EMC Data Sheet

Unidrive-M Modular Drives Frame sizes 9, 10 and 11

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.

Copyright

Unidrive-M Modular Drives, Frame sizes 9, 10 and 11 EMC Data Sheet

Contents

1. Products

This EMC data sheet applies to the following products:

Table 1 Model numbers

Rated voltage (V)	Rated power (kW)		Drive Application			
		Machinery control	High speed	Elevator	Flow (fans and pumps)	HVAC
200	45 / 55	Mxxx-092 01760	HSxx-092 01760	Exxx-092 01760	F300-092 02160	H300-092 02160
200	55 / 75	Mxxx-092 02190	HSxx-092 02190	Exxx-092 02190	F300-092 02660	H300-092 02660
200	75 / 90	Mxxx-102 02830	HSxx-102 02830	Exxx-102 02830	F300-102 03250	H300-102 03250
200	90 / 110	Mxxx-102 03000	HSxx-102 03000	Exxx-102 03000	F300-102 03600	H300-102 03600
400	90 / 110	Mxxx-094 02000	HSxx-094 02000	Exxx-094 02000	F300-094 02210	H300-094 02210
400	110 / 132	Mxxx-094 02240	HSxx-094 02240	Exxx-094 02240	F300-094 02660	H300-094 02660
400	132 / 160	Mxxx-104 02700	HSxx-104 02700	Exxx-104 02700	F300-104 03200	H300-104 03200
400	160 / 200	Mxxx-104 03200	HSxx-104 03200	Exxx-104 03200	F300-104 03610	H300-104 03610
400	185 / 225	Mxxx-114 03770	HSxx-114 03770	Exxx-114 03770	-	-
400	200 / 250	Mxxx-114 04170	HSxx-114 04170	Exxx-114 04170	-	-
400	250 / 280	Mxxx-114 04640	HSxx-114 04640	Exxx-114 04640	-	-
575	75 / 90	Mxxx-095 01040	HSxx-095 01040	Exxx-095 01040	F300-095 01250	H300-095 01250
575	90 / 110	Mxxx-095 01310	HSxx-095 01310	Exxx-095 01310	F300-095 01500	H300-095 01500
575	110 / 130	Mxxx-105 01520	HSxx-105 01520	Exxx-105 01520	F300-105 02000	H300-105 02000
575	132 / 150	Mxxx-105 01900	HSxx-105 01900	Exxx-105 01900	-	-
575	150 / 185	Mxxx-115 02000	HSxx-114 03770	Exxx-114 03770	-	-
575	185 / 225	Mxxx-115 02540	HSxx-114 04170	Exxx-114 04170	-	-
575	225 / 250	Mxxx-115 02850	HSxx-114 04640	Exxx-114 04640	-	-
690	90 / 110	Mxxx-096 01040	HSxx-096 01040	Exxx-096 01040	F300-096 01250	H300-096 01250
690	110 / 132	Mxxx-096 01310	HSxx-096 01310	Exxx-096 01310	F300-096 01550	H300-096 01550
690	132 / 160	Mxxx-106 01500	HSxx-106 01500	Exxx-106 01500	F300-106 01720	H300-106 01720
690	160 / 185	Mxxx-106 01780	HSxx-106 01780	Exxx-106 01780	F300-106 01970	H300-106 01970
690	185 / 225	Mxxx-116 02100	HSxx-114 03770	Exxx-114 03770	-	-
690	200 / 250	Mxxx-116 02380	HSxx-114 04170	Exxx-114 04170	-	-
690	250 / 280	Mxxx-116 02630	HSxx-114 04640	Exxx-114 04640	-	-

Table 2 Model numbers - Rectifiers

Rated voltage (nominal) (V)	Maximum DC output current (A)	Model number	Notes
200	413	RECT 102 04100	Rectifier AC in - DC out
400	455	RECT 104 04520	Rectifier AC in - DC out
400	689	RECT 114 06840	Rectifier AC in - DC out
400	2 X 400	RECT 1142X400	Dual rectifier AC in - DC out
575	246	RECT 105 02430	Rectifier AC in - DC out
575	387	RECT 115 03840	Rectifier AC in - DC out
690	251	RECT 106 02480	Rectifier AC in - DC out
690	411	RECT 116 04060	Rectifier AC in - DC out
690	2 x 308	RECT 1162X380	Dual rectifier AC in - DC out

Where:
Mxxx denotes M600, M700, M701, M702, M708 or M709
HSxx denotes HS70, HS71 or HS72.

The model numbers are followed by a suffix letter: D, E or T.
D = DC to AC inverter undocked
E = AC to AC drive (inverter and single rectifier docked)
T = AC to AC drive (inverter and dual rectifier docked)

The drive rated power e.g. 45 / 55 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 Europe the applicable standard is the equivalent harmonised EN standard.

Table 3 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)

Standard	Type of immunity	Test specification	Application	Level
		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 (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 *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.

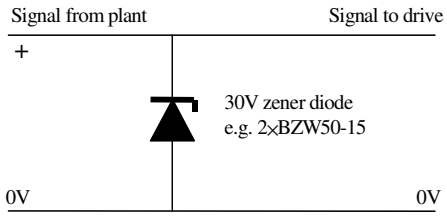

Figure 1 Surge suppression for digital and uni-polar analogue inputs and outputs

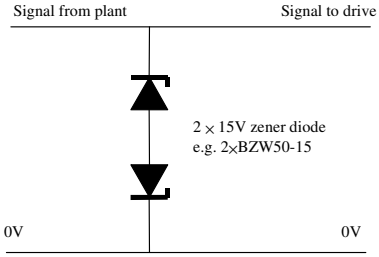

Figure 2 surge suppression for bipolar analogue inputs and outputs

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.

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:	**The drives covered by this EMC data sheet are not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network.**

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 *User Guide* and to section 4 of this data sheet.

3.2.4 Supply harmonics

The drive models covered by this EMC data sheet must be installed with an external input line reactor. The recommended values are given in Table 4. Failure to provide sufficient reactance could damage or reduce the service life of the rectifier or inverter.

