



**The Gambia
Standards Bureau**

**Power cables with extruded insulation and their accessories for rated voltages from 1 kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV) –
Part 2: Cables for rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)**

ICS No.: 29.060.20

COPYRIGHT PROTECTED DOCUMENT

© TGSB 2017

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from The Gambia Standards Bureau

TABLE OF CONTENTS

FOREWORD.....	10
1 Scope.....	12
2 Normative references.....	12
3 Terms and definitions	14
3.1 Definitions of dimensional values (thicknesses, cross-sections, etc.)	14
3.2 Definitions concerning the tests.....	14
4 Voltage designations and materials	15
4.1 Rated voltages	15
4.2 Insulating compounds.....	16
4.3 Sheathing compounds	17
5 Conductors	17
6 Insulation.....	17
6.1 Material.....	17
6.2 Insulation thickness.....	17
7 Screening	19
7.1 General.....	19
7.2 Conductor screen.....	19
7.3 Insulation screen.....	19
8 Assembly of three-core cables, inner coverings and fillers	19
8.1 General.....	19
8.2 Inner coverings and fillers	19
8.2.1 Construction	19
8.2.2 Material	20
8.2.3 Thickness of extruded inner covering	20
8.2.4 Thickness of lapped inner covering	20
8.3 Cables having a collective metal layer (see Clause 9)	20
8.4 Cables having a metal layer over each individual core (see Clause 10)	20
9 Metal layers for single-core and three-core cables.....	21
10 Metal screens	21
10.1 Construction.....	21
10.2 Requirements.....	21
10.3 Metal screens not associated with semi-conducting layers	21
11 Concentric conductors	21
11.1 Construction.....	21
11.2 Requirements.....	21
11.3 Application	22
12 Metal sheaths	22
12.1 Lead sheath	22
12.2 Other metal sheaths	22
13 Metal armour	22
13.1 Types of metal armour	22
13.2 Materials	22
13.3 Application of armour	23
13.3.1 Single-core cables	23
13.3.2 Three-core cables.....	23

13.3.3	Separation sheath.....	23
13.3.4	Lapped bedding under armour for lead sheathed cables	23
13.4	Dimensions of the armour wires and armour tapes.....	24
13.5	Correlation between cable diameters and armour dimensions	24
13.6	Round or flat wire armour	24
13.7	Double tape armour.....	25
14	Over sheath.....	25
14.1	General.....	25
14.2	Material.....	25
14.3	Thickness	25
15	Test conditions	26
15.1	Ambient temperature.....	26
15.2	Frequency and waveform of power frequency test voltages	26
15.3	Waveform of impulse test voltages	26
15.4	Determination of the cable conductor temperature	26
16	Routine tests	26
16.1	General.....	26
16.2	Electrical resistance of conductors	26
16.3	Partial discharge test.....	27
16.4	Voltage test.....	27
16.4.1	General	27
16.4.2	Test procedure for single-core cables.....	27
16.4.3	Test procedure for three-core cables.....	27
16.4.4	Test voltage	27
16.4.5	Requirement	28
16.5	Electrical test on over sheath of the cable.....	28
17	Sample tests.....	28
17.1	General.....	28
17.2	Frequency of sample tests.....	28
17.2.1	Conductor examination and check of dimensions	28
17.2.2	Electrical and physical tests	28
17.3	Repetition of tests	29
17.4	Conductor examination.....	29
17.5	Measurement of thickness of insulation and of non-metal sheaths (including extruded separation sheaths, but excluding inner extruded coverings)	29
17.5.1	General	29
17.5.2	Requirements for the insulation	29
17.5.3	Requirements for the non-metal sheaths	30
17.6	Measurement of thickness of lead sheath	30
17.6.1	General	30
17.6.2	Strip method	30
17.6.3	Ring method	30
17.7	Measurement of armour wires and tapes	30
17.7.1	Measurement on wires	30
17.7.2	Measurement on tapes.....	31
17.7.3	Requirements	31
17.8	Measurement of external diameter	31
17.9	Voltage test for 4 h.....	31

