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Identification of converter type from total harmonic current distortion and dominant harmonic order data

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Introduction

This document is intended to illustrate to the Network Operator how to identify a converter type from published data – such as EMC Test Report data – for an assessment against Stages 1C, 1D, 2A or 2B of EREC G5 Issue 5.

1 Characteristic harmonic current distortion

Table 1 in this document (below) gives typical total harmonic current distortion (THD_I) values for the three common three-phase converter types. The dominant and characteristic harmonic currents are also stated.

Table 1 — Harmonic current distortion characteristics for three converter types

Converter type	Typical THD_I	Characteristic harmonic currents	Dominant harmonic orders
Three-phase six-pulse converter	~30%	5th and 7th, 11th and 13th, 17th and 19th… (6*k*±1), where *k* equates to the number of pulses of the converter.	5th then 7th
Three-phase active-front-end converter	~3–4%	5th and 7th, 11th and 13th, plus components related to pulse-width modulation switching frequency	Varies; highest value may be lower order odd harmonics but higher orders may also be significant/comparable
Three-phase twelve-pulse converter	~6–18%[1]	11th and 13th, 23rd and 25th, 35th and 37th... (12*k*±1), where *k* equates to the number of pulses of the converter.	11th then 13th

2 Using EMC Test Report data to find converter type

An extract from an EMC Test Report for one phase of an item of three-phase equipment is shown in Figure 1 in this document (below). The THD_I value for maximum RMS current is given as 30.99% (see ‘a’ in Figure 1) and the highest harmonic orders are, from column 2, the 5th and 7th harmonics (see ‘b’ in Figure 1). Consequently, with reference to Table 1 in this document, we conclude that this is a six-pulse converter.

[1] Varies with operating condition.

a

Maximum RMS current and corresponding values in timewindow 174:

Voltage:	230.03 Vrms	THD=0.36 %	THV=0.823 V	POHV=0.413 V	PWHD=1.10 %
Current:	74.693 Arms	THD=30.99 %	THC=22.097 A	POHC=5.533 A	PWHD=51.59 %
Power:	16385.8 W	P1=16396.1 W 17181.2 VA		THC/Iref=32.50%	
Power factor:	0.954	CosPhi1: 1.000		PWHC/Iref=54.09%	

Test conditions:EN 61000-3-12:2011, f=50 Hz, Phase=L1, Range=80.00 A
Time window=10/12 (200ms), Grouping (>2nd harm.)=on, Iequ=68 A, Rated Rsce=350
No Ztest selected, Inserted reactor impedance: --
harmonic currents < 1 % of Iref are disregard for calc. of THD, THC, POHC, PWHD, PWHC

HARMONIC ANALYSIS: Test PASS

Tobs = worst 2.5 min: tw 1..750; Avg: THC/Iref=28.0 %, PWHC/Iref=45.8 % (Limits: THC/Iref=47.0 %, PWHC/Iref=47.0 %); Iavg=63.082 Arms ; Iequ exceeded, Iref is set to Iequ (user's choice)

