UNIDRIVE M600-M702 SIZE 7 (15kW ~ 55kW)
ELECTROMAGNETIC COMPATIBLITY DATA

PRODUCT

M600-07200610 to M600-07200830, M600-07400660 to M600-07401000,
M600-07500440 to M600-07500550, M600-07600190 to M600-07600540

M700-07200610 to M700-07200830, M700-07400660 to M700-07401000,
M700-07500440 to M700-07500550, M700-07600190 to M700-07600540

M701-07200610 to M701-07200830, M701-07400660 to M701-07401000,
M701-07500440 to M701-07500550, M701-07600190 to M701-07600540

M702-07200610 to M702-07200830, M702-07400660 to M702-07401000,
M702-07500440 to M702-07500550, M702-07600190 to M702-07600540

General notes on EMC data

The information given in the 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 instruction. The provision of this datasheet doesn't form part of any contracts or undertaking. Where a statement of conformity is made with a specific standard, the company takes all responsible measures to ensure its products are in conformance. Where specific values are given these are subjected to normal engineering variations between samples of the same product. They may also be affected by the environment and detailed operating arrangement.

IMMUNITY

The product complies with the following international and European harmonised standards for immunity.

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2 IEC 61000-4-2	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
EN 61000-4-3 IEC 61000-4-3	Radio frequency radiated field	80% AM (1kHz) modulation Levels prior to modulation: 10V/m 80 - 1000MHz 3V/m 1.4 – 2.0GHz 1V/m 2.0 – 2.7GHz Safe Torque Off (STO) tested to 200% of above levels: 20V/m 80 – 1000MHz 6V/m 1.4 – 2.0 GHz 3V/m 2.0 – 2.7GHz	Module enclosure	Level 3 (industrial)
EN 61000-4-4 IEC 61000-4-4	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
EN 61000-4-5 IEC 61000-4-5	Surges	Common mode 4kV 1.2/50µs wave form	AC supply lines: line to earth	Level 4
		Differential mode 2kV	AC supply lines: line to line	Level 3
		Common mode 1kV	Control lines[1]	
EN 61000-4-6 IEC 61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
EN 61000-4-11 IEC 61000-4-11	Voltage dips, short interruptions & variations	All durations	AC supply lines	
EN 61000-4-8 IEC 61000-4-8	Power frequency magnetic field	1700A/m r.m.s ; 2400A/m peak (2.1mT r.m.s; 3mT peak) continuous at 50Hz	Module enclosure	Exceeds level 5
EN 61000-6-1 IEC 61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN 61000-6-2 IEC 61000-6-2	Generic immunity standard for the industrial environment			Complies
EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

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

Unless stated otherwise, immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the User Guide must be carefully adhered to. All inductive components such as relays, contactors, electromagnetic brakes etc. associated with the drive must be fitted with an appropriate suppression; otherwise the immunity capability of the drive may be exceeded.

Surge immunity of control circuits – long cables and connections outside a building
The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.
These circuits meet the requirements of EN 61000-6-2 (1kV surge) provided the 0V connection is not earthed, i.e. in the common mode. Generally they cannot withstand the surge directly between the control lines and the 0V connection, i.e. in the series mode.

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

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

1. Galvanic isolation, i.e. do not connect the control 0V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its associated return (0V) wire.

2. Screened cable with additional power ground bonding. If isolation at one end is not acceptable, the cable screen may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10mm^2, or 10 times the area of the signal cable screen, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable screen. If the building or plant has a well-designed common bonded network this precaution is not necessary.

3. Additional over-voltage suppression – for the analogue and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figures 1 and 2.

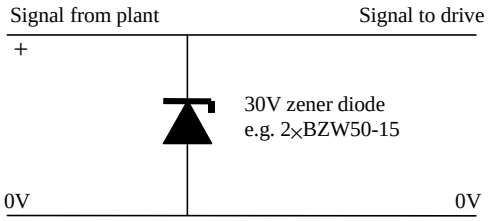


Figure 1: surge suppression for digital and unipolar analogue inputs and outputs

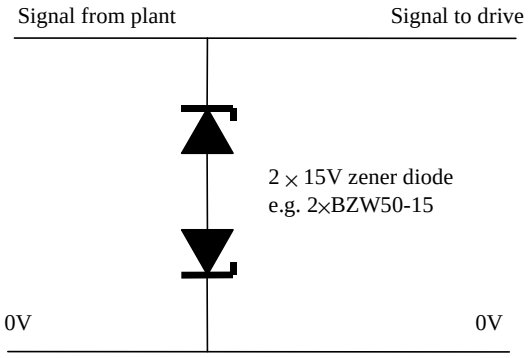


Figure 2: surge suppression for bipolar analogue inputs and outputs

Surge suppression devices are available as rail-mounting modules, e.g. from Phoenix Contact GmbH:
Unipolar TT-UKK5-D/24 DC
Bipolar TT-UKK5-D/24 AC

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

EMISSION

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

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

SUPPLY VOLTAGE NOTCHING

Test results indicate that because of the use of silicon controlled rectifiers the inrush current is low and under control. The drive causes no significant notching to the supply voltage.

SUPPLY HARMONICS

The input current contains harmonics of the supply frequency. The harmonic current levels are affected to some extent by the supply impedance (fault current level). The table shows the levels calculated with fault level of 5kA at 400V 50Hz. This would be typical of a light industrial installation. This meets and exceeds the requirements of IEC 61800-3. For installations where the fault level is lower, so that the harmonic current is more critical, the harmonic current will also be lower than that shown.

The calculations have been verified by laboratory measurements on sample drives.

Note that the RMS current in these tables may differ from the maximum specified in the installation guide, since the latter is a worst-case value provided for safety reasons which takes account of permitted supply voltage imbalance. The motor efficiency also affects the current; a standard IE2 4-pole motor has been assumed.

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

The supply voltages for the calculations were 200V, 400V and 690V at 50Hz. The harmonic percentages do not change substantially for other voltages and frequencies within the drive specification. In particular, the values for 480V 60Hz are very close to those for 400V 50Hz.

This table covers operation in both normal and heavy-duty (shown grey) modes (see next page).

