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**Electrical safety and lightning protection of
medium voltage input and up to ± 400 V DC
output power system in ICT data centre and
telecommunication centre**

Recommendation ITU-T K.151

ITU-T

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Electrical safety and lightning protection of medium voltage input and up to ± 400 V DC output power system in ICT data centre and telecommunication centre

Summary

Recommendation ITU-T K.151 provides guidelines for electrical safety and lightning protection requirements for medium voltage power electronic converter systems, which have medium voltage input with rated system voltages from 1 000 V AC up to 36 kV AC and low voltage output with rated voltages up to ± 400 V DC, used in information and communication technology (ICT) data centres, telecommunication centres, or other application environments.

With the development of big data and cloud computing technology, the quantity and total capacity of the data centres and telecommunication centres together with ICT equipment power densities are increasing rapidly. In this condition, it was found that the traditional power distribution equipment and power systems had the disadvantages of low energy efficiency, high energy consumption, high maintenance difficulties, and high costs in many existing data centres and telecommunication centres. In order to solve these problems, it is necessary to develop a new structure of a whole power system, which may be powered directly by medium voltage and based on power electronic conversion.

From the perspective of electrical safety and lightning protection, there are lots of differences between the data centre and telecommunication centre powered by traditional low-voltage alternating current (AC) and that powered by medium voltage. This Recommendation focuses mainly on electrical insulation, partial discharge, electrical safety, resistibility and lightning surge protection.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
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Keywords

Electrical safety, ICT data centre, lightning protection, medium voltage, power electronic converter systems, telecommunication centre.

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Recommendation ITU-T K.151

Electrical safety and lightning protection of medium voltage input and up to ± 400 V DC output power system in ICT data centre and telecommunication centre

1 Scope

This Recommendation addresses electrical safety, earthing and bonding, and lightning protection requirements for medium voltage power electronic converter systems, which have medium voltage input with rated system voltages from 1 000 V AC up to 36 kV AC and low voltage output with rated voltages up to ± 400 V DC, used in information and communication technology (ICT) data centres, telecommunication centres, or other application environments.

This Recommendation does not include the requirements of traditional -48 V DC or lower output voltage systems.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T K.20] Recommendation ITU-T K.20 (2021), *Resistibility of telecommunication equipment installed in a telecommunication centre to overvoltages and overcurrents*.
- [ITU-T K.27] Recommendation ITU-T K.27 (2015), *Bonding configurations and earthing inside a telecommunication building*.
- [IEC 60071-1] IEC 60071-1:2019, *Insulation co-ordination – Part 1: Definitions, principles and rules*.
- [IEC 60071-2] IEC 60071-2:2018, *Insulation Co-ordination – Part 2: Application guidelines*.
- [IEC 60085] IEC 60085:2007, *Electrical insulation - Thermal evaluation and designation*.
- [IEC 60099-4] IEC 60099-4:2014, *Surge arresters – Part 4: Metal-oxide surge arresters without gaps for a.c. systems*.
- [IEC 60099-6] IEC 60099-6:2019, *Surge arresters – Part 6: Surge arresters containing both series and parallel gapped structures – System voltage of 52 kV and less*.
- [IEC 60112] IEC 60112:2020, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*.
- [IEC 60146-1-1] IEC 60146-1-1:2009, *Semiconductor converters - General requirements and line commutated converters – Part 1-1: Specification of basic requirements*.
- [IEC 60216] IEC 60216-1:2013, *Electrical insulating materials – Thermal endurance properties – Part 1: Ageing procedures and evaluation of test results*.
- [IEC 60364-1] IEC 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*.

- [IEC 60529] IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*.
- [IEC 60664-1] IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*.
- [IEC 60695-11-10] IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*.
- [IEC 61140] IEC 61140:2016, *Protection against electric shock – Common aspects for installation and equipment*.
- [IEC 61180] IEC 61180:2016, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*.
- [IEC 61558-1] IEC 61558-1:2017, *Safety of transformers, reactors, power supply units and combinations thereof - Part 1: General requirements and tests*.
- [IEC 61558-2-16] IEC 61558-2-16:2021, *Safety of transformers, reactors, power supply units and combinations thereof – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units for general applications*.
- [IEC 62271-200] IEC 62271-200:2011, *High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV*.
- [IEC 62477-1] IEC 62477-1:2016, *Safety requirements for power electronic converter systems and equipment – Part 1: General*.
- [IEC 62477-2] IEC 62477-2:2018, *Safety requirements for power electronic converter systems and equipment – Part 2: Power electronic converters from 1 000 V AC or 1 500 V DC up to 36 kV AC or 54 kV DC*.
- [ISO 9772] ISO 9772:2012, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

In this Recommendation, definitions already introduced by [IEC 60071-1], [IEC 62477-1] and [IEC 62477-2] are used to maintain conformity.

3.1.1 power electronic converter (PEC) [IEC 62477-1]: Device or part thereof for the purpose of electronic power conversion, including signalling, measurement, control circuitries and other parts, if essential for the power conversion function.

3.1.2 power electronic converter system (PECS) [IEC 62477-1]: One or more power electronic converters intended to work together with other equipment.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 medium voltage power electronic converter systems (MV-PECS): Power electronic converter system (PECS) that has AC medium voltage input with rated system voltages from 1 000 V AC up to 36 kV AC and low voltage output with rated voltages up to 1 000 V AC and/or 1 500 V DC.

