EMC Data Sheet

Variable Speed Drive

Copeland Scroll™

EMERSON™
Climate Technologies

Safety Warnings

	A Warning contains information which is essential for avoiding a safety hazard.

	A Caution contains information which is necessary for avoiding a risk of damage to the product or other equipment.

NOTE:
A Note contains information which helps to ensure correct operation of the product.

Installation and Use

The information given in this data sheet is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the manufacturer takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement.

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation of the equipment.

The contents of this data sheet are believed to be correct at the time of printing. The manufacturer reserves the right to change the specification of the product or its performance, or the contents of the data sheet, without notice.

	**All electrical installation and maintenance work must be carried out by qualified electricians, familiar with the requirements for safety and EMC. The installer is responsible for ensuring that the end product or system complies with all relevant laws in the country where it is used.**

Copyright

EMC Data Sheet

1. Products

This EMC data sheet applies to the drives used with the ZPV range of Emerson Scroll(TM) compressors.

Table 1 Model numbers

Compressor Series	Drive Model Number	Frame size	Supply Voltage (V)	Output Power (kW)	Output current (A)	
					40 ℃	60 ℃
ZPV0631E-5E9	EVC1150B-J1-*14	6	200-240	15	58	58
ZPV0631E-4E9	EVC1185B-K1-*14	6	380-480	18.5	38	38
ZPV0631E-4E9	EVC1150B-K1-*14	5	380-480	15	31	26
ZPV0631E-4E9	EVC1150B-L1-*14	6	500-575	15	27	27
ZPV0662E-5E9	EVC1150B-J1-*24	6	200-240	15	58	58
ZPV0662E-4E9	EVC1150B-K2-*24	5	380-480	15	31	26
ZPV0662E-7E9	EVC1150B-K1-*24	5	380-480	15	31	26
ZPV0662E-7E9	EVC1150B-L1-*24	6	500-575	15	27	27
ZPV0962E-5E9	EVC1185B-J1-*24	7	200-240	18.5	75	75
ZPV0962E-4E9	EVC1185B-K2-*24	6	380-480	18.5	48	46
ZPV0962E-7E9	EVC1185B-K1-*24	6	380-480	18.5	38	38
ZPV0962E-7E9	EVC1185B-L1-*24	6	500-575	18.5	34	34

Where: * = 1 or 8 denoting OEM or Aftermarket drives respectively.

Note: Drives with suffix K1 are optimised for operation at a supply voltage of 460V. Drives with suffix K2 are optimised for operation on supply voltages in the range 380 - 400V. All K1 and K2 drives are capable of operating over the supply voltage range 380 - 480V.

2. Immunity

2.1.1 Immunity Compliance

The drives comply with the following International standards for immunity. Table 2 references IEC standards. In Europe the applicable standard is the equivalent harmonised EN standard.

Table 2 Immunity test levels

Standard	Type of immunity	Test specification	Application	Level
IEC 61000-4-2	Electrostatic discharge	6 kV contact discharge 8 kV air discharge	Module enclosure	Level 3 (industrial)
IEC 61000-4-3	Radio frequency radiated field	Prior to modulation: 10 V/m 80 - 1000 MHz 3 V/m 1.4 - 2.0 GHz 1 V/m 2.0 - 2.7 GHz 80% AM (1 kHz) modulation Safe Torque Off (STO) tested to : 20V/m 80 - 1000MHz 6V/m 1.4 - 2.0 GHz 3V/m 2.0 - 2.7 GHz	Module enclosure	Level 3 (industrial)
IEC 61000-4-4	Fast transient burst	5/50 ns 2 kV transient at 5 kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50 ns, 2 kV transient at 5 kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC 61000-4-5	Surges	Common mode 4 kV 1.2/50µs wave shape	AC supply lines: line to earth	Level 4
		Differential mode 2 kV	AC supply lines: line to line	Level 3
		Common mode 1 kV	Control lines	(Note:1)
IEC 61000-4-6	Conducted radio frequency	10 V prior to modulation 0.15 - 80 MHz 80% AM (1 kHz) modulation	Control and power lines	Level 3 (industrial)
IEC 61000-4-11	Voltage dips, short interruptions & variations	All durations	AC supply lines	
IEC 61000-4-8	Power frequency magnetic field	1700 A/m RMS. 2400 A/m peak (2.1 mT RMS 3 mT peak) continuous at 50 Hz	Module enclosure	Exceeds level 5
IEC 61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies

Standard	Type of immunity	Test specification	Application	Level
IEC 61000-6-2	Generic immunity standard for the industrial environment			Complies
IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

Note: 1 Applies to ports where connections may exceed 30 m length. Special provisions may be required in some cases – see additional information below.

Unless stated otherwise, immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation, the wiring guidelines specified in the *User Guide* must be followed. All inductive components such as relays, contactors, electromagnetic brakes must be fitted with appropriate suppression.

2.1.2 Surge immunity of control circuits

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 IEC 61000-6-2 (1 kV surge) provided that the 0 V connection is not earthed. In general the circuits cannot withstand the surge directly between the control lines and the 0 V connection.

The surge test simulates the effect of a lightning strike, or a severe electrical fault, where high transient voltages may exist between different points in the grounding system. This is a particular risk where the circuits are routed outside a building, or if the grounding system in a building is not well bonded.

In applications where control circuits are exposed to high-energy voltage surges, some special measures are required to prevent malfunction or damage. In general, circuits that are routed outside the building where the drive is located, or are longer than 30 m need additional protection. One of the following techniques should be used:

1. Galvanic isolation, Do not connect the control 0 V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is routed next to its associated return (0 V) wire.
2. Screened cable. The cable screen may be connected to ground at both ends. In addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equal potential bonding cable) with cross-sectional area of at least 10 mm^2. This ensures that in the event of a fault, the fault current flows through the ground cable and not through signal cable screen. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression. This applies to analogue and digital inputs and outputs. A zener diode network or a commercially available surge suppressor may be connected between the signal line and 0 V as shown in Figures 1 and 2.