Model no.	Motor Power (kW)	RMS current (A)	Fundamental current (A)	THD (%)	PWHD (%)	Harmonic Orders, magnitude as % of the fundamental														
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49
Mxxx-072 00610 A	18.5	60.20	53.5	51.56	39.3	42.87	25.40	8.15	6.38	4.74	3.61	3.28	2.53	2.42	1.97	1.89	1.57	1.50	1.29	1.22	1.06
	15	51.39	44.3	58.9	39.09	48.59	30.43	8.04	7.03	4.68	3.69	3.24	2.52	2.40	1.94	1.89	1.55	1.52	1.28	1.25	1.07
Mxxx-072 00750 A	22	70.13	63.7	46.24	39.31	38.71	21.63	8.23	5.97	4.78	3.57	3.30	2.54	2.41	1.98	1.87	1.56	1.47	1.26	1.17	1.03
	18.5	60.93	54.3	51.09	39.35	42.50	25.07	8.17	6.34	4.75	3.61	3.29	2.53	2.42	1.98	1.90	1.57	1.50	1.29	1.22	1.06
Mxxx-072 00830 A	30	90.71	84.3	39.87	39.16	33.63	17.04	8.28	5.62	4.82	3.56	3.28	2.57	2.39	1.96	1.80	1.53	1.39	1.20	1.07	0.96
	22	66.50	60	47.93	39.35	40.03	22.85	8.21	6.09	4.76	3.59	3.30	2.54	2.42	1.98	1.88	1.56	1.48	1.28	1.19	1.04
Mxxx-074 00660 A	37	69.84	62.7	49.17	38.64	41.17	23.55	8.08	6.04	4.69	3.52	3.24	2.49	2.38	1.94	1.85	1.53	1.46	1.25	1.17	1.03
	30	59.56	52.1	55.68	38.49	46.23	28.12	7.97	6.59	4.65	3.56	3.20	2.48	2.38	1.91	1.85	1.53	1.48	1.25	1.21	1.04
Mxxx-074 00770 A	45	81.44	74.4	44.38	38.57	37.43	20.09	8.13	5.72	4.73	3.48	3.24	2.51	2.37	1.93	1.81	1.52	1.42	1.21	1.11	0.98
	37	67.78	60.6	50.24	38.54	42.01	24.30	8.05	6.13	4.69	3.51	3.23	2.48	2.38	1.92	1.84	1.53	1.46	1.24	1.17	1.02
Mxxx-074 01000 A	55	94.75	87.8	40.71	38.46	34.50	17.43	8.17	5.54	4.75	3.49	3.23	2.52	2.34	1.92	1.76	1.50	1.36	1.18	1.04	0.93
	45	85.41	78.4	43.13	38.59	36.43	19.19	8.15	5.65	4.74	3.49	3.24	2.51	2.37	1.93	1.80	1.52	1.41	1.21	1.09	0.98
Mxxx-075 00440 A	45	44.55	40.9	42.83	42.36	35.35	19.95	8.34	6.19	4.99	3.88	3.49	2.82	2.60	2.20	2.04	1.75	1.63	1.42	1.31	1.17
	30	35.31	31.6	49.97	42.37	40.99	25.01	8.26	6.65	4.94	3.92	3.48	2.80	2.61	2.20	2.07	1.76	1.67	1.46	1.38	1.22
Mxxx-075 00550 A	55	52.42	48.8	39.29	42.26	32.48	17.42	8.38	6.03	5.00	3.89	3.49	2.83	2.58	2.19	2.00	1.73	1.58	1.38	1.25	1.12
	37	42.99	39.4	43.75	42.39	36.07	20.62	8.33	6.25	4.98	3.89	3.49	2.82	2.61	2.20	2.05	1.75	1.63	1.43	1.32	1.17
Mxxx-076 00190 A	18.5	23.53	18.3	81.22	38.03	66.11	44.72	9.56	8.24	4.84	3.99	2.64	2.82	1.48	2.27	1.09	1.82	0.95	1.52	0.96	1.21
	15	18.56	14	87.31	40.47	70.53	48.47	12.70	7.54	6.18	4.03	3.12	2.70	1.69	1.75	1.17	1.16	0.90	0.83	0.73	0.69
Mxxx-076 00240 A	22	26.56	21	77.2	41.71	62.31	43.05	8.13	9.04	4.52	4.50	3.00	3.04	2.25	2.34	1.94	1.80	1.68	1.43	1.49	1.11
	18.5	22.76	17.6	82.16	37.76	66.91	45.20	9.98	8.04	5.03	3.88	2.73	2.73	1.47	2.16	1.01	1.71	0.81	1.43	0.80	1.14
Mxxx-076 00290 A	30	33.24	28.3	61.48	42.15	49.96	32.89	8.13	7.58	4.85	4.06	3.43	2.78	2.57	2.18	2.07	1.73	1.67	1.47	1.42	1.22
	22	26.66	21.1	77.07	41.72	62.19	42.98	8.11	9.03	4.52	4.49	3.04	3.01	2.27	2.33	1.97	1.77	1.67	1.43	1.49	1.10
Mxxx-076 00380 A	37	40.56	36	51.7	42.22	42.38	26.18	8.25	6.74	4.92	3.92	3.47	2.78	2.60	2.19	2.08	1.75	1.67	1.47	1.39	1.21
	30	32.42	27.4	62.98	42.2	51.11	33.93	8.10	7.74	4.85	4.09	3.42	2.80	2.57	2.17	2.06	1.74	1.67	1.47	1.41	1.23
Mxxx-076 00440 A	45	45.79	41.4	47.27	42.35	38.89	23.08	8.28	6.45	4.96	3.88	3.48	2.81	2.62	2.19	2.06	1.77	1.66	1.45	1.36	1.21
	37	36.39	31.7	56.57	42.19	46.17	29.54	8.17	7.15	4.90	3.96	3.44	2.79	2.60	2.17	2.07	1.76	1.69	1.46	1.41	1.23
Mxxx-076 00540 A	55	56.55	52.2	41.5	42.4	34.27	19.01	8.36	6.13	5.00	3.89	3.50	2.83	2.60	2.20	2.03	1.75	1.61	1.42	1.30	1.16
	45	43.19	38.8	49.26	42.39	40.43	24.51	8.26	6.61	4.96	3.91	3.47	2.82	2.62	2.20	2.06	1.77	1.67	1.46	1.38	1.21

Input Line Reactors (line chokes)

Where necessary, a reduction in harmonic current levels can be obtained by fitting reactors in the input supply lines to the drive. This also gives increased immunity from supply disturbances such as voltage surges caused by the switching high current loads or power factor correction capacitors on the same supply circuit. The following table shows corresponding harmonics where reactors are fitted in the supply lines. To avoid excessive voltage drops at full load the values used should not exceed 2% per unit. The reactor current rating must be at least equal to the rms value shown, and the peak current rating (to avoid magnetic saturation) should be twice that value.

Control Techniques available stock line reactors (@simulations 10% less than the stated inductance)

CT 4401-0173, 190µH, 156A
CT 4401-0183-00, 178µH, 145A
CT 4401-0190-03, 89µH, 145A
CT 4401-0171, 315µH, 96A
CT 4401-0170, 390µH, 77A
CT 4402-0226, 500µH, 26A
CT 4400-0240, 450µH, 46A