AC chokes have the benefit of giving 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. Their main disadvantage is that they cause some voltage drop as the load power increases. This means that there is a limit to how much harmonic reduction can be achieved before the loss of torque at full speed becomes unacceptable.

Table 4 Recommended Line Reactors

Inductance (µH)	Rated Current (A)	Model No.	CT Part No.
63	245	INL401	4401-0181
44	370	INL 402	4401-0182
30	557	INL 403	4401-0259
30	403	INL 403L	4401-0274
178	145	INL 601	4401-0183
133	202	INL 602	4401-0184
93	331	INL603	4401-0261

Table 5 shows harmonic currents as a percentage of the fundamental. The calculations assume a supply prospective fault current of 38 kA at rated voltage and a supply frequency of 50 Hz. The rated voltages used for the calculations are 200 V, 400 V, 575 V and 690 V.

The figures in Table 5 are typical of an industrial installation with supply arrangements chosen to prevent excessive voltage distortion arising from the operation of a single drive. 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.

Note that the RMS current in these tables may differ from the maximum specified in the user 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 IE1 4-pole motor has been assumed.

For balanced sinusoidal supplies, all even and triplen harmonics are absent.

The harmonic percentages do not change substantially for other voltages and frequencies within the drive specification, and in particular they are very similar at 480 V, 60 Hz since the per-unit inductive reactances are unchanged.

For multiple, parallel modules the harmonics as a percentage of the fundamental remain the same.

The data are given at full load power. Note that it is power and not torque or motor current which governs input current.

The results are shown for each inverter model and rating for operation in both heavy duty and normal duty. It is assumed that the appropriate rectifier is used according to the instructions in the user guide.

There is no difference in harmonic behaviour between the single and dual rectifiers. The harmonic current is determined by the following parameters:

- Electrical power input to the motor
- Input choke inductance value
- Inverter module model (small effect only)

3.2.6 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.

Further guidance on harmonic reduction techniques is available from Control Techniques. Please contact your drive supplier for further information.

Note that the input current of the drive, including the harmonic content, is determined by the output power, i.e. the product of torque and speed. For a system of drives it is often the case that there is diversity of loading, i.e. the drives never deliver full rated power simultaneously. This should be allowed for in estimating the total harmonic current.

If the harmonic current is excessive, possible remedial measures are:

- 12-pulse rectifier (or higher pulse number if needed)
- Quasi-12-pulse operation of some drives on a separate supply with 30° phase shift
- Series input filter dedicated to one or more drives
- Active input stage (regenerative operation)
- Parallel harmonic filter for the complete installation.

3.2.7 12-pulse operation

For 12-pulse operation the preferred solution is to use a dual rectifier which has a dual, 3-phase input. The simplest arrangement is to provide a dedicated fully-wound transformer to supply the rectifier. Then, provided the transformer is designed to have “loose coupling” between the phase-shifted secondary groups, no additional chokes are required, the transformer can feed the rectifier directly. The requirement is for a transformer reactance of at least 4 % both from primary to secondaries and between secondaries.

The cost of the transformer can be reduced by using an autotransformer or polygonal autotransformer. In this case however some additional chokes are required to bring up the reactance of the source to at least 4 %. The effect of insufficient reactance is to cause high input current in the two input rectifier groups, which includes high levels of 5^{th} and 7^{th} harmonic current circulating between the groups. This causes unnecessary additional losses and may result in overloading of the transformer, and of the rectifier especially.

The theoretical worst-case values of the 11^{th} and 13^{th} harmonics are 9.1 % and 7.7 % respectively. These are reduced in practice because of the transformer leakage inductance. If the transformer is not fully loaded by the drive then its reactance will be proportionately less effective and these harmonics will increase but they will not exceed the values shown for 6-pulse operation.

With such low levels of inherent harmonics, the effects of imperfections can be significant. It is recommended that allowance be made for the possible existence of 5^{th} and 7^{th} harmonics at about 5 %, caused by imperfect balance between the 6-pulse groups, and of 3^{rd} harmonic at about 5 % caused by unbalance between supply phases.

Further guidance is available from the Control Techniques regarding the design of systems using Unidrive-M modules in high pulse numbers.

3.2.8 Approved input filters

Some special series-connected passive harmonic filters are offered for use specifically with variable speed AC. drives. Although these can be effective, some designs can seriously disturb the operation of the drive inrush current control system. Some designs can cause substantial reductions in DC bus voltage. Please consult the drive supplier before considering the use of such a filter.

3.2.9 Active Front End (Regenerative operation)

Regenerative operation is also referred to as “Active Front End”. The diode rectifier at the input is replaced by an active converter which generates a sinusoidal back EMF which does not generate

harmonics, although it may absorb harmonic current from a distorted supply. Please refer to the separately available user guide and EMC data sheet for regenerative operation of Unidrive-M.

3.2.10 Parallel passive filters

These filters are applied to complete installations, or complete LV power systems. Although they can be effective, they present difficulties with AC voltage-source drives because filters have a leading power factor whilst the drives have virtually unity displacement factor, so the system has a surplus of VAr. Also, parallel filters must be rated to handle the harmonics which they absorb from an existing distorted supply. An experienced supplier must be consulted before specifying such a filter.

3.2.11 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 EMC data sheet are outside the scope of EN 61000-3-2.

IEC 61000-3-12

The scope of IEC 61000-3-12 is limited to equipment rated at ≤ 75A. The drives covered by this EMC data sheet are outside the scope of EN 61000-3-12.

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

Table 6 shows the harmonic currents when the drives are fitted with additional line reactance necessary to meet the harmonic current limits in EN 12015, Table 4 for R_{SCE} ≥ 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.

IEC TR 61000-3-4

This Technical Report applies to equipment rated > 75A that generally requires agreement between the supply authority and the consumer before connecting the equipment to the supply. Table 6 shows the harmonic currents when the drives are fitted with additional line reactance necessary to meet the harmonic current limits in IEC TR 61000-3-4, Table 3 for R_{SCE} ≥ 350.

