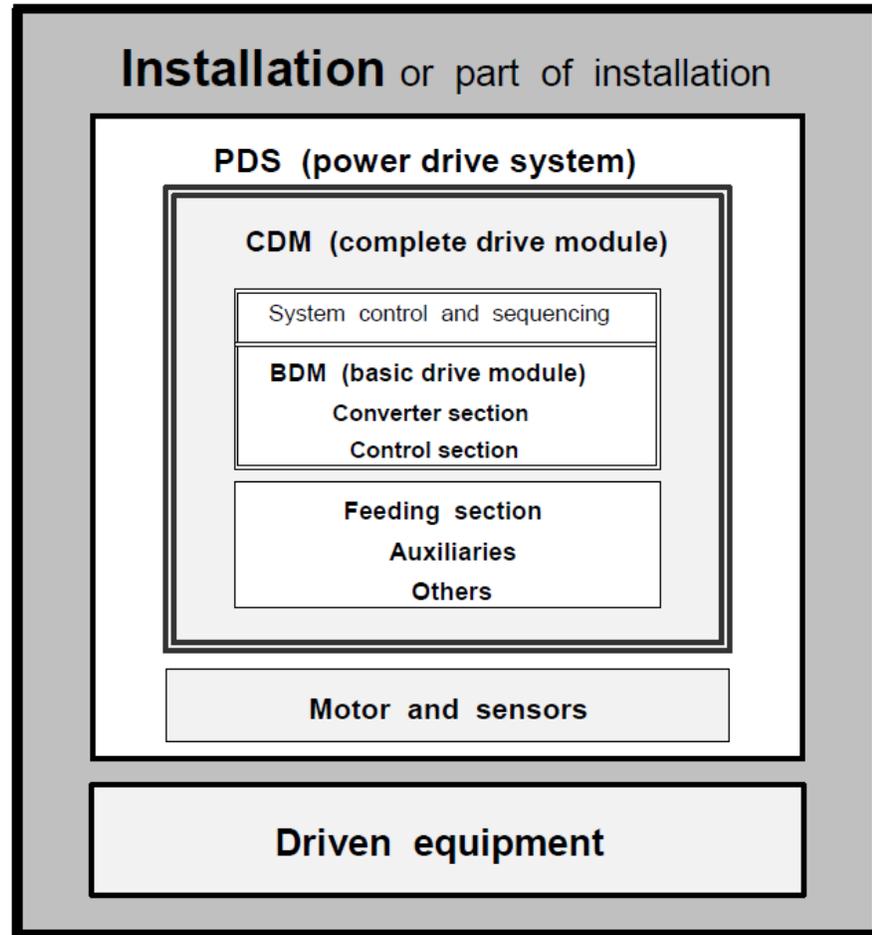


VFD (Variable Frequency Drive) Definitions



IEC 1197/07

- **Basic Drive Module (BDM)**

Drive module, consisting of a converter section and a **control section** for speed, torque, current or voltage, etc.

- **Complete Drive Module (CDM)**

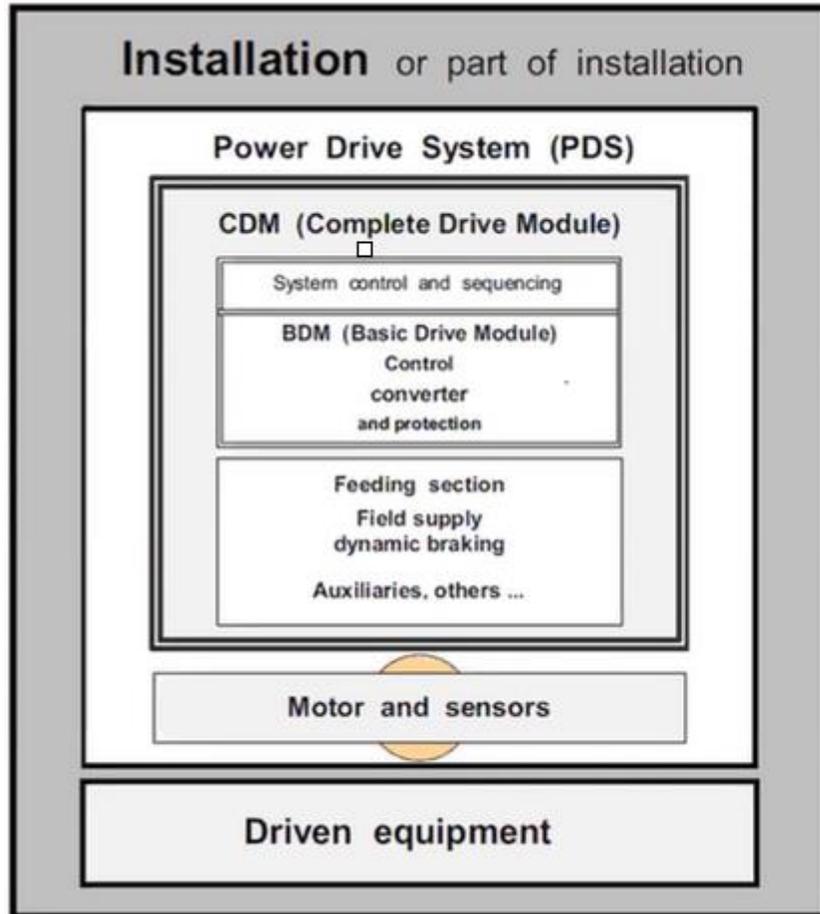
Drive system, without the motor and the sensors which are mechanically coupled to the motor shaft, consisting of, but not limited to, the **BDM**, and **extensions such as feeding section and auxiliaries**

