IEC TS 62257-9-2

Edition 2.0 2016-09

TECHNICAL SPECIFICATION

colour inside

Recommendations for renewable energy and hybrid systems for rural electrification –
Part 9-2: Integrated systems – Microgrids

IEC TS 62257-9-2:2016-09(en)

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RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-2: Integrated systems – Microgrids

FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 62257-9-2, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the fist edition issued in 2006. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- Changing the voltage range covered by the technical specification to a.c. nominal voltage below 1 000 V and d.c. nominal voltage below 1 500 V (introduction).
- Including 240 V 1-Ø/415 V 3-Ø, in the voltage levels (scope).
- Deleted microgrid and micropowerplants from terms and definitions.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/1029/DTS	82/1088/RVC

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

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

This part of IEC 62257 is to be used in conjunction with the IEC 62257 series.

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

The IEC 62257 series intends to provide to different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting up of renewable energy and hybrid systems with a.c. nominal voltage below 1 000 V and d.c. nominal voltage below 1 500 V.

These documents are recommendations:

- to choose the right system for the right place,
- to design the system,
- to operate and maintain the system.

These documents are focused only on rural electrification concentrating on but not specific to developing countries. They should not be considered as all inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms developments at this time (CO_2 emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems and at the lowest life cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application that is: small renewable energy and hybrid off-grid systems.

Decentralized Rural Electrification Systems (DRESs) are designed to supply electric power for sites which are not connected to a large interconnected system, or a national grid, in order to meet basic needs.

The majority of these sites are:

- isolated dwellings,
- village houses,
- community services (public lighting, pumping, health centres, places of worship or cultural activities, administrative buildings, etc.),
- economic activities (workshops, microindustry, etc.).

The DRE systems fall into three categories:

- process electrification systems (for example for pumping),
- individual electrification systems (IES) for single users,
- collective electrification systems (CES) for multiple users.

Process or individual electrification systems exclusively consist of two subsystems:

- an electric energy generation subsystem,
- the user's electrical installation.

Collective electrification systems, however, consist of three subsystems:

- an electric energy generation subsystem,
- a distribution subsystem, also called microgrid,
- user's electrical installations including interface equipment between the installations and the microgrid.

RECOMMENDATIONS FOR RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-2: Integrated systems – Microgrids

1 Scope

This part of IEC 62257, which is a technical specification, specifies the general requirements for the design and the implementation of microgrids used in decentralized rural electrification to ensure the safety of persons and property and their satisfactory operation according to the scheduled use.

This part of IEC 62257 applies to microgrids for decentralized rural electrification purposes. The microgrids covered by this part of IEC 62257 are low voltage a.c., three-phase or single-phase, with rated capacity less than or equal to 100 kVA. They are powered by a single micropower plant and do not include voltage transformation. The rated capacity is at the electrical output of the micropower plant, that is, the upstream terminals of the main switch between the micropower plant and the microgrid.

The voltage levels covered under this specification are voltages of the 240 V 1-Ø/415 V 3-Ø, the 230 V 1-Ø/400 V 3-Ø, the 220 V 1-Ø/380 V 3-Ø, and the 120 V 1-Ø/208 V 3-Ø systems at 60 Hz or 50 Hz; or obeyed by local code.

This part of IEC 62257 specifies microgrids made of overhead lines because of technical and economical reasons in the context of decentralized rural electrification. In particular cases, underground cables can be used.

The requirements cover microgrids with radial architecture.

2 Normative reference

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61439 (all parts), *Low-voltage switchgear and controlgear assemblies*

IEC 62257 (all parts), *Recommendations for renewable energy and hybrid systems for rural electrification*

IEC TS 62257-5, *Recommendations for renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
carrier
messenger
wire or a rope, the primary function of which is to support the cable in aerial installations, which may be separate from or integral with the cable it supports

3.2
block
part of a line between two consecutive stoppage poles

3.3
earth
conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero

3.4
protective conductor
identification: PE
conductor provided for purposes of safety, for example protection against electric shock

[SOURCE: IEC 60050-195:1998, 195-02-09]

3.5
PEN conductor
conductor combining the functions of both a protective earthing conductor and a neutral conductor

[SOURCE: IEC 60050-195:1998, 195-02-12]

3.6
power line
overhead or underground line installed to convey electrical energy for any purpose other than communication

3.7
section of an overhead line
part of a line between two tension poles

Note 1 to entry: A section generally includes several spans.

3.8
selectivity
protection coordination
ability of a protection to identify the faulty section and/or phase(s) of a power system

[SOURCE: IEC 60050-448:1995, 448-11-06]

3.9
service connection line
conductors between the supplier's mains and the customer's installation

Note 1 to entry: In the case of an overhead service connection, this means the conductor between a supply-line pole and the customer's installation.

3.10
span
part of a line between two consecutive poles

3.11
stay
steel wire, rope or rod, working under tension, that connects a point of a support to a separate anchor

4 General

4.1 Limits of a microgrid

The microgrid is defined between the output terminals of the isolating device of the micropower plant and the input terminals of the user's interface as illustrated in Figure 1.

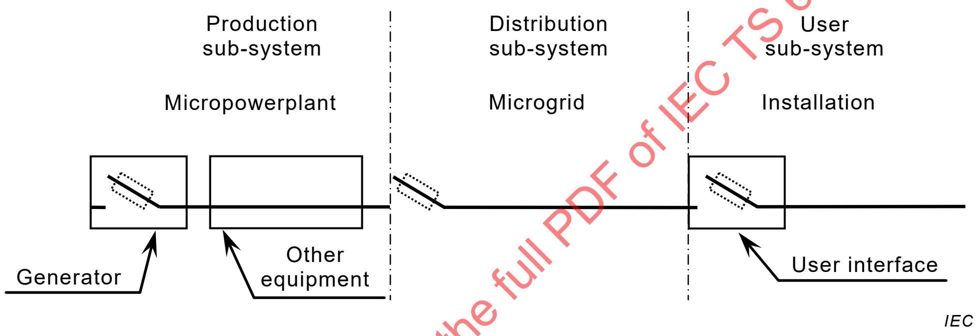


Figure 1 – Microgrid limits

4.2 Voltage drops

The maximum values of the voltage drops in the microgrid shall not exceed the values indicated in Table 1 or the values regulated by local code.

Table 1 – Maximum values of voltage drops

Microgrid	Voltage drop %
Main line	6
Individual service connection line	1

4.3 Composition of a microgrid

Three microgrid schemes are specified in this part of IEC 62257 depending on the maximum active power value required and the topography of the areas to be served.

- Single phase power system output: one single phase feeder with multiple single phase distribution (see Figure 2).

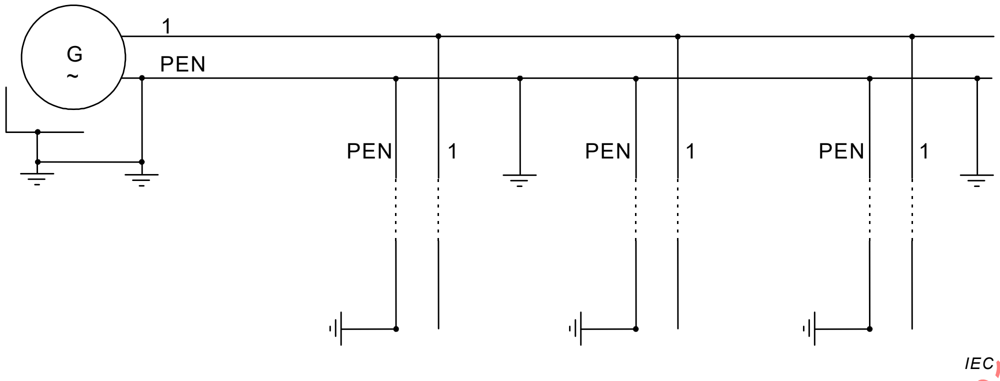


Figure 2 – Microgrid consisting of a single phase feeder

NOTE A community could be served by multiple single phase distribution driven by different single phase generators.

- three phase system output: depending on the power needs of the customers, the layout of the area to be served and the cost, two different distribution architectures can be used, as shown in Figure 3 and Figure 4.
  a) Case 1: Three phase power system output; one three phase feeder with three phase or single phase distribution.