Table 5 Harmonic currents, single rectifier with recommended AC line reactor, 18kA supply

Rated Voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line reactor inductance (µH)	DPF Cos Ø	Power factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
200	55	171.87	155.2	47.80	20.97	43.24	18.10	7.19	3.79	3.24	1.85	1.75	1.24	1.07	0.85	0.68	0.63	0.42	0.48	0.33	0.31	63	0.9733	0.879
	45	148.77	132	52.13	22.03	46.52	21.39	7.31	4.40	3.34	1.97	1.89	1.23	1.19	0.88	0.78	0.66	0.52	0.51	0.38	0.38	63	0.9738	0.864
200	75	227.54	210.6	41.06	18.60	37.96	13.10	6.78	3.23	2.87	1.84	1.44	1.21	0.80	0.79	0.52	0.51	0.40	0.35	0.32	0.27	63	0.971	0.899
	55	194.74	178	44.54	19.96	40.72	15.65	7.03	3.47	3.10	1.83	1.63	1.23	0.94	0.85	0.59	0.58	0.41	0.41	0.32	0.30	63	0.9726	0.889
200	90	277.81	253	45.49	19.46	41.58	16.25	6.78	3.40	3.02	1.77	1.57	1.22	0.91	0.83	0.60	0.56	0.40	0.42	0.30	0.30	44	0.9714	0.885
	75	273.79	249	45.84	19.48	41.86	16.51	6.80	3.44	3.02	1.77	1.59	1.20	0.92	0.83	0.59	0.57	0.40	0.42	0.31	0.30	44	0.9715	0.884
200	110	333.54	308.4	41.29	17.82	38.27	13.15	6.50	3.13	2.75	1.78	1.36	1.17	0.75	0.76	0.51	0.48	0.41	0.34	0.31	0.28	44	0.9693	0.896
	90	288.63	263.8	44.55	19.07	40.86	15.54	6.73	3.32	2.96	1.77	1.53	1.20	0.87	0.82	0.57	0.54	0.40	0.39	0.30	0.29	44	0.971	0.887
400	110	210.47	176.6	64.99	21.77	56.32	30.86	6.45	5.84	3.00	2.37	1.77	1.29	1.18	0.84	0.83	0.62	0.61	0.47	0.47	0.38	63	0.9711	0.815
	90	203.41	169.4	66.64	22.03	57.52	32.10	6.42	6.09	2.98	2.46	1.77	1.33	1.18	0.86	0.84	0.62	0.62	0.47	0.47	0.38	63	0.9708	0.809
400	132	244.37	211.1	58.51	20.78	51.60	25.97	6.51	4.85	3.02	2.01	1.77	1.17	1.15	0.81	0.79	0.61	0.56	0.48	0.41	0.38	63	0.9718	0.839
	110	219.88	186.2	62.98	21.57	54.86	29.36	6.48	5.54	3.02	2.26	1.78	1.25	1.19	0.83	0.84	0.62	0.61	0.48	0.46	0.39	63	0.9714	0.823
400	160	305.30	261.5	60.43	20.97	53.02	27.42	6.47	5.12	3.01	2.10	1.76	1.19	1.16	0.80	0.80	0.61	0.57	0.47	0.43	0.37	44	0.9717	0.832
	132	295.33	251.4	61.84	21.22	54.04	28.50	6.46	5.33	3.01	2.19	1.76	1.22	1.18	0.80	0.81	0.62	0.59	0.47	0.46	0.37	44	0.9716	0.827
400	200	368.96	325.7	53.39	19.51	47.85	22.02	6.46	4.05	2.96	1.76	1.67	1.10	1.04	0.77	0.68	0.58	0.45	0.44	0.32	0.32	44	0.9715	0.858
	160	340.52	297.1	56.15	20.13	49.88	24.17	6.47	4.47	2.98	1.88	1.72	1.13	1.10	0.79	0.74	0.60	0.50	0.47	0.36	0.36	44	0.9716	0.848
400	225	500.76	443.3	52.71	19.20	47.36	21.48	6.37	3.91	2.92	1.73	1.64	1.09	1.02	0.78	0.66	0.57	0.44	0.44	0.32	0.32	93	0.9709	0.859
	185	395.55	337.4	61.4	20.86	53.75	28.16	6.37	5.20	2.97	2.13	1.73	1.19	1.16	0.79	0.80	0.61	0.57	0.47	0.44	0.37	93	0.9712	0.828
400	250	547.51	492.8	48.56	18.96	44.15	18.37	6.49	3.51	2.91	1.71	1.59	1.13	0.94	0.80	0.59	0.57	0.40	0.41	0.30	0.30	93	0.9706	0.874
	200	427.10	372.2	56.46	20.54	50.05	24.46	6.59	4.58	3.04	1.93	1.76	1.15	1.12	0.81	0.75	0.61	0.52	0.47	0.38	0.37	93	0.9716	0.847
400	315	608.35	553.5	45.78	18.17	42.00	16.26	6.38	3.22	2.82	1.68	1.46	1.14	0.83	0.78	0.54	0.51	0.38	0.37	0.28	0.28	178	0.9697	0.882
	250	483.97	429.4	52.19	19.62	46.88	21.18	6.55	3.93	3.00	1.76	1.66	1.13	1.03	0.78	0.67	0.58	0.42	0.45	0.32	0.30	178	0.9714	0.862
575	110	144.71	128.6	51.86	21.12	46.45	21.06	7.04	4.19	3.22	1.88	1.80	1.19	1.13	0.83	0.74	0.64	0.48	0.49	0.36	0.34	30	0.9731	0.864
	75	102.20	85.4	65.97	23.79	56.84	31.68	7.06	6.38	3.25	2.62	1.92	1.42	1.29	0.92	0.90	0.68	0.68	0.50	0.51	0.42	30	0.9718	0.812
575	110	144.71	128.6	51.86	21.12	46.45	21.06	7.04	4.19	3.22	1.88	1.80	1.19	1.13	0.83	0.74	0.64	0.48	0.49	0.36	0.34	30	0.9731	0.864
	90	123.41	107.1	57.51	22.29	50.64	25.36	7.09	5.06	3.27	2.13	1.90	1.24	1.23	0.86	0.84	0.65	0.59	0.51	0.44	0.40	30	0.9731	0.844
575	130	177.50	154.4	56.93	21.09	50.35	24.84	6.74	4.74	3.11	1.99	1.80	1.18	1.16	0.82	0.79	0.62	0.55	0.48	0.40	0.38	30	0.972	0.845
	110	159.20	135.8	61.35	21.95	53.59	28.19	6.74	5.43	3.12	2.23	1.84	1.25	1.22	0.84	0.85	0.63	0.61	0.49	0.46	0.39	30	0.9718	0.829
575	150	198.50	175.5	53.00	20.23	47.45	21.82	6.71	4.14	3.07	1.82	1.74	1.14	1.08	0.81	0.71	0.60	0.47	0.46	0.34	0.34	178	0.9718	0.859
	132	192.15	169.1	54.10	20.66	48.25	22.68	6.73	4.32	3.10	1.88	1.77	1.16	1.12	0.82	0.75	0.62	0.50	0.48	0.37	0.36	178	0.9719	0.855
575	175	243.14	212.3	56.05	21.00	49.67	24.21	6.77	4.62	3.11	1.96	1.80	1.17	1.15	0.83	0.77	0.63	0.53	0.49	0.38	0.38	178	0.9716	0.848
	150	214.63	183.4	61.02	22.00	53.31	27.98	6.79	5.38	3.15	2.22	1.83	1.25	1.22	0.83	0.84	0.64	0.60	0.49	0.46	0.39	178	0.9715	0.830
575	225	283.66	252.9	50.94	19.95	45.86	20.29	6.71	3.87	3.06	1.78	1.69	1.15	1.04	0.81	0.67	0.59	0.43	0.46	0.32	0.32	133	0.9712	0.866
	185	252.39	221.5	54.76	20.9	48.71	23.23	6.77	4.41	3.13	1.92	1.77	1.18	1.15	0.81	0.76	0.64	0.50	0.49	0.39	0.35	133	0.9716	0.853
575	250	325.25	294.4	47.09	19.16	42.94	17.35	6.61	3.42	2.96	1.73	1.57	1.18	0.92	0.81	0.60	0.56	0.40	0.43	0.30	0.30	133	0.9702	0.878
	225	293.46	262.7	49.93	19.73	45.11	19.51	6.69	3.76	3.03	1.76	1.67	1.15	1.01	0.82	0.64	0.59	0.43	0.44	0.31	0.32	133	0.971	0.869
690	110	123.95	104.6	63.78	23.56	55.23	30.07	7.13	6.05	3.29	2.51	1.93	1.36	1.31	0.90	0.89	0.68	0.68	0.49	0.51	0.43	178	0.9723	0.820
	90	105.72	85.7	72.47	25.16	61.57	36.42	7.05	7.41	3.23	3.06	1.91	1.61	1.29	1.04	0.90	0.72	0.71	0.51	0.52	0.45	178	0.9699	0.786
690	132	144.65	125.7	57.10	22.51	50.31	25.07	7.14	5.02	3.30	2.13	1.91	1.26	1.26	0.86	0.85	0.67	0.60	0.52	0.46	0.40	133	0.9733	0.846
	110	126.64	107.4	62.77	23.41	54.49	29.32	7.14	5.89	3.29	2.45	1.93	1.34	1.31	0.89	0.88	0.68	0.67	0.49	0.50	0.43	133	0.9725	0.824
690	160	179.20	152.4	62.07	22.31	54.09	28.74	6.80	5.57	3.16	2.29	1.85	1.28	1.24	0.85	0.86	0.64	0.63	0.49	0.48	0.40	133	0.9718	0.826
	132	161.64	134.4	66.98	23.06	57.66	32.41	6.75	6.31	3.12	2.59	1.84	1.38	1.25	0.90	0.85	0.67	0.66	0.47	0.50	0.41	133	0.9709	0.807

