EMERSON Industrial Automation

CONTROL TECHNIQUES

COMMANDER SK SIZE D (3kW to 7.5kW)
ELECTROMAGNETIC COMPATIBILITY DATA

PRODUCT SKDD200300, SKD3200400, SKD3400550, SKD3400750

General note on EMC data

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 company 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.

Note on EN 61800-3 and IEC 61800-3

The data refers to EN 61800-3:1997 including amendment A11 and the associated standard IEC 61800-3:1996. This is replaced by EN 61800-3:2004 from June 2005 (previous versions withdrawn October 2007).

IMMUNITY

The drive complies with the following international and European harmonised standards for immunity:

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2 IEC 61000-4-2	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
EN 61000-4-3 IEC 61000-4-3	Radio frequency radiated field	80% AM (1kHz) modulation Levels prior to modulation: 10V/m 80 - 1000MHz 3V/m 1.4 – 2.0GHz 1V/m 2.0 – 2.7GHz	Module enclosure	Level 3 (industrial)
EN 61000-4-4 IEC 61000-4-4	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)
EN 61000-4-5 IEC 61000-4-5	Surges	Common mode 4kV 1.2/50μs waveshape	AC supply lines: line to earth	Level 4
		Differential mode 2kV	AC supply lines: line to line	Level 3
		Common mode 1kV	Control lines[1]	
EN 61000-4-6 IEC 61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
EN 61000-4-8	Power frequency magnetic field	12000A/m (15mT) r.m.s.[2] 17000A/m (21mT) peak or d.c.	Module enclosure	Exceeds level 5
EN 61000-4-11 IEC 61000-4-11	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 61000-6-1 IEC 61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 61000-6-2[3] IEC 61000-6-2	Generic immunity standard for the industrial environment			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

[1] Applies to ports where connections may exceed 30m length. Special provisions may be required in some cases – see additional information below.
[2] Limited by test equipment capability
[3] Supersedes EN 50082-2

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 carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with appropriate suppression, otherwise the immunity capability of the drive may be exceeded.

Behaviour with supply voltage dips and interruptions
The test results show that the product behaves as intended during supply dips and interruptions. Attention is required to the setting of the relevant parameters if the behaviour is to be adjusted to best suit the application.
Since the stored energy in the drive is small in comparison with the power flow to the motor, the drive cannot sustain the power flow through any significant interruption – typically the stored energy in the drive is depleted in about 5ms at rated power. When the stored energy has fallen to an unsustainable level the drive trips with the code "UU". The behaviour when the power returns depends upon the external signals in the usual way as when the power is first applied.
One exception to this is where a single phase of a three-phase supply is lost or reduced – the drive will continue to drive the motor until the phase-loss protection operates.
By default, the drive will quickly cease to supply the motor during a power interruption or a dip exceeding about 30%. The drive output will be inhibited following the "UU" trip, and the motor will coast to a halt. When the power returns the drive will be ready to supply power again, depending upon the control signals. During a brief interruption there is a possibility of a trip (OIAC) if the drive attempts to re-start a spinning motor which still has current in its rotor. If the application is such that the drive is required to ride through the disturbance if possible, and/or to re-start at the end of the interruption where the motor has stopped, then the following functions should be considered. Refer to the Advanced User Guide for more information:

Pr 6.03 Mains loss mode – select "ride through". At loss of supply the drive reduces the motor set speed in a controlled fashion and uses power from the mechanical stored energy in the load to keep control for as long as possible. It restores normal operation when the supply returns. The motor remains in synchronisation with the drive unless and until a UU trip occurs, which minimises the risk of an OIAC trip when the interruption ends - unless the load is capable of independently rotating the motor (see next point).
Pr 6.09 Catch a spinning motor. The drive regains control of a motor which is spinning at startup, for example because of natural air flow in a fan, by using a special algorithm to estimate its speed.

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 EN 61000-6-2 (1kV surge) provided the 0V connection is not earthed, i.e. in the common mode. Generally they cannot withstand the surge directly between the control lines and the 0V connection, i.e. in the series mode.

The surge test simulates the effect of lightning or severe electrical faults in a physically extended electrical system, where high differential transient voltages may appear between different points in the grounding system. This is a particular risk where the circuits extend outside the protection of a building, or if the grounding system in a large building is not well bonded.

