WESTERN POWER DISTRIBUTION

Serving the Midlands, South West and Wales

Company Directive

STANDARD TECHNIQUE : SD6J

Connection design - potentially disturbing electrical equipment rated ≤75A/phase subject to conditional connection

Policy Summary

This Standard Technique defines how the connection of potentially disturbing equipment rated ≤75A/phase shall be designed in order to control voltage fluctuations, flicker & harmonic voltage distortion. This only applies to customers with an LV Point of Common Coupling.

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Implementation Date: November 2012

Approved by

Policy Manager

Date: 5 December 2012

1.0 INTRODUCTION

1.1 This Standard Technique (ST) defines the design procedure required for the connection of potentially disturbing equipment to the WPD network where the equipment is rated ≤75A/phase. This is necessary to control voltage fluctuations, flicker & harmonic voltage distortion.

1.2 This ST implements connection requirements for ENA Engineering Recommendation P28 and G5/4-1, updated for the present Electromagnetic Compatibility standards.

2.0 SCOPE

2.1 This ST covers WPD connection design for LV installations with LV equipment rated ≤75A per phase, where there is an LV Point of Common Coupling[1] (PCC).

2.2 Sizing the connection and network for the maximum demand is not within the scope of this ST – see ST:SD5A and ST:SD5K/3.

2.3 Motors and welders not within the scope of the standards BS EN 61000-3-3, 61000-3-11, 61000-3-2 and 61000-3-12 are treated as per ST:SD6F and ST:SD5N.

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[1] The point on a network electrically nearest to a customer's installation at which other customers' loads/generators are, or may be, connected.

3.0 POLICY

3.1 Connection Design for Disturbing Electrical Equipment Rated ≤75A per Phase With LV PCC

3.1.1 It is generally acceptable for customers to install small electrical equipment without specific evaluation of disturbance emission by the Distribution Network Operator (DNO). Equipment rated at ≤16A per phase which complies with BS EN 61000-3-3 and BS EN 61000-3-2 is not subject to conditional connection and so is exempt from connection design as potentially disturbing equipment.

3.1.2 Equipment that is rated ≤75A per phase shall be subject to conditional connection to control disturbances, unless it complies with the technical requirements of BS EN 61000-3-3 and BS EN 61000-3-2 or is not deemed significant by WPD. Table 1 provides guidance on what equipment is considered significant by WPD.

Equipment Type/ Families of Products	**Assessment Type**	
	Voltage Fluctuations & Flicker Control Procedure (Figure 1)	**Harmonic Control Procedure (Figure 2)**
Electric boilers for central heating	✓	✓[2]
Heat pumps, air conditioners and commercial refrigeration equipment	✓	✓
Uninterruptible power supplies, electric vehicle charging systems & industrial battery charging systems	✓	✓
Electric kilns	✓	✓[2]
Industrial/commercial converters (i.e. rectifiers, AC-DC converters [including adjustable speed power drives] & AC-AC converters)	✓	✓
Agricultural lighting control & industrial heating control	✓	✓
PV generators		✓
Wind turbines	✓	✓
Generation export limiting device[3]	✓	✓
Arc welders within scope of BS EN 61000-3-2, -3, -11 & -12 (e.g. non-professional)	✓	✓
Other equipment with stated Z_{max} to 61000-3-11 if known (e.g. electric shower)	✓	
Other equipment with stated S_{sc} to 61000-3-12 if known		✓

Table 1 - Significant Equipment Rated ≤75A Per Phase Requiring Assessment If LV PCC

NOTE: The Distribution Code DPC 5.2.1 states:

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[2] The Harmonic Control Procedure is not required if it is established that the resistive heating elements are simply switched in/out via thermostat/contactor (i.e. the load is linear) as opposed to through power electronics such as AC regulator (e.g. thyristor).
[3] An example is the Coolpower EMMA GVS.

“Users shall contact the DNO in advance if it is proposed to make any significant change to the connection, electric lines or electrical equipment, install or operate any generating equipment or do anything else that could affect the DNO’s Distribution System or require alterations to the connection.”

NOTE: The National Terms for Connection states:

"You must contact us in advance if you propose to make any significant change to the connection or to the electric lines or electrical equipment at the premises, or if you propose to do anything else that could affect our network or if you require alterations to the connection."

NOTE: BS 7671 (The Wiring Regulations) states:

"132.16 Additions and alterations to an installation

No addition or alteration, temporary or permanent, shall be made to an existing installation, unless it has been ascertained that the rating and the condition of any existing equipment, including that of the distributor, will be adequate for the altered circumstances."

NOTE: Products placed on the market have to comply with the protection requirements of the EMC Directive; in practice this means complying with the ‘harmonised’ standards published in the Official Journal of the European Union. Standards EN 61000-3-2, -3, -11 and -12 are published in that Journal as Product Family Standards and so apply to all equipment intended for connection to the public LV network within their scope.

3.1.3 Applications to connect equipment of the type listed in Table 1, where the PCC is at LV, shall be assessed using design procedures given in Figures 1 and 2, as appropriate.

3.1.4 Voltage Fluctuations & Flicker Control Procedure

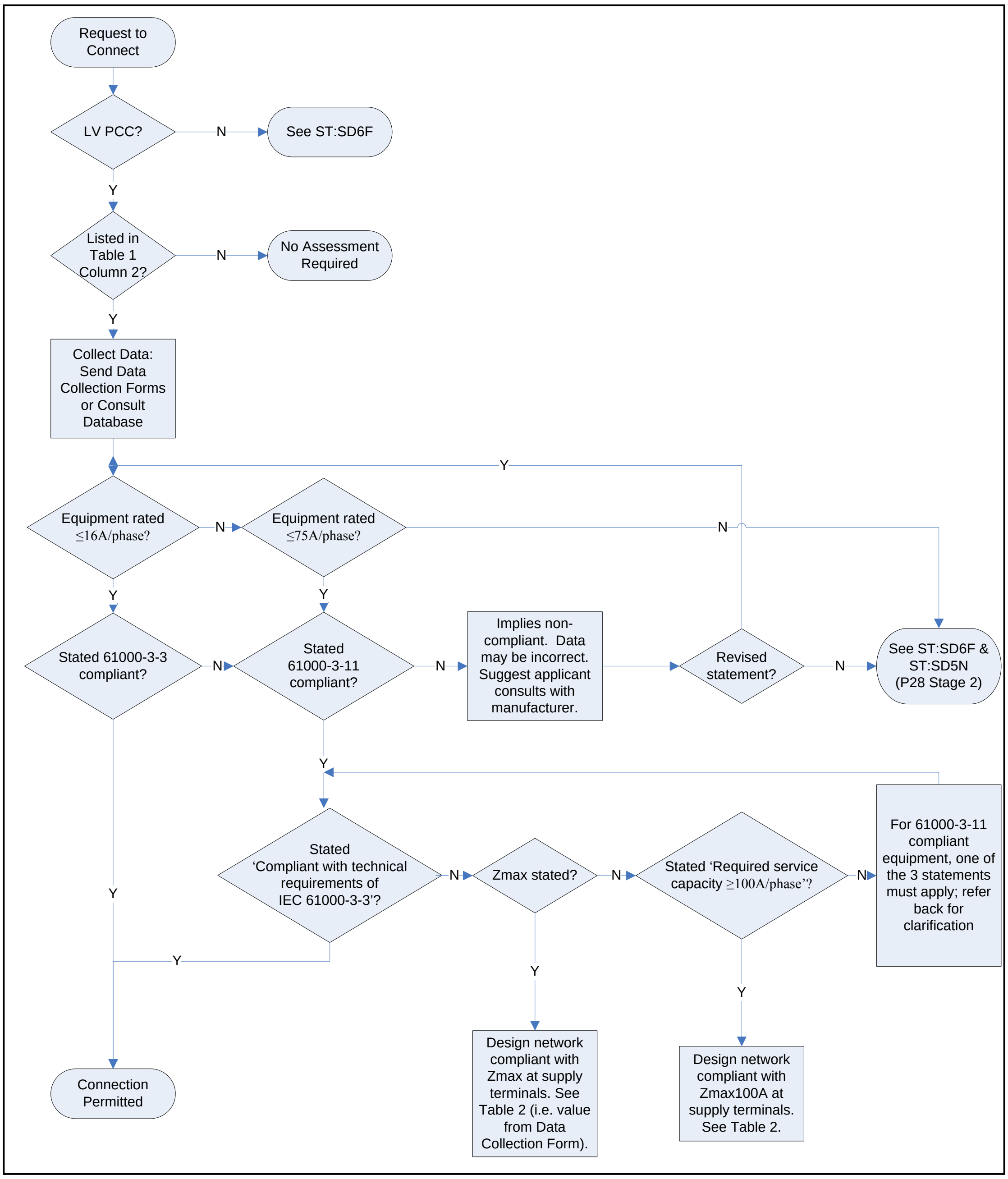


Figure 1 – Flow Chart – Procedure for Connection Design – Voltage Fluctuation/Flicker Control

NOTE: The same process applies whether the connection application concerns single or multiple customer connections on a given LV network. For multiple connections with identical equipment only the connection with the highest source impedance need be considered.

NOTE: For a given system of equipment comprising multiple integrated parts, the manufacturer should only make a single statement to cover the whole integrated system. For example, a heat pump system may comprise an indoor unit and an outdoor unit that together make up a heat pump system. Similarly, some electrical boiler systems are modular with multiple modules making up the overall boiler system. It is not acceptable to consider each system element separately as this does not necessarily control flicker and voltage fluctuations adequately.

NOTE: See Appendix A for Data Collection Forms.

NOTE: 'Consult Database' refers to a possible MCS\Gemserve database.

NOTE: Z_{max} = Maximum permissible source impedance declared by the manufacturer in accordance with BS EN 61000-3-11 clause 4(a).

NOTE: $Z_{max\ 100A}$ = Source impedance defined in BS EN 61000-3-11 clause 6.3 associated with the statement that the equipment is intended for use only in premises having a service current capacity ≥100A per phase as per BS EN 61000-3-11 clause 4(b).

3.1.4.1 Table 2 details the maximum source impedance for each type of connection for the two terms, Z_{max} and $Z_{max\ 100A}$. The relevant source impedance corresponds to how the equipment is connected. For example, phase-neutral connected equipment requires phase-neutral source impedance whereas 3-phase connected equipment requires the 3-phase source impedance, also known as line impedance, which omits the neutral impedance.

