




**SPECIFICATION FOR
LOW VOLTAGE
UNDERGROUND CABLE
(L-S3)**


CKE.LS.01.03.(01).2020

JKR 20300-0138-23

**CAWANGAN KEJURUTERAAN
ELEKTRIK**

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1.0 GENERAL

1.1 SCOPE

- 1.1.1 This section of the Specification describes and specifies requirements for the supply, delivery, installation, testing, commissioning and handing over in approved working order and maintenance during the Defects Liability Period of the underground cabling works in accordance with the Conditions of Contracts, Bill of Quantities, Drawings and other related documents.

1.2 STANDARDS


- 1.2.1 All standards shall conform to the latest Malaysia Standards (MS), International Electrotechnical Commission (IEC), MS IEC, British Standard (BS), and /or BS EN standard.

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2.1 TYPES OF CABLES


2.1 This specification shall cover the following types of cables: -

- 2.1.1 PVC/SWA/PVC Cable (Polyvinyl Chloride / Steel Wire Armoured / Polyvinyl Chloride) - Cable shall be manufactured and tested in accordance with MS 2103. The conductors shall be of Class 2 (stranded conductors) plain aluminium or plain annealed copper in accordance with MS IEC 60228 insulated with polyvinyl chloride (PVC) suitable for a voltage of 600/1000 V laid together and bedded with PVC, armoured with galvanised steel wires and sheathed with PVC. The maximum conductor temperatures during normal operation is 70°C in accordance with MS 2103. The conductor shall be of annealed copper or else specified.
- 2.1.2 PVC/AWA/PVC Cable (Polyvinyl Chloride / Aluminium Wire Armoured / Polyvinyl Chloride) - Cable shall be manufactured and tested in accordance with MS 2101. The conductors shall be of Class 2 (stranded conductors) plain aluminium or plain annealed copper in accordance with MS IEC 60228 insulated with polyvinyl chloride (PVC) suitable for a voltage of 600/1000 V laid together and bedded with PVC, armoured with aluminium wires and sheathed with PVC. The maximum conductor temperatures during normal operation is 70°C in accordance with MS 2101. The conductor shall be of annealed copper or else specified.
- 2.1.3 XLPE/SWA/PVC Cable (Cross-linked Polyethylene / Steel Wire Armoured / Polyvinyl Chloride) - Cable shall be manufactured and tested in accordance with MS 2107 or IEC 60502-1. The conductors shall be of Class 2 (stranded conductors) plain aluminium or plain annealed copper in accordance with MS IEC 60228 insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC, armoured with galvanised steel wires and sheathed with PVC. The maximum conductor temperature during normal operation is 90°C in accordance with IEC 60502-1. The conductor shall be of annealed copper or else specified.
- 2.1.4 XLPE/AWA/PVC Cable (Cross-linked Polyethylene / Aluminium Wire Armoured / Polyvinyl Chloride) - Cable shall be manufactured and tested in accordance with MS 2105 and IEC 60502-1. The conductors shall be of Class 2 (stranded conductors) plain aluminium or plain annealed copper in accordance with MS IEC 60228 insulated with cross-linked polyethylene (XLPE), suitable for a voltage of 600/1000 V laid together and bedded with extruded PVC, armoured with aluminium wires and sheathed with PVC. The maximum conductor temperatures during normal operation is 90°C in accordance with IEC 60502-1. The conductor shall be of annealed copper or else specified.

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2.1.5 All cable shall be legibly and durable marked on the external surface of the cable with at least the following elements;

- a) Manufacturer's identification,
- b) Voltage designation,
- c) Manufacturing year and the standard number.
- d) Number of core (optional)
- e) Nominal cross-sectional area and type of conductor (optional)

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3.0 CABLE ROUTES

- 3.1 Cable routes shown in the Drawings are for tendering purpose only. The Electrical Contractor shall submit working drawings as required in Section 13.0 of the proposed routes and peg out the cable routes for the approval of the S.O / S.O's Representative prior to excavation of the cable trenches. The work programme for excavation of cable trenches, cable piping, laying of cables, reinstatement of trenches etc. shall be submitted to the S.O / S.O's Representative for approval one week before execution of the work.
- 3.2 The Electrical Contractor shall make available all necessary insurance or guarantee and shall also ensure all approvals are obtained from relevant authorities prior to commencing works. The Electrical Contractor shall be responsible in making good any damage to buildings, tarmacs, pavements, concrete areas, slopes, drains, culverts, pipes, etc. which had not been properly make good arising out of his work.

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4.0 LENGTH OF CABLE

- 4.1 The length of cable each indicated in the Drawings and/or Bill of Quantities is for tendering purpose only. The Electrical Contractor shall ascertain the length of each cable required before ordering. Actual length of each cable installed shall be measured on site and the Electrical Contractor shall be paid according to the unit rate in the Contract. However, the rates quoted shall include wastage due to cutting to lengths, terminations, etc.

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5.0 CABLE TRENCH

- 5.1 Unless otherwise specified, cable trenches shall be 750mm depth below finished ground level. The trenches shall be of sufficient width to enable provision of adequate spacing between cables but in any case, shall be of minimum 450mm wide.
- 5.2 Trenches shall be kept as straight as possible and shall have vertical sides which shall be protected where necessary to avoid subsidence and damage. The bottom of the trenches shall be firm and of smooth contour and any other objects likely to damage the cable sheathing shall be removed. The material excavated from the trenches shall be placed or removed so as to prevent nuisance or damage to adjacent areas or buildings.
- 5.3 The trench excavation and filling-in shall be executed that all roads, walls, sewers, drains, pipes, cables, structures, etc. shall be reasonably secured against risk of subsidence damage. Provision shall be made, during excavation and until interim restoration has been completed, for reasonable access of persons and vehicles to the areas of buildings adjacent to the trenches.
- 5.4 The Electrical Contractor shall provide pumps and other appliances for the necessary pumping required for the disposal of water to prevent any risk of the cables and other materials to be laid in the trenches being detrimentally affected. Where necessary, bailing shall be provided.
- 5.5 Where trenches pass from a footway to a roadway or at other positions where a change of level is necessary, the bottom of the trench shall rise or fall gradually as per S.O / S.O's Representative approval.

