Electricity Distribution

nationalgrid

Company Directive

ENGINEERING SPECIFICATION
EE SPEC: 16/10

LV Distribution Fuseboards

Policy Summary

1. This specification details requirements for LV Distribution Fuseboards for use on National Grid Electricity Distribution's distribution system.

2. The specification is based on EA Technical Specification 37-2. (Issue 6, 2023) (Public Electricity Network Distribution Assemblies) (PENDA)

Author: **Anthony Smith**

Implementation Date: **June 2024**

Approved by

Carl Ketley-Lowe
Head of Engineering Policy

Date: **25th June 2024**

Target Staff Group	**Procurement to utilise this document for future framework contracts. Plant centres to note but no action required.**
Impact of Change	**Green**
Planned Assurance checks	**Future framework contracts to be assessed against this specification. Does not affect existing contracts.**

IMPLEMENTATION PLAN

Introduction

This document revises the existing NGED specification and provides for future requirements.

Main Changes

Minor edits to cover updated specifications and correct errors.

Impact of Changes

No direct impact on current application/use of this equipment.

Implementation Actions

Specification EESPEC 16/9 is to be withdrawn on release of this revised version.

Procurement to utilise this revised specification for establishing a new purchasing contract.

Plant Centres to note.

Implementation Timetable

This revised document may be implemented immediately for the purpose of tender and establishing a revised Framework Contract but does not affect existing framework contracts.

REVISION HISTORY

Document Revision & Review Table		
Date	**Comments**	**Author**
June 2024	• Updated references to National standards. • Added requirement for wired out shunt trip on circuit breakers • Amended socket to be latching Type A RCD • MDI replaced with power measurement device • Added section 4.2 for remote voltage measurement	Anthony Smith
January 2019	• Added table of contents. • 3.8.2 replaced “When requested” with “Where possible” Table 1a • Removed option TMC 08/4/- Table 3 • Table revised to allow for additional cable requirements from 4 to 7 or 8 on 800/1250A units and 7 or 8 to 10 or 11 for 1600A units	Anthony Smith
December 2017	• Introduction of an option for current transformers on each outgoing feeder way for future load monitoring and LV network control purposes. • WPD Type References have been revised for ease of specifying. • Additional standard types have been introduced.	S. Hennell

CONTENTS

1.0 SCOPE

This specification covers fuseboards of a shielded pattern with insulation to shield operators and others working on the equipment against inadvertent contact with live components of the following types:-

(i) PENDA-I – Substation Cable Distribution Board - Indoor. NGED designation - IFB.

(ii) PENDA-CCO - Substation Cable Distribution Board - outdoor ground mounted pillar. NGED designation - FP.

(iii) PENDA-TMO - Substation Cable Distribution Board - outdoor transformer mounted fuse cabinet. NGED designation - TMC.

Where the term “shall” or “must” is used in this document, it means the requirement is mandatory. The term “should” is used to express a recommendation. The term “may” is used to express permission.

2.0 INTRODUCTION

All equipment supplied under this specification shall meet the technical requirements of EA Technical Specification 37-2 – Public Electricity Network Distribution Assemblies. Copies can be obtained from the Electricity Networks Association (ENA).

Clauses contained within this specification are in addition to the requirements of EA Technical Specification 37-2. Where there is any conflict between EA Technical Specification 37-2 and this document, this document shall take precedence.

3.0 TYPE AND DESIGN

3.1 General

3.1.1 The range of NGED standard equipment required is detailed in Table 1a, Table 1b and Table 2 of this specification. Alternative equipment, to this standard, shall be as specified at time of purchase.

3.1.2 A Circuit Breaker as specified in clause 3.3 shall be suitable for terminating 8 x 600/740mm^2 “SOLIDAL” or 630mm^2 Copper armoured single core cables.

3.1.3 All equipment shall be supplied complete with bolts, washers, nuts and spring washers to make the connection between the cabinet and the transformer where applicable.

3.1.4 All neutrals on equipment supplied to NGED shall be full sized i.e. the same current rating as the corresponding phases.

3.1.5 A fully rated bolted link shall be provided for disconnection of the neutral.

3.1.6 All outdoor equipment shall be designed to allow water shedding from all surfaces and prevent any accumulation of water or wind-borne materials.

3.1.7 All outdoor equipment shall have a surface preparation and coating system in line with Scheme 4 of ENATS 98-1 ie. 10-20 years to first maintenance in an exposed polluted coastal environment.