- **Power Drive System (PDS)**

system for the speed control of an electric motor, including the CDM and motor but not the driven equipment

VFD (Variable Frequency Drive) Definitions

■ basic drive module_(BDM)

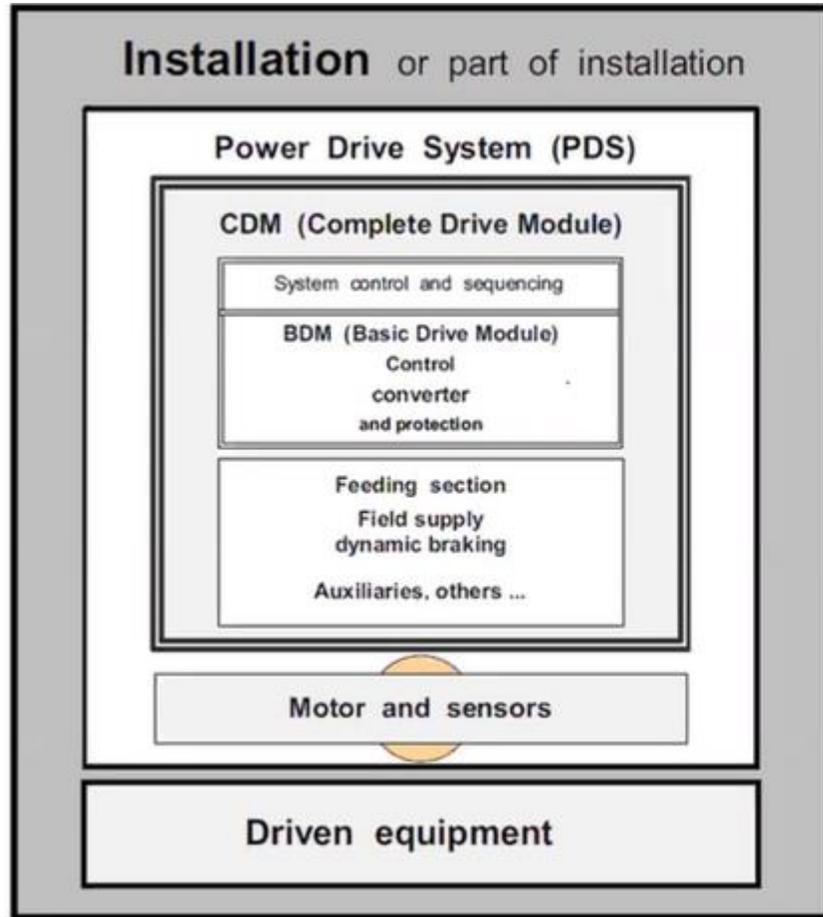


Basic Driver Module (BDM)
(Include Control, converter, protection)



VFD (Variable Frequency Drive) Definitions

■ complete drive module _(CDM)

