



EDC3 (5239) P3

DRAFT TANZANIA STANDARD

Mini-Grid Systems –

**Part 7: Underground Power Cables for rated voltages
0.6kV/1kV (U_m 1.2kV)**

Draft for stakeholders' comments only

TANZANIA BUREAU OF STANDARDS

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0. Foreword

This Draft Tanzania Standard is part of an integrated set of specifications and standards issued to govern design and construction of mini-grid power systems in Tanzania. This standard aims at supporting improved residential, commercial and public services for rural communities of Tanzania. The mini-grid energy systems, when properly designed, will support affordable and reliable energy supply for remote households, community services, commercial and economic activities including shops, workshops, micro-industry, fresh water pumping, secondary schools, health services, public lighting, places of worship or cultural activities, agro-processing activities and other activities.

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1. Scope

- 1.1 This specification covers minimum technical requirements for the design, manufacture, testing, supply, and performance of single and multicore armoured or unarmoured power cables rated 0.6/1 (1.2) kV U_0/U (U_m) for use either direct buried or installed in conduit on 230/400V, 50 Hertz, three-phase four wire multiple neutral earthed underground distribution system for mini-grids.
- 1.2 The rated voltage of the cable is 600/1000 V, whereas 600 volts is the rated power frequency voltage between conductor and earth and 1000 volts is the rated power frequency voltage between conductors, for which the cable shall be designed.

Note 1– This standard shall be read in conjunction with other relevant – Tanzania Standards, applicable standards and specifications to have uniformity, compatibility and standardization in the distribution system.

2. Normative References

The cables shall conform to the latest editions of the IEC standards applicable to their construction, including but not limited to those listed below, and to their normative references:

IEC 61089, *Round wire concentric lay overhead electrical stranded conductors*

IEC 60228, *Conductors of Insulated Cables*

IEC 60502-1, *Cables for Rated Voltages of 1kV ($U_m=1.2kV$) and 3kV ($U_m=3.6kV$)*

TANESCO – Specification S01, *Supply and Installation of Plant and Equipment*

TANESCO engineering manuals

3. Quality Control

Cable shall be manufactured in a plant that has an established and credible past record of production of cables of similar ratings and design and that holds ISO: 9001 certification for quality management.

4. Service Conditions

Cable shall be suitable for underground operation under the local service conditions in Tanzania, which are as follows:

- Altitude above mean sea level (MSL): Up to 3,000 metres
- Maximum/record yearly high ambient temperature: +40°C
- High humidity promoting the growth of fungi
- Extended periods of intense sun exposure

In accordance with the IEC standards, altitudes not exceeding 1000 m are considered as normal service conditions. Altitudes higher than 1000 m are considered as abnormal service conditions, which may require special considerations in the design, manufacture or application of the materials or equipment and shall be called to the attention of the manufacturer.

5. Electrical System Parameters

Mini-grids may be single or three-phase but regardless, system parameters of mini-grids for low voltage underground power distribution network are as follows:

- a) Nominal system voltage (U): 230/400V ($\pm 10\%$)
- b) Maximum permissible system voltage (U_m): 253/440V
- c) Minimum permissible system voltage: 215/374V
- d) System frequency: 50 Hz
- e) Neutral grounding arrangement: multi - grounded
- f) Power frequency withstand voltage for 5 minutes: $3kV_p$

6. Construction

The cables construction shall comply with the following:

- a) Cables may be armoured or unarmoured at the discretion of the purchaser.
- b) The cable shall be designed for a maximum permissible continuous conductor temperature of 90°C , emergency loading conductor temperature of 105°C and maximum conductor short circuit withstand temperature of 250°C for 5 seconds.
- c) Cables shall be Category C per IEC 60502-1, that is, the insulation system may be exposed to full phase-phase voltage applied between any phase and earth.
- d) Cables shall be rated for outdoor installation in wet locations either directly buried or installed in conduit.
- e) Any portion of the cable may be exposed to full sun while in service, so all insulation, sheath, and filler materials shall be certified sun/UV resistant. Black insulation shall be filled with carbon black or other suitable UV protection, and colored materials shall be filled with appropriately colored UV protectants.

7. Conductor

The cable conductor shall comply with the following:

- a) The conductor shall be uncoated soft drawn annealed copper or aluminum as may be specified in the tender document.
- b) Conductors shall be class 2 as per IEC 60228.
- c) Conductor nominal cross section shall be as specified by the purchaser, subject to the tolerances allowed by applicable standards.
- d) For conductor, cross sections greater than 10 mm^2 conductors shall be stranded.
- e) For conductors with cross sections greater than 16 mm^2 conductors shall be compacted.
- f) Stranded conductors shall have the minimum number of strands as specified in the relevant IEC standard.