Model no.	Motor Power (kW)	RMS current (A)	Fund current (A)	THD (%)	PWHD (%)	Harmonic Orders, magnitude as % of the fundamental																AC line choke nom (µH)	DPF Cos Ø
						5	7	11	13	17	19	23	25	29	31	35	37	41	43	47	49		
Mxxx-072 00610 A	18.5	57.11	53.3	38.4	26.82	34.41	13.37	7.76	4.10	3.88	2.51	2.25	1.73	1.42	1.17	0.87	0.83	0.57	0.56	0.43	0.38	190	0.984
	15	47.76	44.1	41.88	27.86	37.21	15.89	7.87	4.28	3.99	2.49	2.40	1.72	1.54	1.23	1.01	0.89	0.68	0.64	0.48	0.45	190	0.984
Mxxx-072 00750 A	22	67.53	63.5	36.12	25.67	32.51	11.86	7.63	4.08	3.77	2.51	2.11	1.69	1.27	1.09	0.76	0.73	0.49	0.49	0.39	0.32	178	0.984
	18.5	57.97	54.1	38.59	27.15	34.53	13.56	7.78	4.14	3.91	2.53	2.28	1.74	1.44	1.19	0.90	0.85	0.59	0.58	0.44	0.39	178	0.984
Mxxx-072 00830 A	30	89.31	84.2	35.39	28.82	31.42	12.06	7.82	4.44	4.06	2.79	2.41	1.90	1.53	1.26	0.94	0.88	0.62	0.58	0.44	0.39	89	0.987
	22	64.68	59.9	40.84	30.98	35.86	15.90	7.98	4.60	4.24	2.79	2.66	1.95	1.80	1.41	1.21	1.06	0.86	0.75	0.59	0.56	89	0.987
Mxxx-074 00660 A	37	66.59	62.5	37	25.71	33.33	12.33	7.61	4.03	3.76	2.48	2.12	1.68	1.30	1.10	0.78	0.75	0.50	0.51	0.41	0.33	315	0.984
	30	55.79	51.8	40.09	26.93	35.85	14.51	7.74	4.13	3.89	2.47	2.29	1.70	1.44	1.19	0.92	0.84	0.60	0.58	0.42	0.40	315	0.984
Mxxx-074 00770 A	45	79.27	74.3	37.17	28.08	33.16	12.90	7.74	4.28	3.98	2.67	2.36	1.83	1.50	1.24	0.93	0.87	0.61	0.58	0.44	0.39	190	0.986
	37	65.23	60.4	40.7	29.39	36.01	15.44	7.85	4.40	4.10	2.66	2.51	1.86	1.67	1.32	1.09	0.98	0.76	0.68	0.52	0.50	190	0.986
Mxxx-074 01000 A	55	92.83	87.7	34.9	26.72	31.27	11.38	7.62	4.26	3.86	2.65	2.20	1.77	1.34	1.14	0.81	0.76	0.52	0.51	0.41	0.34	190	0.986
	45	83.33	78.3	36.39	27.58	32.53	12.34	7.70	4.27	3.94	2.66	2.32	1.80	1.43	1.21	0.89	0.82	0.57	0.55	0.41	0.37	190	0.986
Mxxx-075 00440 A	45	43.69	40.9	37.43	31.16	32.88	13.79	7.92	4.65	4.25	2.92	2.64	2.03	1.75	1.42	1.15	1.03	0.80	0.71	0.54	0.50	390	0.988
	30	34.22	31.6	42.14	32.56	36.64	17.24	7.97	4.87	4.33	2.94	2.78	2.08	1.91	1.53	1.34	1.17	0.97	0.86	0.68	0.66	390	0.988
Mxxx-075 00550 A	55	51.66	48.8	35	29.8	30.87	12.14	7.83	4.61	4.14	2.91	2.50	1.97	1.60	1.32	1.00	0.92	0.66	0.60	0.46	0.40	390	0.988
	37	42.11	39.4	38.06	31.66	33.38	14.24	7.95	4.67	4.28	2.94	2.68	2.06	1.81	1.46	1.20	1.08	0.85	0.75	0.57	0.55	390	0.988
Mxxx-076 00190 A	18.5	21.47	18.1	64.12	33.14	53.61	32.81	7.90	6.93	4.24	3.23	2.80	2.02	1.99	1.50	1.50	1.17	1.17	0.94	0.91	0.79	500	0.980
	15	17.54	13.9	77.22	33.48	63.70	41.42	8.29	8.35	4.20	3.71	2.51	2.29	1.62	1.72	1.21	1.33	1.00	1.07	0.89	0.84	500	0.974
Mxxx-076 00240 A	22	24.24	20.9	59.18	33.26	49.81	29.45	7.93	6.37	4.29	3.11	2.83	2.03	2.01	1.53	1.51	1.20	1.18	0.96	0.90	0.80	450	0.982
	18.5	21.02	17.4	67.61	33.69	56.18	35.31	7.86	7.38	4.25	3.37	2.81	2.07	2.01	1.53	1.53	1.19	1.20	0.96	0.95	0.80	450	0.979
Mxxx-076 00290 A	30	31.37	28.2	48.55	32.79	41.72	21.81	7.98	5.28	4.33	2.91	2.81	2.03	1.98	1.53	1.44	1.19	1.08	0.92	0.80	0.74	450	0.986
	22	24.32	21	59.01	33.31	49.68	29.33	7.94	6.35	4.29	3.12	2.84	2.02	2.01	1.54	1.52	1.20	1.18	0.96	0.90	0.81	450	0.982
Mxxx-076 00380 A	37	39.07	36	42.43	32.04	36.97	17.31	7.96	4.81	4.29	2.88	2.74	2.04	1.87	1.50	1.31	1.14	0.94	0.84	0.67	0.64	450	0.987
	30	30.50	27.3	49.49	32.87	42.44	22.52	7.99	5.36	4.32	2.94	2.82	2.02	1.98	1.53	1.44	1.20	1.10	0.92	0.80	0.76	450	0.985
Mxxx-076 00440 A	45	44.60	41.4	40.38	32.34	35.25	15.94	7.98	4.78	4.33	2.94	2.76	2.07	1.88	1.52	1.31	1.12	0.93	0.83	0.66	0.61	390	0.988
	37	34.85	31.6	46.48	33.25	40.02	20.44	8.00	5.17	4.37	2.96	2.85	2.08	2.00	1.57	1.45	1.22	1.09	0.94	0.80	0.75	390	0.987
Mxxx-076 00540 A	55	55.57	52.2	36.51	30.6	32.14	13.14	7.89	4.63	4.21	2.91	2.59	2.00	1.68	1.39	1.10	0.97	0.73	0.66	0.50	0.46	390	0.988
	45	41.93	38.7	41.67	32.52	36.26	16.91	7.97	4.85	4.33	2.94	2.77	2.08	1.90	1.53	1.33	1.16	0.96	0.86	0.68	0.65	390	0.988

Meet Harmonics Standard EN 61000-3-12

In order to meet the above standard, when $R_{sce} \geq 120$ the line choke with the value shown in the table below should be fitted in the input supply line to the drive.

