

TECHNICAL REPORT



BASIC EMC PUBLICATION

**Electromagnetic compatibility (EMC) –
Part 4-38: Testing and measurement techniques – Test, verification and
calibration protocol for voltage fluctuation and flicker compliance test systems**

IEC TR 61000-4-38:2015

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.20

ISBN 978-2-8322-2870-8

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CONTENTS

FOREWORD	4
INTRODUCTION	6
1 Scope	7
2 Normative references	7
3 Terms and definitions	8
4 General	8
5 Objectives of flicker and voltage fluctuations test protocols	8
6 Manufacturer's or owner's information required	9
7 Performance criteria	9
8 General test guidelines	11
8.1 General	11
8.2 Essential information	11
9 Test equipment and accuracy	12
10 Detailed test procedures	13
10.1 Procedures common to all tests	13
10.2 Test no. 1 – Simple power source qualification test	14
10.2.1 Rationale	14
10.2.2 Test procedure	14
10.3 Test no. 2 – Verification of the Z_{ref} and/or Z_{test} impedance	15
10.3.1 Rationale	15
10.3.2 Test procedure	15
10.4 Tests no. 3 to 6 – Low frequency rectangular modulation rates of 1 CPM to 39 CPM	16
10.4.1 Rationale	16
10.4.2 Test procedure	16
10.5 Tests no. 7 to 9 – High frequency rectangular modulation rates of 110 CPM and up	17
10.5.1 Rationale	17
10.5.2 Test procedure	17
10.5.3 Uncertainties of this protocol, and methods to verify modulation accuracy	18
Annex A (normative) Requirements for external test equipment to verify modulation accuracy	20
Annex B (informative) Example test setup for modulation load unit	21
Annex C (informative) Some typical flicker test system integration issues to avoid	22
Bibliography	25
Figure 1 – Illustration showing a rectangular 8 A current modulation pattern at 7 CPM	15
Figure 2 – Illustration showing the method to determine the inductance of Z_{ref} or Z_{test}	16
Figure 3 – Illustration showing a rectangular modulation pattern at 3,166 7 Hz	17
Figure 4 – Illustration showing a rectangular modulation pattern at 1 052 CPM	18
Figure B.1 – Typical test setup for tests 1 to 9	21
Figure C.1 – Single phase arrangement with excessive or near “zero” impedance	22
Figure C.2 – Single phase arrangement with sense lines present	23

Figure C.3 – Single phase arrangement with connecting lines to power analyzer	23
Figure C.4 – Neutral impedance bypassed externally	24
Table 1 – Calibration points from IEC 61000-4-15:2010, Table 5	10
Table 2 – Summary of tests to verify/calibrate flicker test systems	11

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-38: Testing and measurement techniques –
Test, verification and calibration protocol for voltage
fluctuation and flicker compliance test systems**

FOREWORD

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IEC 61000-4-38, which is a technical report, has been prepared by subcommittee 77A: EMC – Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

It forms Part 4-38 of IEC 61000. It has the status of a basic EMC publication in accordance with IEC Guide 107.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
77A/881/DTR	77A/898/RVC

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.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61000 series, published under the general title *Electromagnetic compatibility (EMC)*, 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

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INTRODUCTION

Flicker measurement systems are used to measure voltage fluctuations from equipment that is tested in accordance with IEC 61000-3-3 and/or IEC 61000-3-11 standards. The IEC adopted measurement and evaluation techniques that are specified in IEC 61000-4-15, but limits, limit comparisons, certain exclusions, and test conditions for a variety of products are specified in IEC 61000-3-3 (for 16 A/phase and below) and IEC 61000-3-11 (up to 75 A/phase).

This TR specifies recommended methods and acceptability criteria for performance verification of test systems designed to measure voltage fluctuations and flicker in accordance with IEC 61000-3-3 and IEC 61000-3-11.