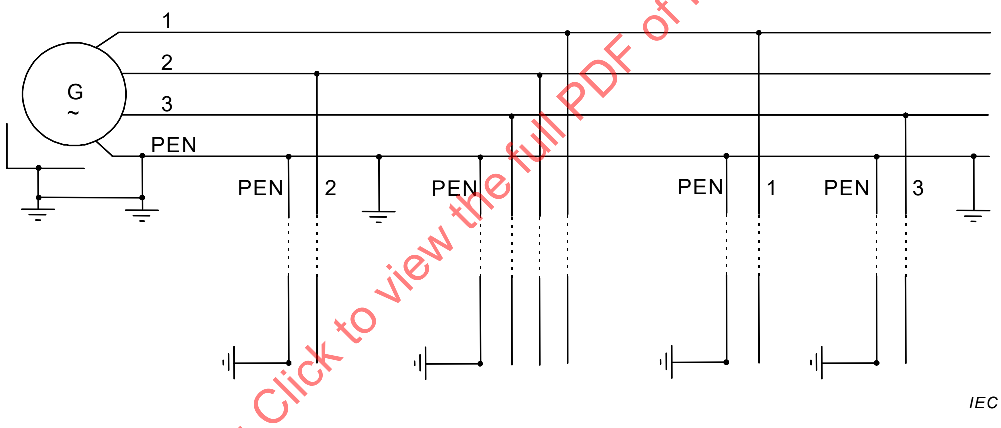


Figure 3 – Three phase system output, single phase distribution or three phase service provided where needed

  b) Case 2: Three phase power system output; single phase distribution is used throughout the community.

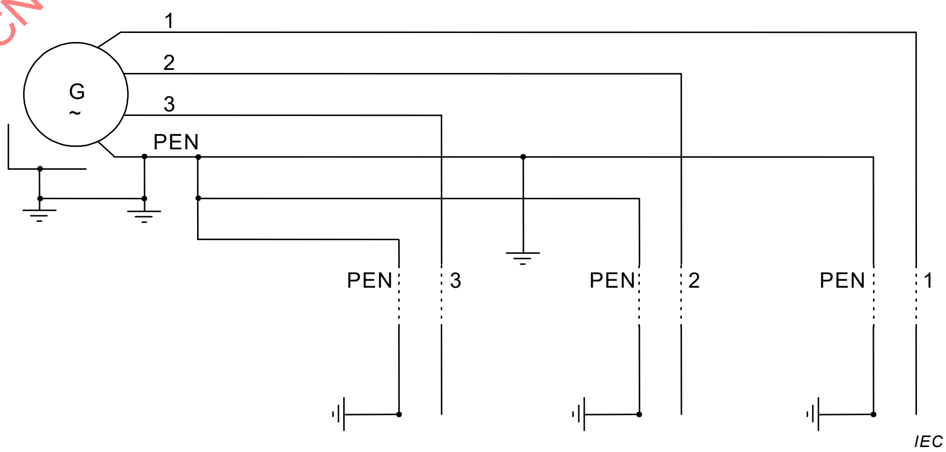


Figure 4 – Three phase system output, single phase distribution

5 Protection against electric shocks

The microgrid shall be designed as a TN-C system (see IEC TS 62257-5).

6 Protection against overcurrents

The microgrid shall be provided with a device to protect against overcurrent. It shall be placed at the interface with the micropower plant

The characteristics of the device shall ensure that, at any point, negligible impedance faults between phase conductor and protection conductor or earth will cause automatic disconnection within a period of time of 0,3 s.

Special attention shall be paid to the selectivity with respect to the overcurrent protective device of the user’s installation. The selectivity between protective devices in series should ensure that any faulty section is interrupted.

7 Selection and erection of equipment

7.1 Equipment installation

All switch gear and control equipment shall be installed in cabinets or cases which allow access only to authorized personnel. The cabinets shall comply with the IEC 61439 series.

7.2 Operational conditions and external influences

7.2.1 Ambient temperature

The conductors shall be chosen and installed so as to suit the highest local ambient temperature.

The microgrid sections, including conductors and accessories, shall be installed within the temperature limits specified by the product manufacturers and according to the manufacturers instructions (see cable characteristics in Annex A).

7.2.2 Sources of heat

To avoid the effects of heat emitted by outside sources, the following methods or equally efficient methods may be used to protect the cables:

- sufficient distance from sources of heat,
- protection screen,
- choice of line to allow for detrimental effects that may occur, local strengthening or change of insulating material.

NOTE The heat given off by outside sources may be transmitted by convection, conduction or radiation.

7.2.3 Presence of water

The microgrid conductors and equipment shall be selected and installed to avoid damage by water. Special precautions may be necessary for microgrid sections frequently exposed to water or are liable to be immersed.

7.2.4 Risk of penetration of solid bodies

The microgrid conductors and equipment shall be selected and installed to minimize hazards caused by the penetration of solid bodies. The cables and equipment shall ensure that the IP protection degree is appropriate to the chosen location.

For locations where large quantities of dust appear, additional precautions shall be taken to prevent the buildup of substances in quantities that are liable to affect the dissipation of heat from the conductors.

7.2.5 Corrosive or polluting substance presence

When there is a possibility of corrosive substances occurring, including water, which are liable to cause degradation or corrosion, all the parts of the line shall be suitably protected or manufactured from material that resists such substances.

Different materials that may form electrolytic couples shall not be brought into contact with the conductors unless special steps are taken to avoid the consequences of such contacts.

The materials that may cause mutual individual degradation or hazardous degradation shall not be allowed to come into contact with other materials.

7.2.6 Mechanical requirements

For fixed installations in which medium, high or very high impact may occur, protection shall be performed by any of the following arrangements:

- mechanical characteristics of the cables,
- chosen location,
- provision of complementary local or general mechanical protection,

or by any combination thereof.

The requirements provided in this part of IEC 62257 allow the project implementer to erect microgrids matching the needs of consumers in rural areas and also matching normal climatic conditions. If harsh conditions are expected, specific design studies shall be performed.

7.2.7 Equipment and supporting structures

Equipment and supporting structure, including their foundations, shall withstand the anticipated mechanical stresses.

7.2.8 Vibration

The conductors and/or equipment supported by or attached to structures affected by medium or high vibration conditions shall be appropriate to such conditions.

7.2.9 Other mechanical constraints for underground microgrid sections

The interior sizes of conduits and connecting accessories shall permit easy pulling or removal of conductors or cables.

The curve radius shall be such that conductors or cables are undamaged (see cable characteristics in Annex A).

The lines through which conductors or cables have to be pulled shall include suitable means of access for pulling.

7.2.10 Presence of flora, mold or fauna

When any known or foreseen conditions represent a hazard because of the presence of flora, mold or fauna, the microgrid equipment shall be selected and installed to include mitigation measures against inherent damage.

Such protection measures include:

- choice of materials with appropriate mechanical properties,
- appropriate choice of location,
- prevention of access to animals.

7.2.11 Solar radiation

Insulated conductors and cables for overhead lines shall be rated to withstand UV exposure.

7.3 Characteristics of lines

7.3.1 General

The microgrid is in general designed with overhead lines made of insulated twisted conductors.

7.3.2 Installation modes

There are two possible modes depending on the type of cable being used:

- cable without carrier neutral: the spans shall be as regular as possible. To prevent festoons from forming, the maximum length of the spans is 30 m for 16 mm^2 cable, and 25 m for 25 mm^2 cable. An installation block is limited to 4 spans.
- cable with carrier neutral: the maximum span length is limited to 50 m.

7.3.3 Minimum height of conductors

The installation tensions shall be determined according to the graphs supplied by the cable manufacturer.

For alignment along a road, and depending on the constraints due to nearby dwellings, cables shall be at a minimum height of 3,5 m or 4,5 m above ground.

For road crossings, and depending on the type of traffic using the road, cables shall be at a minimum height of 4,5 m or 6 m above ground.

The poles shall be chosen so as to limit the sag to a value compatible with the height and in accordance with the setup conditions specified in 7.5.2.3.

7.3.4 Proximity to other services

Where insulated cables cross or are near to communication cables, gas, water, or other pipes, an appropriate clearance shall be maintained between cables and the pipelines. Where this clearance cannot be maintained, contact between the cables and the pipelines shall be prevented.

7.4 Cables

For cables with or without a carrier, the phase conductor(s) and the PEN conductor shall have the same section.

Considering the technology used for light fittings (electronic ballasts), public lighting conductors shall only be used as private wires to transmit controls. Energy shall be drawn off the distribution network.

The characteristics of the cables are given in Annex A.

Minimum cross-sectional areas of conductors for overhead lines are given in Table 2, depending on the rating of the protection devices.

The graphs in Annex B indicate the maximum possible length of the circuit depending on the active power demand for each cable type and for various power factors.

These charts are given for two conditions:

- uniformly widespread loads,
- loads located at the extremity of the cable.

The use of 16 mm^2 and 25 mm^2 cross-sections are recommended for distribution to customers; 35 mm^2, 50 mm^2 and 70 mm^2 are normally used as link between the micropowerplant and the microgrid (if needed). The use of the 150 mm^2 cross-section would probably be exceptional due to the fact that its installation requires heavy means, very strong poles and costly accessories and special skills for the workers. An alternate solution could be to use two 70 mm^2 cross-section cables instead of one 150 mm^2.