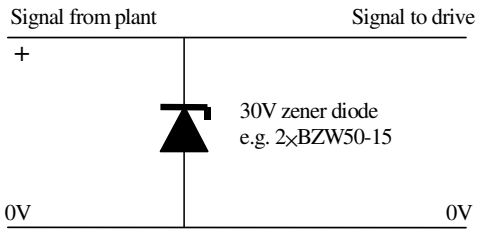

Figure 1 Surge suppression for digital and uni-polar analogue inputs and outputs

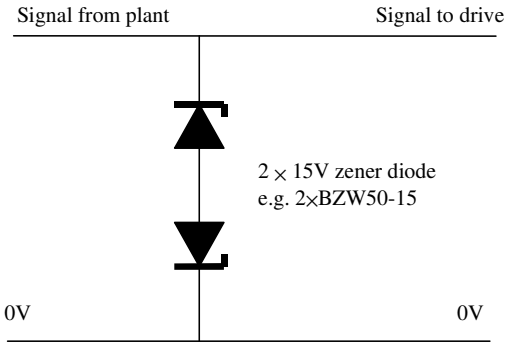

Figure 2 surge suppression for bipolar analogue inputs and outputs

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

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 zener 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.

3. Emission

3.1 General

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:

- Low frequency effects, such as supply harmonics and notching.
- High frequency emission below 30 MHz where emission is predominantly by conduction.
- High frequency emission above 30 MHz where emission is predominantly by radiation.

3.1.1 Environment and Equipment Categories

The EMC product standard for variable speed drives, IEC 61800-3 defines two environments and four equipment categories:

- First Environment - This includes domestic premises, and establishments that share a low-voltage power supply network with buildings used for domestic purposes. Examples include: houses, apartment buildings, shops, commercial property and industrial premises that share a supply with nearby residential property.
- Second Environment - This includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes. Examples include Factories, industrial plants and areas of any building supplied by a dedicated transformer.

- Equipment Category C1 - Equipment that is intended for use in the First Environment
- Equipment Category C2 - Equipment that is neither a plug-in device nor a movable device. This type of equipment may be used in the First Environment if installed and commissioned by a professional (i.e. person or organisation having the necessary skills to install and commission power drive systems, including EMC requirements).
- Equipment Category C3 - Equipment that is intended only for use in the Second Environment. The equipment is not intended for use in the First Environment
- Equipment Category C4 - Equipment with rated voltage ≥ 1000V or rated current equal ≥ 400 A or intended for use as part of a complex system. This equipment is intended only for use in the Second Environment.

In general, the drives are capable of meeting the requirements of Equipment Category C3 without external filters or line reactors. They are capable of meeting the requirements of Equipment Category C1 and C2 when installed with the recommended filters and line reactors.

NOTE:	***In a domestic environment this product may cause radio interference in which case supplementary mitigation measures may be required.***

Examples of common mitigation methods include additional filtering, a dedicated supply transformer and use of screened cables.

3.2 Low Frequency Emissions

3.2.1 Supply voltage notching

The drives do not cause notching of the supply voltage.

3.2.2 Voltage fluctuations and flicker

When running at constant load the drive does not generate voltage fluctuations or flicker. Care must be taken to ensure that the application does not cause the load to vary rapidly, resulting in flicker. Cyclical variations with frequency in the region of 2 Hz to 20 Hz are likely to cause irritating lighting flicker and should be avoided. When power is first applied the drive draws an inrush current which is lower than the rated input current. This meets the requirements of IEC 61000-3-3.

3.2.3 Common mode harmonic emissions

The drives generate switching waveforms with frequency components in the audible range as well as the frequency range commonly used by data systems. The installation instructions include recommendations for segregation and shielding of power and signal cables. Refer to the installation instructions contained in the drive *User Guide* and to section 4 of this data sheet.

3.2.4 Supply harmonics

The drive input current contains harmonics of the supply frequency. The harmonic levels are affected to some extent by the supply impedance (fault current level). Table 3 shows the levels calculated with a fault level of 5 kA. This is typical of a light industrial installation. This meets and exceeds the requirements of IEC 61800-3. For installations where the fault level is lower, so that the harmonic current is more critical, the harmonic current will also be lower than that shown. The calculations have been verified by laboratory measurements on sample drives.

Note that the RMS current in these tables may differ from the maximum specified in the installation guide, since the latter is a worst case value provided for safety reasons which takes account of permitted supply voltage imbalance. The motor efficiency also affects the current. A standard IE2, 4 pole motor has been assumed. For balanced sinusoidal supplies, all even and triplen harmonics are absent. The supply voltages used for the calculations are 200V and 400V at 50 Hz. The harmonic percentages do not change substantially for other voltages and frequencies within the drive specification. In particular, the values for 480V, 60Hz are very close to those for 400V 50Hz.

3.2.5 Input line reactors (line chokes)

Where necessary, a reduction in harmonic current levels can be obtained by fitting reactors in the input supply lines to the drive. This also gives increased immunity to supply disturbances such as voltage surges cause by the switching of high-current loads or power factor correction capacitors on the same supply circuit.

Table 4 shows the corresponding harmonics where reactors are fitted in the supply lines.