Equipment Connection	**Maximum source impedance**	
	Z_{max}	**$Z_{max\ 100A}$**
Phase-Neutral	As specified on Data Collection Form or in Database	0.25+j0.25 Ω = 0.3536 Ω
Phase-Phase		0.30+j0.30 Ω = 0.4243 Ω
3-Phase		0.15+j0.15 Ω = 0.2121 Ω

Table 2 – Maximum source impedance Z_{max} and $Z_{max\ 100A}$

3.1.4.2 Appendix B details how to derive the actual source impedance for a given network and given equipment connection.

3.1.4.3 Worked examples are provided in Appendix E to illustrate the design procedure.

3.1.5 Harmonic Control Procedure

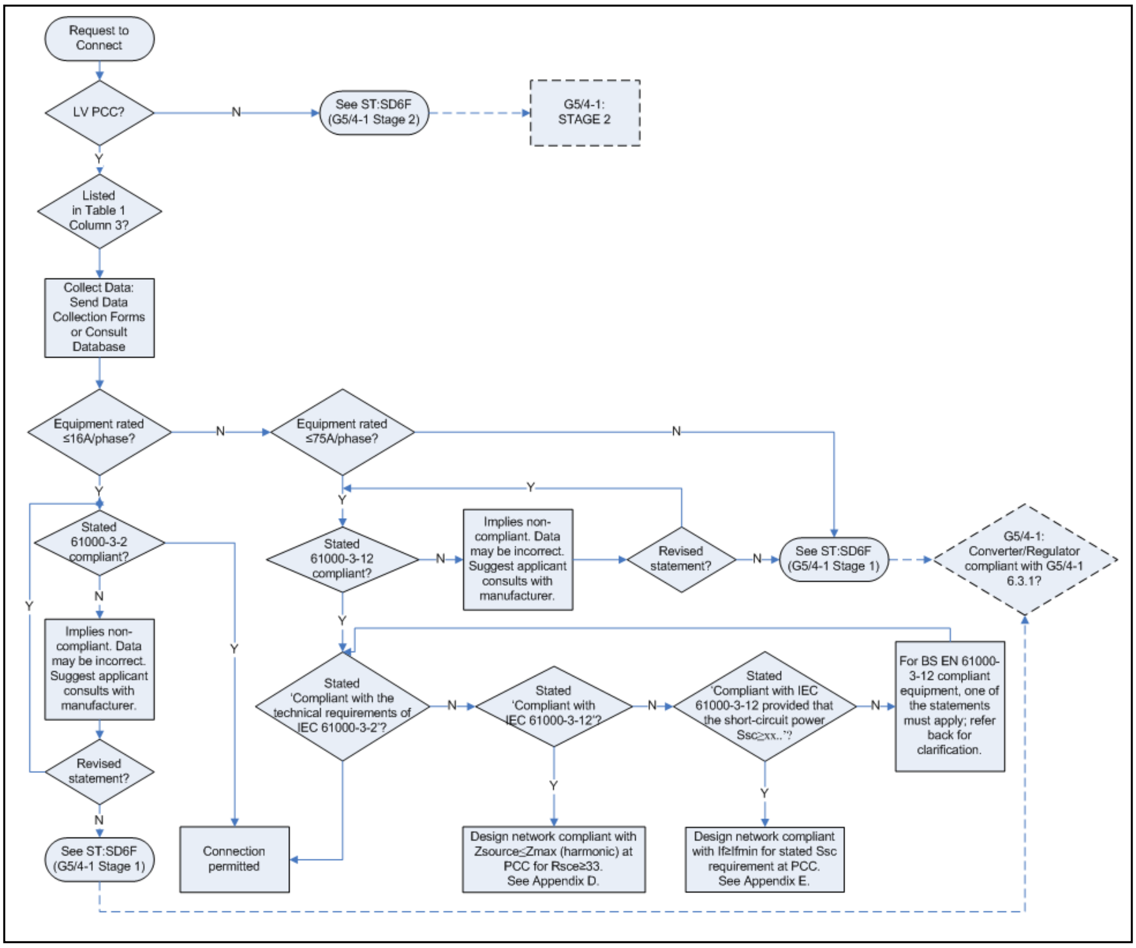


Figure 2 – Flow Chart – Procedure for Connection Design – Harmonic Distortion Control

NOTE: The same process applies whether the connection application concerns single or multiple customer connections on a given LV network. For multiple connections with identical equipment only the one with the lowest fault level at the PCC need be considered.

NOTE: In accordance with BS EN 61000-3-12, when individual self-contained items of equipment (possibly, but not necessarily, of different manufacture) are assembled in a rack or case compliance with the standard shall be achieved either for the system as a whole or for each individual self-contained item at the manufacturer's discretion. For a given system of equipment comprising multiple integrated parts, only one statement should be made to cover the whole system. For example, a heat pump system may comprise an indoor unit and an outdoor unit that together make up a heat pump system. Similarly, some PV inverter systems are modular with multiple micro-inverter modules making up the overall PV system. It is not acceptable to consider each system element separately as this does not necessarily control harmonic emissions adequately.

NOTE: Appendix A gives the Data Collection Forms.

NOTE: 'Consult Database' refers to a possible Microgeneration Certification Scheme or other database.

NOTE: Z_{source} = source impedance at the PCC.

NOTE: $Z_{max\ (harmonic)}$ = maximum source impedance at the PCC corresponding to R_{SCE} = 33 for the given equipment connection. See Table D1.

NOTE: I_f = actual fault current at PCC applicable. Whether this is the single-phase, phase-phase or 3-phase value depends on the equipment connection. See Appendices C and E.

NOTE: I_{fmin} = fault current corresponding to R_{sce} = 33 or S_{sc} as appropriate. Whether this is the single-phase, phase-phase or 3-phase value depends on the equipment connection. See Appendix C and E.

NOTE: R_{sce} is a short-circuit ratio at the PCC as defined in BS EN 61000-3-12. It is a proportional to the ratio of the 3-phase short-circuit fault level at the PCC to the rated apparent power of the equipment. See Appendix C.

NOTE: S_{sc} is the 3-phase short-circuit fault level at the PCC.

3.1.5.1 Appendix D provides minimum fault level and corresponding maximum source impedance for R_{sce} = 33 by equipment rating; this is used to derive $Z_{max\ (harmonic)}$ simply. Appendix E details how to determine whether $Z_{source} \leq Z_{max\ (harmonic)}$ and $I_f \geq I_{fmin}$..

3.1.5.2 Where design for $Z_{source} \leq Z_{max\ (harmonic)}$ or $I_f \geq I_{fmin}$ is the limiting factor in sizing the network, it may be possible to produce a lower cost scheme if the customer provides the actual current emissions and a detailed G5/4-1 Table 7 assessment is conducted with the permitted currents in Table 7, scaled for fault level.

4.0 LIST OF APPENDICES

Appendix	Title
A	Data Collection Forms
B	Use Of Simple WinDebut Model To Derive Actual Source Impedance
C	Formulae For S_{equ}, S_{sc}, R_{sce}, I_{fmin} & I_f
D	Minimum Fault Level/Maximum Source Impedance For R_{sce}=33
E	Worked Examples
F	Example Phase-Neutral Source Impedance
G	Background
H	Superseded Documentation
I	Associated Documentation
J	Implementation of Policy
K	Impact on Company Policy
L	Key Words
M	Document Review

APPENDIX A

DATA COLLECTION FORMS

\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMC.DOC
\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMD.DOC
\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMX.DOC

\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMJ1.DOC
\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMJ2.DOC
\\AVODCS01\DMS\MA\SD\SD006\SD006J\FORMJ3.DOC
S:\MA\SD\SD006\SD006J\FLOWCHART.DOC

Main forms:

Form X	Equipment Rated ≤75A/phase (excluding heat pumps)
Form J Set (ENA Form J1, J2 & J3 Set & Explanatory Flow Chart)	Heat Pump Systems

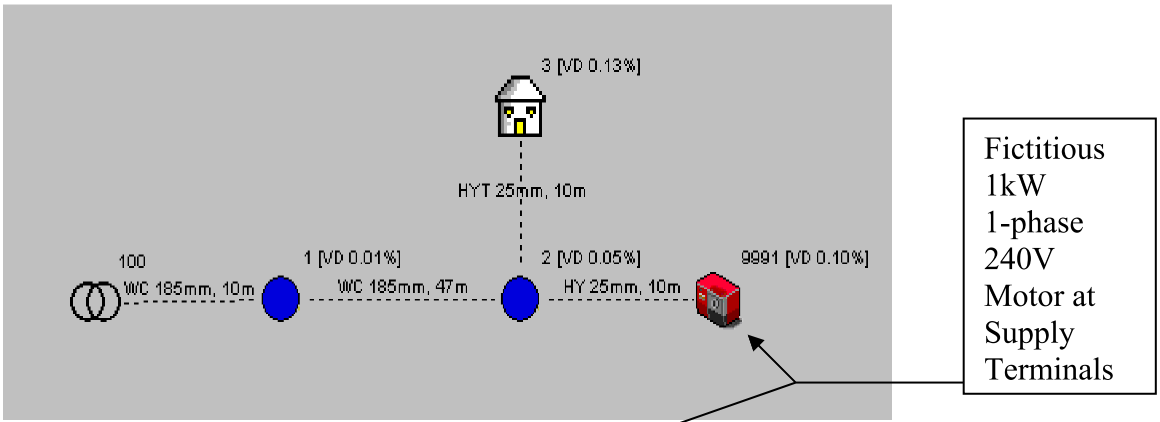
Related Forms:

Form C	Harmonics (>75A/phase or non-compliant with BS EN 61000-3-12/-2)
Form D	Flicker (>75A/phase or non-compliant with BS EN 61000-3-11/-3)

APPENDIX B

USE OF SIMPLE WINDEBUT MODEL TO DERIVE ACTUAL SOURCE IMPEDANCE

Single-phase Equipment



MOTOR DETAILS
Motor Voltage: 1 Phase 240V motor
LV Network Type: 3 phase 4 wire network
Rating: 1 Kilowatts
Type of Starter: Direct on line
Starting Current: 38.1 A
Starting PF: 0.3 pu
Number of Starts: 1 Per Hour
P28 Voltage Disturbance Limit @ PCC: 3.00%

Steady State: Pass

CALCULATED VOLTAGE DISTURBANCE (P28)
P28 Voltage Drop @ Node 100 (Primary): 0.04%
P28 Voltage Drop @ Node 100 (Secondary): 1.44% - PASS
P28 Voltage Drop @ Node 1: 1.48% - PASS
P28 Voltage Drop @ Node 2: 1.63% - PASS
P28 Voltage Drop @ Node 9991: 1.75% - PASS

TOTAL VOLTAGE DROP DURING STARTING
Node 9991: 0.06 + 1.75% - VALUE DOES NOT EXCEED 9% - PASS

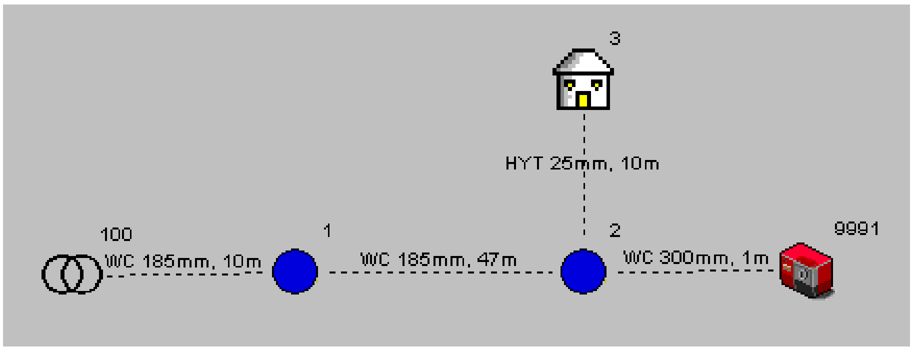
NODE 9991 CHARACTERISTICS
PSSC (Ph-n): 2.07 KA
PME Ze: 0.12 Ohms (0.07980 + j 0.08809 Ohms)
Source Impedance: 0.08011 + j 0.09058 Ohms

Figure B1 - Dummy 1-Phase Motor and Simplified Network - Impedance at the supply terminals

A fictitious single-phase motor is used to derive the phase-neutral impedance at the supply terminals.