7.5 Poles

7.5.1 General

All types of poles may be used: impregnated wood poles, zinc-coated steel poles, metal profiles, concrete poles and other types of wooden poles, etc.

7.5.2 Characteristics of poles

7.5.2.1 Height of poles

In alignment and according to the constraints resulting from environmental conditions:

- total height: 6 m, height above ground, 4,9 m, or
- total height: 8 m, height above ground, 6,7 m.

Crossing roads and depending on type of traffic using the road:

- total height: 8 m, height above ground: 6,7 m, or
- total height: 10 m, height above ground: 8,5 m.

7.5.2.2 Other characteristics

- Maximum force measured at 0,25 m from top:

  The value generally accepted for wooden poles is 140 daN.

  Different values may be chosen for other types of poles depending on the choice offered by suppliers, more often than not local. Installation tensions shall always be suited to the types of poles chosen.

- Attachment of anchorage equipment

  Depending on their types, the poles shall permit easy attachment of the anchorage equipment, at the ends or on alignments, for instance, holes for wooden poles. In other cases, equipment attachment by stainless steel sheet shall be possible.

- Resistance to the environment

By their design or after specific in-depth or surface treatment depending on their types, the poles shall have a minimum life duration of 10 years without any change in characteristics.

- Safety

  The poles shall guarantee the safety of operators, in particular for the attachment of ladders or during climbing, using the technique generally used for operational purposes.

  The type or service conditions shall not represent any risk (catching, tearing, sharp edges, etc.) to the population.

7.5.2.3 Installation of poles

Dressing of poles should precede their erection.

For wooden poles, it is recommended to wedge the poles with dry stone (the use of concrete is forbidden). Any other method that offers the same performance and stability guarantees may be used.

For concrete and metallic poles, concrete shall be used to wedge the poles.

If the pole is not cylindrical, the direction from where the pulling force is applied shall be considered. The pole should be oriented so that it has the maximum strength for the direction to the applied force.

If needed, two poles of the same type may be assembled to suit the direction of the force (see Figure 5).

If the conductors of two consecutive spans form an angle ≥40°, the installation characteristics shall be similar to those used for the end poles.

An example of twin-pole installation is given in Figure 5. The poles are set up one behind the other in the bisecting line of the angle formed by the two spans concerned (maximum direction of force).

Figure 6 provides examples of different poles arrangements within microgrids.

Figure 7 provides an example of the structure of an overhead microgrid line.

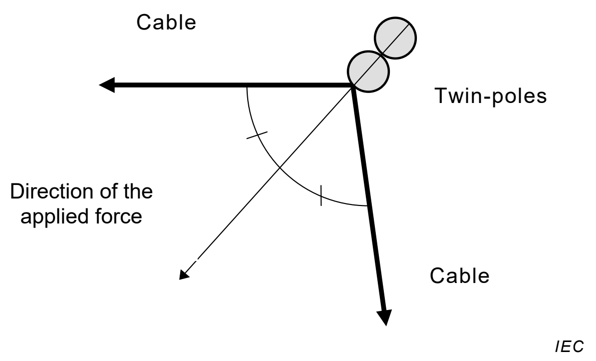


Figure 5 – Diagram showing installation of twinned wooden poles forming an angle

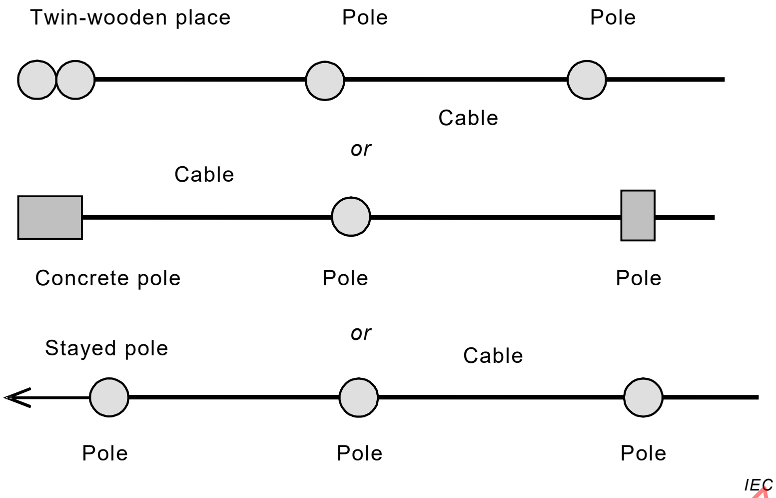


Figure 6 – Examples of different pole arrangements

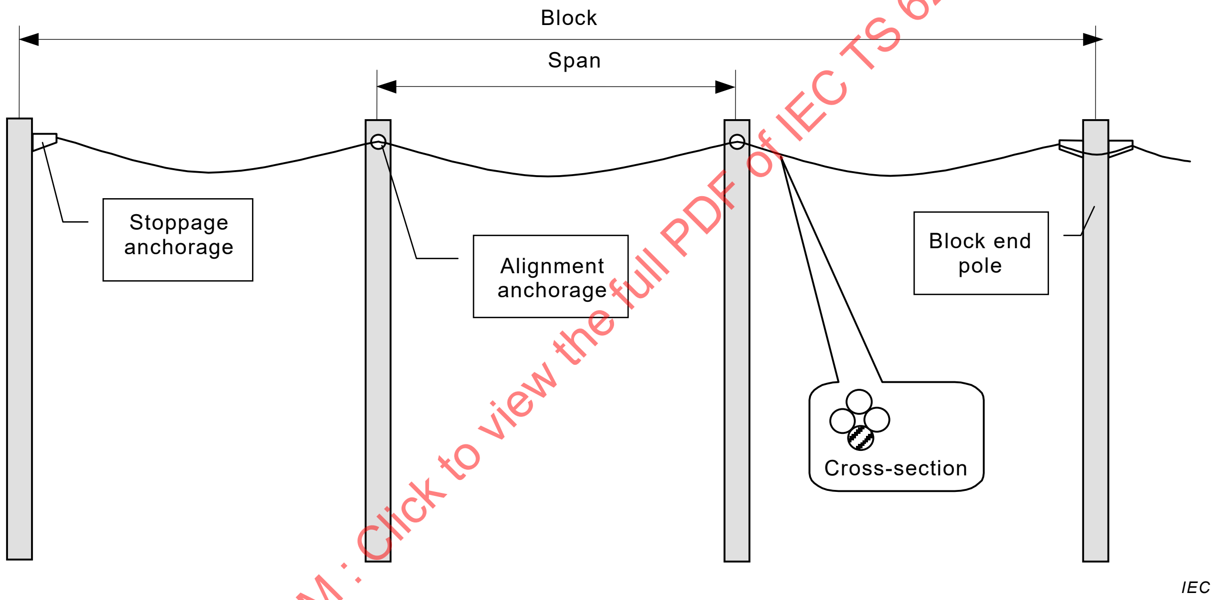


Figure 7 – Example of an overhead line

At the ends and at an angle, the installation of a single pole with guy lines is permitted as long as suitable guy line attachment equipment is used.

Similarly, stays may be installed, provided that the equipment used for attachment to the pole and the ground is suitable.

The presence of the stays, in terms of location and arrangement, shall not represent a risk to the population.

Where stay wires cannot be made off immediately, the stay wires should be tied to the pole at a position above normal reach, to prevent injury to persons and animals.

7.6 Cable anchorage

All network cable connections shall be made to a block end pole.

In all cases, the two ends of each block shall be provided with a stoppage anchorage.

If a cable without a carrier is used, the installation section shall be confined to the length of 4 spans. The two ends of each section shall be provided with a stoppage anchorage point. The spans shall be of equal length.

Stoppage and alignment anchorages shall be selected in accordance with the cross sections of the cables used.

7.7 Connections and accessories

7.7.1 General

Connections between conductors and between the conductors and other equipment shall ensure electrical continuity and offer appropriate mechanical resistance.

The choice of the connection means shall take into consideration:

- the material of the conductors and their insulation,
- the numbers and shapes of the conductor cores,
- the conductor sections,
- the number of conductors to be connected together.

The connections shall be accessible for checking, testing and maintenance.

Welded connections or splices are strictly prohibited. Connectors with pierced insulation shall be used.

Connections shall offer a protection degree of IP2X at the least, by construction or installation.

All necessary precautions shall be taken to prevent conductors from energizing any metal part that is normally insulated from the active parts.

The connections shall be capable of withstanding the forces caused by normal rated current and by short-circuit current, as determined by the characteristics of the protection device.

Connections shall not be affected by unacceptable modifications due to overheating, aging of insulators and vibration during normal service. In particular, it is important to take into consideration the influence of the temperatures reached on the mechanical strength of the materials.