Rated Voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line reactor inductance (µH)	DPF Cos Ø	Power factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
690	185	202.28	175.9	57.03	21.32	50.39	24.94	6.80	4.78	3.14	2.02	1.81	1.19	1.18	0.81	0.79	0.63	0.55	0.49	0.42	0.37	93	0.9723	0.845
	160	185.63	158.9	60.49	21.95	52.93	27.56	6.80	5.32	3.15	2.20	1.84	1.25	1.22	0.83	0.84	0.64	0.60	0.49	0.46	0.39	93	0.972	0.832
690	200	227.76	192.3	63.67	22.72	55.22	29.97	6.85	5.85	3.18	2.39	1.87	1.32	1.25	0.87	0.88	0.65	0.64	0.50	0.49	0.40	93	0.9712	0.820
	185	228.23	192.8	63.56	22.78	55.14	29.90	6.86	5.83	3.18	2.40	1.87	1.33	1.26	0.87	0.87	0.66	0.64	0.50	0.50	0.41	93	0.9713	0.820
690	250	273.58	238.9	56.01	21.11	49.61	24.21	6.83	4.65	3.14	1.98	1.79	1.19	1.15	0.82	0.77	0.63	0.51	0.49	0.38	0.36	93	0.9718	0.849
	200	252.97	218	59.08	21.88	51.87	26.53	6.87	5.11	3.18	2.14	1.84	1.23	1.22	0.83	0.83	0.65	0.58	0.49	0.45	0.38	93	0.9718	0.837
690	315	330.75	296.2	49.84	19.98	45.00	19.48	6.76	3.78	3.07	1.77	1.68	1.17	1.02	0.82	0.66	0.60	0.42	0.46	0.32	0.32	93	0.9714	0.8699
	250	287.73	253.1	54.28	20.99	48.33	22.87	6.84	4.40	3.15	1.91	1.80	1.18	1.14	0.83	0.76	0.63	0.51	0.49	0.38	0.37	93	0.9719	0.8547

Table 6 Harmonic currents, single rectifier with additional line reactance to comply with the elevator standard EN 12015 and IEC TR 61000-3-4, Table 3 for $R_{SCE} \geq 350$