Table 3 Harmonic currents without line reactor

Model No.	Rated voltage (V)	Motor Power (kW)	RMS Current (A)	Fund. Current (A)	THD (%)	Harmonic order, magnitude as % of RMS current																DPF cosΦ
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49	
EVC1150B-J1-*14	200-240	15	48.6	42.7	47.9	39.5	24.3	7.1	5.9	4.2	3.3	2.9	2.3	2.2	1.8	1.7	1.4	1.4	1.2	1.14	1.0	0.87
EVC1185B-K1-*14	380-480	18.5	36.1	30.4	53.9	43.8	29.0	6.7	6.5	4.0	3.4	2.8	2.3	2.1	1.8	1.7	1.4	1.4	1.2	1.2	1.2	0.82
EVC1150B-K1-*14	380-480	15	26.5	23	49.4	40.1	26.0	7.0	6.4	4.3	3.6	3.0	2.6	2.3	2.0	1.9	1.6	1.5	1.4	1.3	1.2	0.86
EVC1150B-L1-*14	500-575	15	23.1	17.2	66.7	53.5	37.4	10.5	5.6	4.8	3.2	2.3	2.1	1.2	1.2	0.9	0.8	0.7	0.6	0.6	0.5	0.75
EVC1150B-J1-*24	200-240	15	48.6	42.7	47.9	39.5	24.3	7.1	5.9	4.2	3.3	2.9	2.3	2.2	1.8	1.7	1.4	1.4	1.2	1.14	1.0	0.87
EVC1150B-K2-*24	380-480	15	31.7	25.5	59.5	48.0	33.0	6.4	7.0	3.8	3.4	2.7	2.2	2.0	1.7	1.6	1.3	1.3	1.1	1.1	0.9	0.84
EVC1150B-K1-*24	380-480	15	26.5	23.0	49.4	40.1	26.0	7.0	6.4	4.3	3.6	3.0	2.6	2.3	2.0	1.9	1.6	1.5	1.4	1.3	1.2	0.86
EVC1150B-L1-*24	500-575	15	23.1	17.2	66.7	53.5	37.4	10.5	5.6	4.8	3.2	2.3	2.1	1.2	1.2	0.9	0.8	0.7	0.6	0.6	0.5	0.75
EVC1185B-J1-*24	200-240	18.5	70.1	63.7	42.0	35.2	19.6	7.5	5.4	4.3	3.2	3.0	2.3	2.2	1.8	1.7	1.4	1.3	1.1	1.1	0.9	0.90
EVC1185B-K2-*24	380-480	18.5	36.1	30.4	53.9	43.8	29.0	6.7	6.5	4.0	3.4	2.8	2.3	2.1	1.8	1.7	1.4	1.4	1.2	1.2	1.2	0.82
EVC1185B-K1-*24	380-480	18.5	36.1	30.4	53.9	43.8	29.0	6.7	6.5	4.0	3.4	2.8	2.3	2.1	1.8	1.7	1.4	1.4	1.2	1.2	1.2	0.82
EVC1185B-L1-*24	500-575	18.5	27.6	21.0	65.1	52.9	35.9	8.8	5.5	4.3	2.8	2.3	1.9	1.2	1.3	0.8	0.9	0.6	0.7	0.5	0.5	0.80

Table 4 Harmonic currents with line reactor

Model	AC line reactor inductance (µH)	Rated voltage (V)	Motor Power (kW)	RMS Current (A)	Fund. Current (A)	THD (%)	Harmonic order, magnitude as % of RMS current															DPF cosΦ
							5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49	
EVC1150B-J1-*14	150	200-240	15	46.1	42.6	38.6	34.1	15.0	7.3	4.1	3.8	2.5	2.3	1.7	1.6	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.910
EVC1185B-K1-*14	240	380-480	18.5	33.7	30.3	43.9	37.9	19.6	7.1	4.6	3.8	2.6	2.5	1.8	1.7	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.882
EVC1150B-K1-*14	480	380-480	15	24.9	23	39.2	34.5	15.6	7.2	4.2	3.8	2.5	2.4	1.8	1.6	1.3	1.1	1.0	0.8	0.7	0.5	0.5	0.908
EVC1150B-L1-*14	720	500-575	15	20.0	17	53.3	45.3	26.3	6.7	5.5	3.4	2.4	2.1	1.5	1.5	1.1	1.1	0.8	0.8	0.6	0.6	0.5	0.860
EVC1150B-J1-*24	150	200-240	15	46.1	42.6	38.6	34.1	15.0	7.3	4.1	3.8	2.5	2.3	1.7	1.6	1.2	1.0	0.9	0.7	0.6	0.5	0.5	0.910
EVC1150B-K2-*24	400	380-480	15	28.1	25.3	43.8	38.1	19.0	7.1	4.4	3.7	2.4	2.3	1.6	1.6	1.2	1.1	0.9	0.8	0.7	0.6	0.5	0.904
EVC1150B-K1-*24	480	380-480	15	24.9	23	39.2	34.5	15.6	7.2	4.2	3.8	2.5	2.4	1.8	1.6	1.3	1.1	1.0	0.8	0.7	0.5	0.5	0.908
EVC1150B-L1-*14	720	500-575	15	20.0	17	53.3	45.3	26.3	6.7	5.5	3.4	2.4	2.1	1.5	1.5	1.1	1.1	0.8	0.8	0.6	0.6	0.5	0.860
EVC1185B-J1-*24	100	200-240	18.5	37.3	30.9	56.0	46.6	29.2	6.4	6.1	3.5	2.8	2.3	1.7	1.7	1.3	1.3	1.0	1.0	0.8	0.8	0.7	0.921
EVC1185B-K1-*24	240	380-480	18.5	33.7	30.3	43.9	37.9	19.6	7.1	4.6	3.8	2.6	2.5	1.8	1.7	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.922
EVC1185B-K1-*24	240	380-480	18.5	33.7	30.3	43.9	37.9	19.6	7.1	4.6	3.8	2.6	2.5	1.8	1.7	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.922
EVC1185B-L1-*24	480	500-575	18.5	20.0	17	53.3	45.3	26.3	6.7	5.5	3.4	2.4	2.1	1.5	1.5	1.1	1.1	0.8	0.8	0.6	0.6	0.5	0.891

The line reactors cause a slight reduction in the DC link voltage, which will normally still permit the full rated torque to be developed in a standard motor. Higher values should not be used unless some reduction of available torque at maximum speed is acceptable. Lower values can be used, and the resulting harmonics currents can be estimated by linear interpolation between the values for no reactor and the reactor value in Table 4. Reactor current ratings must be at least equal to the RMS values shown, and peak current rating (to avoid magnetic saturation) should be twice that value.

The line reactors shown in Table 4 are available as stock items. Refer to Table 5:

Table 5 Recommended line Reactors

Compressor Series	Drive Model Number	Supply Voltage (V)	Line reactor inductance (µH)	Line reactor rated current (A)	Line reactor Model	Line reactor Part No.
ZPV0631E-5E9	EVC1150B-J1-*14	200-240	150	56.6	INL2005	4401-0147
ZPV0631E-4E9	EVC1185B-K1-*14	380-480	240	60.6	INL4008	4401-0156
ZPV0631E-4E9	EVC1150B-K1-*14	380-480	480	32.0	INL4013	4401-0236
ZPV0631E-4E9	EVC1150B-L1-*14	500-575	720	29.4	INL5004	4401-0160
ZPV0662E-5E9	EVC1150B-J1-*24	200-240	150	56.6	INL2005	4401-0147
ZPV0662E-4E9	EVC1150B-K2-*24	380-480	400	36.5	INL4006	4401-0154
ZPV0662E-7E9	EVC1150B-K1-*24	380-480	400	36.5	INL4006	4401-0154
ZPV0662E-7E9	EVC1150B-L1-*24	500-575	720	29.4	INL5004	4401-0160
ZPV0962E-5E9	EVC1185B-J1-*24	200-240	100	88.0	INL2010	4401-0228
ZPV0962E-4E9	EVC1185B-K2-*24	380-480	240	60.6	INL4008	4401-0156
ZPV0962E-7E9	EVC1185B-K1-*24	380-480	240	60.6	INL4008	4401-0156
ZPV0962E-7E9	EVC1185B-L1-*24	500-575	480	47.0	INL5006	4401-0223

If drives are installed in domestic premises or premises that share a low-voltage power supply network with buildings used for domestic purposes then they need to comply with the harmonic currents in IEC 61000-3-12 Table 4 for $R_{SCE} > 120$.

