Nidec
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EMC Data Sheet

Unidrive-M series Frame size 7 All models

Variable Speed AC drive for induction and permanent magnet motors

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.

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Unidrive-M Frame size 7 EMC Data Sheet

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1. Products

This EMC data sheet applies to the following products:

Table 1 Model numbers

Drive rated voltage (V)	Drive rated power (kW)	Drive Application				
		Machinery control	High speed	Elevator	Powerdrive (pumps and fans)	HVAC
200	15 / 18.5	Mxxx-072 00610A	HSxx-072 00610A	Exxx-072 00610A	F300-072 00750A	H300-072 00720A
200	18.5 / 22	Mxxx-072 00750A	HSxx-072 00750A	Exxx-072 00750A	F300-072 00940A	H300-072 00940A
200	22 / 30	Mxxx-072 00830A	HSxx-072 00830A	Exxx-072 00830A	F300-072 01170A	H300-072 01170A
400	30 / 37	Mxxx-074 00660A	HSxx-074 00660A	Exxx-074 00660A	F300-074 00790A	H300-074 00790A
400	37 / 45	Mxxx-074 00770A	HSxx-074 00770A	Exxx-074 00770A	F300-074 00940A	H300-074 00940A
400	45 / 55	Mxxx-074 01000A	HSxx-074 01000A	Exxx-074 01000A	F300-074 01120A	H300-074 01120A
575	30 / 37	Mxxx-075 00440A	HSxx-075 00440A	Exxx-075 00440A	F300-075 00530A	H300-075 00530A
575	37 / 45	Mxxx-075 00550A	HSxx-075 00550A	Exxx-075 00550A	F300-075 00730A	H300-075 00730A
690	15 / 18.5	Mxxx-076 00190A	HSxx-076 00190A	Exxx-076 00190A	F300-076 00230A	H300-076 00230A
690	18.5 / 22	Mxxx-076 00240A	HSxx-076 00240A	Exxx-076 00240A	F300-076 00300A	H300-076 00300A
690	22 / 30	Mxxx-076 00290A	HSxx-076 00290A	Exxx-076 00290A	F300-076 00360A	H300-076 00360A
690	30 / 37	Mxxx-076 00380A	HSxx-076 00380A	Exxx-076 00380A	F300-076 00460A	H300-076 00460A
690	37 / 45	Mxxx-076 00440A	HSxx-076 00440A	Exxx-076 00440A	F300-076 00520A	H300-076 00520A
690	45 / 55	Mxxx-076 00540A	HSxx-076 00540A	Exxx-076 00540A	F300-076 00730A	H300-076 00730A

Where:

Mxxx denotes M600, M700, M701, M702, M708 or M709

HSxx denotes HS70, HS71 or HS72.

Exxx denotes E200 or E300

The drive rated power e.g. 7.5 / 11 denotes Heavy Duty/Normal Duty.

Products with the same drive rated power are identical in construction. The displays, user menus and firmware are optimised for particular applications.

2. Immunity

2.1.1 Immunity Compliance

References to IEC standards are used throughout this EMC data sheet. In the EU 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 : 20 V/m 80 – 1000 MHz 6 V/m 1.4 - 2.0 GHz 3 V/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 / 50 µs 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 (Note: 2)
IEC 61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
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	

Notes:

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

2 Limited by test equipment capability

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 Power Installation 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.

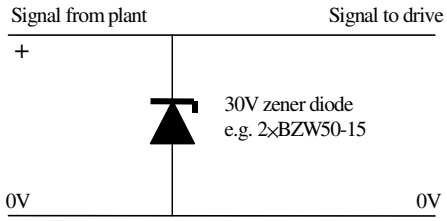

Figure 1 Surge suppression for digital and uni-polar analogue inputs and outputs

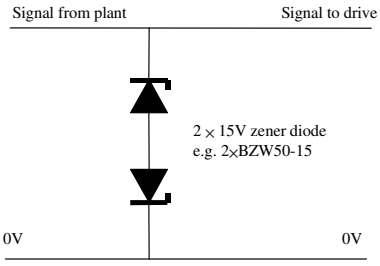

Figure 2 surge suppression for bipolar analogue inputs and outputs

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.

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 C2 when installed with external EMC 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 (crosstalk)

The drives generate switching waveforms with frequency components in the audible range as well as the frequency range commonly used by telephone and 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 *Power Installation Guide* and in 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 4 shows the levels calculated with a fault level of 18 kA. This is typical of an industrial installation. This meets and exceeds the requirements of IEC 61800-3. For installations where the fault level is lower, the harmonic current is more critical and the harmonic current will also be lower. The calculations have been verified by laboratory measurements on sample drives.

Note that the RMS current in the table 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 triple harmonics are absent. The supply voltages used for the calculations are 200 V, 400 V, 575 V and 690 V at 50 Hz. The harmonic percentages do not change substantially for other voltages and frequencies within the drive specification.

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 caused by the switching of high-current loads or power factor correction capacitors on the same supply circuit.

Table 5 shows the harmonic currents when the drives are fitted with the line reactors specified in Table 3.

Table 3 Recommended line reactors

Drive rated voltage (V)	Drive rated power (kW)	Line reactor inductance (µH)	Line reactor rated current (A)	Line reactor Model	Line reactor Part No.
200	15 / 18.5	130	67	INL2009	4401-0227
200	18.5 / 22	100	88	INL2010	4401-0228
200	22 / 30	80	105	INL2011	4401-0229
400	30 / 37	200	74	INL4014	4401-0237
400	37 / 45	170	88	INL4015	4401-0238
400	45 / 55	140	105	INL4016	4401-0239
575	30 / 37	480	47	INL5006	4401-0223
575	37 / 45	340	67	INL5010	4401-0245
690	15 / 18.5	1270	20	INL6001	4401-0248
690	18.5 / 22	980	26	INL6002	4401-0249
690	22 / 30	880	32	INL6003	4401-0250
690	30 / 37	650	39	INL6004	4401-0251
690	37 / 45	580	45	INL6005	4401-0252
690	45 / 55	410	67	INL6006	4401-0253

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 the tables below. 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.