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6.0 CABLE DUCTS

- 6.1 At road crossings, sewerage pipe crossings, water pipe crossings, paved areas, concrete areas, and where specified by the S.O / S.O's Representative, cables shall be protected by heavy duty galvanised iron class B or class C (Road work), or heavy duty uPVC Class D or High-Density Polyethylene (HDPE) PN10 pipes buried to a depth of 900mm below finished ground level. The pipes shall be of heavy-duty type, complying with MS 863 or MS 628 or MS 1058 respectively and complete with screwed and socketed joints. Unless otherwise specified the pipes shall be 150mm in diameter. Where it is necessary to cross drains, culverts or similar obstructions, which is too deep for the cables to be buried below, galvanised iron class B or uPVC class D pipes as specified above shall be provided. All ducts shall be extended at least 600mm beyond paved areas, concrete areas, drains, road crossings, pipe crossings, etc.
- 6.2 Cable entering a building shall be protected by heavy duty galvanised iron class B or or heavy-duty uPVC class D or High-Density Polyethylene (HDPE) PN10 or complying with MS 863 or MS 628 or MS 1058 respectively as specified of 150mm in diameter completed with bend pieces, and buried under the ground beam. The ducts shall be installed with a gradient to drain away any water in the ducts. All ducts passing through walls shall be effectively sealed and made water resistant internally (in between cables) and externally (in between pipes).
- 6.3 The number of cables installed in each duct shall be such that the space factor shall be of maximum 40%. A draw wire shall be provided for each duct.

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7.0 TRAFFIC SAFETY AND CONTROL

- 7.1 When work is being carried out beside any public road or other existing road, appropriate temporary signage for warning signs shall be erected by the Electrical Contractor. The form, placing and light of the temporary signs must comply with all local and national regulations, Arahan Teknik Jalan JKR and safety codes for road works.
- 7.2 Where it is necessary for any trench, pit or manhole to be left open overnight, ample flashing lights (blinkers) shall be placed at each end and at intervals not greater than 10 metres. In built up areas barricades shall be erected along the length of the trench pit or manhole in addition to flashing lights. Flag-men shall be stationed at strategic locations to control prevailing traffic. Where necessary or as directed by the S.O / S.O's Representative.

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8.0 CABLE LAYING AND INSTALLATION

- 8.0.1 All cables shall be handled, laid and installed according to this specification, MS IEC 60364-5-52 and cable manufacturer's recommendations by using proper installation equipment and tools.
- 8.0.2 All cables shall be supplied in complete length to suit the circuits they serve, and no straight through joints shall be used. Straight through joints or other approved joints in the cable, will only be permitted in very exceptional circumstances such as arising from unavoidable limitations in manufacturing length. If straight through joints or other approved joints is permitted, the cost of such joints shall be borne by the Electrical Contractor. No joints in the cable will be allowed unless approved in writing by S.O / S.O's Representative.
- 8.0.3 The minimum internal bending radius of the cable shall be of minimum 12 times the overall diameter of the cable. Wherever cables are cut, the ends shall be immediately sealed in an approved manner unless it is intended to proceed with cable jointing for termination straight away.
- 8.0.4 No cable shall be laid and covered up in the absence of the S.O / S.O's Representative.

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8.1 CABLE LAID DIRECT IN GROUND

8.1.1 Before cable is laid, the trench shall be thoroughly inspected, any debris and sharp objects shall be removed. The bottom of the trench shall be covered with a layer of 75mm of washed river sand. The cables shall then be laid on this bedding in an orderly manner without overlapping and crossing each other. After laying the cables, a layer of 75mm of washed river sand shall cover the cables and carefully spread over the trench before placing the cable protective covers as shown in Figure 1.