Line reactors required to meet this standard are given in Table 6 below.

The line reactors specified in Table 6 will only give the required harmonic reduction effect if the load is equal or greater than stated. If the motor power is lower, the inductance must be increased in inverse proportion. The high value required means that the drive DC bus voltage is reduced by approximately 5%. Depending on the motor voltage rating, this may mean that the available torque at base speed is reduced.

Table 6 Line reactors for compliance with IEC 61000-3-12

Compressor Series	Drive Model Number	Supply Voltage (V)	Motor power (kW)	Line reactor inductance (µH)	Line reactor rated current (A)	Line reactor Model	Line reactor Part No.
ZPV0631E-5E9	EVC1150B-J1-*14	200-240	15	Not required			
ZPV0631E-4E9	EVC1185B-K1-*14	380-480	18.5	170	48.8	INL2004	4401-0146
ZPV0631E-4E9	EVC1150B-K1-*14	380-480	15	170	48.8	INL2004	4401-0146
ZPV0662E-5E9	EVC1150B-J1-*24	200-240	15	Not required			
ZPV0662E-4E9	EVC1150B-K2-*24	380-400	15	320	26.8	INL2003	4401-0145
ZPV0662E-7E9	EVC1150B-K1-*24	380-480	15	170	48.8	INL2004	4401-0146
ZPV0962E-5E9	EVC1185B-J1-*24	200-240	18.5	Not required			
ZPV0962E-4E9	EVC1185B-K2-*24	380-480	18.5	170	48.8	INL2004	4401-0146
ZPV0962E-7E9	EVC1185B-K1-*24	380-480	18.5	170	48.8	INL2004	4401-0146

Table 7 Harmonic current limits from IEC 61000-3-12, Table 4 and typical values when fitted with the reactors shown in Table 6

Parameter	Harmonic distortion factor		Harmonic current amplitudes as a percentage of the reference current (%)				Displacement power factor
Symbol	THD (%)	PWHD (%)	5	7	11	13	DPF
Limit	48	46	40	25	15	10	-
Typical calculated values	45.1	26.4	39.1	20.0	6.9	4.5	0.88

NOTE:	**When fitted with the recommended line reactor, the drive complies with IEC 61000-3-12 provided that the short-circuit power at the interface point between the user's supply and the public system (S_{SC}) is greater than 120 times the rated apparent power of the drive. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with adequate short-circuit power.**

3.2.6 Further measures for reducing harmonics

In cases where harmonic currents cause interference, remedial measures such as harmonic filters may be used, installed at the common supply point. Harmonic currents from drives add approximately arithmetically.

3.3 Conducted Emissions

3.3.1 General

Radio frequency emission in the range from 150 kHz to 30 MHz is generated by the switching action of the main power devices (IGBTs) and is mainly conducted out of the equipment through electrical power wiring. It is essential for compliance with emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided that it has an overall screen, which is continuous for its entire length. For example, the screen formed by the armouring of steel wire armoured cable is acceptable. The capacitance of the cable forms a load on the drive and filter, and should be kept to a minimum.

Compliance tests were carried out with cable having a capacitance between the three power cores and the screen of 412 pF/per meter (measured at 1 kHz), which is typical of steel wire armoured cable. In addition to motor cable length, conducted emission also varies with drive switching frequency. Selecting the lowest switching frequency will produce the lowest level of emission. In order to meet the stated standards, the drive, filter and motor cable must be installed correctly. Wiring guidelines are given in section 4 of this EMC data sheet.

The drive contains a cost-effective internal input filter which gives a reduction of about 30 dB in the level of emission at the supply terminals. Unlike a conventional filter, the internal filter continues to provide this attenuation with a long motor cable. For practical purposes, this filter in conjunction with a screened motor cable is sufficient to prevent the drive from causing interference to most good-quality industrial equipment. It is recommended that the filter be used in any situation unless the earth leakage current (which is up to 56 mA) is unacceptable. The User Guide gives instructions on how to remove and replace it.

For applications where there are stricter requirements for radio frequency emission, e.g. to the generic standards IEC 61000-6-4 etc, or operation in the First Environment according to IEC 61800-3, the optional external filter must be used.

In some applications, the use of a ferrite ring can improve the conducted emissions.

The ferrite ring used for testing is:
Epcos part number B64290 L0040 X 830 (Part Number: 4200-3608).
Outside diameter: 58.3 mm
Inside diameter: 40.8 mm
Thickness: 17.6 mm

The ferrite ring should be mounted close to the drive, and the output power conductors (U, V, W but not E) should be passed once or twice through the central aperture, all together in the same direction.

The tables below summarise the conducted emissions when fitted with various types of filtering.