Model no.	Motor Power (kW)	RMS current (A)	Fund current (A)	THD (%)	PWHD (%)	Harmonic Orders, magnitude as % of the fundamental																AC line choke nom (µH)	DPF Cos Ø
						5	7	10	11	13	17	19	23	25	29	31	35	37	41	43	47	49	
Mxxx-07200610 A	18.5	57.11	53.3	38.4	26.82	34.41	13.37	0.03	7.76	4.10	3.88	2.51	2.25	1.73	1.42	1.17	0.87	0.83	0.57	0.56	0.43	0.38	190	0.984
	15	47.76	44.1	41.88	27.86	37.21	15.89	0.02	7.87	4.28	3.99	2.49	2.40	1.72	1.54	1.23	1.01	0.89	0.68	0.64	0.48	0.45	190	0.984
Mxxx-07500440 A	45	43.35	40.9	35.17	26.81	31.46	11.64	0.02	7.65	4.28	3.87	2.66	2.22	1.77	1.35	1.15	0.81	0.76	0.52	0.51	0.40	0.34	600	0.985
	30	33.83	31.5	39.06	28.78	34.66	14.31	0.02	7.83	4.35	4.06	2.66	2.45	1.84	1.58	1.28	1.02	0.92	0.68	0.63	0.47	0.44	600	0.986
Mxxx-07500550 A	55	51.34	48.7	33.15	25.32	29.74	10.43	0.01	7.50	4.30	3.71	2.64	2.04	1.69	1.18	1.05	0.71	0.66	0.48	0.46	0.39	0.34	600	0.984
	37	41.76	39.3	35.69	27.29	31.89	11.99	0.02	7.69	4.29	3.91	2.67	2.26	1.80	1.40	1.18	0.85	0.80	0.55	0.54	0.42	0.36	600	0.985
Mxxx-07600190 A	18.5	19.18	17.9	38.83	23	35.28	12.89	0.01	7.54	3.74	3.49	2.21	1.88	1.48	1.08	0.98	0.66	0.64	0.45	0.44	0.35	0.32	2500	0.979
	15	14.92	13.7	44.11	25.15	39.46	16.73	0.01	7.84	4.10	3.75	2.22	2.15	1.52	1.34	1.08	0.85	0.78	0.56	0.56	0.41	0.39	2500	0.979
Mxxx-07600240 A	22	22.21	20.7	38.92	23.47	35.28	13.09	0.02	7.57	3.77	3.56	2.23	1.92	1.51	1.12	0.99	0.68	0.65	0.43	0.45	0.35	0.30	2000	0.980
	18.5	18.72	17.2	42.37	25.09	38.02	15.60	0.01	7.77	4.00	3.74	2.26	2.13	1.54	1.31	1.08	0.82	0.77	0.53	0.54	0.39	0.37	2000	0.980
Mxxx-07600290 A	30	29.96	28.1	36.9	23.5	33.49	11.91	0.02	7.48	3.83	3.54	2.31	1.89	1.54	1.10	0.98	0.67	0.63	0.43	0.44	0.36	0.30	1500	0.980
	22	22.59	20.8	42.16	25.92	37.72	15.68	0.03	7.79	4.06	3.81	2.33	2.20	1.61	1.39	1.11	0.87	0.82	0.57	0.57	0.42	0.38	1500	0.981
Mxxx-07600380 A	37	38.21	35.9	36.48	24.97	32.92	11.97	0.00	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	0.983
	30	29.46	27.3	41.12	27.05	36.67	15.27	0.01	7.80	4.17	3.92	2.45	2.31	1.69	1.47	1.18	0.93	0.85	0.62	0.59	0.44	0.40	1000	0.983
Mxxx-07600440 A	45	43.68	41.3	34.64	23.8	31.37	10.80	0.03	7.42	4.00	3.56	2.43	1.89	1.59	1.09	0.98	0.66	0.61	0.44	0.44	0.37	0.32	1000	0.982
	37	33.77	31.5	38.51	26.2	34.58	13.38	0.02	7.69	4.06	3.82	2.47	2.19	1.69	1.36	1.14	0.83	0.79	0.54	0.54	0.41	0.36	1000	0.983
Mxxx-07600540 A	55	54.72	52.1	32.03	21.29	29.12	9.43	0.03	7.10	4.01	3.24	2.34	1.59	1.41	0.86	0.81	0.59	0.48	0.45	0.39	0.35	0.34	1000	0.980
	45	40.98	38.6	35.47	24.33	32.09	11.31	0.01	7.49	4.00	3.61	2.45	1.98	1.59	1.14	1.03	0.68	0.65	0.46	0.44	0.37	0.32	1000	0.982

Further measures for reducing harmonics

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

Note about flicker:

Inrush current at power up is limited by design to less than the drive rated current. The drive does not in itself generate flicker when in operation, but a periodically fluctuating load might result in flicker.

CONDUCTED RADIO FREQUENCY EMISSION

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

The drive contains a cost-effective internal input filter which gives a reduction of about 30dB in the level of emission at the supply terminals. Unlike a conventional filter, the internal filter continues to provide this attenuation with a long motor cable. For practical purposes, this filter in conjunction with a screened motor cable is sufficient to prevent the drive from causing interference to most good-quality industrial equipment. It is recommended that the filter be used in any situation unless the earth leakage current, which is up to 41mA, is unacceptable. The User Guide gives instructions on how to remove and replace it.

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

The tables summarise the performance of the filters.

200V drives

Motor cable length (m)	**Switching frequency (kHz)**					
	2	**3**	**4**	**6**	**8**	**12**
Using the internal filter						
2~10	**C4**					
Using the external filter (CT No. 4200-1132)						
20	**R**	**R**	**R**	**R**	**R**	**R**
40	**R**	**R**	**R**	**R**	**R**	**R**
100	**R**	**R**	**R**	**R**	**I**	**I**

400V drives

Motor cable length (m)	**Switching frequency (kHz)**					
	2	**3**	**4**	**6**	**8**	**12**
Using the internal filter						
2~10	**C4**					
Using the external filter (CT No. 4200-1132)						
20	**R**	**R**	**I**	**I**	**I**	**I**
50	**I**	**I**	**I**	**I**	**I**	**I**
100	**I**	**I**	**I**	-	-	-

575V and 690V drives

Motor cable length (m)	**Switching frequency (kHz)**					
	2	**3**	**4**	**6**	**8**	**12**
Using the internal filter						
2~10	**C4**					
Using the external filter (CT No. 4200-0672)						
20	**R**	**I**	**I**	**I**	**I**	**I**
50	**R**	**I**	**I**	**I**	**I**	**I**
100	**I**	**I**	-	-	-	-

Key to tables

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

Code	Standard	Description	Frequency range	Limits	Application
R	EN 61000-6-3 IEC 61000-6-3 EN 50081-1	Residential: Generic emission standard for the residential commercial and light - industrial environment	0.15 - 0.5MHz limits decrease linearly with log frequency	66-56dBµV quasi peak 56-46dBµV average	AC supply lines
			0.5 - 5MHz	56dBµV quasi peak 46dBµV average	
			5 - 30MHz	60dBµV quasi peak 50dBµV average	
	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Category C1		
I	EN 61000-6-4 IEC 61000-6-4 EN 50081-2	Industrial: Generic emission standard for the industrial environment	0.15 – 0.5MHz	79dBµV quasi peak 66dBµV average	AC supply lines
			0.5 –30MHz	73dBµV quasi peak 60dBµV average	
	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Category C2		
C1	EN 61800-3 IEC 61800-3	Product standard for adjustable speed power drive systems	Category C1 - intended for use in the first environment		
C2			Category C2 - intended for use in the first environment, only when it is neither a plug-in device nor a movable device, and in intended to be installed and commissioned only by a professional		
C3			Category C3 - intended for use in the second environment:		
C4			Category C4 - intended for use in the second environment in a system rated at over 400A, or in a complex system		
-	**Operation in this condition is not recommended due to the risk of over-loading of the filter**				

Environments in IEC 61800-3:	
First	Environment that includes domestic premises or where domestic premises are connected to the same low voltage power supply network
Second	Environment that includes all establishments which are not connected to the same low voltage power supply network

- Caution -

This caution applies where the drive is used in the first environment with restricted distribution according to EN 61800-3:

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

Notes

1. Where the drive is incorporated into a system with rated input current exceeding 100A, the higher emission limits of EN 61800-3 for the second environment are applicable, and no filter is then required.
2. Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN 61800-3 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Recommended filters