Rated Voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line reactor Inductance (µH)	DPF Cos Ø	Power factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
200	55	166.44	154.5	40.21	18.87	37.16	12.65	6.91	3.26	2.94	1.87	1.43	1.25	0.78	0.80	0.54	0.49	0.42	0.36	0.31	0.29	101	0.97	0.90
	45	143.16	131.4	43.46	20.36	39.75	14.98	7.19	3.48	3.16	1.87	1.64	1.28	0.94	0.87	0.61	0.59	0.41	0.43	0.32	0.30	101	0.97	0.89
200	75	226.63	210.5	40.07	18.2	37.16	12.37	6.70	3.17	2.82	1.83	1.37	1.20	0.74	0.77	0.52	0.47	0.42	0.34	0.31	0.29	67	0.97	0.90
	55	193.82	177.9	43.42	19.72	39.84	14.80	6.98	3.37	3.07	1.83	1.58	1.25	0.90	0.84	0.59	0.56	0.40	0.41	0.31	0.29	67	0.97	0.89
200	90	274.76	252.7	42.85	18.7	39.50	14.26	6.71	3.22	2.91	1.78	1.47	1.20	0.82	0.80	0.54	0.52	0.40	0.37	0.31	0.29	51	0.97	0.89
	75	270.70	248.7	43.17	18.87	39.74	14.51	6.73	3.25	2.93	1.79	1.49	1.21	0.84	0.81	0.55	0.53	0.40	0.38	0.31	0.29	51	0.97	0.89
200	110	331.56	308.2	39.81	17.2	37.07	12.06	6.41	3.07	2.64	1.79	1.27	1.14	0.70	0.72	0.49	0.45	0.40	0.32	0.31	0.27	48	0.97	0.90
	90	286.65	263.6	42.90	18.74	39.56	14.28	6.69	3.23	2.89	1.80	1.48	1.20	0.84	0.81	0.54	0.54	0.40	0.38	0.33	0.28	48	0.97	0.89
400	110	189.58	174.5	42.66	19.28	39.21	14.33	6.91	3.33	3.00	1.83	1.52	1.24	0.85	0.82	0.56	0.53	0.41	0.38	0.31	0.29	158	0.97	0.89
	90	182.34	167.3	43.55	19.6	39.92	14.96	6.98	3.40	3.04	1.84	1.58	1.23	0.89	0.84	0.56	0.56	0.40	0.39	0.32	0.28	158	0.97	0.89
400	132	225.66	209	40.87	18.24	37.83	12.98	6.69	3.20	2.82	1.82	1.39	1.19	0.76	0.77	0.51	0.49	0.40	0.34	0.31	0.27	143	0.97	0.90
	110	200.76	184.2	43.43	19.4	39.86	14.83	6.90	3.35	3.01	1.82	1.55	1.23	0.87	0.83	0.56	0.55	0.41	0.39	0.31	0.29	143	0.97	0.89
400	160	280.11	258.8	41.58	18.57	38.40	13.48	6.75	3.23	2.88	1.83	1.44	1.20	0.80	0.79	0.52	0.51	0.40	0.35	0.32	0.28	107	0.97	0.90
	132	270.03	248.7	42.39	19.02	39.03	14.08	6.82	3.28	2.95	1.82	1.49	1.23	0.83	0.82	0.55	0.52	0.41	0.38	0.31	0.30	107	0.97	0.90
400	200	348.81	323.3	40.64	17.76	37.71	12.69	6.53	3.13	2.74	1.80	1.34	1.17	0.74	0.75	0.51	0.47	0.41	0.33	0.31	0.28	87	0.97	0.90
	160	320.12	294.8	42.45	18.5	39.17	14.00	6.68	3.21	2.87	1.79	1.45	1.19	0.81	0.79	0.52	0.51	0.40	0.36	0.31	0.27	87	0.97	0.89
575	110	135.19	127.3	35.78	16.59	33.43	9.91	6.40	3.24	2.49	1.86	1.15	1.10	0.68	0.66	0.51	0.43	0.40	0.32	0.29	0.26	363	0.97	0.91
	75	91.80	84.3	43.2	20.53	39.49	14.88	7.25	3.51	3.19	1.90	1.65	1.29	0.94	0.88	0.61	0.59	0.42	0.43	0.32	0.31	363	0.97	0.89
575	110	137.40	127.7	39.9	18.56	36.94	12.41	6.83	3.24	2.87	1.87	1.41	1.22	0.77	0.79	0.52	0.49	0.41	0.35	0.32	0.28	253	0.97	0.90
	90	115.82	106.2	43.54	20.18	39.84	15.02	7.14	3.47	3.13	1.87	1.63	1.26	0.93	0.86	0.59	0.58	0.42	0.41	0.33	0.30	253	0.97	0.89
575	130	165.12	153	40.75	18.49	37.67	12.98	6.77	3.24	2.86	1.84	1.41	1.21	0.77	0.79	0.52	0.49	0.41	0.34	0.31	0.28	328	0.97	0.90
	110	146.47	134.5	43.36	19.68	39.75	14.86	6.99	3.39	3.06	1.84	1.56	1.25	0.88	0.84	0.58	0.55	0.40	0.41	0.31	0.29	328	0.97	0.89
575	150	189.68	174.5	42.77	18.96	39.38	14.29	6.77	3.27	2.93	1.81	1.50	1.22	0.84	0.82	0.55	0.54	0.41	0.38	0.32	0.29	115	0.97	0.89
	132	183.24	168.1	43.54	19.18	39.99	14.87	6.82	3.31	2.98	1.80	1.52	1.22	0.86	0.82	0.56	0.54	0.40	0.39	0.30	0.29	115	0.97	0.89
690	110	111.05	103.2	39.78	19.11	36.72	12.50	7.01	3.33	2.97	1.91	1.45	1.26	0.79	0.81	0.54	0.50	0.42	0.35	0.32	0.29	375	0.97	0.90
	90	92.04	84.3	43.79	20.9	39.91	15.37	7.36	3.60	3.25	1.91	1.70	1.29	0.98	0.89	0.62	0.60	0.42	0.44	0.33	0.30	375	0.97	0.89
690	132	134.03	124.5	39.98	18.89	36.94	12.56	6.94	3.29	2.94	1.88	1.44	1.24	0.78	0.80	0.54	0.49	0.42	0.35	0.31	0.29	270	0.97	0.90
	110	115.61	106.2	43.12	20.45	39.44	14.80	7.23	3.50	3.16	1.90	1.65	1.28	0.94	0.88	0.60	0.60	0.42	0.42	0.34	0.30	270	0.97	0.89