Table 8 Conducted emissions with external filter, all models

EMC Filter	Maximum motor cable length (m)	Switching frequency (kHz)			
		2	3	4	6
External filter	20	C1	C1	C2	C2
	100	C2	C2	C2	C2

Table 9 Conducted emissions with internal filter, Models EVC1150B-J1-*14 and EVC1150B-J1-*24

EMC Filter	Maximum motor cable length (m)	Switching frequency (kHz)			
		2	3	4	6
Internal filter only	2	C3	C3	C4	C4
Internal filter and ferrite ring with 1 or 2 turns	4	C3	C3	C3	C4
	10	C3	C3	C4	C4

Table 10 Conducted emissions with internal filter, Models EVC1185B-K1-*14, EVC1185B-K1-*24, EVC1185-K2-*24

EMC Filter	Maximum motor cable length (m)	Switching frequency (kHz)			
		2	3	4	6
Internal filter only	4	C3	C3	C4	C4
Internal filter and ferrite ring with 1 or 2 turns	8	C3	C3	C3	C4
	16	C3	C3	C4	C4

Table 11 Conducted emissions with internal filter, Models EVC1150B-K1-*14, EVC1150B-K1-*24

EMC Filter	Maximum motor cable length (m)	Switching frequency (kHz)			
		2	3	4	6
Internal filter only	4	C3	C3	C3	C4
	10	C3	C4	C4	C4
Internal filter and ferrite ring with 2 turns	4	C3	C3	C3	C4
	10	C4	C4	C4	C4

Table 12 Conducted emissions with internal filter, Model EVC1185B-J1-*24

EMC Filter	Maximum motor cable length (m)	Switching frequency (kHz)			
		2	3	4	6
Internal filter only	100	C4	C4	C4	C4
Internal filter with ferrite ring	100	C4	C4	C4	C4

Notes:

1. Where the drive is incorporated into a system with rated input current exceed 75A, the higher emission limits in IEC 61800-3 for the Second environment are applicable, and no filter is required.
2. Operation without a filter is a practical cost-effective option in an industrial environment where existing levels of electrical noise are likely to be high, and any electrical equipment in operation has been designed for such an environment. This is in accordance with IEC 61800-3 in the Second Environment. 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 problems that occur.

3.3.2 External EMC filters

The external EMC filters for use with these drives are available as stock items. The model numbers are shown in Table 13 below:

Table 13 External EMC filters

Compressor Series	Drive Model Number	Supply Voltage (V)	EMC filter rated current (A)	EMC filter Part No.
ZPV0631E-5E9	EVC1150B-J1-*14	200-240	55	4200-2300
ZPV0631E-4E9	EVC1185B-K1-*14	380-480	40	4200-0402
ZPV0631E-4E9	EVC1150B-K1-*14	380-480	40	4200-0402
ZPV0631E-4E9	EVC1150B-L1-*14	500-575	42	4200-3690
ZPV0662E-5E9	EVC1150B-J1-*24	200-240	55	4200-2300
ZPV0662E-4E9	EVC1150B-K2-*24	380-480	40	4200-0402
ZPV0662E-7E9	EVC1150B-K1-*24	380-480	40	4200-0402
ZPV0662E-7E9	EVC1150B-L1-*24	500-575	42	4200-3690
ZPV0962E-5E9	EVC1185B-J1-*24	200-240	113	4200-1132
ZPV0962E-4E9	EVC1185B-K2-*24	380-480	63	4200-4800
ZPV0962E-7E9	EVC1185B-K1-*24	380-480	63	4200-4800
ZPV0962E-7E9	EVC1185B-L1-*24	500-575	42	4200-3690

3.3.1 Earth leakage current

The external filters and the internal filter have earth leakage currents exceeding 3.5 mA. A permanent fixed earth connection is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

3.3.2 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. For details of ground fault protection contact the supplier of the drive.

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.

3.3.3 Shared external filters for multiple drives

When more than one drive is used in the same enclosure, some cost saving is possible by sharing a single filter of suitable current rating between several drives. Tests have shown that combinations of drives with a single filter are able to meet the same emission standard as a single drive, provided that all filters and drives are mounted on the same metal plate. However, due to the unpredictable effect of the additional wiring and the need for separate fuses for the drives on the drive side of the filter, this arrangement is not recommended where strict compliance with a specific standard is required, unless emission tests can be carried out.

Table 14 Comparison of IEC 61800-3 and related emissions standards

Drive standard Equipment Category	Generic standard	Scope of Generic standard	Product standard	Scope of Product standard
C1	IEC 61000-6-3	Emission standard for residential, commercial and light-industrial environments	EN 55011 Class B CISPR 11 Class B	Industrial, scientific and medical equipment
			EN 55014 CISPR 14	Household electrical appliances
			EN 55022 Class B CISPR 22 Class B	Information technology equipment
C2	IEC 61000-6-4	Emission standard for industrial environments	EN 55011 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
			EN 55022 Class A CISPR 22 Class A	Information technology equipment
			EN12015 (rated current ≤ 25 A)	Lifts, elevators and moving walkways

Figure 3 below shows a typical conducted emissions plot.

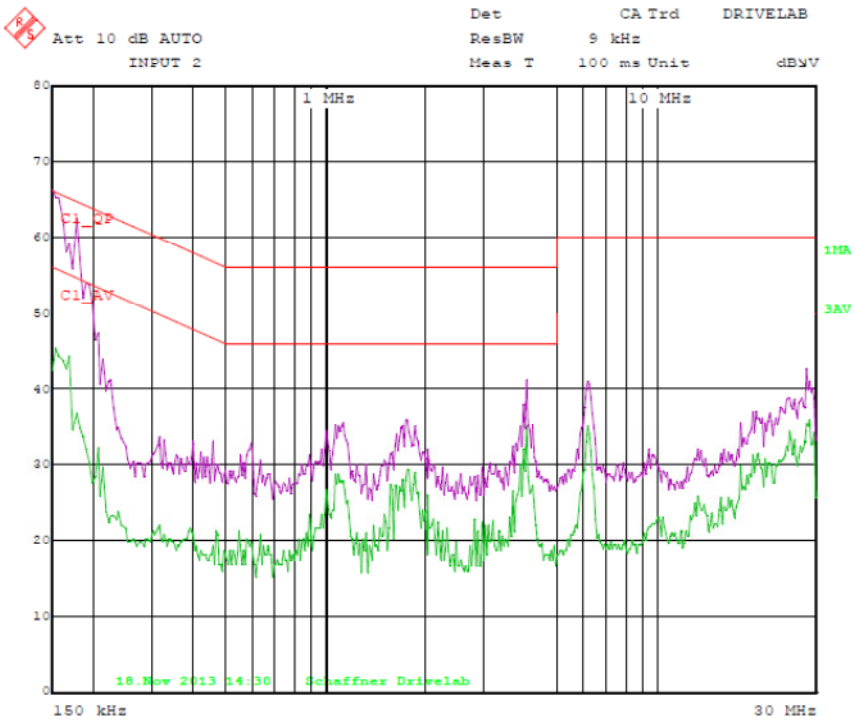

Figure 3 Conducted Emissions with external filter.
Models: EVC1150B-J1-*14, EVC1150B-J1-*24.
Switching frequency = 12 kHz, motor cable length = 20 m, Category C1 limits met

3.4 Radiated Emissions

3.4.1 Measured Results

When installed in a standard metal enclosure according to the wiring guidelines, the drive will meet the radiated emission limits required by the generic industrial standard IEC 61000-6-4.