The phase-neutral source impedance of the network at the supply terminals, $Z_{source\ 1\text{-}ph\ supply\ terminals}$ is given by

$$Z_{source\ 1\text{-}ph\ supply\ terminals} = \sqrt{(R_{source\ 1\text{-}ph\ supply\ terminals}^2 + X_{source\ 1\text{-}ph\ supply\ terminals}^2)} = \sqrt{(0.08011^2 + 0.09058^2)} = 0.1209\Omega$$



MOTOR DETAILS
Motor Voltage: 1 Phase 240V motor
LV Network Type: 3 phase 4 wire network
Rating: 1 Kilowatts
Type of Starter: Direct on line
Starting Current: 38.1 A
Starting PF: 0.3 pu
Number of Starts: 1 Per: Hour
P28 Voltage Disturbance Limit @ PCC: 3.00%

Steady State: Pass

CALCULATED VOLTAGE DISTURBANCE (P28)
P28 Voltage Drop @ Node 100 (Primary): 0.04%
P28 Voltage Drop @ Node 100 (Secondary): 1.44% - PASS
P28 Voltage Drop @ Node 1: 1.48% - PASS
P28 Voltage Drop @ Node 2: 1.63% - PASS
P28 Voltage Drop @ Node 9991: 1.63% - PASS

TOTAL VOLTAGE DROP DURING STARTING
Node 9991: 0.06 + 1.63% - VALUE DOES NOT EXCEED 9% - PASS

NODE 9991 CHARACTERISTICS
PSSC (Ph-n): 2.35 KA
PME Ze: 0.10 Ohms (0.05606 + j 0.08772 Ohms)
Source Impedance: 0.05637 + j 0.09021 Ohms

Figure B2 - Dummy 1-Phase Motor and Simplified Network - Impedance at the Point of Common Coupling (PCC)

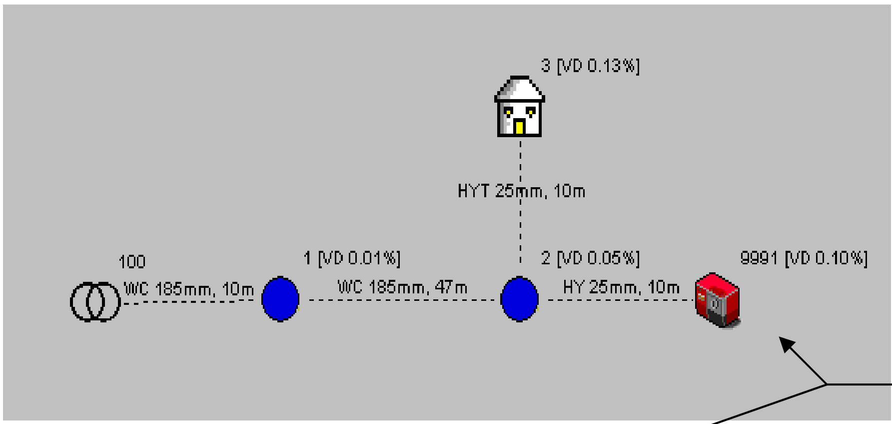
The 3-phase source impedance at the PCC can be obtained by reducing the cable length from the supply terminals to the PCC to the minimum possible – 1m – and increasing the cable size to a large cable type – here WC 300mm. Alternatively, here node 2 could be deleted and the motor connected direct to node 1 by 47m of WC 185mm.

The phase-neutral source impedance of the network at the PCC, $Z_{source\ 1\text{-}ph\ PCC}$ is given by

$$Z_{source\ 1\text{-}ph\ PCC} = \sqrt{(R_{source\ 1\text{-}ph\ PCC}^2 + X_{source\ 1\text{-}ph\ PCC}^2)} = \sqrt{(0.05637^2 + 0.09021^2)} = 0.10637\Omega$$

Three-phase Equipment

If the equipment is 3-phase then a fictitious 3-phase motor should be used to derive the 3-phase source impedance instead. For example:



Fictitious 1kW 3-phase 415V Motor at Supply Terminals

MOTOR DETAILS
Motor Voltage: 3 Phase 415V motor
LV Network Type: 3 phase 4 wire network
Rating: 1 Kilowatts
Type of Starter: Direct on line
Starting Current: 12.7 A
Starting PF: 0.3 pu
Number of Starts: 1 Per: Hour
P28 Voltage Disturbance Limit @ PCC: 3.00%

Steady State: Pass

CALCULATED VOLTAGE DISTURBANCE (P28)
P28 Voltage Drop @ Node 100 (Primary): 0.02%
P28 Voltage Drop @ Node 100 (Secondary): 0.49% - PASS
P28 Voltage Drop @ Node 1: 0.49% - PASS
P28 Voltage Drop @ Node 2: 0.52% - PASS
P28 Voltage Drop @ Node 9991: 0.54% - PASS

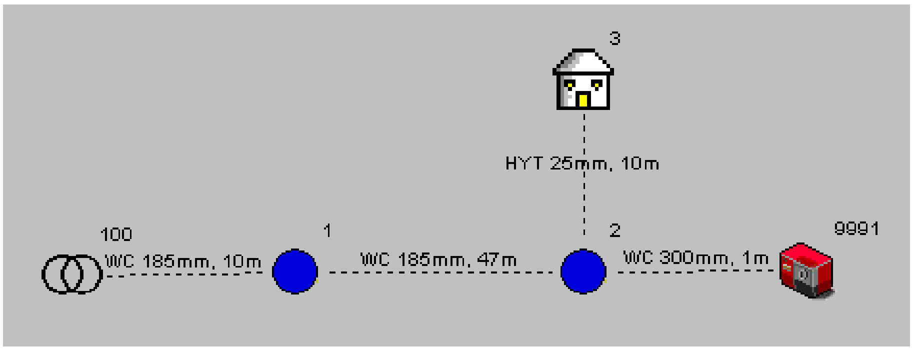
TOTAL VOLTAGE DROP DURING STARTING
Node 9991: 0.06 + 0.54% - VALUE DOES NOT EXCEED 9% - PASS

NODE 9991 CHARACTERISTICS
PSSC (3-Ph): 2.34 KA
PME Ze: 0.12 Ohms (0.07980 + j 0.08809 Ohms)
Source Impedance: 0.05891 + j 0.08937 Ohms

Figure B3 - Dummy 3-Phase Motor and Simplified Network - Impedance at the Supply Terminals

The three-phase source impedance of the network at the <u>supply terminals</u>, $Z_{source\ 3\text{-}ph\ supply\ terminals}$, is given by

$$Z_{source\ 3\text{-}ph\ supply\ terminals} = \sqrt{(R_{source\ 3\text{-}ph\ supply\ terminals}^2 + X_{source\ 3\text{-}ph\ supply\ terminals}^2)} = \sqrt{(0.05891^2 + 0.08937^2)} = 0.10704\Omega$$



MOTOR DETAILS
Motor Voltage: 3 Phase 415V motor
LV Network Type: 3 phase 4 wire network
Rating: 1 Kilowatts
Type of Starter: Direct on line
Starting Current: 12.7 A
Starting PF: 0.3 pu
Number of Starts: 1 Per: Hour
P28 Voltage Disturbance Limit @ PCC: 3.00%

Steady State: Pass

CALCULATED VOLTAGE DISTURBANCE (P28)
P28 Voltage Drop @ Node 100 (Primary): 0.02%
P28 Voltage Drop @ Node 100 (Secondary): 0.49% - PASS
P28 Voltage Drop @ Node 1: 0.49% - PASS
P28 Voltage Drop @ Node 2: 0.52% - PASS
P28 Voltage Drop @ Node 9991: 0.52% - PASS

TOTAL VOLTAGE DROP DURING STARTING
Node 9991: 0.06 + 0.52% - VALUE DOES NOT EXCEED 9% - PASS

NODE 9991 CHARACTERISTICS
PSSC (3-Ph): 2.48 KA
~~**PME Ze:** 0.10 Ohms (0.05606 + j 0.08772 Ohms)~~
Source Impedance: 0.04701 + j 0.08901 Ohms

Figure B4 - Dummy 3-Phase Motor and Simplified Network - Impedance at the Point of Common Coupling (PCC)

The 3-phase source impedance at the PCC can be obtained by reducing the cable length from the supply terminals to the PCC to the minimum possible – 1m – and increasing the cable size to a large cable type – here WC 300mm. Alternatively, here node 2 could be deleted and the motor connected direct to node 1 by 47m of WC 185mm.

The three-phase source impedance of the network at the PCC,
$Z_{\text{source 3-ph PCC}}$, is given by

$Z_{source\ 3\text{-}ph\ PCC} = \sqrt{(R_{source\ 3\text{-}ph\ PCC}{}^2 + X_{source\ 3\text{-}ph\ PCC}{}^2)} = \sqrt{(0.04701^2 + 0.08901^2)} =$ 0.10066Ω.

Phase-Phase or 'Interphase' Equipment

If the equipment is connected across two phases only (i.e. 400V Phase-Phase) the following formula shall be used to derive the phase-phase source impedance, $Z_{source\ ph\text{-}ph}$:

$$Z_{source\ ph\text{-}ph} = 2 \text{ x } Z_{source\ 3\text{-}ph}.$$

FORMULAE FOR S_{equ}, S_{sc}, R_{sce}, I_{fmin} & I_f

This Appendix details the range of calculations used in the worked examples of Appendix E. These are associated with application of Figure 2 and concern control of harmonic current emissions and application of BS EN 61000-3-12.

C1 CALCULATION OF EQUIPMENT RATED APPARENT POWER, S_{equ}

Equipment	S_{equ}
1-phase 230V	230V x I_{equ}
Phase-phase 400V	400V x I_{equ}
3-phase 400V	√3 x 400V x I_{equ}

Note: I_{equ} = rated current of the equipment

C2 CALCULATION OF THREE-PHASE SHORT-CIRCUIT POWER, S_{sc}

$S_{sc} = (U_{nominal})^2/Z_{source} = (400V)^2/Z_{source\ 3\text{-}ph}$

where $Z_{source\ 3\text{-}ph}$ = line impedance of the source as given by WinDebut when modelled with a dummy 3-phase motor. See Appendix B.