17.9.1	Sampling	31
17.9.2	Procedure	31
17.9.3	Test voltages	31
17.9.4	Requirements	31
17.10	Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths	31
17.10.1	Procedure	31
17.10.2	Requirements	32
18	Type tests, electrical	32
18.1	General	32
18.2	Cables having conductor screens and insulation screens	32
18.2.1	General	32
18.2.2	Sequence of tests	32
18.2.3	Special provisions	32
18.2.4	Bending test	33
18.2.5	Partial discharge test	33
18.2.6	Tan δ measurement for cables of rated voltage 6/10 (12) kV and above	33
18.2.7	Heating cycle test	34
18.2.8	Impulse test followed by a voltage test	34
18.2.9	Voltage test for 4 h	34
18.2.10	Resistivity of semi-conducting screens	35
18.3	Cables of rated voltage 3,6/6 (7,2) kV having unscreened insulation	35
18.3.1	General	35
18.3.2	Insulation resistance measurement at ambient temperature	35
18.3.3	Insulation resistance measurement at maximum conductor temperature	36
18.3.4	Voltage test for 4 h	36
18.3.5	Impulse test	37
19	Type tests, non-electrical	37
19.1	General	37
19.2	Measurement of thickness of insulation	37
19.2.1	Sampling	37
19.2.2	Procedure	37
19.2.3	Requirements	37
19.3	Measurement of thickness of non-metal sheaths (including extruded separation sheaths, but excluding inner coverings)	37
19.3.1	Sampling	37
19.3.2	Procedure	37
19.3.3	Requirements	38
19.4	Measurement of thickness of lead sheath	38
19.4.1	Sampling	38
19.4.2	Procedure	38
19.4.3	Requirements	38
19.5	Tests for determining the mechanical properties of insulation before and after ageing	38
19.5.1	Sampling	38
19.5.2	Ageing treatments	38
19.5.3	Conditioning and mechanical tests	38
19.5.4	Requirements	38

19.6	Tests for determining the mechanical properties of non-metal sheaths before and after ageing	38
19.6.1	Sampling	38
19.6.2	Ageing treatments.....	38
19.6.3	Conditioning and mechanical tests	38
19.6.4	Requirements	39
19.7	Additional ageing test on pieces of completed cables.....	39
19.7.1	General	39
19.7.2	Sampling	39
19.7.3	Ageing treatment	39
19.7.4	Mechanical tests	39
19.7.5	Requirements	39
19.8	Loss of mass test on PVC sheaths of type ST ₂	39
19.8.1	Procedure	39
19.8.2	Requirements	39
19.9	Pressure test at high temperature on insulations and non-metal sheaths.....	39
19.9.1	Procedure	39
19.9.2	Requirements	39
19.10	Test on PVC insulation and sheaths at low temperatures	40
19.10.1	Procedure	40
19.10.2	Requirements	40
19.11	Test for resistance of PVC insulation and sheaths to cracking (heat shock test)	40
19.11.1	Procedure	40
19.11.2	Requirements	40
19.12	Ozone resistance test for EPR and HEPR insulations	40
19.12.1	Procedure	40
19.12.2	Requirements	40
19.13	Hot set test for EPR, HEPR and XLPE insulations and elastomeric sheaths	40
19.14	Oil immersion test for elastomeric sheaths	40
19.14.1	Procedure	40
19.14.2	Requirements	40
19.15	Water absorption test on insulation.....	40
19.15.1	Procedure	40
19.15.2	Requirements	40
19.16	Flame spread test on single cables.....	41
19.17	Measurement of carbon black content of black PE over sheaths	41
19.17.1	Procedure	41
19.17.2	Requirements	41
19.18	Shrinkage test for XLPE insulation.....	41
19.18.1	Procedure	41
19.18.2	Requirements	41
19.19	Thermal stability test for PVC insulation.....	41
19.19.1	Procedure	41
19.19.2	Requirements	41
19.20	Determination of hardness of HEPR insulation.....	41
19.20.1	Procedure	41
19.20.2	Requirements	41
19.21	Determination of the elastic modulus of HEPR insulation	41

19.21.1	Procedure.....	41
19.21.2	Requirements	42
19.22	Shrinkage test for PE over sheaths.....	42
19.22.1	Procedure.....	42
19.22.2	Requirements	42
19.23	Strip ability test for insulation screen	42
19.23.1	General	42
19.23.2	Procedure.....	42
19.23.3	Requirements	42
19.24	Water penetration test.....	43
20	Electrical tests after installation.....	43
20.1	General.....	43
20.2	DC voltage test of the over sheath.....	43
20.3	Insulation test.....	43
20.3.1	AC testing.....	43
20.3.2	DC testing.....	44

DATE OF PUBLICATION

This Gambian Standard was Gazetted under the authority of the Bureau on 17 November 2017.