A typical IEC 61000-3-3 and IEC 61000-3-11 compliance test system includes not only the flicker meter, but also a suitable power source and a test impedance. The reference impedance, per IEC TR 60725, is used for IEC 61000-3-3 tests, while the Z_{test} as specified in IEC 61000-3-11 is used for higher power products. This TR therefore also includes a method to verify that the impedance, according to IEC TR 60725 or the Z_{test} specification, is within reasonable tolerances and that the power source does not contribute more to the measured flicker levels as is permitted in IEC 61000-3-3 and IEC 61000-3-11.

This protocol is neither intended as a type test nor as an exhaustive test of all required flicker meter capabilities according to IEC 61000-4-15. The primary objective is to verify, on a periodic basis, that the flicker test system, consisting of a previously type tested analyzer, a suitable power source and impedance unit, performs correctly, and that the system performance is not adversely affected by the system integration or by deterioration of one of the system components. For example this TR can be one of the methods to achieve accreditation of a test laboratory or facility.

NOTE To characterize individual system components, both digital volt meters 1 and 2 (DVM-1 and DVM-2) in Figure B.1 are needed, and care is taken that DVM-2 measures the exact same voltage point that the flicker meter uses as its input. For previously calibrated systems undergoing a periodic verification, the measurement of current will generally suffice and the use of DVM-2 is not mandatory.

The purpose of the flicker test system is to evaluate voltage fluctuations that may be caused by the tested equipment when this equipment will be connected to the public electricity supply. The flicker test system may have automatic limit evaluation software or firmware, data storage, additional analysis capabilities, and report generation capabilities that facilitate the process of certifying the tested products according to IEC 61000-3-3 and/or IEC 61000-3-11.

The primary purpose of the test, verification, and calibration protocol in this technical report is to establish methods that may be used to verify that a given flicker test system measures and evaluates common voltage fluctuations in accordance with the standards and thus allows the user to perform a correct pass/fail analysis of the tested product. Additional capabilities, such as the data storage, reporting, or analysis functions of the analyzer or test system may also be tested using some of the tests described in this protocol.

The methodology used in this protocol consists of applying a known load to the flicker test system. This known load is modulated on/off, simulating an electrical product with varying power demand, which in turn causes voltage fluctuations. Thus, not only is the flicker meter tested, but also the power source that has to accommodate the varying power level and the reference impedance or the Z_{test} as specified in IEC 61000-3-3 or IEC 61000-3-11 is tested.

The tests as summarized in Table 2 and Clause 10 may also be used to calibrate or adjust the flicker test system, including adjustments to the test impedance and/or power source. This calibration can be done by means of comparing the generated voltage fluctuations, verified by using external reference equipment if so required, with the values reported by the system. This calibration includes the response of the power source and the impedance that are part of the test system.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-38: Testing and measurement techniques – Test, verification and calibration protocol for voltage fluctuation and flicker compliance test systems

1 Scope

This part of IEC 61000, which is a Technical Report, defines a test protocol for flicker test systems designed to perform compliance tests in accordance with IEC 61000-3-3 and IEC 61000-3-11. It is intended to provide test system manufacturers and testing laboratories with systematic methods to determine if the flicker test system meets the IEC design specifications for a wide range of voltage fluctuations and fluctuation frequencies, as specified in IEC 61000-4-15:2010, Table 5, that have been observed in product testing.

This protocol is intended to be compatible with related standards, in particular with any requirements set forth by listing organizations or measurement standards of the IEC. Meeting the criteria defined herein should not be construed as a waiver of any other relevant performance or safety requirements.

The main purpose of this technical report is to provide guidance and methods for periodic calibration and verification of systems consisting of previously type tested equipment. For complete flicker test systems that exhibit deviations of less than 5 % from the specifications of this protocol, it can be assumed that individual components are performing properly and separate calibration of individual system components is therefore not necessary.

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2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050-161, *International Electrotechnical Vocabulary – Part 161: Electromagnetic compatibility*

IEC TR 60725, *Consideration of reference impedances and public supply network impedances for use in determining the disturbance characteristics of electrical equipment having a rated current ≤ 75 A per phase*

IEC 61000-3-3:2013, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61000-3-11, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 75 A per phase and subject to conditional connection.*

IEC 61000-4-15:2010, *Electromagnetic compatibility (EMC) – Part 4-15: Testing and measurement techniques – Flickermeter – Functional and design specifications*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-161 as well as the following apply.