3.2.1 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 that 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

3.2.2 Product family standards for harmonics

IEC 61000-3-2

This standard applies to equipment rated ≤ 16A per phase with a supply voltage of 230 / 400V, 50 Hz. The drives covered by this data sheet are outside the scope of this standard.

IEC 61000-3-12

This standard applies to equipment rated > 16 A and ≤ 75 A per phase. The drives covered by this data sheet fall within the scope of this standard Table 6 shows the harmonic currents when the drives are fitted with the minimum line reactance (inductance) necessary to comply with this standard.

3.2.3 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 IE2 induction motor delivering the specified load power. If the actual maximum continuous electrical load is less than this, 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.

EN 12015 Product family standard for lifts, escalators and moving walks - Emission

The harmonic current limits in EN 12015 are referenced to the fundamental current of the complete lift system. With the line reactor values shown in Table 6 fitted, the drive meets the limits in the standard for $R_{SCE} \geq 250$.

Note: R_{SCE} is the short-circuit ratio. It is the ratio of the short circuit power of the supply to the rated apparent power of the variable speed drive.

3.2.4 Further measures for reducing harmonics

It is unusual for harmonics to pose a problem unless more than 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.

Table 4 Harmonic currents without line reactor

Rated voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line choke nom (µH)	DPF Cos ø	Power Factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
200	18.5	60.20	53.5	51.56	39.32	42.87	25.40	8.16	6.38	4.74	3.61	3.28	2.53	2.42	1.98	1.89	1.57	1.50	1.29	1.22	1.06	None	0.9885	0.879
	15	51.39	44.3	58.91	39.09	48.60	30.44	8.04	7.02	4.67	3.69	3.24	2.51	2.40	1.94	1.89	1.55	1.52	1.29	1.25	1.07	None	0.9857	0.850
200	22	70.12	63.7	46.24	39.31	38.71	21.63	8.22	5.97	4.79	3.56	3.29	2.54	2.42	1.97	1.87	1.56	1.47	1.26	1.17	1.03	None	0.9902	0.899
	18.5	60.93	54.3	51.09	39.28	42.51	25.06	8.15	6.35	4.75	3.60	3.28	2.54	2.42	1.97	1.88	1.57	1.50	1.28	1.21	1.06	None	0.9886	0.881
200	30	90.70	84.3	39.88	39.19	33.62	17.05	8.29	5.62	4.82	3.57	3.29	2.57	2.39	1.97	1.80	1.53	1.39	1.20	1.06	0.96	None	0.9919	0.922
	22	66.49	60	47.93	39.38	40.03	22.85	8.21	6.10	4.77	3.59	3.30	2.54	2.42	1.98	1.88	1.57	1.49	1.28	1.19	1.05	None	0.9897	0.893
400	37	69.83	62.7	49.17	38.56	41.18	23.53	8.08	6.03	4.69	3.51	3.24	2.48	2.37	1.93	1.85	1.52	1.46	1.24	1.16	1.02	None	0.989	0.888