THE GAMBIA STANDARDS BUREAU

The Gambia Standards Bureau is a statutory Government specialized Agency established by The Gambia Standards Bureau Act 2010 to standardize products, methods, systems and for connected matters. Hence, the Bureau is the sole National Standardization Body. As such, it has been a member of International Standardization Bodies such as the International Organization for Standardization (ISO) since 2011, International Electrotechnical Commission (IEC) and the Standards and Metrology Institute for Islamic Countries (SMIIC) from 2012.

The objectives of the Bureau, as specified in its Act, are to: establish and promulgate standards for imported and locally-produced goods; facilitate domestic and international trade; foster and promote standards both for industrial efficiency and advancing economic development; promote the health and safety of consumers; enhance international cooperation in relation to standards and standardization. Thus, the National Quality Policy details the responsibilities of the Bureau in Standardization, Metrology and Conformity Assessment services in Testing, Inspection and Certification.

Therefore, the functions, of the Bureau are to define, prepare, publish, modify or amend Standards Specifications as well information-dissemination of standards. In addition to providing Testing, Inspection and Certification services for goods, systems and processes independently or in relation to conformity with its Standards Mark, the Bureau also conducts training and research. In Metrology, the Bureau serves as the custodian of primary national reference measurement standards through its National Metrology Laboratories and conducts calibration of measurement devices and physical standards.

The development of Gambian Standards (GAMS) is carried out by the Bureau through Technical Committees composed of a balanced representation of stakeholders, as may be appropriate to the subject in question. The Bureau ensures that Standards are developed in accordance with the *ISO_IEC_Guide_21-1_2005: Regional or National adoption of International Standards and other International deliverables* and the *World Trade Organization Code of good practice for the preparation, adoption and application of standards*. To the greatest extent possible, Gambian Standards are aligned to or are adoptions of relevant international standards.

For further information on and copies of Gambian Standards, please contact The Gambia Standards Bureau.

TECHNICAL COMMITTEE RESPONSIBLE: NATIONAL ELECTROTECHNICAL COMMITTEE

The National Electrotechnical Committee (NEC) developed this National Wiring Standard. The NEC was initially set up by PURA in 2008 when they became a member of IEC. Upon establishment of the Bureau and replacement of PURA at IEC, the Bureau took over the NEC in 2012 and began the work of development of standards in the electrotechnical field.

The NEC consists of representatives from the following Institutions/Organizations:

- Public Utilities Regulatory Authority
- National Water and Electricity Company
- Gambia Telecommunications Company
- Ministry of Energy
- Ministry of Information and Communication Infrastructure
- University of The Gambia
- Gambia Technical Training Institute
- New Gambia Industrialists
- ComAfrique Intelizon Initiative
- Renewable Energy Association of The Gambia
- Consumer Protection Association of The Gambia
- The Gambia Chamber of Commerce and Industry

The Gambia Standards Bureau is the Secretariat and Secretary to the NEC.

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60502-2 has been prepared by IEC technical committee 20: Electric cables.

This third edition cancels and replaces the second edition, published in 2005, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) a simplified calculation procedure for the thickness of the lead sheath and the over sheath;
- b) a new subclause for the determination of the cable conductor temperature;
- c) a modified procedure for the routine voltage test;
- d) a new subclause for a routine electrical test on over sheath;
- e) modified requirements for the non-metal sheaths including semi-conductive layer;
- f) modified tolerances for the bending test cylinder;
- g) the inclusion of a 0,1Hz test after installation.

In addition, the modified structure of the IEC 60811 series has been adopted for this third edition.

The following editorial changes have been made within the English version:

- 'metallic' has been replaced by 'metal';
- 'thermosetting' has been replaced by 'crosslinked'.