3.4.2 Test conditions

Compliance was achieved in tests using representative enclosures and following the guidelines given below. No special EMC techniques were used beyond those described here. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

3.4.3 Test results

Radiated emissions measurements on representative drive models are shown in Table 15 below.

The tests were carried out in a calibrated Open Area Test Site (OATS) at a measuring distance of 3m. During the test, the vertical position of the receiving antenna was adjusted over then range 1m to 4m, in 0.5 m steps. Both vertical and horizontal polarizations were tested.

The results show that the drive is capable of meeting the limits in IEC 61800-3, Equipment Category C2.

Table 15 Radiated emission measured levels

Test frequency (MHz)	Measured level (dBµV/m)	C2 limit (dBµV/m)	Margin (dBµV/m)
Models EVC1150B-K1-*14, EVC1150B-K1-*24			
39.701	32.84	40	-7.16
50.551	31.49	40	-8.51
56.451	27.33	40	-12.67
62.301	29.69	40	-10.31
70.201	26.74	40	-13.26
245.251	36.44	47	-10.56
246.901	39.36	47	-7.64
638.751	36.84	47	-10.16
740.501	38.71	47	-8.29
Models EVC1150B-J1-*14, EVC1150B-J1-*24			
30.12	32.5	40	-7.5
31.24	31.4	40	-8.6
32.2	29.4	40	-10.6
32.96	29.7	40	-10.3
34.16	29.58	40	-10.42
36.68	32.28	40	-7.72
42.28	34.12	40	-5.88
45.52	28.67	40	-11.33
46.12	29.76	40	-10.24
54.0	30.16	40	-9.84

Test frequency (MHz)	Measured level (dBµV/m)	C2 limit (dBµV/m)	Margin (dBµV/m)
Models: EVC1185B-K1-*14, EVC1150B-J1-*24, EVC1185B-K1-*24			
30.04	28.85	40	-11.15
30.88	30.15	40	-9.85
31.48	30.55	40	-9.45
47.08	30.41	40	-9.59
47.32	30.65	40	-9.35
47.8	31.27	40	-8.73
48.44	32.37	40	-7.63

3.4.4 Conclusion

The test results show that the drive complies with the Equipment Category C2 limit provided that the cable screens are bonded to the metal enclosure. If the cable screens are not bonded, the drive complies with the Equipment Category C3 (industrial) limit. Typical radiated emissions plots are shown below. The narrow peaks are broadcast stations, not emissions from the drives.

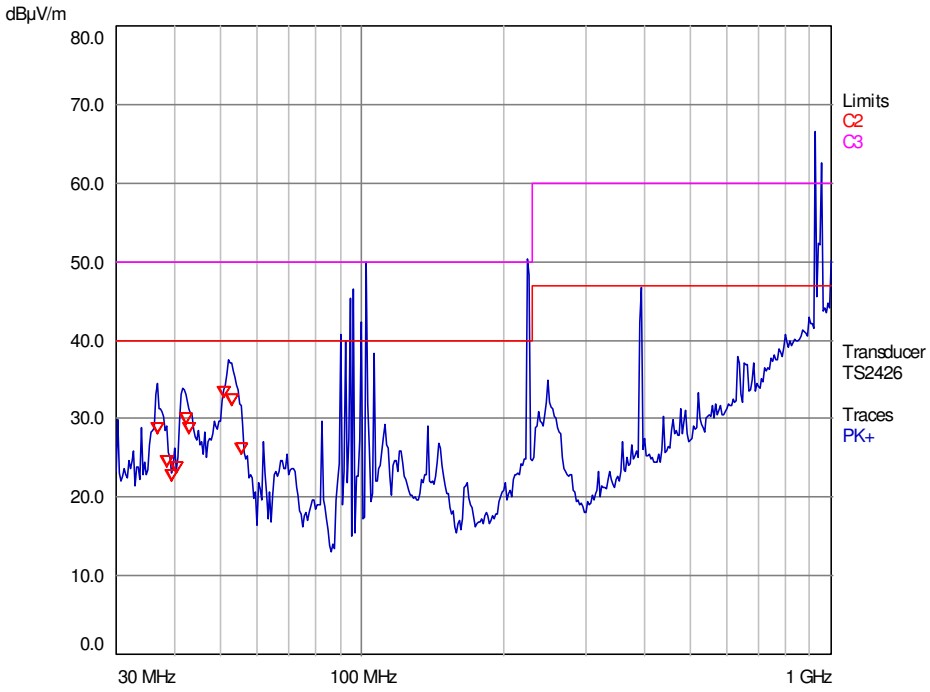

Figure 4 Radiated emissions
Models: EVC1150B-K1-*14, EVC1150B-K1-*24.
Category C2 limits met