	30	59.55	52.1	55.69	38.5	46.22	28.13	7.99	6.58	4.63	3.58	3.21	2.47	2.36	1.93	1.86	1.52	1.48	1.26	1.21	1.04	None	0.9868	0.863
400	45	81.42	74.4	44.38	38.68	37.42	20.11	8.14	5.73	4.73	3.50	3.25	2.51	2.38	1.94	1.82	1.53	1.43	1.22	1.12	0.99	None	0.9905	0.906
	37	67.78	60.6	50.24	38.59	42.00	24.31	8.06	6.13	4.69	3.52	3.23	2.49	2.38	1.93	1.85	1.53	1.46	1.24	1.17	1.02	None	0.9887	0.884
400	55	94.74	87.8	40.71	38.45	34.48	17.45	8.18	5.53	4.74	3.50	3.23	2.51	2.34	1.93	1.76	1.50	1.36	1.17	1.03	0.94	None	0.9915	0.918
	45	85.41	78.4	43.13	38.63	36.43	19.18	8.14	5.66	4.75	3.48	3.24	2.52	2.37	1.93	1.81	1.52	1.41	1.21	1.10	0.97	None	0.9908	0.910
575	45	44.62	40.9	43.26	43.45	35.48	20.47	8.37	6.36	5.06	3.98	3.55	2.91	2.68	2.28	2.11	1.83	1.71	1.50	1.40	1.25	None	0.9926	0.911
	30	35.39	31.6	50.58	43.31	41.29	25.62	8.28	6.82	5.00	4.01	3.53	2.89	2.68	2.26	2.13	1.83	1.74	1.52	1.45	1.28	None	0.9902	0.884
575	55	52.47	48.8	39.61	43.45	32.51	17.89	8.41	6.21	5.08	3.99	3.56	2.93	2.67	2.28	2.08	1.82	1.67	1.47	1.34	1.20	None	0.9936	0.924
	37	43.05	39.4	44.2	43.47	36.23	21.15	8.37	6.40	5.04	4.00	3.57	2.90	2.67	2.29	2.13	1.83	1.71	1.51	1.41	1.25	None	0.9923	0.908
690	18.5	23.52	18.3	81.21	38.09	66.10	44.73	9.56	8.24	4.83	4.00	2.64	2.82	1.48	2.28	1.09	1.83	0.95	1.53	0.96	1.22	None	0.9773	0.759
	15	18.55	14	87.3	40.44	70.53	48.47	12.69	7.53	6.18	4.03	3.12	2.69	1.69	1.75	1.16	1.15	0.90	0.83	0.73	0.68	None	0.9782	0.738
690	22	26.56	21	77.2	41.8	62.30	43.06	8.14	9.04	4.52	4.51	3.01	3.04	2.26	2.36	1.95	1.80	1.68	1.44	1.50	1.11	None	0.9785	0.775
	18.5	22.76	17.6	82.16	37.77	66.91	45.20	9.98	8.04	5.04	3.88	2.72	2.73	1.48	2.16	1.01	1.71	0.81	1.43	0.80	1.14	None	0.9772	0.756
690	30	33.24	28.3	61.46	42.25	49.92	32.90	8.13	7.60	4.86	4.07	3.43	2.79	2.57	2.18	2.07	1.74	1.68	1.47	1.42	1.22	None	0.9857	0.840
	22	26.66	21.1	77.07	41.73	62.19	42.98	8.11	9.03	4.52	4.49	3.03	3.02	2.28	2.33	1.96	1.78	1.68	1.43	1.49	1.11	None	0.9785	0.776
690	37	40.56	36	51.7	42.23	42.38	26.17	8.23	6.75	4.93	3.91	3.46	2.79	2.61	2.18	2.07	1.76	1.68	1.46	1.39	1.22	None	0.9895	0.879
	30	32.41	27.4	62.98	42.27	51.09	33.94	8.11	7.75	4.85	4.10	3.43	2.80	2.57	2.18	2.07	1.74	1.67	1.47	1.42	1.22	None	0.9851	0.834
690	45	45.79	41.4	47.27	42.35	38.89	23.09	8.30	6.43	4.95	3.90	3.49	2.80	2.61	2.20	2.07	1.76	1.66	1.46	1.37	1.20	None	0.991	0.896
	37	36.38	31.7	56.56	42.26	46.14	29.55	8.18	7.16	4.90	3.98	3.44	2.80	2.60	2.18	2.07	1.76	1.69	1.47	1.41	1.23	None	0.9877	0.860
690	55	56.54	52.2	41.51	42.44	34.27	19.02	8.37	6.12	4.99	3.91	3.51	2.82	2.59	2.22	2.04	1.74	1.61	1.43	1.30	1.16	None	0.9928	0.917
	45	43.19	38.8	49.26	42.44	40.42	24.53	8.27	6.61	4.95	3.92	3.48	2.81	2.61	2.21	2.07	1.77	1.67	1.46	1.38	1.21	None	0.9903	0.889