In applications where control circuits may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. As a general rule, if the circuits are to pass outside the building where the drive is located, or if wiring runs within a building exceed 30m, some additional precautions are advisable. One of the following techniques should be used:

1. 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 associated return (0V) wire.

2. Screened cable with additional power ground bonding. If isolation at one end is not acceptable, the cable screen 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 screen, 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 screen. If the building or plant has a well-designed common bonded network this precaution is not necessary.

3. 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 Figures 1 and 2.

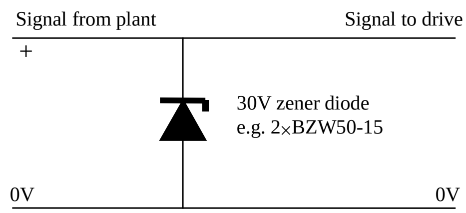


Figure 1: Surge suppression for digital and unipolar analogue inputs and outputs

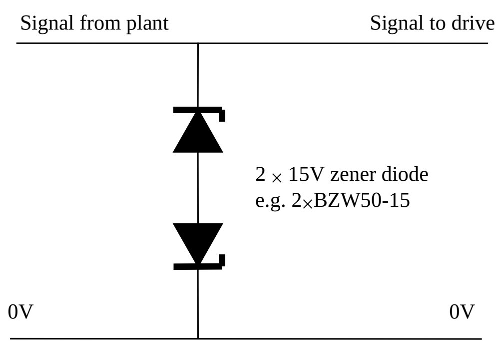


Figure 2: Surge suppression for bipolar analogue inputs and outputs

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 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.

EMISSION

Emission occurs over a wide range of frequencies. The effects are divided into three main categories:
- Low frequency effects, such as supply voltage notching, supply harmonics and lighting flicker.
- High frequency emission below 30MHz where emission is predominantly by conduction.
- High frequency emission above 30MHz where emission is predominantly by radiation.

SUPPLY VOLTAGE NOTCHING

Because of the use of uncontrolled input rectifiers the drives cause no significant notching of the supply voltage.

SUPPLY HARMONICS

The input current contains harmonics of the supply frequency generated by the input rectifier. The harmonic current levels are affected to some extent by the supply impedance (fault current level). The table shows the levels calculated for a fault level of 5kA. This meets and exceeds the requirement of IEC 61800-3 (fault current 250 times the drive rating) and represents a realistic but severe case. A standard Eff2 motor is assumed.
The levels of even harmonics are negligible.
The calculations have been verified by laboratory measurements on sample drives. Note that the r.m.s. current in these tables may be lower than that specified in the published technical data, since the latter is a worst-case value provided for safety reasons which allows for supplies with high fault levels and less efficient motors.
The supply voltage for the calculation was 230/400V 50Hz. The harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

Dual rated 200V drive, single phase operation, 5kA fault level at supply:

				Harmonic order, magnitude as % fundamental											
Drive (kW)	**r.m.s. current (A)**	**Fund current (r.m.s.)**	**THD (%)***	**3**	**5**	**7**	**9**	**11**	**13**	**15**	**17**	**19**	**21**	**23**	**25**
3.0	23.5	16.8	98.0	80.5	50.2	21.6	6.4	6.9	4.8	2.6	2.8	2.0	1.4	1.5	1.1

200V drives, three phase operation, 5kA fault level:

				Harmonic order, magnitude as % fundamental							
Drive (kW)	**RMS current**	**Fund current (r.m.s.)**	**THD (%)***	**5**	**7**	**11**	**13**	**17**	**19**	**23**	**25**
3.0	12.3	9.6	79.9	66.1	42.7	8.4	7.5	4.6	3.1	2.7	2.1
4.0	15.3	12.6	69.8	58.1	36.5	6.9	7.6	4.0	3.5	2.8	2.2

Three-phase 400V drives, 5kA fault level:

				Harmonic order, magnitude as % fundamental							
Drive (kW)	**RMS current**	**Fund current (r.m.s.)**	**THD (%)***	**5**	**7**	**11**	**13**	**17**	**19**	**23**	**25**
5.5	12.1	9.8	72.8	60.8	38.3	5.9	7.4	3.5	3.4	2.5	2.1
7.5	15.1	13.0	58.2	49.6	28.2	6.6	6.0	3.9	3.2	2.8	2.2

* Total Harmonic Distortion, expressed as percentage of fundamental

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 from supply disturbances such as voltage surges caused by the switching of high-current loads or power-factor correction capacitors on the same supply circuit. The following tables show the corresponding harmonics where inductors of approximately 2% per unit are fitted in the supply lines. Higher reactor values should be applied with caution because of the reduction in output voltage. Line reactors should be rated for continuous operation at the RMS current shown, and for a peak current (for no magnetic saturation) of at least twice that.