C3 CALCULATION OF SHORT-CIRCUIT RATIO, R_{sce}

Equipment	R_{sce}
1-phase 230V	$S_{sc}/3S_{equ}$
Phase-phase 400V	$S_{sc}/2S_{equ}$
3-phase 400V	S_{sc}/S_{equ}

C4 CALCULATION OF MINIMUM SHORT-CIRCUIT POWER, S_{sc} FOR R_{sce} =33

Equipment	S_{sc}
1-phase 230V	3 x 33 x S_{equ} = 99 x S_{equ}
Phase-phase 400V	2 x 33 x S_{equ} = 66 x S_{equ}
3-phase 400V	33 x S_{equ}

C5 CALCULATION OF MINIMUM FAULT CURRENT VALUE, I_{fmin}

$I_{fmin} = S_{sc}/(\sqrt{3} \times 400V)$

C6 CALCULATION OF ACTUAL FAULT CURRENT, I_f, FROM SOURCE IMPEDANCE

Equipment	**I_f**
1-phase 230V	$230V/Z_{source\ 1\text{-}ph}$
Phase-phase 400V	$400V/(2 \times Z_{source\ 3\text{-}ph})$
3-phase 400V	$400V/(\sqrt{3} \times Z_{source\ 3\text{-}ph})$

NOTE: $Z_{source\ 1\text{-}ph}$ = phase-neutral source impedance as given by WinDebut when modelled with a dummy single-phase motor and $Z_{source\ 3\text{-}ph}$ = line impedance of the source as given by WinDebut when modelled with a dummy 3-phase motor. See Appendix B.

MINIMUM FAULT LEVEL/MAXIMUM SOURCE IMPEDANCE FOR R_{sce}=33

Equipment Rating Iequ (A)	Equipment rated apparent power, Sequ (kVA)			Minimum 3-ph short-circuit power (MVA)			Minimum fault current, If min (kA)			Max permitted source impedance, Zmax harmonic PCC (ohms) for Rsce=33		
	230V 1-ph Equt.	400V Ph-Ph Equt.	400V 3-ph Equt.	230V 1-ph Equt.	400V Ph-Ph Equt.	400V 3-ph Equt.	230V 1-ph Equt.	400V Ph-Ph Equt.	400V 3-ph Equt.	1-ph Equt. Zph-n	Ph-Ph Equt Zline-line	3-ph Equt. Zline
16	3.680	6.400	11.085	0.364320	0.422400	0.365809	525.9	609.7	528.0	0.4356	0.7576	0.4374
17	3.910	6.800	11.778	0.387090	0.448800	0.388672	558.7	647.8	561.0	0.4100	0.7130	0.4117
18	4.140	7.200	12.471	0.409860	0.475200	0.411535	591.6	685.9	594.0	0.3872	0.6734	0.3888
19	4.370	7.600	13.164	0.432630	0.501600	0.434398	624.4	724.0	627.0	0.3668	0.6380	0.3683
20	4.600	8.000	13.856	0.455400	0.528000	0.457261	657.3	762.1	660.0	0.3485	0.6061	0.3499
21	4.830	8.400	14.549	0.478170	0.554400	0.480124	690.2	800.2	693.0	0.3319	0.5772	0.3332
22	5.060	8.800	15.242	0.500940	0.580800	0.502988	723.0	838.3	726.0	0.3168	0.5510	0.3181
23	5.290	9.200	15.935	0.523710	0.607200	0.525851	755.9	876.4	759.0	0.3030	0.5270	0.3043
24	5.520	9.600	16.628	0.546480	0.633600	0.548714	788.8	914.5	792.0	0.2904	0.5051	0.2916
25	5.750	10.000	17.321	0.569250	0.660000	0.571577	821.6	952.6	825.0	0.2788	0.4848	0.2799
26	5.980	10.400	18.013	0.592020	0.686400	0.594440	854.5	990.7	858.0	0.2681	0.4662	0.2692
27	6.210	10.800	18.706	0.614790	0.712800	0.617303	887.4	1028.8	891.0	0.2581	0.4489	0.2592
28	6.440	11.200	19.399	0.637560	0.739200	0.640166	920.2	1066.9	924.0	0.2489	0.4329	0.2499
29	6.670	11.600	20.092	0.660330	0.765600	0.663029	953.1	1105.0	957.0	0.2403	0.4180	0.2413
30	6.900	12.000	20.785	0.683100	0.792000	0.685892	986.0	1143.2	990.0	0.2323	0.4040	0.2333
31	7.130	12.400	21.477	0.705870	0.818400	0.708755	1018.8	1181.3	1023.0	0.2248	0.3910	0.2257
32	7.360	12.800	22.170	0.728640	0.844800	0.731618	1051.7	1219.4	1056.0	0.2178	0.3788	0.2187
33	7.590	13.200	22.863	0.751410	0.871200	0.754481	1084.6	1257.5	1089.0	0.2112	0.3673	0.2121
34	7.820	13.600	23.556	0.774180	0.897600	0.777344	1117.4	1295.6	1122.0	0.2050	0.3565	0.2058
35	8.050	14.000	24.249	0.796950	0.924000	0.800207	1150.3	1333.7	1155.0	0.1991	0.3463	0.1999
36	8.280	14.400	24.942	0.819720	0.950400	0.823071	1183.2	1371.8	1188.0	0.1936	0.3367	0.1944
37	8.510	14.800	25.634	0.842490	0.976800	0.845934	1216.0	1409.9	1221.0	0.1884	0.3276	0.1891
38	8.740	15.200	26.327	0.865260	1.003200	0.868797	1248.9	1448.0	1254.0	0.1834	0.3190	0.1842
39	8.970	15.600	27.020	0.888030	1.029600	0.891660	1281.8	1486.1	1287.0	0.1787	0.3108	0.1794
40	9.200	16.000	27.713	0.910800	1.056000	0.914523	1314.6	1524.2	1320.0	0.1742	0.3030	0.1750
41	9.430	16.400	28.406	0.933570	1.082400	0.937386	1347.5	1562.3	1353.0	0.1700	0.2956	0.1707
42	9.660	16.800	29.098	0.956340	1.108800	0.960249	1380.4	1600.4	1386.0	0.1659	0.2886	0.1666
43	9.890	17.200	29.791	0.979110	1.135200	0.983112	1413.2	1638.5	1419.0	0.1621	0.2819	0.1627
44	10.120	17.600	30.484	1.001880	1.161600	1.005975	1446.1	1676.6	1452.0	0.1584	0.2755	0.1590
45	10.350	18.000	31.177	1.024650	1.188000	1.028838	1479.0	1714.7	1485.0	0.1549	0.2694	0.1555
46	10.580	18.400	31.870	1.047420	1.214400	1.051701	1511.8	1752.8	1518.0	0.1515	0.2635	0.1521
47	10.810	18.800	32.563	1.070190	1.240800	1.074564	1544.7	1790.9	1551.0	0.1483	0.2579	0.1489
48	11.040	19.200	33.255	1.092960	1.267200	1.097427	1577.6	1829.0	1584.0	0.1452	0.2525	0.1458
49	11.270	19.600	33.948	1.115730	1.293600	1.120290	1610.4	1867.2	1617.0	0.1422	0.2474	0.1428
50	11.500	20.000	34.641	1.138500	1.320000	1.143154	1643.3	1905.3	1650.0	0.1394	0.2424	0.1400
51	11.730	20.400	35.334	1.161270	1.346400	1.166017	1676.1	1943.4	1683.0	0.1367	0.2377	0.1372
52	11.960	20.800	36.027	1.184040	1.372800	1.188880	1709.0	1981.5	1716.0	0.1340	0.2331	0.1346
53	12.190	21.200	36.719	1.206810	1.399200	1.211743	1741.9	2019.6	1749.0	0.1315	0.2287	0.1320
54	12.420	21.600	37.412	1.229580	1.425600	1.234606	1774.7	2057.7	1782.0	0.1291	0.2245	0.1296
55	12.650	22.000	38.105	1.252350	1.452000	1.257469	1807.6	2095.8	1815.0	0.1267	0.2204	0.1272
56	12.880	22.400	38.798	1.275120	1.478400	1.280332	1840.5	2133.9	1848.0	0.1245	0.2165	0.1250
57	13.110	22.800	39.491	1.297890	1.504800	1.303195	1873.3	2172.0	1881.0	0.1223	0.2127	0.1228
58	13.340	23.200	40.184	1.320660	1.531200	1.326058	1906.2	2210.1	1914.0	0.1202	0.2090	0.1207
59	13.570	23.600	40.876	1.343430	1.557600	1.348921	1939.1	2248.2	1947.0	0.1181	0.2054	0.1186
60	13.800	24.000	41.569	1.366200	1.584000	1.371784	1971.9	2286.3	1980.0	0.1162	0.2020	0.1166
61	14.030	24.400	42.262	1.388970	1.610400	1.394647	2004.8	2324.4	2013.0	0.1143	0.1987	0.1147
62	14.260	24.800	42.955	1.411740	1.636800	1.417510	2037.7	2362.5	2046.0	0.1124	0.1955	0.1129
63	14.490	25.200	43.648	1.434510	1.663200	1.440373	2070.5	2400.6	2079.0	0.1106	0.1924	0.1111
64	14.720	25.600	44.341	1.457280	1.689600	1.463237	2103.4	2438.7	2112.0	0.1089	0.1894	0.1093
65	14.950	26.000	45.033	1.480050	1.716000	1.486100	2136.3	2476.8	2145.0	0.1072	0.1865	0.1077
66	15.180	26.400	45.726	1.502820	1.742400	1.508963	2169.1	2514.9	2178.0	0.1056	0.1837	0.1060
67	15.410	26.800	46.419	1.525590	1.768800	1.531826	2202.0	2553.0	2211.0	0.1040	0.1809	0.1045
68	15.640	27.200	47.112	1.548360	1.795200	1.554689	2234.9	2591.1	2244.0	0.1025	0.1783	0.1029
69	15.870	27.600	47.805	1.571130	1.821600	1.577552	2267.7	2629.3	2277.0	0.1010	0.1757	0.1014
70	16.100	28.000	48.497	1.593900	1.848000	1.600415	2300.6	2667.4	2310.0	0.0996	0.1732	0.1000
71	16.330	28.400	49.190	1.616670	1.874400	1.623278	2333.5	2705.5	2343.0	0.0982	0.1707	0.0986
72	16.560	28.800	49.883	1.639440	1.900800	1.646141	2366.3	2743.6	2376.0	0.0968	0.1684	0.0972
73	16.790	29.200	50.576	1.662210	1.927200	1.669004	2399.2	2781.7	2409.0	0.0955	0.1660	0.0959
74	17.020	29.600	51.269	1.684980	1.953600	1.691867	2432.1	2819.8	2442.0	0.0942	0.1638	0.0946
75	17.250	30.000	51.962	1.707750	1.980000	1.714730	2464.9	2857.9	2475.0	0.0929	0.1616	0.0933

Table D1 – Minimum Fault Level & Maximum Source Impedance at Point of Common Coupling (PCC) by Equipment Rating

WORKED EXAMPLES

Example	Equipment	Phases	Number	Flicker Statement	Harmonic Statement
1	45A Heat Pump	1-ph	1 off	Z_{max}	61000-3-12
1a	45A Heat Pump	1-ph	20 off	Z_{max}	61000-3-12
2	4kW$_e$ Heat Pump	3-ph	1 off	61000-3-3	S_{sc}
3	3.81kW$_e$ Heat Pump	1-ph	1 off	61000-3-3	S_{sc}
3a	3.81kW$_e$ Heat Pump	1-ph	15 off	61000-3-3	S_{sc}
4	45A UPS	3-ph	1 off	61000-3-3	61000-3-12
5	18A EV Charger	1-ph	1 off	61000-3-3	61000-3-12

Table E1 – Summary of Worked Examples

EXAMPLE 1

Application: Request to connect one Heat Pump.
Network PCC: LV
Manufacturer: A.
Model: B = ground source heat pump system 45A 230V input.