Rated Voltage (V)	Motor Power (kW)	RMS current (A)	Fund. current (A)	THD (%)	PWHD (%)	Harmonic order, magnitude as % of fundamental																AC line reactor Inductance (µH)	DPF Cos Ø	Power factor
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49			
690	160	162.55	150.6	40.75	18.93	37.60	13.07	6.90	3.29	2.94	1.86	1.45	1.24	0.79	0.81	0.54	0.50	0.42	0.36	0.31	0.29	388	0.97	0.90
	132	144.51	132.7	43.31	20.16	39.63	14.91	7.12	3.46	3.13	1.88	1.62	1.28	0.92	0.86	0.60	0.58	0.42	0.42	0.32	0.30	388	0.97	0.89
690	185	188.48	174.3	41.25	18.88	38.06	13.34	6.84	3.27	2.92	1.85	1.46	1.23	0.80	0.81	0.54	0.51	0.42	0.36	0.32	0.29	328	0.97	0.90
	160	171.51	157.5	43.33	19.77	39.71	14.85	7.01	3.40	3.07	1.84	1.57	1.26	0.89	0.85	0.59	0.56	0.41	0.41	0.31	0.30	328	0.97	0.89
400	225	470.18	439.5	38.15	16.51	35.65	11.05	6.28	3.09	2.51	1.80	1.18	1.10	0.67	0.67	0.49	0.43	0.39	0.32	0.29	0.26	175	0.97	0.91
	185	363.97	334	43.42	19.06	39.92	14.76	6.78	3.29	2.96	1.80	1.51	1.22	0.85	0.82	0.56	0.53	0.40	0.39	0.31	0.29	175	0.97	0.89
400	250	523.58	489.8	37.93	16.32	35.47	10.91	6.24	3.08	2.47	1.79	1.16	1.09	0.67	0.65	0.49	0.42	0.39	0.32	0.29	0.26	165	0.97	0.91
	200	402.47	369.5	43.34	19	39.86	14.70	6.76	3.29	2.95	1.80	1.51	1.22	0.85	0.82	0.56	0.53	0.41	0.38	0.31	0.29	165	0.97	0.89
400	315	589.08	550.9	37.99	16.12	35.57	10.88	6.13	3.05	2.44	1.76	1.14	1.07	0.65	0.66	0.48	0.42	0.39	0.31	0.29	0.26	200	0.97	0.91
	250	464.40	427.1	42.84	18.41	39.52	14.24	6.62	3.19	2.86	1.77	1.44	1.19	0.80	0.79	0.53	0.51	0.40	0.36	0.30	0.28	200	0.97	0.89
575	175	227.09	210.4	40.71	18.39	37.64	12.95	6.76	3.23	2.86	1.83	1.40	1.21	0.76	0.78	0.52	0.48	0.41	0.34	0.30	0.28	240	0.97	0.90
	150	198.09	181.6	43.69	19.81	40.01	15.10	7.01	3.43	3.06	1.85	1.60	1.24	0.91	0.85	0.57	0.58	0.41	0.40	0.33	0.29	240	0.97	0.89
575	225	271.58	251.5	40.91	18.11	37.87	12.99	6.64	3.18	2.80	1.81	1.38	1.19	0.76	0.77	0.51	0.48	0.41	0.34	0.31	0.28	200	0.97	0.90
	185	240.03	220.1	43.61	19.37	40.02	14.96	6.86	3.34	3.01	1.81	1.54	1.24	0.87	0.83	0.58	0.54	0.41	0.40	0.31	0.30	200	0.97	0.89
575	250	316.39	293.3	40.57	17.58	37.66	12.68	6.49	3.12	2.72	1.79	1.32	1.16	0.72	0.74	0.50	0.46	0.40	0.32	0.30	0.27	137	0.97	0.90
	225	284.48	261.6	42.84	18.6	39.48	14.31	6.68	3.22	2.89	1.78	1.46	1.20	0.80	0.80	0.54	0.50	0.40	0.36	0.30	0.29	137	0.97	0.89
690	200	207.72	190.2	43.99	20.2	40.20	15.39	7.11	3.50	3.13	1.87	1.64	1.26	0.94	0.87	0.60	0.59	0.42	0.42	0.33	0.31	218	0.97	0.89
	185	208.22	190.7	43.94	20.18	40.16	15.34	7.11	3.50	3.12	1.87	1.64	1.26	0.94	0.87	0.59	0.59	0.42	0.41	0.33	0.30	218	0.97	0.89
690	250	256.67	237	41.76	19.16	38.47	13.70	6.88	3.31	2.95	1.87	1.50	1.24	0.84	0.83	0.55	0.54	0.42	0.38	0.34	0.29	193	0.97	0.90
	200	235.70	216.1	43.65	19.79	39.98	15.07	7.02	3.43	3.06	1.85	1.60	1.24	0.91	0.85	0.57	0.58	0.41	0.40	0.33	0.29	193	0.97	0.891
690	315	317.58	294.6	40.39	18.01	37.44	12.65	6.63	3.18	2.77	1.83	1.36	1.18	0.76	0.76	0.51	0.48	0.40	0.34	0.32	0.27	162	0.97	0.90
	250	274.25	251.5	43.55	19.37	39.96	14.93	6.89	3.36	3.00	1.83	1.56	1.22	0.88	0.83	0.56	0.56	0.40	0.39	0.32	0.28	162	0.97	0.90

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 User Guide gives instructions on how to remove and replace the internal EMC filter.

3.3.4 External filtering

If the equipment needs to meet the generic standard for emission IEC 61000-6-4 or operate in the First Environment then an optional external EMC filter is necessary.

Suitable filters are available from Control Techniques. The ratings and part numbers are shown in Table 8. Table 8 shows the typical leakage currents due to the external EMC filter. The external filter should be used in conjunction with the internal filter.