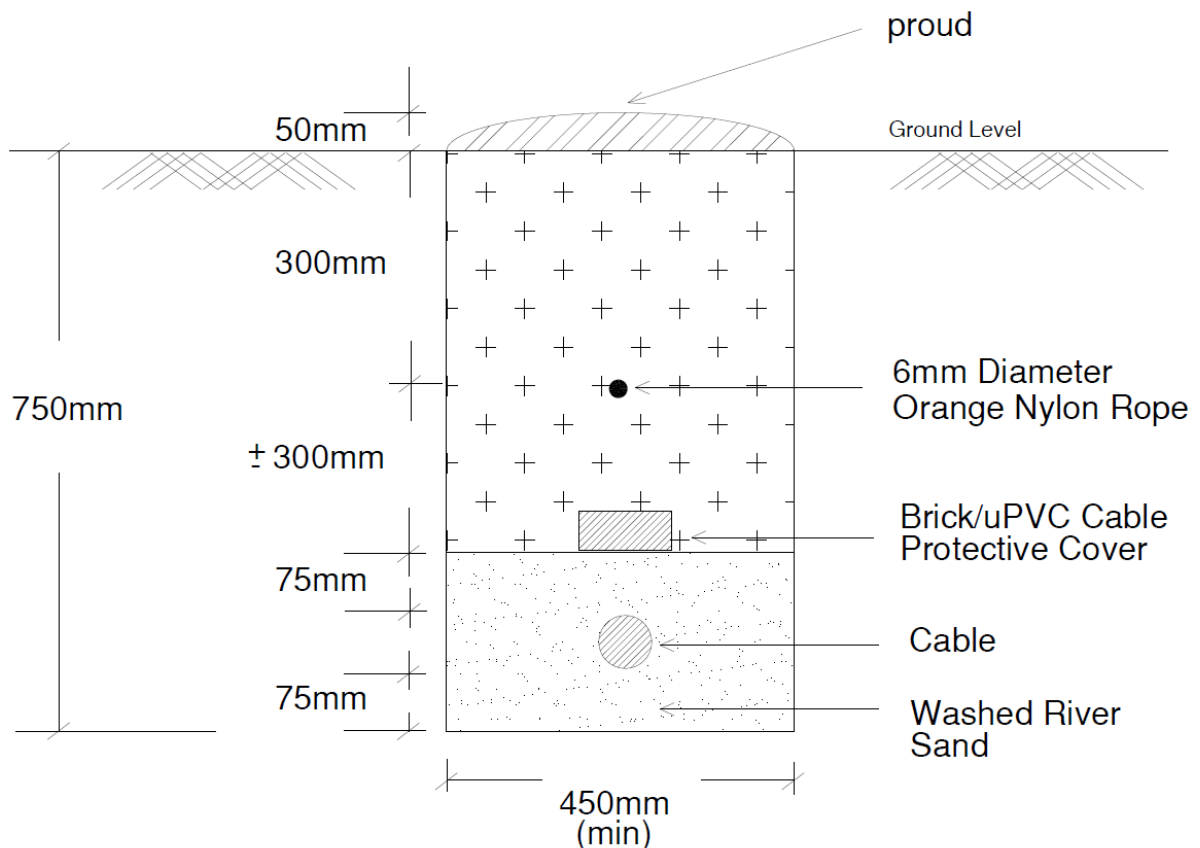



Figure 1: Cable Laid Direct In Ground

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8.1.2 Unless otherwise specified, uPVC cable protective covers complying with BS EN 12613 shall be of polyvinylchloride without plasticizer type with specific density between 1.37g/cm³ to 1.42g/cm³ as shown in Figure 2, Figure 3 and Table 1 approved by the S.O / S.O's Representative. The uPVC cover shall be resistant to aggressive soils and of dimension 150mm / 250mm wide and 1000mm long. The covers shall be single coloured green and top side shall be embossed with standard danger sign and bold letters **"BAHAYA! KABEL ELEKTRIK DI BAWAH"**. The covers shall be provided with male and female interlocking device. The covers are laid together lengthwise from end to end along the entire cable route and they are held together tightly by the interlocking device. At least 25 mm overhang on each side of the cable shall be provided to protect the cable underneath.