BS EN 61000-3-11 Voltage Fluctuation/Flicker Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-3? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-3 then there is no need to complete the rest of this table.	No
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-11 provided that the source impedance is no more than Z_{max}?	Yes

Z max	R	0.1442	ohms	X	0.0901	ohms

Extracts from Form J2

BS EN 61000-3-12 Harmonic Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-2? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-2 then there is no need to complete the rest of this table.	No
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-12?	Yes
Manufacturer states Heat Pump System complies with EN/IEC 61000-3-12 provided that the short-circuit power Ssc is greater than or equal to xx. If yes then complete S_{sc} value below.	~~No~~

Extracts from Form J2

Design as follows…

Design for Acceptable Voltage Fluctuations/Flicker

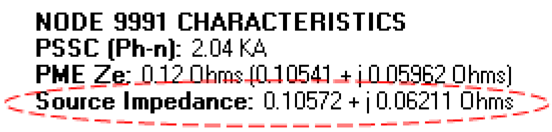
Step 1

As the proposed equipment is single-phase, use WinDebut to check the single-phase source impedance at the supply terminals.

Model the basic network from the supply terminals to the source in WinDebut. Insert a dummy single-phase motor and derive the single-phase source impedance at the supply terminals in accordance with Appendix B.

Derive $Z_{source\ 1\text{-}ph\ supply\ terminals}$ from $R_{source\ 1\text{-}ph\ supply\ terminals} + j\ X_{source\ 1\text{-}ph\ supply\ terminals}$

For example…



$Z_{source\ 1\text{-}ph\ supply\ terminals} = \sqrt{(R_{source\ 1\text{-}ph\ supply\ terminals}{}^2 + X_{source\ 1\text{-}ph\ supply\ terminals}{}^2)} = \sqrt{(0.10572^2 + 0.06211^2)} = 0.12261\Omega$

Note: this differs slightly from the *PME Ze* value as *Source Impedance* in WinDebut uses the transformer impedance values from Engineering Recommendation P28.

Step 2

Check if $Z_{source\ 1\text{-}ph\ supply\ terminals} \leq Z_{max}$. Here $Z_{source\ 1\text{-}ph\ supply\ terminals} = 0.12261\Omega$ and $Z_{max} = \sqrt{(0.1442\ \Omega^2 + 0.0901\ \Omega^2)} = 0.17\ \Omega$. Therefore, $Z_{source\ 1\text{-}ph\ supply\ terminals} < Z_{max}$.

In this case then the requirement is met. If $Z_{source\ 1\text{-}ph\ supply\ terminals} > Z_{max}$ then the network would need to be reinforced until $Z_{source\ 1\text{-}ph\ supply\ terminals} \leq Z_{max}$ to allow connection of this equipment.

Design for acceptable harmonic distortion

Note: In accordance with BS EN/IEC 61000-3-12, when the above statement is made compliance with harmonic current limits assumes a minimum ratio of 3-phase fault level at the PCC, $S_{sc\ PCC}$, to the rated apparent power of the equipment, S_{equ}, of 3 x 33 = 99.

Step1

Determine I_{equ} (or S_{equ}):

I_{equ} = 45A (or S_{equ} = 45A x 230V = 10.35kVA).

Step 2

Determine $Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ from Table D1 of Appendix D:

$Z_{max\ harmonic\ 1\text{-}ph\ PCC} = 0.1549\Omega$.

Step 3

Amend the basic network model dummy motor position to the PCC. Determine the single-phase source impedance at the PCC in accordance with Appendix B.

NODE 9991 CHARACTERISTICS
PSSC (Ph-n): 3.26 KA
PME Ze: 0.07 Ohms (0.05214 + j 0.05347 Ohms)
Source Impedance: 0.05246 + j 0.05595 Ohms

$$Z_{source\ 1\text{-}ph\ PCC} = \sqrt{(R_{source\ 1\text{-}ph\ PCC}^2 + X_{source\ 1\text{-}ph\ PCC}^2)} = \sqrt{(0.05246^2 + 0.05595^2)} = 0.07670\Omega$$

Step 4

Check if $Z_{source\ 1\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 1\text{-}ph\ PCC}$. Here $Z_{source\ 1\text{-}ph\ PCC} = 0.0767\Omega$ and $Z_{max\ harmonic\ 1\text{-}ph\ PCC} = 0.1549\Omega$. Therefore, $Z_{source\ 1\text{-}ph\ PCC} < Z_{max\ harmonic\ 1\text{-}ph\ PCC}$.

In this case then the requirement is met. If $Z_{source\ 1\text{-}ph\ PCC} > Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ then the network would need to be reinforced until $Z_{source\ 1\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ to allow connection of this equipment.

EXAMPLE 1A

Detail as for Example 1 but with 20 Heat Pump connections across an LV network.

The method of Example 1 is applied to the electrically most remote Heat Pump connection. The connection with the highest source impedance and lowest fault level is checked.

EXAMPLE 2

Application:	Request to connect one Heat Pump.
Network PCC:	LV
Manufacturer:	C
Model:	D air source heat pump 4kW$_e$ 400V three-phase input

BS EN 61000-3-11 Voltage Fluctuation/Flicker Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-3? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-3 then there is no need to complete the rest of this table.	Yes
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-11 provided that the source impedance is no more than Z_{max}?	No

Extracts from Form J2

BS EN 61000-3-12 Harmonic Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-2? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-2 then there is no need to complete the rest of this table.		No
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-12?		~~No~~
Manufacturer states Heat Pump System complies with EN/IEC 61000-3-12 provided that the short-circuit power Ssc is greater than or equal to xx. If yes then complete S_{sc} value below.		Yes
State minimum 3-phase supply short circuit level, S_{sc}, required to allow connection under EN 61000-3-12	1100	kVA

Extracts from Form J2

Design as follows…

Design for Acceptable Voltage Fluctuations/Flicker

See Figure 1. As it is stated that the equipment is compliant with IEC 61000-3-3 then connection is permitted.

Design for acceptable harmonic distortion

Note: In accordance with BS EN/IEC 61000-3-12, the stated required minimum short-circuit power, S_{sc}, is a 3-phase value at the Point of Common Coupling (PCC).

Step 1

Convert the 3-phase MVA value, S_{sc}, to a minimum fault current value, I_{fmin}:

$$I_{fmin} = S_{sc}/(\sqrt{3} \text{ x } 400V) = 1100kVA/(\sqrt{3} \text{ x } 400V) = 1588A.$$

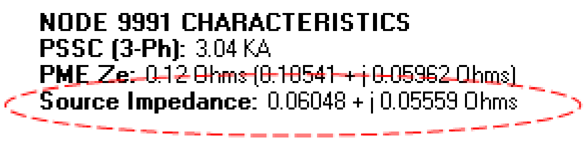
Step 2

As the proposed equipment is 3-phase, use WinDebut to check the 3-phase fault current at the PCC.

Model the basic network from the PCC to the source in WinDebut. Insert a dummy 3-phase motor and derive the 3-phase (line) source impedance in accordance with Appendix B.

Derive $Z_{source\ 3\text{-}ph\ PCC}$ from $R_{source\ 3\text{-}ph\ PCC} + j\ X_{source\ 3\text{-}ph\ PCC}$.

For example…



$Z_{source\ 3\text{-}ph\ PCC} = \sqrt{(R_{source\ 3\text{-}ph\ PCC}{}^2 + X_{source\ 3\text{-}ph\ PCC}{}^2)} = \sqrt{(0.06048^2 + 0.05559^2)} = 0.08215\Omega$.

Derive the 3-phase fault current from $I_f = 400/(\sqrt{3} \times 0.08215\Omega) = 2811A$.

Note: this differs slightly from the *PSSC(3-ph)* value as *Source Impedance* in WinDebut uses the transformer impedance values from Engineering Recommendation P28.

Step 3

Check if $I_f \geq I_{fmin}$. Here $I_f = 2811A$ and $I_{fmin} = 1588A$. Therefore, $I_f > I_{fmin}$.

In this case then the requirement is met. If $I_f < I_{fmin}$ then the network would need to be reinforced until $I_f \geq I_{fmin}$ to allow connection of this equipment.

EXAMPLE 3

Application:	Request to connect one Heat Pump.
Network PCC:	LV
Manufacturer:	E
Model:	F air source heat pump 3.81kW$_e$ 230V single-phase input

BS EN 61000-3-11 Voltage Fluctuation/Flicker Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-3? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-3 then there is no need to complete the rest of this table.	Yes
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-11 provided that the source impedance is no more than Z_{max}?	No

Extracts from Form J2

BS EN 61000-3-12 Harmonic Statement

Manufacturer states Heat Pump System meets technical requirements of EN/IEC 61000-3-2? Note: Where the heat pump system meets the technical requirements of BS EN/IEC 61000-3-2 then there is no need to complete the rest of this table.		No
Manufacturer states Heat Pump System complying with EN/IEC 61000-3-12?		~~No~~
Manufacturer states Heat Pump System complies with EN/IEC 61000-3-12 provided that the short-circuit power Ssc is greater than or equal to xx. If yes then complete S_{sc} value below.		Yes
State minimum 3-phase supply short circuit level, S_{sc}, required to allow connection under EN 61000-3-12	858	kVA

Extracts from Form J2

Design as follows…

Design for Acceptable Voltage Fluctuations/Flicker

See Figure 1. As it is stated that the equipment is compliant with IEC 61000-3-3 then connection is permitted.

Design for acceptable harmonic distortion

In accordance with BS EN/IEC 61000-3-12, the stated required minimum short-circuit power, S_{sc}, is a 3-phase value at the Point of Common Coupling (PCC). However, the equipment is single-phase.

