

Distribution Code Consultation - DCRP/PC/18/01

Title: Engineering Recommendation (EREC) P28

Voltage fluctuations and the connection of disturbing equipment to transmission systems and distribution networks in the United Kingdom.

Target Audience:

The requirements in EREC P28 are intended for persons who:

- propose to connect disturbing equipment to the public electricity supply system that have the potential for causing voltage fluctuations
- propose to alter disturbing equipment/installations connected to the public electricity supply system that would result in material changes in voltage fluctuations
- carry out assessments of disturbing equipment and resultant voltage fluctuations
- measure voltage fluctuations caused by disturbing equipment for the purpose of checking conformance with requirements and limits in EREC P28.

Date Published: 8th January 2018

Deadline for responses: 31st January 2018

Summary

This Distribution Code public consultation is seeking the views from industry stakeholders on the proposed modification to Engineering Recommendation P28, subsequently referred to as EREC P28 Issue 2.

This modification has been prepared under the authority of the Distribution Code Review Panel (DCRP) of Great Britain – EREC P28 being a Qualifying Standard and Licence Standard under the Distribution Code¹. However, given Engineering Recommendation P28 is also referenced within the Grid Code and there is potential for consequent modification of the Grid Code, the views from Grid Code stakeholders are also being sought.

The DCRP establish and maintain governance arrangements for Qualifying Standards that have a material effect on Users of the Distribution System. Annex 1 documents, such as EREC P28, are approved by the Authority (Ofgem) before publication.

The proposed EREC P28 Issue 2 constitutes a full technical revision of Issue 1 published in 1989 and has been extended, amongst other things, to cover assessment and limits for rapid voltage changes (RVCs).

The review and subsequent revision of EREC P28 has been overseen by a joint Working Group of various key stakeholders with co-ordination provided by the Energy Networks Association (ENA).

¹ <http://www.dcode.org.uk/the-gb-distribution-code/>
8th January 2018 v1.1

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The main technical modifications in EREC P28 Issue 2 include:

- the introduction of requirements and planning levels for RVCs.
- improved definition and clarity of worst case operating conditions to be used in the assessment of voltage fluctuations.
- an intermediate planning level and associated flicker severity limits for supply systems with nominal voltages of 3.3 kV, 6.6 kV, 11 kV, 20 kV and 33 kV.
- improved definition of voltage step change.
- improved clarity concerning information requirements for assessment and responsibilities for provision of information.
- concept of transfer coefficients for determining voltage fluctuation contributions from different nodes.
- additional recommendations for assessing voltage fluctuations caused by renewable energy and low carbon technologies.

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1 Introduction

EREC P28 defines planning levels and compatibility levels for the assessment of voltage fluctuations from customer disturbing equipment and fluctuating installations to be connected to transmission systems and distribution networks in the United Kingdom.

Voltage fluctuations that could result in flicker as well as those characterised as rapid voltage changes (RVCs) are covered. The requirements apply to new connections of customer disturbing equipment to the public electricity supply system as well as changes to existing connections, in so far as they affect voltage fluctuation.

EREC P28 has been modified to include assessment of voltage fluctuations caused by distributed/embedded generation equipment powered by renewable energies and other low carbon technology equipment that are capable of disturbance to other connected customers. The recommendations in EREC P28 Issue 2 have been aligned with the requirements of the BS EN 61000 series of Standards, so far as they apply to the limitation of voltage fluctuations in public electricity supply systems. The limits for voltage fluctuation in EREC P28 Issue 2 are compatible with application of the flicker curve defined in BS EN 61000-3-3.

2 Analysis and Proposal

2.1 General

In addition to being a Distribution Code Annex 1 document, EREC P28 is referenced in the Grid Code hence a joint Distribution Code and Grid Code Working Group was established to oversee the revision of EREC P28. This Working Group is now seeking comments from wider industry stakeholders on the proposals highlighted in this consultation paper, the contents of the Draft EREC P28 Issue 2 and the proposed modifications to the Distribution Code.

A copy of the Draft EREC P28 Issue 2, the proposed modification to the Distribution Code and the comment proforma are included in the consultation pack.

The sections below describe the main changes between the draft EREC P28 Issue 2 and the existing EREC P28.