3.1.8 All transformer mounted cabinets shall be supplied with deep doors in order to readily accommodate any future LV automation devices or monitoring equipment.

3.1.9 All equipment shall be supplied complete with shear-off type connectors, to NGED standard, for making outgoing cable connections to 630amp fuseways where applicable.

3.1.10 All equipment shall be supplied with bolts, washers, nuts and spring washers to make the connection between a circuit breaker and the outgoing "SOLIDAL" cables where applicable.

3.2 Short Circuit Rating (3 second)

3.2.1 Equipment of 800A or below shall have a short circuit rating of 18kA.

3.2.2 Equipment above 800A to 2000A inclusive shall have a short circuit rating of 35.5kA as detailed in Table ENATS3 of ENATS 37-2 irrespective of transformer size.

3.2.3 2400A and 3150A equipment shall have a short circuit rating of 50.0kA

3.3 Specification of Circuit breaker

3.3.1 Minimum rated service short circuit breaking capacity (I_{cs}) shall be 35.5kA unless apparatus rating per 3.2.3. Minimum rated short time withstand current (I_{cw}) shall be 20kA for 1 second. Rated current for the circuit breaker shall be 800A, 1250A or 1600A etc as determined by the unit type.

3.3.2 The mechanism shall be independent manual.

3.3.3 The circuit breaker shall be suitable for providing a point of isolation.

3.3.4 The unit shall be Selectivity category B. (As outlined in BS EN 60947-2 Clause 4.4).

3.3.5 The ratings of the circuit breaker shall be when the circuit breaker is fitted in the cabinet / pillar / distribution board and the whole assembly subject to temperature rise test as detailed in clause 10.10 of ENATS 37-2. (Verification of temperature-rise limits).

3.3.6 The circuit breaker shall be equipped with integral, adjustable, phase fault protection with characteristics and setting ranges specified below:

- Overload characteristic, adjustable between 0.5 x and 1.0x circuit breaker Rated Current (at least 5 steps).
- I^2t characteristic with time settings adjustable between 1 and 20s at 6x the overload setting (at least 4 steps).
- A short time characteristic, selectable between definite time and I^2t with current setting adjustable between 2x and 8x overload setting (at least 5 steps) and with time setting adjustable between 0 and 0.4s (at least 4 steps).

- An instantaneous characteristic with current setting adjustable between 2x and 10x the circuit breaker Rated Current (at least 5 steps).

In addition to phase fault protection, 1600A circuit breakers shall be equipped with residual earth fault protection satisfying the following requirement:

- Earth fault characteristic selectable between definite time and I^2t with current setting adjustable between 600A and 1200A (at least 5 steps) and with time setting adjustable between 0 and 0.4s (at least 4 steps).

A facility must be provided to lock the circuit breaker in the open position with a padlock. This locking arrangement shall meet the requirements of Clause 8.201.c of ENATS 37.2

The circuit breaker must comply with BS EN 61000 – Electromagnetic Compatibility (EMC).

3.3.7 The circuit breaker shall have a 240V 50Hz shunt trip coil and auxiliary switch that shall be wired out to a termination via a protective fuse.

3.4 Indoor Fuseboards and Fusepillars only

3.4.1 For indoor fuseboards the design shall permit the use of incoming insulated bars or cables as follows:-

- 1600A units suitable for 12 cables
- 1250A units suitable for 8 cables
- 800A units and below suitable for 4 cables

3.4.1 The arrangement of the incoming and outgoing units shall be suitable for cables approaching from below.

3.4.1.1 In the case of indoor fuseboards, however, the design shall be such that the cable support bar can be refitted on site so that the transformer connections and/or distributor cables may approach from either below or above.

3.4.2 The palms to accept the compression lugs or mechanical connectors on the ends of the incoming cables shall be drilled with 4 holes drilled in accordance with Figure 16 of BS2562:1979

3.4.3 Bolts, nuts, locknuts and washers to secure the lugs and connectors to the palms on the transformer unit shall be provided, but lugs or connectors are not to be supplied. (Provision shall be made for the palm on the lug or connector having a minimum thickness of 13mm).

3.4.4 The copper connections between the transformer terminals and the transformer isolator in the pillar shall be made in bolted sections so that they can be re-arranged on site to give any desired sequence of phase connections to the busbars.

3.5 Generator Connection

3.5.1 Provision for connecting a generator shall be provided, with all units except the outdoor feeder pillar design.

3.5.2 The connection from the transformer side to the synchronising reference fuses shall be double insulated and of not less than 16mm².