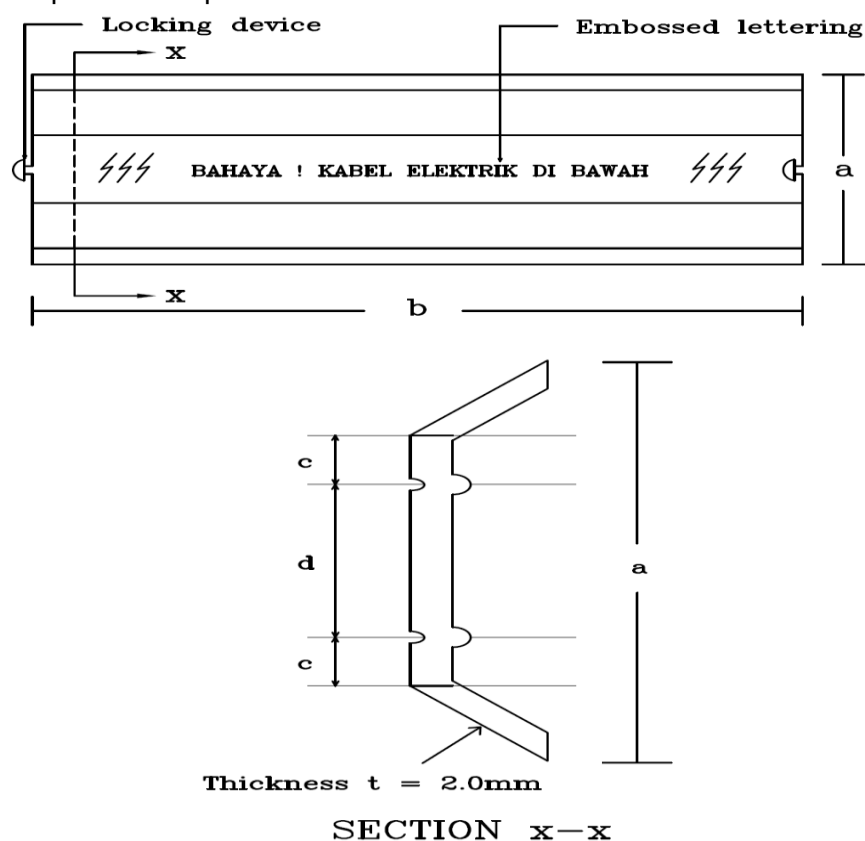




Figure 2: uPVC Cable Protective Cover

SIZE (mm)	a	b	c	d	t
150/1000	150	1000	35	50	2.0
250/1000	250	1000	60	100	2.0

Table 1 : uPVC Cable Protective Cover Dimension


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- 8.1.3 If the cable protective covers are of clay bricks, the bricks shall be new, well burnt and in complete pieces. They shall be laid lengthwise from end to end along the entire route of the underground cable if the cable size is not more than 120mm². For cable size more than 120mm², more than one row of the bricks shall be laid. Each shall be separately protected by these bricks and the cover shall have at least 25mm overhang on each side of the cable.
- 8.1.4 The trench shall then be backfilled with earth and shall be consolidated after every 150 mm of backfilling using a mechanical rammer / compactor. Multi-strand orange nylon rope of minimum (six) 6 mm diameter shall be laid at a depth of 300mm along the trench to identify the cable route. At every 10 meters interval, an extra (two) 2 meters length of nylon rope shall be coiled. The finished surface shall be left proud by 50mm to allow for subsidence and the Electrical Contractor shall be responsible for the removal of any surplus to a position indicated by the S.O / S.O's Representative.
- 8.1.5 The surface of the refilled trench shall be temporarily reinstated and maintained in a thoroughly safe condition until complete consolidation of the soil is achieved. As soon as the soil has consolidated, the trenches shall be made good to the original conditions to the satisfaction of the S.O / S.O's Representative.

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8.2 CABLE INSTALLED IN CABLE CHANNEL

- 8.2.1 Method of installation of cables in cable channel shall be in accordance with Method in Table A.52.3 of MS IEC 60364-5-52.
- 8.2.2 Cables laid at the bottom of the trenches shall be in accordance with Table A.52.3 of MS IEC 60364-5-52.
- 8.2.3 The trenches inside the buildings shall be filled with washed river sand above cable ducts.


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8.3 CABLE RUN ON WALLS AND UNDER FLOOR SLABS

- 8.3.1 Cable run on walls and under floor slabs shall be mounted on perforated hot dipped galvanised sheet steel cable trays or cable ladders. Method of installation of the cables shall be in accordance with Table A.52.3 of MS IEC 60364-5-52. The construction and finished of the cable trays or cable ladders and the method of installation of the cables on the cable trays shall be as described in L-S1 Specification.


8.4 CABLE RUN ON CABLE TRAY

- 8.4.1 The cable tray system shall comply with MS IEC 61537 and shall be fabricated from perforated hot dipped galvanized sheet steel complete with all necessary bends, tee pieces, adaptors and other accessories. The perforated hot dipped galvanised sheet steel cable trays shall be minimum of (two) 2.0mm thickness. The hangers, brackets and other suspending and supporting structures shall be hot dipped galvanized. All brackets shall be securely fastened with steel raw bolts and nuts. Samples of cable tray and bracket shall be submitted to the S.O / S.O's Representative for approval prior to installation.
- 8.4.2 The cable trays shall be suspended from floor slabs by hangers or mounted on wall by brackets at 600mm interval.
- 8.4.3 Whenever cable trays pass through floors or fire-resistant walls, the cables shall be sealed with fire resisting barrier of non-hygroscopic fire-resisting material at minimum (two) 2-hour fire rating. The floor openings and wall openings shall also be sealed with similar type of compound.
- 8.4.4 To provide electrical continuity, all cable tray joints shall be bridged by means of tinned copper tape of dimension not less than 25 mm x 3 mm.
- 8.4.5 The minimum bending radius shall be not less than 12 times the cable overall diameter and steel bend spacing not more than 500mm for vertical run and 1000mm for horizontal run. All steel bend complying with BS EN 61914 for cables on cable trays shall be installed by bolts, washers and nuts. All cable tray tees, intersection units, adaptor units etc. shall be factory manufactured.

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8.5 CABLE RUN ON CABLE LADDER

- 8.5.1 Cable ladder system shall comply with MS IEC 61537 and fabricated from mild steel and finished in hot-dipped galvanised steel complete with all necessary horizontal elbow, horizontal tee, horizontal cross, reducer straight, outside riser, inside riser, reducer left, reducer right, cable clamp, cantilever arm, hold down clip/clamp, hanger bar, vertical bar for welded type and horizontal splice plate for screwed type. The sheet steel shall be minimum of (two) 2.0mm thickness.
- 8.5.2 Cable ladder may either be suspended from floor slabs by hangers or mounted on walls or vertical structure by cantilever arm. Cable ladder shall be supported rigidly and adequately by external spring hangers mounted on channel base. The cable ladder shall be supported at maximum intervals of 3000mm for vertical runs and 1500mm for horizontal runs so that the cable ladder will not be in contact with the wall or floor slab surfaces. The spring hangers shall be supplied by the cable ladder manufacturer. All supports, hangers and structures shall be robust in construction and adequately installed to cater for the weights of the cables and ladder supported on them so that cable ladder and cables will not sag.
- 8.5.3 All cable ladder joints shall be bridged by means of tinned copper tape of dimension not less than 25mm x 3mm for electrical continuity.
- 8.5.4 Minimum bending radius shall be not less than 12 times the cable overall diameter and steel bend spacing not more than 500mm for vertical run and 1000mm for horizontal run. All steel bend complying with BS EN 61914 for cables on cable ladder shall be installed by bolts, washers and nuts. All cable ladder tees, intersection units, adaptor units, etc. shall be factory manufactured.

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9.0 CABLE TERMINATION, CABLE JOINTING AND CABLE LUG

- 9.0.1 All cable termination and jointing works shall only be carried out in the presence of the S.O / S.O's Representative. A plastic laminated plate engraved with details such as size of cable, number of core, date of commissioning, date of jointing, length of cable, distance of cable joint, etc. shall be securely fixed near the termination. All cable terminations and jointing shall be undertaken by Certified Cable Joiner (PK1) as prescribed in Electricity Regulations 1994. The Electrical Contractor shall submit the certificate of Certified Cable Joiner to S.O / S.O's Representative.

