **08**).

Low DC bus operation (Pr 6.10)

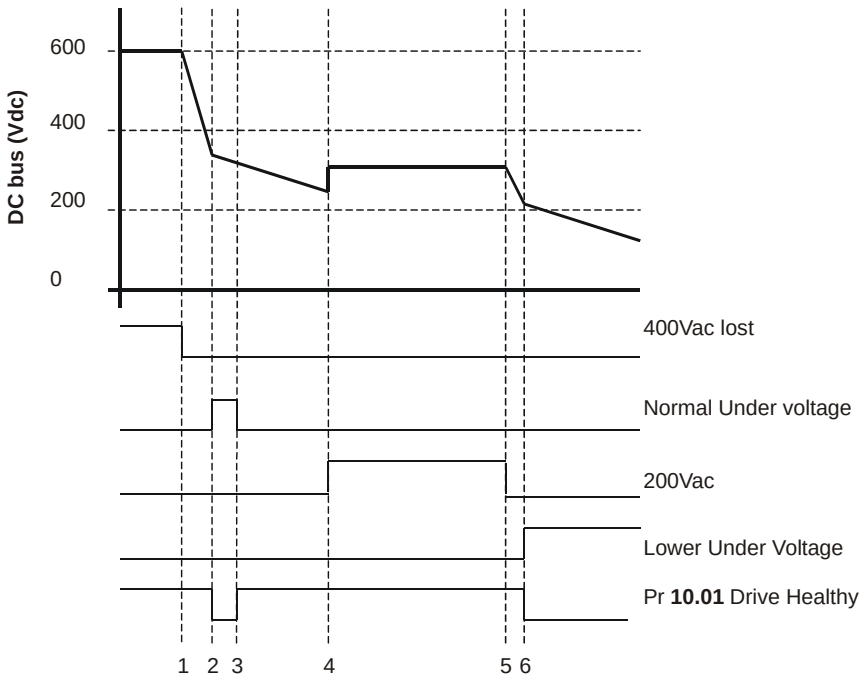
0 Low DC bus operation disabled
1 Low DC bus operation enabled

The Low DC bus operation is designed to enable 3 phase 400VAC (medium voltage) VARIDYNE 2's to be run off a single phase 200VAC (low voltage) supply in the event of a primary 400VAC supply failure.

When the primary supply fails, the back up supply can be switched in. This will allow the drive to control the motor at a reduced power, for example to move an elevator up or down to the next floor.

There is no de-rating as such when low DC bus operation is enabled however the power will be limited by the reduced voltage and ripple generated on the DC bus of the drive.

Figure 3-1 Low DC bus operation



1. The mains AC supply is removed.
2. The drive trips UV. Power down parameters are saved.
3. After the down parameters are saved, the UV trip is cleared. Drive will operate normally with the lower UV level set.
4. Back-up AC supply is applied
5. Back-up AC supply is removed
6. Drive trips UV. Power down parameters are not saved.

Note: If the DC voltage is greater than 425Vdc after 3, the UV level will return to normal.

NOTE

This function is only available on sizes B and C.

When Pr **6.10** is enabled and the DC bus voltage is less than 330VDC, the drives display will flash LoAC (Low AC) to indicate that it is running off the low voltage back up supply.

NOTE

This mode is designed for use with a backup power supply and not for using a 400VAC (medium voltage) VARIDYNE 2 in a 200VAC (low voltage) application. As shown in the above diagram, the drives power down save parameters are saved at point 2. If the drive was to be used on a 200VAC supply, the DC bus will never fall through point 2 and power down save parameters will not be saved.

Low DC bus operation voltage levels (Pr 6.10 enabled)

>425Vdc - normal operation
<330Vdc - LoAC operation
<230Vdc - UV trip

3.1 Input voltage

3.1.1 Single phase

100V to 120V ±10%

48Hz to 62Hz

or:

200V to 240V ±10%

48Hz to 62Hz

3.1.2 Three phase 200V

200V to 240V ±10%

48Hz to 62Hz (48Hz to 65Hz for size 2 to 6)

Phase imbalance 3% (between phases) or 2% negative phase sequence (IEC 146-1-1 Immunity class C)

3.1.3 Three phase 400V

380V to 480V ±10%

48Hz to 62Hz (48Hz to 65Hz for size 2 to 6)

Phase imbalance 3% (between phases) or 2% negative phase sequence (IEC 146-1-1 Immunity class C)

It is possible to run the drives on lower supply voltages than those specified above (up to -20%) but only with de-rating of the product. Running a 400V product on a 230V single phase supply (at a very much reduced output power) is possible on frame sizes B & C.

3.1.4 Three phase 575V

500V to 575V ±10%

48Hz to 65Hz

3.1.5 Three phase 690V

500V to 690V ±10%

48Hz to 65Hz

On products without a DC bus choke (up to 4kW), the maximum supply capacity connected to the drive without using external line chokes will be 5kA short circuit current.

Detailing the maximum output capability for Unidrive SP when supplied from a single phase power source.

3.2 Single phase ratings (size 2 and 3)

See Table 3-1 for the single phase supply capability of VARIDYNE 2.

NOTE

The supply should be connected between L1 and L2.

The single phase supply should have the same RMS voltage as the line to line RMS voltage that the drive is designed for. Minimum and maximum voltages are the same as for 3 phase operation.

With a single-phase supply the drive power rating is considerably reduced in comparison with the normal case. The output current capability is not reduced. There are two possible modes of operation:

1. Motor matched to the drive power capability. In this case the motor can deliver its full rated torque at any speed up to base speed, but this is less than the drive capability at reduced speed. Table 3-1 shows the power and current ratings for a suitable motor.
2. Motor run with restricted power. In this case the motor may have any current rating up to the normal output current rating of the drive. The available torque will be reduced at higher speeds in order to avoid exceeding the power restriction. Table 3-1 shows the power ratings for a suitable motor. The current rating should be selected to suit the required maximum torque at low speed.

The current and power ratings given are for continuous operation.

A PH trip would result if the limits are exceeded.

Continuous operation at output currents above the values given will result in the drive tripping OHT3.

Drive rated output power is given for 220V, 400V and 525V supplies.

Values have been derived from extensive calculations and take into account capacitor ripple current and life time, rectifier peak and RMS current and supply RMS current.

Supply fuses and cable sizes need to be the same value as specified for the drive operating with a 3 phase supply at normal rated power. This is because with a single phase supply the RMS supply current is much greater for the same output power.

There is no further derating due to switching frequency as it is the input stage and DC bus components which derate the drive.

Table 3-1 Single phase ratings (size 2 and 3)

Drive type	Corresponding motor rated current (A)	Drive rated output power (kW)
VFK2201	11.6	3.5
VFK2202	11.6	3.5
VFK2203	11.6	3.5
VFK3201	28.4	8.5
VFK3202	28.4	8.5
VFK2401	6.6	3.4
VFK2402	6.6	3.4
VFK2403	6.6	3.4
VFK3401	11.4	5.9
VFK3402	11.4	5.9
VFK3403	11.4	5.9
VFK3501	5.4	3.7
VFK3502	6.1	4.2
VFK3503	8.4	5.7
VFK3504	11.0	7.5
VFK3505	12.0	8.2
VFK3506	12.0	8.2
VFK3507	12.0	8.2

4 DC bus design

4.1 VARIDYNE 2 size A to C

Table 4-1 VARIDYNE 2 200V units DC bus data

Model	DC Bus Capacitance μF	DC bus inductance mH	Inrush resistance at 25°C Ω	Peak inrush current A
VFKA1200025	330		22	17.0
VFKA1200037	390		22	17.0
VFKA1200055	660		22	17.0
VFKA1200075	780		22	17.0
VFKBD200110	940		13.6	27.4
VFKBD200150	1410		13.6	27.4
VFKCD200220	1880		20.4	18.3

Table 4-2 VARIDYNE 2 400V units DC bus data

Model	DC Bus Capacitance μF	DC bus inductance mH	Inrush resistance at 25°C Ω	Peak inrush current A
VFKB3400037	165		44	17.0
VFKB3400055	165		44	17.0
VFKB3400075	165		44	17.0
VFKB3400110	195		44	17.0
VFKB3400150	235		44	17.0
VFKC3400220	470		66	11.3
VFKC3400300	470		66	11.3
VFKC3400400	470		66	11.3

4.2 VARIDYNE 2 size 2 to 6

Table 4-3 VARIDYNE 2 size 2 DC bus data

Model	DC Bus Capacitance μF	DC Bus Inductance mH	Peak inrush current A
VFK2201	2820	1.4	12
VFK2202	2820	1.4	
VFK2203	2820	1.4	
VFK2401	705	1.4	24
VFK2402	705	1.4	
VFK2403	705	1.4	
VFK2404	705	1.4	

Table 4-4 VARIDYNE 2 Size 3 DC bus data

Model	DC Bus Capacitance μF	DC Bus Inductance mH	Peak inrush current A
VFK3201	5400	0.7	8
VFK3202	5400	0.7	
VFK3401	1350	0.7	14
VFK3402	1350	0.7	
VFK3403	1350	0.7	
VFK3501	1000	4	18
VFK3502	1000	4	
VFK3503	1000	4	
VFK3504	1000	4	
VFK3505	1000	4	
VFK3506	1000	4	
VFK3507	1000	4	

Table 4-5 VARIDYNE 2 size 4 DC bus data

Model	DC Bus Capacitance μF	DC Bus Inductance mH	Peak inrush current A
VFK4201	4400	0.211	73
VFK4202	4400	0.211	
VFK4203	4400	0.211	
VFK4401	1100	0.85	37
VFK4402	2200	0.423	73
VFK4403	2200	0.423	
VFK4601	733	1.27	35
VFK4602	733	1.27	
VFK4603	733	1.27	
VFK4604	733	1.27	
VFK4605	733	1.27	
VFK4606	733	1.27	

VARIDYNE 2 size 5 and 6 use AC line chokes instead of DC bus chokes

Table 4-6 VARIDYNE 2 size 5 DC bus data

Model	DC Bus Capacitance μF	AC line Inductance per phase (mH)	Peak inrush current A
VFK5401	3300	0.150	110
VFK5402	3300	0.150	
VFK5601	1467	0.470	70
VFK5602	1467	0.470	

Table 4-7 VARIDYNE 2 size 6 DC bus data

Model	DC Bus Capacitance μF	AC line Inductance per phase (mH)	Peak inrush current A
VFK6401	4400	0.054	
VFK6402	5500	0.054	
VFK6601	2200	0.313	
VFK6602	2200	0.313	

NOTE

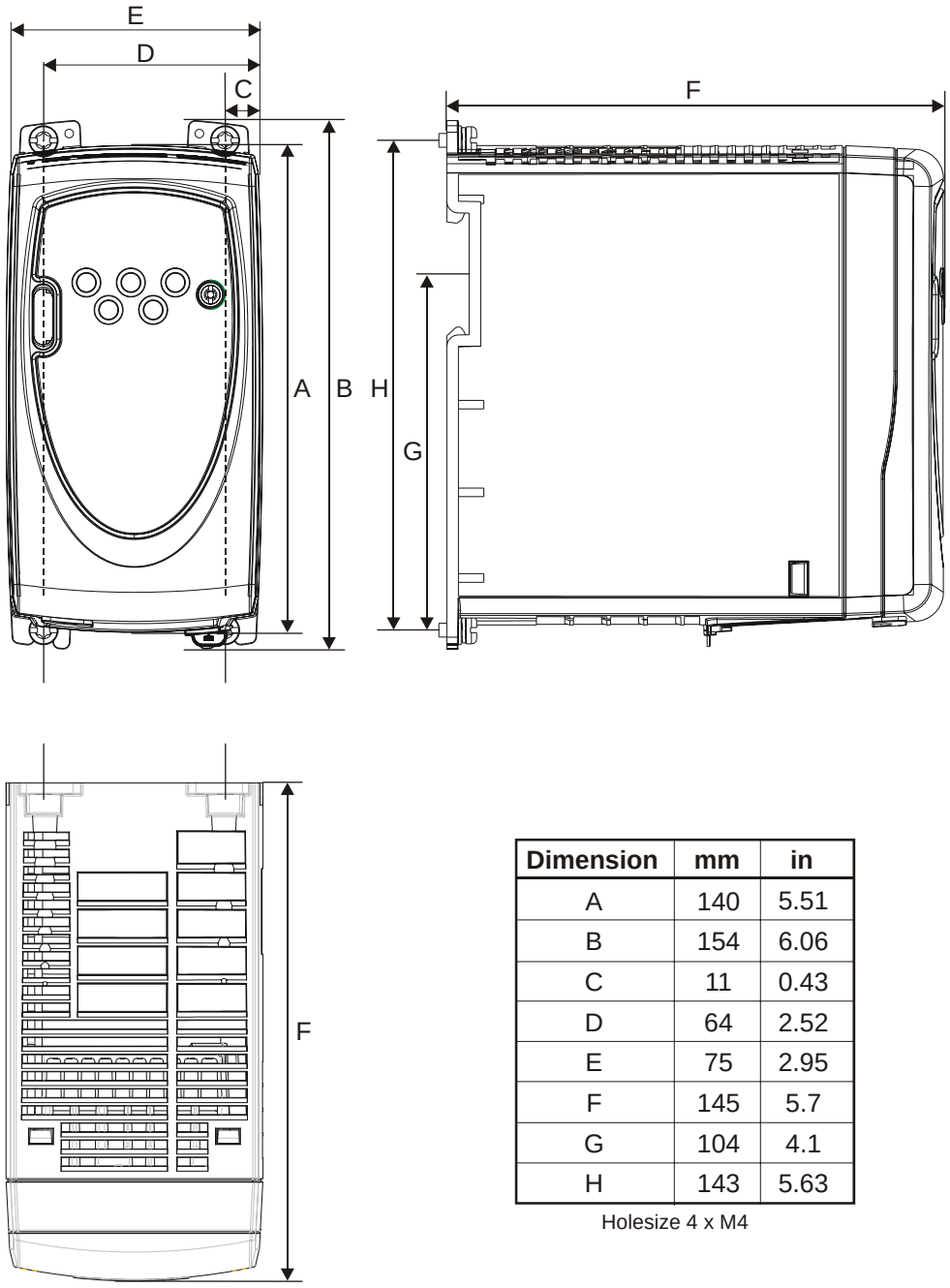
The inrush current for all drives after a brown-out can be larger than the power-up inrush.

5 Mechanical installation

5.1 VARIDYNE 2 size A to C

5.1.1 Mechanical dimensions

Figure 5-1 Size A mounting dimensions



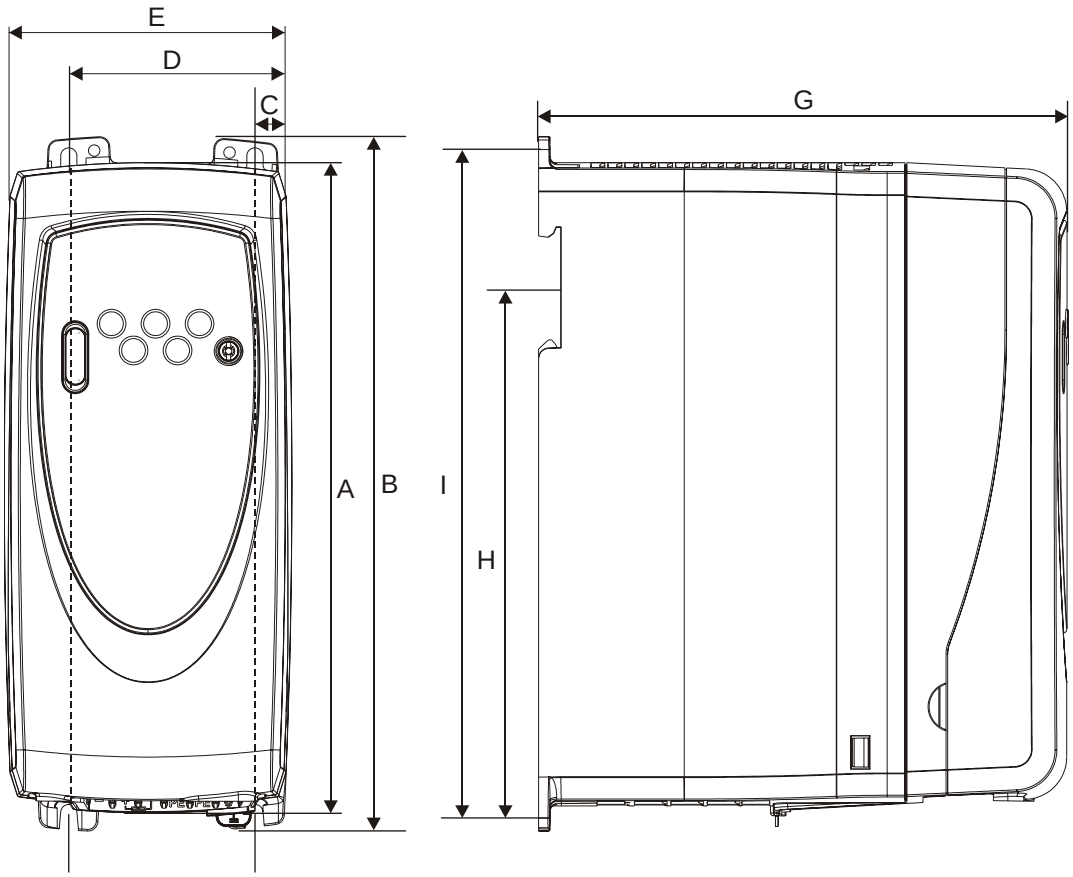
Dimension	mm	in
A	140	5.51
B	154	6.06
C	11	0.43
D	64	2.52
E	75	2.95
F	145	5.7
G	104	4.1
H	143	5.63

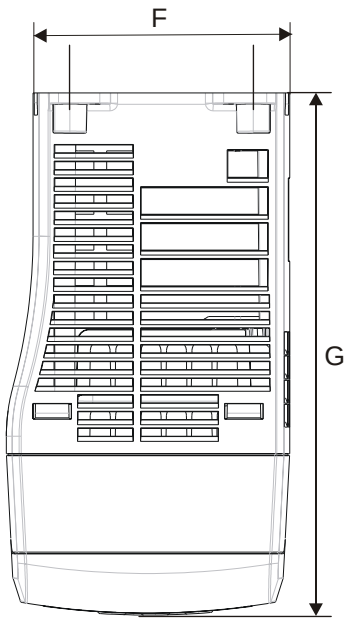
Holesize 4 x M4

NOTE

If DIN rail mounting is used in an installation where the drive is to be subjected to shock or vibration, it is recommended that the bottom mounting screws are used to secure the drive to the back plate. If the installation is going to be subjected to heavy shock and vibration, then it is recommended that the drive is surface mounted rather than DIN rail mounted

Figure 5-2 Size B mounting dimensions





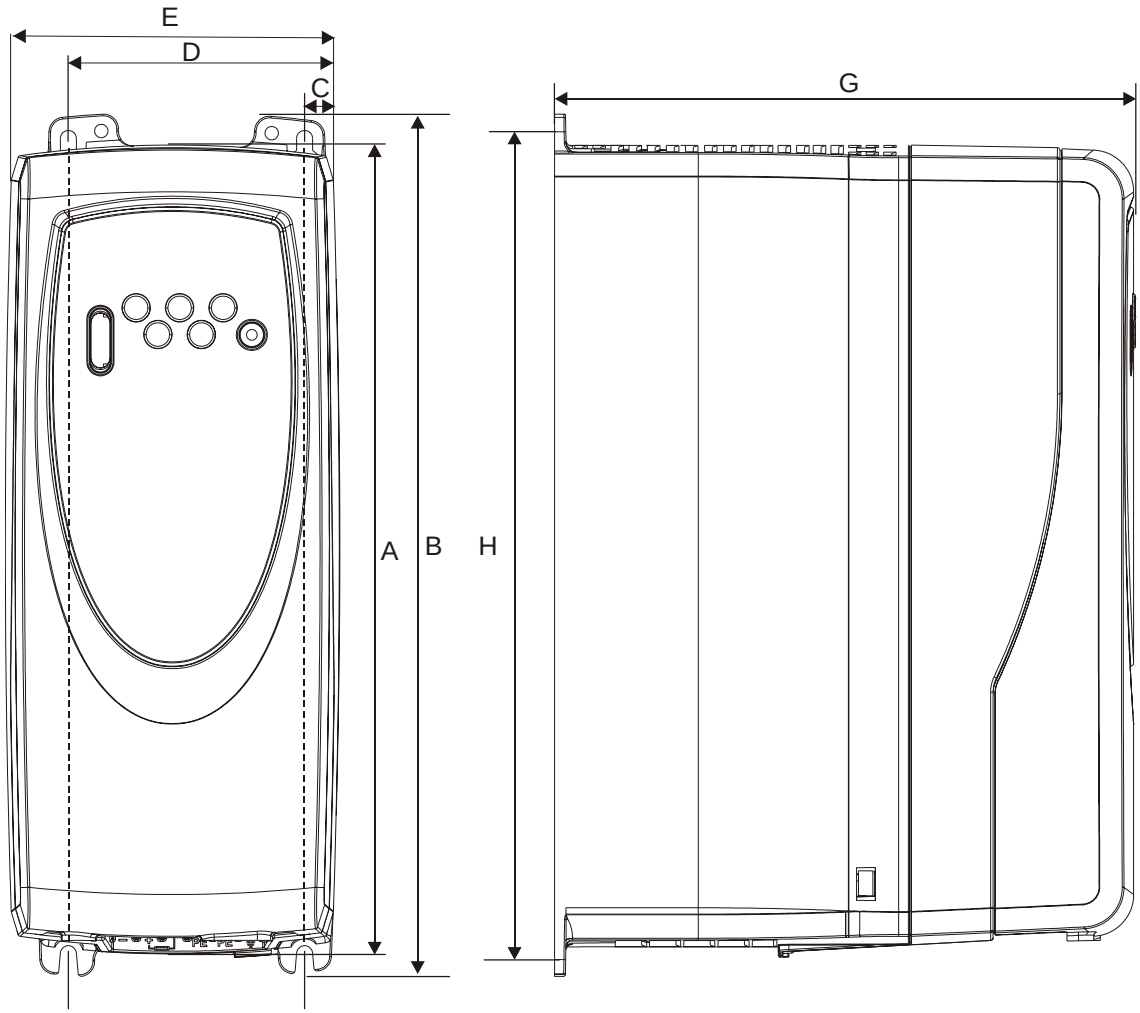
Dimension	mm	in
A	190	7.48
B	205	8.07
C	10.9	0.43
D	65.9	2.6
E	85	3.35
F	77	3
G	156	6.15
H	155.5	6.1
I	194	7.64

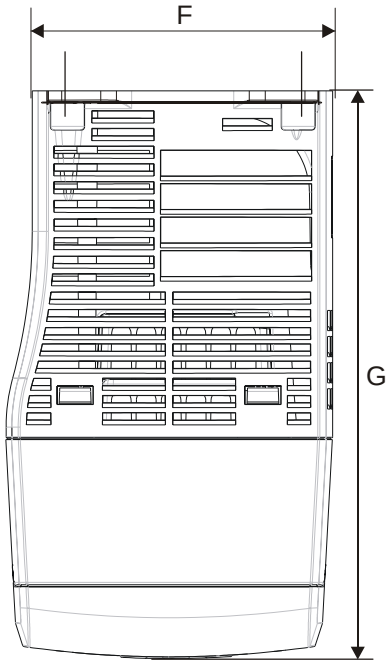
Holesize 4 x M4

NOTE

If DIN rail mounting is used in an installation where the drive is to be subjected to shock or vibration, it is recommended that the bottom mounting screws are used to secure the drive to the back plate. If the installation is going to be subjected to heavy shock and vibration, then it is recommended that the drive is surface mounted rather than DIN rail mounted

Figure 5-3 Size C mounting dimensions





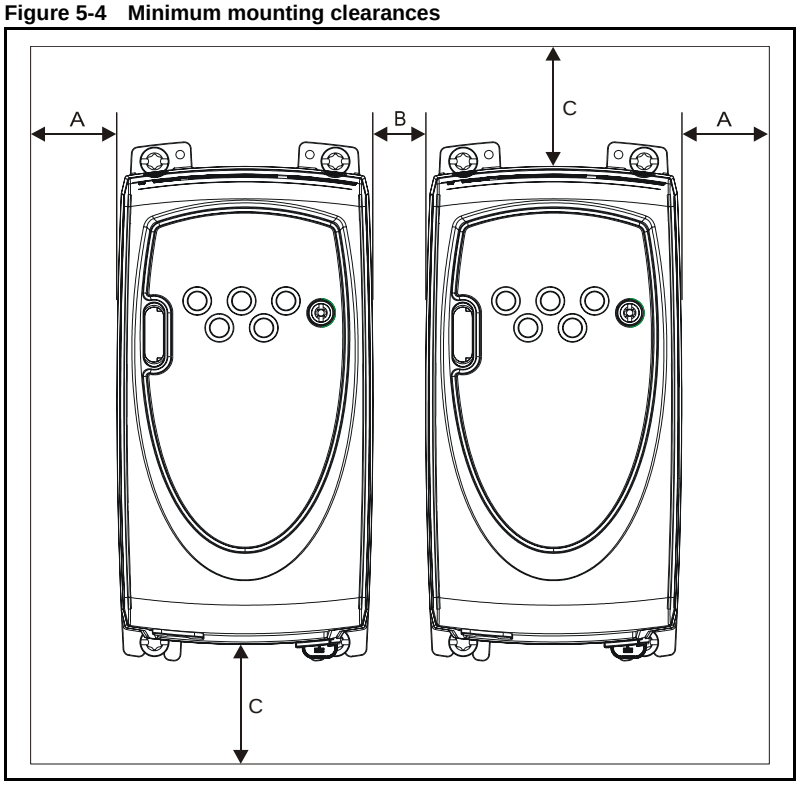
Dimension	mm	in
A	240	9.45
B	258	10.16
C	10.4	0.41
D	81.1	3.2
E	100	3.94
F	91.9	3.62
G	173	6.8
H	244	9.61

Holesize 4 x M4

Size C is not DIN rail mountable.

5.1.2 Minimum mounting clearances

Figure 5-4 Minimum mounting clearances



Drive size	A		B		C	
	mm	in	mm	in	mm	in
A	10	0.39	0	0	100	3.94
B (≤0.75kW)			10*	0.39*		
B (≥1.1kW)			0	0		
C			50*	1.97*		

*This is the minimum spacing between drives measured at the base of the drives where it is mounted against a back plate/flat surface.

5.2 VARIDYNE 2 size 2 to 6

5.2.1 Mounting methods

The VARIDYNE 2 size 2 to 6 can be either surface or through-panel mounted using the appropriate brackets.

The following drawings show the dimensions of the drive and mounting holes for each method to allow the back plate to be prepared.

WARNING

If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70°C (158°F). Human contact with the heatsink should be prevented.