3.5.3 Female ‘Litton’ connectors (or equivalent) shall be provided on each busbar and the neutral/earth bar to allow the safe connection of generator cables onto live PENDA’s. Two connectors shall be provided for each phase and neutral on equipments with 1600A or greater busbar rating. One connector shall be provided for each phase and neutral on equipments with 800A busbars. Each connector shall be rated at 600A and shall be easily accessible for fitting and removal

3.5.4 Evidence of temperature rise tests shall be supplied at the time of tender with all the generator cables carrying the full 600A current and the adjacent outgoing ways arranged to obtain current balance.

3.5.5 The cabinet/pillar doors shall be able to be closed and locked with the generator cables connected without applying too much stress to the cables.

3.6 Auxiliaries

3.6.1 The phase connections to the auxiliary fuses from the busbars shall be insulated or fully shrouded copper strap of not less than 75mm².

3.6.2 All PENDA-CCO and PENDA-TMO’s shall be fitted with a guarded internal light with an on/off switch. Replacement of lamp should not require access to live parts.

3.6.3 All PENDA-CCO and PENDA-TMO’s shall be fitted with a 230Vac BS1363 Type A Latching RCD socket. The device shall be mounted in a separate protective recess such that replacement can be made without affecting the IP rating of the primary equipment and without requiring to access live parts.

3.6.4 For hot sites, the provision of an optional isolation transformer will be required.

3.6.5 A suitable DIN rail shall be provided with 6A fused power connections for powering any LV monitoring apparatus within the substation environment.

3.7 Cables

3.7.1 Where 'SOLIDAL' cables are to be terminated on one of the outgoing circuits, holes drilled in accordance with Figure 16 of BS2562:1979, to accommodate mechanical connectors shall be fitted.

The connectors to NGED specification, shall be supplied along with bolts, nuts, washers and lock washers. Provision should be made for the connector to have a palm thickness of 13.2mm and no offset.

A means shall be provided for supporting the cables. For feeder ways this shall be a cleat or clamp arrangement suitable for the range of cable sizes to be terminated.

Where aluminium wire armoured singles cables are utilised then a suitable split, non-ferrous, gland plate or cable support arrangement shall be installed. Ferrous plates shall be insulated. This arrangement shall provide for the armour wires of the singles cables to be connected together and independently connected as a group to earth to permit the earthing and bonding requirements of SD5E Figures 8 to 14 to be met.

The gland plate shall be pre-drilled to accept 4, 7 or 8 glands with grommets provided to blank off holes that are not required. [See Table 3 & Table 4]

3.7.2 The neutral/earth busbar connection for each outgoing distributor cable shall be at least as Clause 8.201.d (Neutral and Earth Connectors) of ENATS 37-2, but the bolt being long enough to accept a lug with a 12mm thick palm and full washer/nut/lock nut.

3.8 Current Transformers

3.8.1 A current transformer shall be provided within each phase of the incoming transformer disconnecting unit for operation of eg a power meter. Ratios are as detailed in Table 1. Details of the power measurement device are outlined below.

3.8.2 A current transformer ratio 500/5, 2.5VA output and Class 0.5S accuracy, of a design supplied by the manufacturer, shall be fitted to all 3 phases of each outgoing distributor unit of transformer mounted fuse cabinets. Current transformers shall have a thermal rating that matches the rating of the outgoing distributor unit.

3.8.3 The secondary connections of each CT shall be brought out to an accessible terminal block, preferably within the unit.

Where this is not practicable then the connections shall be brought out to an external box mounted on the left hand side of the PENDA. This box shall be designed and manufacturer to the same specification as the PENDA housing, have a hinged padlockable door.

Any connections within the CT wiring shall be made at an accessible terminal block.

The terminal blocks shall have integral CT shorting links.

The terminal box shall have a suitable gland plate for the termination of multicore cable.

3.9 Rogowski Coil

Where current transformers are not requested on outgoing ways then the facility shall be provided to fit a Rogowski coil to each phase of each outgoing way with the cabinet live and the outgoing fuses fitted. The facility shall be able to accept a flexible probe of up to 8mm diameter.

4.0 LOAD MEASUREMENT

4.1 Power Indication

4.1.1 A suitable device, as below, capable of displaying basic power measurements integrated over a 30 minute period. The Meter shall be capable of displaying currents from 0 to the maximum values identified in Table ENATS1, without re-selection of scale. The instrument may display three-phase current and voltage, or be capable of switching between phases.