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9.1 CABLE TERMINATION FOR ARMOURED CABLE

- 9.1.1 PVC/SWA/PVC, PVC/AWA/PVC, XLPE/SWA/PVC and XLPE/AWA/PVC cable shall be provided with compression cable gland for termination.
- 9.1.2 Cable glands shall be installed for termination of armoured cables. It shall be mechanical type complying with BS EN 50262. Each cable gland shall be installed with back nuts (lock nuts) for plain hole fixing.
- 9.1.3 Cable gland shall be installed for termination of steel armoured multicore cables and shall comply with BS EN 50262. The cross sectional of a protective conductor connecting a gland earth tag washer to the switchboard earthing bar shall be selected in accordance with Table 54.3 of MS IEC 60364-5-54 (Table 2).

Cross-sectional area of line conductor S (mm) ²	Minimum cross-sectional area of the corresponding protective conductor (mm) ²	
	If the protective conductor is of the same material as the line conductor	If the protective conductor is not of the same material as the line conductor
$S \leq 16$	S	$\frac{k_1}{k_2} \times S$
$16 < S \leq 35$	16	$\frac{k_1}{k_2} \times 16$
$S > 35$	$\frac{S}{2}$	$\frac{k_1}{k_2} \times \frac{S}{2}$


Table 2: Minimum Cross-Sectional Area of Protective Conductors

- 9.1.4 The heat shrinkable termination materials used shall be supplied in a complete kit to suit various sizes of cable and to provide stress control, non-tracking and environmentally sealed termination. It shall consist of high permittivity, high resistivity, heat shrinkable, stress control, UV stable, non-tracking polymeric materials and heat activated sealant to prevent ingress of moisture and contamination. The termination shall meet the sequence test of IEC 60112 and the conductors shall be identified by colour.
- 9.1.5 Protective conductor for single core aluminium wire armoured underground cables shall be of aluminium braided type.

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9.2 CABLE JOINTING

- 9.2.1 The type of cable boxes, compound and jointing materials used shall be factory manufactured. Cast iron joint boxes shall be used, and all jointing kits shall be approved by the S.O / S.O's Representative before joints being carried out. Every cable joint shall be started and finished on the same day. Whenever cables are to be jointed openly during wet weather conditions, the Electrical Contractor shall take all necessary precautions to prevent moisture getting into the cables. Phasing and Insulation Resistance tests shall be carried out and witness by S.O / S.O's Representative before jointing is commenced.
- 9.2.2 Core numbers printed on the papers shall be observed when jointing and whenever possible such numbers shall be maintained throughout the system. Core number '0', '1', '2' and '3' shall denote as neutral, red, yellow and blue phases respectively. In the case of two core cables, number '1' shall denote the phase conductor and '0' the neutral. Crossing of core in the boxes shall be avoided wherever possible but connections shall be consistent with the foregoing requirements. The jointing of cables shall be undertaken by Certified Cable Jointer (PKI) as prescribed in Electricity Regulations 1994. The Electrical Contractor shall submit the certificate of Certified Cable Jointer to S.O / S.O's Representative.

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9.3 CABLE LUG

9.3.1 Cable lug shall comply with MS 1540.

9.3.2 The copper material for the cable lug shall comply with the following specifications:

Description	Specification
Material type	Copper
Grade of copper	Electrolytic Tough Pitch Copper (ETP Grade)
Electrical conductivity of copper	99% IACS ^a
Purity of copper	99.9%


Note: ^aIACS - International Annealed Copper Standard

Table 3: Material Specification for Cable Lug

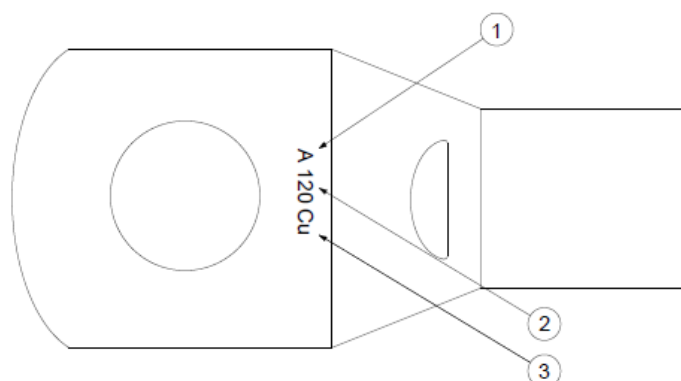
9.3.3 The finishing for the cable lug shall comply with the following specifications:

Description	Specification
Finishing type	Electro tin plating
Purity of tin	99%
Minimum thickness of tin plating	3 micron

Table 4: Finishing Specification for Cable Lug

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9.3.4 The cable lug shall be clearly marked by stamping the conductor size on the palm of the cable lug, as shown in Figure 3:



Legend

- 1 Manufacturer's symbol representation (for the minimum cable size of 70mm² and above)
- 2 Conductor size 120mm²
- 3 Cable lug material and corresponding cable material type (for the minimum cable size of 70mm² and above)

Figure 3: Markings of Cable Lug

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9.4 BI-METAL CABLE LUG

9.4.1 Cable lug used for aluminium armoured cables termination shall be of bimetal type.

9.4.2 Connector comprising a copper palm, friction welding to an aluminium barrel, for connecting aluminium conductor to an equipment copper terminal. The bi-metal cable lugs mentioned in MS 2584, applies to crimp type bi-metal lugs for low voltage applications.