Surface mounting

Figure 5-5 Surface mounting the size 2 drive

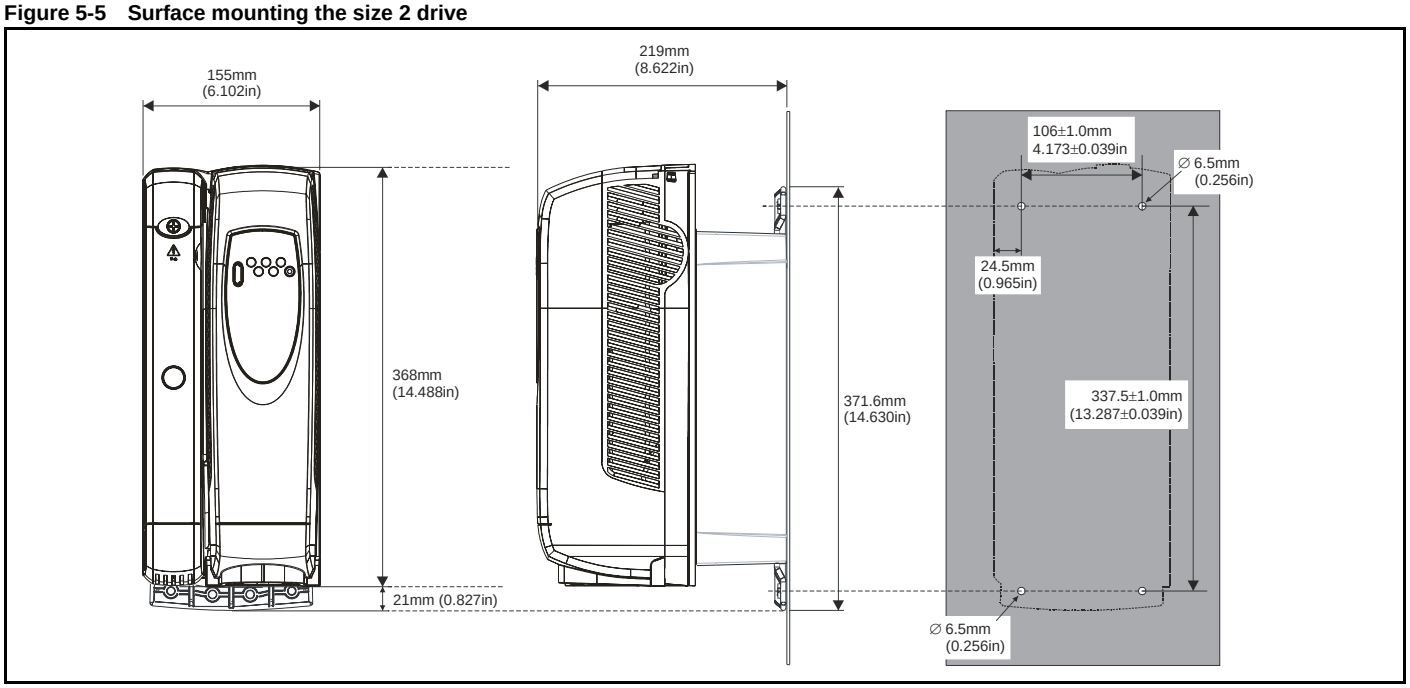


Figure 5-6 Surface mounting the size 3 drive

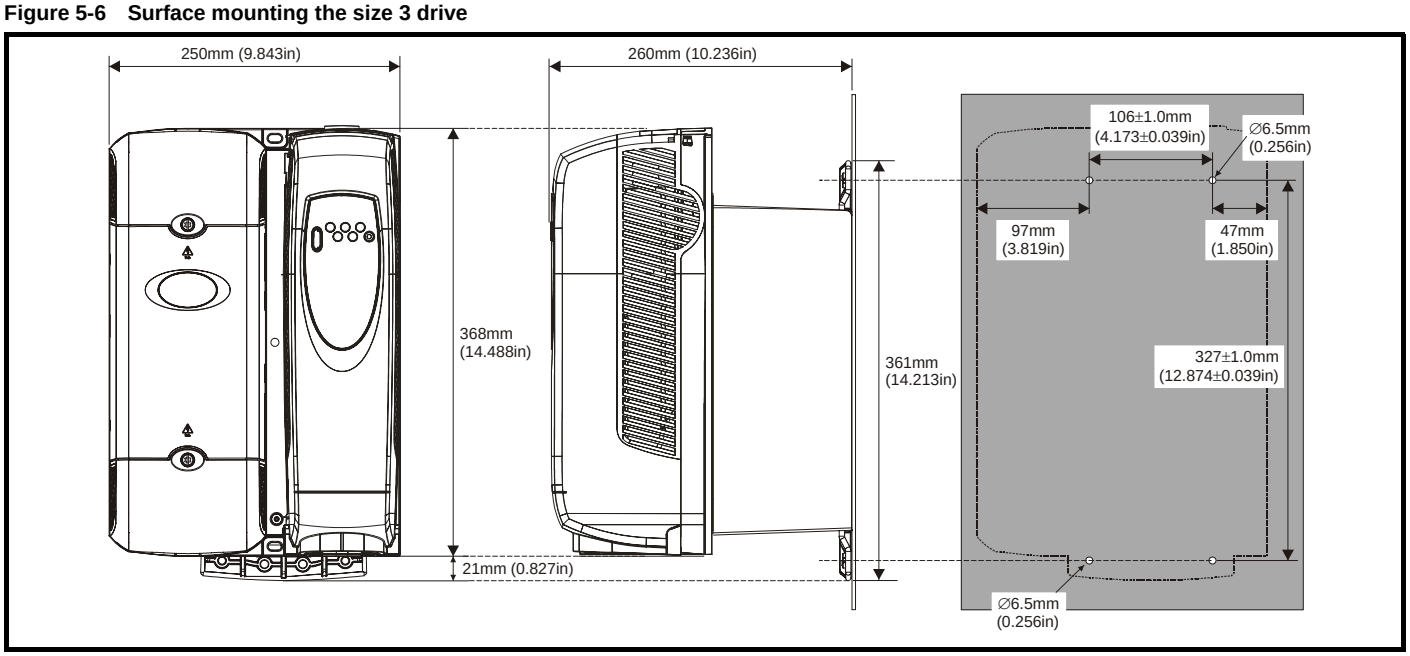


Figure 5-7 Surface mounting the size 4 drive

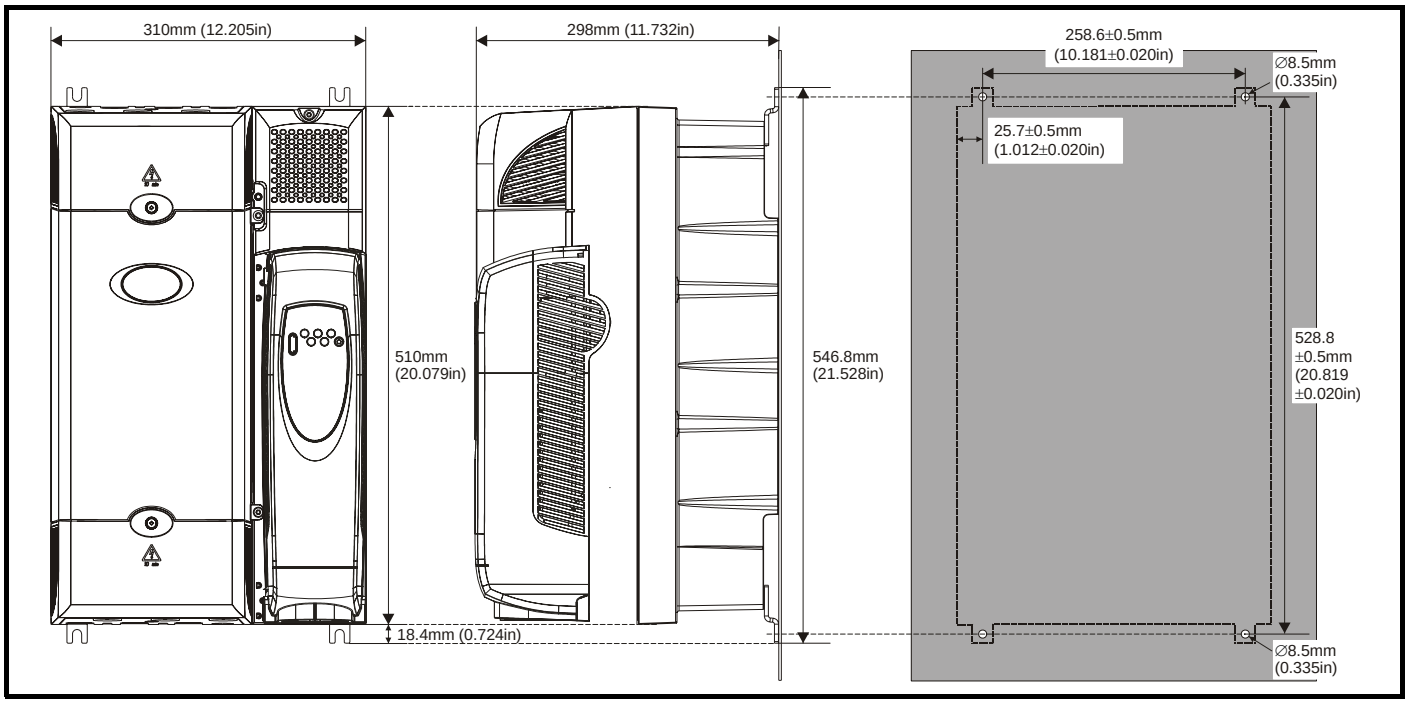


Figure 5-8 Surface mounting the size 5 drive

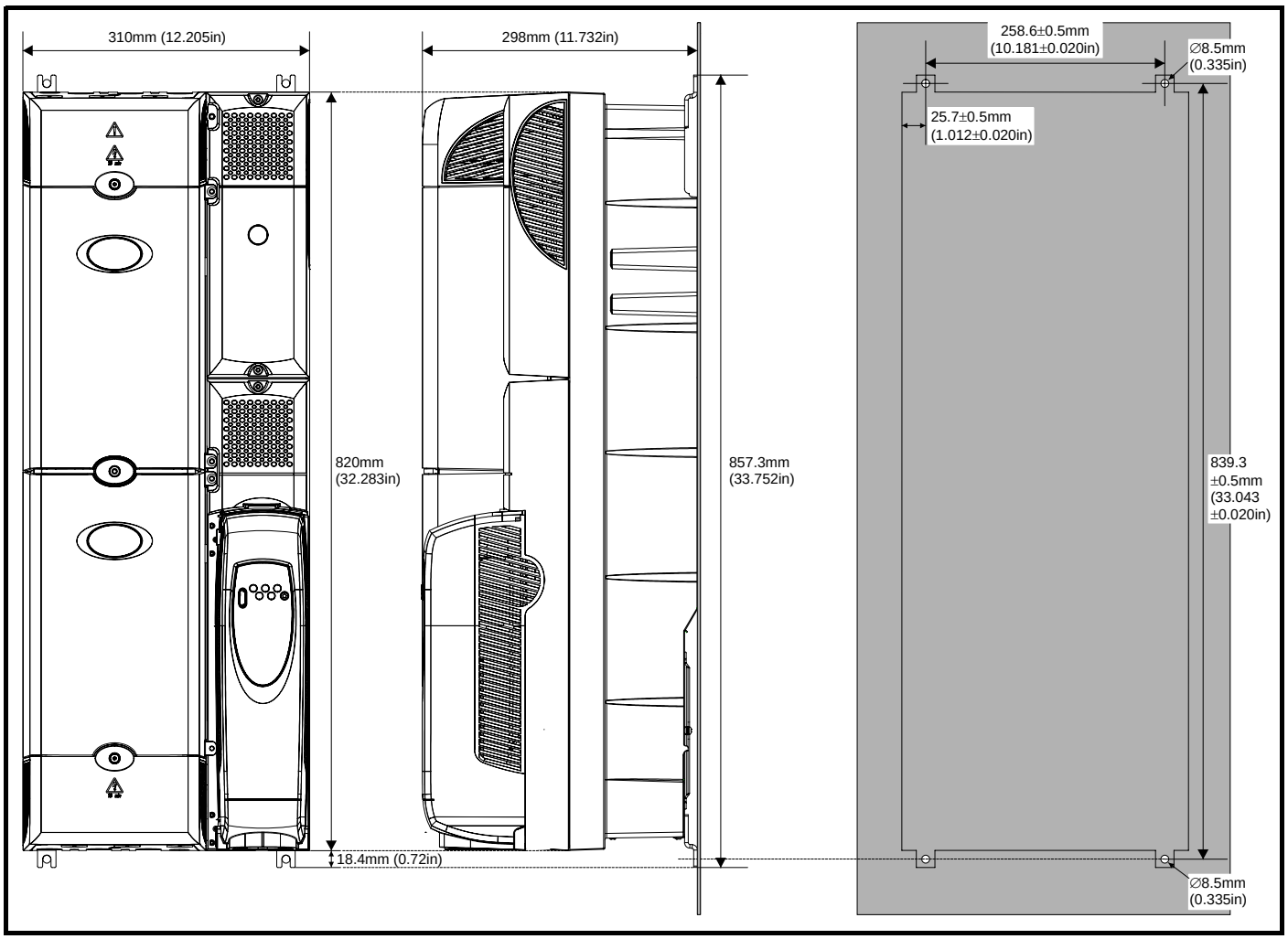
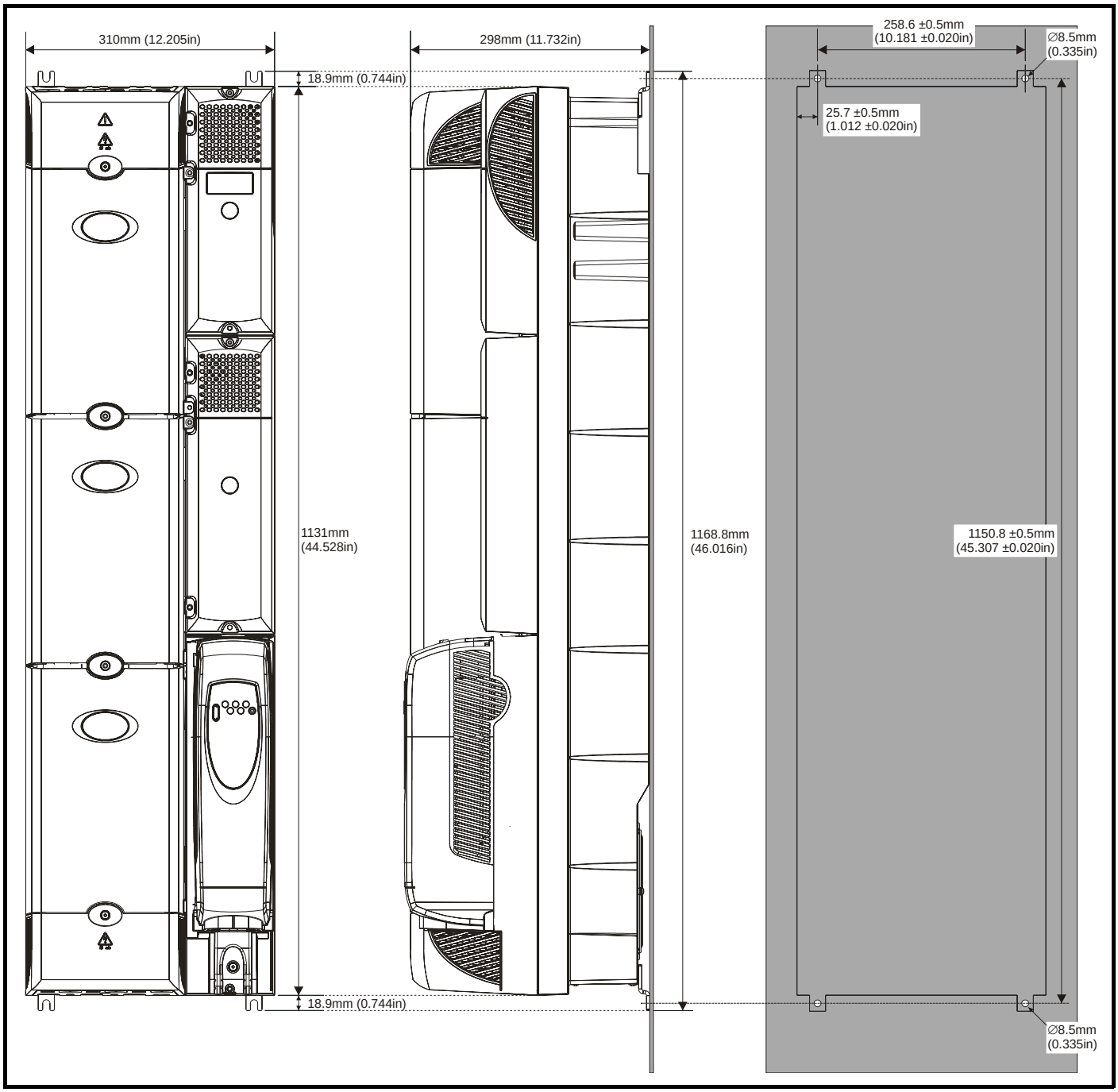


Figure 5-9 Surface mounting the size 6 drive



Through-panel mounting

When the drive is through-panel mounted, the main terminal cover(s) must be removed in order to provide access to the mounting holes. Once the drive has been mounted, the terminal cover(s) can be replaced.

Figure 5-10 Through-panel mounting of a size 2 drive

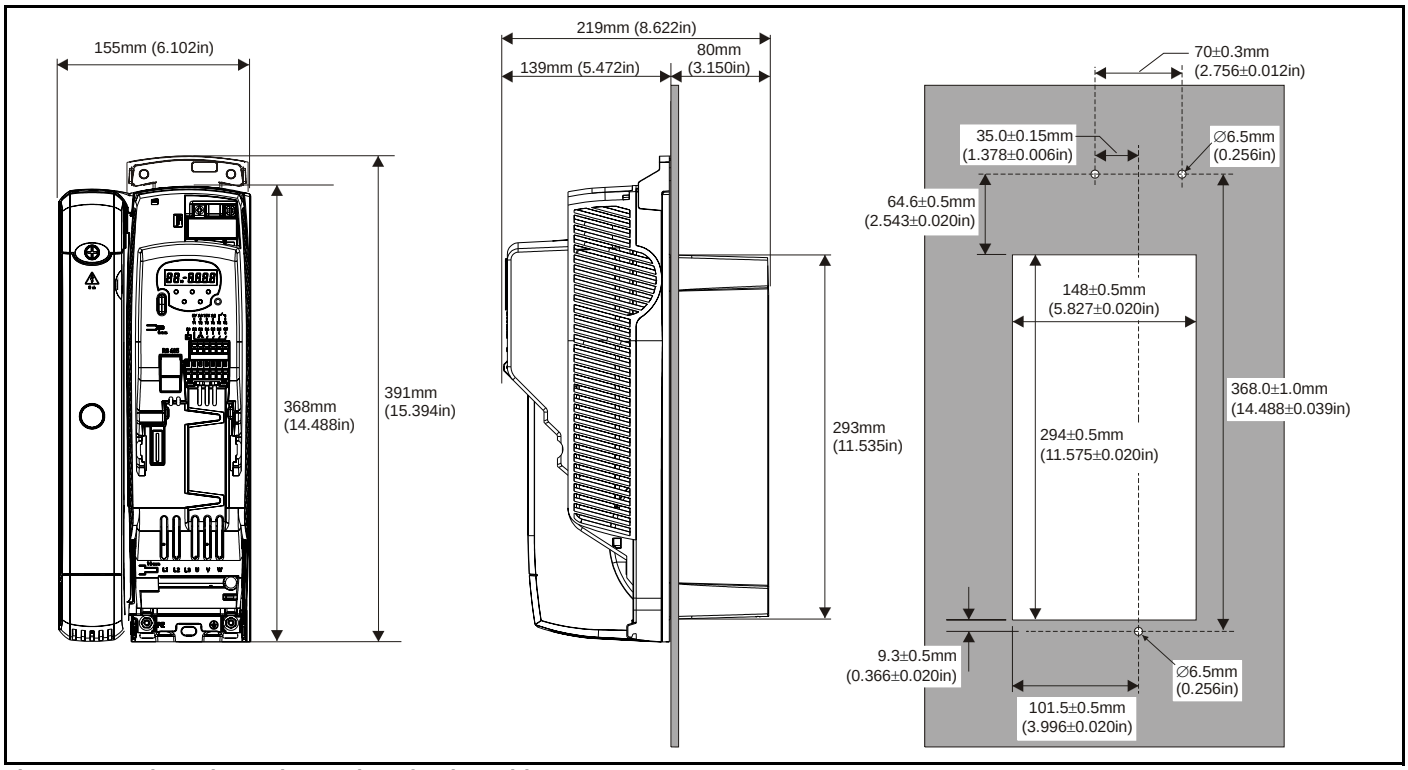
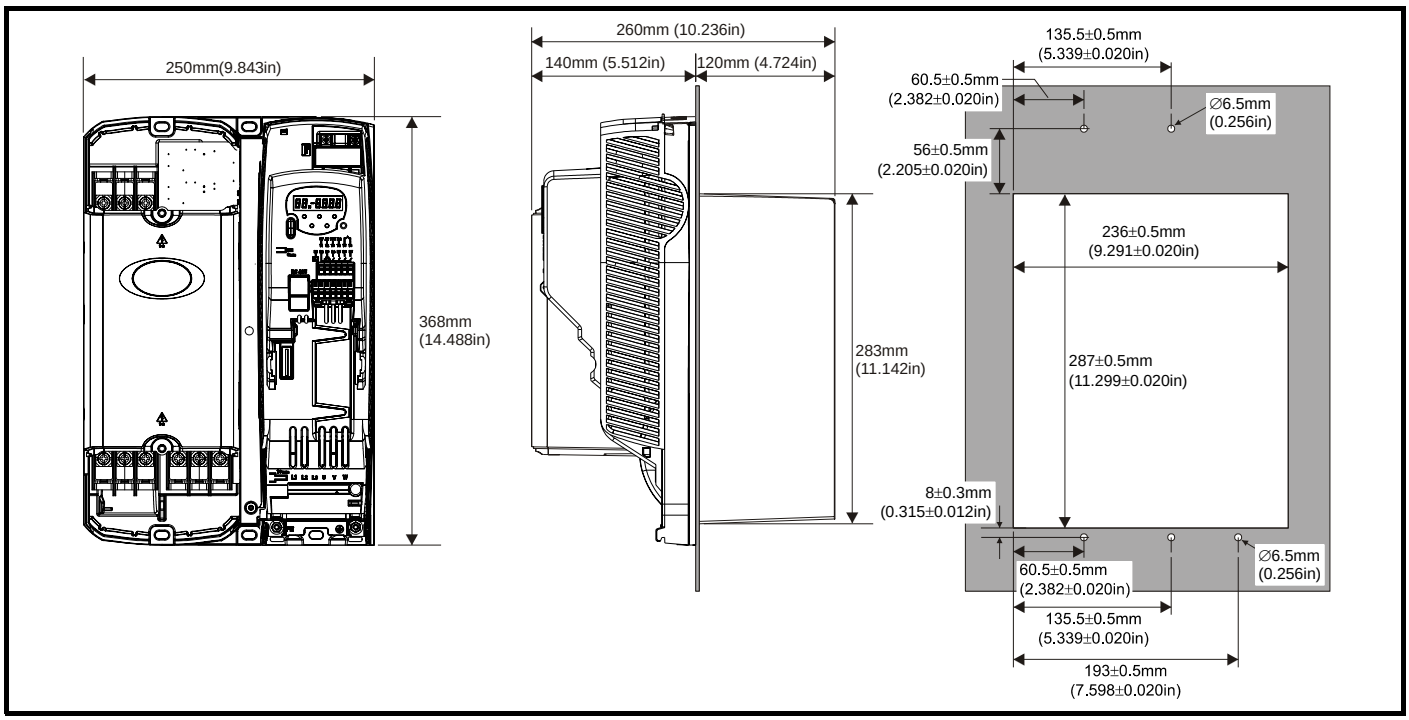


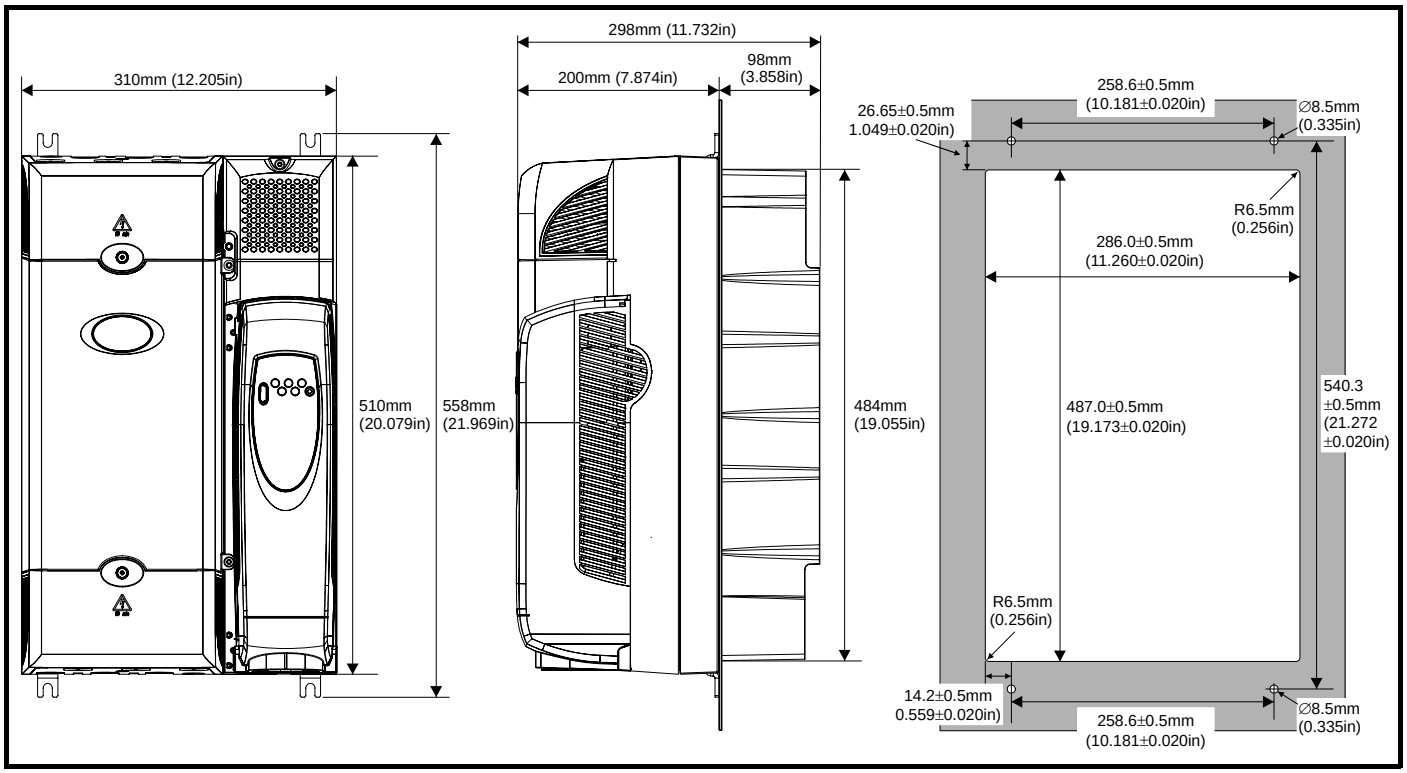
Figure 5-11 Through-panel mounting of a size 3 drive



NOTE

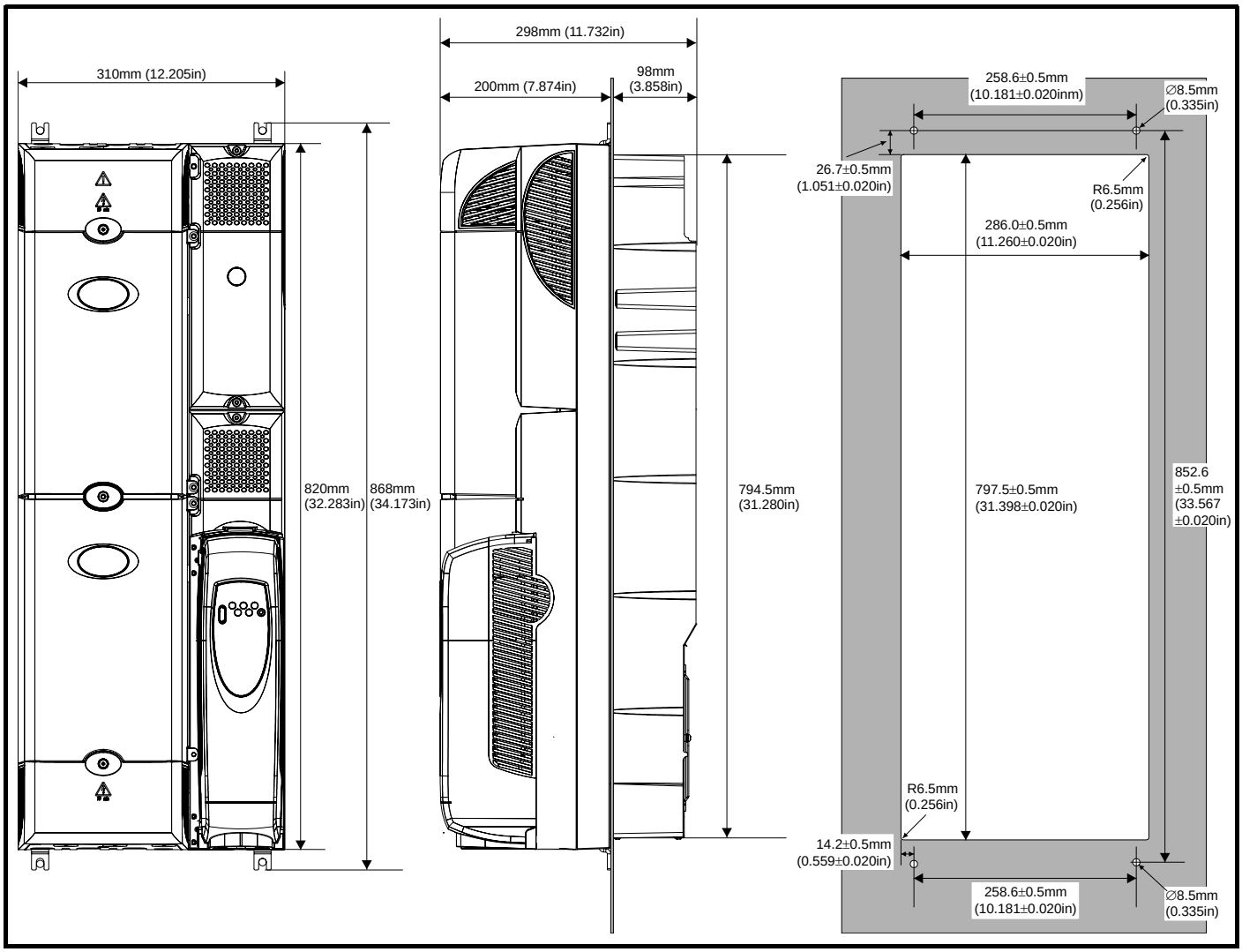
The control terminal cover must be removed on VARIDYNE 2 sizes 2 and 3 to allow access to the mounting holes for through panel mounting.