Step 1

Convert the minimum 3-phase MVA value, S_{sc}, to a minimum fault current value, I_{fmin}:

$$I_{fmin} = S_{sc}/(\sqrt{3} \times 400V) = 858kVA/(\sqrt{3} \times 400V) = 1238A.$$

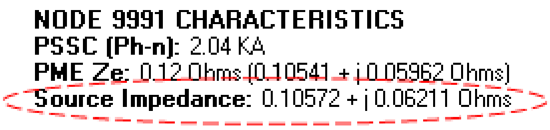
Step 2

As the proposed equipment is single-phase, use WinDebut to check the single-phase fault current at the PCC.

Model the basic network from the PCC to the source in WinDebut. Insert a dummy single-phase motor and derive the single-phase source impedance in accordance with Appendix B.

Derive $Z_{source\ 1\text{-}ph\ PCC}$ from $R_{source\ 1\text{-}ph\ PCC} + j\ X_{source\ 1\text{-}ph\ PCC}$.

For example…



$Z_{source\ 1\text{-}ph\ PCC} = \sqrt{}(R_{source\ 1\text{-}ph\ PCC}{}^2 + X_{source\ 1\text{-}ph\ PCC}{}^2) = \sqrt{}(0.10572^2 + 0.06211^2) = 0.12261\Omega$.

Derive the single-phase fault current from $I_f = 230V/0.12261\Omega = 1876A$.

Note: this differs slightly from the *PSSC(1-ph)* value as *Source Impedance* uses the transformer impedance values from Engineering Recommendation P28.

Step 3

Check if $I_f \geq I_{fmin}$. Here $I_f = 1876A$ and $I_{fmin} = 1238A$. Therefore, $I_f > I_{fmin}$.

In this case then the requirement is met. If $I_f < I_{fmin}$ then the network would need to be reinforced until $I_f \geq I_{fmin}$ to allow connection of this equipment.

EXAMPLE 3A

Detail as for Example 3 but with 15 heat pump connections across an LV network.

The method of Example 3 is applied to the electrically most remote Heat Pump connection. The connection with the lowest fault level is checked.

EXAMPLE 4

Application: Request to connect one Uninterruptible Power Supply (UPS).
Network PCC: LV
Manufacturer: G
Model: H UPS 45A 400V three-phase input

BS EN 61000-3-11 Voltage Fluctuation/Flicker Statement

Voltage Fluctuation/Flicker Standard Compliance	☐ Compliant with BS EN 61000-3-3 ☒ Compliant with BS EN 61000-3-11 ☐ Not compliant with either of above – see Form D
• If BS EN 61000-3-11 applies (rating ≤75A/phase), which required statement is made by the manufacturer?	☐ Stated 'Maximum impedance (Zmax) ………….Ω' ☐ Stated 'Required service capacity ≥100A/phase' ☒ Stated 'Compliant with the technical requirements of BS EN 61000-3-3'

Manufacturer states equipment meets technical requirements of EN/IEC 61000-3-3? Note: Where the equipment meets the technical requirements of BS EN/IEC 61000-3-3 then there is no need to complete the rest of this table.	Yes
Manufacturer states equipment complying with EN/IEC 61000-3-11 provided that the source impedance is no more than Z_{max}?	No

Extracts from Form X

BS EN 61000-3-12 Harmonic Statement

Harmonics Standard Compliance	☐ Compliant with BS EN 61000-3-2 ☒ Compliant with BS EN 61000-3-12 ☐ Not compliant with either of above – see Form C
• If BS EN 61000-3-12 applies (rating ≤75A/phase), which required statement is made by the manufacturer?	☒Stated 'Compliant with IEC 61000-3-12' ☐ Stated 'Compliant with IEC 61000-3-12 provided that the short circuit power, S_{sc}≥ …………….MVA ☐ Stated 'Compliant with the technical requirements of BS EN 61000-3-2'

Manufacturer states equipment meets technical requirements of EN/IEC 61000-3-2? Note: Where the equipment meets the technical requirements of BS EN/IEC 61000-3-2 then there is no need to complete the rest of this table.	No
Manufacturer states equipment complying with EN/IEC 61000-3-12?	Yes
Manufacturer states equipment complies with EN/IEC 61000-3-12 provided that the short-circuit power Ssc is greater than or equal to xx. If yes then complete S_{sc} value below.	~~No~~

Extracts from Form X
'

Design as follows…

Design for Acceptable Voltage Fluctuations/Flicker

See Figure 1. As it is stated that the equipment is compliant with IEC 61000-3-3 then connection is permitted.

Design for acceptable harmonic distortion

Note: In accordance with BS EN/IEC 61000-3-12, when the above statement is made compliance with harmonic current limits assumes a minimum ratio of 3-phase fault level at the PCC, $S_{sc\ PCC}$, to the rated apparent power of the equipment, S_{equ}, of 33.

Step1

Determine I_{equ} (or S_{equ}):

I_{equ} = 45A (or $S_{equ} = \sqrt{3} \times 45 \times 400V = 31.177kVA$).

Step 2

Determine $Z_{max\ harmonic\ 3\text{-}ph\ PCC}$ from Table D1 of Appendix D:

$Z_{max\ harmonic\ 3\text{-}ph\ PCC} = 0.1555\Omega$.

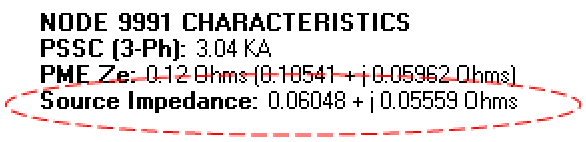
Step 3

As the proposed equipment is 3-phase, use WinDebut to check the <u>3-phase</u> source impedance at the PCC.

Model the basic network from the PCC to the source in WinDebut. Insert a dummy <u>3-phase</u> motor and derive the 3-phase (line) source impedance at the PCC in accordance with Appendix B.

Derive $Z_{source\ 3\text{-}ph\ PCC}$ from $R_{source\ 3\text{-}ph\ PCC} + j\ X_{source\ 3\text{-}ph\ PCC}$.

For example…



$Z_{source\ 3\text{-}ph\ PCC} = \sqrt{(R_{source\ 3\text{-}ph\ PCC}^2 + X_{source\ 3\text{-}ph\ PCC}^2)} = \sqrt{(0.06048^2 + 0.05559^2)} = 0.08215\Omega$.

Step 4

Check if $Z_{source\ 3\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 3\text{-}ph\ PCC}$. Here $Z_{source\ 3\text{-}ph\ PCC} = 0.08215\Omega$ and $Z_{max\ harmonic\ 3\text{-}ph\ PCC} = 0.1555\Omega$. Therefore, $Z_{source\ 3\text{-}ph\ PCC} < Z_{max\ harmonic\ 3\text{-}ph\ PCC}$.

In this case then the requirement is met. If $Z_{source\ 3\text{-}ph\ PCC} > Z_{max\ harmonic\ 3\text{-}ph\ PCC}$ then the network would need to be reinforced until $Z_{source\ 3\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 3\text{-}ph\ PCC}$ to allow connection of this equipment.

EXAMPLE 5

Application:	Request to connect one Electric Vehicle Charging System.
Network PCC:	LV
Manufacturer:	I
Model:	J Electric Vehicle Charger 18A 230V single-phase input

BS EN 61000-3-11 Voltage Fluctuation/Flicker Statement

Voltage Fluctuation/Flicker Standard Compliance	☐ Compliant with BS EN 61000-3-3 ☒ Compliant with BS EN 61000-3-11 ☐ Not compliant with either of above – see Form D
• If BS EN 61000-3-11 applies (rating ≤75A/phase), which required statement is made by the manufacturer?	☐ Stated 'Maximum impedance (Zmax) …………..Ω' ☐ Stated 'Required service capacity ≥100A/phase' ☒ Stated 'Compliant with the technical requirements of BS EN 61000-3-3'

Manufacturer states equipment meets technical requirements of EN/IEC 61000-3-3? Note: Where the equipment meets the technical requirements of BS EN/IEC 61000-3-3 then there is no need to complete the rest of this table.	Yes
Manufacturer states equipment complying with EN/IEC 61000-3-11 provided that the source impedance is no more than Z_{max}?	No

Extracts from Form X

BS EN 61000-3-12 Harmonic Statement

Harmonics Standard Compliance	☐ Compliant with BS EN 61000-3-2 ☒ Compliant with BS EN 61000-3-12 ☐ Not compliant with either of above – see Form C
• If BS EN 61000-3-12 applies (rating ≤75A/phase), which required statement is made by the manufacturer?	☒Stated 'Compliant with IEC 61000-3-12' ☐ Stated 'Compliant with IEC 61000-3-12 provided that the short circuit power, S_{sc}≥ ……………..MVA ☐ Stated 'Compliant with the technical requirements of BS EN 61000-3-2'

Manufacturer states equipment meets technical requirements of EN/IEC 61000-3-2? Note: Where the equipment meets the technical requirements of BS EN/IEC 61000-3-2 then there is no need to complete the rest of this table.	No
Manufacturer states equipment complying with EN/IEC 61000-3-12?	Yes
Manufacturer states equipment complies with EN/IEC 61000-3-12 provided that the short-circuit power Ssc is greater than or equal to xx. If yes then complete S_{sc} value below.	No

Extracts from Form X

Design as follows…

Design for Acceptable Voltage Fluctuations/Flicker

See Figure 1. As it is stated that the equipment is compliant with IEC 61000-3-3 then connection is permitted.

Design for acceptable harmonic distortion

Note: In accordance with BS EN/IEC 61000-3-12, when the above statement is made compliance with harmonic current limits assumes a minimum ratio of 3-phase fault level at the PCC, $S_{sc\ PCC}$, to the rated apparent power of the equipment, S_{equ}, of 3 x 33 = 99.

Step1

Determine I_{equ} (or S_{equ}):

I_{equ} = 18A (or S_{equ} = 18 x 230V = 4.14kVA).

Step 2

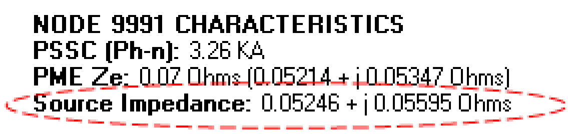
Step 2

Determine $Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ from Table D1 of Appendix D:

$Z_{max\ harmonic\ 1\text{-}ph\ PCC} = 0.3872\Omega$.

Step 3

Determine the single-phase source impedance at the PCC in accordance with Appendix B.


NODE 9991 CHARACTERISTICS
PSSC (Ph-n): 3.26 KA
PME Ze: 0.07 Ohms (0.05214 + j 0.05347 Ohms)
Source Impedance: 0.05246 + j 0.05595 Ohms

$Z_{source\ 1\text{-}ph\ PCC} = \sqrt{(R_{source\ 1\text{-}ph\ PCC}^2 + X_{source\ 1\text{-}ph\ PCC}^2)} = \sqrt{(0.05246^2 + 0.05595^2)} = 0.07670\Omega$

Step 4

Check if $Z_{source\ 1\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 1\text{-}ph\ PCC}$. Here $Z_{source\ 1\text{-}ph\ PCC} = 0.0767\Omega$ and $Z_{max\ harmonic\ 1\text{-}ph\ PCC} = 0.3872\Omega$. Therefore, $Z_{source\ 1\text{-}ph\ PCC} < Z_{max\ harmonic\ 1\text{-}ph\ PCC}$.