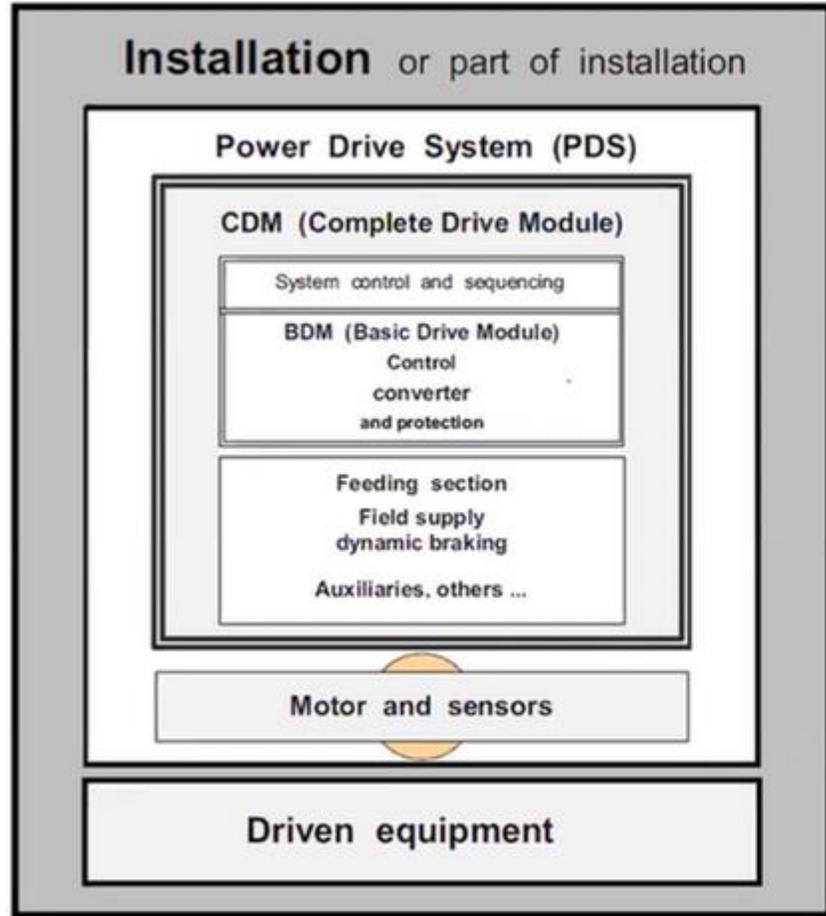


Complete Driver Module (CDM)
(the motor and the sensors which are mechanically coupled to the motor shaft are not included)



VFD (Variable Frequency Drive) Definitions

■ power drive system _(PDS)

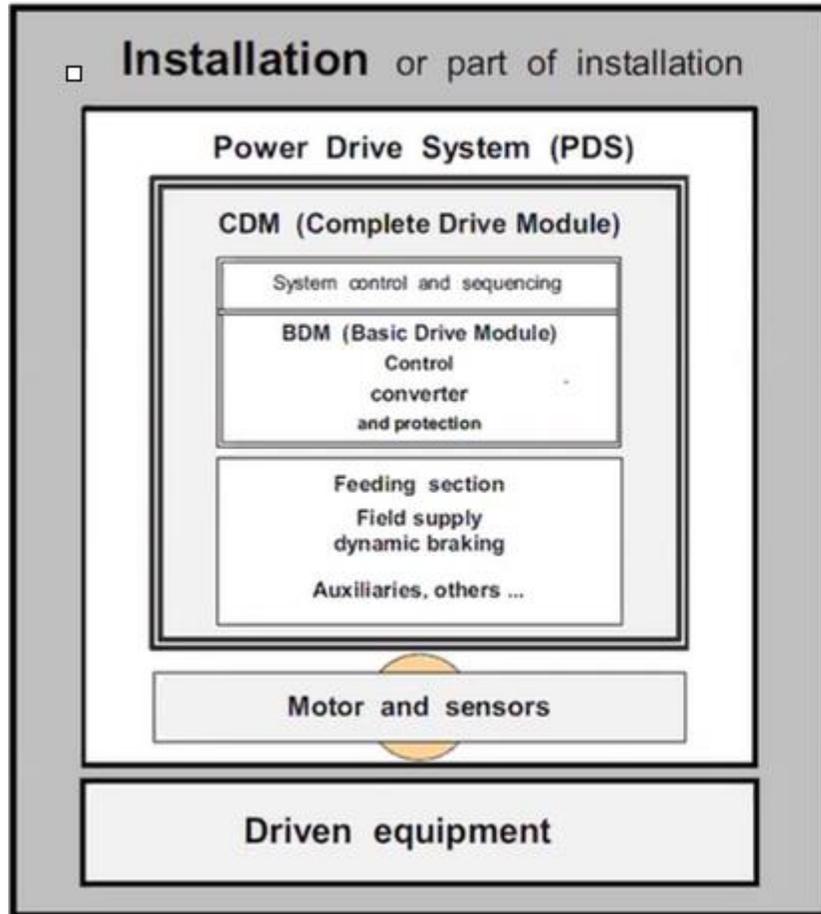


Power Driver System (PDS)
(Include CDM, motor, sensor)