8. Insulation

The cables insulation shall comply with the following:

- a) LV Power cables insulation shall be extruded cross-linked polyethylene (XLPE). Insulation shall comply with the appropriate requirements specified in IEC 60502-1. Except for UV resistance agents such as carbon black, the XLPE insulation shall be otherwise unfilled.
- b) The nominal insulation thickness shall be as per values specified in IEC60502-1, with respect to voltage rating and cable cross-section.
- c) The average insulation thickness shall not be less than the specified nominal value.
- d) The minimum thickness of the insulation at any point shall not fall below the nominal value by more than 0.1 mm +10% of the specified nominal value.
- e) XLPE insulation shall be certified sun/UV resistant, including insulation on cores whether black or colored.
- f) For unarmoured cables, an inner covering over the cores is not required; however, the outer shape of the cable shall remain practically circular using non-hygroscopic film fillers to fill out the circular shape.
- g) Multi-core, sector shape cables may have non-hygroscopic film fillers in order to form a compact circular outer shape.
- h) For armoured cables, an inner covering over the assembled cores shall be extruded consisting of a material in accordance with section 7.1 of IEC 60502-1.
- i) Care shall be taken so that no adhesion occurs between cores and either the inner layer (armoured cables only) or the outer sheath.

9. Armour

Cables specified with armour shall comply with the following:

- a) Armour shall consist of galvanized steel wires applied over the inner covering specified in 8.h).
- b) The dimensions of the armour wires shall conform to the requirements of IEC 60502-1, Part 12.5.

10. Outer Sheath

All cables shall be supplied with an outer sheath. If the cable is armoured, the sheath shall be applied over the armour. The cables outer sheath shall comply with the following:

- a) The outer sheath material shall be black PVC, type ST2 as per IEC 60502-1. The nominal thickness of the outer sheath shall be as per IEC 60502-1. Minimum thickness at any point shall not be less than value specified as per IEC 60502-1.
- b) The PVC outer sheath shall be certified sun/UV resistant.

11. Marking

11.1 Core Identification

- a) The XLPE insulation of the four-core cable shall be colored: Brown, Black, Grey and Blue.
- b) The XLPE insulation of a single core cable shall be colored: Black.
- c) The XLPE insulation of a three-core cable shall be colored Brown and Black

11.2 Jacket Identification

- a) The jacket for all cables shall be marked by raised embossing at intervals not exceeding one meter with the following minimum information:
 - i) The manufacturer's name (in English or trademark)
 - ii) Voltage designation (in English)
 - iii) Type of insulation, XLPE (in English)
 - iv) Conductor size and material (in English)
 - v) Year of manufacture (in English)
 - vi) Cumulative length at every one meter with the highest length mark on the outer end of the cable
- b) All marking/numbering shall be embossed; marking by matrix print shall not be acceptable.

12. Tests

The tests required by this standard include:

12.1 General

- a) All cables shall be tested in accordance with the latest standards and as specified herein. Supplier shall provide all test results for review and acceptance by the purchaser.
- b) The full range of routine, sample and type tests specified in IEC 60502-1, clause 14, 15, 16, 17 and 18 shall be carried out as applicable.
- c) All XLPE insulations, whether colored or black, and the PVC sheath material shall have passed a sun resistance test consisting of exposure to either a carbon arc or a Xenon arc lamp in accordance with ISO 4892-3 for a period of 720 hours while retaining 80% of their tensile and elongation properties.
- d) Routine and/or special tests shall be carried out in the supplier's factory. Certified test reports shall be supplied for each test unit of cable prior to delivery.
- e) Sample tests shall be carried out during the course of manufacture on the frequency and with the sample size specified by IEC 60502-1. Sample test reports shall be available to the purchaser for review prior to delivery of the cables.
- f) Type test report/certificate from Tanzania Bureau of Standards or an independent testing laboratory shall be submitted with proposal.

12.2 Routine Tests

- a) Electrical resistance of conductors, resistance values shall be in accordance with IEC 60228.
- b) AC voltage test, cable shall be tested per IEC 60502-1.

12.3 Sample Tests

- a) Conductor examination shall be in accordance with IEC 60228.
- b) Other sample tests shall be in accordance with IEC 60502-1.

12.4 Type Tests

Complete test (electrical and non-electrical) shall be carried out as per the relevant IEC standards. Type test reports and certificates of sun resistance, or certificates of qualification shall be provided at the time of tender from Tanzania Bureau of Standards or an independent accredited testing laboratory.

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