9.4.3 The copper material for the bi-metal cable lug shall comply with the following specifications: -

Description	Specification
Grade of Copper	Electrolytic Tough – Pitch (ETP)
Electrical conductivity of copper	≥99% IACS ^a
Purity Of Copper	99% IACS ^a
Finishing	Natural


Note: ^aIACS - International Annealed Copper Standard

Table 5: Material Specification for Copper Bi-Metal Cable Lug

9.4.4 The aluminium barrel shall comply with the following specifications: -

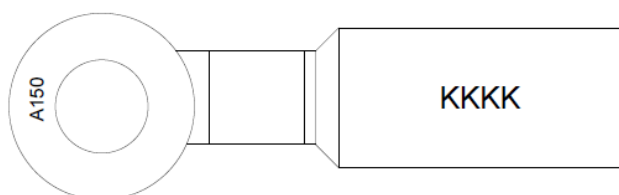
Description	Specification
Grade of Aluminium	1050-0
Purity Of Aluminium	Minimum 99.5%
Finishing	Natural

Table 6: Material Specification for Aluminium Barrel Bi-Metal Cable Lug

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9.4.5 Bi-metal cable lug shall be clearly marked by stamping the conductor size, model or part number and manufacturer's marking or symbol as per Figure 4.


9.4.6 Additionally, the barrel of the bi-metal cable lugs shall be embossed or printed with the name of manufacturer. Marked on the barrel as shown in figure 4:



Legend

A	Manufacturer's marking or symbol
150	Conductor size 150mm ²
KKKK	Name of manufacturer

Figure 4: Markings of Bi-Metal Cable Lug

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10.0 CABLE MARKERS

10.0.1 Cable marker with lettering and sign as shown in Figure 5 and Figure 6 shall be provided by the Electrical Contractor at every change in direction of underground cable routes and at every 15m on straight run. Cable markers shall be of heavy duty reinforced concrete construction. The cable marker and its actual locations shall be approved by the S.O / S.O's Representative.

10.0.2 The cable marker shall be of trapezoidal block with 100mm square top face, 150mm square bottom face and 400mm in height as shown in Figure 7. The top face shall be indented with bold lettering 'L.V.' and directional sign indicating the direction/directions of the cable route. The lettering and directional sign shall be fully painted orange colour. The cable marker shall be buried to a depth of 300mm. Cable joint marker of similar construction but with the lettering and sign as shown in Figure 7 shall be provided and installed at every cable joint in the similar manner.

Lettering: 40mm (H) x 30mm (L) x 10mm (W) x 5mm (D)

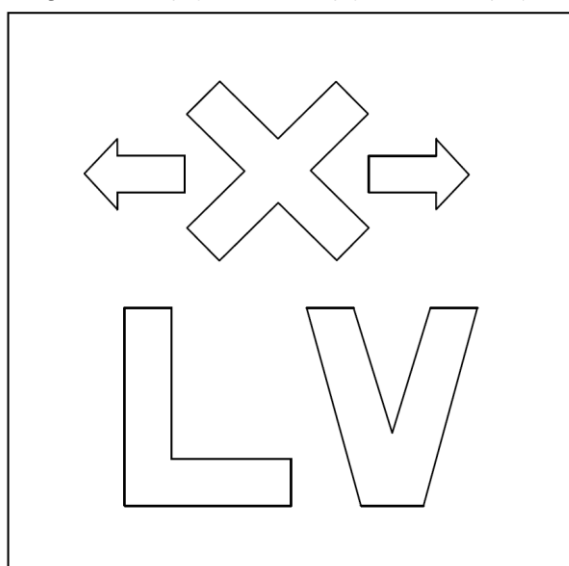



Figure 5: Cable Marker – Joint Sign & Lettering

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Lettering: 40mm (H) x 30mm (L) x 10mm (W) x 5mm (D)