4.1.2 The power measuring instrument may utilise conventional or non-conventional (i.e. electronic) design components which shall provide a high level of security and reliability and should have an anticipated asset life commensurate with the primary equipment.

4.1.3 In cases where the measuring instrument or its sub-components have an anticipated asset life of less that the primary equipment (taking account of its operating environment) then the equipment shall be designed to be physically interchangeable.

It shall be possible to safely replace the instrument without affecting the IP rating of the primary equipment and without requiring to access live parts. Secondary screening behind the instrument panel shall be provided to enable the maximum demand indicator to be changed with the cabinet live.

It shall be possible to change the instrument whilst ensuring that CT secondary circuits are not open-circuited.

4.1.4 If the measuring device utilises batteries then it shall be possible to change the batteries without any intrusive work and with the primary equipment in service. The manufacturer shall declare the frequency for replacing the batteries.

4.1.5 The device shall be driven by suitable current transformers, and be rated at 1A or 5A

4.1.6 The measurement device shall be pre programmed by the cabinet supplier to match the ratings (current/voltage) of the feeder(s) it is connected to primarily the transformer feeder leg.

4.1.7 Ideally, the measurement device should have the ability to output its readings via an RS232/485 cable which shall be wired to the DIN rail within the cabinet.

4.2 Feeder Voltage Measurement

4.2.1 A 1A fused termination shall be provided at the same accessible location provided for the feeder CTs, to facilitate remote measurement of a feeder voltage

Table 1a - Arrangements of Transformer Mounted Fuse Cabinets

NGED Type		**TMC 16/5/-**	**TMC 16/4/-**	**TMC 16/7/-**
Previous NGED Designation		IX	VII	III
ENA Type Designation		PENDA-TMO1	PENDA-TMO2	N/A
Transformer size (Max)		1000kVA	1000kVA	1000kVA
Transformer type (ENA Technical Specification 35-1)		Unit / Cable connected	Unit / Cable connected	Unit / Cable connected
Current rating of busbars and incoming transformer unit	(a) phases	1600A	1600A	1600A
	(b) neutral	1600A	1600A	1600A
Type on incoming transformer unit		Disconnector	Disconnector	Disconnector
No. and size of outgoing distributor units	Fuseway	5 x 630A	4 x 630A	7 x 630A
	MCCB	-	-	-
Transformer flange to Fig. 25 BS2562		F	F	F
Deep door		Yes	Yes	Yes
Current Transformer ratio – one per phase – incoming transformer circuit		1600/800/5	1600/800/5	1600/800/5
Current/voltage measurement – one indicator per phase – incoming transformer unit and feeders (a) Scales		0-1920A 0-960A	0-1920A 0-960A	0-1920A 0-960A
(b) minimum scale marking		320/160A	320/160A	320/160A
Maximum Dimensions External width of enclosure body		760mm	610mm	1060mm
Height from centre line of truncking (i) to top of enclosure		460mm	460mm	460mm
(ii) to bottom of enclosure		1270mm	1270mm	1270mm
Number of Generator Connections		2 sets	2 sets	2 sets

Table 1b - Arrangements of Transformer Mounted Fuse Cabinets c/w Circuit Breakers

NGED Type		**TMC 16/2/CB8**	**TMC 16/4/CB8**	**TMC 16/2/CB12**	**TMC 16/4/CB12**	**TMC 16/-/CB16**	**TMC 16/-/2CB8**
Previous NGED Designation		XIII	-	XIV	-	XV	XVI
ENA Type Designation		N/A	N/A	N/A	N/A	N/A	N/A
Transformer size (Max)		1000kVA	1000kVA	1000kVA	1000kVA	1000kVA	1000kVA
Transformer type (ENA Technical Specification 35-1)		Unit / Cable connected	Unit / Cable connected	Unit / Cable connected	Unit / Cable connected	Unit / Cable connected	Unit / Cable connected
Current rating of busbars and incoming transformer unit	(a) phases	1600A	1600A	1600A	1600A	1600A	1600A
	(b) neutral	1600A	1600A	1600A	1600A	1600A	1600A
Type on incoming transformer unit		Disconnector	Disconnector	Disconnector	Disconnector	Disconnector	Disconnector
No. and size of outgoing distributor units	Fuseway	2 x 630A	4 x 630A	2 x 630A	4 x 630A	-	-
	MCCB	1 x 800A	1 x 800A	1 x 1250A	1 x 1250A	1 x 1600A	2 x 800A
Transformer flange to Fig. 25 BS2562		F	F	F	F	F	F
Deep door		Yes	Yes	Yes	Yes	No	No
Current Transformer ratio – one per phase – incoming transformer circuit		1600/5	1600/5	1600/5	1600/5	1600/5	1600/5
Current/voltage measurement – one indicator per phase – incoming transformer unit and feeders							
(a) Scales		0-1920A 0-960A 230/400±10%	0-1920A 0-960A 230/400±10%	0-1920A 0-960A 230/400±10%	0-1920A 0-960A 230/400±10%	0-1920A 0-960A 230/400±10%	0-1920A 0-960A 230/400±10%
(b) minimum scale marking		320/160A	320/160A	320/160A	320/160A	320/160A	320/160A
Maximum Dimensions External width of enclosure body		750mm	1100mm	750mm	1100mm	750mm	750mm
Height from centre line of truncking (i) to top of enclosure		460mm	460mm	460mm	460mm	460mm	460mm
(ii) to bottom of enclosure		1270mm	1270mm	1270mm	1270mm	1270mm	1270mm
Number of Generator Connections		2 sets	2 sets	2 sets	2 sets	2 sets	2 sets