Dual rated 200V drive, single phase operation:

Drive (kW)	L (mH)	RMS current	Fund current (r.m.s.)	THD (%)*	Harmonic order, magnitude as % fundamental											
					3	5	7	9	11	13	15	17	19	21	23	25
3.0	0.5	22.4	17.0	86.5	75.2	39.7	12.2	7.1	5.7	2.9	2.9	1.9	1.6	1.4	1.0	1.0

Suitable single-phase chokes are available from Control Techniques with the following part number:
0.5mH 4402-0226

200V drives, three phase operation:

Drive (kW)	L (mH)	RMS current	Fund current (r.m.s.)	THD (%)*	Harmonic order, magnitude as % fundamental							
					5	7	11	13	17	19	23	25
3.0	0.4	10.8	9.6	52.3	45.8	22.7	7.7	5.1	3.9	2.5	2.5	1.7
4.0	0.4	13.7	12.5	44.8	40.0	17.2	7.8	4.3	3.9	2.4	2.4	1.7

* Total Harmonic Distortion, expressed as percentage of fundamental

Suitable three-phase chokes are available from Control Techniques with the following part number:
0.4mH 4402-0229

Three phase 400V drives:

Drive (kW)	L (mH)	RMS current	Fund current (r.m.s.)	THD (%)*	Harmonic order, magnitude as % fundamental							
					5	7	11	13	17	19	23	25
5.5	1	10.6	9.7	44.1	39.6	16.4	7.5	4.1	3.8	2.4	2.4	1.7
7.5	1	14.0	13.0	38.4	35.0	12.2	7.4	3.9	3.7	2.5	2.2	1.7

* Total Harmonic Distortion, expressed as percentage of fundamental

Suitable three-phase chokes are available from Control Techniques with the following part number:
1.0mH 4402-0228

The effect of load on harmonics

With reducing load the major harmonics fall in absolute magnitude, although they generally rise as a fraction of the fundamental. Note that it is mechanical load power which controls input current, i.e. the product of torque and speed. As the speed is reduced the motor current becomes increasingly reactive so the drive input current falls, together with its harmonics.

Product family standards for harmonics

IEC 61000-3-2 (EN 61000-3-2)

This standard applies to equipment rated at ≤16A per phase with a supply voltage of 230/400V 50Hz.
The 400V drives are within the scope of the standard. For professional equipment rated over 1kW there are no limits specified, so when used for professional purposes the drives meet the requirements without further assessment.

IEC 61000-3-12 (EN 61000-3-12)

This standard applies to equipment rated at ≤75A per phase with a supply voltage of 230/400V 50Hz.
Table 4 of the standard can be met by the following products, using external reactors (chokes) in the input supply lines:

	External reactor (mH)	Reactor current rating (A)
SKD3400550	1.7	11
SKD3400750	1.0	14

The condition for meeting the standard is $R_{SCE} \geq 120$, i.e. the short-circuit current at the point of common coupling with other supply users must be at least 120 times the rating of the drive(s). Equipment containing these drives and required to meet this standard must include this requirement with the installation instructions.

Applications with 200V 3 phase supplies have no limits specified in IEC 61000-3-12.
It is not practicable to meet IEC 61000-3-12 with the SKDD200300 drive on a single-phase supply.

Note on load power for IEC 61000-3-12 compliance
The value of the required input reactor depends upon the load power, i.e. the product of shaft speed and torque. The values given above are correct for the stated load, which is a standard 4-pole Eff2 induction motor delivering the specified load power. If the actual maximum continuous electrical load is less than this then the inductance must be scaled up in inverse proportion to the actual load. If tests according to IEC 61000-3-12 are carried out it is important to arrange for the equipment to be fully loaded in order to obtain valid results.

Lifts standard EN 12015
No data is given regarding harmonics limits relative to EN 12015 because the drive is not suitable for use as a hoist drive. It may be used for lift auxiliary equipment, but in that case its harmonic emission is small in comparison with the main hoist drive.