Figure 5-12 Through-panel mounting of a size 4 drive



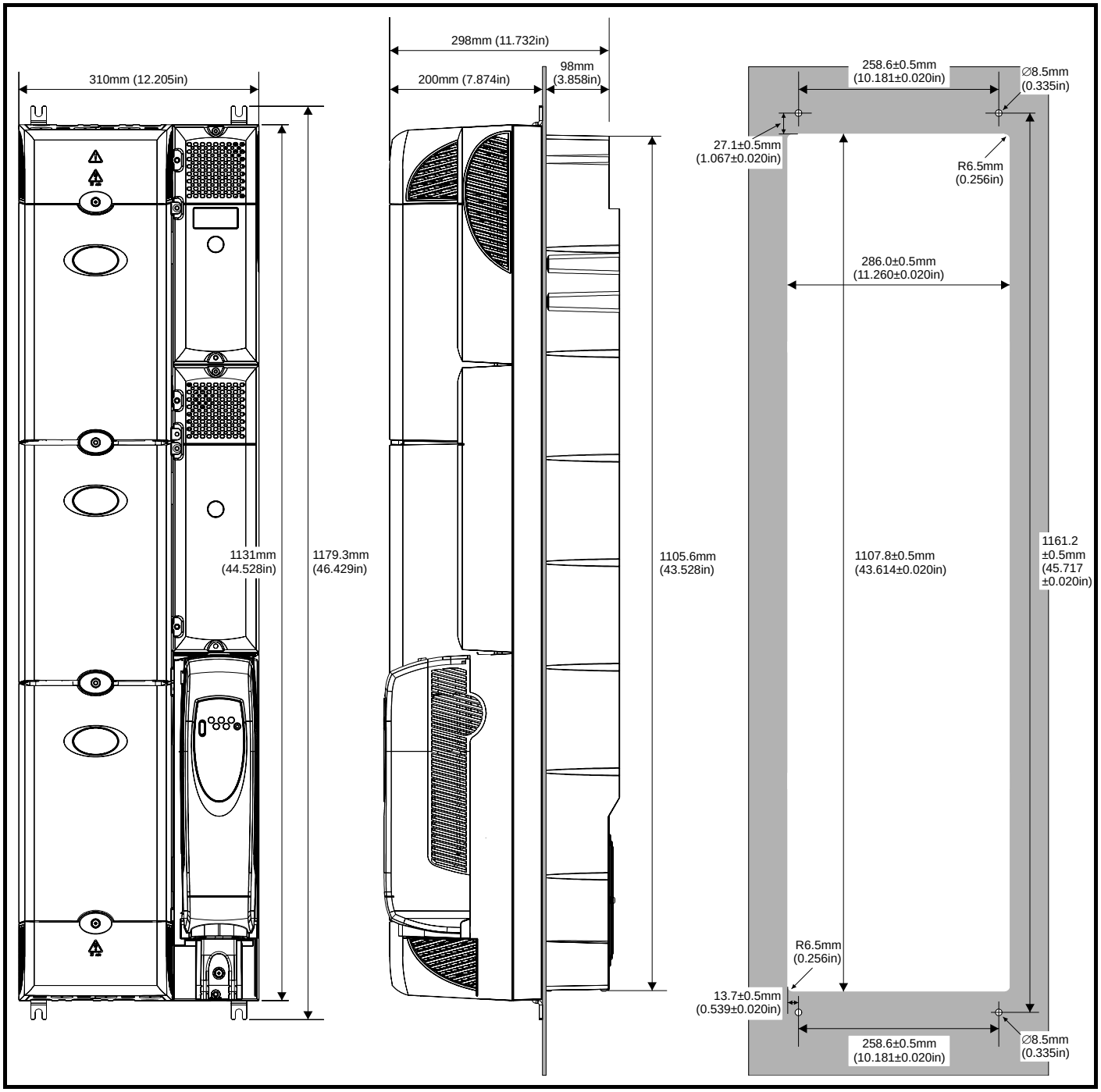
When a VARIDYNE 2 size 4 or 5 is through-panel mounted, the grounding link bracket must be folded upwards. This is required to provide a grounding point for the grounding bracket. See section *Grounding hardware* on page 81 for details.

Figure 5-13 Through-panel mounting of a size 5 drive



When a VARIDYNE 2 size 4 or 5 is through-panel mounted, the grounding link bracket must be folded upwards. This is required to provide a grounding point for the grounding bracket. See section *Grounding hardware* on page 81 for details.

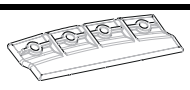
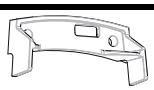
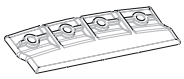
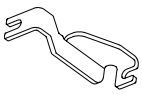
Figure 5-14 Through-panel mounting of a size 6 drive



NOTE

In order to achieve IP54 rating and/or NEMA 12 for through-panel mounting, an IP54 insert must be fitted (size 2) and the heatsink fan must be replaced with an IP54 rated fan (size 2 to 4). Additionally, the gasket provided should be fitted between the drive and the backplate to ensure a good seal for the cubicle. See section 5.2.3 *IP Rating (Ingress Protection)* on page 52

5.2.2 Mounting brackets

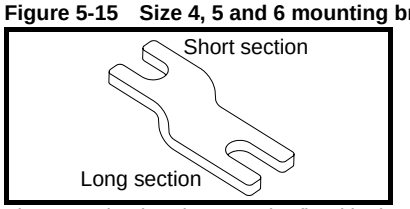
Model size	Surface	Through-panel	Hole size
2	 x2	 x1	6.5mm (0.256in)
3	 x2		
4	 x4		8.5mm (0.335in)
5 & 6	 x4		
	 x2		

Fitting of the VARIDYNE 2 mounting brackets on size 4, 5 and 6

VARIDYNE 2 size 4,5 and 6 use the same mounting brackets for surface and through-panel mounting.

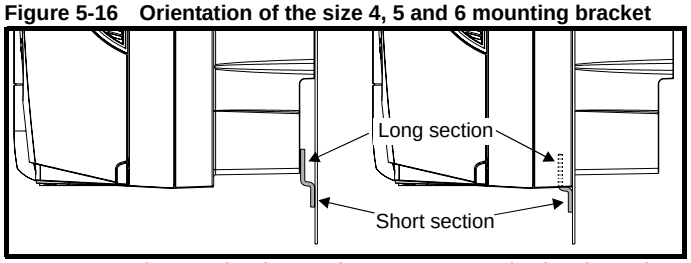
The mounting bracket has a long section and short section.

Figure 5-15 Size 4, 5 and 6 mounting bracket



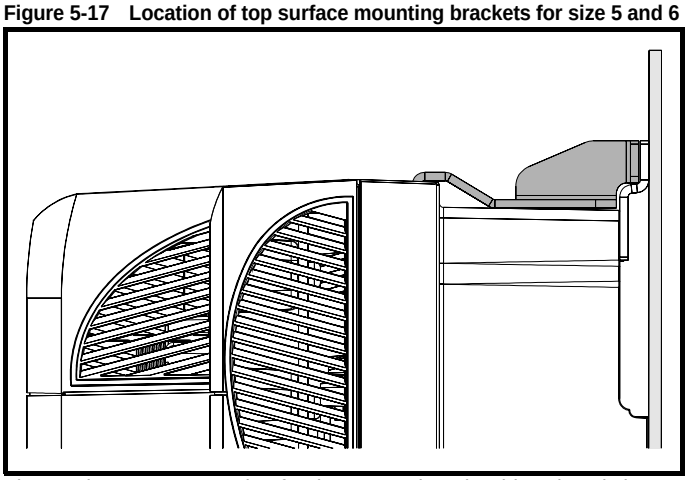
The mounting bracket must be fitted in the correct orientation with the long section inserted into or attached to the drive and the short section attached to the backplate. Figure 5-16 shows the orientation of the mounting bracket when the drive is surface mounted and through-panel mounted.

Figure 5-16 Orientation of the size 4, 5 and 6 mounting bracket



VARIDYNE 2 size 5 and 6 also requires two top mounting brackets when the drive is surface mounted. The two brackets should be fitted to the top of the drive as shown in Figure 5-17.

Figure 5-17 Location of top surface mounting brackets for size 5 and 6



The maximum torque setting for the screws into the drive chassis is 10Nm (7.4 lb ft).

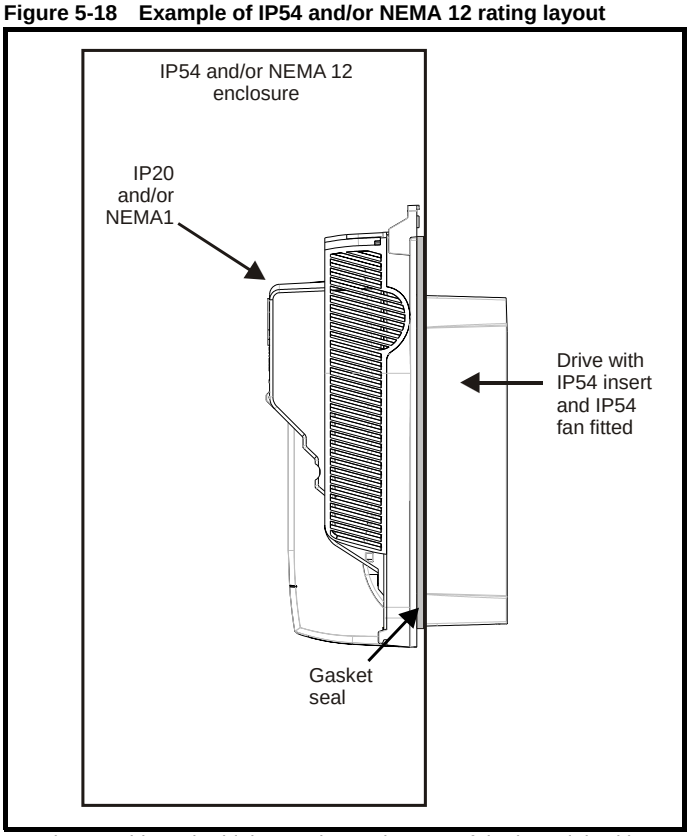
5.2.3 IP Rating (Ingress Protection)

VARIDYNE 2 size 2, 3 and 4

The VARIDYNE 2 size 2, 3 and 4 is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) and/or NEMA 1. However, it is possible to configure the drive to achieve IP54 rating and/or NEMA 12 at the rear of the heatsink for through-panel mounting (some current de-rating is required for size 2).

This allows the front of the drive, along with various switchgear, to be housed in an IP54 and/or NEMA 12 enclosure with the heatsink protruding through the panel to the external environment. Thus, the majority of the heat generated by the drive is dissipated outside the enclosure maintaining a reduced temperature inside the enclosure. This also relies on a good seal being made between the heatsink and backplate using the gasket provided.

Figure 5-18 Example of IP54 and/or NEMA 12 rating layout



In order to achieve the high IP rating at the rear of the heatsink with VARIDYNE 2 size 2, it is necessary to seal a heatsink vent by fitting the IP54 insert as shown in Figure 5-19 on page 53.

For increased fan lifetime in a dirty environment the heatsink fan must be replaced with an IP54 or IP55 fan.

Table 5-1 Fan part numbers

Frame size	IP54 fan part number	IP55 fan part number
2	3251-4824-00	3251-3824-00
3		3251-1224-00
4	3251-7824-00	

If the standard fan is used in a dirt/dusty environment, reduced fan lifetime will result. Regular cleaning of the fan and heatsink is recommended in this environment.

VARIDYNE 2 size 5 and 6

When through hole mounted, the VARIDYNE 2 size 5 and 6 are rated to IP54 and/or NEMA 12 as standard.

Table 5-2 Environmental considerations

Environment	IP54 Insert	Fan	Comments
Clean	Not fitted	Standard	
Dry and dusty (non-conductive)	Fitted	Standard	Regular cleaning recommended. Fan lifetime may be reduced.
Dry and dusty (conductive)	Fitted	Standard/ IP54	Regular cleaning recommended. Fan lifetime may be reduced.
IP54 compliance	Fitted	IP54	Regular cleaning recommended.

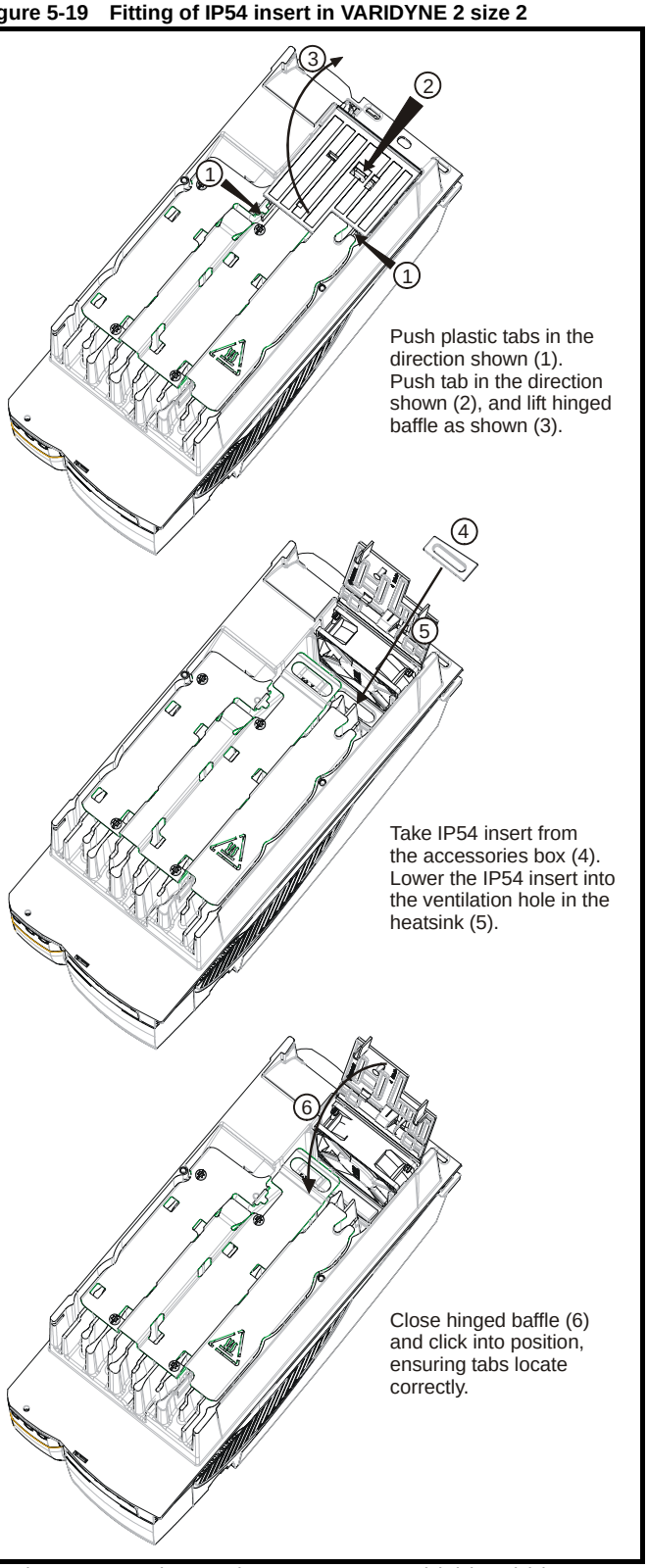
Through-panel mounting losses

When designing an IP54 and/or NEMA 12 cubicle, the losses from the front of the drive must be taken into consideration.

Table 5-3 Through-panel mounting losses

Frame size	Power loss (W)
2	≤75
3	≤100
4	≤204
5	≤347
6	≤480

Figure 5-19 Fitting of IP54 insert in VARIDYNE 2 size 2

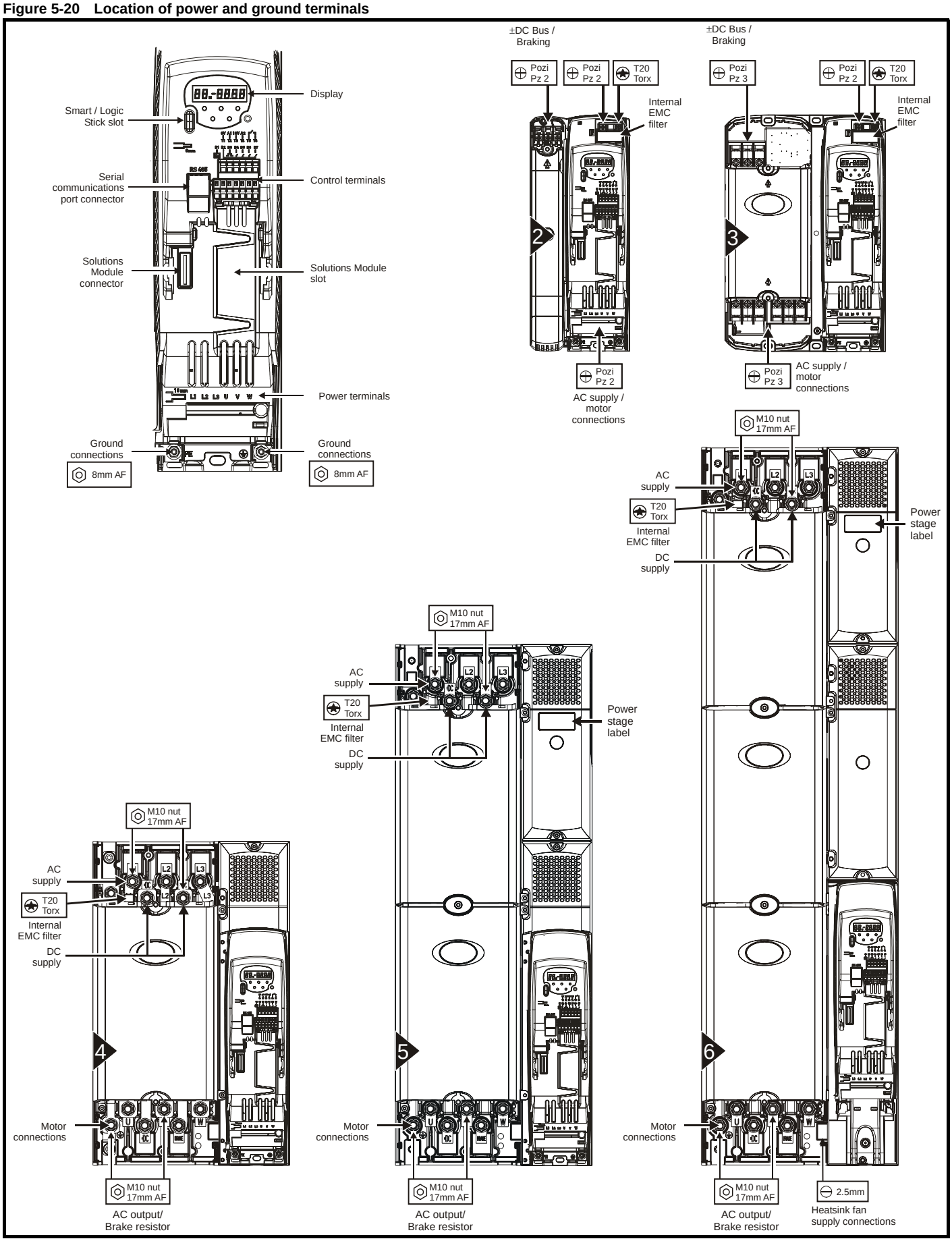


In order to remove the IP54 insert, repeat steps (1) (2) and (3), reverse steps (5) and (4) and repeat step (6).

The IP54/55 fan can be fitted at the same time as the IP54 insert. The connector on the existing fan should be unplugged from the power PCB. The existing fan then unclips from the black housing and can be removed. Once the new assembly is complete, the power lead of the new IP5X fan can then be pushed back through the heatsink and the grommet inserted in to the hole to ensure the correct seal is maintained. The fan is then clipped into the housing ensuring the blades rotate freely indicating that the fan is fitted in the correct orientation.

5.2.4 Electrical terminals

Figure 5-20 Location of power and ground terminals



Terminal sizes and torque settings

WARNING

To avoid a fire hazard and maintain validity of the UL Listing, adhere to the specified tightening torques for the power and ground terminals. Refer to the following tables.

Table 5-4 Drive control and relay terminal data

Model	Connection type
All	Spring terminals

Table 5-5 Drive power terminal data

Model size	AC terminals	DC and braking terminals	Ground terminals
2	Plug-in terminal block 1.5Nm (1.1 lb ft)	Terminal block (M5 screws) 1.5Nm (1.1 lb ft)	M5 stud 4.0Nm (2.9 lb ft)
3	Terminal block (M6 screws) 2.5Nm (1.8 lb ft)		6.0Nm (4.4 lb ft)
4	M10 stud 15Nm (11.1 lb ft)		M10 stud 12Nm (8.8 lb ft)
5			
6			
Torque tolerance			±10%

5.2.5 Heatsink mounted braking resistor

WARNING

If the drive has been used at high load levels for a period of time, the heatsink and heatsink mounted braking resistor can reach temperatures in excess of 70°C (158°F). Human contact with the heatsink and heatsink mounted braking resistor should be prevented.

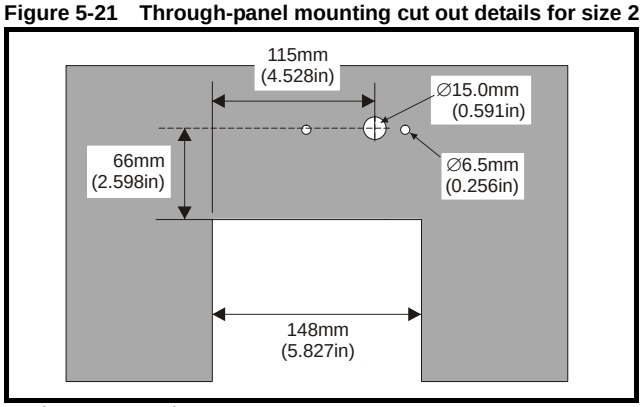
WARNING

To avoid the risk of fire when the drive is surface mounted with the braking resistor fitted, the back plate should be a non-flammable material.

The VARIDYNE 2 size 2 has been designed with an optional space-saving heatsink mounted resistor. The resistor can be fitted within the heatsink fins of the drive. When the heatsink mounted resistor is used, an external thermal protection device is not required as the resistor is designed such that it will fail safely under fault conditions. The built-in software overload protection is set-up at default to protect the resistor. The resistor is rated to IP54 and/or NEMA 12.

If the drive is to be through-panel mounted with the heatsink mounted brake resistor fitted, then the aperture in the panel through which the drive is mounted must be modified as shown in Figure 5-21. This is in order to allow for the braking resistor cables and grommets.

Figure 5-21 Through-panel mounting cut out details for size 2



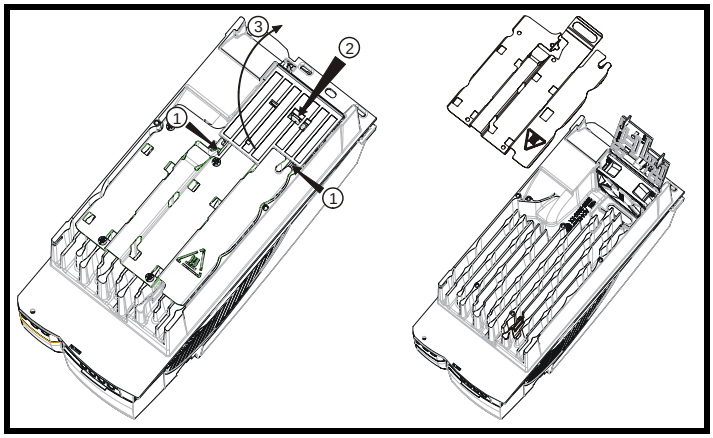
Resistor part number: 1220-2758-01

Each kit contains the following parts:

- A braking resistor assembly
- A through-panel grommet
- A wire clip
- An installation sheet

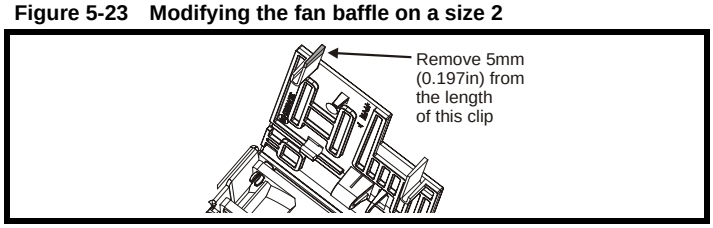
Size 2 braking resistor fitting instructions

Figure 5-22 Removing the baffle plate on a size 2



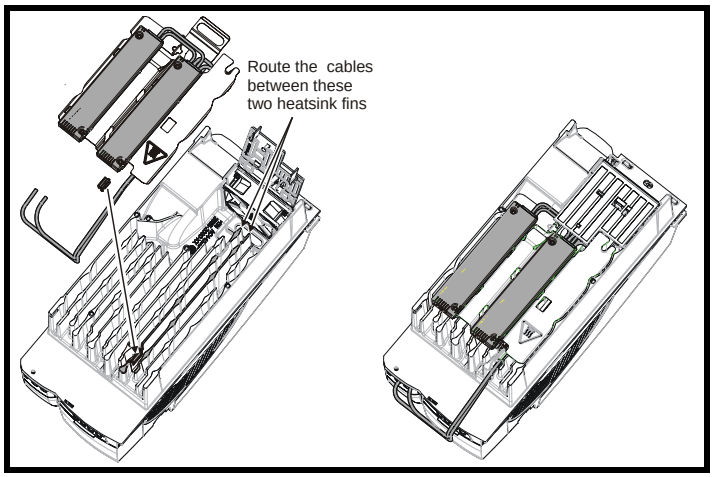
- Remove the DC cover as detailed in Menu 3 in the *VARIDYNE 2 size 2 to 6 Getting Started Guide*.
- Remove the 2 breakouts that line-up with the BR and +DC terminal connections as detailed in Menu 3 in the *VARIDYNE 2 size 2 to 6 Getting Started Guide*.
- Lift the hinged baffle plate by pushing the plastic tabs in the direction shown (1). Push tab in the direction shown (2), and lift the baffle as shown (3).
- Remove the baffle plate by removing the two screws. These two screws are no longer required.

Figure 5-23 Modifying the fan baffle on a size 2



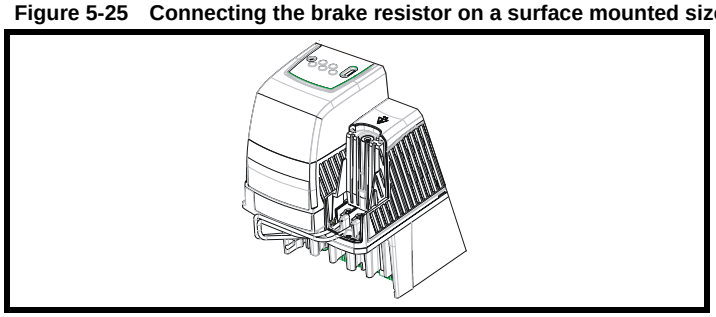
- Remove 5mm (0.197in) from the length of the clip on the plastic fan baffle.

Figure 5-24 Fitting the heatsink mounted braking resistor on a size 2



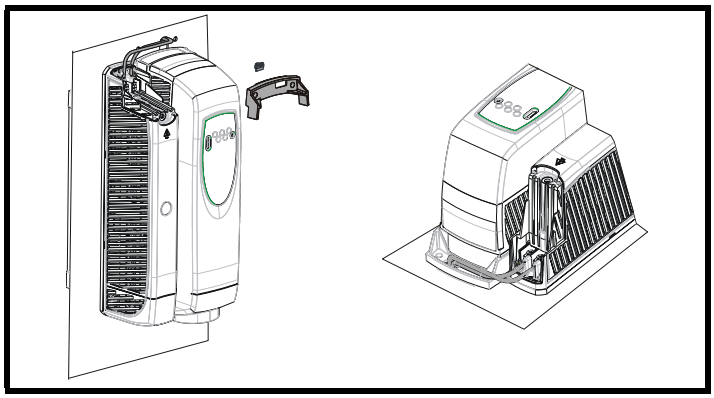
- Fit clip to heatsink in the position shown in diagram opposite. Route the long cables of the resistor assembly between the fins of the heatsink as shown in Figure 5-24.
- Fit the heatsink baffle plate in place with the cables routed underneath. Ensure the cables are not trapped between a heatsink fin and the baffle plate.
- Fit the braking resistors to the heatsink. The resistors are fitted with captive screws.
- The screws should be tightened to a maximum torque of 2.0 N m (1.5 lb ft).
- Close the hinged fan baffle.
- Fit cables to heatsink clip.

Figure 5-25 Connecting the brake resistor on a surface mounted size 2



- Fit the DC terminal cover grommets supplied in the accessory box with the drive, to the cables. To ensure a good seal, the grommets are a tight fit. Lubrication may be required to help fit the grommets to the cables.
- Terminate the cables with suitable crimps and connect to the BR and DC2 terminals.
- Replace the terminal cover.

Figure 5-26 Connecting the brake resistor on a through-panel mounted size 2



- See Figure 5-21 for through-panel mounting cut-out details.
- Pass the cables through the hole in the panel and fit the hole grommet.
- Fit the mounting bracket.
- Fit the DC terminal cover grommets supplied in the accessory box with the drive, to the cables. To ensure a good seal, the grommets are a tight fit. Lubrication may be required to help fit the grommets to the cables.
- Terminate the cables with suitable crimps and connect to the BR and DC2 terminals.
- Replace the terminal cover.

CAUTION

Braking resistor overload protection parameter settings
Failure to observe the following information may damage the resistor.
The *VARIDYNE 2* software contains an overload protection function for a braking resistor. On *VARIDYNE 2* size 2 this function is enabled at default to protect the heatsink mounted resistor. Below are the parameter settings.

Parameter		200V drive	400V drive
Full power braking time	Pr **10.30**	0.09	0.02
Full power braking period	Pr **10.31**	2.0	

For more information on the braking resistor software overload protection, see the *VARIDYNE 2 Advanced User Guide*.

If the heatsink mounted braking resistor is to be used at more than half of its average power rating then the drive's cooling fan must be set to full speed by setting Pr **6.45** to On (1).

WARNING

Braking resistor: High temperatures and overload protection
Braking resistors can reach high temperatures. Locate braking resistors so that damage cannot result. Use cable having insulation capable of withstanding the high temperatures.

It is essential that the braking resistor be protected against overload caused by a failure of the brake control. Unless the resistor has built in protection, the circuit below should be used, where the thermal protection device disconnects the AC supply to the drive.

Figure 5-27 Typical protection circuit for a braking resistor

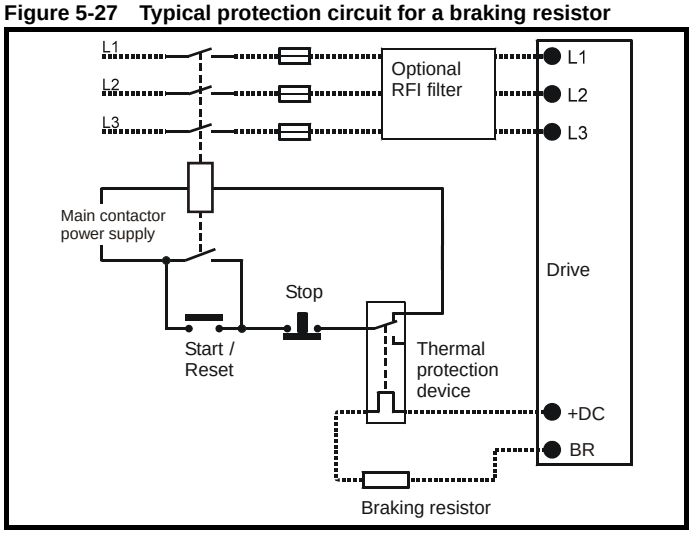


Table 5-6 Heatsink mounted braking resistor data

Parameter	Size 2
Part number	1220-2758-01
DC resistance at 25ºC	37.5Ω
Peak instantaneous power over 1ms at nominal resistance	16kW
Average power over 60s*	100W
Ingress Protection (IP) rating	IP54
Maximum altitude	2000m

* To keep the temperature of the resistor below 70ºC (158ºF) in a 30ºC (86ºF) ambient, the average power rating is 100W for size 2. The previous parameter settings ensure this is the case.