The text of this standard is based on the following documents:

FDIS	Report on voting
20/1469A/FDIS	20/1472/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60502 series, published under the general title *Power cables with extruded insulation and their accessories for rated voltages from 1kV ($U_m = 1,2$ kV) up to 30 kV ($U_m = 36$ kV)*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or;
- amended.

1. Scope

This part of GAMS IEC 60502 specifies the construction, dimensions and test requirements of power cables with extruded solid insulation from 6 kV up to 30 kV for fixed installations such as distribution networks or industrial installations.

When determining applications, it is recommended that the possible risk of radial water ingress is considered. Cable designs with barriers claimed to prevent longitudinal water penetration and an associated test are included in this part of GAMS IEC 60502.

Cables for special installation and service conditions are not included, for example cables for overhead networks, the mining industry, nuclear power plants (in and around the containment area) nor for submarine use or shipboard application.

2. Normative References

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60038, *IEC standard voltages*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60060-3, *High-voltage test techniques – Part 3: Definitions and requirements for on-site testing*

IEC 60183, *Guide to the selection of high-voltage cables*

IEC 60228, *Conductors of insulated cables*

IEC 60229:2007, *Tests on cable over sheaths which have a special protective function and are applied by extrusion*

IEC 60230, *Impulse tests on cables and their accessories*

IEC 60287-3-1, *Electric cables – Calculation of the current rating – Part 3: Sections on operating conditions – Section 1: Reference operating conditions and selection of cable type*

IEC 60332-1-2, *Tests on electric and optical fibre cables under fire conditions – Part 1-2: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW pre-mixed flame*

IEC 60811 (all parts), *Electric and optical fibre cables – Test methods for non-metallic materials*

IEC 60811-201, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 201: General tests – Measurement of insulation thickness*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-401, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 401: Miscellaneous tests – Thermal ageing methods – Ageing in an air oven*

IEC 60811-402, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 402: Miscellaneous tests – Water absorption tests*

IEC 60811-403, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 403: Miscellaneous tests – Ozone resistance test on cross-linked compounds*

IEC 60811-404, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 404: Miscellaneous tests – Mineral oil immersion tests for sheaths*

IEC 60811-405, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 405: Miscellaneous tests – Thermal stability test for PVC insulations and PVC sheaths*

IEC 60811-409, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 409: Miscellaneous tests – Loss of mass test for thermoplastic insulations and sheaths*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-502, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 502: Mechanical tests – Shrinkage test for insulations*

IEC 60811-503, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 503: Mechanical tests – Shrinkage test for sheaths*

IEC 60811-504, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 504: Mechanical tests – Bending tests at low temperature for insulation and sheaths*

IEC 60811-505, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 505: Mechanical tests – Elongation at low temperature for insulations and sheaths*

IEC 60811-506, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 506: Mechanical tests – Impact test at low temperature for insulations and sheaths*

IEC 60811-507, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 507: Mechanical tests – Hot set test for cross-linked materials*

IEC 60811-508, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 508: Mechanical tests – Pressure test at high temperature for insulation and sheaths*

IEC 60811-509, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 509: Mechanical tests – Test for resistance of insulations and sheaths to cracking (heat shock test)*

IEC 60811-605, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 605: Physical tests – Measurement of carbon black and/or mineral filler in polyethylene compounds*

IEC 60811-606, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 606: Physical tests – Methods for determining the density*

IEC 60853 (all parts), *Calculation of the cyclic and emergency current rating of cables*

IEC 60853-2, *Calculation of the cyclic and emergency current rating of cables – Part 2: Cyclic rating of cables greater than 18/30 (36) kV and emergency ratings for cables of all voltages*

IEC 60885-3, *Electrical test methods for electric cables – Part 3: Test methods for partial discharge measurements on lengths of extruded power cables*

IEC 60986, *Short-circuit temperature limits of electric cables with rated voltages from 6 kV ($U_m = 7,2$ kV) up to 30 kV ($U_m = 36$ kV)*

ISO 48, *Rubber, vulcanized or thermoplastic – Determination of hardness (hardness between 10 IRHD and 100 IRHD)*