7.7.2 Connections between conductors, connections to other equipment

Connections between conductors (for end-to-end conductor extensions) and connections to other equipment shall not be affected by any pulling or twisting forces.

Accordingly, such connections shall be made at the poles where the network shall be secured on both ends by anchoring clamps.

7.7.3 Connection points for individual service connections

Connection points for individual service connections shall be made only at a pole.

7.7.4 Connection equipment

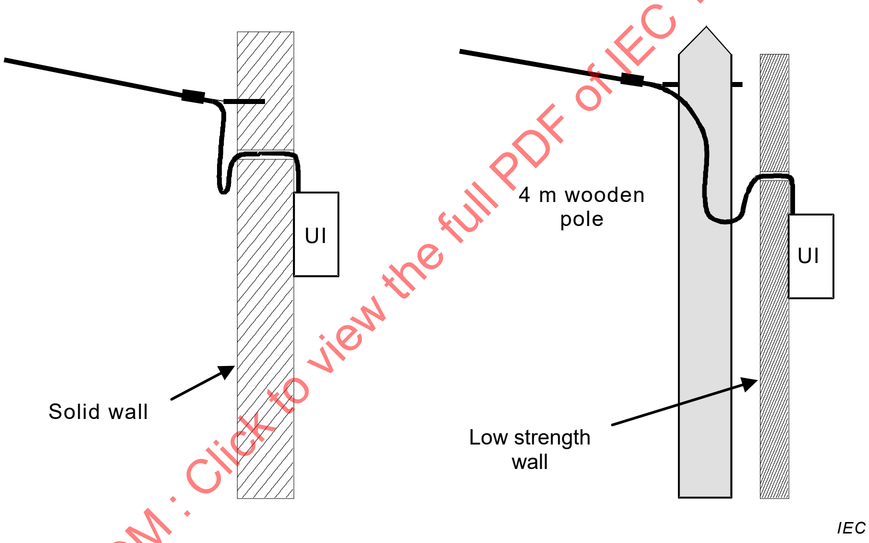
The connection and accessory equipment listed below may be used (non-exhaustive list):

- insulator piercing connectors for connections,
- insulator piercing connectors for public lighting connections,

- connection sleeves for phase and neutral conductors,
- retracting end caps for networks,
- insulating bands for the attachment of LV conductors and cables,
- pre-insulated connection sleeves for twisted insulated conductor connections,
- flexible collars for connections to accessories,
- plasticized collars for connections,
- regular flexible and bending insulating tubes,
- black insulating tubes for connections,
- neutral grease,
- self-welding insulating plates,
- protection sheaths for cables.

The connection mode shall allow for the characteristics of the walls or surfaces on which they are to be anchored.

Figure 8 shows two cases that are liable to occur.



Key

UI User Interface

Figure 8 – Connection mode diagram

7.8 Where poles are used for other purposes

7.8.1 Public lighting points

The height of poles supporting public lighting shall be determined according to the recommended position of the latter to offer optimum lighting.

7.8.2 Telecommunication lines

Microgrid poles may support telecommunication lines. In this case, they are used as common support.

The power lines shall be placed above the telecommunication line.

The distance between lines shall be at least 0,25 m. On the supports, the difference in level between the conductors of the two lines shall be at least 0,50 m.

The pole height is determined so that the minimum heights above ground of the lowest line, as specified in 7.3.3, is allowed for.

7.9 Isolation and switching

7.9.1 Overcurrent protection device

Protection shall be performed by a fused switch or by a thermo-magnetic circuit-breaker.

Table 2 indicates the ratings of the fuses to be used for 230 V (and 240 V) a.c.

Table 3 indicates the ratings of the fuses to be used for 120 V a.c.

Table 4 indicates the ratings of the circuit breakers to be used for protection from short-circuiting.

Table 2 – Fuse ratings for protection from short-circuiting in 230 V (and 240 V) a.c. microgrids (overhead lines)

Rating	Fuse type	Minimum cross-sectional area of conductors mm^2
5 kVA: 25 A	gG 10/38	2 x 16
15 kVA: 3 x 25 A	gG 10/38	4 x 16
30 kVA: 3 x 50 A	gG 22/58	4 x 16
50 kVA: 3 x 80 A	gG 22/58	4 x 16 or 4 x 25
100 kVA: 3 x 160 A	gG Size 00	3 x 70 + 1 x 54,6

Table 3 – Fuse ratings for protection from short-circuiting in 120 V a.c. microgrids (overhead lines)

Rating	Fuse type	Minimum cross-sectional area of conductors mm^2
5 kVA: 50 A	gG 22/58	2 x 162
15 kVA: 3 x 50 A	gG 22/58	4 x 162
30 kVA: 3 x 100 A	gG 22/58	4 x 252
50 kVA: 3 x 160 A	gG Size 00	3 x 702 + 1 x 54,6
100 kVA: 3 x 315 A	gG Size 2	3 x 1502 + 1 x 702

Table 4 – Circuit breaker ratings for protection from short-circuiting in microgrids (overhead lines)

Rating	230 V a.c.		120 V a.c.	
	I A	calibre A	I A	calibre A
5 kVA (single phase)	22	25	42	63
15 kVA (three phases)	22	25	42	63
30 kVA (three phases)	44	63	83	100
50 kVA(three phases)	73	100	139	160
100 kVA (three phases)	145	160	278	320

7.9.2 Isolating devices

Isolating devices shall be included for the isolation of the microgrid to permit servicing, checking, fault location and repairs.

Isolation shall be provided on all of the conductors.

Isolation can be carried out by a device installed for other purposes (circuit breaker, etc.).

Isolation devices shall be equipped with a suitable locking device.

7.10 Earthing arrangement, protective conductors and protective bonding conductors

The PEN conductor is earthed at both ends of the network and regularly every 200 m (see Figure 9).

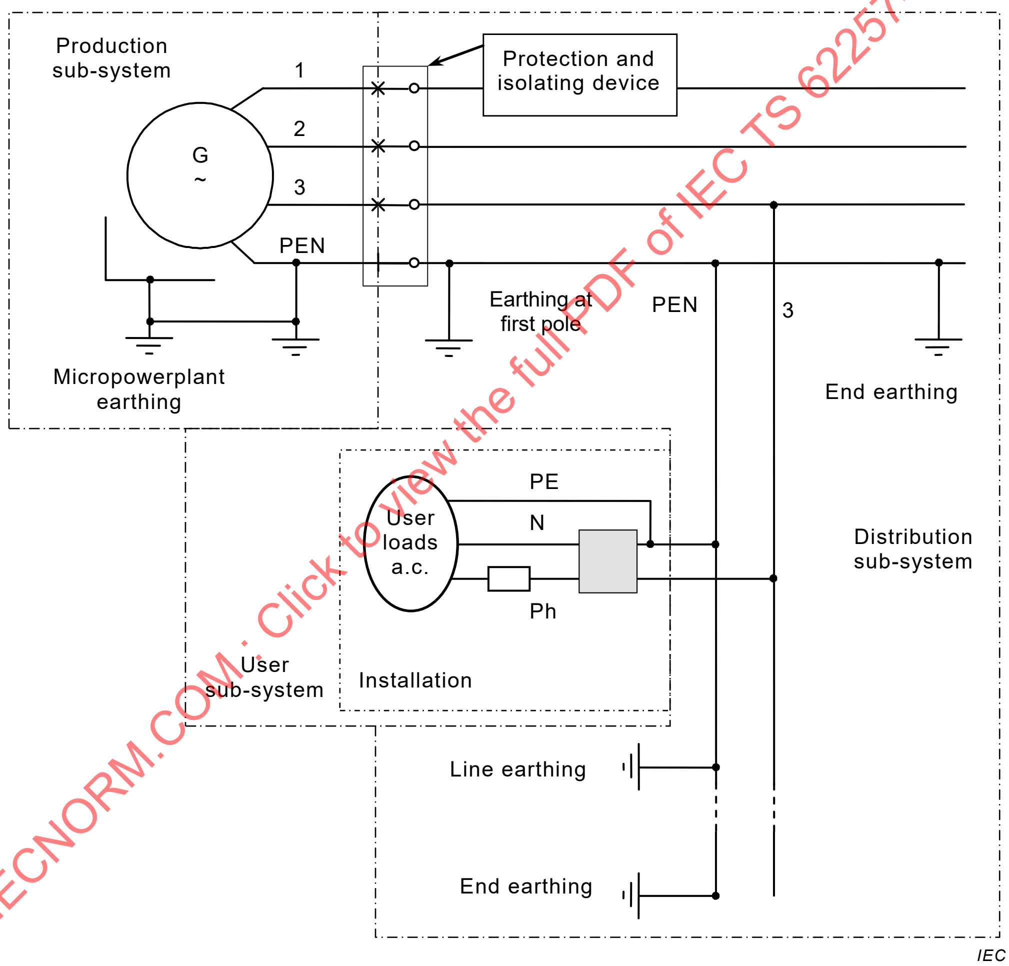


Figure 9 – Microgrid earthing scheme

Earthing of PEN conductor shall be performed according to Table 5:

- at the origin of the microgrid, at the first pole,
- regularly every 200 m.