Further measures for reducing harmonics
It is unusual for harmonics to pose a problem unless a substantial part (e.g. over 50%) of the supply system capacity is accounted for by drives or other power electronic loads. Harmonic currents from drives add approximately arithmetically. It is usually most cost-effective to analyse a complete installation for harmonic current or voltage and to apply remedial measures such as harmonic filters, if necessary, for the entire installation at the common supply point.

Voltage fluctuations and lighting flicker
When power is first applied the drive draws an inrush current which is limited to 12.5A for the 200V versions and 7A for the 400V versions, this meets the requirements of EN 61000-3-3 and EN 61000-3-11 for manually switched equipment.
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 power to vary frequently and rapidly, resulting in flicker. Cyclical variations with frequency in the region of 2Hz to 20Hz are likely to cause irritating lighting flicker and should be avoided where possible. This is particularly important for equipment rated at no more than 16A where EN 61000-3-3 applies.

CONDUCTED HIGH FREQUENCY EMISSION
Radio frequency emission in the frequency range from 150kHz to 30MHz is generated by the switching action of the main power devices (IGBTs) and is mainly conducted out of the equipment through electrical wiring. It is essential for compliance with the emission standards that the recommended filter and a shielded (screened) motor cable are used. Most types of cable can be used provided it has an overall screen, for example the screen formed by the armouring of steel wired armoured cable is acceptable. The capacitance of the cable forms a load on the drive and should be kept to a minimum. Compliance tests were done with cable having a capacitance between the three power cores and the screen of 412pF per metre (measured at 1kHz), which is typical of steel wire armoured cable. In addition to motor cable length, conducted emission will also vary with drive switching frequency: selecting the lowest switching frequency will produce the lowest level of emission. Wiring guidelines are given in Figure 3 which shows full precautions where minimum emissions are required.

The drive contains a cost-effective internal input filter which gives a reduction of about 30dB 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 is unacceptable. The Getting Started guide gives instructions on how to remove and replace it. Maximum leakage currents are:

200V single phase supply	21mA
200V three phase supply	8.2mA
400V three phase supply	10mA

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

Standard external filters have earth leakage current of up to 40mA under normal working conditions.

They should be used in conjunction with the drive internal filter, giving a total current of 41mA. (The currents do not add arithmetically since they have different frequencies.)

The low-leakage filter has a reduced earth leakage current of 3.0mA maximum, but the permissible motor cable length is reduced. *To achieve this earth leakage value, the drive internal filter must be disconnected.*

Recommended external filters

Drive	Motor cable length (m)	Input filter (CT Part No.)	Filter Type
SKDD200300 single phase	0 to 100	4200-6409	Footprint / Side-mounted Standard
SKDD200300 single phase	0 to 10	4200-6410	Footprint / Side-mounted Low Earth Leakage (<3.5mA)
SKDD200300 three phase SKD3400400 – SKD3400750	0 to 100	4200-6411	Footprint / Side-mounted Standard
SKDD200300 three phase SKD3400400 – SKD3400750	0 to 10	4200-6412	Footprint / Side-mounted Low Earth Leakage (<3.5mA)

Mechanical and electrical data, including earth leakage current and power loss, is given in the drive technical data.

- WARNING -

Except for the low earth leakage versions, these filters have earth leakage current exceeding 3.5mA. 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.

The drive complies with the requirements for conducted emission in the following standards.

Single-phase applications:

Motor cable length (m)	**Filter and switching frequency (kHz)**								
	Internal with external ferrite ring			**Standard (4200-6409)**			**Low Leakage (4200-6410)**		
	3	**6**	**12**	**3**	**6**	**12**	**3**	**6**	**12**
10				R	R	R	R	R	R
20				R	R	R			
50				I	I	I			
100				I	I	I			

Three-phase applications 200V:

Motor cable length (m)	**Filter and switching frequency (kHz)**								
	Internal with external ferrite ring			**Standard (4200-6411)**			**Low Leakage (4200-6412)**		
	3	**6**	**12**	**3**	**6**	**12**	**3**	**6**	**12**
10				R	R	R	R	R	R
20				R	R	R			
50				I	I	I			
100				I	I	I			

Three-phase applications 400V:

Motor cable length (m)	Filter and switching frequency (kHz)								
	Internal with external ferrite ring			Standard (4200-6411)			Low Leakage (4200-6412)		
	3	6	12	3	6	12	3	6	12
8	E2U	E2R	E2R	R			R	R	R
10	E2R	E2R	E2R	R			R	R	R
20	E2R	E2R	E2R	R	I	I			
50	E2R	E2R	E2R	I	I				
100	E2R	E2R	E2R	I	I	-			

Blank table entries are to be advised

Key to tables

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				

- Caution -

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.