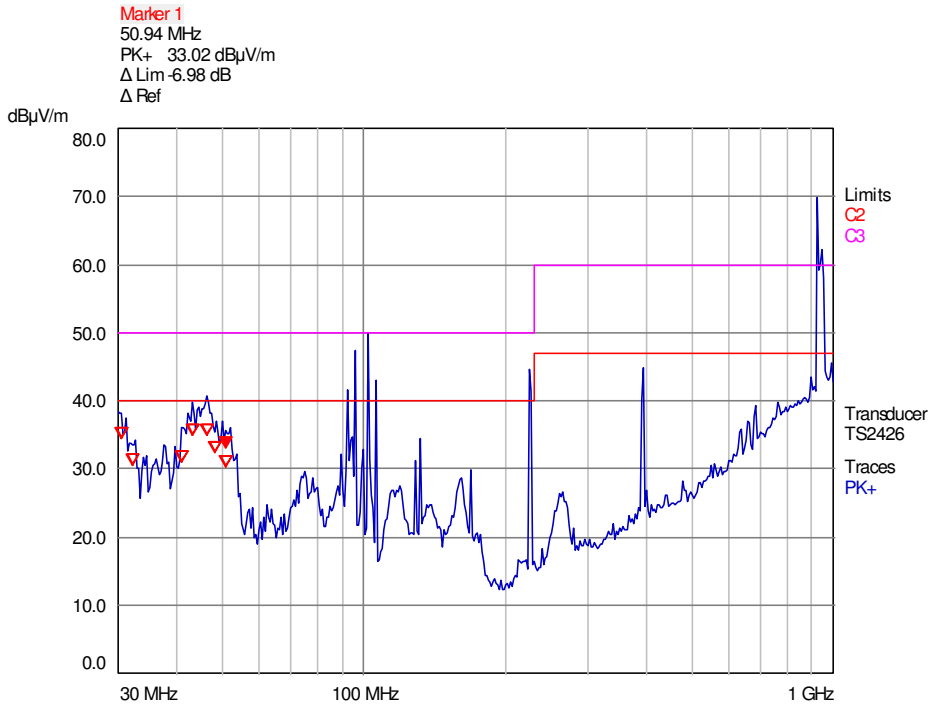

Figure 5 Radiated emissions
Models: EVC1185B-K1-*14, EVC1185B-K1-*24.
Category C2 limits met

3.4.5 Test conditions for radiated emissions testing

The drive was installed in a standard metal enclosure according to the wiring guidelines given in section 4 of this data sheet.

A standard steel enclosure was used having dimensions 1900 mm (high) × 600 mm (wide) × 500 mm (deep). Two ventilation grilles, both 200 mm square, were provided on the upper and lower faces of the door. No special EMC techniques were used, for example use of EMC gaskets around the enclosure doors.

The drive and recommended EMC input filter were fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate via the fixing screws. Standard unscreened power cable was used to connect the cubicle to the AC supply.

A standard AC induction motor was connected by 3 m of shielded cable (steel braided - type SY) and mounted externally. The screen of the motor cable was bonded to the back plate of the enclosure. The drive was operated at an output frequency of 6 Hz, and a switching frequency of 12 kHz. The screens of the signal and encoder cables were bonded to EMC bracket. Communications cables were not bonded to earth.

Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

3.4.6 Radiated emissions test limits

The radiated emissions limits in the drive EMC product standard, IEC 61800-3 are shown in Table 16.

Table 16 Radiated emissions limits in IEC 61800-3

Frequency range (MHz)	Category C1	Category C2	Category C3	Units
30 - 230	30	40	50	dBµV Quasi peak
230 - 1000	37	47	60	

Note: The limits apply at a measuring distance of 10 m. The measurements may be made at 3m with the limits increased by 10 dB.

3.4.7 Compliance with FCC requirements

The radiated emission limits in FCC regulations for unintentional radiators are shown in Table 17 below:

Table 17 Comparison of FCC radiated emissions limits with Limits for equipment category C2 from IEC 61800-3

Frequency of emission (MHz)	Field strength limit (µV/m)	Limits (dBµV/m)	IEC 61800-3 Equipment category C2 limits (dBµV/m)
30-88	100	40	40
88-216	150	43.52	40
216-960	200	46.02	40/47
Above 960	500	53.98	47

In the terminology of the FCC regulations, the drives are unintentional radiators. The FCC limits for conducted emissions are broadly equivalent to the limits for equipment category C2 in IEC 61800-3.

4. Installation and Wiring Guidelines

4.1.1 General

The installation and wiring guidelines in this data sheet cover the general principles to be followed when installing a drive for EMC compliance. More detailed instructions are contained in the *User Guide* or *Installation Guide*.

4.1.2 Types of supply

Drives rated for supply voltage up to 575 V 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 greater than 575 V are not permitted.

4.1.3 Surge Immunity

Drives are suitable for use on supplies of installation category III and lower, according to IEC 60664-1. This means they may be 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.

4.1.4 Drive Mounting

The Drive and EMC filter must be mounted on the same metal back-plate, and their mounting surfaces must make a good direct electrical connection to it. The use of a plain, unpainted metal back-plate is recommended.

4.1.5 Motor cable

A shielded (screened) or steel wire armoured cable must be used to connect the drive to the motor. The shield must be bonded to the drive using the grounding clamp provided. In addition, the motor cable shield must be bonded to the metal back-plate.

4.1.6 Connection of motor cable shield at the motor

The earth connection at the motor should be as short as possible, not exceeding 50 mm (2 inches) in length. If the motor housing is made of metal, a full 360° termination of the shield to the motor terminal housing is beneficial.

4.1.7 Layout

The EMC filter must be mounted close to the drive with short connections to the rectifier input terminals.

If a separate rectifier is used, it must not be mounted directly above the inverter. This is to prevent the heated air expelled from the inverter being re-circulated through the rectifier.

4.1.8 Cables

The AC supply cables must be kept at least 100 mm (4 inches) away from the motor cable, the braking resistor cable and the drive enclosure, in order to prevent cross coupling.

Signal and control wiring must be kept at least 300 mm (12 inches) from the power cables.

The control wiring “0 V” connection should be connected to earth at one point only, preferably at the controller and not at the drive.

4.1.9 Control wiring routed outside the enclosure

Refer to section 2.1.2 of this data sheet for guidelines on the protection of control wiring from surges and transients.

If drive control wiring leaves the enclosure then one of the following additional measures must be taken: (This includes all control, encoder and option module wiring but not the status relay circuit or the serial port).

1. Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) to the grounding bracket provided.

2. Pass the control wires through a ferrite clamp HITEK part number H8FE 1004-AS, (part number 3225-1004). More than one cable can pass through the clamp. Ensure that the length of cable between the ring and drive does not exceed 125 mm (5 inches).

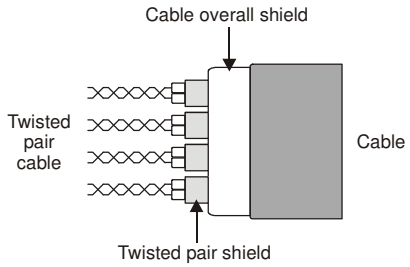

Figure 6 Shielded control cable

4.1.10 Use of additional safety earth wire

If an additional safety earth wire is required for the motor, it can either be carried inside or outside the motor cable shield. If it is carried inside then it must be terminated at both ends as close as possible to the point where the screen is terminated. It must always return to the drive and not to any other earth circuit.