The earth conductor shall be in direct contact with earth. The minimum cross-section shall be:

- 16 mm^2 of copper or galvanized steel if protected against corrosion,
- 25 mm^2 of copper or 50 mm^2 of galvanized steel if not protected against corrosion.

If the earthing electrode consists of a rod, resistance between the rod and the earth should be less than 1 500 Ω.

NOTE The calculation of the resistance of the rod is made by using the following formula:

$R=\rho / L$

where

ρ is the soil resistivity (Ωm), and

L the length of the rod (m).

Common resistivity (Ωm) values are given here:

Arable rich soil, humid compact soil	50
Bad soil, gravel, backfill	500
Rocky soils, dry sand, waterproof rocks	3 000

See IEC 60364.

If lower values are desired, another earthing technique, chosen from those of Table 5 should be implemented.

Table 5 – Characteristics of earthing components

Method	Type	Size	Layout
Rod	Galvanized steel tube Galvanized steel profiles Copper or copper-coated steel bars	L = 1,5 m diameter ≥ 25 mm L = 1,5 m, side ≥ 60 mm L = 1,5 m, diameter ≥ 15 mm	1 or several set out vertically under the permanent damp level, depth of stake tip ≥ 2 m.
Conductor cable in trench	Bare copper cable Galvanized steel cable	L = 10 m, S = 25 mm^2 L = 10 m, S = 95 mm^2	At the foot of the support, a 10 m coil in a trench L = 3 m, depth = 1 m.
Other conductors	Thin plates Metal poles, etc.		Centre of plate at depth of 1 m. Depth ≥ 1 m.

8 Verification and acceptance

8.1 General

Electrical microgrid erection shall be monitored and shall be verified before commissioning and whenever any major change is made by a qualified person, to make sure that it complies with this part of IEC 62257.

Safety rules shall be complied with during acceptance to avoid all danger to persons, animals and property.

8.2 Supervision of works

During the works, supervision shall concern more essentially:

- the setting up conditions of the wooden poles (excavation depth, wedging),
- the installation conditions of metal poles, if any,
- conductor pulling,

- the construction of earth points,
- compliance with professional practice rules in the establishing of the service connections,
- the production of connections on conductors,
- the compliance with safety instructions.

8.3 Verification before commissioning (on site acceptance)

Electrical microgrid erection shall be verified before commissioning.

On site acceptance consists of verification of:

- the conformity of the equipment,
- the height of the conductors above the ground at the minimum of the sag within the spans,
- the correct identification of the phase and PEN conductors,
- the construction of cabinet and unit cabling,
- the value of the earth point resistance,
- the operation of the de-energized equipment (e.g. mechanical test for circuit breakers),
- the insulation resistance of the microgrid,
- the acknowledgment of any remarks made during work supervision.

Any major change to the microgrid shall be made by a qualified person to make sure that it complies with this part of IEC 62257.

8.4 Operation tests

Acceptance shall end with the following tests under normal operation condition.

- checking the operation of the protection devices when devices have specific test function (short circuit tests are not recommended),
- checking the voltage drops at the microgrid ends when under load,
- checking the performance of the public lighting if any.

Annex A
(informative)

Characteristics of cables

Table A.1 – Example of characteristics of grid conductors for overhead lines (insulated twisted conductors without carrier neutral) *(1 of 2)*

	2 x 16 mm²	2 x 16 mm²+ 2 x 1,5 mm²	2 x 25 mm²	2 x 25 mm² + 2 x 1,5 mm²	4 x 16 mm²	4 x 16 mm² + 2 x 1,5 mm²	4 x 25 mm²	4 x 25 mm² + 2 x 1,5 mm²
Cable core type	aluminium	aluminium	aluminium	aluminium	aluminium	aluminium	aluminium	aluminium
PE core type		bare copper		bare copper		bare copper		bare copper
Cable shape	round	round	round	round	round	round	round	round
PE shape		round		round		round		round
Cable flexibility	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled	cl. 2 cabled
PE flexibility		cl. 1 solid		cl. 1 solid		cl. 1 solid		cl. 1 solid
Insulation	black CRP	black CRP	black CRP	black CRP	black CRP	black CRP	black CRP	black CRP
Ambient temp. range	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C	–60 °C + 70 °C
Min. inst. temp.	–20 °C	–20 °C	–20 °C	–20 °C	–20 °C	–20 °C	–20 °C	–20 °C
Core diameter (mm)	4,6	4,6	5,9	5,9	4,6	4,6	5,9	5,9
Diameter on ins. (mm)	7,9	7,9	9,6	9,6	7,9	7,9	9,6	9,6
Twist diameter (mm)	16,8	17,0	19,2	21,0	19,1	24,0	23,2	30,0
Mass (kg/km)	140	185	210	260	280	325	420	470
Core min. brig. strength (daN)	190	190	300	300	190	190	300	300
Max. linear R at 20 °C cont. (Ω/km)	1,91	1,91	1,20	1,20	1,91	1,91	1,20	1,20
Constant state current (A)	93	93	122	122	83	83	111	111
Voltage drop at cos ρ = 0,8 (V/A/km)	3,98	3,98	2,54	2,54	3,44	3,44	2,20	2,20
Resistance to solar irradiation	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent	Excellent
Resistance to mechanical impact	low 0,225 J	low 0,225 J	low 0,225 J	low 0,225 J	low 0,225 J	low 0,225 J	low 0,225 J	low 0,225 J
Min. curve *R*	6 *D*	6 *D*	6 *D*	6 *D*	6 *D*	6 *D*	6 *D*	6 *D*

Table A.1 *(2 of 2)*

	2 x 16 mm²	**2 x 16 mm²+ 2 x 1,5 mm²**	**2 x 25 mm²**	**2 x 25 mm² + 2 x 1,5 mm²**	**4 x 16 mm²**	**4 x 16 mm² + 2 x 1,5 mm²**	**4 x 25 mm²**	**4 x 25 mm² + 2 x 1,5 mm²**
Water resistance	Puddles	Puddles	Puddles	Puddles	Puddles	Puddles	Puddles	Puddles
Fire resistance	Not rated	Not rated	Not rated	Not rated	Not rated	Not rated	Not rated	Not rated
Resistance to chemicals	Good	Good	Good	Good	Good	Good	Good	Good

D: Diameter.

CRP: Chemically Reticulated Polyethylene.

Annex B
(informative)

Maximum circuit length

Maximum lengths are given as a function of active power, for different cross-sections and voltage drop.

Two situations are considered:

- The loads are uniformly distributed (marked “outspread” on the charts)
- The loads are located at the extremity of the cable (marked “end” on the charts)