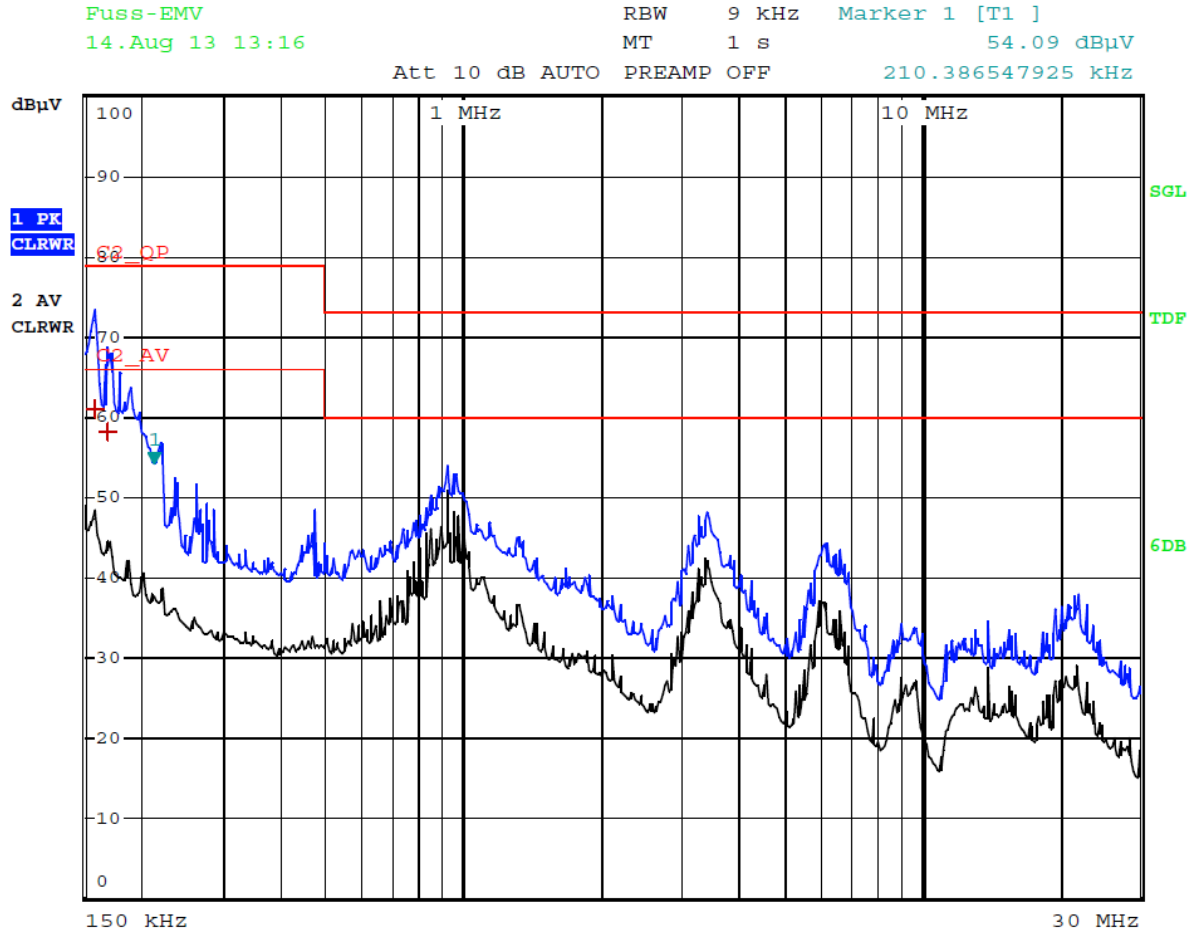
Drive	CT Part Number
07200610 to 07200830 and 07400660 to 07401000	4200-1132
07500440 to 07500550 and 07600190 to 07600540	4200-0672

- WARNING -

These filters and the internal filter have earth leakage current exceeding 3.5mA. A permanent fixed earth connection with cross-section exceeding 10mm^2 is necessary to avoid electrical shock hazard. Further precautions, such as a supplementary earth connection or earth monitoring system, may also be required.

Typical conducted emission test data

The conducted emission from a M700-074-01000 operating with filter part number 3F480-113.290CT, at 6kHz switching frequency with 20m motor cable, is shown in the emission plot.1.



Plot.1 Conducted Emission measured at input phase L1

Note on ungrounded supply systems (IT systems)
Care is needed when using inverter drives with RFI filters on ungrounded supply systems. The recommended filters are designed to operate safely with an earth fault on the supply. However damage could occur to the filter if an earth fault occurs in the driven motor, as the drive might not trip, and excessive high-frequency current could flow into the filter.

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

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

Conducted emission from 150kHz to 30MHz		
Generic standard	**Product standard**	
EN 61000-6-4 EN 50081-2	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

RADIATED EMISSION

When installed in a standard metal enclosure according to the wiring guidelines, the drive will meet the radiated emission limits required by the generic industrial emission standard EN 61000-6-4 (previously EN 50081-2).

Important note

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

EN 61800-3 (IEC 61800-3) requires the following, in order of increasing emission level:

As EN 61000-6-3	First environment - unrestricted distribution C1
As EN 61000-6-4	First environment - restricted distribution C2
As EN 61800-3 30 – 230MHz 50dBµV/m at 30m 230 – 1000MHz 60dBµV/m at 30m	Second environment – unrestricted distribution C3

For products complying with C3 the manufacturer must provide a guide for installation and use, including mitigation devices.

Important Information

Radiated emission test results indicate the drive complies with the C2 limit of the first environment – restricted distribution. The communication module fit in the drive's control pod can be an Ethernet module. If a RS485 communication module is fit, then braided shielding cables must be used and the cable shielding must be clamped to the metal enclosure where the drive is mounted. Especially the drive is complying with C2 limit when there is no communication module fit in the control pod. If above three conditions are not satisfied, the drive still complies with the C3 limit of the second environment – unrestricted distribution, as long as the guide for installation and use is followed.

Communication module	Limits EN61800-3	Limits EN55022	General requirements for IO, Encoder and motor cables	Special requirements for communication cables
Ethernet	C2	Class A	Use a braided shielding cable and clamp it [1]	NA
None[2]	C2	Class A		NA
RS485	C2	Class A		Use a braided shielding cable and clamp it[1]
RS485	C3	NA		NA

[1] The braided shielding must be bonded or clamped to the metal enclosure which accommodates the drive.

[2] No communication option modules fit in the slot -4 of the control pod or cables being unplugged from the module.

Test Configurations

The test data is based on radiated emission measurements made in a standard steel enclosure containing a single M700-074-01000 drive, in a calibrated open area test site. Details of the test arrangement are described:

A standard Rittall steel enclosure was used having dimensions 1900mm (high) × 600mm (wide) × 500mm (deep). Two ventilation grilles, both 200mm square, were provided on the upper and lower faces of the door. No special EMC features were incorporated.

The drive and recommended RFI input filter were 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 cable was used to connect the cubicle to the supply.

A standard 11kW AC induction motor was connected by 3m of shielded cable (steel braided - type SY) and mounted externally. The cable screen was clamped directly to the back-plate near the drive, and connected to the motor frame by a pig-tail approximately 70mm long. The motor cable screen was not bonded to the enclosure wall at the point of entry.

A 3.0m screened control cable and a 3.0m screened encoder cable were connected to the drive control and encoder terminals, with screens clamped to the drive EMC grounding bracket as recommended in the user guide.
There are two options for the communication module fit in slot 4 in the control pod: RS485 module and Ethernet module. For the Ethernet module foil shielded cables are used and keep floating straight in front of the drive. For the RS485 module cables can be floating to meet C3 or bonded to the back plane (for braided shielding cables only) to meet C2 and EN55011 Class A.
The drive was operated at 6Hz (180rpm motor speed), with a switching frequency of 12 kHz which is the worst case for RF emission.
No additional EMC preventative measures were taken, e.g. RFI gaskets around the cubicle doors.