Notes

1. 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.
2. External filters should not be operated under conditions at or beyond where the result is shown as “-“ in the table, since the filter magnetic components may become saturated and operate beyond their rated energy density.

EN 61800-3:2004

The 2004 revision of the standard uses different terminology to align the requirements of the standard better with the EC EMC Directive.
Power drive systems are categorised C1 to C4:

Category	Definition	Corresponding code used above
C1	intended for use in the first or second environments	R
C2	not a plug-in or movable device, and intended for use in the first environment only when installed by a professional, or in the second environment	I
C3	intended for use in the second environment, not the first environment	E2U
C4	rated at over 1000V or over 400A, intended for use in complex systems in the second environment	E2R

Note that category C4 is more restrictive than E2R, since the rated current of the PDS must exceed 400A or the supply voltage exceed 1000V, for the complete PDS.

Sample conducted emission test data

The conducted emission from a SKD3400750 operating with filter part no. 4200-6411, at 3kHz switching frequency and 100m of screened motor cable, is shown in Figure 6.

Multiple drives

In multiple drive applications it is preferable to use one RFI filter for each drive. Filters of appropriate current rating may be shared between drives, but deviations from the stated standards may then occur. The motor cable length limits apply to the total for all drives connected to a given filter.

Related product standards

The conducted emission levels specified in the standards specified above are equivalent to the levels required by the following product specific standards:

Conducted emission from 150kHz to 30MHz		
Standard	**Product/product family standard**	
EN 61000-6-3	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
EN 61000-6-4	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
	EN 12015	Lifts (limits for all ratings)
EN 61800-3 C3 (E2U)	EN 12015	Lifts (limits for current ratings 25A – 100A)
EN 61800-3 C4 (E2R)	EN 12015	Lifts (limits for current ratings >100A and with dedicated supply transformer)

RADIATED EMISSION

Industrial emission standard EN 61000-6-4

When installed in a standard metal enclosure according to the wiring guidelines in Figure 3 and using the standard or low-leakage mains input filters, the drive will meet the radiated emission limits required by the generic industrial emission standard EN 61000-6-4.

Important note

Compliance was achieved in tests using representative enclosures and following the guidelines given. 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.

The limits for emission required by the generic emission standards are summarised in the following table:

Radiated emission from 30 to 1000MHz				
Standard	**Application**	**Frequency range**	**Limits**	**Comments**
EN 61000-6-4	Enclosure	30 - 230MHz	40dBμV/m quasi peak at 10m	Standard specifies limits of 30 and 37dBμV/m respectively at a measuring distance of 30m; emission may be measured at 10m if limits are increased by 10dB
		230 - 1000MHz	47dBμV/m quasi peak at 10m	

EN 61800-3:1997 requires the following:

As EN 61000-6-3	First environment - unrestricted distribution
As EN 61000-6-4	First environment - restricted distribution - any drive
30 – 230MHz 40dBμV/m at 30m 230 – 1000MHz 50dBμV/m at 30m	Second environment

Example test data

The test data is based on radiated emission measurements made on a standard steel enclosure containing a single SKDD200300 drive with three-phase supply, which has the highest emission level in this product range, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall enclosure was used having dimensions 1900mm (high) × 600mm (wide) × 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door.

The drive was mounted onto the 'Standard' RFI input filter (4200-6411), which was fitted to the internal back-plate of the enclosure, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cables were used to connect the complete unit to the supply.