Note: Shaded cells are for Heavy Duty Mode. Unshaded cells are for Normal mode.

Table 5 Harmonic currents with line reactor

Rated voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line choke nom (µH)	DPF Cos Ø	Power Factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
200	18.5	57.48	53.4	40.19	28.51	35.69	14.93	7.88	4.30	4.04	2.59	2.43	1.80	1.59	1.26	1.01	0.93	0.69	0.63	0.48	0.45	130	0.9854	0.915
	15	48.20	44.1	44.18	29.63	38.83	17.86	7.95	4.57	4.12	2.61	2.56	1.82	1.72	1.33	1.17	1.01	0.83	0.74	0.58	0.56	130	0.9849	0.901
200	22	68.09	63.6	38.6	29.13	34.23	14.03	7.88	4.37	4.09	2.69	2.48	1.87	1.61	1.30	1.03	0.94	0.70	0.64	0.48	0.45	100	0.9865	0.921
	18.5	58.61	54.1	41.57	30.1	36.60	16.21	7.96	4.51	4.17	2.70	2.59	1.88	1.74	1.35	1.15	1.02	0.83	0.71	0.55	0.54	100	0.9863	0.911
200	30	89.29	84.2	35.39	28.85	31.42	12.06	7.82	4.44	4.06	2.80	2.41	1.91	1.53	1.27	0.94	0.89	0.62	0.58	0.45	0.39	80	0.9872	0.931
	22	64.67	59.9	40.83	30.92	35.86	15.89	7.97	4.60	4.24	2.78	2.65	1.95	1.79	1.41	1.21	1.05	0.86	0.75	0.59	0.56	80	0.9872	0.914
400	37	67.12	62.5	39.13	28	34.87	14.14	7.77	4.25	3.99	2.59	2.38	1.79	1.52	1.24	0.97	0.88	0.64	0.60	0.44	0.41	200	0.9854	0.918
	30	56.38	51.9	42.8	29.29	37.76	16.84	7.86	4.46	4.09	2.60	2.52	1.82	1.68	1.32	1.13	0.98	0.79	0.71	0.55	0.52	200	0.9852	0.906
400	45	79.27	74.3	37.2	28.12	33.18	12.93	7.75	4.28	3.99	2.67	2.36	1.83	1.51	1.23	0.93	0.88	0.62	0.58	0.45	0.39	170	0.9859	0.924
	37	65.23	60.4	40.74	29.4	36.04	15.47	7.84	4.41	4.10	2.66	2.52	1.86	1.66	1.33	1.10	0.98	0.76	0.69	0.52	0.50	170	0.9859	0.913
400	55	93.06	87.7	35.65	28.16	31.77	12.03	7.72	4.38	3.99	2.74	2.36	1.85	1.46	1.25	0.92	0.84	0.59	0.56	0.41	0.39	140	0.9866	0.930
	45	83.58	78.4	37.23	28.98	33.08	13.14	7.78	4.40	4.06	2.74	2.45	1.88	1.57	1.30	1.01	0.91	0.66	0.62	0.46	0.43	140	0.9868	0.925
575	45	43.52	40.9	36.33	29.15	32.22	12.69	7.81	4.46	4.08	2.79	2.46	1.90	1.56	1.31	1.00	0.90	0.65	0.61	0.45	0.42	480	0.9868	0.928
	30	34.02	31.5	40.62	30.91	35.67	15.81	7.93	4.60	4.21	2.82	2.64	1.97	1.78	1.41	1.19	1.07	0.86	0.74	0.58	0.57	480	0.9868	0.915
575	55	51.70	48.8	35.26	30.54	31.01	12.40	7.88	4.67	4.21	2.96	2.57	2.02	1.67	1.37	1.06	0.96	0.71	0.64	0.48	0.44	340	0.9884	0.932
	37	42.15	39.4	38.36	31.97	33.56	14.56	7.96	4.74	4.31	2.96	2.72	2.07	1.83	1.48	1.23	1.09	0.86	0.76	0.59	0.55	340	0.9884	0.923
690	18.5	19.91	18	47.91	28.06	42.06	20.12	7.94	4.68	3.99	2.45	2.43	1.67	1.62	1.22	1.10	0.94	0.78	0.70	0.55	0.54	1270	0.9817	0.886
	15	15.76	13.7	56.41	29.13	48.48	26.37	8.00	5.73	4.04	2.66	2.51	1.69	1.72	1.23	1.23	0.96	0.91	0.75	0.68	0.61	1270	0.9796	0.854
690	22	23.00	20.8	47.64	28.94	41.68	20.18	7.94	4.74	4.05	2.55	2.50	1.73	1.69	1.27	1.14	1.00	0.84	0.72	0.58	0.58	980	0.9827	0.888
	18.5	19.59	17.3	53.12	29.56	45.84	24.23	7.98	5.35	4.07	2.65	2.56	1.73	1.76	1.29	1.23	1.01	0.94	0.76	0.65	0.64	980	0.9815	0.867
690	30	30.50	28.2	41.68	28.05	37.01	15.84	7.85	4.28	3.99	2.52	2.40	1.75	1.57	1.24	1.01	0.92	0.69	0.64	0.49	0.46	880	0.9839	0.909
	22	23.23	20.9	48.9	29.44	42.58	21.22	7.94	4.93	4.09	2.58	2.55	1.76	1.73	1.31	1.21	1.01	0.87	0.77	0.63	0.60	880	0.9828	0.883
690	37	38.62	35.9	39.43	28.38	35.03	14.51	7.82	4.30	4.03	2.62	2.41	1.81	1.56	1.25	0.98	0.91	0.66	0.60	0.46	0.42	650	0.9854	0.917
	30	29.95	27.3	45.19	30.16	39.51	18.81	7.92	4.72	4.14	2.68	2.59	1.86	1.76	1.37	1.21	1.05	0.87	0.78	0.61	0.60	650	0.9846	0.898
690	45	44.17	41.3	37.79	28.58	33.59	13.46	7.80	4.35	4.03	2.69	2.42	1.85	1.54	1.28	0.99	0.89	0.65	0.61	0.46	0.42	580	0.9859	0.923
	37	34.33	31.6	42.81	30.34	37.58	17.15	7.92	4.59	4.17	2.71	2.60	1.90	1.76	1.38	1.19	1.05	0.85	0.76	0.59	0.57	580	0.9855	0.906
690	55	56.54	52.2	41.51	42.44	34.27	19.02	8.37	6.12	4.99	3.91	3.51	2.82	2.59	2.22	2.04	1.74	1.61	1.43	1.30	1.16	None	0.9928	0.917
	45	43.19	38.8	49.26	42.44	40.42	24.53	8.27	6.61	4.95	3.92	3.48	2.81	2.61	2.21	2.07	1.77	1.67	1.46	1.38	1.21	None	0.9903	0.889

Note: Shaded cells are for Heavy Duty Mode. Unshaded cells are for Normal mode.

Table 6 Harmonic currents with minimum line reactance needed to comply with harmonic current limits in EN 61000-3-12, Table 4 for $R_{SCE} \geq 120$