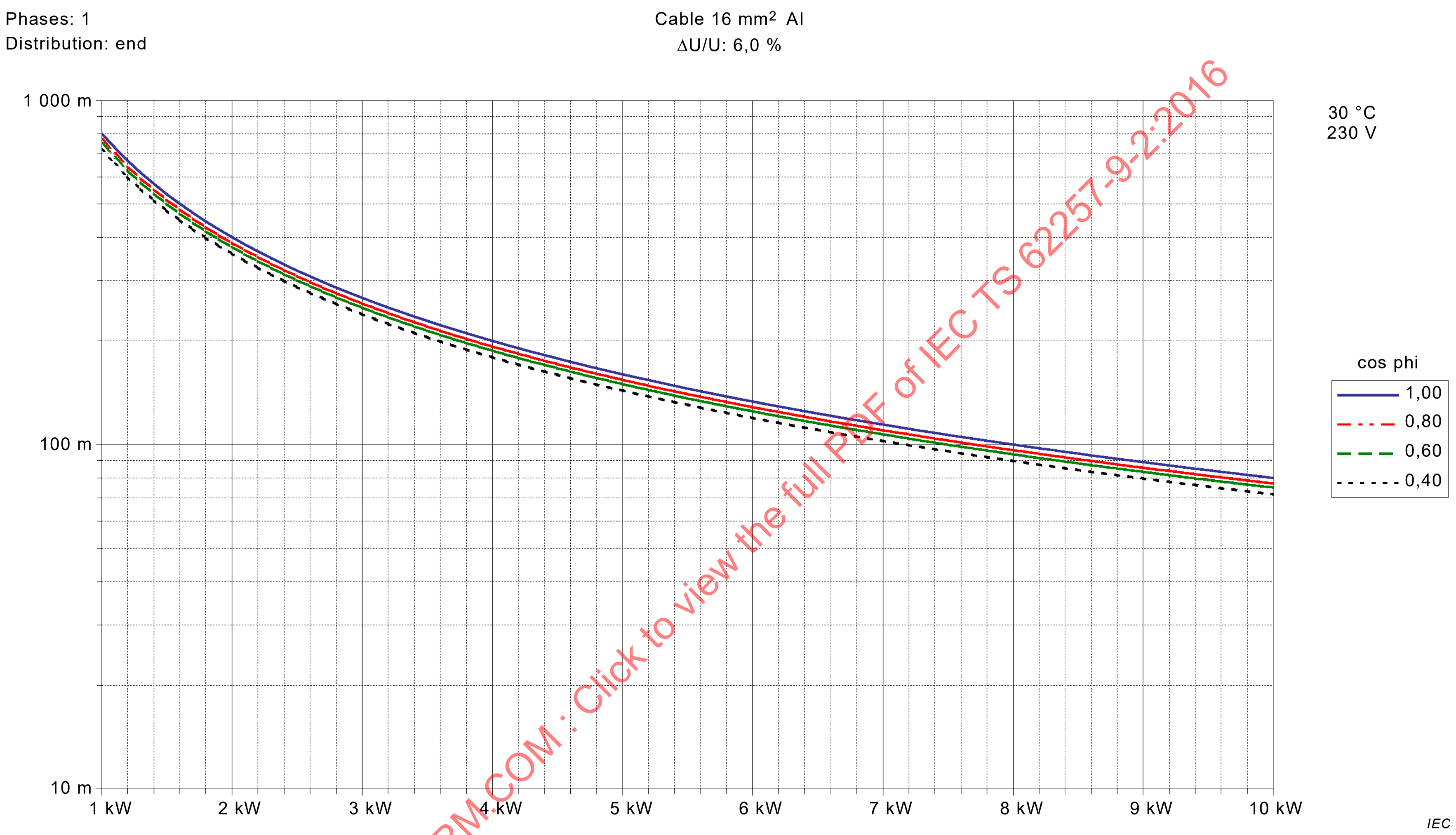


Figure B.1 – Maximum lengths as a function of active power (1 phase) for 16 mm² cable and 6 % voltage drop with loads at end of cable

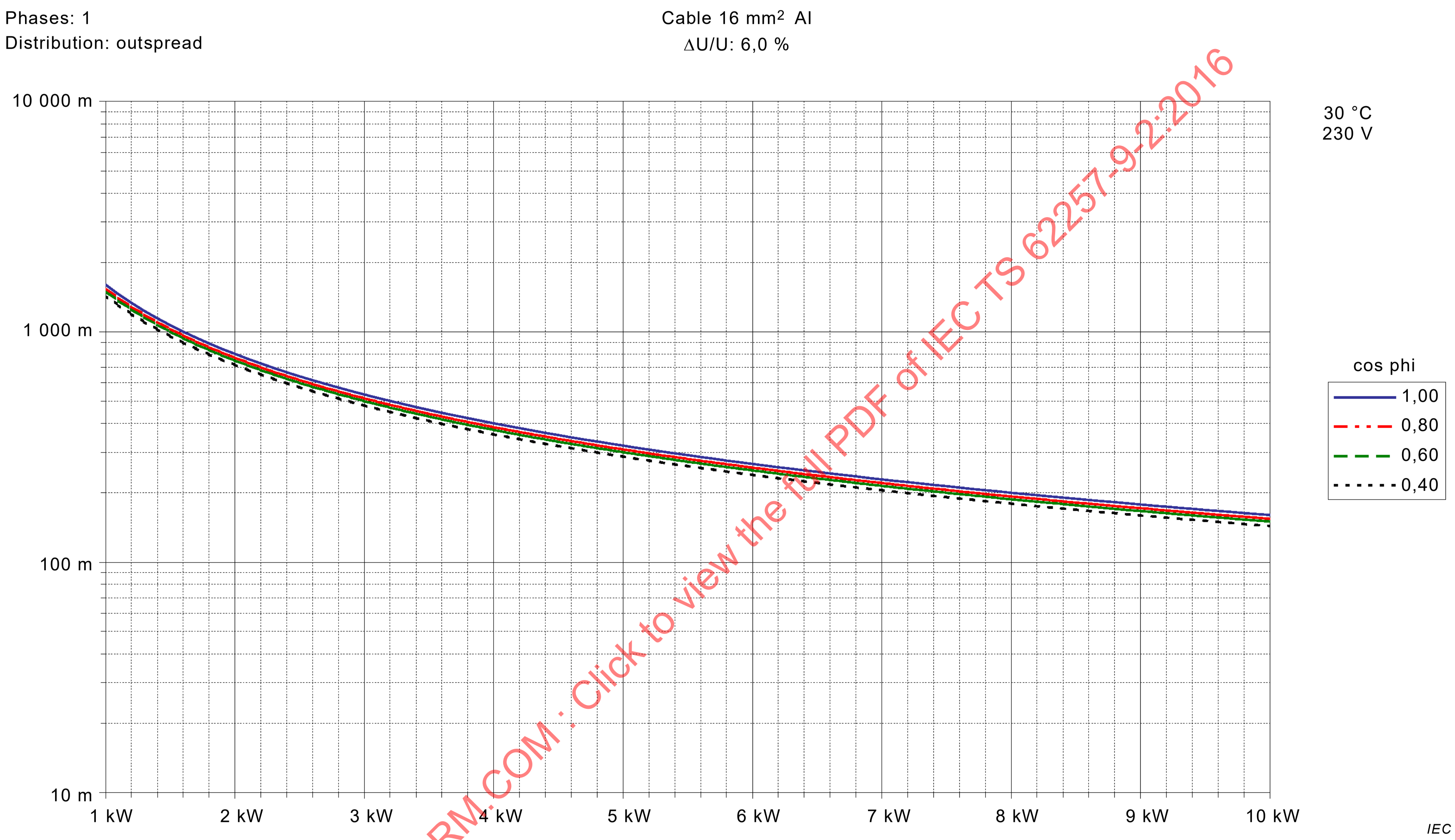


Figure B.2 – Maximum lengths as a function of active power (1 phase) for 16 mm^2 cable and 6 % voltage drop with loads spread across cable

