IEC TR 63401-3

Edition 1.0 2023-12

TECHNICAL REPORT

colour inside

Dynamic characteristics of inverter-based resources in bulk power systems – Part 3: Fast frequency response and frequency ride-through from inverter-based resources during severe frequency disturbances

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160; 27.180; 29.020

ISBN 978-2-8322-8000-3

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

DYNAMIC CHARACTERISTICS OF INVERTER-BASED RESOURCES IN BULK POWER SYSTEMS –

Part 3: Fast frequency response and frequency ride-through from inverter-based resources during severe frequency disturbances

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 63401-3 has been prepared by subcommittee 8A: Grid Integration of Renewable Energy Generation, of IEC technical committee 8: System aspects of electrical energy supply. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
8A/130/DTR	8A/150/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 63401 series, published under the general title *Dynamic characteristics of inverter-based resources in bulk power systems*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document 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

Primary frequency response (PFR) denotes the autonomous reaction of system resources to change in frequency. In most power systems, the main contributor to PFR is the governor response of synchronous generation. In the systems with less synchronous generators, the system inertia is relatively low and PFR capability is relatively weak and slow, so the system frequency tends to change dramatically in severe power imbalance disturbances, which will trigger under-frequency load shedding (UFLS) or OPC (over speed protection control) of synchronous generators possibly. Therefore, it is an effective coping method to introduce some new frequency responses in the systems with high penetration of inverter-based resources.

This document studies fast frequency response (FFR) as a potential mitigation option in maintaining grid security during severe frequency disturbances. Broadly, FFR is some kind of rapid injection of electrical power from inverter-based resources or relief of loads that helps arrest the decline of system frequency during severe disturbances.

DYNAMIC CHARACTERISTICS OF INVERTER-BASED RESOURCES IN BULK POWER SYSTEMS –

Part 3: Fast frequency response and frequency ride-through from inverter-based resources during severe frequency disturbances

1 Scope

This part of IEC 63401, which is a Technical Report, provides an insight into the various forms of fast frequency response and frequency ride-through techniques that involve inverter-based generation sources (mainly wind and PV) in a bulk electrical system.

This document first focuses on extracting the clear definition of FFR from different references around the world, while studying the mechanism of FFR acting on system frequency and the unique features of FFR. It then compares various kinds of frequency response and demonstrates the relationship among synchronous inertia response, fast frequency response, and primary frequency response. Several system needs and conditions where FFR is suitable are identified. This document also focuses on the performance objectives, practicality and capabilities of various non-synchronous resources, and discusses the test methods for verifying FFR capability at different levels. Finally, it focuses on the ROCOF issues and on the robust performances of FFR.

2 Normative references

There are no normative references in this document.