2.2 Rapid Voltage Changes (RVCs)

EREC P28 has been amended to assess the acceptability of voltage fluctuations, including RVCs, and includes three different envelopes that prescribe the maximum allowable magnitude and duration of voltage fluctuations depending upon the maximum number of occurrences permitted in a given time period (see Clause 5.3.2 of EREC P28 Issue 2). These envelopes encompass limits for voltage step changes.

The proposed envelopes in EREC P28 Issue 2 are replicated below (see Figure 5, Figure 6 and Figure 7).

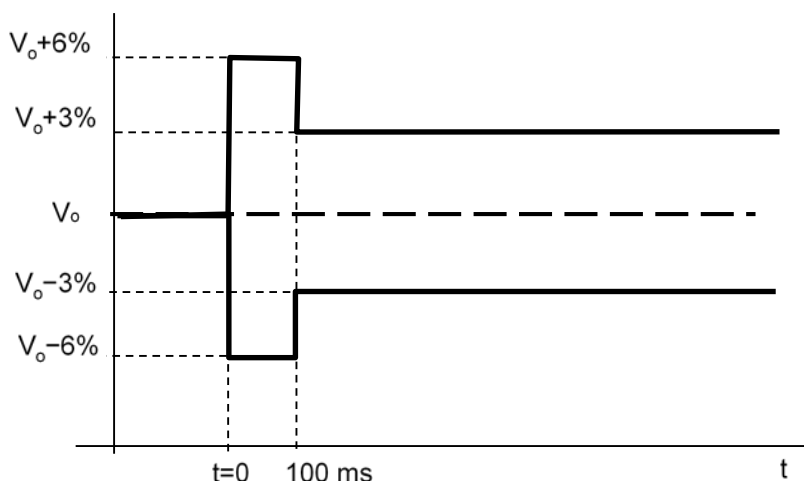


Figure 5 — Voltage characteristic for frequent events (Category 1)

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The minimum interval between frequent events fitting within the envelope in Figure 5 is determined by conformance to flicker severity (P_{st}) limits in EREC P28.

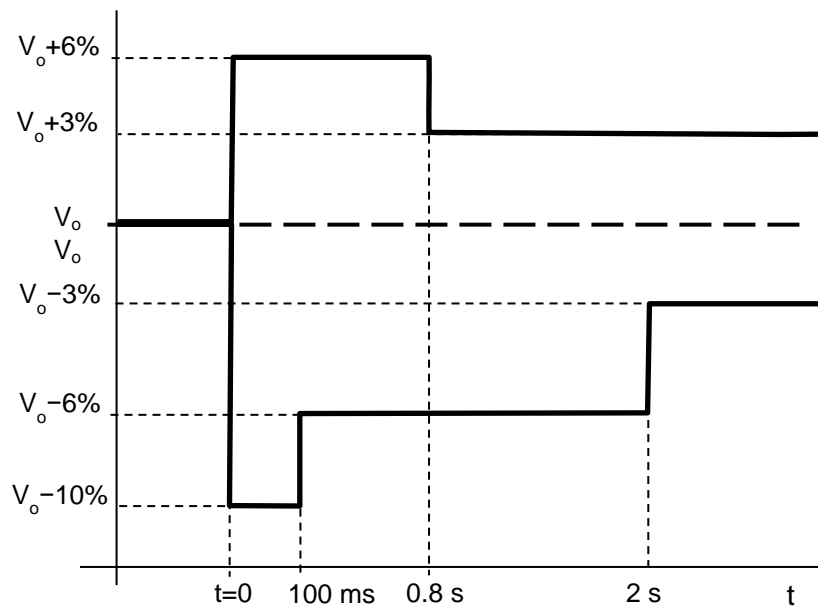


Figure 6 — Voltage characteristic for infrequent events (Category 2)

Up to 4 RVC events per calendar month are permitted for voltage fluctuations fitting within the envelope in Figure 6.