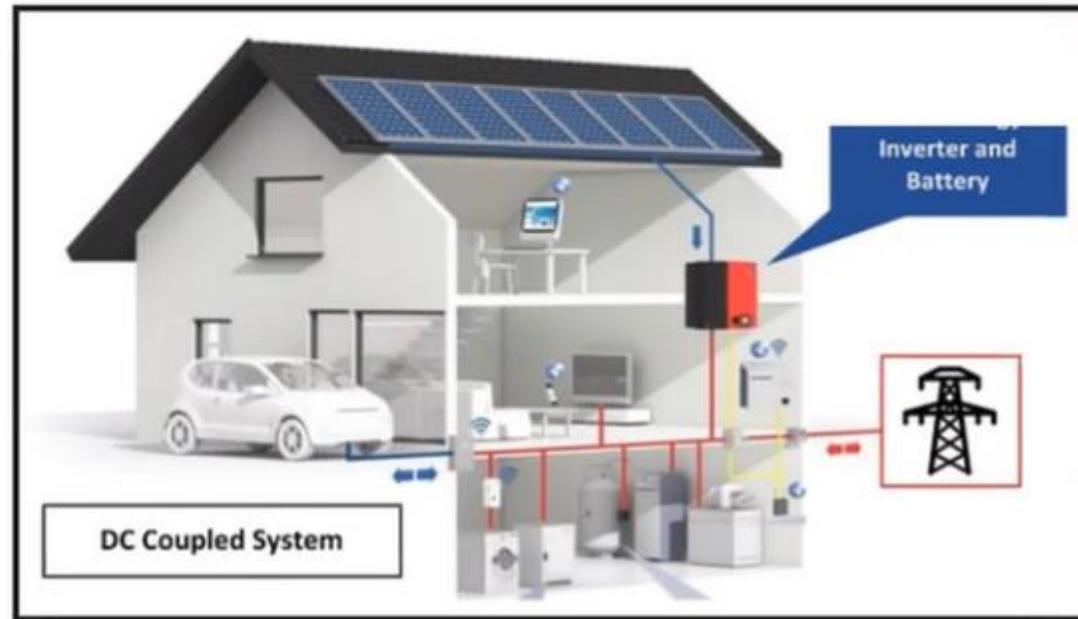
VFD (Variable Frequency Drive) Definitions

■ (Installation)



Installation

(Include PDS, CDM, motor, sensor, driven equipment)



EU Directive and Standard for VFD

- EU Directive

LVD: 2014/35/EU – EN61800-5-1:2007+A1:2017+A11:2021

EMI: 2014/30 EU – EN IEC 61800-3:2018

Energy efficiency COMMISSION REGULATION (EU) 2019/1781 – EN 61800-9-2:2017 (with Indicative motor)

- Standard

Standard	IEC	EN	DOP (date of Publication) DOW (date of Withdrawal)
Safety	IEC 61800-5-1:2007/A1:2016 IEC 61800-5-1:2022 (2022.08.31 publish)	EN 61800-5-1:2007+A1/2017+A11/2021	2021.8.5 2023.06.21
EMC	IEC 61800-3:2017	EN IEC 61800-3:2018	2019.4.9 2021.7.9
Energy efficiency	IEC 61800-9-2:2017	EN 61800-9-2:2017	2018.1.7 2020.4.7

VFD Safety Standard – IEC 61800-5-1

- IEC 61800-5-1 CB Testing laboratories (CBTLs)**

IEC 61800-5-1:2022	IEC 61800-5-1:2007/AMD1:2016	
No information declared	Bureau Veritas Consumer Product Services Germany GmbH	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch
	DEKRA Testing and Certification (Suzhou) Co.,Ltd.	TÜV SÜD Product Service GmbH Munich
	Intertek Semko AB	UL International Demko A/S
	SGS Fimko Ltd.	UL International Germany GmbH
	SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch	UL Solutions Melville
	TÜV Rheinland (Shenzhen) Co., Ltd.	VDE Prüf- und Zertifizierungsinstitut GmbH
	TÜV Rheinland Shanghai Co. Ltd	

No CBTLs can perform IEC 61800-5-1:2022 testing

VFD Safety Standard – IEC 61800-5-1

• Difference between EN 61800-5-1 and EN 62368 OVC III

Item	EN 61800-5-1	EN 62368-1	Compare EN61800-1 with EN 62368-1
For Input 300Vac			
Safety voltage	60Vdc (DVC-A)	60Vdc (ES1)	-
Primary – Secondary (Cr)	5.5 mm	5.5 mm	-
Primary – Secondary (CI)	5.5 mm	5.5 mm	-
Primary – Earth (Cr)	3.0 mm	3.0 mm	-
Primary – Earth (CI)	3.0 mm	3.0 mm	-
Hi Pot (Basic Insulation)	1500 Vac	4000 Vac	↓ (Looser)
Hi Pot (Double Insulation)	3000 Vac	6000 Vdc	
Impulse test (Basic Insulation)	4000 Vac	無	↓ (Looser)
Impulse test (Double Insulation)	6000 Vac		