3.1

linear resistive load

load unit that is predominantly resistive in nature, with negligible inductance and capacitance

3.2

load modulation

method to turn the load on and off, usually in a 50 % duty cycle pattern, with a frequency that is controlled, either manually by the user or automatically by the test equipment

4 General

In this technical report, all voltages and currents are stated as r.m.s values unless otherwise described.

Flicker meters in accordance with IEC 61000-4-15 may be used for power quality analysis and surveys covering a very wide range of voltage fluctuations. Flicker test systems, used to verify that a product complies with IEC 61000-3-3 and/or IEC 61000-3-11, have a more limited range of applications. The test class definition for flicker meters used in a compliance test system, is Class- F2 according to IEC 61000-4-15, and a reduced set of tests is applied.

For example, the highest permitted d_{\max} according to IEC 61000-3-3 or IEC 61000-3-11 is 7 %. Even with a substantial margin, allowing voltage fluctuations of say 10 %, i.e. more than 40 % above the highest permitted d_{\max} , the instantaneous flicker sensation P_{inst} will be limited to no more than 1 600. In addition, a d_{\max} level of 10 % would require a power source that is capable of delivering up to 58 A for at least a half cycle if the test is done according to IEC 61000-3-3, and in fact, as much as 92 A if tested according to IEC 61000-3-11.

Higher amplitude voltage fluctuations are therefore extremely unlikely during product testing, and thus tests at these higher levels are not provided for in this protocol as they would impose unnecessary demands and costs upon the system and the test method. Equally, the P_{st} level a product is permitted to exhibit is 1,0, and thus tests exceeding a P_{st} of 4,0 are not necessary for a flicker compliance test system. Similarly, since a product is permitted to have a P_{lt} of at least 0,65, it is not necessary to have extreme resolution or accuracy below a P_{st} of 0,4, although the testing authority may include tests to P_{st} and P_{lt} levels below 0,4 or higher than 4,0 using the methodology described in this protocol.

In general, the procedures and methodologies specified in ISO/IEC 17025 should be followed to verify that the test and verification signals, measurement protocols, external reference equipment and evaluation methods specified in this technical report are produced with sufficient accuracy to meet the stated goal of evaluating the flicker test system.

The test protocol uses rectangular voltage fluctuation patterns in accordance with IEC 61000-4-15:2010, Table 5, possibly augmented – at the user's discretion – by additional tests from IEC 61000-4-15:2010, Table 1 and Table 2, and also employs a non-linear current pattern to evaluate not only the flicker meter, but also the suitability of the power source and the flicker test impedance.

5 Objectives of flicker and voltage fluctuations test protocols

The primary objective of this test protocol is to assure that a flicker test system meets the requirements set forth in this technical report and produces results that lead to correct and reproducible pass/fail evaluations when testing products in accordance with IEC 61000-3-3

and/or IEC 61000-3-11. Thus, it is intended that various test systems that pass the tests described in this protocol produce similar test results, within specified tolerances, when evaluating the same equipment (unit) under test (EUT or UUT) under identical or near identical environmental and test conditions.

Flicker test systems that are evaluated using this protocol should be obtained with the cooperation of the system owner or the system manufacturer. The testing authority should ensure that only the tests of this protocol are applied and that they correspond to the power and current range for which the system is specified.

6 Manufacturer's or owner's information required

To assist the user in correctly applying the tests in this protocol, the manufacturer or system owner should provide detailed accuracy specifications on the flicker test system in accordance with its intended use. That is, the user should have enough information so that, in its intended environment, the flicker test system will be used within its voltage, current, d_{\max} , d_c , P_{inst} , and P_{st} ranges. Essential information should be provided with the flicker test system package. The following list is provided as an example, and may be expanded as required.