In this case then the requirement is met. If $Z_{source\ 1\text{-}ph\ PCC} > Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ then the network would need to be reinforced until $Z_{source\ 1\text{-}ph\ PCC} \leq Z_{max\ harmonic\ 1\text{-}ph\ PCC}$ to allow connection of this equipment.

EXAMPLE PHASE-NEUTRAL SOURCE IMPEDANCE

	Phase-Neutral Source Impedance (Ω)					
LV Circuit Length (m)	**0**	**100**	**200**	**300**	**400**	**500**
Conductor						
AO 0.025	0.1175	0.3227	0.5448	0.7693	0.9945	1.2201
AO 0.05	0.1175	0.2330	0.3541	0.4765	0.5994	0.7226
AO 0.1	0.1175	0.1935	0.2704	0.3476	0.4247	0.5020
AO 0.15	0.1175	0.1807	0.2536	0.3078	0.3713	0.4348
AO 50	0.1175	0.2330	0.3541	0.4765	0.5994	0.7226
AO 100	0.1175	0.1934	0.2703	0.3473	0.4244	0.5016
AO 150	0.1175	0.1808	0.2443	0.3079	0.3715	0.4351
CO 0.0225	0.1175	0.3497	0.6006	0.8538	1.1077	1.3620
CO 0.05	0.1175	0.2337	0.3554	0.4784	0.6019	0.7256
CO 0.1	0.1175	0.1943	0.2719	0.3497	0.4277	0.5057
CO 0.15	0.1175	0.1822	0.2472	0.3121	0.3771	0.4421
CO 70	0.1175	0.1941	0.2714	0.3489	0.4263	0.5039
CO 100	0.1175	0.1831	0.2489	0.3148	0.3806	0.4464
HY 25	0.1175	0.3196	0.5529	0.7903	1.0290	1.2681
HY 35	0.1175	0.2478	0.4026	0.5620	0.7229	0.8846
CC 16	0.1175	0.3161	0.5446	0.7772	1.0109	1.2452
CC 25	0.1175	0.2367	0.3777	0.5231	0.6701	0.8177
CC 35	0.1175	0.2027	0.2973	0.3947	0.4931	0.5920

Table F1 – Source Impedance by circuit length for a 25kVA 1-ph transformer

NOTE: Values in cells shown with grey shading exceed Z_{ref}. See Appendix G for explanation of Z_{ref}.

Transformer Type	**Phase-Neutral Source Impedance (Ω) at Transformer LV Terminals**
5 kVA 1-phase	0.5663
10 kVA 1-phase	0.2855
15 kVA 1-phase	0.1925
16 kVA 1-phase	0.1808
25 kVA 1-phase	0.1175
50 kVA 1-phase	0.06164
100 kVA 1-phase	0.03301

Table F2– Source Impedance at 1-phase Transformer Terminals by Rating

NOTE: Value in cell shown with grey shading exceed Z_{ref}. See Appendix G for explanation of Z_{ref}.

G1.0 BACKGROUND

In line with the Distribution Code, POL:SD5/1 requires that connections shall be designed to ensure compliance with:

- Engineering Recommendation P28 to limit flicker and voltage fluctuations
- Engineering Recommendation G5/4-1 to limit harmonic voltage distortion.

Both of these Engineering Recommendations contain a 3-stage approach – each stage has increased complexity with Stage 1 being simplest. Equipment proposed for connection with an LV PCC and rated ≤75A falls within Stage 1. At present, however, the standards referred to in Stage 1 of each document are superseded in part, namely:

- P28 refers to BS 5406 which is now withdrawn; the nearest equivalent current standards are BS EN 61000-3-3 and BS EN 61000-3-11.
- G5/4-1 refers to IEC TR 61000-3-4; the latter is replaced by BS EN 61000-3-12 for equipment rated up to 75A per phase.

The IEC 61000 series of standards deals with 'electromagnetic compatibility' (EMC) which is the ability of equipment or a system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment. Part 3 of the IEC 61000 series of standards deals with emissions and immunity of equipment. Specific standards within the IEC 61000-3-X series are of particular note to Distribution Network Operators as they deal with the limitation of:

- Emission of voltage changes, voltage fluctuations and flicker impressed on the public low voltage system.
- Emission of harmonic currents into the public low-voltage systems.

See Table G1 which gives the UK implementation of these IEC standards. The standards apply to all equipment intended to be connected to public low-voltage systems. They do not apply to equipment only intended to be connected to private low-voltage systems interfacing with the public supply only at HV. Compliance with these standards is now effectively a requirement for all equipment within their scope because of the Electromagnetic Compatibility (EMC) Directive[4]. They are 'horizontal' EMC standards; this means that they apply regardless of the type of

[4] Apparatus is required to comply with the protection requirements of the EMC Directive. Compliance with these protection requirements is demonstrated by applying the conformity assessment procedure in the Directive. Technical documentation has to be prepared by the manufacturer to demonstrate evidence of compliance. This includes evidence that the apparatus complies with the relevant 'harmonised' standards or, if harmonised standards are not used or only used in part, a detailed technical justification. Relevant harmonised standards are those published in the Official Journal of the European Union (OJEU) and the above standards are published in that. The manufacturer is also required to complete an EC Declaration of Conformity and affix the CE Mark. Compliance with European harmonised EMC standards is the most frequently used and recommended way to demonstrate EMC compliance.

equipment or of any generic or product-family EMC standards which may also apply. Note however that harmonic producing equipment designated by the manufacturer as ‘professional equipment’ and that does not comply with the standards is subject to special treatment.

PQ Parameters Controlled	Standard	Title
Voltage changes, voltage fluctuations & flicker	BS EN 61000-3-3	Limitation of voltage changes, voltage fluctuations & flicker in public low-voltage supply systems, for equipment with rated current ≤16A per phase and not subject to conditional connection
	BS EN 61000-3-11	Limitation of voltage changes, voltage fluctuations & flicker in public low-voltage supply systems – equipment with rated current ≤75A and subject to conditional connection
Harmonic distortion	BS EN 61000-3-2	Limits for harmonic current emissions (equipment input current ≤16A per phase)
	BS EN 61000-3-12	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16A and ≤75A per phase

Table G1 – Standards for control of voltage changes, voltage fluctuations, flicker and harmonic emissions for equipment to be connected to public LV networks

G1.1 Voltage Changes, Voltage Fluctuations, Flicker and Maximum Source Impedance

Equipment compliant with BS EN 61000-3-3 is not subject to conditional connection. To verify compliance with this standard, voltage changes, voltage fluctuations and flicker produced using a reference source impedance, Z_{ref}, are checked against the limits of Table G2. The values for Z_{ref} are shown in Table G3 and represent the source impedance at the supply terminals. Equipment rated at ≤16A per phase which does not comply with this standard using Z_{ref} may be evaluated to show conformity with BS EN 61000-3-11 instead which allows the use of a lower source impedance.

Equipment falling within the scope of BS EN 61000-3-11 may be subject to conditional connection. When compliance with the limits in the standard is only achieved by keeping the upstream network source impedance below a determined value lower than Z_{ref} above then the manufacturer is required to make one of two statements:

a) '*This equipment complies with IEC 61000-3-11 provided that the source impedance,* Z_{max} $\leq$ *xx…*' because of the requirement to '*determine the maximum permissible system impedance* Z_{max} *at the interface point of the user's supply in accordance with 6.2, declare* Z_{max} *in the equipment instruction manual and instruct the user to determine in consultation with the supply authority, if necessary, that the equipment is connected only to a supply of that impedance or less*'

b) '*This equipment complies with IEC 61000-3-11 provided that the service current capacity ≥100A per phase*' because of the requirement to '*test the equipment in accordance with 6.3 and declare in the equipment instruction manual that the equipment is intended for use only in premises having a service current capacity ≥100 A per phase, supplied from a distribution network having a nominal voltage of 400/230 V, and instruct the user to determine in consultation with the supply authority, if necessary, that the service current capacity at the interface point is sufficient for the equipment. The equipment shall be clearly marked as being suitable for use only in premises having a service current capacity equal to or greater than 100 A per phase.*'

In a note associated with the above, the standard states: *'For options a) and b), if the supply capacity and/or the actual system impedance* Z_{act} *have been declared to, or measured by, the user, this information may be used to assess the suitability of equipment without reference to the supply authority.*'

Thus, the responsibility is initially on the customer to ensure compliance.

In theory, BS EN 61000-3-11 can deal with the issue of multiple connections on a network by scaling down the Z_{max} value so that it is not necessary to consider the impedance at the Point of Common Coupling to cover off the cumulative effect of multiple connections. This scaling down to cover off the cumulative effect of multiple connections is not done within BS EN 61000-3-3.

The limits specified within the above standards are detailed in Table G2.

Parameter	Limit
Short-term flicker[5], P_{st}	1.0
Long-term flicker[6], P_{lt}	0.65
Relative voltage change d(t)	3.3% for more than 500ms
Relative steady-state voltage change[7], d_c	3.3%
Maximum relative voltage change, d_{max}	4% - no additional conditions
	6% - manual switching
	6% - switched automatically more frequently than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds), or manual restart, after a power supply interruption.
	7% - equipment which is attended whilst in use (for example: hair dryers, vacuum cleaners, kitchen equipment such as mixers, garden equipment such as lawn mowers, portable tools such as electric drills),
	7% - equipment which is switched on automatically, or is intended to be switched on manually, no more than twice per day, and also has either a delayed restart (the delay being not less than a few tens of seconds) or manual restart, after a power supply interruption.

Table G2 – Limits from BS EN 61000-3-3 and BS EN 61000-3-11

Equipment Connection	Impedance at Connection Point
Phase-Neutral	0.4+j0.25 Ω = 0.4717 Ω
Phase-Phase	0.48+j0.3 Ω = 0.5660 Ω
3-Phase	0.24+j0.15 Ω = 0.2830 Ω

Table G3 – Reference Impedance, Z_{ref}, according to IEC 60725

G1.2 Harmonic Distortion

Equipment compliant with BS EN 61000-3-2 is not subject to conditional connection. Professional equipment which falls within the scope of this standard but which does not comply with it may be designated by the manufacturer as ‘professional equipment’ requiring application to the supply authority for permission to connect. Other equipment falling within the scope of this standard that does not comply cannot be retested or evaluated to show conformity with BS EN 61000-3-12. This is different to the approach in the flicker control standard BS EN 61000-3-11.

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[5] Short-term flicker severity is the flicker severity evaluated over a short period (in minutes); $P_{st} = 1$ is the conventional threshold of irritability.

[6] Long-term flicker severity is the flicker severity evaluated over a 2-hour period using successive *P*st values.