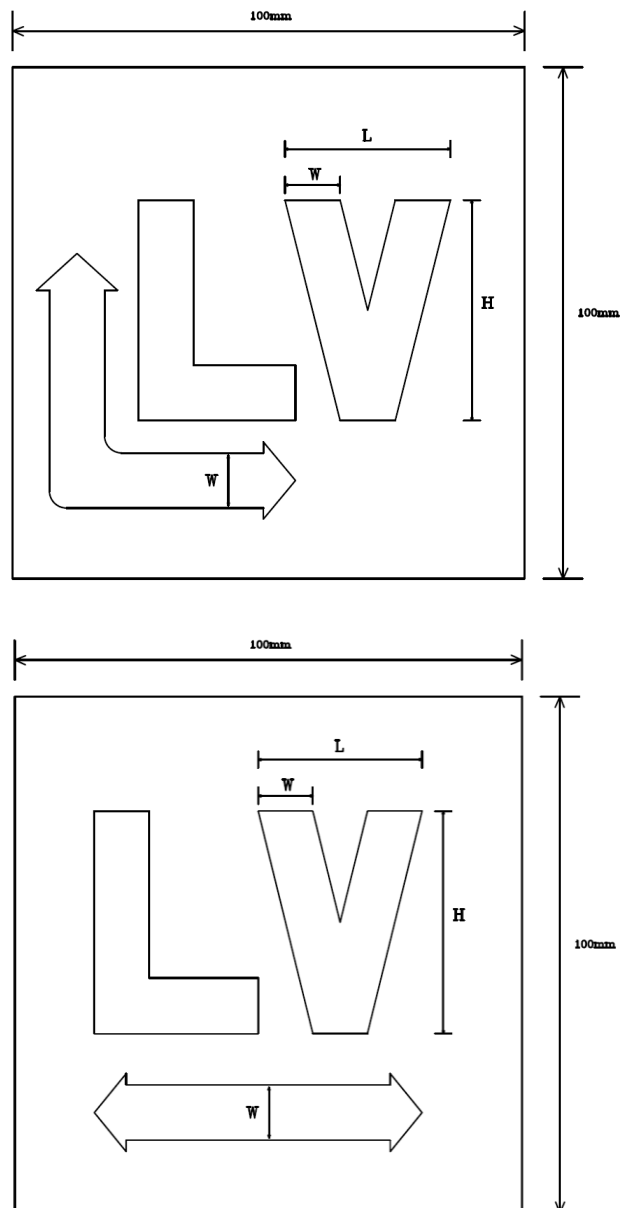


Figure 6: Cable Marker- Directional Sign & Letter



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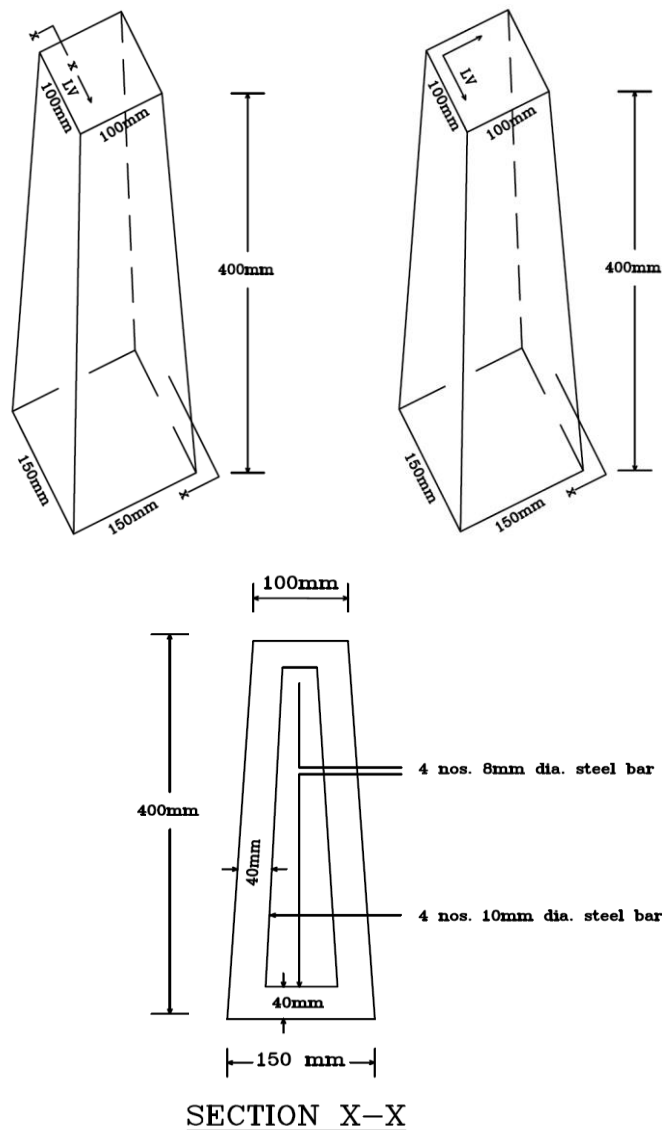



Figure 7: Cable Marker – Construction

Note:

1. All covers to be 40mm (W)
2. Grade 20 (1:2:4) concrete 20mm (3/4) aggregate

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11.0 TESTING AND COMMISSIONING

11.1 TEST INSTRUMENTS

- 11.1.1 All measuring and test instruments used for testing and commissioning of the installations shall be regularly tested and calibrated by the manufacturers or accredited calibration laboratories for their functionality and accuracy. Test and Calibration Reports or Certificates for the measuring and test instruments issued by the calibration laboratory shall be valid for two (2) years from the date of issuance.
- 11.1.2 The instruments and their Test and Calibration Reports or Certificates shall be submitted to S.O / S.O's Representative for verification two (2) weeks before testing of the installations being carried out. No test on the installations shall be carried out without prior approval of the S.O / S.O's Representative. Notwithstanding the validity of the aforesaid Reports or Certificates the measuring and test instruments shall be re-calibrated if so required by the S.O / S.O's Representative after any mechanical or electrical mishandling. Fee required for the testing and calibrating of the measuring and test instruments is deemed to be included in the Contract.


11.2 TEST AND TEST CERTIFICATES

- 11.2.1 After the installation work has been completed and before Certificate of Practical Completion is issued, the whole system shall be tested for compliance and performance as follows: -
- 11.2.1.1 Insulation Resistance Test
- 11.2.1.2 Continuity Test
- 11.2.2 The S.O / S.O's Representative reserves the right to be present at all tests and the Contractor shall give at least one week notice in writing to the S.O / S.O's Representative for this purpose. In any case, no test shall be carried out without prior approval of the S.O / S.O's Representative. A copy of test results certified by competent person shall be submitted to the S.O / S.O's Representative. Copies of all the test certificates together with As Installed Drawings properly bound and titled shall be submitted to the S.O / S.O's Representative within one week after the completion of the testing.

