IEC TR 62001-1

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TECHNICAL REPORT

colour inside

High-voltage direct current (HVDC) systems – Guidance to the specification and design evaluation of AC filters –

Part 1: Overview

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Part 1: Overview

FOREWORD

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IEC TR 62001-1, 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.

This first edition of IEC TR 62001-1, together with IEC TR 62001-2[1], IEC TR 62001-3[1] and IEC TR 62001-4, cancels and replaces IEC TR 62001 published in 2009. This edition constitutes a technical revision.

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1 To be published.

IEC TR 62001-1 includes the following significant technical changes with respect to IEC TR 62001:

a) Clauses 3 to 5, 7 to 9, 17, 20, Annexes A and C to E have been expanded and supplemented;
b) Annexes C and F on the definition of telephone interference parameters and voltage sourced converters have been added.

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

Enquiry draft	Report on voting
22F/378/DTR	22F/384A/RVC

Full information on the voting for the approval of this document 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 TR 62001 series, published under the general title *High-voltage direct current (HVDC) systems – Guidance to the specification and design evaluation of AC filters*, 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 website 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- withdrawn,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.

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC TR 62001 is structured in four parts:

Part 1 – Overview

This part concerns specifications of AC filters for high-voltage direct current (HVDC) systems with line-commutated converters, permissible distortion limits, harmonic generation, filter arrangements, filter performance calculation, filter switching and reactive power management and customer specified parameters and requirements.

Part 2 – Performance

This part deals with current-based interference criteria, design issues and special applications, field measurements and verification.

Part 3 – Modelling

This part addresses the harmonic interaction across converters, pre-existing harmonics, AC network impedance modelling, simulation of AC filter performance.

Part 4 – Equipment

This part concerns steady-state and transient ratings of AC filters and their components, power losses, audible noise, design issues and special applications, filter protection, seismic requirements, equipment design and test parameters.

HIGH-VOLTAGE DIRECT CURRENT (HVDC) SYSTEMS – GUIDANCE TO THE SPECIFICATION AND DESIGN EVALUATION OF AC FILTERS –

Part 1: Overview

1 Scope

This part of IEC TR 62001, which is a Technical Report, provides guidance on the specifications of AC filters for high-voltage direct current (HVDC) systems with line-commutated converters and filter performance calculation.

This document deals with the specification and design evaluation of AC side harmonic performance and AC side filters for HVDC schemes. It is intended to be primarily for the use of the utilities and consultants who are responsible for issuing the specifications for new HVDC projects and evaluating designs proposed by prospective suppliers.

The scope of this document covers AC side filtering for the frequency range of interest in terms of harmonic distortion and audible frequency disturbances. It excludes filters designed to be effective in the Power Line Carrier (PLC) and radio interference spectra.

The bulk of this document concentrates on the "conventional" AC filter technology and line-commutated HVDC converters. The changes entailed by new technologies are also discussed.

2 Terms and definitions

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

2.1
specification
document which defines the overall system requirements for an AC filter and the AC system environment in which it operates

Note 1 to entry: Such a document is normally issued by utilities to the prospective HVDC manufacturers. It also ensures the uniformity of proposals and sets guidelines for the evaluation of bids.

Note 2 to entry: The term as used here does not refer to the detailed engineering specifications relating to individual items of equipment, which are prepared by the HVDC manufacturer as a result of the filter design process.

Note 3 to entry: The specification defines the technical basis for a contract between two parties: the customer (2.2) and the contractor (2.3).

2.2
customer
organization which is purchasing the HVDC converter station, including the AC filters

Note 1 to entry: The term “customer” is taken to cover similar terms which may be used in specifications, such as owner, client, buyer, utility, user, employer and purchaser, and also covers a consultant representing the customer.

2.3
contractor
organization which has the overall responsibility for delivery of the HVDC converter station, including the AC filters, as a system

Note 1 to entry: The contractor may in turn contract one or more sub-suppliers of individual items of equipment.

Note 2 to entry: The term “contractor” is taken to cover similar terms which may be used in specifications, such as manufacturer, or supplier.

Note 3 to entry: Where the context clearly refers to the pre-contract stage of a project, the word “bidder” has been used instead of “contractor”, to indicate a prospective contractor, or tenderer.

2.4
branch
arm
set of components (capacitor, inductor, resistor), either in singular or interconnected arrangement, which may be isolated off load for maintenance

Note 1 to entry: In interconnected arrangement, it forms a smallest tuned filter unit.

SEE: Figure 22

2.5
sub-bank
one or more branches which can be switched (connected or disconnected) on load for reactive power control

Note 1 to entry: The switch does not necessarily need to have fault clearing capability.

SEE: Figure 22

2.6
bank
one or more sub-banks which can be switched together by a circuit breaker

SEE: Figure 22

3 Outline of specifications of AC filters for HVDC systems

3.1 General

When installing an HVDC converter station in an AC system, the way in which it may affect the quality of power supply in that system is always an important issue. One of the main power quality topics is that of harmonic performance.

The AC side current of an HVDC converter has a highly non-sinusoidal waveform, and, if allowed to flow in the connected AC system, might produce unacceptable levels of distortion. AC side filters are therefore required as part of the total HVDC converter station, in order to reduce the harmonic distortion of the AC side current and voltage to acceptably low levels.

HVDC converters also consume substantial reactive power, a large proportion of which is normally supplied locally within the converter station. Shunt connected AC filters appear as capacitive sources of reactive power at fundamental frequency, and normally in conventional HVDC schemes the AC filters are used to compensate most or all of the reactive consumption of the converter. Additional shunt capacitors and reactors may also be used to ensure that the desired reactive balance is maintained within specified limits under defined operational conditions.

The design of the AC filters therefore normally has to satisfy these two requirements of harmonic filtering and reactive power compensation, for various operational states and load levels. Optimization of this design is the task of the AC filter designer, and the constraints under which the design is made are defined in the specification.

The AC filters form a substantial part of a conventional HVDC converter station. The fundamental reactive power rating of the AC filters (including shunt capacitors where