A standard 5.5kW AC induction motor was connected by 2m of shielded cable (steel braided - type SY) and mounted externally.
The motor cable screen was clamped to the enclosure back-plate. The motor cable screen was also bonded to the motor frame.
The motor cable was interrupted by a DIN rail terminal block mounted in the enclosure and the shield pigtails (50mm long) were bonded to the back plate through an earthed DIN rail terminal block.
In addition, the motor cable screen was bonded to the back-plate on both sides of the DIN rail using metal clamps.
A 2m screened control cable was connected to the drive control terminals with the screen clamped to the enclosure back-plate
A 2m unscreened status relay cable was connected to the drive.
A 2m screened communications cable was connected to the drive. The screen was not electrically connected to the drive or cubicle back panel.

The drive was operated at 6Hz, with a switching frequency of 12kHz which is the worst case for RF emission.
No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

The following tables summarise the results for radiated emission, showing the six highest measurements over the frequency range 30 to 1000 MHz:

Frequency MHz	Emission dBμV/m	Level required by industrial standard EN61000-6-4 at 10m
46.4	35.9	40
45.35	33.6	40
45.05	33.4	40
55.55	32.9	40
55.15	32.6	40
54.85	32.0	40

The results show that the limit for the industrial emission standard is met with a margin of at least 4dB. The limit for EN 61800-3 (IEC 61800-3) is met for the first environment with restricted distribution.

Enclosure construction
For many installations, an enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall (refer to wiring guidelines in Figure 3). However, there is no disadvantage if the motor cable is bonded at the point of exit as well, through the normal gland fixings.

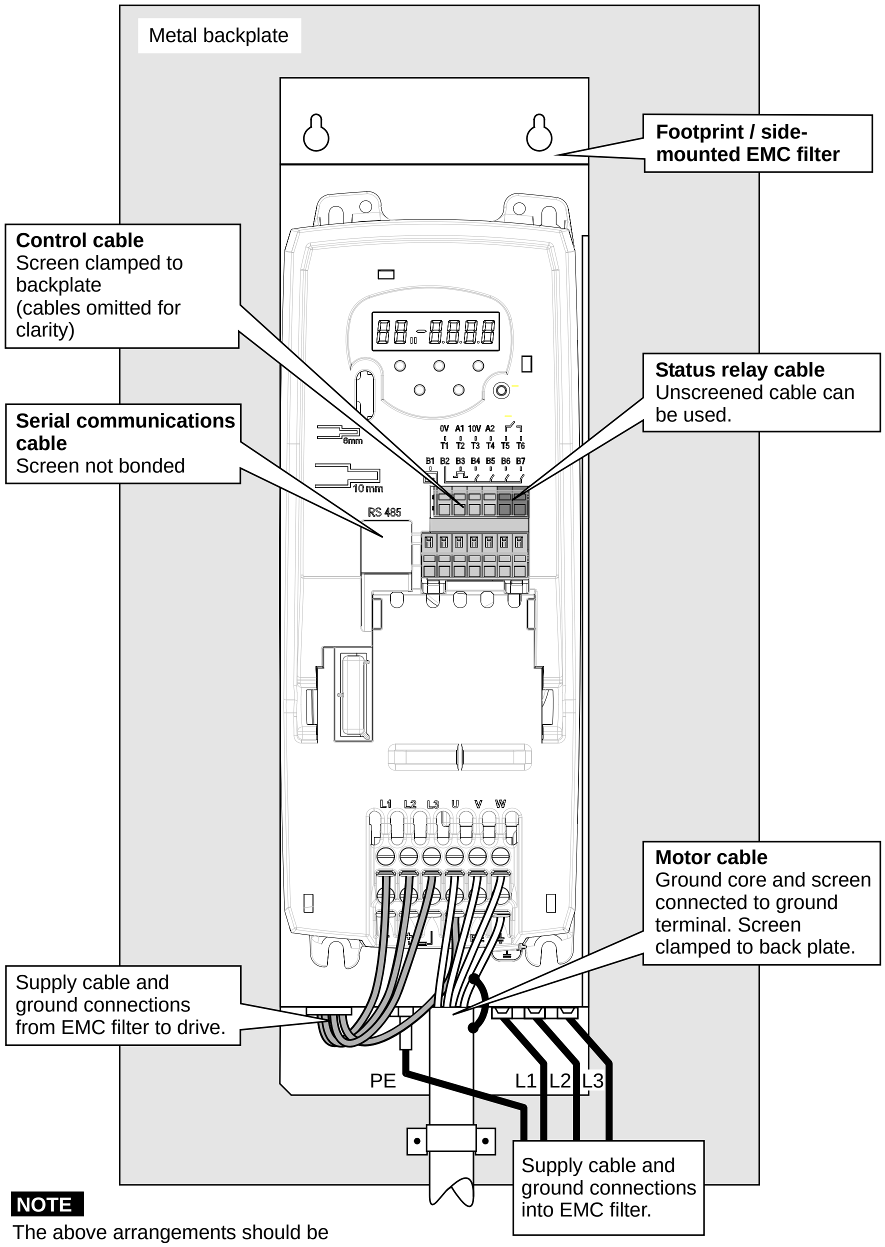
Depending on construction, the enclosure wall used for cable entry may have separate panels and could make poor electrical contact at high frequencies with the remaining structure. If the motor cable is only bonded to these surfaces and not to a back-plate, then the enclosure may provide insufficient attenuation of RF emission. It is the bonding to a common metal plate which minimises radiated emission. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure design is not critical.