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12.0 SERVICE AND MAINTENANCE

- 12.1 During the Defects Liability Period, the Contractor shall be responsible for the service and maintenance work of the complete installation. All works shall be carried out by competent person. All labour, material, tools and parts necessary to rectify the defect due to manufacturing or installation faults shall be supplied and/or executed at the Contractor's cost.
- 12.2 The service and maintenance to be performed and defects to be rectified and making good shall include but not limited to the following: -
- 12.2.1 Replace or make good any defective cables, cable joints and cable terminations
 - 12.2.2 Replace any broken or defective cable markers
 - 12.2.3 Making good any damage to roads, buildings, drains, existing cables, pipes, concrete areas, paved areas, slopes, drains, culverts etc. which had not been properly made good arising out of his work; and
 - 12.2.4 Any other works deemed necessary by the S.O / S.O's Representative.
- 12.3 All works shall be carried out as soon as the Contractor is being informed by the S.O / S.O's Representative or the occupant, and shall be completed within a reasonable time except under emergency situation. If the Contractor fails to comply with the above requirements, the S.O / S.O's Representative reserves the right to engage another party to carry out the work, in which case, the Contractor shall be responsible for all the expenses incurred.

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13.0 WORKING DRAWINGS, AS INSTALLED DRAWINGS AND AS BUILT DOCUMENTS

13.1 WORKING DRAWINGS

Within 2 weeks after award of the Tender, the Electrical contractor shall submit to the S.O / S.O's Representative for his approval dimensioned general arrangement and section drawings of the equipment ordered. These drawings are to be submitted in quadruplicate. The drawings submitted are to be modified if necessary as requested by the S.O / S.O's Representative and re-submitted for final approval.

13.2 AS INSTALLED DRAWINGS


13.2.1 The as installed drawings shall comprise of: -

- 13.2.1.1 Site plan;
- 13.2.1.2 External cable routes;
- 13.2.1.3 Site and type of cables; and
- 13.2.1.4 Location and type of joint.

13.2.2 These drawings shall be labelled at the lower right hand corner with the Electrical Contractor's name and address, date of commissioning, scale, drawing number (the drawing number to be obtained from the S.O. / S.O's Representative), title and following particulars: -


**JABATAN KERJA RAYA
CAWANGAN KEJURUTERAAN ELEKTRIK
CONTRACT NO.:**

- 13.2.3 If the drawings submitted are not according to the actual installation at site and/or not acceptable to the S.O / S.O's Representative, the Contractor shall amend and re-submit the drawings within two weeks from the date of return of the drawings to the satisfaction of the S.O / S.O's Representative.
- 13.2.4 In addition, one (1) set of the as installed drawing shall be submitted in the form of original document, and four (4) sets in physical digital storage.

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13.3 AS BUILT DOCUMENTS

- 13.3.1 As built document shall consist of but not limited to the as installed drawings, manuals, certificates, catalogues and inventories. Manual and documents for the installation shall be supplied. It shall comprise of: -
- 13.2.5.1 Inventories;
 - 13.2.5.2 Product data and catalogue;
 - 13.2.5.3 Product test certificates; and
 - 13.2.5.4 Installation test results.
- 13.2.6 Each of the as built documents shall be bound together with hard cover and submitted in minimum four (4) sets upon issuance of Certificate of Practical Completion of the project.
- 13.2.7 The cost of all these prints, manuals, tools etc. whether or not provided in the Bill of Quantities, is deemed to be included in the Contract.
- 13.2.8 One set of the as installed drawing shall be properly framed up in the MSB Room.

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14.0 LIST OF STANDARDS

STANDARD	DESCRIPTION
BS EN 12613	Plastics Warning Devices For Underground Cables And Pipelines With Visual Characteristics (British Standard)
BS EN 50262	Cable Glands For Electrical Installation
BS EN 61914	Cable Cleats For Electrical Installation
IEC 60112	Method For Determination Of The Proof And The Comparative Tracking Indices Of Solid Insulating Materials
IEC 60502-1	Power Cables With Extruded Insulation And Their Accessories For Rated Voltages From 1 kV (Um = 1.2 kV) Up To 30 kV (Um = 36 kV) – Part 1: Cables For Rated Voltages Of 1 kV (Um = 1.2 kV) And 3 kV (Um = 3.6 kV)
MS 628	Specification For Unplasticised PVC ((uPVC) Pipes For Water Supply.
MS 863	Non-Alloy Steel Tubes Suitable For Welding And Threading – Technical Delivery Conditions
MS 1058	Polyethylene (PE) Piping System For Water Supply
MS 1540	Specification For The Material, Marking And Dimensions Of Crimp Type Cable Lugs For Use With Copper Conductors In Low Voltage Applications
MS 2101	Electric Cable And Wire: 600/1000 (Um = 1.2 kV) Single Core PVC Insulated Cable – Armoured
MS 2103	Electric Cable And Wire: 600/1000 (Um = 1.2 kV) Multi Core PVC Insulated Cable – Armoured
MS 2105	Electric Cable And Wire: 600/1000 (Um = 1.2 kV) Single Core XLPE Insulated Cable – Armoured
MS 2107	Electric Cable And Wire: 600/1000 (Um = 1.2 kV) Multi Core XLPE Insulated Cable – Armoured
MS 2584	Crimp Type Copper Aluminium Bi-Metal Lugs For Use With Compact Copper Conductor In Single And Multi Core Power Cable In Low Voltage Applications – Specification For The Material, Marking, Dimensions And Type Test.

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STANDARD	DESCRIPTION
MS IEC 60228	Conductors Of Insulated Cables
MS IEC 60364-5-52	Electrical Installations Of Buildings -Part 5-52: Selection And Erection Of Electrical Equipment – Wiring Systems
MS IEC 60364-5-54	Electrical Installations Of Buildings -Part 5-54: Selection And Erection Of Electrical Equipment – Earthing Arrangements And Protective Conductors
MS IEC 61537	Cable Tray Systems And Cable Ladder Systems For Cable Management