NOTE – In this Recommendation, the output voltage limits up to ± 400 V DC.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
CTI	Comparative Tracking Index
DC	Direct Current
ICT	Information and Communication Technology
LV	Low Voltage
MET	Main Earthing Terminal
MOA	Metal-Oxide Surge Arrester
MV	Medium Voltage
MV-PECS	Medium Voltage Power Electronic Converter Systems
OVC	Overvoltage Category
PE	Protective Earthing
PEC	Power Electronic Converter
PECS	Power Electronic Converter System
PWB	Printed Wiring Board
SELV	Safety Extra Low Voltage

5 Conventions

None.

6 Reference configuration

6.1 Typical configuration of MV-PECS

The typical configuration of medium voltage power electronic converter systems (MV-PECS) includes a medium voltage input cabinet, AC/DC conversion cabinets, DC/AC conversion cabinets (optional, for low voltage AC output only), and battery cabinets. The quantities of AC/DC conversion cabinets, DC/AC conversion cabinets and battery cabinets can be configured for the customer's requirements. The typical configuration of MV-PECS is shown as Figure 1.

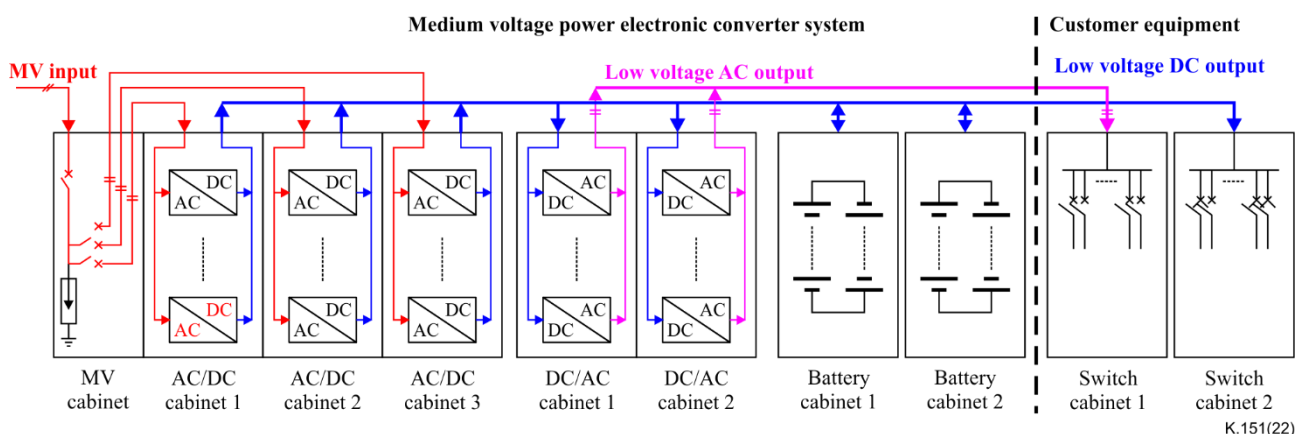


Figure 1 – Typical configuration of MV-PECS

The MV-PECS is powered by either overhead medium voltage (MV) power lines, as for most cases, or underground buried cables. Typically, the MV power lines or cables to MV-PECS consist of a three phase conductor without neutral conductor.

From the point view of the arrangement of current-carrying conductors under normal operating conditions, two types of DC low voltage (LV) output for MV-PECS are considered in this Recommendation as shown in Figure 2:

- 1) two-wire DC system without mid-point conductor,
- 2) three-wire DC system with mid-point conductor.

The typical voltages of DC output include 240 V DC, 400 V DC, etc.

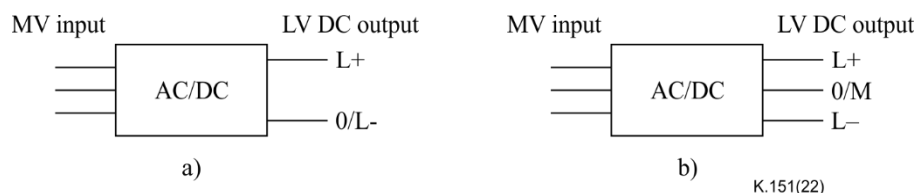


Figure 2 – Two types of DC low voltage output for MV-PECS

6.2 The consideration for electrical safety

6.2.1 Influencing factors

This clause gives minimum requirements for insulation, based on the principles of the IEC 60664 and IEC 60071 series standards.

Manufacturing tolerances shall be taken into account for the requirements in clause 6.2.

Insulation shall be selected after consideration of the following influences:

- pollution degree;
- overvoltage category;
- supply system earthing;
- impulse withstand voltage, temporary overvoltage and working voltage;
- location of insulation;
- type of insulation.

6.2.2 Pollution degree

Insulation, especially when provided by clearances and creepage distances, is affected by pollution which occurs during the expected lifetime of the MV-PECS. The micro-environmental conditions for insulation shall be applied according to Table 1.

Table 1 – Definitions of pollution degrees

Pollution degree	Description
1	No pollution or only dry, non-conductive pollution occurs. The pollution has no influence.
2	Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected.
3	Conductive pollution or dry non-conductive pollution occurs which becomes conductive due to condensation which is to be expected.
4	The pollution generates persistent conductivity caused for example by conductive dust or rain or snow.