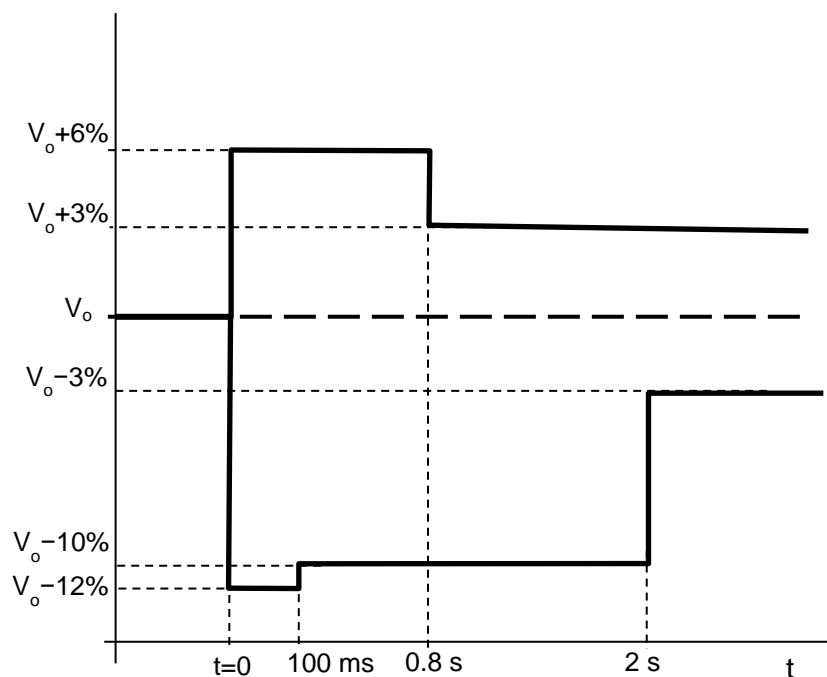


Figure 7 — Voltage characteristic for very infrequent events (Category 3)

One RVC event not more frequent than once in 3 calendar months is permitted for voltage fluctuations fitting within the envelope in Figure 7.

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Table 4, is replicated from EREC P28 Issue 2, which summarises the proposed categories, maximum number of occurrences within a defined time period, limits and examples of applicability for RVCs.

Table 4 — Planning levels for RVC

Cat-egory	Title	Maximum number of occurrence	Limits $\% \Delta V_{\max}$ & $\% \Delta V_{\text{steadystate}}$	Example Applicability
1	Frequent events	(see NOTE 1)	As per Figure 5	Any single or repetitive RVC that falls inside Figure 5
2	Infrequent events	4 events in 1 calendar month (see NOTE 2)	As per Figure 6 $ \% \Delta V_{\text{steadystate}} \leq 3\%$ For decrease in voltage: $ \% \Delta V_{\max} \leq 10\%$ (see NOTE 3) For increase in voltage: $ \% \Delta V_{\max} \leq 6\%$ (see NOTE 4)	Infrequent motor starting, transformer energisation, G59 [4] re-energisation (see NOTE 7)
3	Very infrequent events	1 event in 3 calendar months (see NOTE 2)	As per Figure 7 $ \% \Delta V_{\text{steadystate}} \leq 3\%$ For decrease in voltage: $ \% \Delta V_{\max} \leq 12\%$ (see NOTE 5) For increase in voltage: $ \% \Delta V_{\max} \leq 6\%$ (see NOTE 6)	Commissioning, maintenance & post fault switching (see NOTE 7)

NOTE 1: $\pm 6\%$ is permissible for 100 ms reduced to $\pm 3\%$ thereafter as per Figure 5.
If the profile of repetitive voltage change(s) falls within the envelope given in Figure 5, the assessment of such voltage change(s) shall be undertaken according to the recommendations for assessment of flicker and shall conform to the planning levels provided for flicker.
If any part of the voltage change(s) falls outside the envelope given in Figure 5, the assessment of such voltage changes, repetitive or not, shall be done according to the guidance and limits for RVCs.

NOTE 2: No more than 1 event is permitted per day, consisting of up to 4 RVCs, each separated by at least 10 minutes with all switching completed within a two-hour window.

NOTE 3: -10% is permissible for 100 ms reduced to -6% until 2 s then reduced to -3% thereafter as per Figure 6.

NOTE 4: $+6\%$ is permissible for 0.8 s from the instant the event begins then reduced to $+3\%$ thereafter as per Figure 6.

NOTE 5: -12% is permissible for 100 ms reduced to -10% until 2 s then reduced to -3% thereafter as per Figure 7.

NOTE 6: $+6\%$ is permissible for 0.8 s from the instant the event begins then reduced to $+3\%$ thereafter as per Figure 7.

NOTE 7: These are examples only. Customers may opt to conform to the limits of another category providing the frequency of occurrence does not exceed the 'Maximum frequency of occurrence' for the chosen category.