- a) Manufacturer's name or trademark.
- b) Product name and/or model number, serial number, and software or firmware identification.
- c) Mains voltage and frequency operating range.
- d) Limits for nominal voltage and current input range(s).
- e) Limit for voltage variations at the flicker meter input ($\pm x, x \% d_{\max}$ and d_c).
- f) Operating range of output 5 (P_{inst}) of the flicker meter.
- g) P_{st} operating range of the flicker meter.
- h) Compliance with applicable standards (e.g. IEC 61000-3-3, IEC TR 60725, IEC 61000-3-11, IEC 61000-4-15 and applicable editions).
- i) Device specifications and accuracy specification.
- j) Installation and usage instructions.
- k) Maintenance instructions as appropriate.

7 Performance criteria

IEC 61000-4-15 defines the flicker meter in detail and provides certain accuracy requirements including those shown in Table 1 (reproduced from IEC 61000-4-15:2010, Table 5). It has been shown, however, that different flicker test system implementations— all claiming to meet the accuracies defined in IEC 61000-4-15 – can still disagree significantly in some actual measurements. It has been shown that the AC test source and the reference impedance can substantially affect the measured parameters. Problems with flicker analyzer implementations, and initial differences in interpretation of requirements in standards IEC 61000-3-3 and IEC 61000-3-11 have been found as well, although IEC 61000-4-15 has substantially reduced the interpretation ambiguities. The informative Annex C provides some examples of typical integration problems that have been found using the methods defined in this protocol.

The individual steps of the test protocol in this technical report are intended therefore to provide a set of tests to ensure that the analyzer, AC power source, reference impedance or Z_{test} and overall system implementation are correct and produce the desired results. To characterize individual system components, both DVM-1 and DVM-2 in Figure A.1 are mandatory, and care should be taken that DVM-2 measures the voltage at the exact same point that the flicker meter uses as its input. For complete flicker test systems that exhibit deviations of less than 5 % from the specifications in Clause 10 of this protocol, it can be assumed that individual components are performing properly and separate calibration of individual system components is therefore not necessary. If performance requirements are not

met during a periodic verification, the use of DVM-2 is necessary in order to isolate and identify the cause of deviations.

The performance criteria can be separated into two main categories, one being the directly measured parameters such as d_c and d_{\max} and the other being the correct indication of the P_{st} value and calculation of the P_{lt} value. The first category can be viewed as a system level test, as it will reveal any errors in either the flicker meter, the test impedance, the power source, or the overall system integration.

For test systems with a limited scope of use, only a subset of the tests might be required so as to demonstrate acceptable performance over some specific range of application. For example, if a particular manufacturer's EMC test facility only needs to test to a reduced power level, there is no need to apply current levels that are higher than needed for the user's products.

In some cases, the user may adjust the system impedance, either by changing passive components or by adjusting the programmable impedance. If required, and provided the flicker meter has appropriate adjustments, the accuracy of directly measured parameters – mainly voltage – may be optimized by adjusting the instrument.

A test system meeting the requirements of this TR is recommended for testing in accordance with the requirements of IEC 61000-3-3 and IEC 61000-3-11. Alternatively, this TR may be used to demonstrate that a test system is not recommended for testing in accordance with IEC 61000-3-3 and IEC 61000-3-11.

Table 1 – Calibration points from IEC 61000-4-15:2010, Table 5

Rectangular changes per minute (CPM)	Voltage fluctuation %			
	120 V lamp 50 Hz system	120 V lamp 60 Hz system	230 V lamp 50 Hz system	230 V lamp 60 Hz system
1	3,178	3,181	2,715	2,719
2	2,561	2,564	2,191	2,194
7	1,694	1,694	1,450	1,450
39	1,045	1,040	0,894	0,895
110	0,844	0,844	0,722	0,723
1 620	0,545	0,548	0,407	0,409
4 000	3,426	Test not required	2,343	Test not required
4 800	Test not required	4,837	Test not required	3,263
NOTE 1 620 rectangular changes per minute correspond to a rectangular square wave modulation frequency of 13,5 Hz.				