Rated voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line choke nom (µH)	DPF Cos Ø	Power Factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
200	18.5	56.95	53.3	37.62	25.7	33.86	12.72	7.67	4.03	3.77	2.45	2.15	1.66	1.29	1.11	0.79	0.75	0.51	0.50	0.38	0.35	190	0.9833	0.921
	15	47.60	44.1	40.96	27.21	36.55	15.12	7.83	4.18	3.93	2.46	2.33	1.70	1.47	1.20	0.95	0.86	0.63	0.61	0.44	0.43	190	0.9836	0.911
200	22	67.35	63.5	35.51	24.67	32.08	11.37	7.55	4.01	3.67	2.46	2.00	1.63	1.18	1.02	0.70	0.66	0.44	0.45	0.37	0.30	178	0.9831	0.927
	18.5	57.82	54.1	37.86	26.27	34.01	12.94	7.71	4.08	3.83	2.49	2.21	1.69	1.34	1.15	0.84	0.78	0.54	0.53	0.39	0.37	178	0.9837	0.920
200	30	89.18	84.2	35.03	27.98	31.19	11.72	7.76	4.38	3.99	2.74	2.32	1.85	1.45	1.21	0.88	0.83	0.57	0.55	0.43	0.36	89	0.9866	0.931
	22	64.53	59.9	40.3	30.35	35.51	15.39	7.94	4.52	4.19	2.74	2.60	1.92	1.73	1.38	1.16	1.01	0.80	0.72	0.56	0.52	89	0.9869	0.916
400	37	66.44	62.5	36.3	24.63	32.83	11.75	7.52	3.97	3.65	2.43	2.02	1.61	1.18	1.04	0.71	0.68	0.46	0.45	0.36	0.32	315	0.9826	0.924
	30	55.63	51.8	39.27	26.24	35.25	13.83	7.70	4.03	3.83	2.44	2.20	1.68	1.39	1.13	0.84	0.81	0.55	0.54	0.41	0.36	315	0.9833	0.916
400	45	79.11	74.3	36.65	27.19	32.81	12.43	7.69	4.20	3.91	2.62	2.27	1.78	1.42	1.18	0.86	0.82	0.55	0.54	0.41	0.35	190	0.9853	0.926
	37	65.06	60.4	40.03	28.58	35.55	14.84	7.80	4.32	4.03	2.61	2.45	1.81	1.58	1.28	1.03	0.91	0.69	0.64	0.47	0.45	190	0.9856	0.915
400	55	92.68	87.6	34.46	25.68	30.98	10.99	7.54	4.20	3.75	2.60	2.11	1.69	1.23	1.09	0.74	0.69	0.48	0.45	0.37	0.33	190	0.9847	0.931
	45	83.19	78.3	35.92	26.93	32.20	11.94	7.65	4.23	3.87	2.63	2.25	1.76	1.37	1.18	0.85	0.79	0.55	0.53	0.40	0.37	190	0.9852	0.928
575	45	43.37	40.9	35.3	27.12	31.55	11.76	7.67	4.31	3.90	2.68	2.25	1.79	1.37	1.18	0.84	0.78	0.54	0.52	0.40	0.36	600	0.9853	0.929
	30	33.85	31.5	39.24	29.07	34.78	14.49	7.84	4.39	4.08	2.68	2.48	1.86	1.60	1.31	1.04	0.93	0.70	0.65	0.48	0.45	600	0.9858	0.918
575	55	51.36	48.7	33.26	25.58	29.81	10.53	7.52	4.32	3.74	2.65	2.07	1.71	1.20	1.06	0.72	0.67	0.48	0.46	0.39	0.34	600	0.9845	0.934
	37	41.77	39.3	35.84	27.63	31.99	12.12	7.72	4.31	3.94	2.69	2.29	1.83	1.44	1.20	0.87	0.83	0.57	0.55	0.43	0.37	600	0.9855	0.928
690	18.5	19.19	17.9	38.84	23.1	35.29	12.91	7.54	3.74	3.50	2.21	1.88	1.49	1.09	0.98	0.67	0.65	0.45	0.45	0.36	0.32	2500	0.9786	0.913
	15	14.92	13.7	44.12	25.23	39.47	16.74	7.85	4.11	3.76	2.23	2.16	1.52	1.34	1.09	0.86	0.79	0.57	0.57	0.41	0.41	2500	0.9795	0.897
690	22	22.21	20.7	38.92	23.49	35.28	13.09	7.57	3.78	3.56	2.24	1.92	1.51	1.12	0.99	0.68	0.66	0.43	0.45	0.35	0.30	2000	0.9795	0.913
	18.5	18.71	17.2	42.37	25.08	38.02	15.60	7.77	3.99	3.74	2.25	2.12	1.55	1.32	1.07	0.82	0.77	0.53	0.54	0.40	0.36	2000	0.9802	0.903
690	30	29.94	28.1	36.89	23.44	33.50	11.91	7.48	3.82	3.54	2.31	1.89	1.54	1.09	0.98	0.66	0.63	0.43	0.44	0.35	0.30	1500	0.9804	0.920
	22	22.58	20.8	42.15	25.79	37.72	15.66	7.78	4.07	3.80	2.32	2.20	1.59	1.37	1.12	0.86	0.80	0.56	0.56	0.40	0.38	1500	0.9814	0.905
690	37	38.21	35.9	36.48	24.96	32.92	11.97	7.56	4.01	3.68	2.46	2.06	1.63	1.21	1.07	0.73	0.70	0.49	0.47	0.38	0.34	1000	0.9825	0.923
	30	29.45	27.3	41.12	27.03	36.67	15.27	7.80	4.16	3.91	2.45	2.31	1.69	1.47	1.18	0.93	0.85	0.61	0.59	0.44	0.40	1000	0.9833	0.910
690	45	43.67	41.3	34.63	23.79	31.38	10.78	7.42	4.00	3.54	2.45	1.92	1.56	1.08	0.99	0.65	0.62	0.46	0.42	0.37	0.32	1000	0.9818	0.928
	37	33.77	31.5	38.5	26.13	34.57	13.38	7.69	4.05	3.81	2.46	2.18	1.68	1.35	1.13	0.83	0.79	0.53	0.54	0.41	0.35	1000	0.983	0.918
690	55	54.70	52.1	32.03	21.31	29.13	9.42	7.10	4.02	3.23	2.36	1.61	1.40	0.86	0.81	0.58	0.50	0.46	0.39	0.36	0.33	1000	0.9818	0.928
	45	40.97	38.6	35.47	24.26	32.08	11.32	7.48	3.99	3.61	2.44	1.96	1.61	1.14	1.01	0.68	0.64	0.44	0.45	0.37	0.31	1000	0.9822	0.926

Note: Shaded cells are for Heavy Duty Mode. Unshaded cells are for Normal mode.

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.

In order to comply with emission standards, a shielded (screened) cable must be used to connect the variable speed drive to the motor. Most types of cable are acceptable provided that it has an overall screen that is continuous for its entire length. For example, steel wire armoured cable is acceptable.

3.3.2 Measures to reduce conducted emissions

The following measures can be used to reduce conducted emissions:

- Use the lowest possible switching frequency.
- Use the shortest possible motor cable length
- Follow the installation instructions given in section 4 of this data sheet

3.3.3 Internal filtering

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. This filter (in conjunction with a screened motor cable) is sufficient to meet Equipment Category C3 (See section 3.1 for definition of equipment categories).

The Power Installation Guide gives instructions on how to remove and replace the internal EMC filter.

3.3.4 Use of a ferrite ring

Passing the motor cable through a ferrite ring can reduce conducted emissions.

Two sizes of ferrite ring have been used for testing, as shown in Table 7.