VFD Safety Standard – IEC 61800-5-1

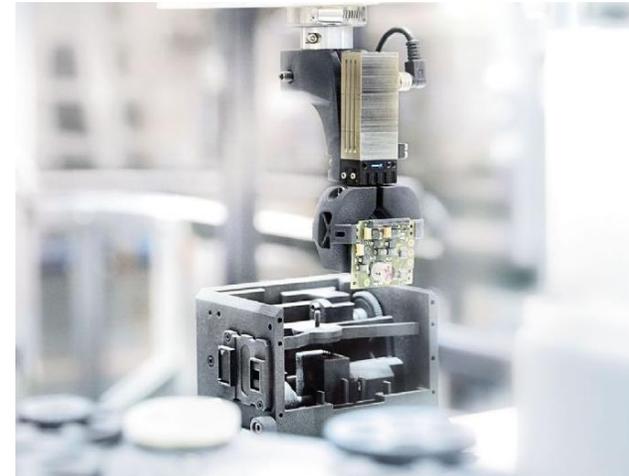
- Difference with EN 61800-5-1 and EN 62368-1**

Item	EN 61800-5-1	EN 62368-1	Compare EN61800-1 with EN 62368-1
Insulation tape	Min. 2 layers 1 layer meet Basic Insulation 2 layers meet Double Insulation	Min. 2 layers 1 layer meet Basic Insulation	↑ (Stricter)
Discharge test	Limit: 60V after 1 sec	Limit: Min. 60V after 2 sec	↑ (Stricter)
Touch current test	Limit: 3.5mA	Limit: 10mA	↑ (Stricter)
Earthing test	10A/2 mins	40A/2 mins	↓ (Looser)
Glow wire test	850°C	N/A	↑ (Stricter)
Test with electric load	Yes	Yes	-

VFD Energy efficiency Directive

COMMISSION REGULATION (EU) 2019/1781

- Dow: 2021/7/1
- Modification
 1. Induction electric motors (1000V ↓)
 2. Variable Speed Drives (VSD) Scope
 - (a). Within 120~1200W
 - (b). Rated Voltage 100-1000Vac
 - (c). 3 Phases input
 - (d). Only one AC voltage output
 - (e). Not apply to the motors for nuclear installations
 - (f). Not apply to the drives with sinusoidal input current



- Requirement

From 2021/7/1	Motor	Three phases 0.75KW-1000KW meet IE3 Three phases 0.12KW-0.75KW meet IE2
	VSD	Three phases 0.12KW-1000KW meet IE2
From 2023/7/1	Motor	Three phases 0.75KW-200KW meet IE4 Single phase 0.12KW-1000KW meet IE2