[7] For example, no load to full load. Note, however, that steady state refers to a condition held for a second or more so the d_c value for a multiple element boiler, for instance, that incorporate a delay of a second or more between switching of each element would relate to the steady state voltage change for a single element and not no load to full load.

Equipment falling within the scope of BS EN 61000-3-12 is subject to conditional connection. Compliance with the current emission limits in the standard is checked at a specific ratio of 3-phase short-circuit fault level at the PCC to equipment rating giving the short circuit ratio, R_{sce}. Thus, compliance is achieved provided that the ratio is at least equal to the specified ratio. The standard states:

> '*For equipment complying with the harmonic current emission limits corresponding to R_{sce} = 33, the manufacturer shall state in the instruction manual supplied with the equipment: "Equipment complying with IEC 61000-3-12"*'

Where the equipment does not comply when $R_{sce} = 33$ then the manufacturer must state:

> "*This equipment complies with IEC 61000-3-12 provided that the short-circuit power S_{sc} is greater than or equal to xx at the interface point between the user's supply and the public system. It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a short-circuit power S_{sc} greater than or equal to xx.*"

where 'xx' is the value of 3-phase short-circuit fault level at the Point of Common Coupling corresponding to the minimum value of R_{sce} for which the relevant limits are not exceeded.

Note that the $R_{sce} = 33$ requirement implies lower values of source impedance than the reference impedance, Z_{ref}, used for unconditional connection with respect to BS EN 61000-3-3 (flicker), noting that Z_{ref} applies at the supply terminals and R_{sce} at the PCC. Typical sizes of heat pump units for new accommodation are 18A for small and 34A for large. The typical size for a retrofit unit is 47A[8]. The resulting maximum phase-neutral source impedances at the PCC are ≤0.3872 Ω for 18A, ≤0.2050 Ω for 34A and 0.1483Ω for 47A. Thus, this requirement is very onerous for the larger equipment ratings. Appendix D gives the complete set of calculated values for equipment rated at 16A through to 75A.

BS EN 61000-3-2 and -12 are intended to deal with the issue of the cumulative effect of multiple connections on a network by selection of the harmonic current limits.

G2.0 Policy Considerations

Although there are duties on installers and customers arising from the above, these appear to be largely ineffective. Experience has shown that the statements required by the standards are not always made or easy to find and rarely acted upon by installers. Some manufacturers have also been found to be unaware of the relevant standards. However, the DNOs have a duty under Regulation 3 of the ESQC Regulations 2002 to prevent interference so far as is reasonably practicable. Therefore, to ensure the source impedance is suitable for connection of possibly disturbing equipment a more pro-active policy than simply responding to requests for Z_{max}, R_{sce} and S_{sc} is required. Thus, it is necessary to identify relevant equipment, as

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[8] Source: BEAMA presentation.

far as is reasonably practicable, and seek to design to ensure the network source impedance is sufficiently low and conversely the fault level sufficiently high. There is a balance to be struck such that the number of assessments is limited to those that really matter.

G2.1 Flicker and Source Impedance

At present, we effectively state a phase-neutral source impedance of 0.35 Ω for new Protective Multiple Earth (PME) connections, which constitute the majority of new connections, by virtue of this being the same as the earth loop impedance for PME. We design to a resistive phase-neutral source impedance limit of 0.25 Ω in WinDebut for new; this applies to main and service so refers to the source impedance at the supply terminals. Equipment that conforms to BS EN 61000-3-3 and, therefore, can be unconditionally connected is checked with a reference impedance, Z_{ref}, of 0.4717 Ω = 0.4 + j0.25 Ω for single-phase equipment as per Table G3. However, from Table G2 it can be seen that this does allow flicker at the supply terminals to reach the annoying level (i.e. P_{st} =1.0). Thus, there may be some risk with multiple connections from the combined flicker. Furthermore, there may also be risk of P_{st} exceeding 1.0 at sites with source impedance exceeding Z_{ref}. Appendix F gives some examples.

G2.1.1 Flicker from Multiple Connections of BS EN 61000-3-3 Compliant Equipment

WinDebut has a phase-neutral source resistance limit of 0.20 Ω for the main without the service. This can be seen as the source resistance at the PCC and corresponds to an impedance of around 0.23 Ω. Thus, equipment which just passes BS EN 61000-3-3 for short-term flicker would produce a maximum P_{st} of around 0.23/0.4717 x 1.0 = 0.5 at the PCC of a network designed to the above limit. This flicker level is the same as is permitted by P28 Stage 2. Thus, this risk appears acceptable.

For existing networks, predating WinDebut, the phase-neutral source impedance at the PCC may be higher than 0.23 Ω. Examples include networks with small size transformers or long, small sized conductors – see Appendix F. Note that IEC TR 60725 quotes that 98% of residential customers have a phase-neutral source impedance at the supply terminals of less than 0.64 Ω and 90% less than 0.34 Ω, equating to around 0.512 Ω and 0.27 Ω, respectively, at the PCC. In this case, equipment which just passes BS EN 61000-3-3 for short-term flicker would produce a maximum P_{st} of around 0.512/0.4717 x 1.0 = 1.085 and 0.27/0.4717 x 1.0 = 0.576 at the PCC for source impedance of 0.512 Ω and 0.27 Ω, respectively. Multiple connections, where the flicker is combined at the PCC using a cube, sum and cubed root formula could therefore be problematic in a small number of cases:

$$P_{st\ combined} = \sqrt[3]{(P_{st\ background}^3 + P_{st\ source1}^3 + P_{st\ source2}^3 + \ldots P_{st\ sourceN}^3)}$$

However, high source impedances would tend to occur with small numbers of customers and so limiting the number of flicker sources on a given LV network. Furthermore, BS EN 61000-3-3 also has a long-term flicker limit of P_{lt} = 0.65 and this may tend to limit the P_{st} too. For example, for frequent switching P_{st} approaches P_{lt} and hence with a 0.512 Ω source impedance at the PCC the P_{st} would approach a maximum of 0.512/0.4717 x 0.65 = 0.71.

In conclusion, multiple connections of equipment compliant with BS EN 61000-3-3 are not expected to be problematic in the majority of cases.

G2.1.2 Flicker From Multiple Connections of BS EN 61000-3-11 Compliant Equipment

BS EN 61000-3-11 uses the same voltage change, voltage fluctuation and flicker limits as BS EN 61000-3-3. Experience to date has revealed equipment specific phase-neutral Z_{max} values stated by manufacturers ranging from 0.17 Ω to just under Z_{ref}.

BS EN 61000-3-11 has a control in clause 6.2.2 aimed at dealing with the effect of multiple connections by scaling down the Z_{max} stated. This uses $Z_{ref}\,(1/P_{st})^{3/2}$. Whilst some manufacturers have been seen to apply this technique there is some confusion over the wording of clause 6.2.2 as to whether it applies to automatically switched equipment. This is being pursued with the relevant standards committee. If it proves that the stated Z_{max} has not been derived as above then it would be necessary to derive a lower $Z_{max'}$ than the stated one from $Z_{max'} = 0.3892(Z_{max}^{2/3})$ to allow for multiple connections. This scaling down to cover off the cumulative effect of multiple connections is not done within BS EN 61000-3-3.

In conclusion, multiple connections of equipment compliant with BS EN 61000-3-11 is not expected to be problematic in the majority of cases provided the network is designed to achieve the associated lower source impedance, Z_{max} or $Z_{max\ 100A}$, at the supply terminals.

G2.2 Harmonic Distortion and Fault Level

BS EN 61000-3-2 and -12 are intended to deal with the issue of the cumulative effect of multiple connections on a network by selection of the harmonic current limits. For BS EN 61000-3-12 the effectiveness of the limits is dependent on the network having a sufficiently high fault level. As the penetration of harmonic equipment increases it may be necessary for the relevant standards committees to consider reducing the permitted harmonic current emissions or consider harmonic filters.

A key decision DNOs have to make is whether to ensure $R_{sce} \geq 33$ at the PCC as this imposes onerous source impedance requirements. Appendix D tabulates the values. It is clear that the values required for harmonic control are much lower than for flicker control using Z_{ref}. BS IEC 61000-3-4 predates BS EN 61000-3-12 but covers the same issue; it states that *'Equipment complying with Table 1 for the emission of harmonic currents into the public supply system can be connected at any point of the supply system provided the short-circuit ratio R_{sce} is equal to or higher than 33.'* Thus, the intention is that the requirement is conditional. Furthermore, values for typical ratings are much lower than Z_{ref}; for a typical retrofit unit rated at 47A single-phase this equates to a phase-neutral source impedance of 0.1483 Ω. Thus, we deduce that to adequately control harmonic distortion it is necessary to design the network to meet the minimum fault level corresponding to $R_{sce} \geq 33$ and networks must be designed to ensure it is met.

APPENDIX H

SUPERSEDED DOCUMENTATION

ST:SD6G	Potentially Disturbing Electrical Equipment - Equipment Subject to Conditional Connection - Electric Boilers for Central Heating
ST:SD6H	Potentially Disturbing Electrical Equipment - Equipment Subject to Conditional Connection - Electric Heat Pumps for Heating/Hot Water

APPENDIX I

ASSOCIATED DOCUMENTATION

POL:SD5/4	LV System Design
ST:SD5A/1	Design of Low Voltage Domestic Connections
ST:SD5K/3	Use of WinDebut Software
ST:SD6F	Dealing with Potentially Disturbing Electrical Loads/Equipment
ST:SD5N	Use of WinDebut Software for Assessing Motor and Welder Voltage Disturbance (Flicker)
ST:SD5O/1	Load Approval at Domestic Properties Requiring No Detailed Investigation
Engineering Recommendation G5/4-1	Planning Levels for Harmonic Voltage Distortion and the Connection of Non-linear Equipment to Transmission Systems and Distribution Networks in the United Kingdom.
Engineering Recommendation P28	Planning Limits for Voltage Fluctuations Caused By Industrial, Commercial and Domestic Equipment in the United Kingdom
BS EN 61000-3-2	Limits for harmonic current emissions (equipment input current ≤16A per phase)
BS EN 61000-3-3	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
BS EN 61000-3-11	Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75A and subject to conditional connection
BS EN 61000-3-12	Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16A and ≤75A per phase

IEC TR 61000-3-4	Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16A

APPENDIX J

IMPLEMENTATION OF POLICY

This Standard Technique shall be implemented on issue. No retrospective action is required unless subject to justified complaint.

APPENDIX K

IMPACT ON COMPANY POLICY

This Standard Technique is relevant to planning staff involved in LV connection design of potentially disturbing electrical equipment, including heat pumps, electric central heating boilers and electric vehicle chargers. It is intended to simplify the overall design process.

APPENDIX L

KEY WORDS

Boiler, Connection, Electric Vehicle, Flicker, Harmonic, Heat Pump, Kiln, PV, PCC, UPS, WinDebut, Wind Turbine.

APPENDIX M

DOCUMENT REVIEW

This document requires review in November 2015.