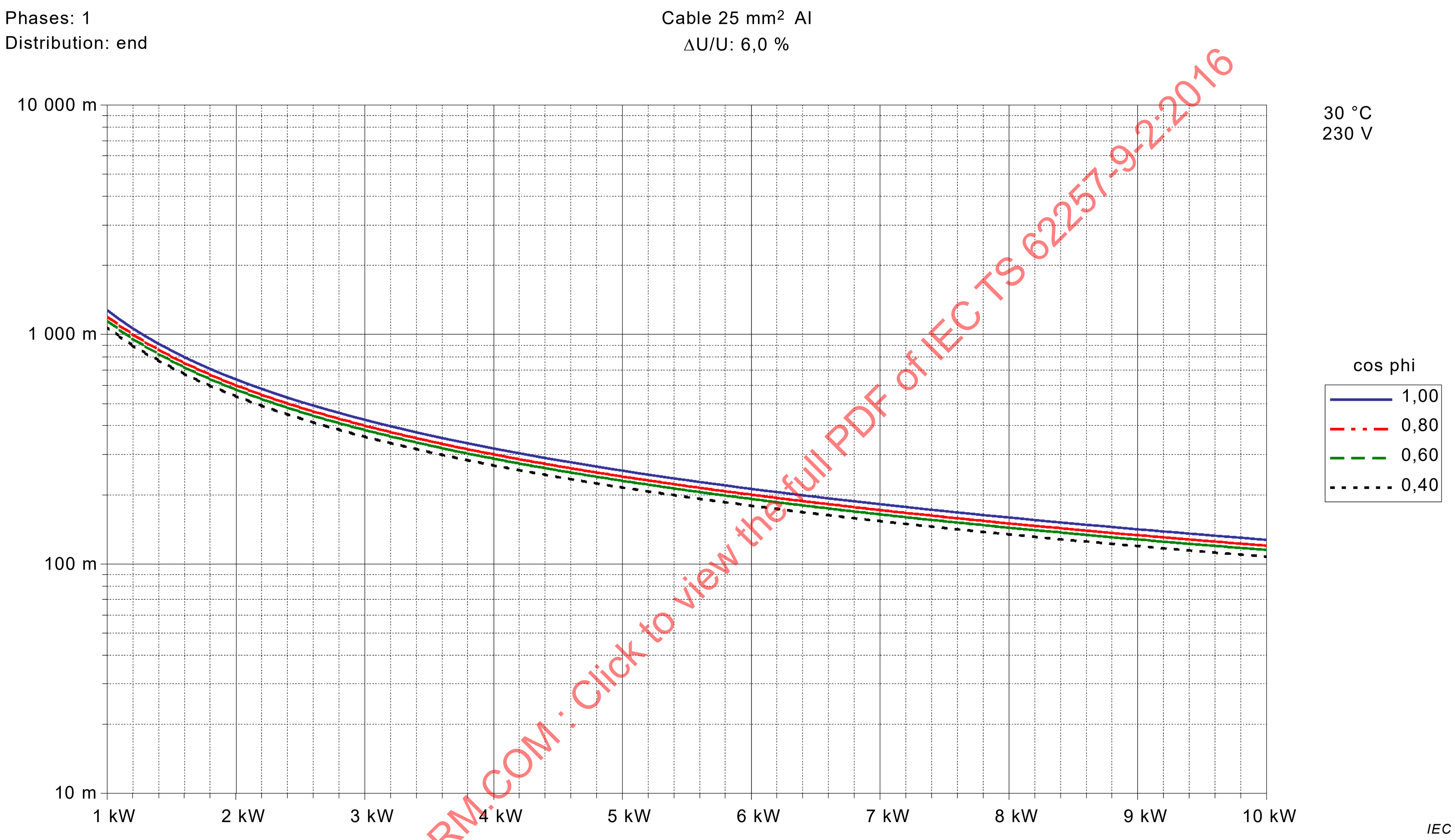


Figure B.3 – Maximum lengths as a function of active power (1 phase) for 25 mm² cable and 6 % voltage drop with loads at end of cable

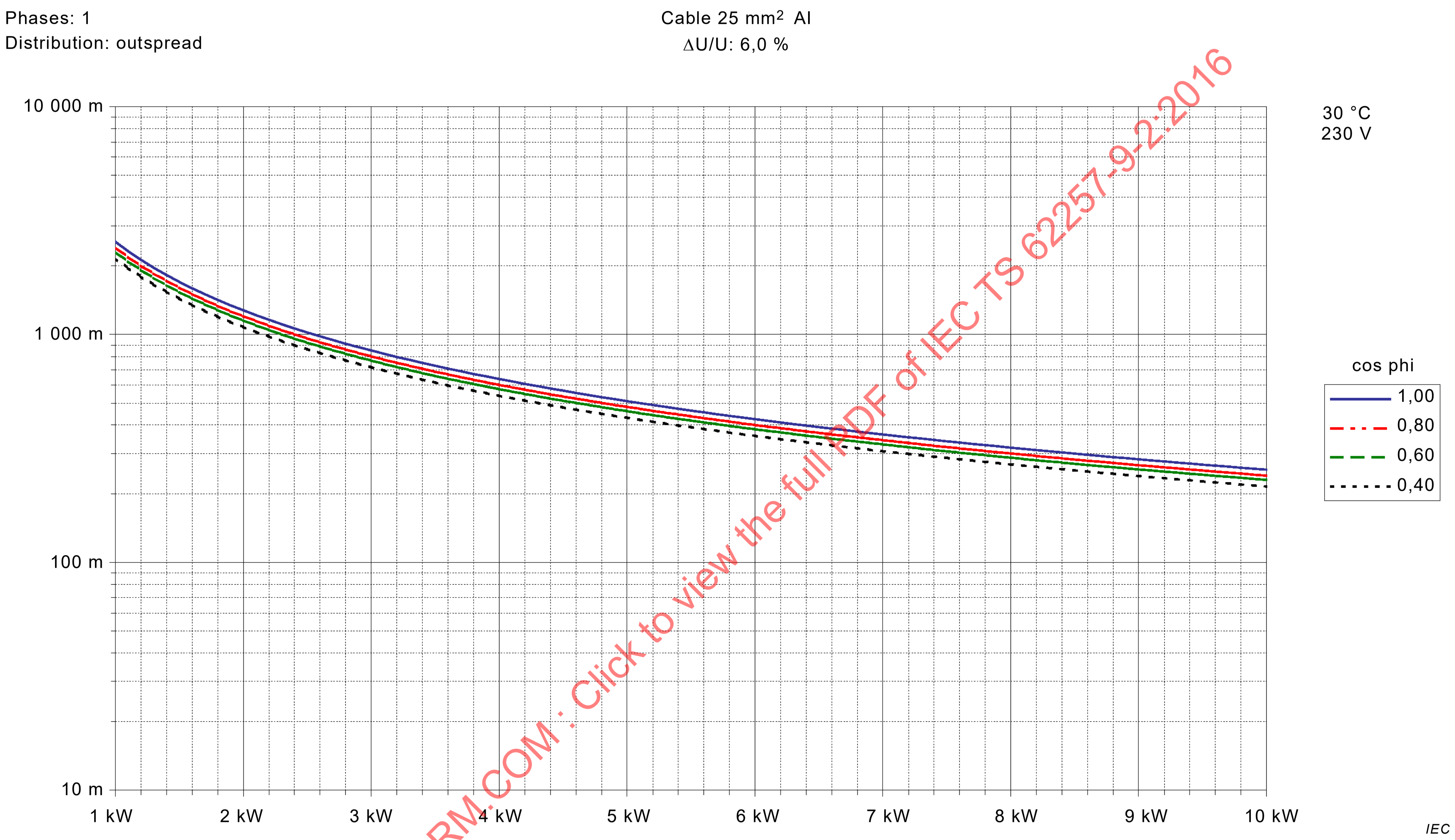


Figure B.4 – Maximum lengths as a function of active power (1 phase) for 25 mm^2 cable and 6 % voltage drop with loads spread across cable

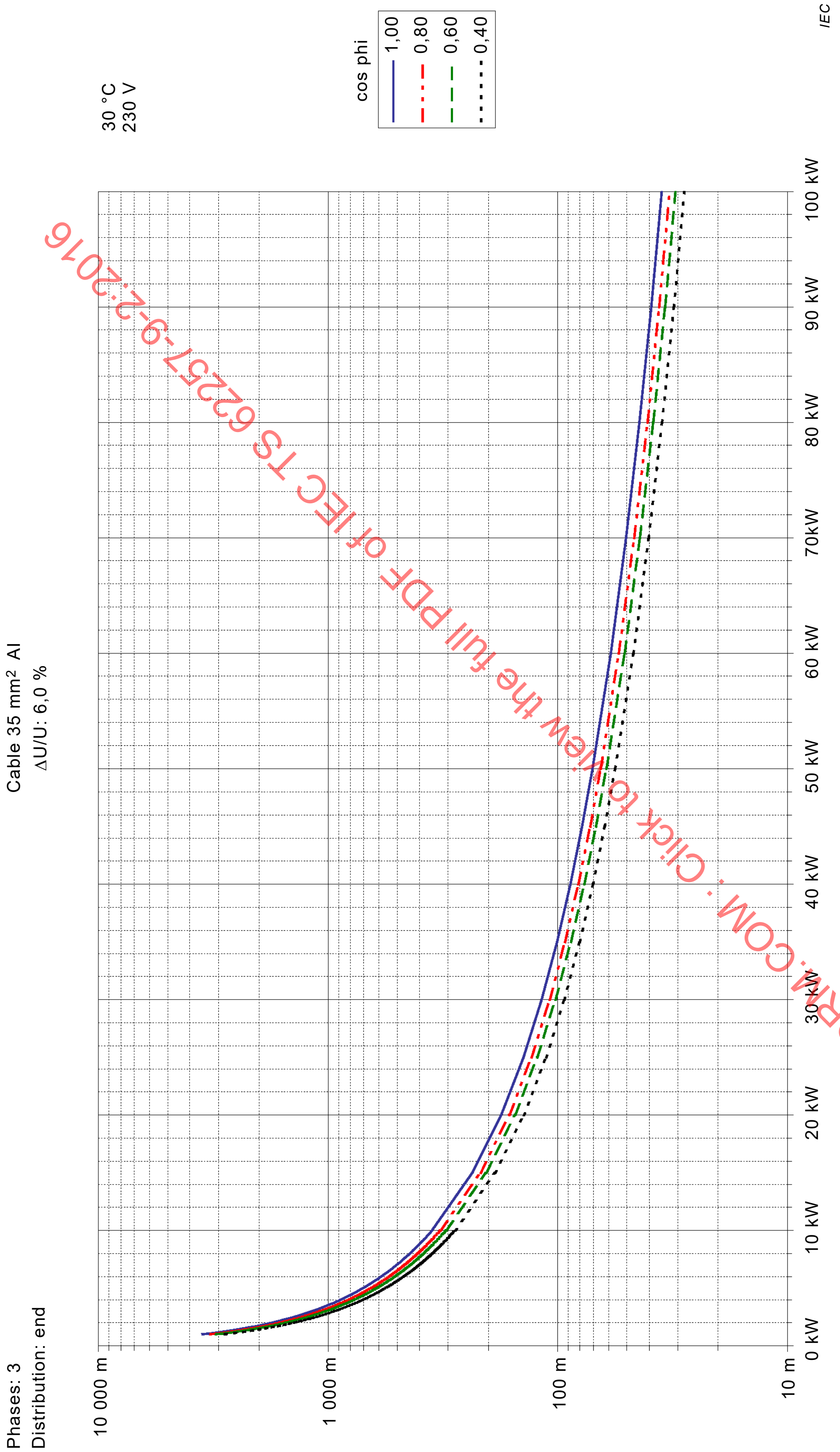


Figure B.5 – Maximum lengths as a function of active power (3 phase) for 35 mm² cable and 6 % voltage drop with loads at end of cable