VARIDYNE 2 size 3 and larger do not have heatsink mounted braking resistors, hence the default values of Pr **10.30** and Pr **10.31** are 0 (i.e. software braking resistor overload protection disabled).

Braking resistor software overload protection

The VARIDYNE 2 software contains an overload protection function for a braking resistor. In order to enable and set-up this function, it is necessary to enter two values into the drive:

- Resistor short-time overload time (Pr **10.30**)
- Resistor minimum time between repeated short-time overloads (Pr **10.31**)

This data should be obtained from the manufacturer of the braking resistors.

Pr **10.39** gives an indication of braking resistor temperature based on a simple thermal model. Zero indicates the resistor is close to ambient and 100% is the maximum temperature the resistor can withstand. A br.rS alarm is given if this parameter is above 75% and the braking IGBT is active. An It.br trip will occur if Pr **10.39** reaches 100%, when Pr **10.37** is set to 0 (default value) or 1.

If Pr **10.37** is equal to 2 or 3 an It.br trip will not occur when Pr **10.39** reaches 100%, but instead the braking IGBT will be disabled until Pr **10.39** falls below 95%. This option is intended for applications with parallel-connected DC buses where there are several resistors, each of which cannot withstand full DC bus voltage continuously. With this type of application it is unlikely the braking energy will be shared equally between the resistors because of voltage measurement tolerances within the individual drives. Therefore with Pr **10.37** set to 2 or 3, then as soon as a resistor has reached its maximum temperature the drive will disable the braking IGBT, and another resistor on another drive will take up the braking energy. Once Pr **10.39** has fallen below 95% the drive will

allow the braking IGBT to operate again.

See the *VARIDYNE 2 Advanced User Guide* for more information on Pr **10.30**, Pr **10.31**, Pr **10.37** and Pr **10.39**.

This software overload protection should be used in addition to an external overload protection device.

5.3 Sizing a braking resistor

The size and rating of the resistor are calculated with respect to the energy to be absorbed, the rate at which the power is delivered and the time between successive decelerations.

Kinetic energy of the motor and the driven machine = 0.5 J ω^2

Where:

ω = angular velocity in radians s^{-1}

$$\omega = \frac{2\pi \times n}{60}$$

Where: n = motor speed in RPM

J = total moment of inertia (kg m^2) of the motor and driven machine. If there is gearing between the motor and the machine, J is the value reflected at the motor shaft.

As energy is proportional to the square of the angular velocity, most of the energy is concentrated at the higher operating speeds. If the motor is operated above base speed, the power delivered to the resistor is constant until the speed falls below base speed.

Example

The information required to calculate the size of the braking resistor is as below:

Inertia	J	2kg m^2
Braking cycle		10 seconds in every 60 seconds
Time required to decelerate to stop	t_b	10 seconds
Motor size		4kW
Drive size		4kW
Motor nominal torque		26Nm
Motor rated speed	n	1450RPM
Braking transistor operating voltage	V	780VDC

The first stage is to determine the maximum braking torque (M) available.

M = 150% x nominal motor torque
= 1.5 x 26
= 39Nm

Now calculate the minimum deceleration time possible to ensure that the time required is within specification.

$$\mathbf{M} = \mathbf{J} \times \alpha$$

Where:

α = angular acceleration (rad / s^2)

J = moment of inertia (kg m^2)

$$\alpha = \frac{\omega}{\mathbf{t_b}}$$

$$= \mathbf{J} \times \frac{\omega}{\mathbf{t_b}}$$

Where:

ω = angular velocity (rad / s)

$\mathbf{t_b}$ = minimum deceleration time (s)

$$\omega = \frac{\mathbf{2} \times \pi \times \mathbf{n}}{\mathbf{60}}$$

n = motor speed RPM

$$= \frac{\mathbf{J} \times \pi \times \mathbf{n}}{\mathbf{30} \times \mathbf{t_b}}$$

$$= \frac{\mathbf{2} \times \pi \times \mathbf{1450}}{\mathbf{30} \times \mathbf{t_b}}$$

$$\mathbf{39} = \frac{\mathbf{2} \times \pi \times \mathbf{1450}}{\mathbf{30} \times \mathbf{t_b}}$$

$$\mathbf{t_b} = \frac{\mathbf{2} \times \pi \times \mathbf{1450}}{\mathbf{30} \times \mathbf{39}}$$

$$\mathbf{t_b} = \mathbf{7.8\,seconds}$$

The minimum time for deceleration is 7.8 seconds. The required deceleration time is 10 seconds and is therefore within the specification for the drive.

Now using the required deceleration time of 10 seconds, calculate the required braking torque:

$$\mathbf{M_b} = \frac{\mathbf{2} \times \pi \times \mathbf{1450}}{\mathbf{30} \times \mathbf{10}}$$

$$\mathbf{M_b} = \mathbf{30.4\,Nm}$$

Now calculate the braking power:

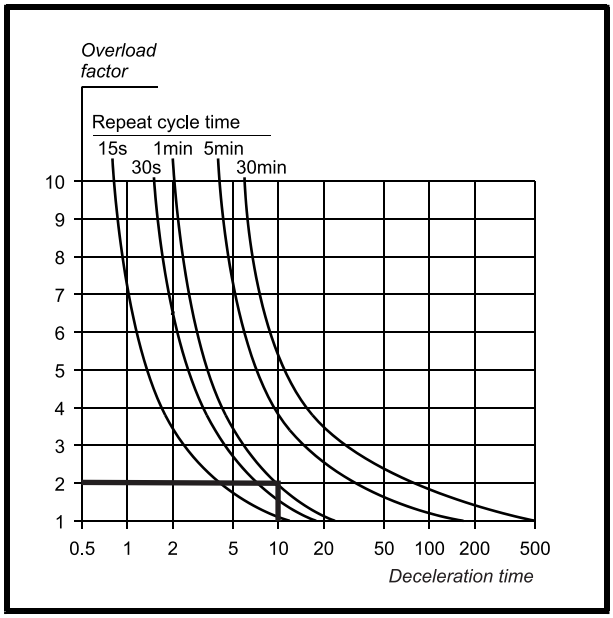
$$\mathbf{P_b} = \frac{\mathbf{M_b} \times \pi \times \mathbf{n}}{\mathbf{30} \times \mathbf{10^3}}$$

$$= \frac{\mathbf{30.4} \times \pi \times \mathbf{1450}}{\mathbf{30} \times \mathbf{10^3}}$$

$$= \mathbf{4.6\,kW}$$

Since braking occurs intermittently, the resistor can be rated for intermittent rather than continuous power dissipation so that the overload factor of the resistor can be used. This factor can be obtained from the cooling curves for resistor type that is being used. See the following example:

Figure 5-28 Examples cooling curves for power resistors (in practice, refer to the cooling curves for the resistor to be used)



The cooling curve indicates that for a braking time of 10 seconds and a repeat cycle time of 60 seconds, the overall factor (F) is 2.0.

Calculate the required power rating of the resistor:

$$P_R = \frac{P_b}{F} = \frac{4.6 \times 10^3}{2.0} = 2.3\text{kW}$$

Now calculate the value of the braking resistor:

$$R_{max} = \frac{(VR)^2}{P_b} = \frac{780^2}{4.6 \times 10^3} = 132\Omega$$

For this example use 120Ω which is the nearest value in the E12 range of resistors.

In practice, use a resistor having a preferred value close to and lower than the calculated value. This is because the calculated value would cause the braking transistor to be switched on almost continuously during braking. In this case, the drive will not have full control of the DC Bus voltage. A lower value of braking resistor will cause the braking transistor to act as a chopper which will then allow the drive to control the DC Bus voltage more accurately.

This reduction in value does not increase the power dissipation since the average voltage across the resistor is reduced by the braking transistor operating as a chopper.

5.3.1 Sizing an appropriate thermal overload relay

Calculate the maximum permissible continuous current through the braking resistor as follows:

$$I_{Rmax} = \sqrt{\frac{P_R}{R}} = \sqrt{\frac{2.3 \times 10^3}{120}} = 4.4\text{A}$$

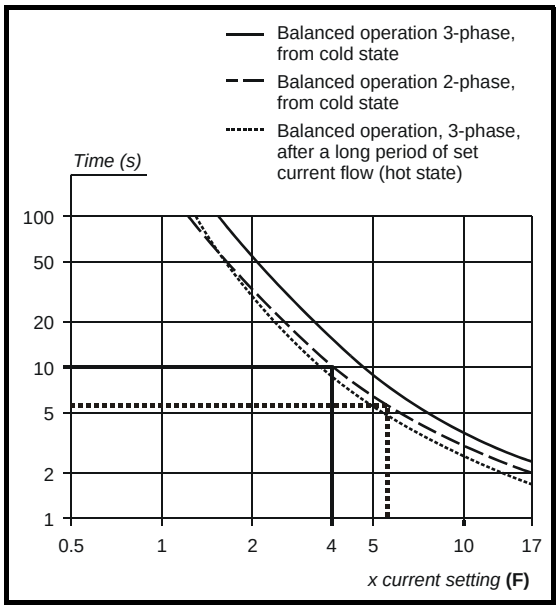
Where:

P_R is the power rating of the resistor to be used.

R is the actual value of the braking resistor (not the calculated).

Use the tripping curves for the chosen manufacturer of thermal overload relay in order to find the overload factor (F) that will cause the relay to trip after 10 seconds.

Figure 5-29 Example tripping curves for the Telemecanique thermal overload relays type LR-Dx3xx



Calculate the current setting required for the thermal overload relay as follows:

$$I_{SET} = \frac{I_{SET}}{F} = \frac{4.4}{4} = 1.1\text{A}$$

Select a model of thermal overload relay that can be set at 1.1A (e.g. Telemecanique LR2-D1306).

Calculate the maximum current that could flow through the resistor (e.g. due to the braking transistor becoming short circuit) as follows:

$$I_{Rpk} = \frac{V_R}{R} = \frac{780}{120} = 6.5\text{A}$$

Calculate the overload factor for this condition as follows:

$$F_{S/C} = \frac{I_{Rpk}}{I_{SET}} = \frac{6.5}{1.1} = 5.9$$

Use the tripping curves to find the time that the thermal overload relay will take to trip (e.g. 5 seconds approximately).

Check that the braking resistor can tolerate the overload current for this duration.

NOTE

Braking resistors must be installed equipped with a thermal overload device.

Resistors intended for braking duty should be capable of tolerating thermal shock. ‘Pulse rated’ resistors are recommended.

The resistance value calculated above does not take into account any tolerance in the resistance value.

The power ratings above are at the limit of satisfactory operation and thus a 10% safety factor should be built in to ensure any tolerances do not add up to cause overvoltage trips. This could be critical where inaccurate values are used for inertia etc. This safety factor should be increased where necessary to incorporate any sort of inaccuracy in values used.

5.4 Terminal sizes and torque settings

To avoid a fire hazard and maintain validity of the UL listing, adhere to the specified tightening torques for the power and ground terminals. Refer to the following tables.

Table 5-7 Drive control and relay terminal data

Model	Connection type
All	Spring terminals

Table 5-8 Wall mounted drive power terminal data

Model size	AC terminals	DC and braking	Ground terminal
2	Plug-in terminal block 1.5 N m (1.1 lb ft)	Terminal block (M5 screws) 1.5 N m (1.1 lb ft)	Stud (M5) 4.0 N m 2.9 lb ft
3	Terminal block (M6 screws) 2.5 N m 1.8 lb ft		6.0 N m 4.4 lb ft
4	M10 stud 15 N m (11.1 lb ft)		M10 stud 12 N m (8.8 lb ft)
5			
6			
Torque tolerance			±10%

Table 5-9 Schaffner external EMC filter terminal data

CT part number	Power connections		Ground connections	
	Max cable size	Max torque	Ground stud size	Max torque
4200-6210	10mm^2 8AWG	2 N m (1.5 lb ft)	M5	3.5 N m (2.6 lb ft)
4200-6305	16mm^2 6AWG	2.2 N m (1.6 lb ft)	M6	3.9 N m (2.9 lb ft)
4200-6307				
4200-6309				
4200-6406	50mm^2 0AWG	8 N m (5.9 lb ft)	M10	25 N m (18.4 lb ft)
4200-6408	25mm^2 4AWG	2.3 N m (1.7 lb ft)	M6	3.9 N m (2.9 lb ft)
4200-6503	95mm^2 4/0AWG	20 N m (14.7 lb ft)	M10	25 N m (18.4 lb ft)
4200-6504	50mm^2 0AWG	8 N m (5.9 lb ft)	M10	25 N m (18.4 lb ft)
4200-6603			M10	25 N m (18.4 lb ft)
4200-6604				

Table 5-10 Epcos external EMC Filter terminal data

CT part number	Power connections		Ground connections	
	Max cable size	Max torque	Ground stud size	Max torque
4200-6211	10mm^2 8AWG	1.35 N m (1.0 lb ft)	M5	3.0 N m (2.2 lb ft)
4200-6306	16mm^2 6AWG	2.2 N m (1.6 lb ft)	M6	5.1 N m (3.8 lb ft)
4200-6308	10mm^2 8AWG	1.35 N m (1.0 lb ft)		
4200-6405	50mm^2 0AWG	6.8 N m (5.0 lb ft)	M10	10 N m (7.4 lb ft)
4200-6407				
4200-6501	95mm^2 4/0AWG	20 N m (14.7 lb ft)		
4200-6502				
4200-6601				
4200-6602				

5.4.1 Routine maintenance

The drive should be installed in a cool, clean, well ventilated location. Contact of moisture and dust with the drive should be prevented.

Regular checks of the following should be carried out to ensure drive / installation reliability are maximised:

Environment	
Ambient temperature	Ensure the enclosure temperature remains at or below maximum specified
Dust	Ensure the drive remains dust free – check that the heatsink and drive fan are not gathering dust. The lifetime of the fan is reduced in dusty environments.
Moisture	Ensure the drive enclosure shows no signs of condensation
Enclosure	
Enclosure door filters	Ensure filters are not blocked and that air is free to flow
Electrical	
Screw connections	Ensure all screw terminals remain tight
Crimp terminals	Ensure all crimp terminals remains tight – check for any discolouration which could indicate overheating
Cables	Check all cables for signs of damage

5.4.2 Heatsink fan

Heatsink fan operation

The VARIDYNE 2 is ventilated by an internal heatsink mounted fan. The fan housing forms a baffle plate, channelling the air through the heatsink chamber. Thus, regardless of the mounting method (surface or through-panel mounting), the fitting of additional baffle plates is not required.

Ensure the minimum clearances around the drive are maintained to allow air to flow freely.

The heatsink fan on VARIDYNE 2 size 2 is a dual speed fan and on size 3 to 6, it is a variable speed fan. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system. The VARIDYNE 2 size 3 to 6 is also fitted with a single speed fan to ventilate the capacitor bank.

The heatsink fan on the VARIDYNE 2 size 2 to 5 is supplied internally by the drive. The heatsink fan on the size 6 requires an external +24Vdc power supply.

Heatsink fan supply

The heatsink fan on size 6 requires an external +24Vdc supply. The connections for the heatsink fan supply must be made to the upper terminal connector near to the W phase output on the drive. See Figure 5-30 for the position of the heatsink fan supply connector.

Figure 5-30 Location of size 6 heatsink fan supply connections

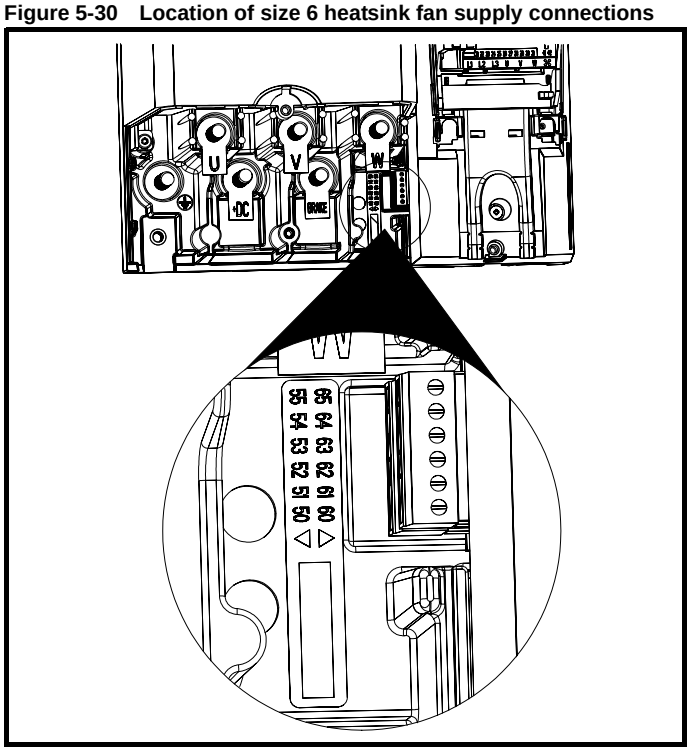
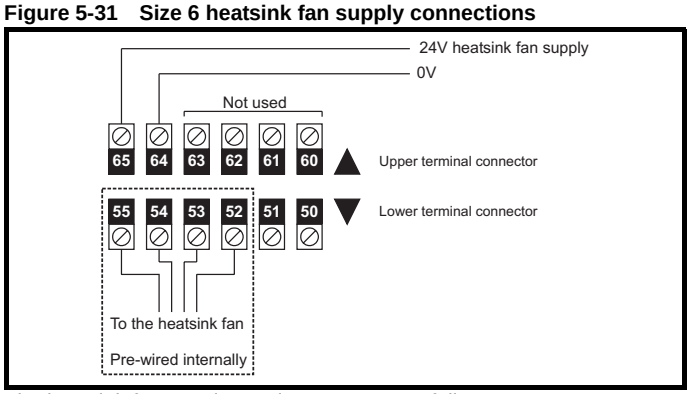


Figure 5-31 Size 6 heatsink fan supply connections



The heatsink fan supply requirements are as follows:

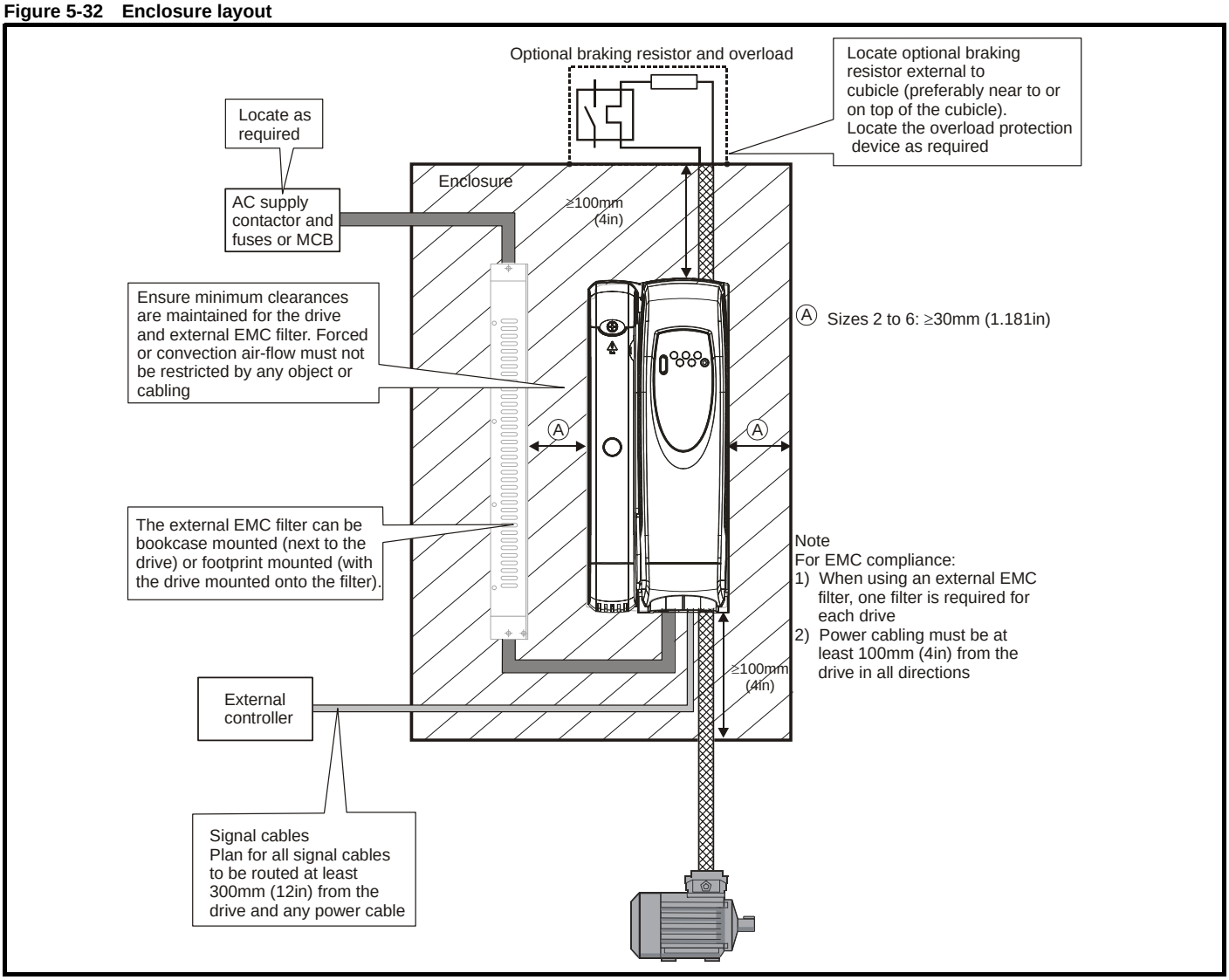
Nominal voltage:	24Vdc
Minimum voltage:	23.5Vdc
Maximum voltage:	27Vdc
Current drawn:	3.3A
Recommended power supply:	24V, 100W, 4.5A
Recommended fuse:	4A fast blow (I^2t less than $20A^2s$)

5.4.3 Enclosure

Enclosure layout (size 2 to 6)

Please observe the clearances in the diagram below taking into account any appropriate notes for other devices / auxiliary equipment when planning the installation.

Figure 5-32 Enclosure layout



Enclosure sizing

1. Add the dissipation figures from section 2.4.2 *Drive losses* on page 29 for each drive that is to be installed in the enclosure.
2. If an external EMC filter is to be used with each drive, add the dissipation figures from Table 6-6 on page 69 for each external EMC filter that is to be installed in the enclosure.
3. If the braking resistor is to be mounted inside the enclosure, add the average power figures for each braking resistor that is to be installed in the enclosure.
4. Calculate the total heat dissipation (in Watts) of any other equipment to be installed in the enclosure.
5. Add the heat dissipation figures obtained above. This gives a figure in Watts for the total heat that will be dissipated inside the enclosure.

Calculating the size of a sealed enclosure

The enclosure transfers internally generated heat into the surrounding air by natural convection (or external forced air flow); the greater the surface area of the enclosure walls, the better is the dissipation capability. Only the surfaces of the enclosure that are unobstructed (not in contact with a wall or floor) can dissipate heat.

Calculate the minimum required unobstructed surface area $\mathbf{A_e}$ for the enclosure from:

$$\mathbf{A_e} = \frac{\mathbf{P}}{\mathbf{k}(\mathbf{T_{int}} - \mathbf{T_{ext}})}$$

Where:

$\mathbf{A_e}$	Unobstructed surface area in m^2 (1 m^2 = 10.9 ft^2)
$\mathbf{T_{ext}}$	Maximum expected temperature in ^oC *outside* the enclosure
$\mathbf{T_{int}}$	Maximum permissible temperature in ^oC *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Heat transmission coefficient of the enclosure material in $W/m^2/^oC$

Example

To calculate the size of an enclosure for the following:

- Two VFK2203 models operating at the Normal Duty rating
- Each drive operate at 6kHz PWM switching frequency
- Schaffner 32A (4200-6210) external EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40ºC
- Maximum ambient temperature outside the enclosure: 30ºC

Losses in each drive: 302W (see section 2.4.2 *Drive losses* on page 29).

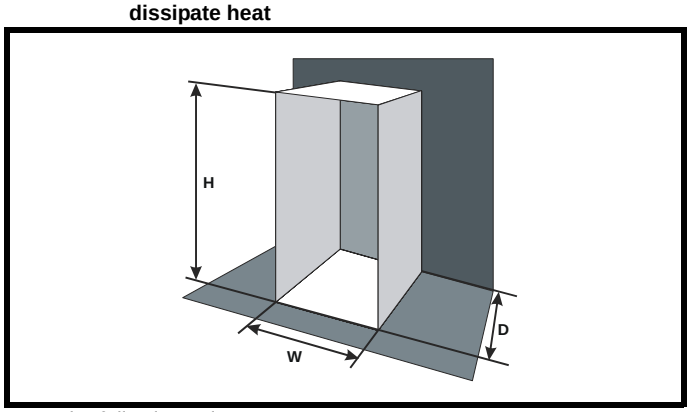
Losses of each external EMC filter: 11W (max) (see section on page 68).

Total losses: 2 x (302 + 11) = 626W

The enclosure is to be made from painted 2 mm (0.079 in) sheet steel having a heat transmission coefficient of 5.5 W/m^2/ºC. Only the top, front, and two sides of the enclosure are free to dissipate heat.

The value of 5.5 W/m^2/ºC can generally be used with a sheet steel cubicle (exact values can be obtained by the supplier of the material). If in any doubt, allow for a greater margin in the temperature rise.

Figure 5-33 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

$\mathbf{T_{int}}$	40°C
$\mathbf{T_{ext}}$	30°C
k	5.5
P	626 W

The minimum required heat conducting area is then:

$$\mathbf{A_e} = \frac{\mathbf{626}}{\mathbf{5.5(40-30)}}$$

=11.38 m^2 (124 ft^2) (1 m^2 = 10.9 ft^2)

Estimate two of the enclosure dimensions - the height (H) and depth (D), for instance. Calculate the width (W) from:

$$\mathbf{W} = \frac{\mathbf{A_e - 2HD}}{\mathbf{H + D}}$$

Inserting **H** = 2m and **D** = 0.6m, obtain the minimum width:

$$\mathbf{W} = \frac{\mathbf{11.38 - (2 \times 2 \times 0.6)}}{\mathbf{2 + 0.6}}$$

=3.454 m (136 in)

If the enclosure is too large for the space available, it can be made smaller only by attending to one or all of the following:

- Using a lower PWM switching frequency to reduce the dissipation in the drives
- Reducing the ambient temperature outside the enclosure, and/or applying forced-air cooling to the outside of the enclosure
- Reducing the number of drives in the enclosure
- Removing other heat-generating equipment

Calculating the air-flow in a ventilated enclosure

The dimensions of the enclosure are required only for accommodating the equipment. The equipment is cooled by the forced air flow.

Calculate the minimum required volume of ventilating air from:

$$\mathbf{V} = \frac{\mathbf{3kP}}{\mathbf{T_{int} - T_{ext}}}$$

Where:

V	Air-flow in m^3 per hour (1 m^3/hr = 0.59 ft^3/min)
$\mathbf{T_{ext}}$	Maximum expected temperature in °C *outside* the enclosure
$\mathbf{T_{int}}$	Maximum permissible temperature in °C *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Ratio of $\frac{\mathbf{P_o}}{\mathbf{P_I}}$

Where:

$\mathbf{P_o}$ is the air pressure at sea level

$\mathbf{P_I}$ is the air pressure at the installation

Typically use a factor of 1.2 to 1.3, to allow also for pressure-drops in dirty air-filters.

Example

To calculate the size of an enclosure for the following:

- Three VFK3201 models operating at the Normal Duty rating
- Each drive to operate at 6kHz PWM switching frequency
- Schaffner 75A (4200-6307) external EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40ºC
- Maximum ambient temperature outside the enclosure: 30ºC

Losses in each drive: 380W

Losses of each external EMC filter: 29W (max)

Total losses: 3 x (380 + 29) = 1227W

Insert the following values:

$\mathbf{T_{int}}$	40°C
$\mathbf{T_{ext}}$	30°C
k	1.3
P	1227 W

Then:

$$\mathbf{V} = \frac{\mathbf{3 \times 1.3 \times 1227}}{\mathbf{40-30}}$$

= **478.5 m^3/hr (282.3 ft^3 /min)** (1 m^3/ hr = 0.59 ft^3/min)

5.4.4 Cubicle design and drive ambient temperature

Drive derating is required for operation in high ambient temperatures

Totally enclosing or through panel mounting the drive in either a sealed cabinet (no airflow) or in a well ventilated cabinet makes a significant difference on drive cooling.

The chosen method affects the ambient temperature value (T_{rate}) which should be used for any necessary derating to ensure sufficient cooling for the whole of the drive.

The ambient temperature for the four different combinations is defined below:

1. Totally enclosed with no air flow (<2 m/s) over the drive
   $T_{rate} = T_{int} + 5°C$
2. Totally enclosed with air flow (>2 m/s) over the drive
   $T_{rate} = T_{int}$
3. Through panel mounted with no airflow (<2 m/s) over the drive
   T_{rate} = the greater of T_{ext} +5°C, or T_{int}
4. Through panel mounted with air flow (>2 m/s) over the drive
   T_{rate} = the greater of T_{ext} or T_{int}

Where:

T_{ext} = Temperature outside the cabinet

T_{int} = Temperature inside the cabinet

T_{rate} = Temperature used to select current rating from tables in Chapter 2 *Derating curves and losses* .

6 EMC

6.1 VARIDYNE 2 size A to C

EMC filters are available as optional extra parts where required.

