



**BSI Standards Publication**

## **Performance of unified power flow controller (UPFC) in electric power systems**

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## National foreword

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# TECHNICAL REPORT



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## Performance of unified power flow controller (UPFC) in electric power systems

INTERNATIONAL  
ELECTROTECHNICAL  
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## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms, definitions and symbols.....	9
3.1 Terms and definitions.....	9
3.2 Symbols.....	10
4 Principles and configurations .....	11
4.1 Basic principles.....	11
4.2 UPFC configurations .....	12
4.2.1 Basic structure.....	12
4.2.2 UPFC configuration in single transmission line .....	13
4.2.3 UPFC configuration in double transmission lines .....	13
4.2.4 UPFC configuration in multiple transmission lines .....	15
5 Design rules .....	15
5.1 Proposal selection .....	15
5.2 Parameter selection and coordination .....	15
6 Performance requirements for key equipment.....	16
6.1 General.....	16
6.2 Voltage sourced converters (VSCs) .....	16
6.2.1 General .....	16
6.2.2 Three-level converters .....	16
6.2.3 Modular multi-level converters (MMCs).....	17
6.3 Series transformer .....	18
6.3.1 General .....	18
6.3.2 Winding connection mode.....	18
6.3.3 Insulation level .....	19
6.3.4 Short circuit capability .....	20
6.3.5 Over-excitation tolerance.....	20
6.3.6 DC biasing.....	20
6.4 Shunt transformer .....	20
6.4.1 General .....	20
6.4.2 Winding connection .....	20
6.4.3 On-load voltage regulation.....	21
6.4.4 DC biasing.....	21
6.4.5 Harmonics and over-excitation tolerance .....	21
6.5 Fast bypass switch (FBS) .....	22
7 Control and protection .....	22
7.1 Control system of UPFC.....	22
7.1.1 Basic requirement.....	22
7.1.2 Configuration requirements.....	23
7.1.3 Functions of control system .....	23
7.2 Protection system of UPFC .....	24
7.2.1 Basic requirements .....	24
7.2.2 Configuration requirements.....	24
7.2.3 Functions of protection system .....	24

7.3	Requirements on UPFC monitoring system .....	25
7.4	Requirements on communication interfaces .....	26
8	Insulation co-ordination .....	26
8.1	Principles of insulation co-ordination.....	26
8.1.1	General .....	26
8.1.2	Insulation co-ordination procedure .....	26
8.1.3	Arrester protective scheme .....	27
8.2	Voltages and overvoltages in service .....	27
8.2.1	Maximum operating voltage .....	27
8.2.2	Sources of overvoltages .....	28
8.3	Determination of the required withstand voltages ( $U_{rw}$ ) .....	28
9	System performance.....	30
9.1	General.....	30
9.2	Steady-state performance .....	30
9.2.1	General .....	30
9.2.2	Steady state control requirement of transmission line power .....	30
9.2.3	Steady state control requirement of reactive power compensation and voltage control .....	30
9.2.4	Overload capacity requirement .....	30
9.3	Dynamic performance .....	30
9.4	Fault ride-through performance .....	31
10	Tests .....	31
10.1	General.....	31
10.2	Off-site tests of main components .....	31
10.2.1	Converter valve .....	31
10.2.2	Fast bypass switch (FBS) .....	32
10.2.3	Transformers .....	32
10.3	Onsite commissioning test .....	33
10.3.1	General .....	33
10.3.2	Converter energizing test.....	33
10.3.3	Energizing test of series transformer .....	34
10.3.4	UPFC initial operational tests .....	34
10.3.5	Steady-state performance test.....	34
10.3.6	Dynamic performance test .....	34
10.3.7	Protection trip test .....	34
10.3.8	Additional control function test.....	34
10.3.9	Overload test.....	34
10.3.10	Fault ride-through test of AC system.....	34
Annex A (informative)	Examples of typical UPFC projects.....	35
A.1	Inez UPFC project structure of U.S.A. ....	35
A.2	Kangjin UPFC project structure of South Korea.....	35
A.3	Marcy UPFC project structure of U.S.A. ....	36
A.4	Nanjing UPFC project structure of China.....	36
A.5	Shanghai UPFC project structure of China .....	37
A.6	Suzhou UPFC project structure of China .....	37
A.7	Other information for typical UPFC projects .....	38
A.8	Technical and economic evaluation for UPFC projects .....	38
Annex B (informative)	The difference between UPFC and other FACTS.....	39