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

Table 7 Ferrite rings

Manufacturer	Manufacturers Part No.	CT Part No.	Dimensions (mm)		
			Outside diameter	Inside diameter	Thickness
Epcos	B64290 L0040 X 830	4200-3608	58.3	40.8	17.6
	B64290 L0048 X 830	4200-0003	34.0	20.5	12.5

3.3.5 External filtering

If the equipment needs to comply with the generic standard for emission IEC 61000-6-4 or operate in the First Environment then an external EMC filter is necessary. Suitable filters are available from Control Techniques. The ratings and part numbers are shown in Table 8.

Table 8 External EMC filters

Drive models	Filter Part No.	Rated voltage (V)	Rated Current (A)	Operational leakage current (mA) [1]	Worst case leakage current (mA) [2]
All 200 V and 400 V models	4200-1132	528	117	11.7	188
All 575 V and 690 V models	4200-0672	759	67	24.5	395

[1] Calculation with 3% capacitance tolerance

[2] Calculation with two phases open circuit

3.3.6 Earth leakage current

WARNING	**When either the internal filter, the external filter or both filters are connected, the earth leakage current will exceed 3.5 mA.** **A permanent fixed earth connection is necessary to avoid an electric shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.**

3.3.7 Operation with IT (ungrounded) supplies

WARNING	**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.

3.3.8 Conducted emission measured results

Tables 9 to 13 show measured results for conducted emissions under various conditions. The equipment categories are defined in section 3.1.1.

Table 9 Conducted emissions, 200 V models. Current rating ≤ 100A

Filter	Ferrite ring No of turns	Maximum motor cable length (m)	Switching frequency (kHz)					
			2	3	4	6	8	12
Internal	0 or 1	2	C4	C4	C4	C4	C4	C4
	2	2	C3	C3	C4	C4	C4	C4
External	0	20	C1	C1	C2	C2	C2	C2
		100	C1	C1	C2	C2	C2	C2

Table 10 Conducted emissions, 200 V models. Current rating > 100A

Filter	Ferrite ring No of turns	Maximum motor cable length (m)	Switching frequency (kHz)					
			2	3	4	6	8	12
Internal	0	10	C3	C3	C3	C3	C3	C3
External	0	20	C1	C1	C2	C2	C2	C2
		100	C1	C1	C2	C2	C2	C2

Table 11 Conducted emissions, 400 V models. Current rating ≤ 100A

Filter	Ferrite ring No of turns	Maximum motor cable length (m)	Switching frequency (kHz)					
			2	3	4	6	8	12
Internal	0 or 1	2	C4	C4	C4	C4	C4	C4
	2	2	C3	C3	C4	C4	C4	C4
External	0	20	C1	C1	C2	C2	C2	C2
		100	C2	C2	C2	C3	C3	C3

Table 12 Conducted emissions, 400 V models. Current rating > 100A

Filter	Ferrite ring No of turns	Maximum motor cable length (m)	Switching frequency (kHz)					
			2	3	4	6	8	12
Internal	0	10	C3	C3	C3	C3	C3	C3
External	0	20	C1	C1	C2	C2	C2	C2
		100	C2	C2	C2	C3	C3	C3

Table 13 Conducted emissions, 575V and 690V models

Filter	Ferrite ring No of turns	Maximum motor cable length (m)	Switching frequency (kHz)					
			2	3	4	6	8	12
Internal	0, 1 or 2	2	C4	C4	C4	C4	C4	C4
	3	2	C3	C3	C3	C4	C4	C4
	3	2	C3	C3	C3	C4	C4	C4
		4	C4	C4	C4	C4	C4	C4
External	0	20	C1	C2	C2	C2	C2	C2
		100	C2	C2	C3	C3	C3	C3

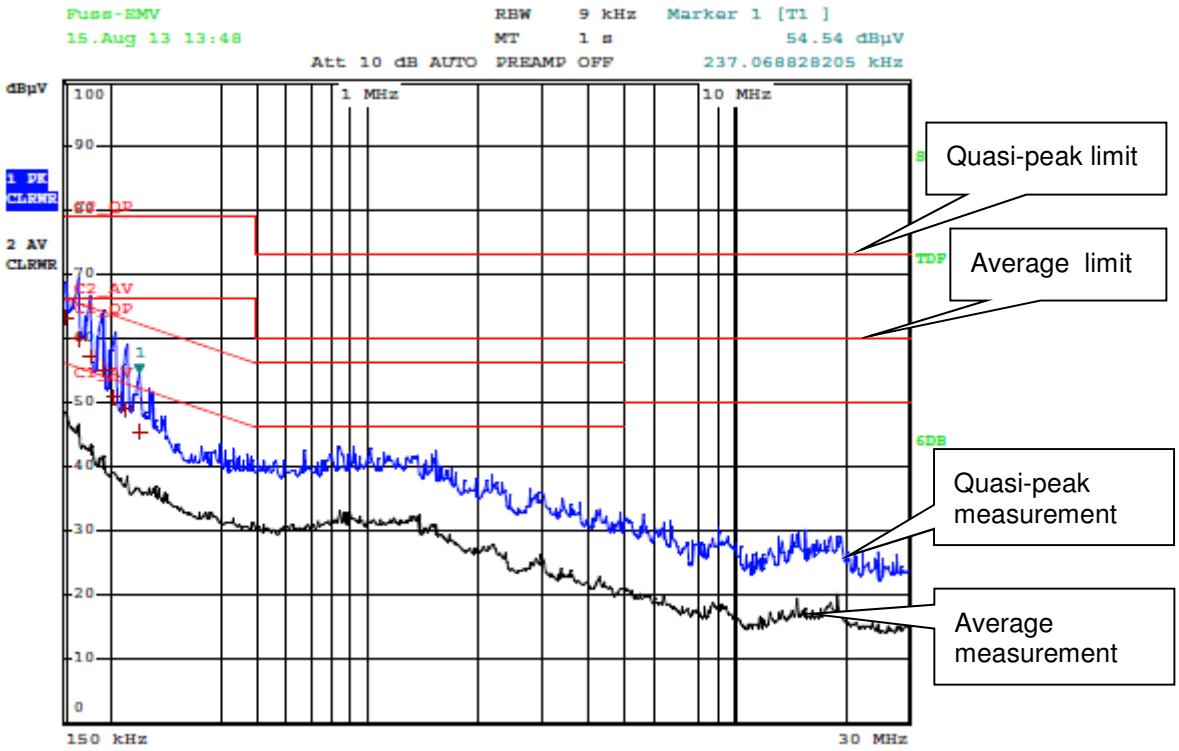

Figure 3 Conducted Emission, Model: M700-074 01000A, switching frequency = 3 kHz, motor cable length = 100 m