Table 2 - Arrangements of Outdoor Feeder Pillars and Indoor Fuseboards

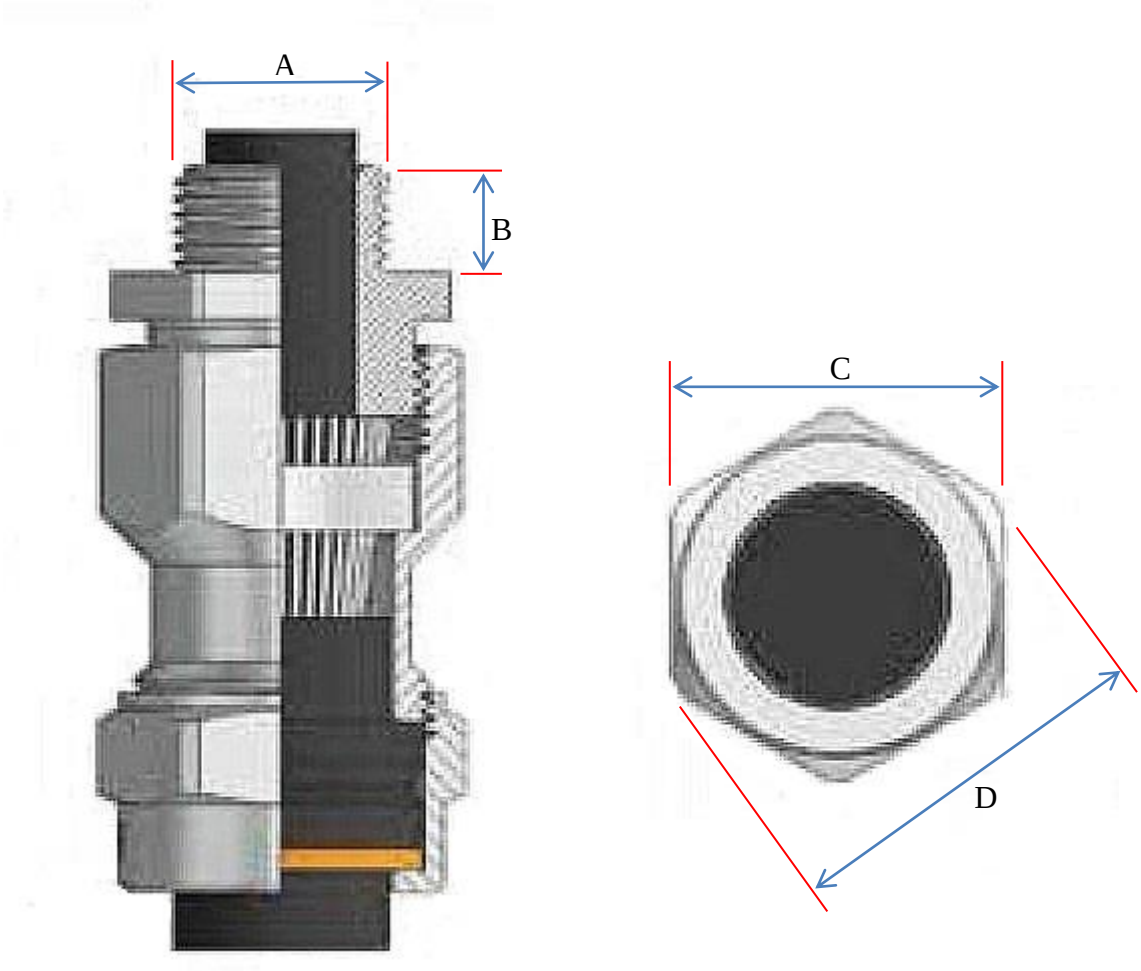
NGED Type	**OFP 08/3/-**	**OFP 08/5/-**	**OFP 16/6/-**	**OFP 16/10/-**	**IFB 16/7/-**	**IFB 16/10/-**
Previous NGED Designation	FP3	FP5	-	-	IFB7	-
ENA Type Designation	N/A	N/A	N/A	N/A	N/A	N/A
Transformer size (Max)	N/A	N/A	N/A	N/A	N/A	N/A
Transformer type (ENA Technical Specification 35-1)	N/A	N/A	N/A	N/A	N/A	N/A
Current rating of busbars Current rating of incoming transformer unit (a) phases (b) neutral	800A 630A 630A	800A 630A 630A	1600A 1600A 1600A	1600A 1600A 1600A	1600A 1600A 1600A	1600A 1600A 1600A
Type on incoming transformer unit	1 x 630A Solid Link	2 x 630A Solid Links	Solid Link	Solid Link	Solid Link	Solid Link
No. and size of outgoing distributor units	3 x 630A	5 x 630A	6 x 630A	10 x 630A	7 x 630A	10 x 630A
Transformer flange to Fig. 25 BS2562	N/A	N/A	N/A	N/A	N/A	N/A
Current Transformer ratio – one per phase – incoming transformer circuit	None	None	1600/5	1600/5	1600/5	1600/5
Current/voltage measurement – one indicator per phase – incoming transformer unit and feeders (a) Scales (b) minimum scale marking	None	None	 0-1920A 0-960A 230/400±10% 320/160A	 0-1920A 0-960A 230/400±10% 320/160A	 0-1920A 0-960A 230/400±10% 320/160A	 0-1920A 0-960A 230/400±10% 320/160A
Maximum Dimensions External width of enclosure body	As required	As required	As required	As required	As required	As required
Height from centre line of truncking (i) to top of enclosure (ii) to bottom of enclosure						
Number of Generator Connections	N/A	N/A	2 sets	2 sets	2 sets	2 sets