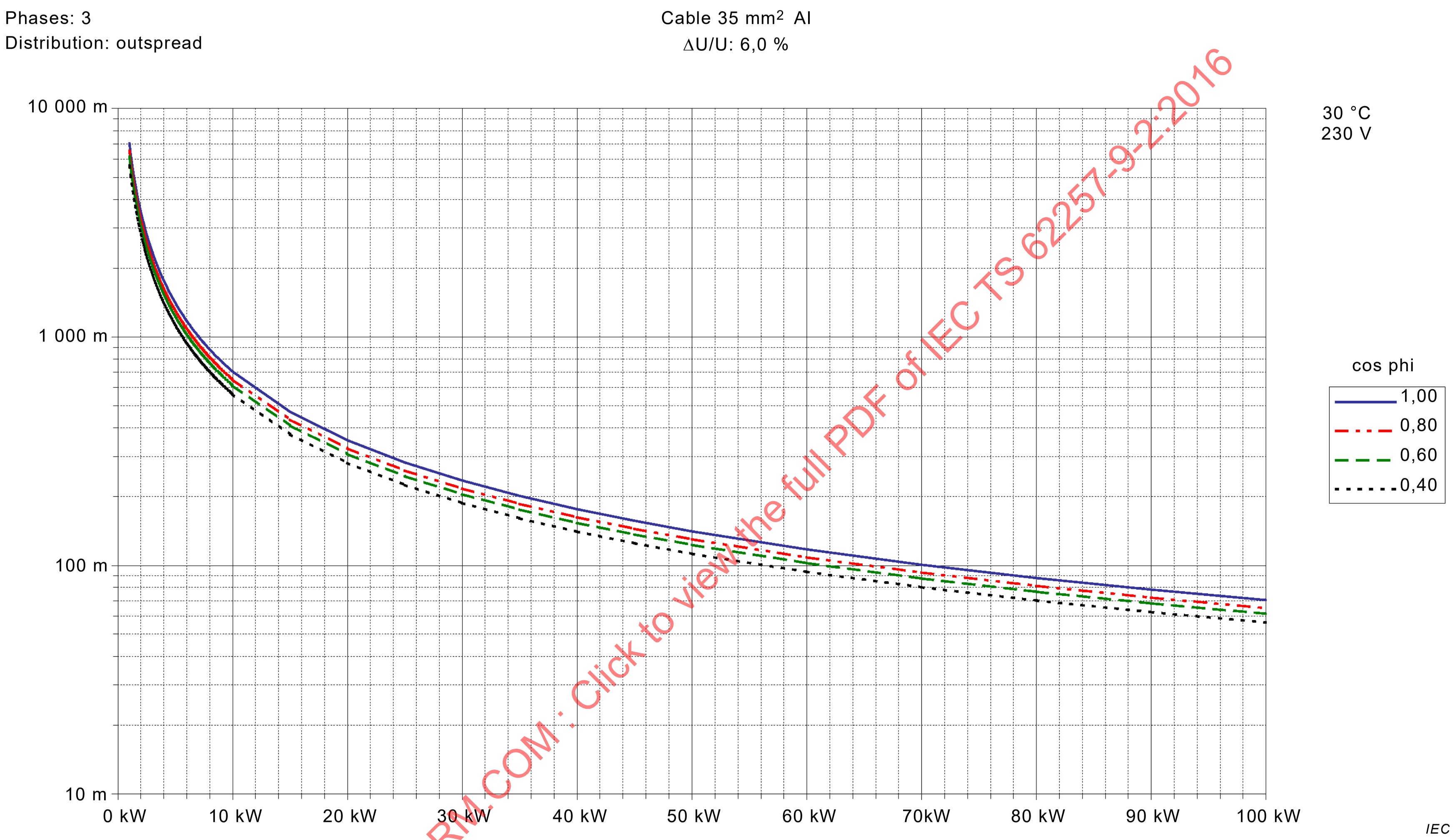


Figure B.6 – Maximum lengths as a function of active power (3 phase) for 35 mm² cable and 6 % voltage drop with loads spread across cable

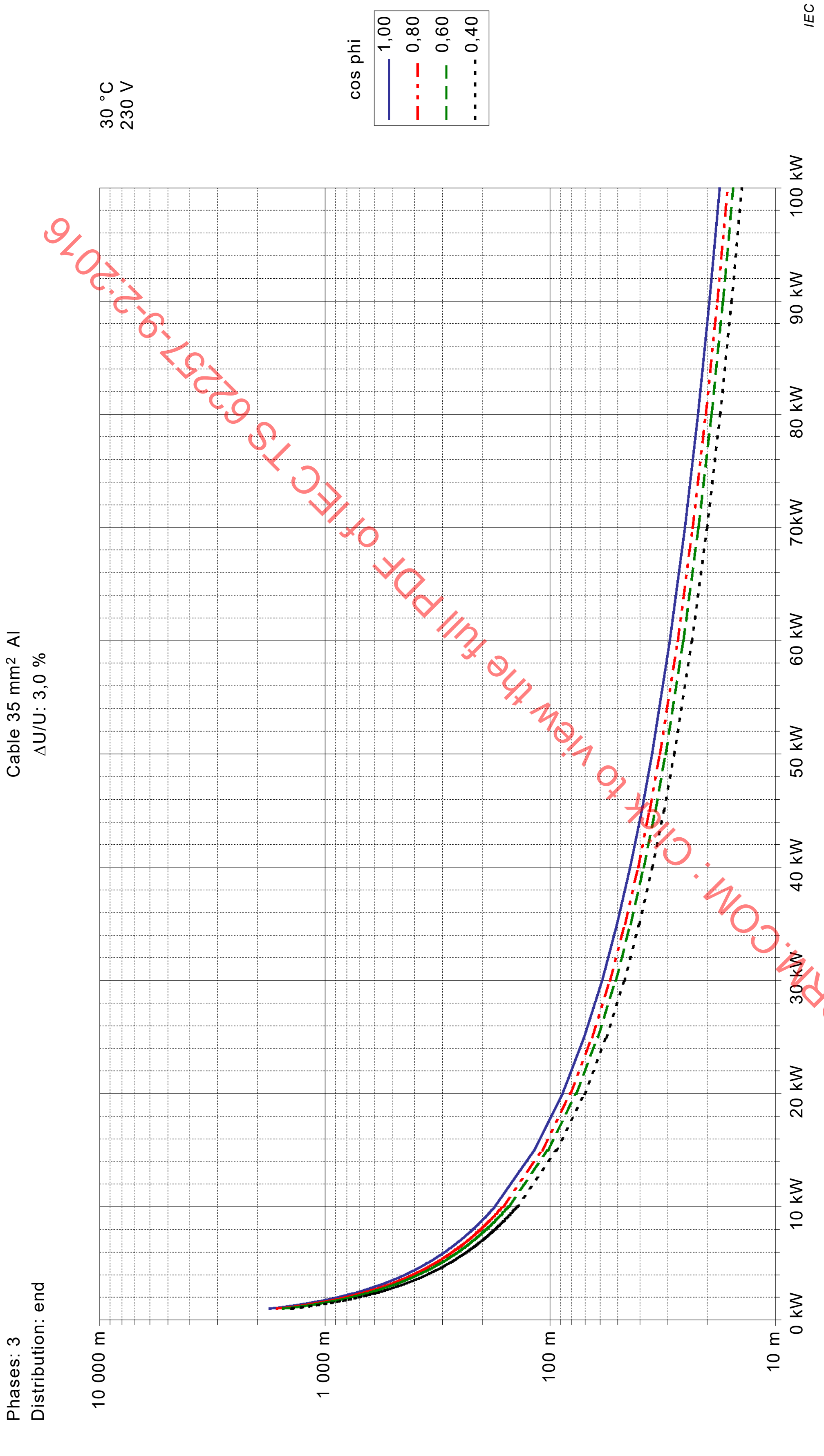


Figure B.7 – Maximum lengths as a function of active power (3 phase) for 35 mm² cable and 3 % voltage drop with loads at end of cable