Notes:

1. Where the drive is incorporated into a system with rated input current exceeding 75 A, the higher emission limits in IEC 61800-3 for equipment installed in 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.

3.3.9 Shared external filters for multiple drives

In multiple drive applications it is preferable to use one EMC 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.

3.3.10 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:

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

Equipment category in IEC 61800-3	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

3.4 Radiated Emissions

3.4.1 Industrial emission standard IEC 61000-6-4

When installed in a standard metal enclosure according to the wiring guidelines in section 4 of this EMC data sheet 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 IEC 61000-6-4.

3.4.2 Limits for radiated emission

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 Table 15.

Table 15 Radiated emissions limits in IEC 61800-3

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

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

3.4.3 Example test data

The test data is based on radiated emission measurements made on a standard steel enclosure containing a single drive with three-phase supply. These drives have the highest emission levels in this product range. The tests were carried out in a calibrated open area test site. Details of the test arrangement are described below:

A standard 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.

The drive was mounted next to the EMC input filter on a common back plate, the filter casing making electrical contact with the back-plate by the fixing screws. Standard unscreened power cables were used to connect the complete filter to the supply.

A suitably rated, standard AC induction motor was connected by 2 m 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 (50 mm 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 2 m screened control cable was connected to the drive control terminals with the screen clamped to the enclosure back-plate

A 2 m unscreened status relay cable was connected to the drive.

A 2 m 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 6 Hz, with a switching frequency of 12 kHz. This is the worst case condition for radiated 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 highest measurements over the frequency range 30 MHz to 1000 MHz:

Table 16 Ethernet communication module fitted. Cable screen not bonded.

Frequency (MHz)	Antenna Height (m)	Polarisation H/V	Field Strength (dBuV/m)	C2 Limit (dBuV/m)	Margin (dBuV/m)
34.92	1.0	V	33.04	40	-6.96
35.16	1.0	V	33.52	40	-6.48
35.34	1.0	V	34.03	40	-5.97
35.64	1.0	V	33.63	40	-6.37
40.38	1.0	V	29.20	40	-10.80
62.22	1.0	V	32.43	40	-7.57
58.68	1.5	V	32.35	40	-7.65
62.22	1.5	V	31.79	40	-8.21
35.34	1.5	V	31.30	40	-8.70

Table 17 RS485 communication module fitted. Cable screen not bonded

Frequency (MHz)	Antenna Height (m)	Polarisation H/V	Field Strength (dBuV/m)	C3 limit (dBuV/m)	Margin (dBuV)
40.08	1.0	V	39.91	50	-10.09
41.4	1.0	V	39.86	50	-10.14
41.94	1.0	V	40.60	50	-9.40
42.96	1.0	V	42.15	50	-7.85
43.68	1.0	V	41.10	50	-8.90
44.52	1.0	V	39.49	50	-10.51
41.4	1.5	V	38.30	50	-11.70
41.94	1.5	V	38.34	50	-11.66
42.96	1.5	V	38.68	50	-11.32

Table 18 RS485 communication module fitted. Cable screen bonded

Frequency (MHz)	Antenna Height (m)	Polarisation H/V	Field Strength (dBuV/m)	C2 limit (dBuV/m)	Margin (dBuV/m)
30.0	1.0	V	31.82	40	-8.18
30.12	1.0	V	30.79	40	-9.21
30.18	1.0	V	30.32	40	-9.68
32.1	1.0	V	30.80	40	-9.20
32.82	1.0	V	33.00	40	-7.00
33.0	1.0	V	33.43	40	-6.57
100.98	1.5	H	30.99	40	-9.01
101.52	1.5	H	30.91	40	-9.09
98.34	2.0	H	30.54	40	-9.46
100.98	2.0	H	30.56	40	-9.44
101.52	2.0	H	30.65	40	-9.35

Table 19 No communication modules fitted

Frequency (MHz)	Antenna Height (m)	Polarisation H/V	Field Strength (dBuV/m)	C2 limit (dBuV/m)	Margin (dBuV/m)
30.18	1.0	V	27.76	40	-12.24
31.56	1.0	V	29.14	40	-10.86
34.86	1.0	V	30.90	40	-9.10
35.64	1.0	V	31.06	40	-8.94
38.34	1.0	V	26.77	40	-13.23
62.4	1.0	V	28.64	40	-11.36
34.86	1.5	V	28.46	40	-11.54
35.64	1.5	V	28.32	40	-11.68
62.4	1.5	V	27.97	40	-12.03

3.4.4 Conclusion

The effect of bonding the cable screens on the radiated emissions levels is shown in Table 20. 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 limit.

Table 20 Effect of bonding the communication cable screens on radiated emissions

Communication module	Cables	Equipment category achieved
Communication modules not fitted	Cable screen not bonded	C2
Ethernet module fitted	Cable screen not bonded	C2
RS485 module fitted	Cable screen not bonded	C3
RS485 module fitted	Cable screen bonded to the metal enclosure	C2

3.4.5 Enclosure construction

In many installations, an enclosure has a back-plate which is used to mount variable speed drives together with the EMC filters and ancillary equipment. The motor cable should be bonded to the back-plate close to the drive before it leaves the enclosure wall. 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.