Table 6-1 EMC filter data

Used with	Number of phases	Filter part number		Filter type		Mounting		Max motor cable length (m)
		CT	Schaffner	Standard	Low leakage	Footprint	Side	
VFKA1200025 and VFKA1200037	1	4200-6122	FS6512-12-07	Y		Y	Y	50
		4200-6123	FS6512-12-07-LL		Y	Y	Y	30
VFKA1200055 and VFKA1200075	1	4200-6122	FS6512-12-07	Y		Y	Y	75
		4200-6123	FS6512-12-07-LL		Y	Y	Y	30
VFKB1100075 and VFKB1100110	1	4200-6216	FS6513-27-07	Y		Y	Y	100
VFKBD200110 to VFKBD200150	1	4200-6212	FS6513-20-07	Y		Y	Y	100
		4200-6214	FS6513-20-07-LL		Y	Y	Y	75
VFKBD200110 to VFKBD200150	3	4200-6213	FS6513-10-07	Y		Y	Y	100
		4200-6215	FS6513-10-07-LL		Y	Y	Y	15
VFKB3400037 to VFKB3400150	3	4200-6213	FS6513-10-07	Y		Y	Y	100
		4200-6215	FS6513-10-07-LL		Y	Y	Y	15
VFKCD200220	1	4200-6310	FS6514-24-07	Y		Y	Y	100
		4200-6312	FS6514-24-07-LL		Y	Y	Y	10
VFKCD200220	3	4200-6311	FS6514-14-07	Y		Y	Y	100
		4200-6217	FS6514-14-07-LL		Y	Y	Y	50
VFKC3400220 to VFKC3400400	3	4200-6311	FS6514-14-07	Y		Y	Y	100
		4200-6217	FS6514-14-07-LL		Y	Y	Y	20

Table 6-2 EMC filter ratings

Used with	Number of phases	Filter part number		Power losses at rated current	IP rating	Weight		Operational leakage current	Worst case leakage current	Filter terminal tightening torque		Filter current rating
		CT	Schaffner	W		Kg	lb	mA	mA	Nm	lb ft	A
VFKA1200025 to VFKA1200075	1	4200-6122	FS6512-12-07	4.1	20	0.42	0.9	25.7	49.5	0.8	0.6	12
		4200-6123	FS6512-12-07-LL	6.7	20	0.44	1.0	2.5	5	0.8	0.6	12
VFKB1100075 and VFKB1100110	1	4200-6216	FS6513-27-07	7.2	20	0.68	1.5	24.9	48.2	0.8	0.6	27
VFKBD200110 to VFKBD200150	1	4200-6212	FS6513-20-07	11.2	20	0.57	1.3	25.7	50	0.8	0.6	20
		4200-6214	FS6513-20-07-LL	12.8	20	0.64	1.4	3.6	7	0.8	0.6	20
VFKBD200110 to VFKBD200150	3	4200-6213	FS6513-10-07	7.5	20	0.63	1.4	40	137.2	0.8	0.6	10
		4200-6215	FS6513-10-07-LL	7.5	20	0.63	1.4	3	18.3	0.8	0.6	10
VFKB3400037 to VFKB3400150	3	4200-6213	FS6513-10-07	7.5	20	0.63	1.4	40	137.2	0.8	0.6	10
		4200-6215	FS6513-10-07-LL	7.5	20	0.63	1.4	3	18.3	0.8	0.6	10
VFKCD200220	1	4200-6310	FS6514-24-07	16.2	20	0.84	1.9	25.7	50	0.8	0.6	24
		4200-6312	FS6514-24-07-LL	18.5	20	0.91	2.0	3.6	7	0.8	0.6	24
VFKCD200220	3	4200-6311	FS6514-14-07	11.8	20	0.75	1.7	40	137.2	0.8	0.6	14
		4200-6217	FS6514-14-07-LL	11.8	20	0.74	1.6	3	18.3	0.8	0.6	14
VFKC3400220 to VFKC3400400	3	4200-6311	FS6514-14-07	11.8	20	0.75	1.7	40	137.2	0.8	0.6	14
		4200-6217	FS6514-14-07-LL	11.8	20	0.74	1.6	3	18.3	0.8	0.6	14

6.1.1 Conformity

Table 6-3 Conformity

Used with	Number of phases	Motor cable length m	Filter and switching frequency											
			Internal				Standard				Low leakage			
			3kHz	6kHz	12kHz	18kHz	3kHz	6kHz	12kHz	18kHz	3kHz	6kHz	12kHz	18kHz
VFKA1200025 and VFKA1200037	1	5	E2U		E2R		R	I			R	I		
		10	E2U	E2R			R	I			R	I		
		20	E2R				R	I			I			
		30	E2R				I				I			
		50	E2R				I							
VFKA1200055 and VFKA1200075	1	5	E2U		E2R		R	I			R	I		
		10	E2U	E2R			R	I			R	I		
		20	E2R				R	I			I			
		30	E2R				I				I			
		50	E2R				I							
		75	E2R				I			E2U				
VFKB1100075 and VFKB1100110	1	4	E2U		E2R		R							
		10	E2R				R							
		20	E2R				R			I				
		50	E2R				I							
		75	E2R				I							
		100	E2R				I							
VFKBD200110 to VFKBD200150	1	4	E2U		E2R		R				R			
		10	E2R				R	I			R			
		40	E2R				I				I			
		50	E2R				I				I			
		75	E2R				I				I			
		100	E2R				I							
VFKBD200110 to VFKBD200150	3	2	E2U			E2R	R				R	I		
		4	E2U	E2R			R				R	I		
		5	E2R				R				R	I		
		9	E2R				R	I			R	I		
		15	E2R				R	I			I			
		50	E2R				R	I						
		75	E2R				I							
		100	E2R				I							
VFKB3400037 to VFKB3400150	3	2	E2U				R				R	I		
		5	E2U		E2R		R				R	I		
		9	E2U		E2R		R	I			R	I		
		15	E2R				R	I			I			
		50	E2R				R	I						
		75	E2R				I							
		100	E2R				I							
VFKCD200220	1	7	E2U		E2R		R				R	I		
		9	E2U	E2R			R				R	I		
		10	E2R				R				R	I		
		15	E2R				R							
		20	E2R				R			I				
		100	E2R				I							
VFKCD200220	3	4	E2U		E2R		R				I			
		5	E2U		E2R		R				I			
		10	E2R				R				I			
		20	E2R				R				I			
		50	E2R				R	I			I			
		75	E2R				I							
		100	E2R				I	I						
VFKC3400220 to VFKC3400400	3	4	E2U		E2R		R				I			
		5	E2U	E2R			R				I			
		10	E2R				R				I			
		20	E2R				R				I			
		50	E2R				I							
		75	E2R				I							
		100	E2R				I							

Key to Table 6-3 *Conformity*

The requirements are listed in descending order of severity, so that if a particular requirement is met then all requirements listed after it are also met.

	Standard	Description	Frequency range	Limits	Application
R	EN 61000-6-3 (previously EN 50081-1)	Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBμV quasi peak 56-46dBμV average	AC supply lines
			0.5 - 5MHz	56dBμV quasi peak 46dBμV average	
			5 - 30MHz	60dBμV quasi peak 50dBμV average	
	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1], with unrestricted distribution		
I	EN 61000-6-4 (previously EN 50081-2)	Generic emission standard for the industrial environment	0.15 - 0.5MHz	79dBμV quasi peak 66dBμV average	AC supply lines
			0.5 -30MHz	73dBμV quasi peak 60dBμV average	
	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Requirements for the first environment[1] with restricted distribution[2]		
E2U	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Requirements for the second environment with unrestricted distribution		
E2R	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Requirements for the second environment with restricted distribution[2]		
	Operation in this condition is not recommended				
1	The first environment is one where the low voltage supply network also supplies domestic premises				
2	When distribution is restricted, drives are available only to installers with EMC competence				

This caution applies where the drive is used in the first environment according to EN 61800-3.
This is a product of the restricted distribution class according to IEC 61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

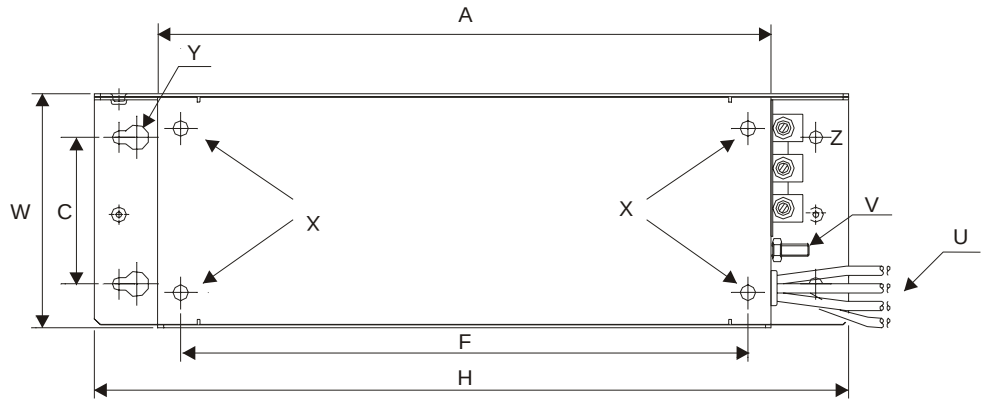
NOTE

Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN 61800-3 for the second environment are applicable, and no filter is then required.

NOTE

Operation without an external filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN 61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Figure 6-1 EMC filter dimensions



V: Ground stud:
X:Threaded holes for footprint mounting of the drive
Y: Footprint mounting holes ∅
Z: Bookcase mounting holes ∅

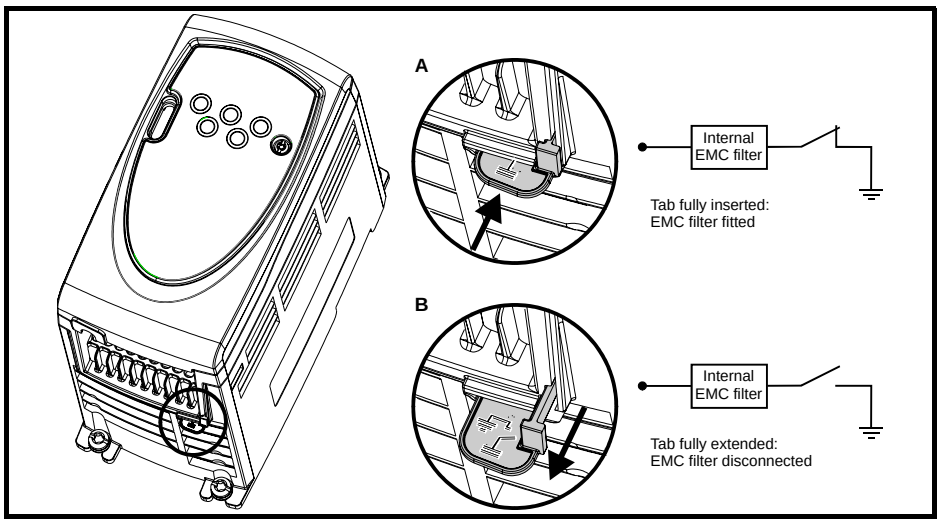
Table 6-4 EMC filter dimensions

CT part no.	Schaffner part no.	A	B	C	D	E	F	H	U	V	W	X	Y	Z
4200-6122	FS6512-12-07	155mm (6.10in)	183.5mm (7.22in)	45mm (1.77in)	40mm (1.57in)	20mm (0.78in)	144mm (5.66in)	203mm (7.99in)	16 AWG	M4	75mm (2.95in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6123	FS6512-12-07-LL	155mm (6.10in)	183.5mm (7.22in)	45mm (1.77in)	40mm (1.57in)	20mm (0.78in)	144mm (5.66in)	203mm (7.99in)	16 AWG	M4	75mm (2.95in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6212	FS6513-20-07	209mm (8.22in)	237.7mm (9.35in)	50mm (1.96in)	40mm (1.57in)	20mm (0.78in)	193.5mm (7.61in)	257.2mm (10.12in)	14 AWG	M4	80mm (3.15in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6214	FS6513-20-07-LL	209mm (8.22in)	237.7mm (9.35in)	50mm (1.96in)	40mm (1.57in)	20mm (0.78in)	193.5mm (7.61in)	257.2mm (10.12in)	14 AWG	M4	80mm (3.15in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6213	FS6513-10-07	209mm (8.22in)	237.7mm (9.35in)	50mm (1.96in)	40mm (1.57in)	20mm (0.78in)	193.5mm (7.61in)	257.2mm (10.12in)	14 AWG	M4	80mm (3.15in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6215	FS6513-10-07-LL	209mm (8.22in)	237.7mm (9.35in)	50mm (1.96in)	40mm (1.57in)	20mm (0.78in)	193.5mm (7.61in)	257.2mm (10.12in)	14 AWG	M4	80mm (3.15in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6216	FS6513-27-07	209mm (8.22in)	237.7mm (9.35in)	50mm (1.96in)	40mm (1.57in)	20mm (0.78in)	193.5mm (7.61in)	257.2mm (10.12in)	12 AWG	M4	80mm (3.15in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6310	FS6514-24-07	260mm (10.23in)	288.5mm (11.35in)	65mm (2.55in)	45mm (1.77in)	20mm (0.78in)	244mm (9.60in)	308mm (12.12in)	12 AWG	M4	94mm (3.70in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6312	FS6514-24-07-LL	260mm (10.23in)	288.5mm (11.35in)	65mm (2.55in)	45mm (1.77in)	20mm (0.78in)	244mm (9.60in)	308mm (12.12in)	12 AWG	M4	94mm (3.70in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6311	FS6514-14-07	260mm (10.23in)	288.5mm (11.35in)	65mm (2.55in)	45mm (1.77in)	20mm (0.78in)	244mm (9.60in)	308mm (12.12in)	16 AWG	M4	94mm (3.70in)	M4	8.7mm (0.34in)	4.5mm (0.17in)
4200-6217	FS6514-14-07-LL	260mm (10.23in)	288.5mm (11.35in)	65mm (2.55in)	45mm (1.77in)	20mm (0.78in)	244mm (9.60in)	308mm (12.12in)	16 AWG	M4	94mm (3.70in)	M4	8.7mm (0.34in)	4.5mm (0.17in)

6.1.2 Internal EMC filter

It is recommended that the internal EMC filter be kept in place unless there is a specific reason for removing it.

Figure 6-2 Removal and re-fitting of internal EMC filter



6.2 VARIDYNE 2 size 2 to 6

Table 6-5 External EMC filter data

Drive	Filter part number		Mounting		Max motor cable length to meet EMC requirements (m)
	Schaffner	Epcos	Footprint	Side	
VFK2201 to VFK2203	4200-6210		Y	Y	100
		4200-6211	Y	Y	
VFK3201 to VFK3202	4200-6307		Y	Y	
		4200-6306	Y	Y	
VFK4201 to VFK4203	4200-6406		Y	Y	
		4200-6405			
VFK2401 to VFK2404	4200-6210		Y	Y	
		4200-6211	Y	Y	
VFK3401 to VFK3403	4200-6305		Y	Y	
		4200-6306	Y	Y	
VFK4401 to VFK4403	4200-6406		Y	N	
		4200-6405	Y	N	
VFK5401 to VFK5402	4200-6503				
		4200-6501	Y	N	
VFK6401 to VFK6402	4200-6603		Y	N	
		4200-6601			
VFK3501 to VFK3507	4200-6309		Y	Y	
		4200-6308	Y	Y	
VFK4601 to VFK4606	4200-6408		Y	N	
		4200-6407	Y	N	
VFK5601 to VFK5602	4200-6504		Y	N	
		4200-6502	Y	N	
VFK6601 to VFK6602	4200-6604				
		4200-6602			

Table 6-6 External EMC filter ratings

CT part number	Manufacturer	Maximum continuous current		Voltage rating	IP rating	Power dissipation at rated current	Ground leakage		Discharge resistors
		@ 40°C (104°F) A	@ 50°C (122°F) A	V		W	Balanced supply phase-to-phase and phase-to-ground mA	Worst case mA	
4200-6210	Schaffner	32	28.2	400	20	11	38.0	206	See Note 1
4200-6305		62	56.6	400		23	66.0	357	
4200-6307		75	68.5	200		29	24.0	170	
4200-6309		30	30	575		15	102.0	557	See Note 3
4200-6406		101	92.2	400		25	73.0	406	See Note 1
4200-6408		58	52.8	690		31	66.0	344	See Note 1
4200-6503		164	150	480		30	39.1	216	See Note 4
4200-6504		95	86.7	690		30	66.0	344	See Note 1
4200-6603		260	237	480	00	14.2	41.0	219	
4200-6604		160	146	690		5.4	88.5	296	
4200-6211	Epcos	32	29.1	400	20	17.8	<30.0	186.5	See Note 2
4200-6306		75	68.3			19.4		238	
4200-6308		30	22.5	660		17.6	<35.0	230	
4200-6405		101	75	480		30	<30.0	180	
4200-6407		58	44	690		15	<40.0	<340	See Note 5
4200-6501		165	125	480		27	<20.0	<120	See Note 2
4200-6502		95	71	690		19	<55.0	<450	See Note 5
4200-6601		260	195	480	00	13	<45.0	<375	
4200-6602		160	120	690		5	<60.0	<520	

NOTE

1. 1MΩ in a star connection between phases, with the star point connected by a 680kΩ resistor to ground (i.e. line to line 2MΩ, line to ground 1.68MΩ)
2. 1MΩ in a star connection between phases, with the star point connected by a 1.5MΩ resistor to ground (i.e. line to line 2MΩ, line to ground 2.5MΩ)
3. 2MΩ between phases with each phase connected by a 660kΩ resistance to ground.
4. 1.5MΩ in a star connection between phases, with the star point connected by a 680kΩ resistor to ground (i.e. line to line 3MΩ, line to ground 2.18MΩ)
5. 1.8MΩ in a star connection between phases, with the star point connected by a 1.5MΩ resistor to ground (i.e. line to line 3.6MΩ, line to ground 3.3MΩ)

6.2.1 Overall external EMC filter dimensions

Table 6-7 Optional external EMC filter dimensions

CT part number	Manufacturer	Dimension			Weight	
		H	W	D	kg	lb
4200-6210	Schaffner	428.5 mm (16.870 in)	155 mm (6.102 in)	55 mm (2.165 in)	2	4.4
4200-6305		414 mm (16.299 in)	250 mm (9.842 in)	60 mm (2.362 in)	3.5	7.7
4200-6307						
4200-6309						
4200-6406		300 mm (11.811 in)	225 mm (8.858 in)	100 mm (3.937 in)	4	8.8
4200-6408			208 mm (8.189 in)		3.8	8.4
4200-6503			249 mm (9.803 in)	120 mm (4.724 in)	6.8	15
4200-6504			225 mm (8.858 in)	100 mm (3.937 in)	4.4	9.7
4200-6603		135 mm (5.315 in)	295 mm (11.614 in)	230 mm (9.055 in)	5.25	11.6
4200-6604						
4200-6211	Epcos	431.5 mm (16.988 in)	155 mm (6.102 in)	55 mm (2.165 in)	3.3	7.3
4200-6306		425 mm (16.732 in)	250 mm (9.843 in)	60 mm (2.362 in)	5.1	11.2
4200-6308						
4200-6405		300 mm (11.811 in)	207 mm (8.150 in)	90 mm (3.543 in)	7.8	17.2
4200-6407			205 mm (8.071 in)		8.0	17.6
4200-6501			249 mm (9.803 in)	120 mm (4.724 in)	12.0	26.5
4200-6502					10.0	22.0
4200-6601		364 mm (14.331 in)	230 mm (9.055 in)	147 mm (5.787 in)	8.6	19.0
4200-6602						

6.2.2 External EMC filter torque settings size 2 to 6

Table 6-8 Optional external EMC filter terminal data

CT part number	Manufacturer	Power connections		Ground connections	
		Max cable size	Max torque	Ground stud size	Max torque
4200-6210	Schaffner	10mm^2 8AWG	2.0 N m (1.5 lb ft)	M5	3.5 N m (2.6 lb ft)
4200-6305		16mm^2 6AWG	2.2 N m (1.6 lb ft)	M6	3.9 N m (2.9 lb ft)
4200-6307					
4200-6309					
4200-6406		50mm^2 0AWG	8 N m (5.9 lb ft)	M10	25 N m (18.4 lb ft)
4200-6408		25mm^2 4AWG	2.3 N m (1.7 lb ft)	M6	3.9 N m (2.9 lb ft)
4200-6503		95mm^2 4/0AWG	20 N m (14.7 lb ft)	M10	25 N m (18.4 lb ft)
4200-6504		50mm^2 0AWG	8 N m (5.9 lb ft)		
4200-6603					
4200-6604					
4200-6211	Epcos	10mm^2 8AWG	1.35 N m (1.0 lb ft)	M5	3.0 N m (2.2 lb ft)
4200-6306		16mm^2 6AWG	2.2 N m (1.6 lb ft)	M6	5.1 N m (3.8 lb ft)
4200-6308		10mm^2 8AWG	1.35 N m (1.0 lb ft)		
4200-6405		50mm^2 0AWG	6.8 N m (5.0 lb ft)	M10	10 N m (7.4 lb ft)
4200-6407					
4200-6501		95mm^2 4/0AWG	20 N m (14.7 lb ft)		
4200-6502					
4200-6601					
4200-6602					

The external EMC filters for sizes 2 and 3 can be footprint or bookcase mounted, see Figure 6-3 and Figure 6-4. The external EMC filters for sizes 4 to 6 are designed to be mounted above the drive, as shown in Figure 6-5.

WARNING

High ground leakage current
When an EMC filter is used, a permanent fixed ground connection must be provided which does not pass through a connector or flexible power cord. This includes the internal EMC filter.

NOTE

The installer of the drive is responsible for ensuring compliance with the EMC regulations that apply where the drive is to be used.

Mount the external EMC filter following the guidelines in section *Compliance with generic emission standards* on page 78.

Figure 6-3 Footprint mounting the EMC filter

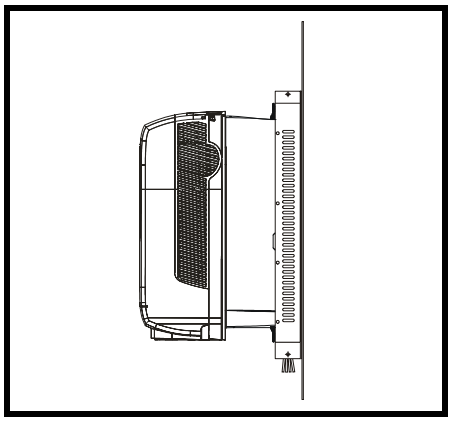


Figure 6-4 Bookcase mounting the EMC filter

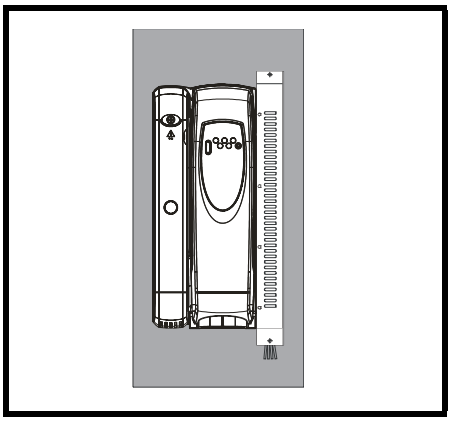


Figure 6-5 Size 4 to 6 mounting of EMC filter

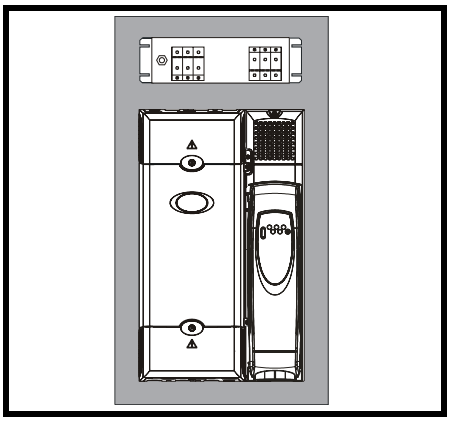
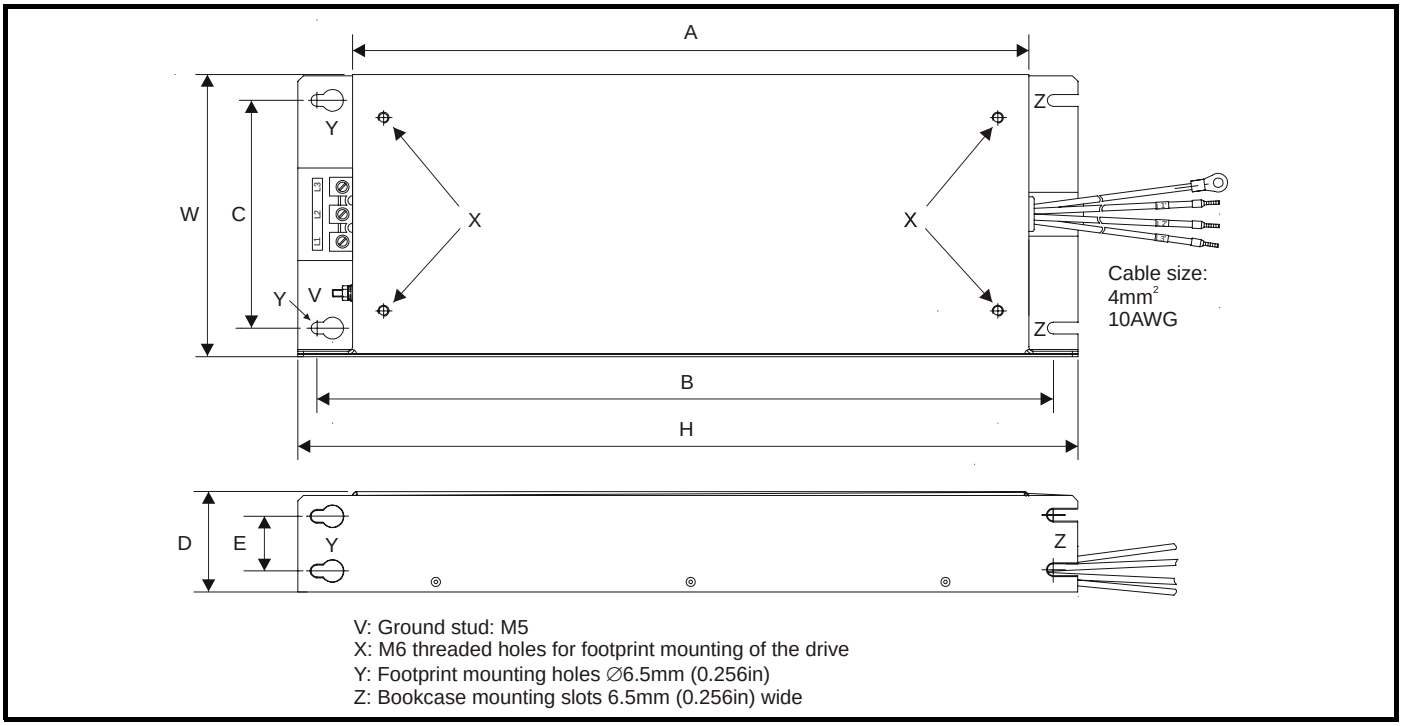


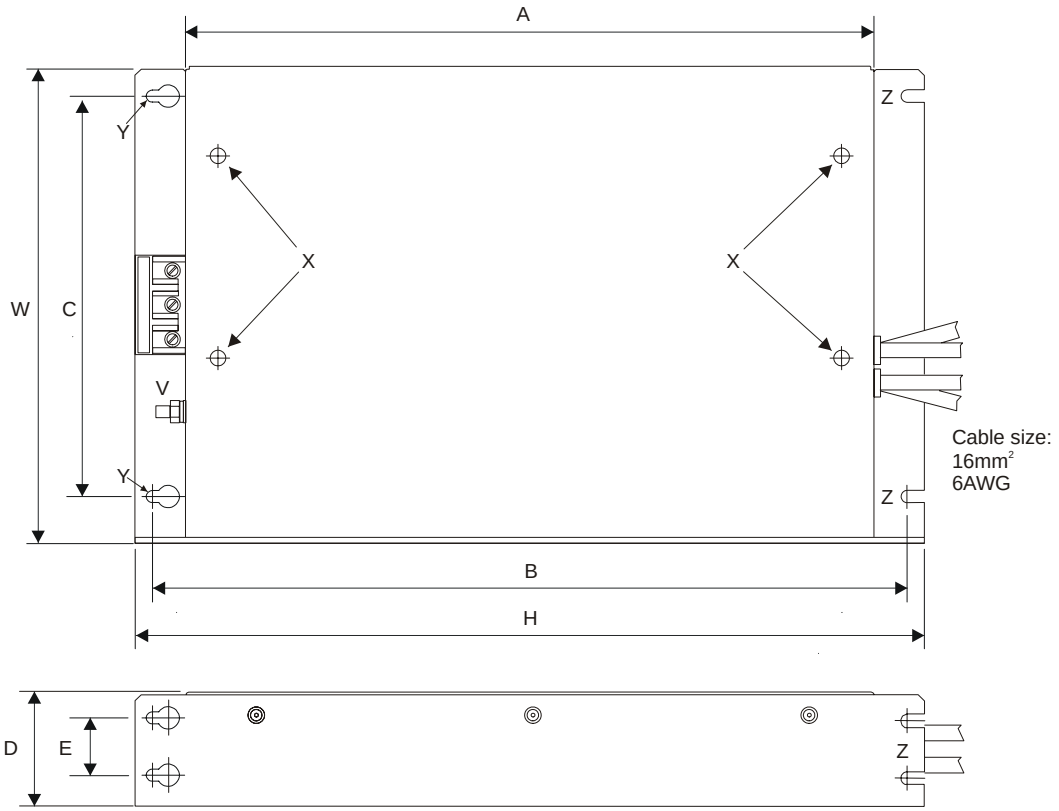
Figure 6-6 Size 2 external EMC filter



All filter mounting holes are suitable for M6 fasteners.