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The limits for RVCs proposed in EREC P28 Issue 2 take into account those in the recent GC0076 modification to the Grid Code. The key differences between the requirements in EREC P28 Issue 2 and those in the Grid Code are as follows.

- Allowable voltage changes are expressed as a percentage of nominal voltage (V_n) in P28 Issue 2 as opposed to a percentage of the initial voltage (V_o) in the Grid Code. The intention being to align with the approach taken in National and International Standards.
- For increases in voltage:
 - EREC P28 Issue 2 proposes a limit on the maximum voltage change between two steady state conditions of $\Delta V_{\max} \leq 6\%$ for a maximum duration of 0.8 s from the initiation of a voltage change.
 - The Grid Code has a limit of $\Delta V_{\max} \leq 5\%$ for a maximum duration of 0.5 s.
- For decreases in voltage:
 - EREC P28 Issue 2 proposes a time limit of 100 ms from initiation of a voltage change during which the maximum voltage change permitted (-12% for 'very infrequent events' and -10% for 'infrequent events') can persist.
 - The Grid Code has a time limit of 80 ms from initiation of a voltage change during which the maximum permitted voltage change is -12%.
- For increases and decreases in voltage, EREC P28 Issue 2 permits a greater maximum number of occurrences for Category 3 'very infrequent' events:
 - EREC P28 Issue 2 proposes to permit up to a maximum of 4 RVCs in one day (irrespective of type of operational event causing the RVC) not more frequent than once every 3 months.
 - The Grid Code permits up to a maximum of 4 RVCs in one day (for commissioning, maintenance and fault restoration) typically not planned more than once per year on average over the lifetime of the connection.
- EREC P28 Issue 2 introduces an intermediate category of RVC (Category 2) for 'infrequent events', where up to a maximum of 4 RVCs in one day are permitted not more frequent than 4 times per month providing the $\Delta V_{\max} \leq -10\%$ for ≤ 100 ms then reducing to $\leq 6\%$ for up to 2 s after initiation of the event (see Figure 6).

The proposed RVC limits in EREC P28 Issue 2 (and associated differences with the requirements in the Grid Code) reflect the:

- further work carried out by the EREC P28 joint Working Group and the experience of National Grid in applying RVC limits since the GC0076 modification was implemented in the Grid Code.
- limits for RVCs in Category 2 and Category 3 of Table 4 taking into account differences in the perceptibility of RVC compared with flicker associated with continuously fluctuating loads.

These proposals allow for a greater number of RVCs at any point in the system in a given calendar year on the basis they would be required to either be completed within a 2-hour time window or would be sufficiently spaced apart so as not to result in unacceptable disturbance. Such a modification would facilitate disconnection and reconnection of complete customer sites with significant numbers of transformers for infrequent or very infrequent switching operations, including unplanned outages, with the ability to re-establish distributed generation more quickly after an unplanned outage, e.g. fault outage.

NOTE: DPC4.2.3.3 of the existing Distribution Code places a restriction of not more than one switching event per year for a single voltage change event up to 10% in magnitude. The proposal is to replace this code requirement with the planning levels for RVC in EREC P28 Issue 2.

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The intention is that requirements for RVCs currently stated in the Grid Code are modified to align with the proposed limits in EREC P28 Issue 2, although such a modification would need to be progressed through the Grid Code modification process.

2.3 Applicability to Operating Conditions and Fault Outages

EREC P28 Issue 2 has been amended to provide improved clarity for the assessment of voltage fluctuations under worst case normal operating conditions (see Clause 6.1.6 of EREC P28 Issue 2).

Worst case normal operating conditions as defined in EREC P28 Issue 2 include credible outages conditions for which the public electricity supply system is designed to operate within acceptable/statutory limits. These conditions include planned outages and fault outages consistent with securing demand as required by relevant security of supply standards.

Notwithstanding, the limits in EREC P28 Issue 2 are not intended to apply to transient voltage fluctuations between fault initiation and fault clearance or during any reconfiguration of the public electricity supply system immediately following a fault to secure supplies.

This proposal is intended to provide a more consistent understanding and application of the network conditions by customers and system/network operators for EREC P28 type assessments as the present EREC P28 is not particularly clear in this respect and is open to interpretation.