3.4.6 Related product standards

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

Table 21 Related radiated emission standards

Generic standard	Product standard	
IEC 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

3.4.7 Radiated emissions test limits for lifts, elevators and moving walkways.

The limits for Radiated Emissions in the standard for Electromagnetic compatibility, Product family standard for lifts, escalators and moving walks, Emission, EN 12015 are the same as those in IEC 61800-3 for equipment category C2.

4. Installation and Wiring Guidelines

4.1.1 General

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.

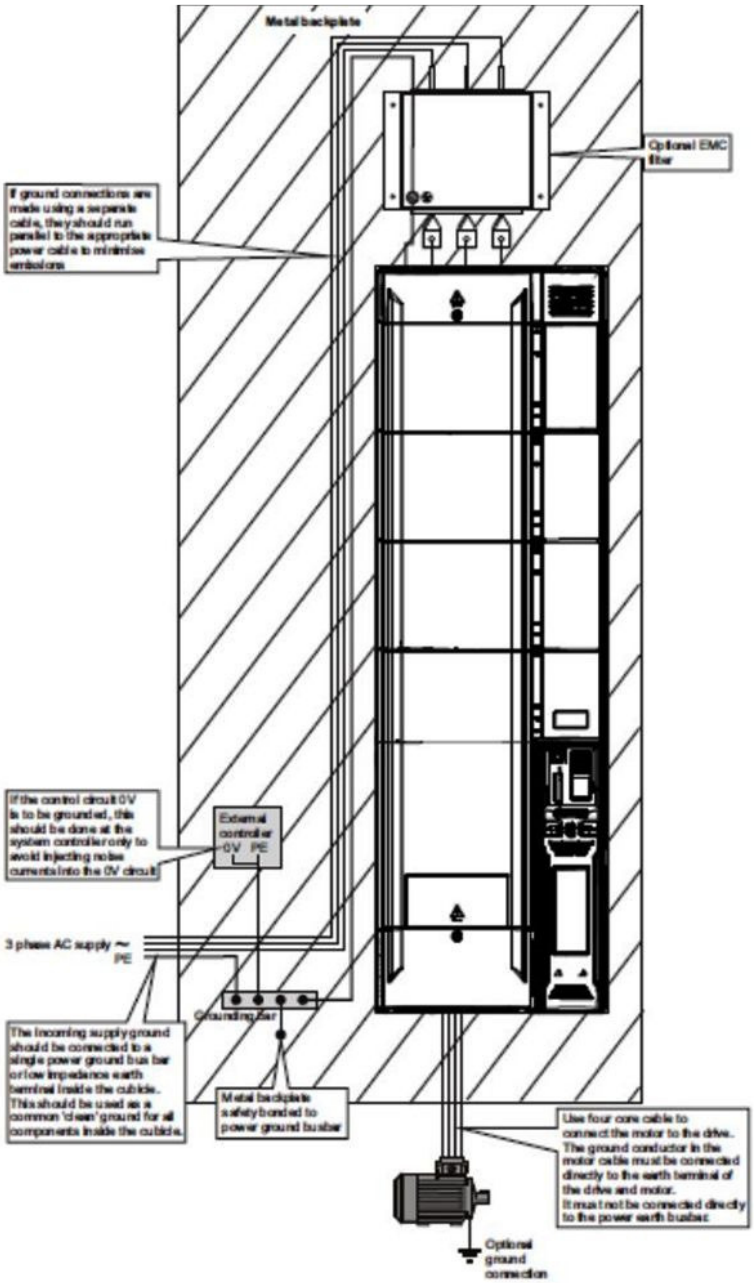

Figure 4 Wiring guidelines

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. 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 50 mm (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 0.3 m (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.
11. 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.

4.1.2 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.

4.1.3 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.

4.1.4 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 0.3 m (12 in) away from the terminal block. See Figure 5.

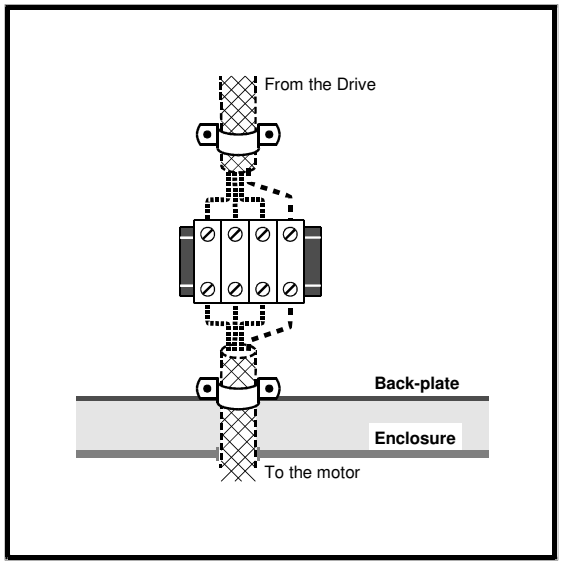

Figure 5 Arrangement for terminal block in motor cable

4.1.5 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 the power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3 m (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. See Figure 6.

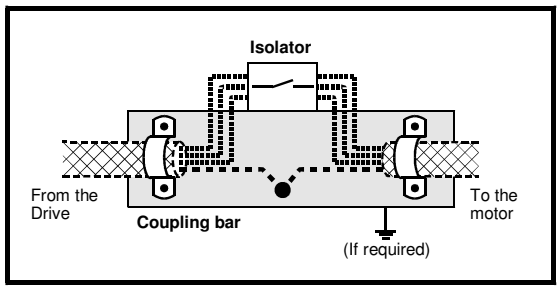

Figure 6 Arrangement for isolator switch in motor cable