b

Ha	Entire measurement (2.5 min = 750 time windows)						Worst 2.5 min		Worst 2.5 min avg		PASS	FAIL
	Maximum	Window	EN61000-3-12 No balanced 3phin	Margin MaxWin	100 to 150%	Ex-ceeded	100 to 150%	Ex-ceeded	Value	Ex-ceeded		
DC	0.3042 A	232	-.- - - -	- - - .-	0	0	0	0	0.2614 A	0	X	
1	71.2970 A	174	-.- - - -	- - - .-	0	0	0	0	60.0958 A	0	X	
2	0.1373 A	195	5.4400 A	-97.5 %	0	0	0	0	0.0517 A	0	X	
3	0.4156 A	190	27.8800 A	-98.5 %	0	0	0	0	0.4038 A	0	X	
4	0.0363 A	194	2.7200 A	-98.7 %	0	0	0	0	0.0157 A	0	X	
5	16.3094 A	174	16.3200 A	-0.1 %	0	0	0	0	14.1277 A	0	X	
6	0.0409 A	194	1.8133 A	-97.7 %	0	0	0	0	0.0146 A	0	X	
7	9.9809 A	174	10.2000 A	-2.1 %	0	0	0	0	8.6685 A	0	X	
8	0.0295 A	190	1.3600 A	-97.8 %	0	0	0	0	0.0164 A	0	X	
9	0.0420 A	197	8.1600 A	-99.5 %	0	0	0	0	0.0387 A	0	X	
10	0.0246 A	192	1.0880 A	-97.7 %	0	0	0	0	0.0142 A	0	X	
11	6.2854 A	174	6.8000 A	-7.6 %	0	0	0	0	5.2796 A	0	X	
12	0.0224 A	192	0.9067 A	-97.5 %	0	0	0	0	0.0094 A	0	X	
13	5.0154 A	174	5.4400 A	-7.8 %	0	0	0	0	4.2435 A	0	X	
14	0.0227 A	190	-.- - - -	- - - .-	0	0	0	0	0.0155 A	0	X	
15	0.0488 A	188	-.- - - -	- - - .-	0	0	0	0	0.0403 A	0	X	
16	0.0212 A	192	-.- - - -	- - - .-	0	0	0	0	0.0138 A	0	X	
17	3.9476 A	184	-.- - - -	- - - .-	0	0	0	0	3.3274 A	0	X	
18	0.0151 A	195	-.- - - -	- - - .-	0	0	0	0	0.0077 A	0	X	
19	3.4343 A	174	-.- - - -	- - - .-	0	0	0	0	2.8964 A	0	X	
20	0.0203 A	190	-.- - - -	- - - .-	0	0	0	0	0.0151 A	0	X	
21	0.0481 A	128	-.- - - -	- - - .-	0	0	0	0	0.0404 A	0	X	
22	0.0180 A	192	-.- - - -	- - - .-	0	0	0	0	0.0133 A	0	X	
23	2.8637 A	187	-.- - - -	- - - .-	0	0	0	0	2.4202 A	0	X	
24	0.0117 A	194	-.- - - -	- - - .-	0	0	0	0	0.0072 A	0	X	
25	2.6070 A	174	-.- - - -	- - - .-	0	0	0	0	2.2034 A	0	X	
26	0.0197 A	190	-.- - - -	- - - .-	0	0	0	0	0.0155 A	0	X	
27	0.0510 A	130	-.- - - -	- - - .-	0	0	0	0	0.0430 A	0	X	
28	0.0170 A	190	-.- - - -	- - - .-	0	0	0	0	0.0130 A	0	X	
29	2.2356 A	184	-.- - - -	- - - .-	0	0	0	0	1.8971 A	0	X	
30	0.0111 A	192	-.- - - -	- - - .-	0	0	0	0	0.0071 A	0	X	
31	2.0867 A	174	-.- - - -	- - - .-	0	0	0	0	1.7703 A	0	X	
32	0.0197 A	190	-.- - - -	- - - .-	0	0	0	0	0.0157 A	0	X	
33	0.0481 A	131	-.- - - -	- - - .-	0	0	0	0	0.0406 A	0	X	
34	0.0175 A	190	-.- - - -	- - - .-	0	0	0	0	0.0129 A	0	X	
35	1.8138 A	174	-.- - - -	- - - .-	0	0	0	0	1.5463 A	0	X	
36	0.0104 A	197	-.- - - -	- - - .-	0	0	0	0	0.0067 A	0	X	
37	1.7267 A	174	-.- - - -	- - - .-	0	0	0	0	1.4732 A	0	X	
38	0.0198 A	190	-.- - - -	- - - .-	0	0	0	0	0.0158 A	0	X	
39	0.0502 A	126	-.- - - -	- - - .-	0	0	0	0	0.0430 A	0	X	
40	0.0164 A	190	-.- - - -	- - - .-	0	0	0	0	0.0124 A	0	X	

average value < 1.0 % of Iref

Figure 1 — Annotated EMC Test Report