VFD Energy efficiency Standard – IEC/EN 61800-9-2

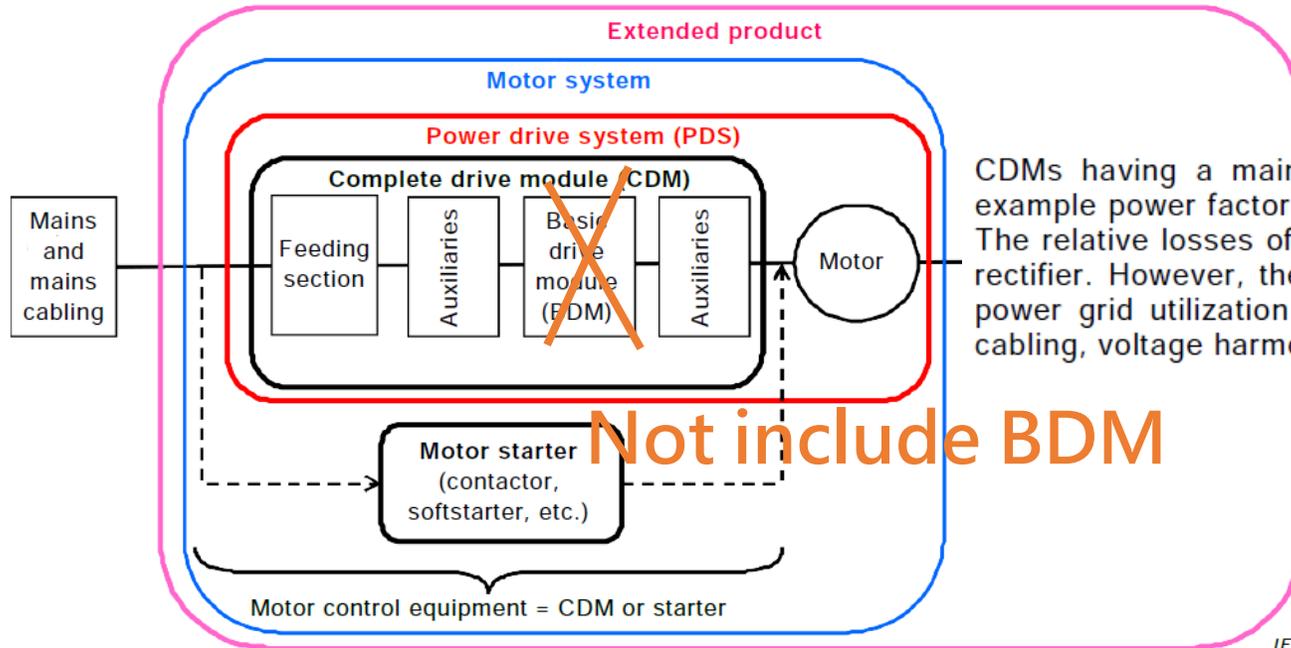
IEC/EN 61800-9-2 Scope

Energy efficiency indicators of power electronics

- Complete drive modules (CDM) and
- Power drive systems (PDS) and
- motor starters, all used for motor driven equipment

Not Mandatory

- 100V ↓
- 1000V ↑
- Servo PDS
- Other than single output
- Input current THD < 10%



CDMs having a mains current THD of 10 % or lower (according to IEC 61000-3-12), for example power factor correction (PFC) fed CDMs, can be excluded from the IE classification. The relative losses of an active rectifier are typically twice the losses of a CDM with a diode rectifier. However, the efficiency contribution of an active rectifier can be seen in improved power grid utilization and lower system level losses and disturbances (power transformer, cabling, voltage harmonics, flicker).

VFD EMI Standard – IEC 61800-3

■ Intended use

a) First environment: environment that includes residential premises and establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes

Note 1 to entry: Houses, apartments, commercial premises or offices in a residential building are examples of first environment locations.