Test Data

The following tables summarise results for radiated emission when different communication modules are fitted, showing the eight highest measurements over the frequency range 30 to 1000 MHz:

Ethernet communication module fitted; cables floating					
Frequency (MHz)	**Antenna Height (m)**	**Polarisation H/V**	**Field Strength (dBuV/m @10m)**	**EN55022 Class A (dBuV/m @10m)**	**Margin Under Spec. (dBuV @10m)**
34.92	1.0	V	33.04	40.00	-6.96
35.16	1.0	V	33.52	40.00	-6.48
35.34	1.0	V	34.03	40.00	-5.97
35.64	1.0	V	33.63	40.00	-6.37
40.38	1.0	V	29.20	40.00	-10.80
62.22	1.0	V	32.43	40.00	-7.57
58.68	1.5	V	32.35	40.00	-7.65
62.22	1.5	V	31.79	40.00	-8.21
35.34	1.5	V	31.30	40.00	-8.70

RS485 communication module fitted; cables floating					
Frequency (MHz)	**Antenna Height (m)**	**Polarisation H/V**	**Field Strength (dBuV/m @10m)**	**C3 limit EN61800-3 (dBuV/m @10m)**	**Margin Under Spec. (dBuV @10m)**
40.08	1.0	V	39.91	50.00	-10.09
41.4	1.0	V	39.86	50.00	-10.14
41.94	1.0	V	40.60	50.00	-9.40
42.96	1.0	V	42.15	50.00	-7.85
43.68	1.0	V	41.10	50.00	-8.90
44.52	1.0	V	39.49	50.00	-10.51
41.4	1.5	V	38.30	50.00	-11.70
41.94	1.5	V	38.34	50.00	-11.66
42.96	1.5	V	38.68	50.00	-11.32

RS485 communication module fitted; Braided shielding cables bonded to the back plane					
Frequency (MHz)	**Antenna Height (m)**	**Polarisation H/V**	**Field Strength (dBuV/m @10m)**	**EN55022 Class A dBuV/m@10m**	**Margin Under Spec. (dBuV @10m)**
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

Without any communication modules fit in slot 4 on the control pod;					
Frequency (MHz)	**Antenna Height (m)**	**Polarisation H/V**	**Field Strength (dBuV/m @10m)**	**EN55022 Class A (dBuV/m @10m)**	**Margin Under Spec. (dBuV @10m)**
30.18	1.0	V	27.76	40.00	-12.24
31.56	1.0	V	29.14	40.00	-10.86
34.86	1.0	V	30.90	40.00	-9.10
35.64	1.0	V	31.06	40.00	-8.94
38.34	1.0	V	26.77	40.00	-13.23
62.4	1.0	V	28.64	40.00	-11.36
34.86	1.5	V	28.46	40.00	-11.54
35.64	1.5	V	28.32	40.00	-11.68
62.4	1.5	V	27.97	40.00	-12.03

To take into account uncertainties in the radiated emission test, all test results must have a margin of at least 4.5dB below the limit required by the standard.

Enclosure construction

For most installations the enclosure will have a back-plate which will be used to mount variable speed drive modules, RFI filters and ancillary equipment. This back-plate can be used as the EMC earth plane, so that all metal parts of these items and cable screens are fixed directly to it. Its surface should have a conductive protective surface treatment such as zinc plate. If it is painted then paint will have to be removed at the points of contact to ensure a low-inductance earth connection which is effective at high frequency.

The motor cable screen must be clamped directly to the back-plate. It may also be bonded at the point of exit, through the normal gland fixings.

Depending on construction, the enclosure wall used for cable entry might have separate panels and have a poor connection with the remaining structure at high frequencies. 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. There is no need for a special EMC enclosure with gaskets etc. In the tests described, opening the cubicle door had little effect on the emission level, showing that the enclosure itself does not provide significant screening.

Related product standards

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

Radiated emission from 30 to 1000MHz		
Generic standard	**Product standard**	
EN 61000-6-4	CISPR 11 Class A Group 1 CISPR 11 Class A Group 1	Industrial, scientific and medical equipment
	EN 55022 Class A CISPR 22 Class A	Information technology equipment

WIRING GUIDELINES

The wiring guidelines on the following pages should be observed to achieve minimum radio frequency emission. The details of individual installations may vary, but aspects which are indicated in the guidelines as 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 is not necessary unless specifically stated in the instructions.

1. The drive and filter must be mounted on the same metal back-plate, and their mounting surfaces must make a good direct electrical connection to it (*see fig.3*). The use of a plain metal back-plate (e.g. galvanised not painted) is beneficial for ensuring this without having to scrape off paint and other insulating finishes.
2. The filter must be mounted close to the drive so that its connecting wires can be directly connected. The wires must not be extended.
3. A shielded (screened) or steel wire armoured cable must be used to connect the drive to motor. The shield must be bonded to the drive using the grounding clamp provided.

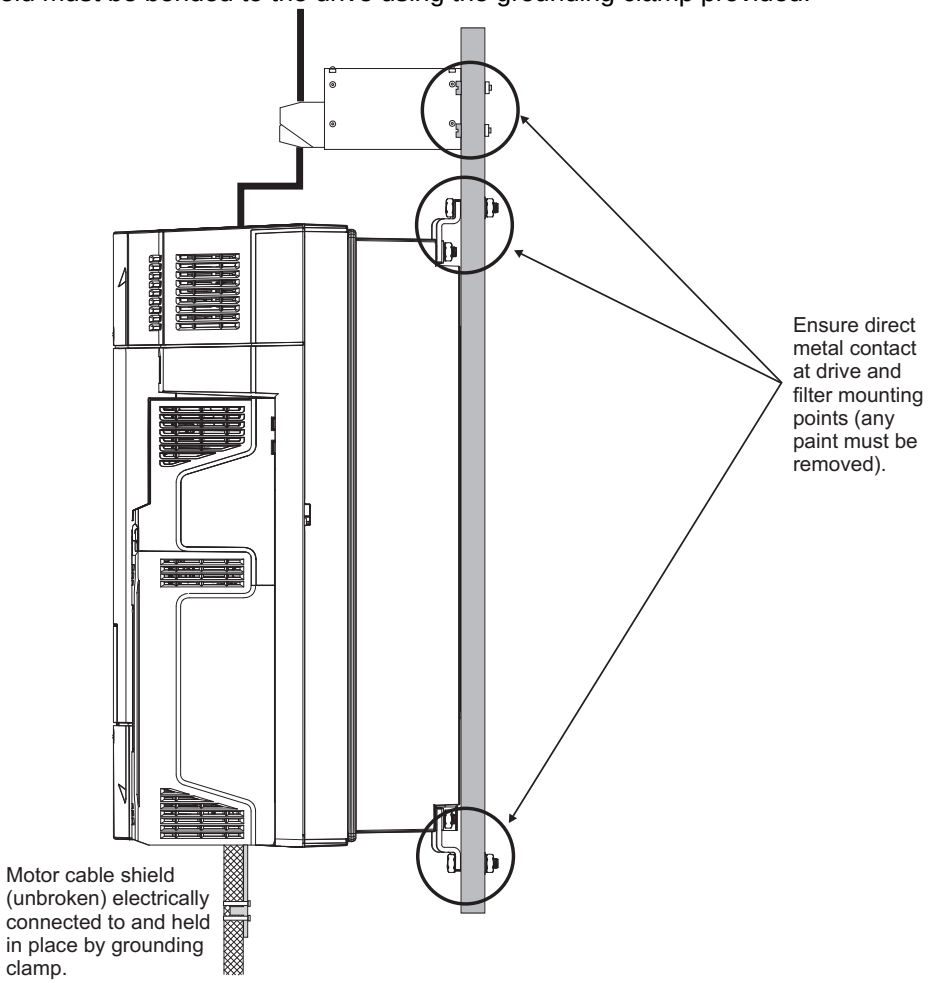


Fig.3 Grounding the drive, the filter and the motor cable screen

4. The AC supply connections must be kept at least 4in (100mm) from the drive, motor cable and braking resistor cable (*see fig.4*).