Related product standards
The radiated emission levels specified in EN 61000-6-4 are equivalent to the levels required by the following product standards:

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN 61000-6-4	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN55022 Class A CISPR 22 Class A	Information technology equipment
	EN 12015	Lifts

WIRING GUIDELINES

The wiring guidelines on the following pages should be observed to achieve minimum emission. The details of individual installations may vary, but details which are indicated in the guidelines to be important for EMC must be adhered to closely. The guidelines do not preclude the application of more extensive measures which may be preferred by some installers. For example, the use of full 360° ground terminations on shielded cables in the place of 'pig-tail' ground connections is beneficial, but not necessary unless specifically stated in the instructions.



NOTE

The above arrangements should be adhered to when either:

1. The drive is mounted on the filter. (Footprint mounted)
2. The filter is mounted next to the drive. (Side mounted)

NOTE

If the optional gland plate is used then cable screens may be bonded to ground in the glands and need not be clamped to the back plate.

Figure 3 Wiring guidelines for SKD

1. The correct RFI filter must be fitted at the input to the drive.

2. The limits given above regarding motor cable length and drive switching frequency for the relevant filter must be adhered to.

3. Footprint filter: the drive must be correctly mounted on the filter and make good direct electrical contact with it.
   Side mounted filter: the drive and filter must be mounted together on a metal back-plate and make good electrical contact with it.

4. The filter must be connected to the drive using the wires provided. The wires must not be extended in any way.

5. The mounting surface of the filter must make good direct electrical contact with the enclosure back-plate. Any paint or other non-conducting surface must be removed.

6. A shielded (screened) or steel wire armoured cable must be used to connect the drive to motor. The shield must be connected to the enclosure back-plate by a good high-frequency connection, for example by direct clamping using a "Ω" clamp or similar.

7. 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 (2 in) in length. A full 360° termination of the shield to the motor terminal housing (if metal) is beneficial.

8. Ensure that the cables carrying the AC supply and the ground to the filter are at least 100mm (4 in) from the drive and the motor cable.

9. Avoid locating sensitive signal circuits in a zone extending 0.3m (12 in) all around the drive.

10. If the control circuit 0V is to be grounded, this should preferably be done at the host controller (e.g. PLC) and not at the drive, to avoid injecting noise current into the 0V circuit.
    This requirement does not apply if the complete system has been built to a high standard for EMC, using a highly bonded earth arrangement which prevents differential earth noise voltages.

SPECIAL REQUIREMENTS

Control wiring leaves the enclosure

The control wiring must be carried in shielded cable (one or more cables) and the shield must be clamped to the enclosure back-plate.

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 following guidelines should be observed.

Terminal block within enclosure
The motor cable shields should be bonded to the back-plate using uninsulated cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of unscreened power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12in) away from the terminal block. See Figure 4.

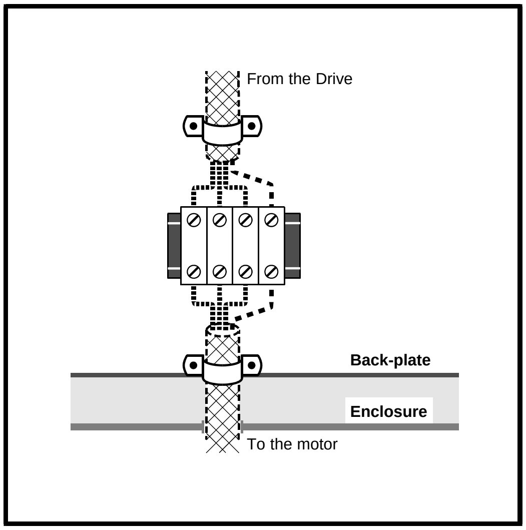


Figure 4 Arrangement for terminal block in motor cable

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 uninsulated metal cable-clamps. Keep the length of the power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12in) 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. See Figure 5.