VFD EMI Standard – IEC 61800-3

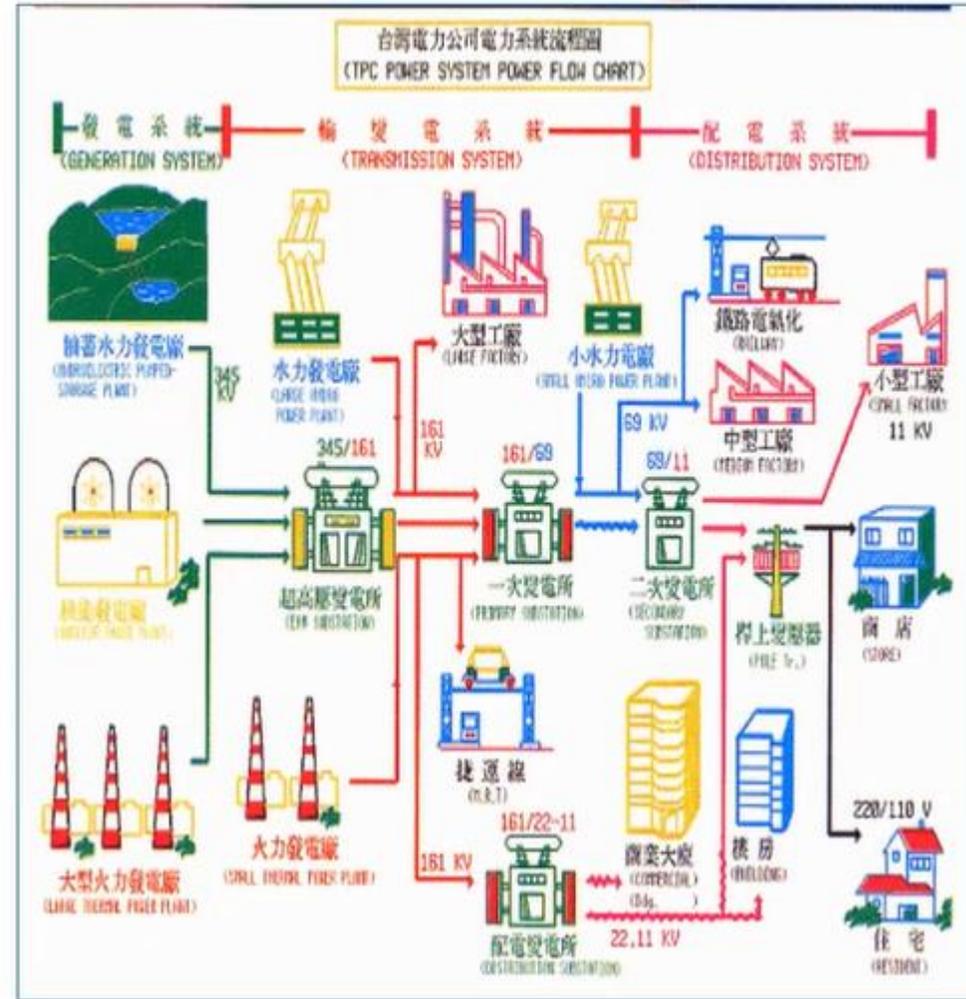
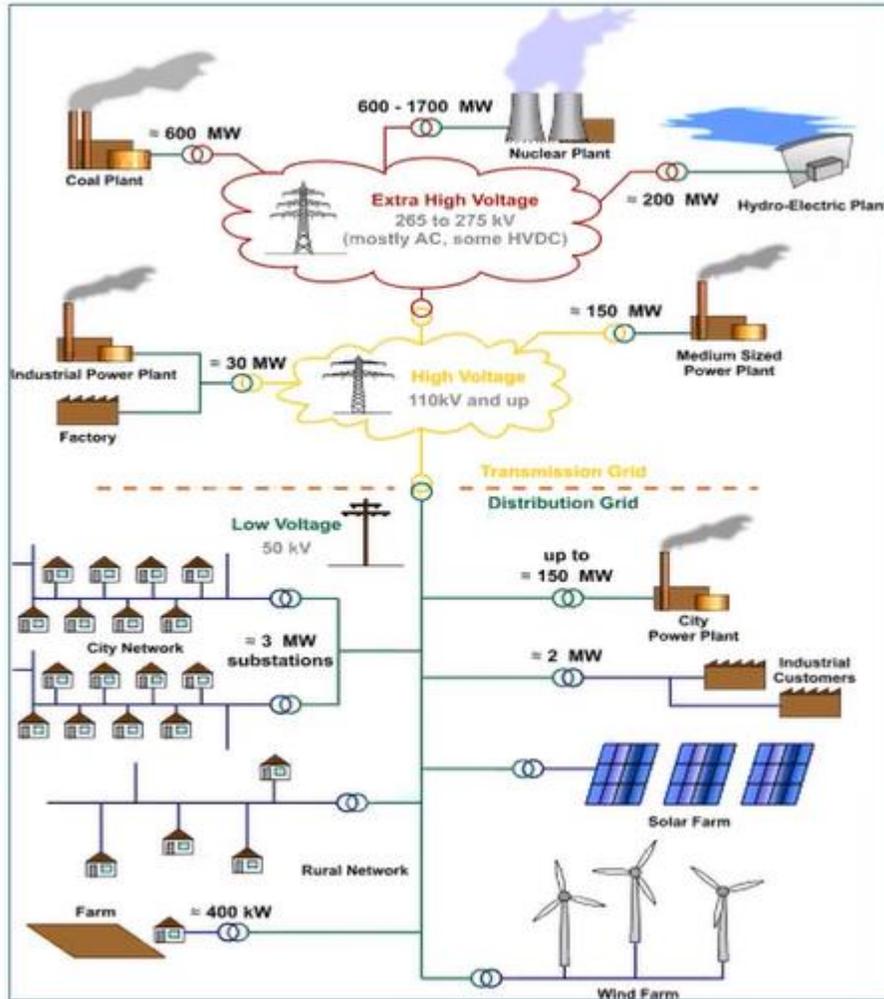
- Intended use

b) Second environment environment that includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for residential purposes

Note 1 to entry: Industrial areas or technical areas of any building fed from a dedicated transformer are examples of second environment locations.

VFD EMI Standard – IEC 61800-3

Example



VFD EMI Standard – IEC 61800-3

■ Intended use

PDS of category C1 :

PDS of rated voltage less than 1 000 V, intended for use in the first environment

PDS of category C2 :

PDS of rated voltage less than 1 000 V, which is neither a plug in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional

Note 1 to entry: A professional is a person or an organisation having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

VFD EMI Standard – IEC 61800-3

■ Intended use

PDS of category C3 :

PDS of rated voltage less than 1 000 V, intended for use in the second environment and not intended for use in the first environment

PDS of category C4 :

PDS of rated voltage equal to or above 1 000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment

VFD EMI Standard – IEC 61800-3

■ user manual

If special EMC measures are necessary to fulfil the required limits, these shall be clearly stated in the user documentation.