Table 7 External EMC filters

CT part No.	Rated voltage (V)	Rated current (A)	Operational leakage current (mA) [1]	Worst case leakage current (mA) [2]
4200-3021	275/ 480	302	30	202
4200-4460	275/ 480	446	30	283
4200-0400	275/ 480	600	5.9	275
4200-1660	400/ 690	166	21	332
4200-2210	400/ 690	220	21	434
4200-0690	400/ 690	403	14	583

In practice, the external filter should always be used in conjunction with the internal filter. The total earth leakage current with both filters connected will be higher than the figures shown above.

[1] Calculation with 3% capacitance tolerance

[2] Calculation with two phases open circuit

WARNING	**When either the internal filter, the external filter or both filters are connected, the earth leakage current is > 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.**

3.3.1 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.

3.3.2 Conducted Emission Measured Results

Tables 9 and 10 show measured results for conducted emissions under various conditions. The equipment categories are defined in section 3.1.1.

Table 8 Conducted Emissions Measured Results (200 V and 400 V models, frame size 9 and 10)

Filter	Maximum motor cable length (m)	Switching frequency (kHz)						
		2	3	4	6	8	12	16
Internal	100	C3	C3	C3	C3	C3	C3	C4
External	20	C2	C2	C2	C2	C2	C2	C2
	100	C2	C2	C3	C3	C3	C3	C3

Table 9 Conducted Emissions Measured Results (575 V and 690 V models, frame size 9 and 10)

Filter	Maximum motor cable length (m)	Switching frequency (kHz)						
		2	3	4	6	8	12	16
Internal	50	C3	C3	C3	C3	C3	C3	C3
External	20	C2	C2	C2	C2	C2	C2	C2
	100	C2	C2	C3	C3	C3	C3	C3

Table 10 Conducted Emissions Measured Results (400 V models, frame size 11)

Filter	Maximum motor cable length (m)	Switching frequency (kHz)						
		2	3	4	6	8	12	16
Internal	50	C3	C3	C3	C3	C3	C3	C3
	100	C3	C3	C3	C3	C4	C4	C4
External	20	C2	C2	C2	C2	C2	C3	C3
	100	C2	C2	C3	C3	C3	C3	C3

Table 11 Conducted Emissions Measured Results (575 V and 690 V models, frame size 11)

Filter	Maximum motor cable length (m)	Switching frequency (kHz)						
		2	3	4	6	8	12	16
Internal	3	C3	C3	C3	C3	C3	C3	C4
	10	C3	C3	C3	C3	C3	C4	C4

Filter	Maximum motor cable length (m)	Switching frequency (kHz)						
		2	3	4	6	8	12	16
	50	C3	C4	C4	C4	C4	C4	C4
External	20	C2	C2	C2	C2	C2	C3	C3
	100	C2	C2	C3	C3	C3	C3	C3

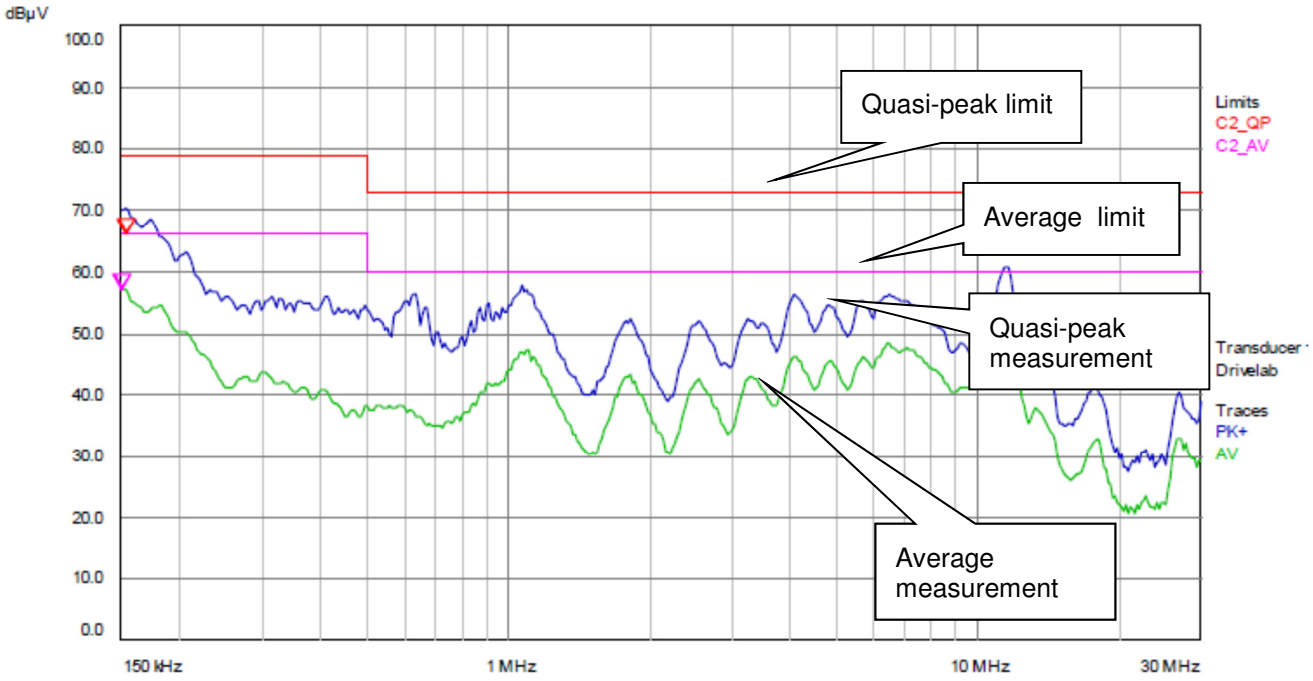

Figure 3 Conducted Emission with external filter. Model: M700-114 04640A, switching Frequency = 3 kHz, motor cable length = 100 m. category C2 limits.

Notes:

1. Where the drive is incorporated into a system with rated input current exceeding 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.

3.3.3 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.

3.3.4 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 12 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 the following table:

Table 13 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 were as follows.