CT part no.	Manufacturer	A	B	C	D	E	H	W
4200-6210	Schaffner	371.5 mm (14.626 in)	404.5 mm (15.925 in)	125 mm (4.921 in)	55 mm (2.165 in)	30 mm (1.181 in)	428.5 mm (16.870 in)	155 mm (6.102 in)
4200-6211	Epcos						431.5 mm (16.988 in)	

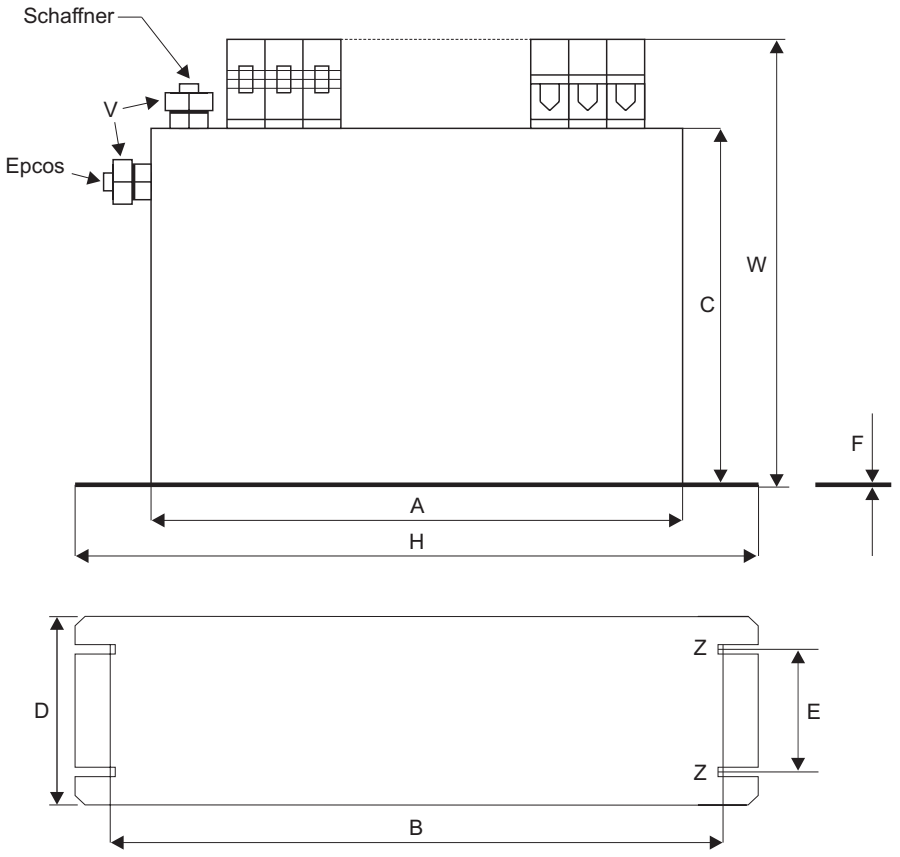
Figure 6-7 Size 3 external EMC filter



V: Ground stud: M6
X: M6 threaded holes for footprint mounting of the drive
Y: Footprint mounting holes ∅6.5mm (0.256in)
Z: Bookcase mounting slots 6.5mm (0.256in) wide

CT part no.	Manufacturer	A	B	C	D	E	H	W
4200-6305	Schaffner	361 mm (14.213 in)	396 mm (15.591 in)	210 mm (8.268 in)	60 mm (2.362 in)	30 mm (1.181 in)	414 mm (16.299 in)	250 mm (9.843 in)
4200-6307								
4200-6309								
4200-6306	Epcos	365 mm (14.370 in)					425 mm (16.732 in)	
4200-6308								

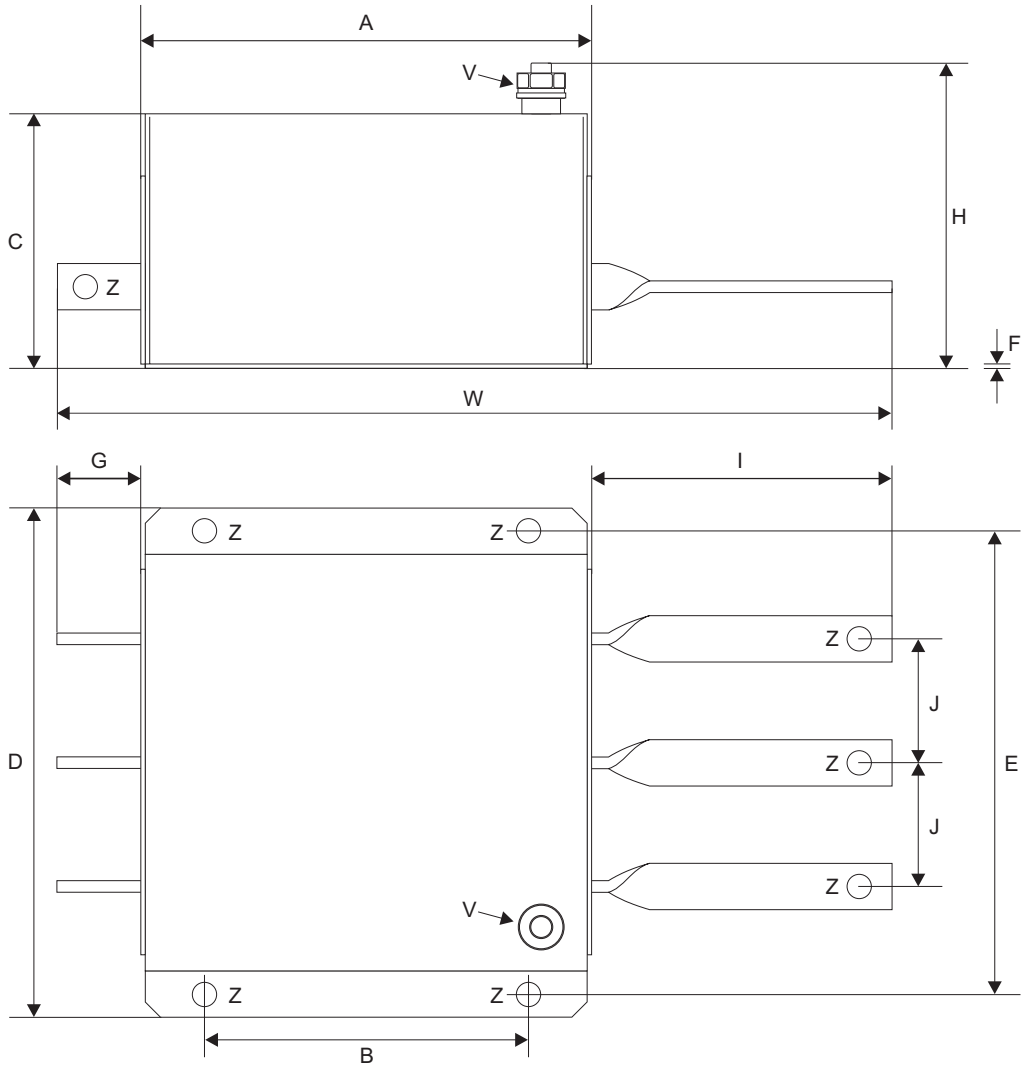
Figure 6-8 Size 4 and 5 external EMC filter



V: Ground stud: M10
Z: Bookcase mounting slots 6.5mm (0.256in wide)

CT part no.	Manufacturer	A	B	C	D	E	F	H	W
4200-6406	Schaffner	260 mm (10.236 in)	275 mm (10.827 in)	170 mm (6.693 in)	100 mm (3.937 in)	65 mm (2.559 in)	1.5 mm (0.059in)	300 mm (11.811 in)	225 mm (8.858 in)
4200-6408									208 mm (8.189 in)
4200-6503					120 mm (4.724 in)	85 mm (3.346 in)			249 mm (9.803 in)
4200-6504					100 mm (3.937 in)	65 mm (2.559 in)			225 mm (8.858 in)
4200-6405	Epcos			150 mm (5.906 in)	90 mm (3.543in)	65 mm (2.559 in)	2 mm (0.079 in)		207 mm (8.150 in)
4200-6407									205 mm (8.071 in)
4200-6501				170 mm (6.693 in)	120 mm (4.724 in)	85 mm (3.346 in)	1 mm (0.039 in)		249 mm (9.803 in)
4200-6502									

Figure 6-9 Size 6 external EMC filter



V: Ground stud: M10
Z: Hole size: ∅10.5mm

CT part no.	Manufacturer	A	B	C	D	E	F	G	H	I	J	W
4200-6603	Schaffner	196 mm (7.717 in)	139.9 mm (5.508 in)	108 mm (4.252 in)	230 mm (9.055 in)	210 mm (8.268 in)	2 mm (0.079in)	38 mm (1.496 in)	136 mm (5.354 in)	128 mm (5.039 in)	53.5 mm (2.106 in)	364 mm (14.331 in)

6.2.3 Conformity for sizes 2 to 6

Table 6-9 Conformity size 2 to 4

Drive	Motor cable length (m)	Filter and switching frequency								
		Internal			Internal and ferrite*			External		
		3kHz	6kHz	12kHz	3kHz	6kHz	12kHz	3kHz	6kHz	12kHz
VFK2201 to VFK2203	Any	E2R								
	0 to 4				E2U		E2R			
	4 to 10				E2U	E2R				
	> 10				E2R					
	0 to 25							R		I
	25 to 75							I		
	75 to 100							I		
VFK2401 to VFK2404	Any	E2R								
	0 to 4				E2U		E2R			
	4 to 10				E2U	E2R				
	> 10				E2R					
	0 to 25							R		I
	25 to 75							I		
	75 to 100							I		
VFK3201 to VFK3202	Any	E2R								
	0 to 10				E2U	E2R				
	> 10				E2R					
	0 to 20							R	I	
	20 to 50							I		
	50 to 75							I		
	75 to 100							I		
VFK3401 to VFK3403	Any	E2R								
	0 to 10				E2U	E2R				
	> 10				E2R					
	0 to 20							R	I	
	20 to 50							I		
	50 to 75							I		
	75 to 100							I		
VFK3501 to VFK3507	Any									
	0 to 10									
	> 10									
	0 to 20									
	20 to 50									
	50 to 75									
	75 to 100									
VFK4201 to VFK4203	Any	E2R								
	0 to 25							I		
	25 to 50							I		
	50 to 75							I	E2U	
	75 to 100							I	E2U	
VFK4401 to VFK4403	Any	E2R								
	0 to 25							I		
	25 to 50							I		
	50 to 75							I	E2U	
	75 to 100							I	E2U	

* Included in the Accessory Kit Box.

Table 6-10 Conformity size 4 to 6

Drive	Motor cable length (m)	Filter and switching frequency			
		Internal		External	
		3kHz	6kHz	3kHz	6kHz
VFK4601 to VFK4606	Any	E2R			
	0 to 25			I	I
	25 to 50			I	E2U
	50 to 75			I	E2U
	75 to 100			I	E2U
VFK5401 to VFK5402	100	E2U			
	0 to 100			I	I
VFK5601 to VFK5602	100	E2R			
	0 to 25			I	I
	0 to 100			I	
VFK6401 to VFK6402	0 to 100	E2U			
	100 to max*	E2R			
	0 to 100			I	I
VFK6601 to VFK6602	0 to 100	E2U			
	100 to max*	E2R			
	0 to 25			I	I
	0 to 100			I	Do not use

See Chapter 8 *Motor cable lengths* on page 88 for maximum permitted length.

Key (shown in decreasing order of permitted emission level):

E2R EN 61800-3 second environment, restricted distribution (Additional measures may be required to prevent interference)

E2U EN 61800-3 second environment, unrestricted distribution

I Industrial generic standard EN 50081-2 (EN 61000-6-4) EN 61800-3 first environment restricted distribution (The following caution is required by EN 61800-3)

CAUTION

This is a product of the restricted distribution class according to IEC 61800-3. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

R Residential generic standard EN 50081-1 (EN 61000-6-3) EN 61800-3 first environment unrestricted distribution

EN 61800-3 defines the following:

- The first environment is one that includes domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.
- The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes.
- Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

Electromagnetic compatibility (EMC)

This is a summary of the EMC performance of the drive.

Table 6-11 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC61000-4-2 EN61000-4-2	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
IEC61000-4-3 EN61000-4-3	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3 (industrial)
IEC61000-4-4 EN61000-4-4	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC61000-4-5 EN61000-4-5	Surges	Common mode 4kV 1.2/50µs waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2kV 1.2/50µs waveshape	AC supply lines: line to line	Level 3
		Lines to ground	Signal ports to ground [1]	Level 2
IEC61000-4-6 EN61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
IEC61000-4-11 EN61000-4-11	Voltage dips and interruptions	-30% 10ms +60% 100ms -60% 1s <-95% 5s	AC power ports	
EN50082-1 IEC61000-6-1 EN61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN50082-2 IEC61000-6-2 EN61000-6-2	Generic immunity standard for the industrial environment			Complies
EN61800-3 IEC61800-3 EN61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

[1] See section *Surge immunity of control circuits - long cables and connections outside a building* on page 78 for control ports for possible requirements regarding grounding and external surge protection

Emission

The drive contains an in-built filter for basic emission control. An additional optional external filter provides further reduction of emission. The requirements of the standards are met, depending on the motor cable length and switching frequency.

Surge immunity of control circuits - long cables and connections outside a building

The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.

These circuits meet the requirements of EN61000-6-2 (1kV surge) provided the 0V connection is not grounded.

In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. This is a particular risk where the circuits extend outside the protection of a building.

As a general rule, if the circuits are to pass outside the building where the drive is located, or if cable runs within a building exceed 30m, some additional precautions are advisable. One of the following techniques should be used:

6. Galvanic isolation, i.e. do not connect the control 0V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0V) wire.
7. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least $10mm^2$, or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
8. Additional over-voltage suppression - for the analogue and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 6-10 and Figure 6-11.

If a digital port experiences a severe surge its protective trip may operate (O.Ld1 trip code 26). For continued operation after such an event, the trip can be reset automatically by setting Pr **10.34** to 5.

Figure 6-10 Surge suppression for digital and unipolar inputs and outputs

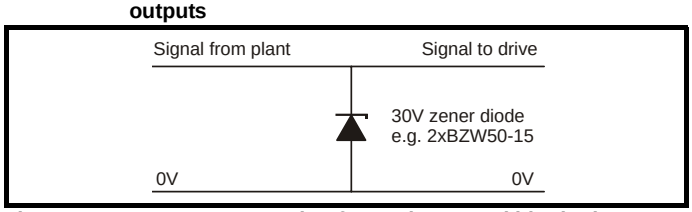
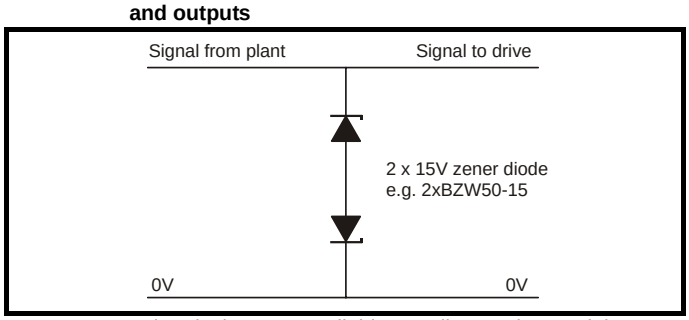


Figure 6-11 Surge suppression for analogue and bipolar inputs and outputs



Surge suppression devices are available as rail-mounting modules, e.g. from Phoenix Contact:

Unipolar TT-UKK5-D/24 DC
Bipolar TT-UKK5-D/24 AC

These devices are not suitable for encoder signals or fast digital data networks because the capacitance of the diodes adversely affects the signal. Most encoders have galvanic isolation of the signal circuit from the motor frame, in which case no precautions are required. For data networks, follow the specific recommendations for the particular network.

Compliance with generic emission standards

The following information applies to frame sizes 2 to 5.

Size 6 upwards does not comply with the requirements of the generic standards for radiated emission.

Size 6 complies with the requirements for conducted emission.

Use the recommended filter and shielded motor cable. Observe the layout rules given in Figure 6-12. Ensure the AC supply and ground cables are at least 100mm from the power module and motor cable.

Figure 6-12 Supply and ground cable clearance (size 2 to 3)

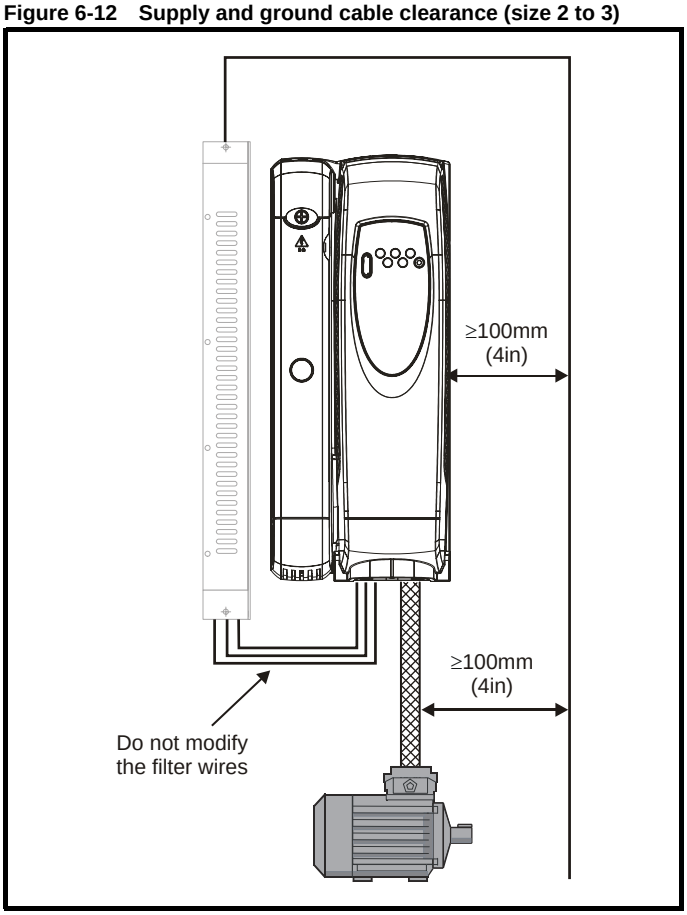
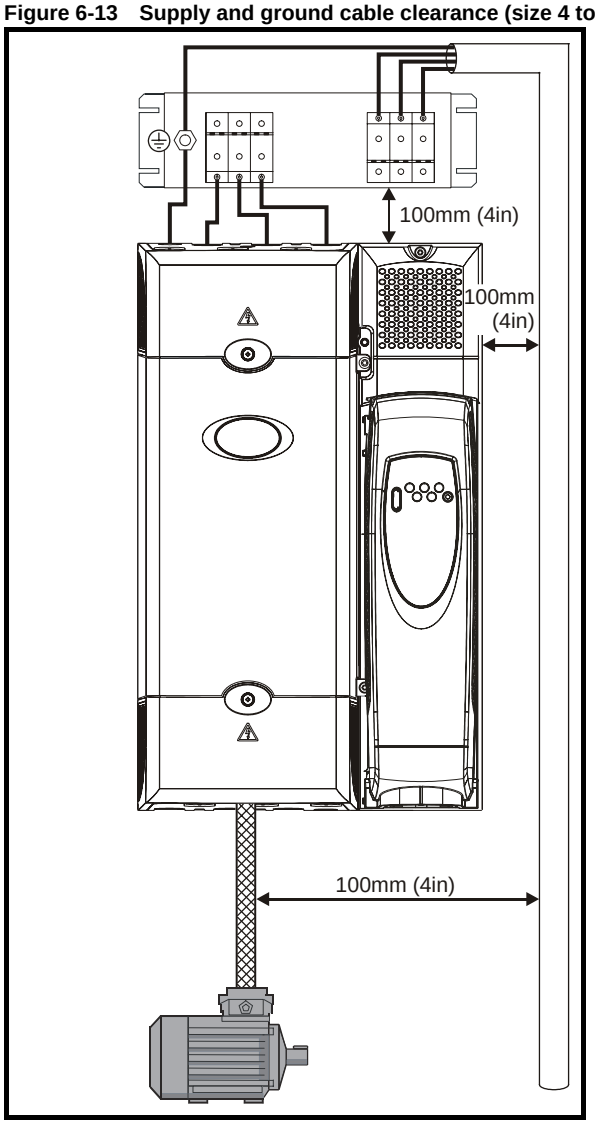
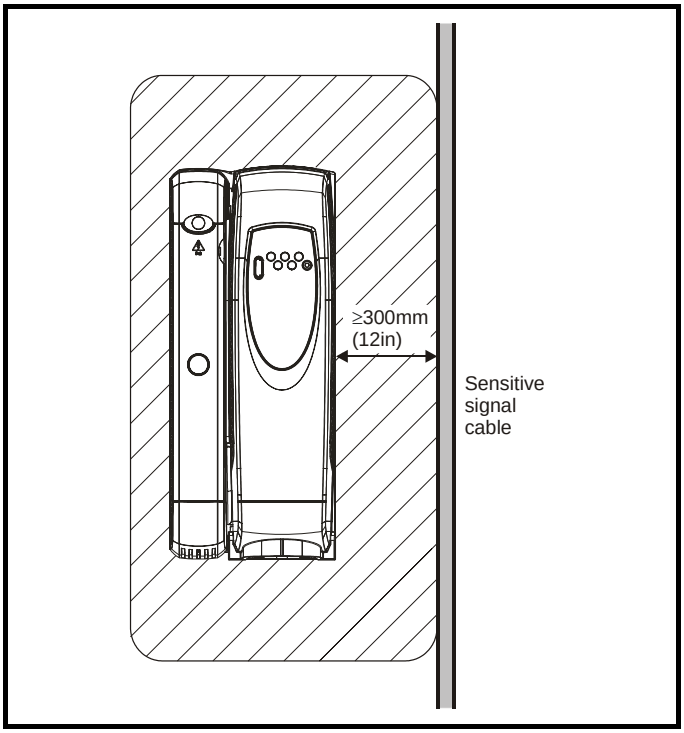


Figure 6-13 Supply and ground cable clearance (size 4 to 6)



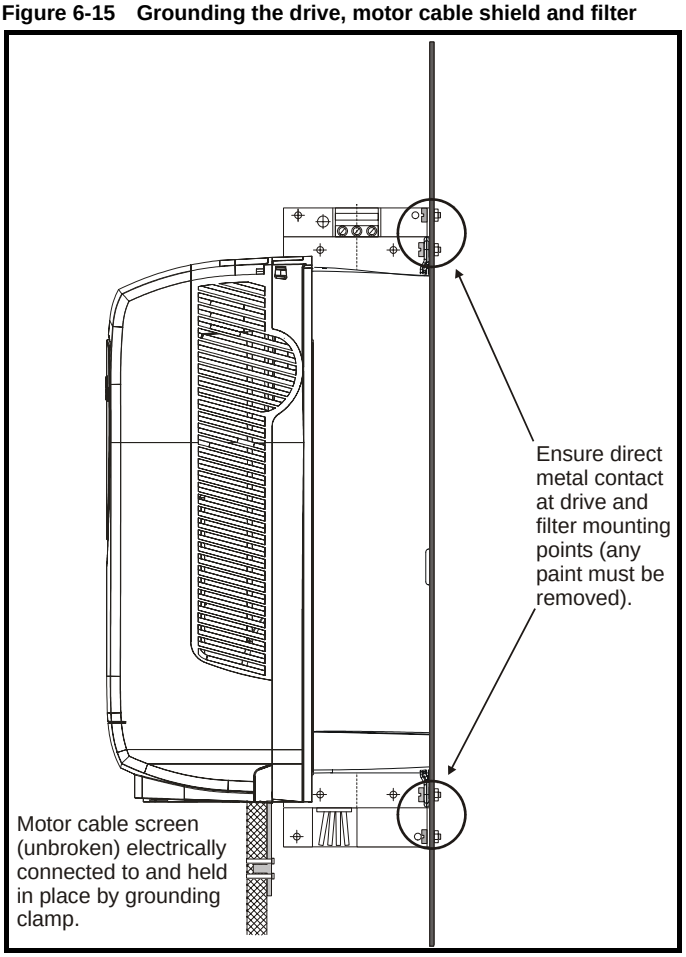
Avoid placing sensitive signal circuits in a zone 300mm (12in) all around the power module.

Figure 6-14 Sensitive signal circuit clearance



Ensure good EMC grounding.

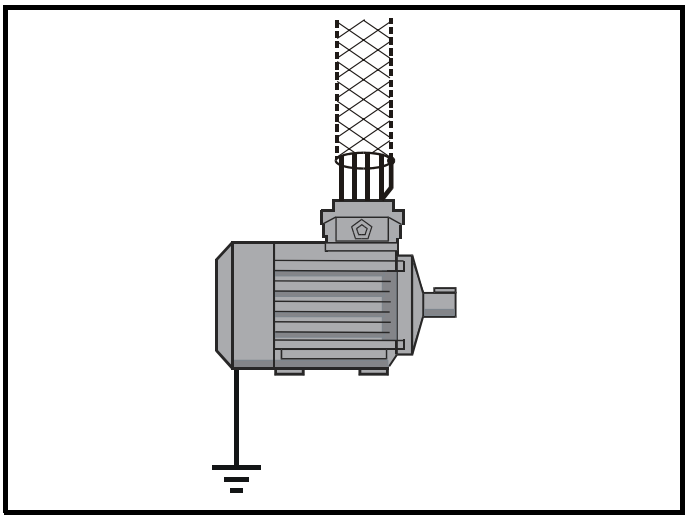
Figure 6-15 Grounding the drive, motor cable shield and filter



Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2in) long. A full 360° termination of the shield to the terminal housing of the motor is beneficial.

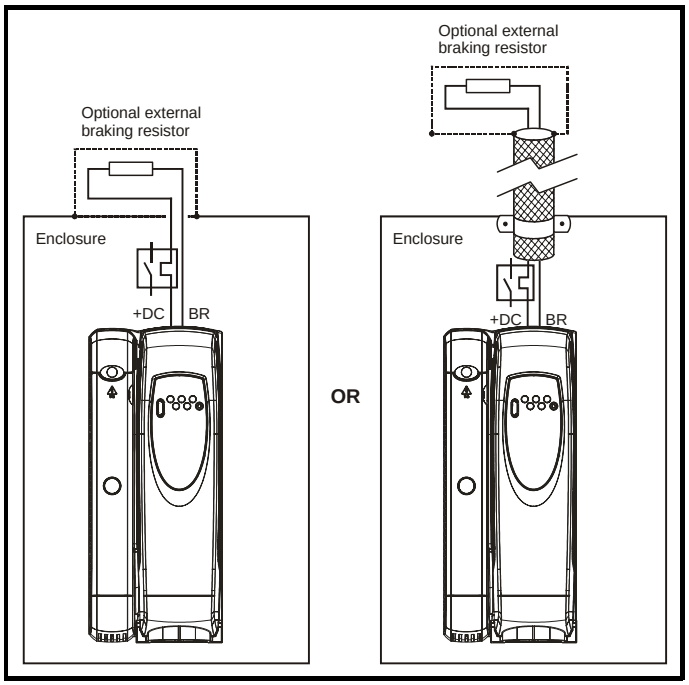
It is unimportant for EMC purposes whether the motor cable contains an internal (safety) ground core, or there is a separate external ground conductor, or grounding is through the shield alone. An internal ground core will carry a high noise current and therefore it must be terminated as close as possible to the shield termination.

Figure 6-16 Grounding the motor cable shield



Unshielded wiring to the optional braking resistor(s) may be used, provided the wiring does not run external to the enclosure. Ensure a minimum spacing of 300mm (12in) from signal wiring and the AC supply wiring to the external EMC filter. Otherwise this wiring must be shielded.

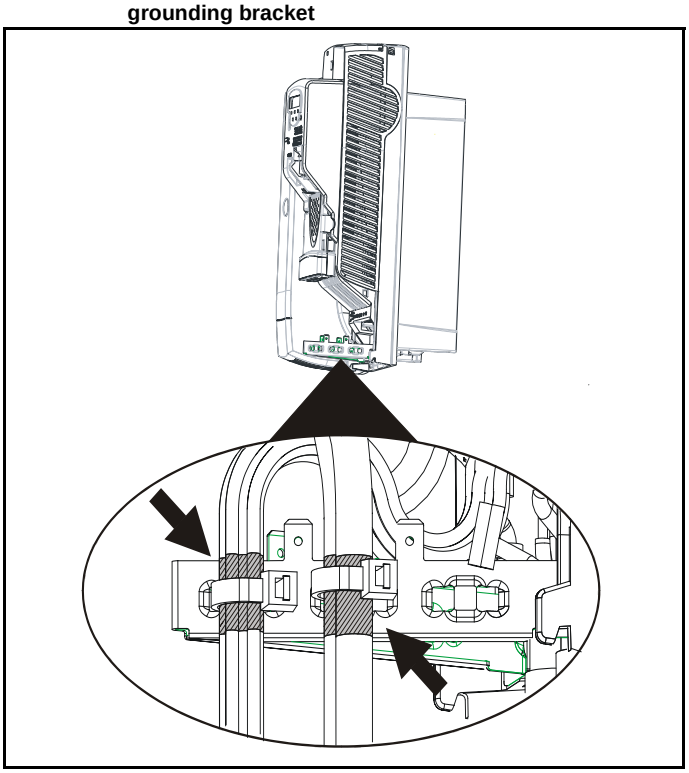
Figure 6-17 Shielding requirements of optional external braking resistor



If the control wiring is to leave the enclosure, it must be shielded and the shield(s) clamped to the drive using the grounding bracket as shown in Figure 6-18. Remove the outer insulating cover of the cable to ensure the shield(s) make contact with the bracket, but keep the shield(s) intact until as close as possible to the terminals

Alternatively, wiring may be passed through a ferrite ring, part no. 3225-1004.

Figure 6-18 Grounding of signal cable shields using the grounding bracket



Variations in the EMC wiring
Interruptions to the motor cable

The motor cable should ideally be a single length of shielded or armoured cable having no interruptions. In some situations it may be necessary to interrupt the cable, as in the following examples:

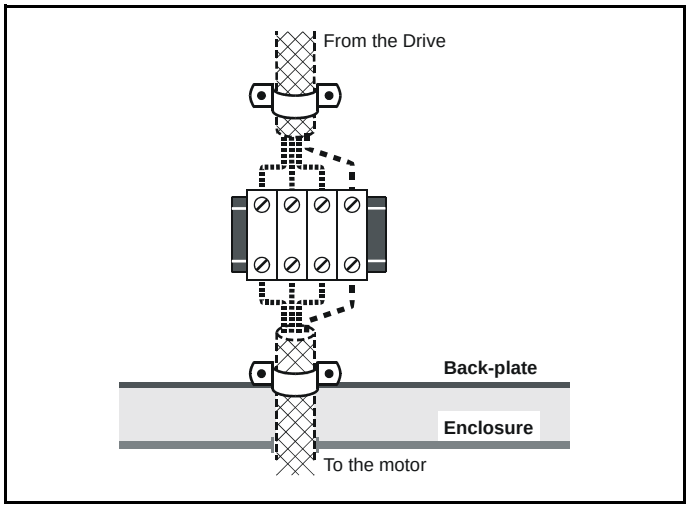
- Connecting the motor cable to a terminal block in the drive enclosure
- Fitting a motor isolator switch for safety when work is done on the motor

In these cases the following guidelines should be followed.