Table 3 - Numbers of Cable Cores per Circuit Breaker Rating

Cables [Aluminium Tape Armoured]	Circuit Breaker Rating		
	800A	1250A	1600A
600mm^2 "Solidal"	7 or 8 (2 per ph. / 1 or 2 neutral)	7 or 8 (2 per ph. / 1 or 2 neutral)	10 or 11 (3 per ph. / 1 or 2 neutral)
740mm^2 Solidal"	7 or 8 (2 per ph. / 1 or 2 neutral)	7 or 8 (2 per ph. / 1 or 2 neutral)	10 or 11 (3 per ph. / 1 or 2 neutral)
630mm^2 Copper	7 or 8 (2 per ph. / 1 or 2 neutral)	7 or 8 (2 per ph. / 1 or 2 neutral)	10 or 11 (3 per ph. / 1 or 2 neutral)

Table 4 - Cable Gland Characteristics
600mm^2, 630mm^2 and 740mm^2 Aluminium Wire Armoured Cables

Gland Kit Reference	Entry Thread mm (A)	Thread Length mm (B)	Hexagon	
			Across Faces mm (C)	Across Corners mm (D)
KA422-58	M50 x 1.5	15	65.5	72.1
KA422-59	M50 x 1.5	15	70.1	77.2



APPENDIX A

SUPERSEDED DOCUMENTATION

This document supersedes EE SPEC: 16/9 dated January 2019 that has now been withdrawn.

APPENDIX B

RECORD OF COMMENT DURING CONSULTATION

No comments required as only minor update of document.

APPENDIX C

ASSOCIATED DOCUMENTATION

ST: SD5E Design of Low Voltage Commercials and Industrial Connections

ENA Technical Specification 37-2 Public Electricity Network Distribution Assemblies
ENA Technical Specification 98-1 Environmental classification & corrosion protection of Structure, plant and equipment

APPENDIX D

KEYWORDS

Fuseboard, Cabinet, Transformer, Pillar, LV (Low Voltage), Fusebox, Fuse, Fuse-links, Fuse-carriers, Disconnector.