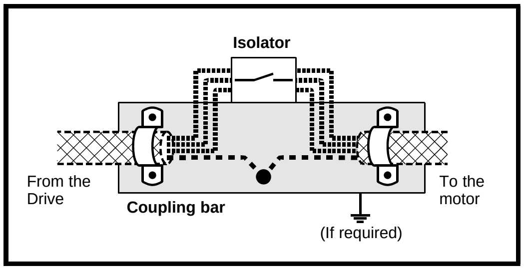


Figure 5 Arrangement for isolator switch in motor cable

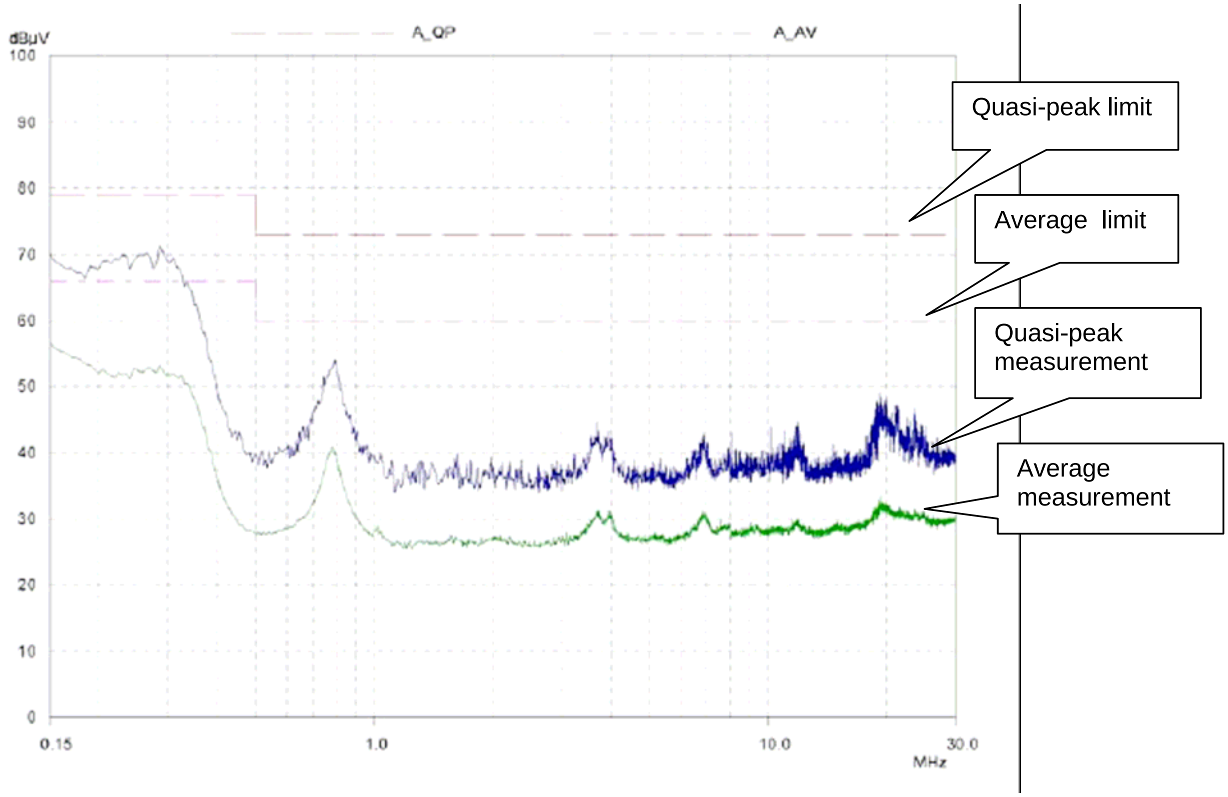


Figure 6 Conducted emission plot: SKD3400750 drive, 100m cable 3kHz switching using filter 4200-6411