Terminal block in the enclosure

The motor cable shields should be bonded to the back-plate using uninsulated metal cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away from the terminal block.

Figure 6-19 Connecting the motor cable to a terminal block in the enclosure



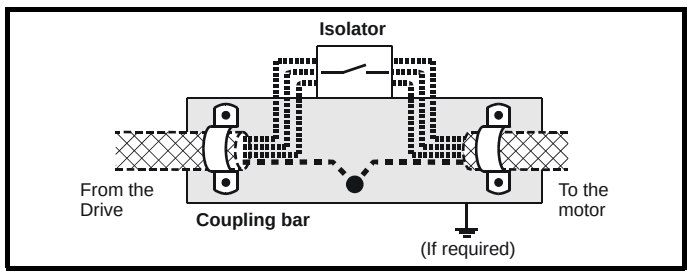
Using a motor isolator-switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal coupling-bar is recommended; conventional wire is not suitable.

The shields should be bonded directly to the coupling-bar using uninsulated metal cable-clamps. Keep the length of the exposed power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away.

The coupling-bar may be grounded to a known low-impedance ground nearby, for example a large metallic structure which is connected closely to the drive ground.

Figure 6-20 Connecting the motor cable to an isolator switch

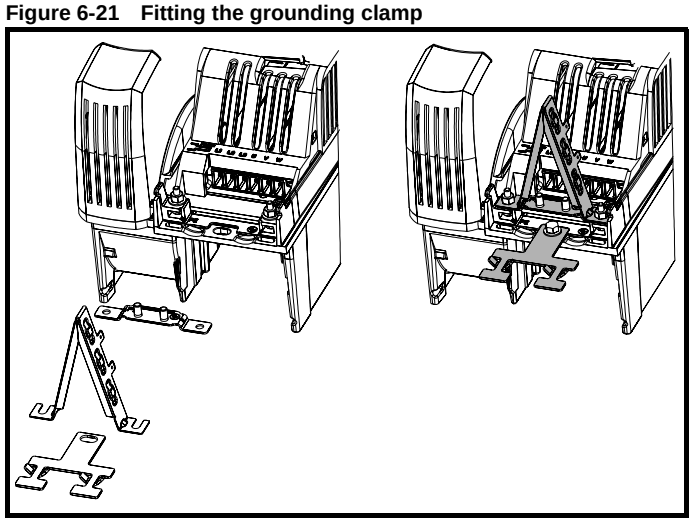


Grounding hardware

The VARIDYNE 2 size 2 and 3 are provided with a grounding bracket and grounding clamp. They can be used as cable management bracket/ clamp or they can be used to facilitate EMC compliance. They provide a convenient method for direct grounding of cable shields without the use of 'pig tails'. Cable shields can be bared and clamped to the grounding bracket using metal clips or clamps* (not supplied) or cable ties. Note that the shield must in all cases be continued through the cable clamp to the intended terminal on the drive, in accordance with the connection details for the specific signal.

*A suitable clamp is the Phoenix DIN rail mounted SK14 cable clamp (for cables with a maximum outer diameter of 14mm).

Figure 6-21 Fitting the grounding clamp



A faston tab is located on the grounding bracket for the purpose of connecting the drive 0V to ground should the user require to do so.

WARNING On VARIDYNE 2 size 2, the grounding bracket is secured using the power ground terminal of the drive. Ensure that the supply ground connection is secure after fitting/removing the grounding bracket. Failure to do so will result in the drive not being grounded.

When a VARIDYNE 2 size 4 or 5 is through-panel mounted, the grounding link bracket must be folded upwards. A screw can be used to secure the bracket or it can be located under the mounting bracket to ensure that a good ground connection is made. This is required to provide a grounding point for the grounding bracket as shown in Figure 6-22.

Figure 6-22 Grounding link bracket in its surface mount position (as supplied)

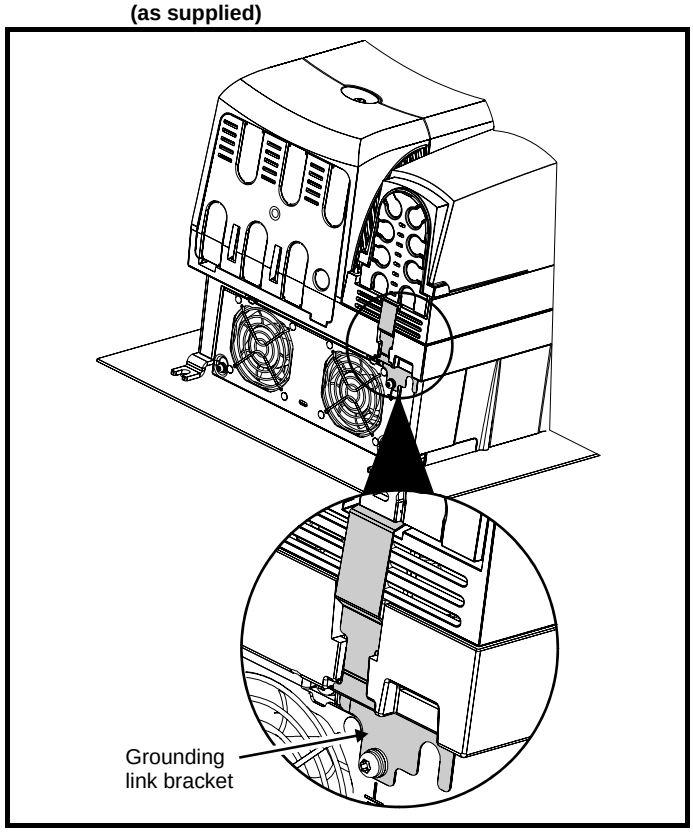
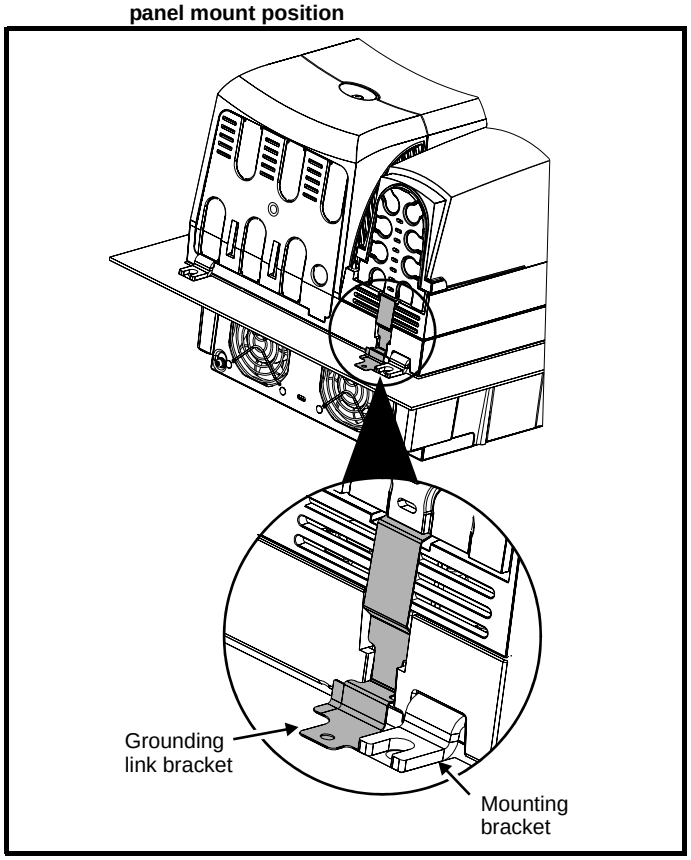


Figure 6-23 Grounding link bracket folded up into its through-panel mount position



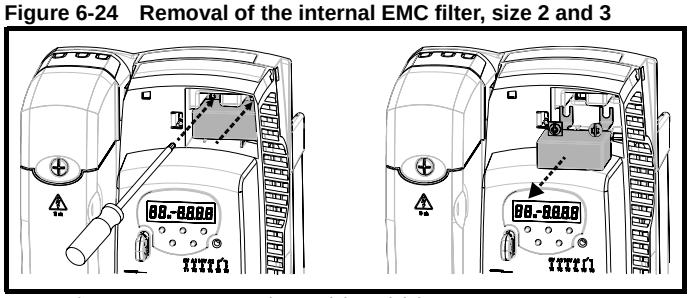
Internal EMC filter

It is recommended that the internal EMC filter be kept in place unless there is a specific reason for removing it.

> **WARNING** On VARIDYNE 2 size 3, 4, 5 and 6, when used with ungrounded (IT) supplies, the internal EMC filter must be removed unless additional motor ground fault protection is fitted or, in the case of size 3 only, the external EMC filter is also used.

For instructions on removal, refer to Figure 6-24.

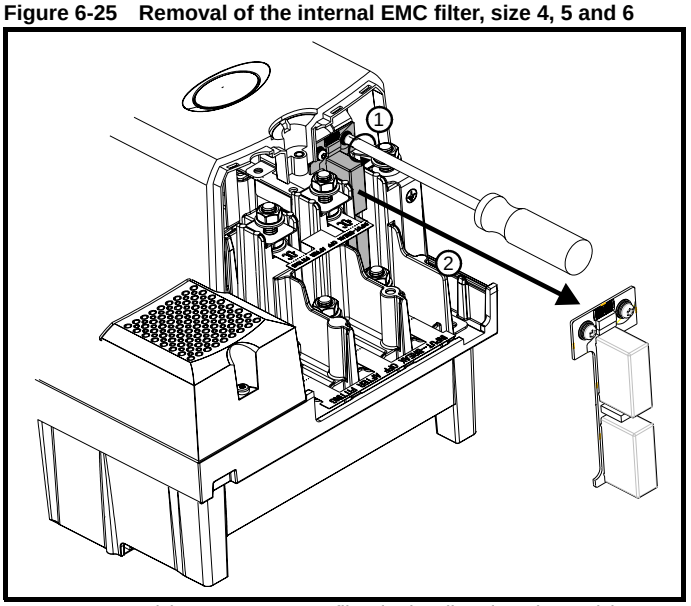
Figure 6-24 Removal of the internal EMC filter, size 2 and 3



Loosen/remove screws as shown (1) and (2).

Remove filter (3) and ensure the screws are replaced and re-tightened (4).

Figure 6-25 Removal of the internal EMC filter, size 4, 5 and 6



Loosen screws (1). Remove EMC filter in the direction shown (2).

The internal EMC filter reduces radio-frequency emissions into the mains supply. Where the motor cable length is short, it permits the requirements of EN61800-3 to be met for the second environment. For longer motor cables, the filter continues to provide a useful reduction in emission level, and when used with any length of shielded motor cable up to the limit for the drive, it is unlikely that nearby industrial equipment will be disturbed. It is recommended that the filter be used in all applications unless the instructions given above require it to be removed or the ground leakage current of 28mA is unacceptable.

Use of earth (ground) leakage circuit breakers (ELCB) / residual current device (RCD)

There are three common types of ELCB/RCD:

Type AC - detects AC fault currents
Type A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
Type B - detects AC, pulsating DC and smooth DC fault currents

- Type AC should never be used with drives
- Type A can only be used with single phase drives
- Type B must be used with three phase drives

Further EMC precautions

Further EMC precautions are required if more stringent EMC emission requirements apply:

- Operation in the first environment
- Conformity to the generic emission standards
- Equipment which is sensitive to electrical interference operating nearby

In this case it is necessary to use:

The optional external EMC filter

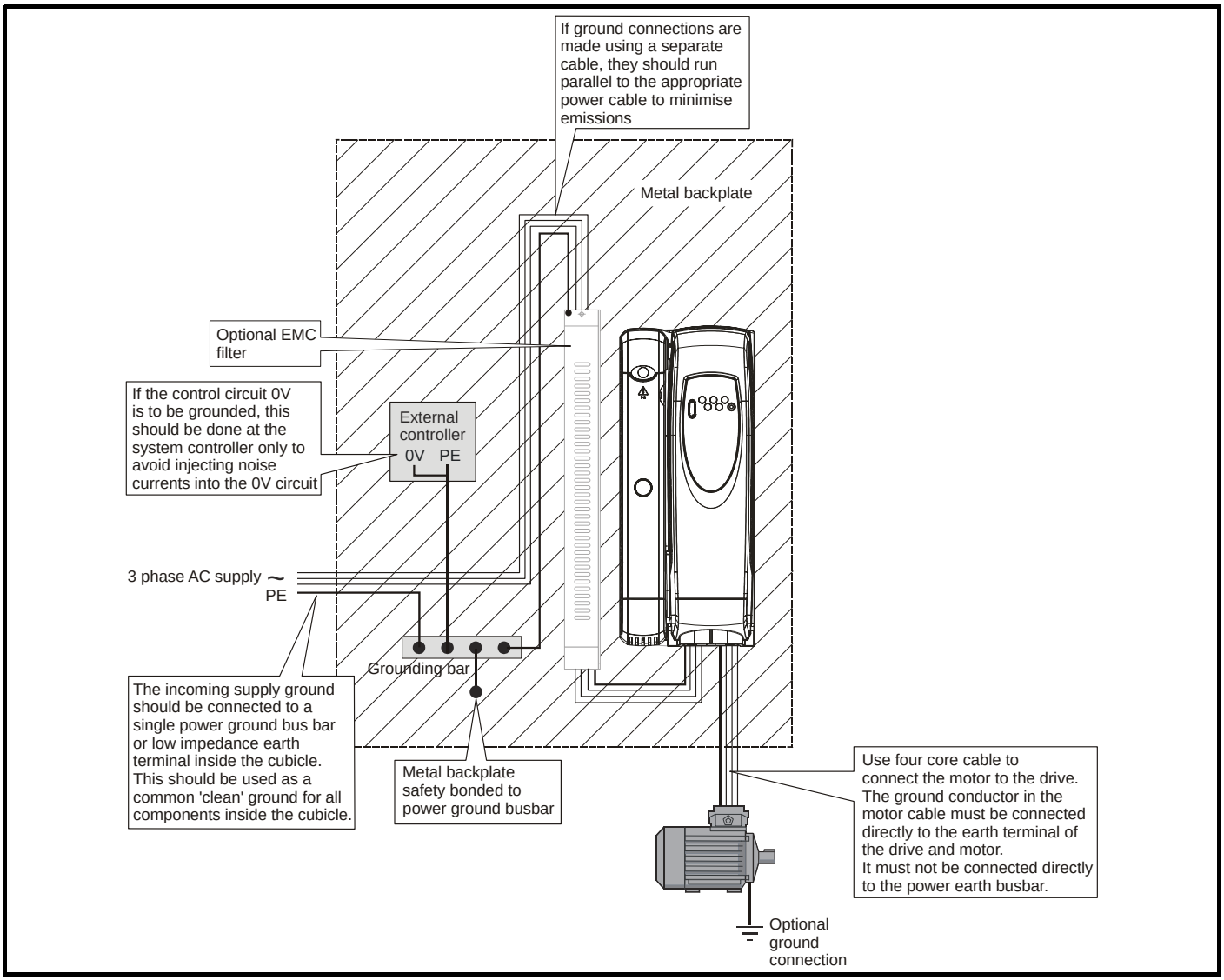
- A screened motor cable, with the screen clamped to the grounded metal panel
- A screened control cable, with the screen clamped to the grounded metal panel
- Full instructions are given in the *VARIDYNE 2 EMC Guide*
- A full range of external EMC filters is also available for use with VARIDYNE 2.

General requirements for EMC
Ground (earth) connections

The grounding arrangements should be in accordance with Figure 6-26, which shows a single drive on a back-plate with or without an additional enclosure.

Figure 6-26 shows how to manage EMC when using an unshielded motor cable. However a shielded cable is preferable, in which case it should be installed as shown in section *Compliance with generic emission standards* on page 78.

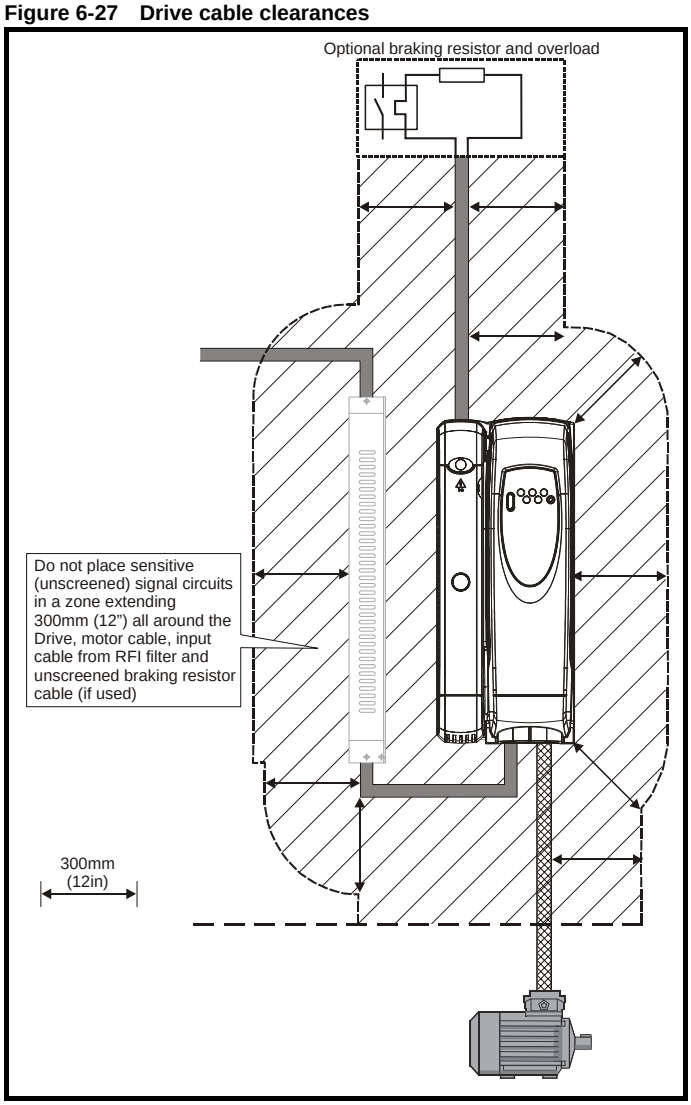
Figure 6-26 General EMC enclosure layout showing ground connections



Cable layout

Figure 6-27 indicates the clearances which should be observed around the drive and related ‘noisy’ power cables by all sensitive control signals / equipment.

Figure 6-27 Drive cable clearances



NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor, motor brake) will pick up large pulse currents via the cable capacitance. The screen of these signal cables must be connected to ground close to the motor cable, to avoid this noise current spreading through the control system.

7 AC line reactors

Table 7-1 AC line reactor values

Drives used with	Reactor part number	Input phases	Inductance	Continuous rms current	Peak current	Weight	Dimensions		
			mH	A	A	Kg	L	D	H
VFKA1200025	4402-0224	1	2.25	6.5	13	0.8	72	65	90
VFKA1200037									
VFKA1200055	4402-0225	1	1.0	15.1	30.2	1.1	82	75	100
VFKA1200075									
VFKBD200110									
VFKBD200150	4402-0226	1	0.5	26.2	52.4	1.5	82	90	105
VFKCD200220									
VFKBD200110	4402-0228	3	1.0	15.4	47.4	3.8	150	90	150
VFKBD200150									
VFKCD200220	4402-0229	3	0.4	24.6	49.2	3.8	150	90	150
VFKB3400037	4402-0227	3	2.0	7.9	15.8	3.5	150	90	150
VFKB3400055									
VFKB3400075									
VFKB3400110									
VFKB3400150									
VFKC3400220	4402-0228	3	1.0	15.4	47.4	3.8	150	90	150
VFKC3400300									
VFKC3400400									
VFK2201	4402-0229	3	0.4	24.6	49.2	3.8	150	90	150
VFK2202									
VFK2401									
VFK2402	4402-0232	3	0.6	27.4	54.8	6	180	100	190
VFK2403	4400-0240**	3	0.45	46	92		190	150	225
VFK2404									
VFK3401									
VFK3402									
VFK2203	4400-0241**	3	0.3	74	148		250	150	275
VFK3201*									
VFK3202*									
VFK4201*									
VFK3403									
VFK4401									

NOTE

VARIDYNE 2 sizes 2, 3 and 4 drives include DC chokes, AC reactors are only required for harmonic reduction.

NOTE

* The reactance values will be higher than 2% with these drives, which may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

** These input reactors are not stocked by USEM. Therefore they should be ordered directly from the manufacturer, Skot Transformers, or sourced locally.

sales@skot.co.uk

They can be ordered using the above part numbers or Skot reference numbers:

4400-0240 = 35232

4400-0241 = 35233

7.1 Line reactors

Input line reactors reduce the risk of damage to the drive resulting from poor phase balance or severe disturbances on the supply network.

Where line reactors are to be used, reactance values of approximately 2% are recommended. Higher values may be used if necessary, but may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

For all drive ratings, 2% line reactors permit drives to be used with a supply imbalance of up to 3.5% negative phase sequence (equivalent to 5% voltage imbalance between phases).

Severe disturbances may be caused by the following factors, for example:

- Power factor correction equipment connected close to the drive.
- Large DC drives having no or inadequate line reactors connected to the supply.
- Direct-on-line started motor(s) connected to the supply such that when any of these motors are started, the voltage dip exceeds 20%.

Such disturbances may cause excessive peak currents to flow in the input power circuit of the drive. This may cause nuisance tripping, or in extreme cases, failure of the drive.

Drives of low power rating may also be susceptible to disturbance when connected to supplies with a high rated capacity.

Model sizes VFK2201 to VFK4606 have an internal DC choke and VFK5401 to VFK6602 have internal AC line chokes, so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions.

When required, each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

NOTE

RFI filters (for EMC purposes) do not give adequate protection against these conditions.

7.2 Reactor current ratings

Continuous current:

Not less than the continuous input current rating of the drive.

Repetitive peak current rating:

Not less than twice the continuous input current rating of the drive.

Voltage fluctuation (Flicker) standard EN61000-3-3 (IEC61000-3-3)

Those models that fall within the scope of EN61000-3-3, as stated in the declaration of Conformity, conform to the requirements for manual switching, i.e. the voltage dip caused when a drive at room temperature is switched on is within the permitted limits.

The drive does not of itself cause periodic voltage fluctuation in normal operation. The installer must ensure that the control of the drive is such that periodic fluctuations in supply current do not infringe the flicker requirements where applicable. Note that large periodic load fluctuations in the frequency range of between 1Hz and 30Hz are particularly inclined to cause irritating lighting flicker and are subject to stringent limits under EN61000-3-3.

7.3 Input line reactors for harmonics standards EN61000-3-2 and IEC61000-3-2

The following input line reactors allow the VARIDYNE 2 0.25 - 0.55kW drives to conform to harmonic standards EN61000-3-2 and IEC61000-3-2.

Table 7-2 Input line reactors for harmonics standards EN61000-3-2 and IEC61000-3-2

Drive	Reactor part number	Drive power de-rating	Input power	Inductance	Continuous rms current
			W	mH	
VFKA12200025	4400-0239	None	374	4.5	2.4
VFKA12200037	4400-0238	None	553	9.75	3.2
VFKA12200055	4400-0237	18%	715	16.25	4.5

EN61000-3-2 and IEC61000-3-2 applies to equipment with a supply voltage of 230VAC and a line current up to 16A, single or three phase. Professional equipment with rated input power exceeding 1kW has no limits - this applies to the 0.75kW drive.

Further information on EN61000-3-2 and IEC61000-3-2 is included on the EMC data sheets available from your local drive centre or distributor.

Figure 7-1 Input line reactor 4402-0224, 4402-0225 and 4402-0226

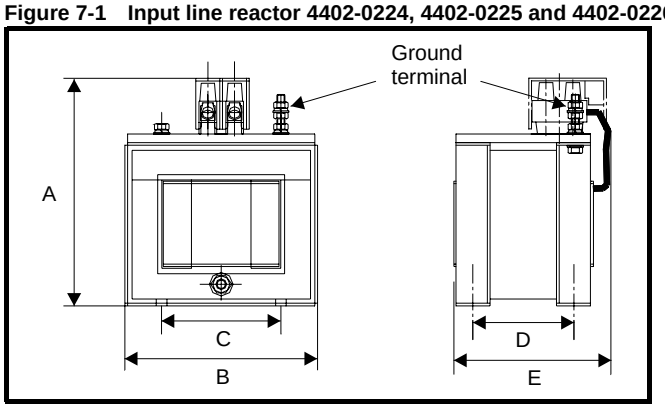


Table 7-3 Dimensions

Part No	Dimensions						Ground terminal
	A	B	C	D	E	Fixing hole	
4402-0224	90mm (3.54in)	72mm (2.84in)	44.5mm (1.75in)	35mm (1.38in)	65mm (2.56in)	8mm x 4mm (0.32in x 0.16in)	M3
4402-0225	100mm (3.94in)	82mm (3.23in)	54mm (2.13in)	40mm (1.58in)	75mm (2.95in)		
4402-0226	105mm (4.13in)			53mm (2.09in)	90mm (3.54in)		

Figure 7-2 Input line reactor 4402-0227, 4402-0228, 4402-0229

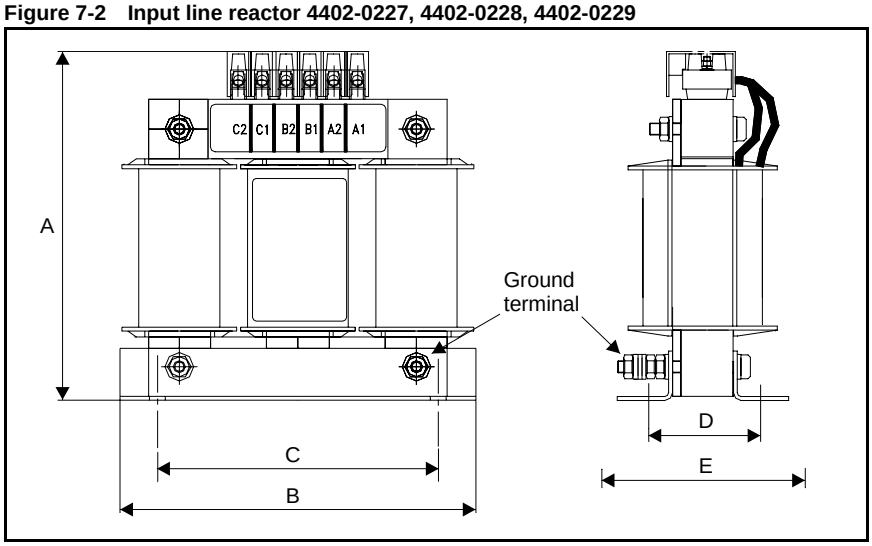


Table 7-4 Dimensions

Part No	Dimensions						Ground terminal
	A	B	C	D	E	Fixing slot	
4402-0227	150mm (5.91in)	150mm (5.91in)	120mm (4.72in)	47mm (1.85in)	90mm (3.54in)	17mm x 7 mm (0.67in x 0.28in)	M5
4402-0228							
4402-0229							

7.3.1 Input Inductor calculation

To calculate the inductance required (at **Y**%), use the following equation:

$$\mathbf{L} = \frac{\mathbf{Y}}{\mathbf{100}} \times \frac{\mathbf{V}}{\sqrt{\mathbf{3}}} \times \frac{\mathbf{1}}{\mathbf{2\pi f I}}$$

Where:

I = drive rated input current (A)
L = inductance (H)
f = supply frequency (Hz)
V = voltage between lines

8 Motor cable lengths

8.1 VARIDYNE 2 size A to C

Table 8-1 Motor cable lengths

Drive frame size	kW rating	Maximum motor cable length
A	0.25 and 0.37	50m
	0.55 and 0.75	75m
B		100m
C		100m

The capacitive loading of the drive by the motor cable means that the cable length limits shown in table 8-1 must be observed. Failure to do so can result in spurious OI.AC tripping of the drive. If longer cable lengths are required, consult your local Drive Centre or Distributor.

The maximum cable lengths were measured using cable with capacitance of 130pF/m.

This capacitance was measured by taking one phase as one node and the screen (shield) and earth (ground) (if any) as the other node, then measuring the capacitance between the two points.

8.2 VARIDYNE 2 size 2 to 6

Table 8-2 Maximum motor cable lengths (200V drives)

200V Nominal AC supply voltage			
Model	**Maximum permissible motor cable length for each of The following frequencies**		
	3kHz	**6kHz**	**12kHz**
VFK2201	200m (660ft)	100m (330ft)	50m (165ft)
VFK2202			
VFK2203			
VFK3201			
VFK3202			
VFK4201	250m (820ft)	125m (410ft)	
VFK4202			
VFK4203			

Table 8-3 Maximum motor cable lengths (400V drives)

400V Nominal AC supply voltage			
Model	**Maximum permissible motor cable length for each of The following frequencies**		
	3kHz	**6kHz**	**12kHz**
VFK2401	200m (660ft)	100m (330ft)	50m (165ft)
VFK2402			
VFK2403			
VFK2404			
VFK3401			
VFK3402			
VFK3403			
VFK4401	250m (820ft)	125m (410ft)	
VFK4402			
VFK4403			
VFK5401			
VFK5402			
VFK6401			
VFK6402			

Table 8-4 Maximum motor cable lengths (575V drives)

575V Nominal AC supply voltage			
Model	**Maximum permissible motor cable length for each of The following frequencies**		
	3kHz	**6kHz**	**12kHz**
VFK3501	200m (660ft)	100m (330ft)	
VFK3502			
VFK3503			
VFK3504			
VFK3505			
VFK3506			
VFK3507			

Table 8-5 Maximum motor cable lengths (690V drives)

690V Nominal AC supply voltage			
Model	**Maximum permissible motor cable length for each of The following frequencies**		
	3kHz	**6kHz**	**12kHz**
VFK4601	250m (820ft)	125m (410ft)	
VFK4602			
VFK4603			
VFK4604			
VFK4605			
VFK4606			
VFK5601			
VFK5602			
VFK6601			
VFK6602			

- Cable lengths in excess of the specified values may be used only when special techniques are adopted; refer to the supplier of the drive.
- The default switching frequency is 3kHz.