2.4 Planning Levels for Flicker

The planning levels for flicker severity at any point of the supply system are currently stated in Table 1 of Engineering Recommendation P28 Issue 1.

Table 1 of Engineering Recommendation P28 Issue 1

Supply system Nominal voltage	Planning level	
	P_{st}	P_{lt}
132 kV and below	1.0	0.8
Above 132 kV	0.8	0.6

Table 2 of EREC P28 Issue 2 proposes an intermediate planning level and associated flicker severity limits for supply systems with nominal voltages of 3.3 kV, 6.6 kV, 11 kV, 20 kV and 33 kV as follows:

Table 2 of Engineering Recommendation P28 Issue 2

Supply system Nominal voltage	Planning level	
	P_{st}	P_{lt}
LV	1.0	0.8
3.3 kV, 6.6 kV, 11 kV, 20 kV, 33 kV	0.9	0.7
66 kV, 110 kV, 132 kV, 150 kV, 200 kV, 220 kV, 275 kV, 400 kV	0.8	0.6

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This proposal is intended to improve the co-ordination of flicker transfer from higher voltage to lower voltage supply systems. This will reduce the possibility of background flicker severity levels exceeding compatibility limits at low voltage (LV) from the transfer of voltage fluctuations down through the supply system.

2.5 Voltage Step Changes

The general limit on the magnitude of voltage step changes of $\pm 3\%$ remains the same in EREC P28 Issue 2. However, EREC P28 Issue 2 now clarifies that the $\pm 3\%$ general limit relates to the voltage change between steady state conditions, referred to as $V_{\text{steadystate}}$, (see Clause 4.7 of EREC P28 Issue 2).

Although EREC P28 Issue 2 does not place a limit on the time for transient decay, it requires that voltage changes must be within $\pm 3\%$ after 2 s from event initiation.

NOTE: Limits for voltage fluctuations in between steady state conditions (referred to as V_{max}) can be greater than $\pm 3\%$ for infrequent events and very infrequent events and fall under requirements for Rapid Voltage Changes in EREC P28 Issue 2.

The intention of this proposal is to allow a clear distinction between distinct different voltage change events.

3 Applicable Distribution Code Objectives

The Applicable Distribution Code Objectives are to:

- (a) permit the development, maintenance, and operation of an efficient, co-ordinated, and economical system for the distribution of electricity; and
- (b) facilitate competition in the generation and supply of electricity; and
- (c) efficiently discharge the obligations imposed upon distribution licensees by the distribution licences and comply with the Regulation and any relevant legally binding decision of the European Commission and/or the Agency for the Co-operation of Energy Regulators; and
- (d) promote efficiency in the implementation and administration of the Distribution Code.

4 Consultation Questions

- 4.1 Do you agree with the proposed requirements and planning levels for RVCs in EREC P28 Issue 2 (as provided in Figure 5, Figure 6, Figure 7 and Table 4 of EREC P28 Issue 2)?
- 4.2 Do you agree with the proposal for providing improved clarity of what constitutes 'worst case normal operating conditions' for the assessment of voltage fluctuations under EREC P28?
- 4.3 Do you agree with the proposals for an intermediate planning level to assist with co-ordination of the transfer of flicker severity from higher voltage to lower voltage supply systems?
- 4.4 Do you have any objections to the proposed amendments in EREC P28 Issue 2 as they currently stand? If so, please describe your concerns and if possible propose any alternatives.
- 4.5 Do you agree that the proposed modification proposal better facilitates the Distribution Code objectives?
- 4.6 Recognising that any consequential changes to the Grid Code will need to be progressed via the Grid Code governance process, the Working Group would welcome any concerns you have at this stage if the EREC P28 Issue 2 proposal was to be considered for adoption in the Grid Code?
- 4.7 Do you have any other comments to make on the proposed changes?

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5 Next Steps

Responses to this consultation should be sent to the Distribution Code Review Panel Secretary at dcode@energynetworks.org by **17:00 Wednesday 31st January 2018** on the proforma provided expressly for the purpose. Responses after this date may not be considered.

6 Consultation Pack

- Distribution Code Consultation DCRP/17/07 [this Paper]
- Draft EREC P28 Issue 2 [Draft_v3.5]
- Draft Proposed Changes to the Distribution Code
- Stakeholder membership of the ENA ER P28 Working Group
- Proforma comment form

For more information, please contact:

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