

EMC Category C2 Three Phase Power Drive System

Abstract

There is substantial market confusion in Australia in relation to the high frequency component of AS 61800.3 and the implementation of category C1 and C2 limits for a power drive system (PDS).

AS 61800.0 defines a power drive system (PDS) as “a motor and a complete drive module (CDM). It does not include the equipment driven by the motor”. The most common examples of PDS’s in HVAC are EC Fans, and motors controlled by variable speed drives.

The high frequency limits imposed by the AS 61800.3 apply to single phase and three phase equipment with the delineation being whether the equipment is moveable or fixed in position.

Category C1 limits are more restrictive than category C2 limits and the standard clearly defines the reason for the differences. Equipment that has a plug and is moveable, are covered by category C1 limits in the first environment because no skill is required for installation. These limits are imposed because the manufacturer does not know where and how the equipment will be installed. Such equipment (whether a PDS or not) can be factory-tested and released for public use with the qualifying level of compliance.

Category C2 limits, whilst only marginally less restrictive, are required by manufacturers of the drive (CDM) component of a PDS. The onus being that if this CDM is installed as per the manufacturer’s instructions, then the installation will comply with category C2 conducted and radiated emissions. The length of shielded cable between the CDM and the motor has significant impact on the conducted emissions, and this length is defined by the manufacturer of the CDM. In the HVAC industry a compliance shielded cable length of up to 100m is expected from a quality CDM.

It is important to table that there is no valid argument as to what kW size PDS (or drive) is subjected to the rules, that is, the ruling covers all kW sizes.

Category C1, C2, C3 and C4 high frequency emissions

“First environment – environment that includes domestic premises, it also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes.” ^(a)

“Second environment – environment that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings for domestic purposes”. ^(a)

“This standard is intended as a complete EMC product standard for the EMC conformity assessment of products of categories C1, C2 and C3, when placing them on the market”. ^(a)

First Environment: Category C1 or C2:

Category C1	Unrestricted distribution. Usually single phase “plug & play” equipment. No technical knowledge required. For all kW sizes of applicable equipment.
Category C2	Restricted distribution. Usually three phase non-moveable equipment. Installed and commissioned by a technical competent person. For all kW sizes of applicable equipment.

Second Environment: Category C3 or C4:

Second environment installations are not covered in this document.

“PDS of category C1 – PDS of rated voltage less than 1000V, intended for use in the first environment”. ^(a)

“PDS of category C2 – PDS of rated voltage less than 1000V, which is neither a plug in device nor a moveable device and, when used in the first environment, is intended to be installed and commissioned only by a professional”. ^(a)

The standard specifically states that a PDS of category C3 is “not intended for use in the first environment”. ^(a)

Conducted emissions cover the frequency range 150kHz to 30MHz (CISPR22) and this encompass’ the broadcasting AM band of 531kHz to 1602kHz within Australia. Therefore, a CDM ‘without a RFI filter’ may cause interference. Inclusion of a category C2 RFI filter within the CDM and installed by a professional negates any issues in this area.

Conducted emission voltage levels (in dB) are stipulated within Table 14 of AS 61800.3:

Frequency Band MHz	Category C1		Category C2	
	Quasi Peak dB (μ V)	Average dB (μ V)	Quasi Peak dB (μ V)	Average dB (μ V)
150kHz to 500kHz	66 down to 56	56 down to 46	79	66
500kHz to 5MHz	56	46	73	60
5MHz to 30MHz	60	50	73	60