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 onto the EMC input filter, 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 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 table summarises the results for radiated emission, showing the highest measurements over the frequency range 30 MHz to 1000 MHz:

Table 14 Typical Radiated Emissions Measurements, M700-114 04640E

Frequency (MHz)	Maximum Measured value Quasi-Peak (dBµV/m)	Category C3 limit (dBµV/m)	Margin (dB)
30.18	37.25	50	-12.75
33.36	43.80	50	-6.20
34.32	44.73	50	-5.27
40.44	42.85	50	-7.15
41.64	42.35	50	-7.65
43.5	41.66	50	-8.34
45.0	44.04	50	-5.96
47.04	39.11	50	-10.89

The results show that the limit for industrial radiated emission (C2) is met with a margin of at least 5 dB.

3.4.4 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.

3.4.5 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 15 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

3.4.6 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.

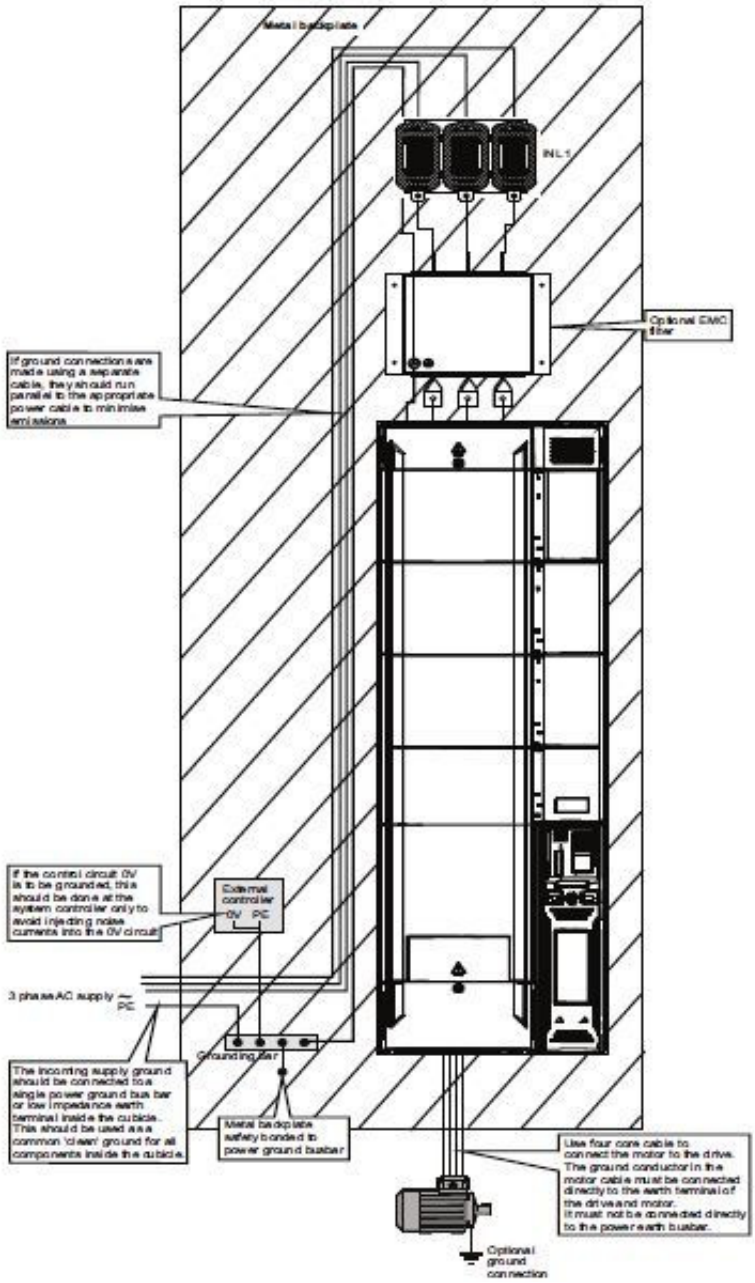

Figure 4 Wiring guidelines

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. Footprint filter: the drive must be correctly mounted on the filter and make good direct electrical contact with it.
4. Side mounted filter: the drive and filter must be mounted together on a metal back-plate and make good electrical contact with it.
5. The filter must be connected to the drive using the wires provided. The wires must not be extended in any way.
6. 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.
7. 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.
8. 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.
9. Ensure that the cables carrying the AC supply and the ground to the filter are at least 100 mm (4 in) from the drive and the motor cable.
10. Avoid locating sensitive signal circuits in a zone extending 0.3 m (12 in) all around the drive.
11. If the control circuit 0 V 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 0 V circuit.
12. 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.

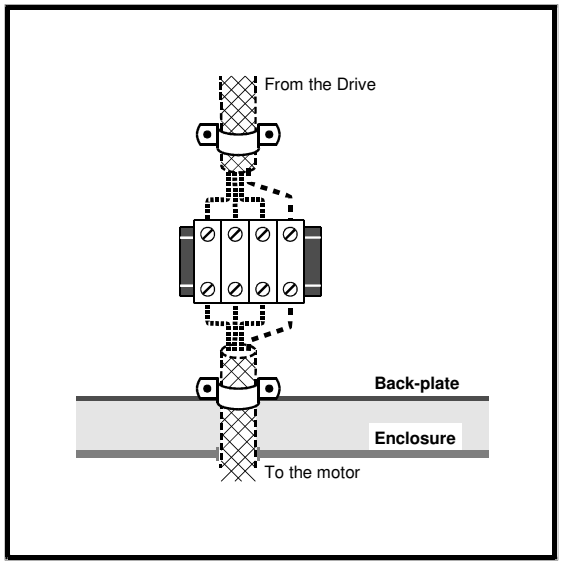

Figure 5 Arrangement for terminal block in motor cable

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.

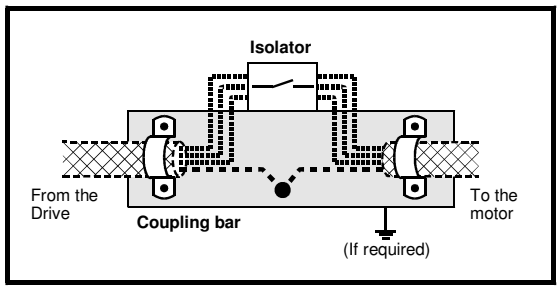

Figure 6 Arrangement for isolator switch in motor cable