4.1.11 Braking resistor wiring

Wiring to the braking resistor should be shielded. The shield must be bonded to the back-plate using an un-insulated metal cable-clamp. It need only be connected at the drive end.

If the braking resistor is outside the enclosure then it should be surrounded by an earthed metal shield.

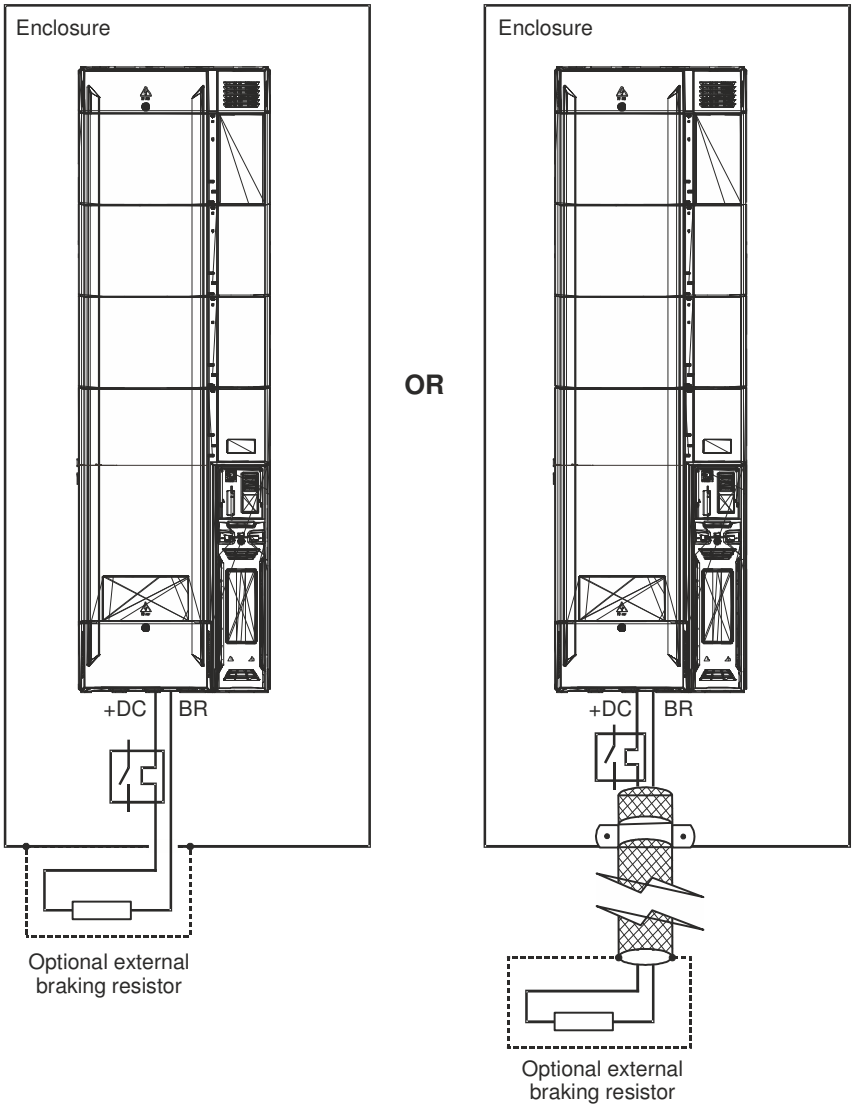

Figure 7 Shielding of brake resistor cables

4.1.12 Interruptions to the motor cable

The motor cable should ideally be a single run of shielded cable having no interruptions. In some situations it may be necessary to interrupt the cable, for example to connect the motor cable to a terminal block within the drive enclosure, or to fit an isolator switch to allow safe working on the motor. In these cases the guidelines in the following sections should be observed. The most important factor is always to minimise the inductance of the connection between the cable shields.

4.1.13 Terminal block within enclosure

The motor cable shields should be bonded to the back-plate using un-insulated 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 0.3 m (12 inches) away from the terminal block.

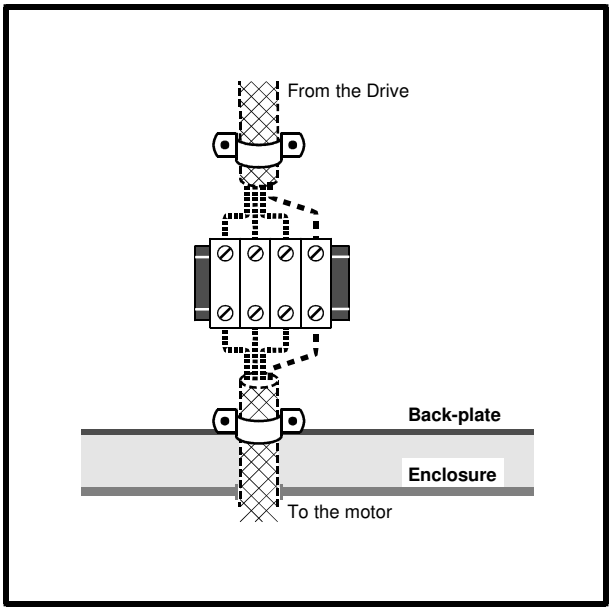

Figure 8 Connecting the motor cable to a terminal block in the enclosure

4.1.14 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 bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using un-insulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are separated by at least 0.3 m (12 inches). 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.

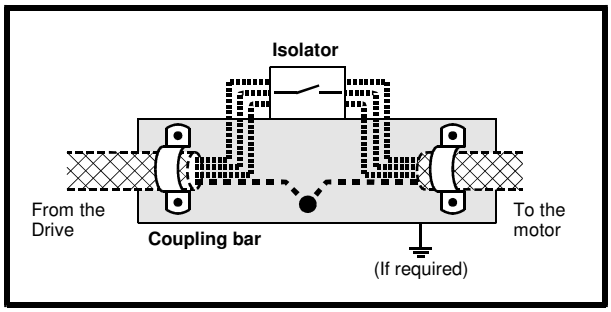

Figure 9 Connecting the motor cable to an isolating switch

1-000-021-361

EMERSON. CONSIDER IT SOLVED