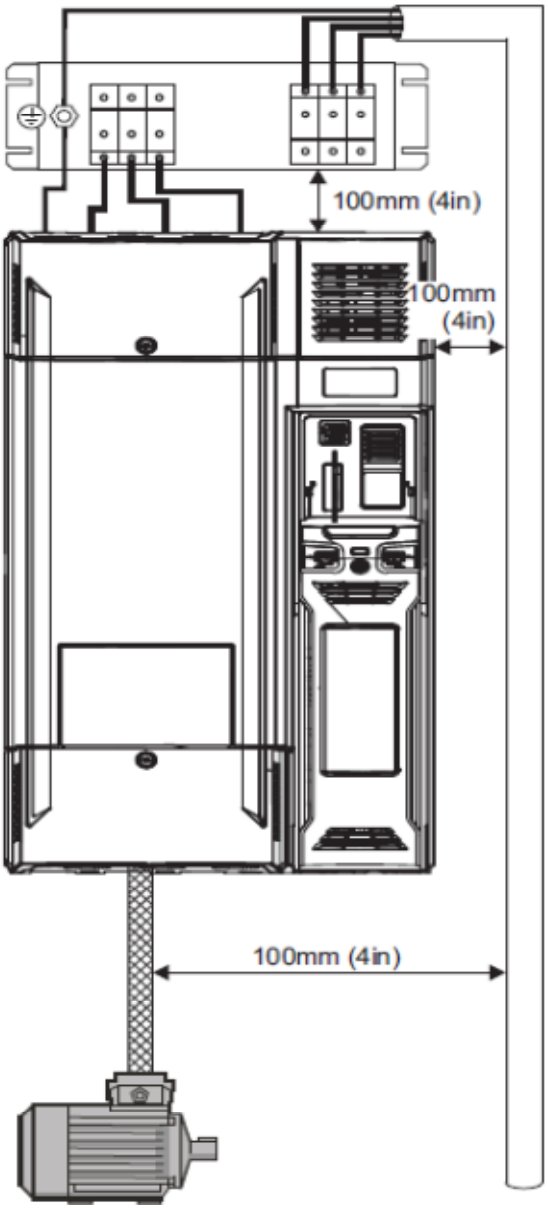


Figure.4 Wire spacing

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

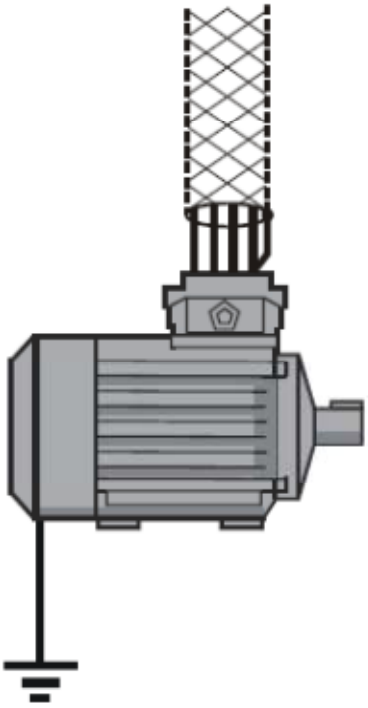


Figure 5: Connecting the motor cable shield at the motor

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

7. Wiring to the braking resistor should be shielded. The shield must be bonded to the back-plate using an un-insulated metal cable-clamp. It need only be connected at the drive end (fig.6).