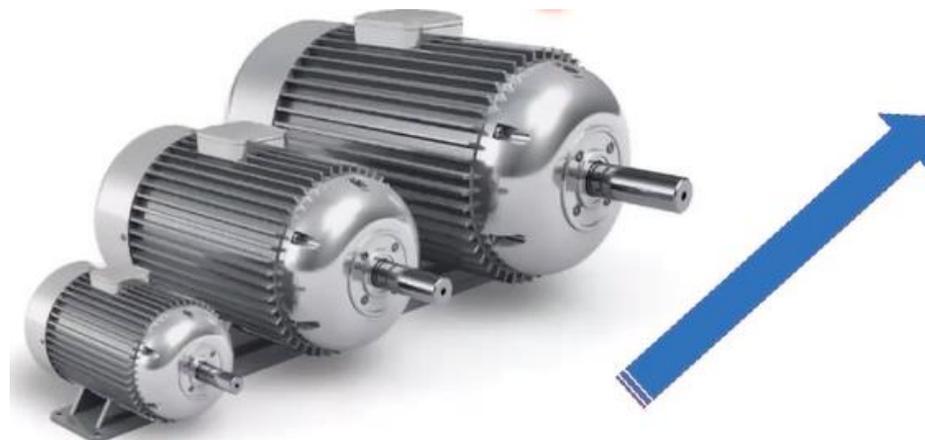
- maximum and minimum acceptable supply network impedance;
- the use of shielded or special cables (power and/or control);
- cable shield connection requirements;
- maximum permissible cable length;
- cable segregation;
- the use of external devices such as filters;
- the correct bonding to functional earth.

VFD EMI Standard – IEC 61800-3

■ operating mode

A selection of representative operation modes shall be made, taking into account that not all functions, but only the most typical functions of the electronic equipment can be tested. The estimated worst-case dv/dt operating modes for normal application shall be selected.

On the other hand, it is important to consider the effect of passive capacitive, resistive, or inductive power circuit components, such as snubber components that are used to control the rate of rise of this voltage. The output waveform with these devices present can have dv/dt characteristics that are load dependent. In this case, **it is important that the PDS be tested at the worst case dv/dt point of operation.**



VFD EMI Standard – IEC 61800-3

■ test items

- Conducted (in/output) , Radiated Emission
- Harmonics (EN 61000-3-2)
- Flicker (EN 61000-3-3)
- ESD (Electrostatic Discharge) EN 61000-4-2
- RS (Radiated Radio) EN 61000-4-3
- EFT/Burst (Electrical Fast Transient) EN 61000-4-4
- Surge (EN 61000-4-5)
- CS (Conducted Disturbances) EN 61000-4-6
- Voltage dips (EN 61000-4-11)
- Total Harmonic Distortion / Voltage Deviations / Frequency Variations
Frequency rate of change (IEC 61000-2-4)
- Harmonic Order (IEC 61000-4-13)
- Commutation notches test (IEC 60146-1-1)

VFD EMI Standard – IEC 61800-3

■ other test

(Signal interface) >3m , increase EFT/CS test

Signal interfaces	Fast transient-burst ^e	IEC 61000-4-4	1 kV/5 kHz Capacitive clamp	B
	Conducted radio-frequency common mode ^e	IEC 61000-4-6 see also 5.3.4	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A

(Auxiliary DC power ports below 60 V) >3m , increase EFT/CS test ;
>30m increase Surge test

Ports for process measurement control lines Auxiliary DC power ports below 60 V	Fast transient-burst ^e	IEC 61000-4-4	2 kV/5 kHz Capacitive clamp	B
	Surge ^f 1,2/50 μs, 8/20 μs	IEC 61000-4-5	1 kV ^{d,f}	B
	Conducted radio-frequency common mode ^e	IEC 61000-4-6 see also 5.3.4	0,15 MHz to 80 MHz 10 V 80 % AM (1 kHz)	A

VFD EMI Standard – IEC 61800-3

■ conduction limit

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)
$0,15 \leq f < 0,50$	66 Decreases with log of frequency down to 56	56 Decreases with log of frequency down to 46	79	66
$0,5 \leq f \leq 5,0$	56	46	73	60
$5,0 < f < 30,0$	60	50	73	60

Where a PDS does not comply with the limits of category C1, the following warning shall be included in the instructions for use:

Warning

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.

VFD EMI Standard – IEC 61800-3

■ radiation limit

Frequency band MHz	Electric field strength component Quasi-peak dB(μ V/m)			
	Measurement distance 10 m ^a		Measurement distance 3 m ^a	
	Category C1	Category C2	Category C1	Category C2
$30 \leq f \leq 230$	30	40	40	50
$230 < f \leq 1\ 000$	37	47	47	57

^a For selection of measurement distance, see 6.3.1.3.3.

Where a PDS does not comply with the limits of category C1, the following warning shall be included in the instructions for use:

Warning

In a residential environment, this product may cause radio interference, in which case supplementary mitigation measures may be required.