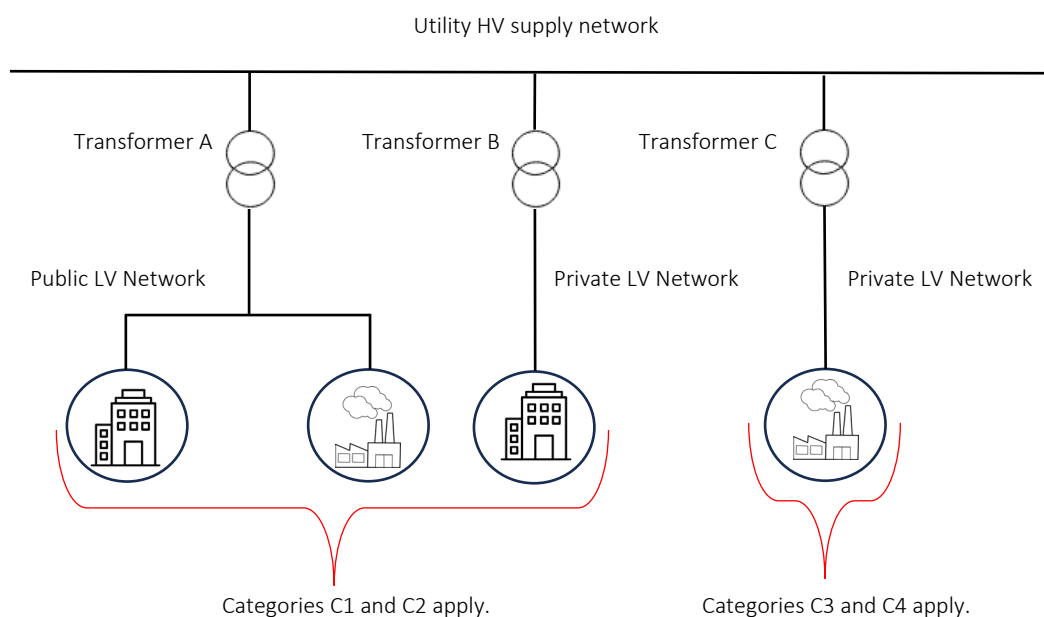
The values within Table 14 are small and therefore referenced in dB.

Conducted emission voltage levels (in Volts) from Table 14 data:

Frequency Band MHz	Category C1		Category C2	
	Quasi Peak mV	Average mV	Quasi Peak mV	Average mV
150kHz to 500kHz	2 down to 0.6	0.6 down to 0.2	8.9	2
500kHz to 5MHz	0.6	0.2	4.5	1
5MHz to 30MHz	1	0.32	4.5	1

The installation topology has the greatest impact on conducted emission levels.

Installations with a dedicated supply transformer are technically second environment, but for installations such as, shopping centres, hospitals, airports, metro transit stations, universities etc., there are multiple tenants sharing the network. This quasi environment sits within the first and second environments and is sometimes referred to as a 'private supply network'. In such installations when a private low voltage network is characterised by its own supply transformer with multiple tenants (or users), the implementation of category C1 (moveable) and category C2 (fixed) EMC limits are normally implemented (not category C3).



Transformer A supplies the public 415Vac LV network – First Environment.

Transformer B supplies a private 415Vac LV network – considered First Environment.

Transformer C supplies a private 415vac LV industrial network – Second Environment.

Annexure D of AS 61800.3 provides guidelines and considerations of high frequency emissions.

“D.1.2.4 Categories C2 and C4 – In this case, the user has the technical competence to apply a correct EMC concept for the installation. The manufacturer should provide information about the emission category of the PDS.” (a)

The reason category C2 and C4 are grouped is because a skill is required for compliant installation. C2 in first environment and C4 in second environment.

Whilst Annexure D is mainly focused on the second environment, it does distinguish between conducted voltage disturbances and radiated disturbances. The following paragraph is in reference to a CDM ‘without a RFI filter’:

“D.1.1.2 conductive voltage disturbance – In most cases, this equipment is used without interference, but mitigation methods (for example HF filtering) have to be taken in the vicinity of a radio-receiver or of a sensitive apparatus, such as for very low-voltage measurements”. (a)

Conclusion

A CDM installed as per the manufacturer’s instructions and connected to a motor will ensure the PDS has category C2 conducted and radiated EMC compliance for the manufacturer’s stated shielded cable length.

Further to the above, all drives should conform to the requirements of the Australian Communications & Media Authority and display the Regulated Compliance mark (RCM). (b)

The RCM indicates compliance with the electrical safety, EMC, EME and telecommunication requirements as applicable to each product.

Notes:

- (a) AS 61800.3-2005 Adjustable speed electrical power drive systems
- (b) The RCM replaced the C-Tick and A-Tick compliance marks.

Main References:

- 1 AS 61800.3-2005 Adjustable speed electrical power drive systems
- 2 [ABB Technical Guide No.3 - 3AFE61348280 - Rev D.pdf](#)
- 3 [Siemens Industry Mall](#)
- 4 [Filtering out the noise understanding IEC 61800-3 \(Part 1\)](#)
- 5 [Filtering out the noise understanding IEC 61800-3 \(Part 2\)](#)

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