8. If the braking resistor is outside the enclosure then it should be surrounded by an earthed metal shield (fig.6).

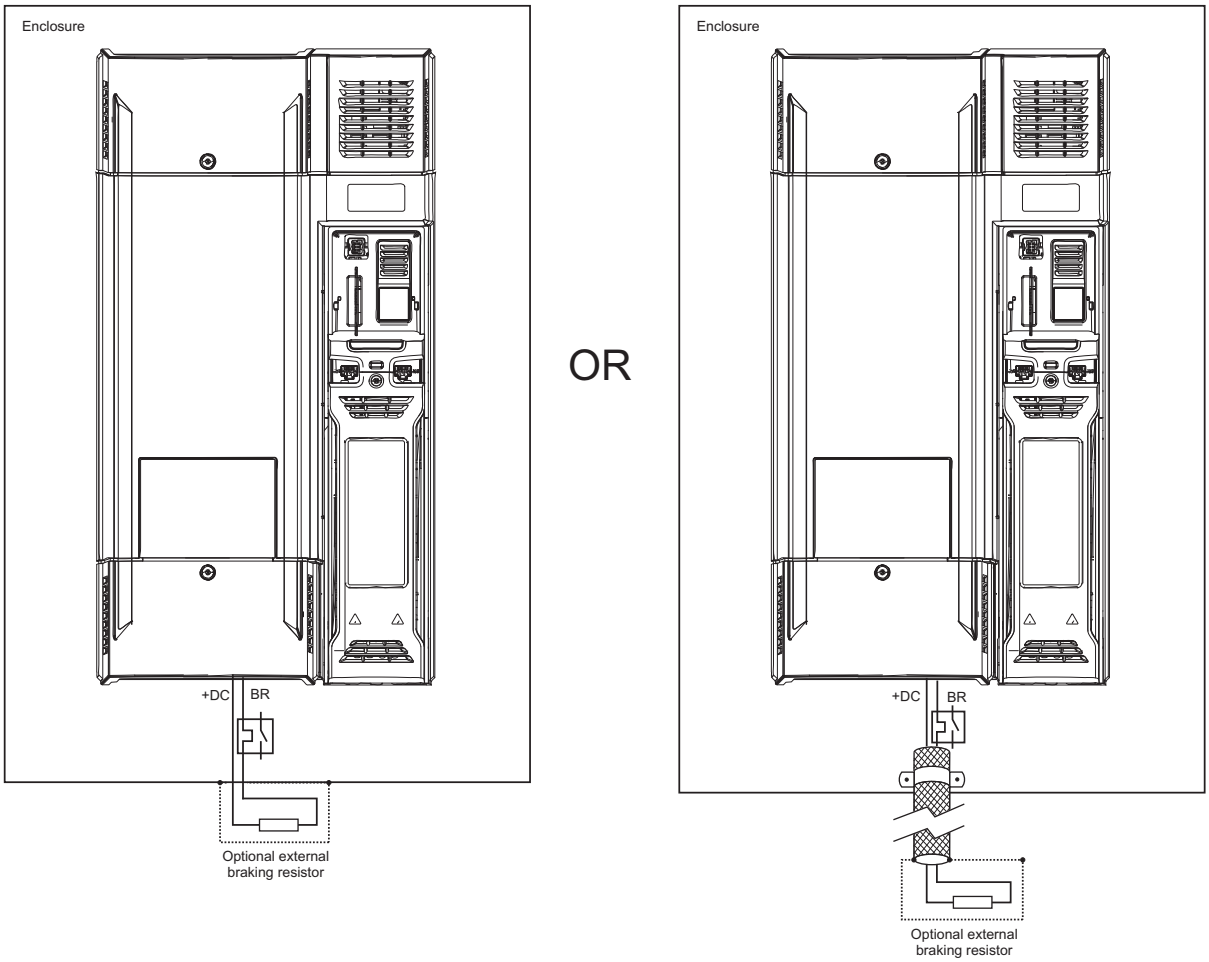


Figure 6: Screening of braking circuit

9. Signal and control wiring must be kept at least 12in (300mm) from the drive and motor cable.

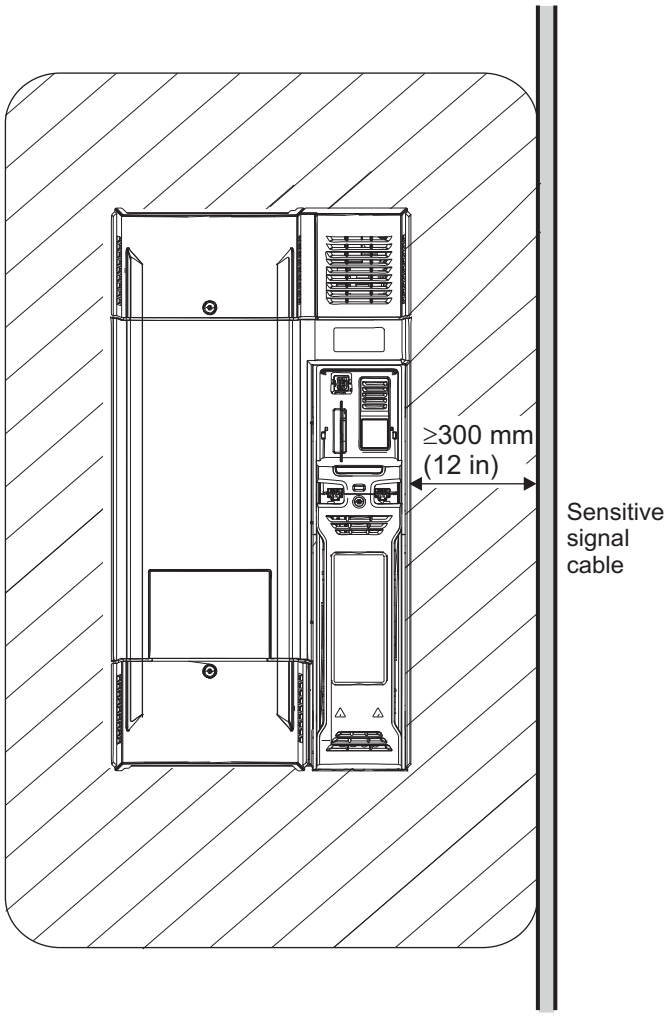


Figure 7: Signal wiring spacing

10. The control wiring “0V” connection should be earthed at one point only, preferably at the controller and not at a drive.

Variations to wiring guidelines

– **Output ferrite ring**

If the ferrite ring is to be used to further reduce conducted emission, it should be mounted close to the drive, and the output power conductors (U,V,W but not E) should be passed twice through the central aperture, all together in the same direction.

– **If drive control wiring leaves the enclosure**

This includes all control, encoder and option module wiring but not the status relay circuit or the serial port. One of the following additional measures must be taken:

- Use shielded cables (one overall shield or separate shielded cables) and clamp the shield(s) to the grounding bracket provided, as shown in Figure 8.

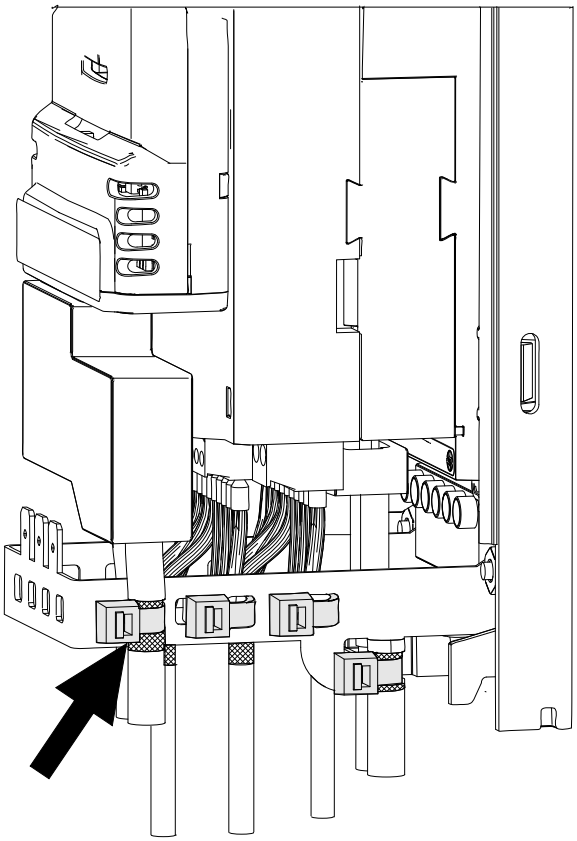


Figure 8: Earthing of signal cable screens using the grounding bracket

– **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. The most important factor is always to minimise the inductance of the connection between the cable shields.

– **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 power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away from the terminal block.

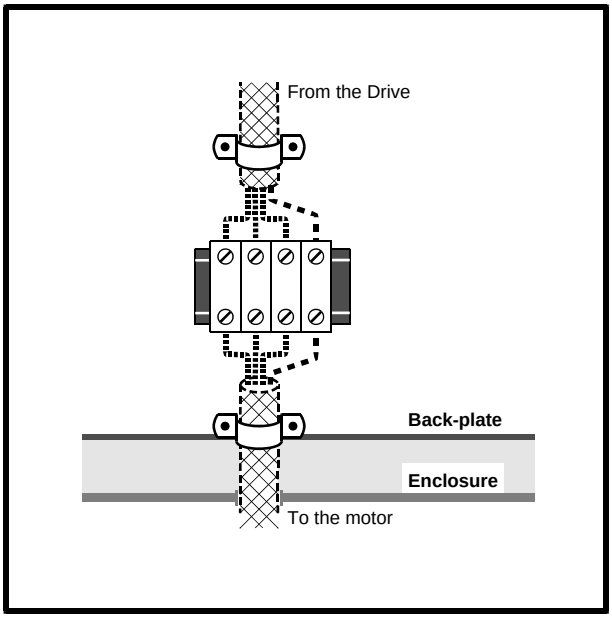


Figure 9: Connecting the motor cable to a terminal block in the enclosure

– **Using a motor isolator switch**

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal bar is recommended; conventional wire is not suitable. The shields should be bonded directly to the coupling bar using uninsulated metal cable-clamps. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3m (12 in) away. The coupling bar may be grounded to a known low impedance ground nearby, for example a large metallic structure which is connected closely to the drive ground.

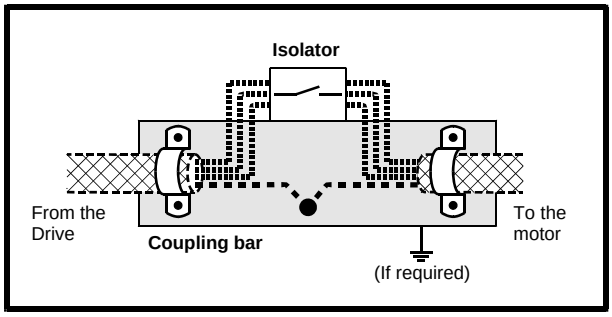


Figure 10: Connecting the motor cable to an isolating switch