Bibliography .....	40
Figure 1 – UPFC used in a two-terminal transmission system .....	11
Figure 2 –UPFC power flow schematic diagram .....	12
Figure 3 – UPFC control functions .....	12
Figure 4 – UPFC structure diagram.....	13
Figure 5 – UPFC configuration in single transmission line VSC.....	13
Figure 6 – UPFC configuration with non-common DC bus .....	14
Figure 7 – UPFC configuration with common DC bus .....	14
Figure 8 – Typical three-level converter topology .....	16
Figure 9 – Typical MMC topology.....	17
Figure 10 – Single-phase voltage waveform on the AC side .....	18
Figure 11 – Typical structure of series transformer winding.....	19
Figure 12 – Typical winding structure of the shunt transformer.....	21
Figure 13 – Typical structure of TBS .....	22
Figure 14 – UPFC protection function areas.....	25
Figure 15 – Example of arresters protecting areas for a MMC-UPFC .....	29
Figure A.1 – Main electrical circuit of Inez UPFC project.....	35
Figure A.2– Main electrical circuit of Kangjin UPFC project [1].....	35
Figure A.3 – Main electrical circuit of Marcy UPFC project [1] .....	36
Figure A.4– Main electrical circuit of Nanjing UPFC project [1].....	36
Figure A.5 – Main electrical circuit of Shanghai UPFC project [1].....	37
Figure A.6 – Main electrical circuit of Suzhou UPFC project [1].....	37
Table 1 – Arrester protective scheme for an MMC-UPFC .....	27
Table 2 – Indicative values of ratios of required impulse withstand voltage to impulse protective level .....	29
Table 3 – Main test items of converter valve .....	31
Table 4 – Main test items of TBS .....	32
Table 5 – Main test items of transformers .....	33
Table A.1 – Main parameters of typical UPFC projects [1].....	38
Table A.2 – Main parameters of transformers in Kangjin UPFC project .....	38
Table A.3 – Main parameters of transformers in Nanjing UPFC project .....	38
Table B.1 – Comparison of control parameters and application of each FACTS .....	39

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IN ELECTRIC POWER SYSTEMS****FOREWORD**

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IEC TR 63262, which is a Technical Report, has been prepared by subcommittee 22F: Power electronics for electrical transmission and distribution systems, of IEC technical committee 22: Power electronic systems and equipment.

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

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## INTRODUCTION

A unified power flow controller (UPFC) adjusts both the active and reactive power of a transmission line by regulating and controlling line impedance, bus voltage and phase angle difference. When addressing a lack of power control methods and the insufficient supporting capacity of dynamic conditions, a UPFC provides an effective solution. Before 2005, there were three UPFC projects around the world: Inez UPFC project installed in 1998 in U.S.A., Kangjin UPFC project installed in 2003 in South Korea, Marcy UPFC project installed in 2004 in U.S.A. (see Annex A).

Ten years later, with relevant technology upgrades and increasing electric power demand, three more UPFC projects have been constructed and placed into service, all in China. They are the Nanjing 220 kV UPFC project installed in 2015, Shanghai 220 kV UPFC project installed in 2017 and Suzhou 500 kV UPFC project also installed in 2017. All these projects are based on the modular multilevel converter (MMC) technology which has successfully mitigated the issue of uneven power flow distribution, improved power supply capacity and the reliability of power supply in related areas. It is believed that with the further growth of electric power demand, UPFC technology will be more extensively applied in the power marketplace.

This document is based on the practical experience of UPFC projects using modular multilevel converter (MMC) which is a most perfect type of a voltage sourced converter (VSC) that can provide technical references for UPFC design, manufacture, test, commissioning, operation and maintenance.

## PERFORMANCE OF UNIFIED POWER FLOW CONTROLLER (UPFC) IN ELECTRIC POWER SYSTEMS

### 1 Scope

This document provides guidelines for applying unified power flow controllers (UPFC) in power systems. It includes letter symbols, terms and definitions, principles and configurations, design rules, performance requirements for key equipment, control and protection, insulation co-ordination, system performance and tests. This technical report applies to the UPFC based on modular multi-level converter (MMC) technology, as well as UPFC based on three-level converter technology.

### 2 Normative references

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 60071-1, *Insulation co-ordination – Part 1: Definitions, principles and rules*

IEC 60071-5:2014, *Insulation co-ordination – Part 5: Procedures for high-voltage direct current (HVDC) converter stations*

IEC 60076-2, *Power transformers – Part 2: Temperature rise for liquid-immersed transformers*

IEC 60076-3, *Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air*

IEC 60076-4, *Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors*

IEC 60700-1, *Thyristor valves for high voltage direct current (HVDC) power transmission – Part 1: Electrical testing*

IEC 61954, *Static var compensators (SVC) – Testing of thyristor valves*

IEC 62501, *Voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) power transmission – Electrical testing*

IEC TR 62543, *High-voltage direct current (HVDC) power transmission using voltage sourced converters (VSC)*

IEC 62751-2, *Power losses in voltage sourced converter (VSC) valves for high-voltage direct current (HVDC) systems – Part 2: Modular multilevel converters*

IEC 62823, *Thyristor valves for thyristor controlled series capacitors (TCSC) – Electrical testing*