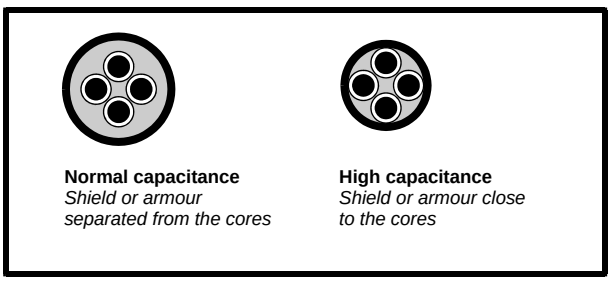
High-capacitance cables

The maximum cable length is reduced from that shown in Table 8-1, Table 8-2, Table 8-3 and Table 8-4 if high capacitance motor cables are used.

Most cables have an insulating jacket between the cores and the armour or shield; these cables have a low capacitance and are recommended.

Cables that do not have an insulating jacket tend to have high capacitance; if a cable of this type is used, the maximum cable length is half that quoted in the tables. (Figure 8-1 shows how to identify the two types.)

Figure 8-1 Cable construction influencing the capacitance



9 General data

9.1 Ratings

9.1.1 IP rating

All sizes

IP20

- The drive complies with the requirements of IP20 as standard.

Size A to C

IP4X

- The top surface of the drive complies with the requirements of IP4X when the drive is mounted vertically with the optional top cover fitted.

Size 2 to 6

IP54

- The drive can achieve IP54 rating (NEMA 12) at the rear of the heatsink for through-panel mounting (some current derating is required).

First digit: Protection against contact and ingress of foreign bodies.

2 - Protection against medium size foreign bodies Ø > 12mm (e.g. finger)

4 - Protected against solid objects over 1mm (e.g. tools, wires and small wires)

5 - Protection against dust deposit, complete protection against accidental contact

Second digit: Protection against ingress of water.

0 - No protection

4 - Protection against splash water (from all directions)

X - Not tested

9.2 Input phase imbalance

3% between phases or 2% negative phase sequence.

9.3 Ambient temperature

Size A to C:

-10°C (14°F) to 40°C (104°F) at 3kHz

Operation up to 55°C (131°F) with de-rating.

(see de-rating curves for further information)

Size 2 to 6:

Ambient temperature operating range:
0°C to 50°C (32°F to 122°F).

Output current derating must be applied at ambient temperatures >40°C (104°F).

Minimum temperature at power-up:
-15°C (5°F), the supply must be cycled when the drive has warmed up to 0°C (32°F).

Cooling method: Forced convection

NOTE

The drive can be powered up and run at a minimum temperature of -10°C (14°F).

9.4 Storage temperature

Size A to C:

-40 to +60°C (-40 to +140°F) for 12 months max

Size 2 to 6:

-40 (-40°F) to +50°C (122°F) for long term storage, or to +70°C (158°F) for short term storage.

9.5 Altitude

Size A to C:

Rated altitude: 1000m (3250 ft)

Reduce the normal full load current by 1% for every 100m (325 ft) above 1000m (3250 ft) up to a maximum of 3000m (9750 ft).

Size 2 to 6:

Altitude range: 0 to 3,000m (9,900 ft), subject to the following conditions:

1,000m to 3,000m (3,300 ft to 9,900 ft) above sea level: de-rate the maximum output current from the specified figure by 1% per 100m (330 ft) above 1,000m (3,300 ft)

For example at 3,000m (9,900ft) the output current of the drive would have to be de-rated by 20%.

9.6 Humidity

Maximum relative humidity 95% non-condensing at 40°C (104°F).

9.7 Storage humidity

Maximum relative humidity 93%, 40°C, 4 days.

9.8 Pollution degree

Designed for operation in Pollution degree 2 environments (dry, non-conductive contamination only)

9.9 Materials

Flammability rating of main enclosure: UL94 - 5VA

9.10 Vibration

9.10.1 Random

Standard: In accordance with IEC68-2-64 and IEC68-2-36: Test Fh

Severity: 1.0 m^2/s^3 (0.01g^2/Hz) ASD from 5 to 20Hz, -3dB/octave from 20 to 200Hz

Duration: 30 minutes in each of 3 mutually perpendicular axes.

9.10.2 Sinusiodal

Standard:	IEC68-2-6: Test Fc
Frequency range:	2 to 500Hz
Severity:	3.5mm peak displacement from 2 to 9Hz
	10m/s^2 peak displacement from 9 to 200Hz
	15m/s^2 peak displacement from 200 to 500Hz
Sweep rate:	1 octave/minute
Duration:	15 minutes in each of 3 mutually perpendicular axes.

9.10.3 Bump

Standard:	IEC68-2-29: Test Eb
Severity:	18g, 6ms, half sine
Number of bumps:	600 (100 in each direction of axes)

9.11 Frequency accuracy

0.01%

9.12 Resolution

0.1Hz

9.13 Output frequency range

0 to 1500Hz

9.14 Starts per hour

Electric starts

With the supply permanently connected the number of electronic motor starts per hour is only limited by motor and drive thermal limits.

Power starts

The number of starts by connection of the ac supply is limited. The start up circuit will allow for three consecutive starts at 3-second intervals on initial power up. Exceeding the rated number of starts per hour, presented in the table below, could result in damage to the start up circuit.

Drive frame size	Maximum AC line starts per hour evenly spaced in time
A, B, C and 2 to 6	20

9.15 Start-up time

The soft-start circuit must charge the dc bus and SMPS outputs and stabilise to allow the control processor to start operation in the following times:-

Drive frame size	Voltage	Maximum time taken to charge DC bus and SMPS outputs to stabilise
A	200	1s
B and C	200	2s
B and C	400	1s
2 to 6	All	4s

9.16 Serial communications

Modbus RTU

9.17 Switching frequencies

The software allows for the following switching frequencies:

Drive size	Voltage rating	3kHz	6kHz	12kHz	18kHz
A, B & C	200	√	√	√	√
B & C	400	√	√	√	
2	All	√	√	√	
3	VFK320X	√	√	√	
	VFK3401 & VFK3402	√	√	√	
	VFK3403	√	√	√	
	VFK350X	√	√		
4	All	√	√		
5	All	√	√		
6	All	√	√		

NOTE

With drive firmware V01.07.01 onwards, the size C 400V drive will have an actual switching frequency of 3kHz when the output frequency is below 6Hz.

9.18 Harmonics

The VARIDYNE 2 industrial AC variable speed drives are classified as class A professional equipment as defined in BS EN61000-3-2: 1995. Drives with input power equal to or below 1kW that do not meet the requirements of EN61000-3-2 are to be corrected, to ensure compliance, at the point of installation using suitable AC line chokes. See 7.2 (Reactor current ratings)

9.19 Acoustic noise

Frame	Power ratings	Condition	Max SPL measurement (dBA)
A	All ratings	N/A	None contributed by drive (no fan)
B	≤0.75kW	N/A	None contributed by drive (no fan)
B	≥1.1kW	rd mode, fan on	50
C	All ratings	rd mode, fan on	53

Size	Max speed dBA	Min speed dBA
2	54	35
3	56	43
4		
5		
6		

10 I/O specification

The control circuits are isolated from the power circuits in the drive by basic insulation (single insulation) only. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation (supplementary insulation) rated for use at the AC supply voltage.

If the control circuits are to be connected to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to personal computer), an additional isolating barrier must be included in order to maintain the SELV classification.

T1	**0V common**

T2	**Analogue input 1 (A1), either voltage or current**
Voltage: Current input	0 to 10V: mA as parameter range
Parameter range	4-20, 20-4, 0-20, 20-0, 4-.20, 20-.4, Volt
Scaling	Input range automatically scaled to Pr **01** (*Minimum set speed*) to Pr **02** (*Maximum set speed*)
Input impedance	200Ω (current): 100kΩ (voltage)
Resolution	0.1%
Accuracy	± 2%
Sample time	6ms
Absolute maximum voltage range	+35V to -18V with respect to 0V common

T3	**+10V reference output**
Maximum output current	5mA
Protection	Tolerates continuous short circuit to 0V
Accuracy	± 2%

T4	**Analogue input 2 (A2), either voltage or digital input**
Voltage: Digital input	0 to +10V: 0 to +24V
Scaling (as voltage input)	Input range automatically scaled to Pr **01** *Minimum set speed* / Pr **02** *Maximum set speed*
Input impedance	100kΩ (voltage): 6k8 (digital input)
Resolution	0.1%
Accuracy	± 2%
Sample time	6ms
Nominal threshold voltage	+10V (positive logic only)
Absolute maximum voltage range	+35V to -18V with respect to 0V common

T5 **T6**	**Status relay - Drive healthy (Normally open)**
Contact voltage rating	240Vac 30Vdc
Contact maximum current rating	2Aac 240V 4Adc 30V resistive load (2A 35Vdc for UL requirements) 0.3Adc 30V inductive load (L/R = 40ms)
Contact minimum recommended rating	12V 100mA
Contact isolation	1.5kVac (over voltage category II)
Update time	1.5ms
Operation of contact	OPEN - AC supply removed from drive. - AC supply applied to drive with drive in tripped condition. CLOSED - AC supply applied to drive with drive in a 'ready to run' or 'running' condition (not tripped)

WARNING

Provide fuse or other over-current protection in status relay circuit.

B1	**Analogue voltage output - Motor speed**
Voltage output	0 to +10V
Scaling	0V represents 0Hz/rpm output +10V represents the value in Pr **02**, maximum set speed
Maximum output current	5mA
Resolution	0.1%
Accuracy	± 5%
Update time	6ms
Protection	Tolerates continuous short circuit to 0V

B2	**+24V output**
Maximum output current	100mA
Protection	Tolerates continuous short circuit to 0V
Accuracy	± 15%

B3	**Digital output - Zero speed**
Voltage range	0 to +24V
Maximum output current	50mA at +24V (current source)
Output impedance	6.8kΩ
Update time	1.5ms
Absolute maximum voltage range	+35V to -1V with respect to 0V common

NOTE

The total available current from the digital output plus the +24V output is 100mA

B4 **B5** **B6** **B7**	**Digital Input - Enable/Reset */**** **Digital Input - Run Forward **** **Digital Input - Run Reverse **** **Digital Input - Local/Remote speed reference select (A1/A2)**
Logic	Positive logic only
Voltage range	0 to +24V
Input impedance	6.8kΩ
Sample time	1.5ms
Nominal threshold voltage	+10V
Absolute maximum voltage range	+35V to -18V with respect to 0V common

NOTE

If the drives enable terminal is opened, the drives output is disabled and the motor will coast to a stop. The drive will not re-enable for 1s after the enable terminal is closed again.

10.1 Drive reset

*****Following a drive trip, opening and closing the enable terminal will reset the drive. If the run forward or run reverse terminal is closed, the drive will run straight away.

******Following a drive trip and a reset via the stop/reset key, the enable, run forward or run reverse terminals will need to be opened and closed to allow the drive to run. This ensures that the drive does not run when the stop/reset key is pressed.

The enable, run forward and run reverse terminals are level triggered apart from after a trip where they become edge triggered. See ***** and ****** above.

If the enable and run forward or enable and run reverse terminals are closed when the drive is powered up, the drive will run straight away up to a set speed.

If both the run forward and run reverse terminals are closed, the drive will stop under the control of the ramp and stopping modes set in Pr **30** and Pr **31**.

10.2 Sample/update times

The sample/update times shown in the control terminal specification within the *VARIDYNE 2 Technical Guide* are the default sample/update times for the default terminal set-up. The sample/update time depends on the destination/source parameter of the digital or analogue inputs/ outputs.

These sample/update times are the sample or update times for the control microprocessor. The actual sample/update time maybe slightly longer due to the design of the VARIDYNE 2.

10.3 Task routine times

At the beginning of each menu, there is a single line parameter description and this contains the update rate for each parameter. This time signifies the task routine time in the software that the parameter is updated on. For a background task, the time depends on processor loading i.e. what functions the drive is carrying out and what advanced menus are being used.

Update rate	Microprocessor update time	Comments
2ms	2ms	Updated every 2ms
5ms	5ms	Updated every 5ms
21ms	21ms	Updated every 21ms
128ms	128ms	Updated every 128ms
Reset	N/A	Destination/source parameter changed on a Reset
B	Background	Updated as a background task. Update rate depends on processor loading.
BR	Background read	
BW	Background write	

From practical tests carried out:

Condition	Minimum ms	Maximum ms	Average ms
Time for drive to respond to a run command	4.1	5.62	5.02
Time for the drive to respond to a stop command	2.82	3.94	3.31
Time for the drive to respond to a step change in analogue input voltage			7.93

11 Supply types

Drives rated for supply voltages up to 575V are suitable for use with any supply type, i.e. TN-S, TN-C-S, TT, IT, with grounding at any potential, i.e. neutral, centre or corner ("grounded-delta").

Grounded delta supplies >575V are not permitted.

Drives are suitable for use on supplies of installation category III and lower, according to IEC60664-1. This means they maybe connected permanently to the supply at its origin in a building, but for outdoor installation additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce category IV to category III.

WARNING

Operation with IT (ungrounded) supplies:
Special attention is required when using internal or external EMC filters with ungrounded supplies, because in the event of a ground (earth) fault in the motor circuit, the drive may not trip and the filter could be over-stressed. In this case, either the filter must not be used (removed) or additional independent motor ground fault protection must be provided. Refer to Table 11-1.
For instructions on removal, refer to Menu 4 in the VARIDYNE 2 size 2 to 6 Getting Started Guide.
For details of ground fault protection contact the supplier of the drive.

A ground fault in the supply has no effect in any case. If the motor must continue to run with a ground fault in its own circuit, then an input-isolating transformer must be provided and if an EMC filter is required it must be located in the primary circuit.

Unusual hazards can occur on ungrounded supplies with more than one source, for example on ships. Contact the supplier of the drive for more information.

Table 11-1 Behaviour of the drive in the event of a motor circuit ground (earth) fault with an IT supply

Drive size	Internal filter only	External filter (with internal)
2	Drive trips on fault	Drive trips on fault
3	May not trip – precautions required	Drive trips on fault
4 to 6	May not trip – precautions required	May not trip – precautions required

11.1 AC supply requirements

Single phase drives
Single phase - Between one phase and neutral of a star connected three phase supply.

- Between two phases of a three phase supply.

Three phase models
Three-phase star or delta supply of the correct voltage.

Dual rated models
Any of the above supplies can be used.

11.2 Safety

WARNING

Electric shock risk
The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- DC and brake cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

Unless otherwise indicated, control terminals are single insulated and must not be touched.

WARNING

Isolation device
The AC supply must be disconnected from the drive using an approved isolation device before any cover is removed from the drive or before any servicing work is performed.

WARNING

STOP function
The STOP function does not remove dangerous voltages from the drive, the motor or
any external option units.

WARNING

Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.
Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge, or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult USEM or their authorized distributor.

WARNING

Equipment supplied by plug and socket
Special attention must be given if the drive is installed in equipment which is connected to the AC supply by a plug and socket. The AC supply terminals of the drive are connected to the internal capacitors through rectifier diodes which are not intended to give safety isolation. If the plug terminals can be touched when the plug is disconnected from the socket, a means of automatically isolating the plug from the drive must be used (e.g. a latching relay).

11.3 Cables

Recommended cable sizes are given in Chapter 1 *Technical data* on page 5. They are only a guide; refer to local wiring regulations for correct size of cables. In some cases, a larger cable size is required to avoid excessive voltage drop.

Use 105°C (221°F) (UL 60/75°C temp rise) PVC-insulated cable with copper conductors having a suitable voltage rating, for the following power connectors:

- AC supply to external EMC filter (when used)
- AC supply (or external EMC filter) to drive
- Drive to motor
- Drive to braking resistor

Motor cables
The recommended output cable sizes assume that the motor maximum current matches that of the drive. Where a motor of reduced rating is used, the cable rating may be chosen to match that of the motor. To

ensure that the motor and cable are protected against overload, the drive must be programmed with the correct motor rated current.

11.4 Fuses

The AC supply to the drive must be fitted with suitable protection against overload and short circuits. Chapter 1 *Technical data* on page 5 shows the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

A fuse or other protection device must be included in all live connectors to the AC supply.

An MCB (miniature circuit breaker) or MCCB (moulded case circuit breaker) with type C tripping characteristics maybe used in place of fuses as long as the fault clearing capacity is sufficient for the installation. On VARIDYNE 2 sizes 2 and 3 an MCB/MCCB of type C maybe used in place of fuses under the following conditions:

- The fault-clearing capacity must be sufficient for the installation.
- The drive must be mounted in an enclosure which meets the requirements for a fire enclosure.

Fuse types

Europe: Type gG HRC fuses complying with EN60269 parts 1 and 2 (BS88)

USA: Bussman Limitron KTK series, class CC fast acting fuses up to 30A, class J above 30A.

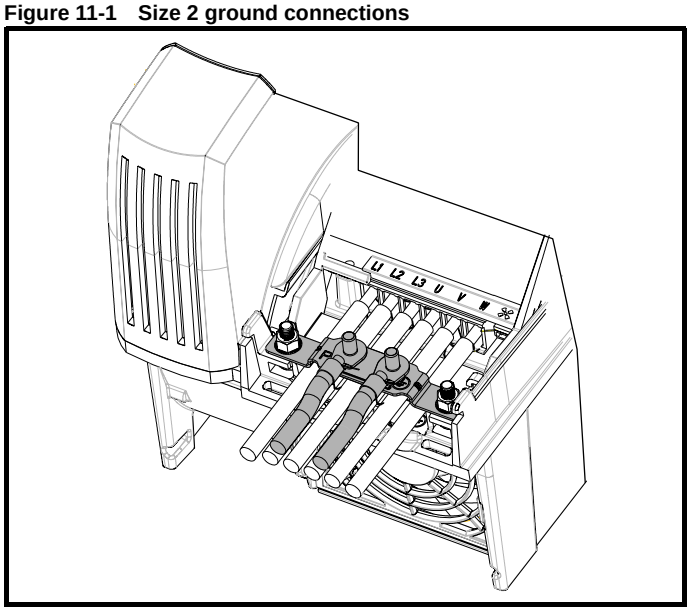
11.5 Ground connections

The drive must be connected to the system ground of the AC supply. The ground wiring must conform to local regulations and codes of practice.

The ground loop impedance must conform to the requirements of local safety regulations. The ground connections must be inspected and tested at appropriate intervals.

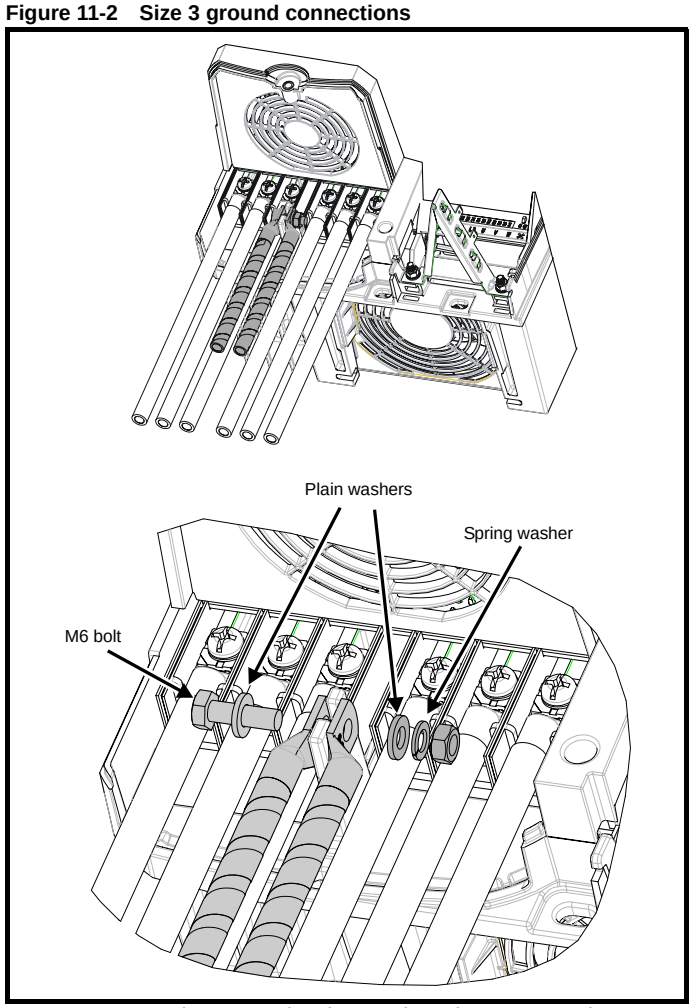
On VARIDYNE 2 size 2, the supply and motor ground connections are made using the grounding bridge that locates at the bottom of the drive.

Figure 11-1 Size 2 ground connections



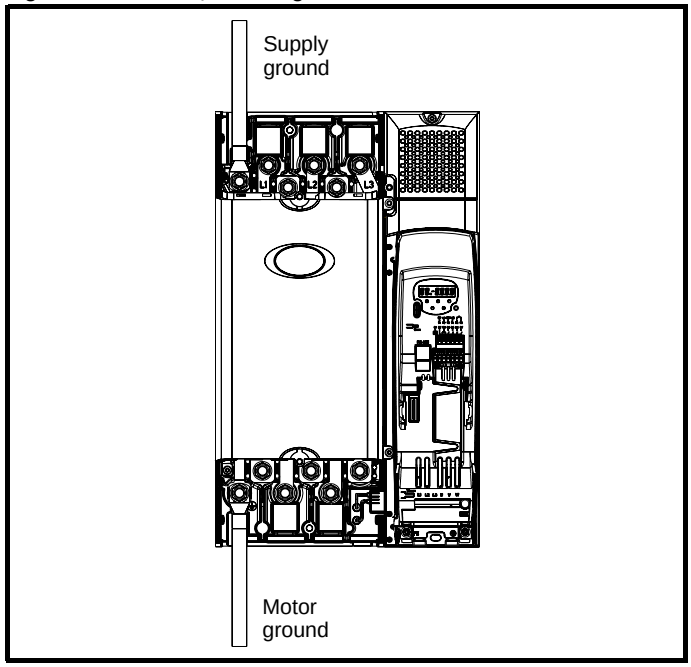
On VARIDYNE 2 size 3, the supply and motor ground connections are made using an M6 nut and bolt that locates in the fork protruding from the heatsink between the AC supply and motor output terminals.

Figure 11-2 Size 3 ground connections



On VARIDYNE 2 size 4, 5 and 6, the supply and motor ground connections are made using an M10 bolt at the top (supply) and bottom (motor) of the drive.

Figure 11-3 Size 4, 5 and 6 ground connections



The supply and motor ground connections to the drive are connected internally by a copper conductor with a cross-sectional area given below:

size 4: 19.2mm2 (0.03in^2, or slightly bigger than 6 AWG)

size 5: 60mm2 (0.09in^2, or slightly bigger than 1 AWG)

size 6: 75mm2 (0.12in^2, or slightly bigger than 2/0 AWG)

This connection is sufficient to provide the ground (equipotential bonding) connection for the motor circuit under the following conditions:

To standard	Conditions
IEC 60204-1 & EN 60204-1	Supply phase conductors having cross-sectional area not exceeding: size 4: 38.4mm^2 size 5: 120mm^2 size 6: 150mm^2
NFPA 79	Supply protection device rating not exceeding: size 4: 200A size 5: 600A size 6: 1000A

If the necessary conditions are not met, an additional ground connection must be provided to link the motor circuit ground and the supply ground.

Use of RCDs - residual current device

There are three common types of RCD/ELCB

Type AC - detects AC fault currents

Type A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)

Type B - detects AC, pulsating DC, and smooth DC fault currents

- Type AC should never be used with inverter drives
- Type A can only be used with single phase drives
- Type B must be used with three phase drives.

It is recommended that only Type B RCDs be used with inverter drives

If an external EMC filter is used, a delay of at least 50ms should be incorporated in the RCD to ensure spurious trips are not seen. The leakage current is likely to exceed the trip level if all of the phases are not energised simultaneously.

11.6 Ground leakage

The ground leakage current depends upon the internal EMC filter is fitted. The drive is supplied with the filter fitted. Instructions for removal of the internal EMC filter are given in the *VARIDYNE 2 Getting Started Guide*.

With internal EMC filter fitted

Size A

10mA AC at 230V, 50Hz (proportional to supply voltage and frequency)

Size B and C

1 phase 200V product
20mA AC at 230V, 50Hz (proportional to supply voltage and frequency)

3-phase 200V product
7mA AC at 230V, 50Hz (proportional to supply voltage and frequency)

3-phase 400V product
8.2mA AC at 415V, 50Hz (proportional to supply voltage and frequency)
30μA DC (10Ω)

Size 2 to 6

10μA DC (10MΩ internal bleed resistor)

NOTE

The above leakage currents are just the leakage currents of the drive with the internal EMC filter connected and do not take into account any leakage currents of the motor or motor cable.

With internal EMC filter removed

<1mA

NOTE

In both cases, there is an internal voltage surge suppression device connected to ground. Under normal circumstances, this carries negligible current.

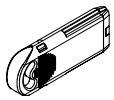
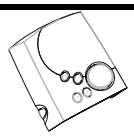
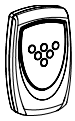
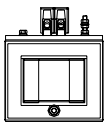
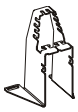
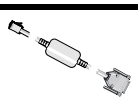
WARNING

When the internal EMC filter is fitted, the leakage current is high. In this case, a permanent fixed ground connection must be provided using two independent conductors each with a cross-section equal to or exceeding that of the supply conductors. The drive is provided with two earth terminals to facilitate this. The purpose is to prevent a safety hazard occurring if the connection is lost.

12 Options

All VARIDYNE 2 Solutions Modules are colour-coded, in order to make identification easy. The following table shows the colour-code key and gives further details on their function.

Type	Option	Colour	Name	Further details	Minimum option firmware version	Unidrive SP compatible ?
Fieldbus*		Purple	SM-PROFIBUS-DP	**PROFIBUS-DP option** PROFIBUS-DP adapter for communication with VARIDYNE 2	03.00.00	Yes
		Medium Grey	SM-DeviceNet	**DeviceNet option** DeviceNet adapter for communication with VARIDYNE 2	03.00.00	Yes
		Dark Grey	SM-INTERBUS	**INTERBUS option** INTERBUS adapter for communication with VARIDYNE 2	03.00.00	Yes
		Light Grey	SM-CANopen	**CANopen option** CANopen adapter for communication with VARIDYNE 2	03.00.00	Yes
		Beige	SM-Ethernet	**Ethernet option** Ethernet adapter for communication with VARIDYNE 2	01.00.00	Yes
Extended IO*		Dark Yellow	SM-I/O Lite	**I/O Lite option** Increases the I/O capability by adding the following to the existing I/O in the drive: • ±10V bi-polar / 4-20mA analogue input • 1.0-10V / 4-20mA analogue output • Digital inputs x 3 • Encoder speed reference input (A, /A, B, /B) • Relay x 1	01.01.07	Yes
		Dark Red	SM-I/O Timer	**Timer I/O option** Same features is I/O Lite, but with the addition of a battery backed-up real time clock.	01.01.07	Yes
		Olive	SM-I/O 120V	**Additional I/O conforming to IEC 1131-2 120Vac** 6 digital inputs and 2 relay outputs rated for 120Vac operation	01.00.01	Yes
		Turquoise	SM-I/O PELV	**Isolated I/O to NAMUR NE37 specifications** For chemical industry applications 1 x Analogue input (current modes) 2 x Analogue outputs (current modes) 4 x Digital input / outputs, 1 x Digital input, 2 x Relay outputs	03.01.03	Yes
		Cobalt Blue	SM-I/O 24V Protected	**Additional I/O with overvoltage protection up to 48V** 2 x Analogue outputs (current modes) 4 x Digital input / outputs, 3 x Digital inputs, 1 x Relay output	03.01.03	Yes

Type	Option	Colour	Name	Further details	Minimum option firmware version	Unidrive SP compatible ?
Automation		Black	SmartStick	**SmartStick option** Upload drive parameters to the SmartStick for storage or for easy set-up of identical drives or downloading to replacement drives		No
		White	LogicStick	**LogicStick option** The LogicStick plugs into the front of the drive and enables the user to program PLC functions within the drive. (The LogicStick can also be used as a SmartStick)		No
Keypad			SM-Keypad Plus	**LCD keypad display option** Remote panel mounting LCD multilingual text keypad display to IP54 (NEMA 12) with additional help key	04.03.01	Yes
			Keypad Remote	**LED keypad display option** Remote panel mounting LED display to IP65 (NEMA 12) with additional function key	01.00.00	No
EMC			EMC Filters	These additional filters are designed to operate together with the drive's own integral EMC filter in areas of sensitive equipment		No
			AC input line reactors	To reduce supply harmonics		No
Cable management**			Bracket	Cable management bracket		No
			UL type 1 kit	Bottom metal gland plate, top cover and side covers to allow the drive to comply with the requirements of UL type 1		No
Cover kit**			Cover kit	The additional cover kit will increase the environmental protection of the top face to IP4X in vertical direction.		No
Communications			CT Comms cable	Cable with isolation RS232 to RS485 converter. For connecting PC/Laptop to the drive when using CTSoft or SyPTLite		Yes
			CTSoft	Software for PC or Laptop which allows the user to commission and store parameter settings	01.04.01	Yes
			SyPTLite	Software for PC or Laptop which allows the user to program PLC functions within the drive	01.02.02	Yes
Braking resistor			Braking resistor	Optional internal braking resistor for VARIDYNE 2 size 2		Yes

*Not compatible with size A

** Not available for size 2 to 6.

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