



IEC TR 61000-4-37

Edition 1.0 2016-01

TECHNICAL REPORT



**Electromagnetic compatibility (EMC) –
Part 4-37: Testing and measurement techniques – Calibration and verification
protocol for harmonic emission compliance test systems**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.100.10

ISBN 978-2-8322-3120-3

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

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope	8
2 Normative references	8
3 General	9
4 Objectives of harmonic analysis test procedures	10
5 Performance criteria	10
6 General test guidelines.....	14
7 Essential information	14
8 Test equipment and accuracy	15
9 Detailed test procedures.....	16
9.1 General.....	16
9.2 Procedures common to all tests	16
9.3 Test no. 0	17
9.4 Test no. 1 – General Class A test at ~540 W, to verify overall accuracy and allow verification of the measuring ranges being used.....	17
9.4.1 Rationale	17
9.4.2 Test procedure	18
9.5 Test no. 2 – Class A test at ~700 W with harmonics failing the Class A limits.....	22
9.5.1 Rationale	22
9.5.2 Test procedure	22
9.6 Test no. 3a – Class A at ~3 000 W with higher orders failing Class A limits.....	24
9.6.1 Rationale	24
9.6.2 Test procedure	24
9.7 Test no. 3b – Class B at ~3 000 W with higher orders passing Class B limits	26
9.7.1 Rationale	26
9.7.2 Test procedure	26
9.8 Test no. 4 – Class B at ~1 000 W with harmonics that fail Class B limits	29
9.8.1 Rationale	29
9.8.2 Test procedure	29
9.9 Test no. 5 – Class C at ~640 W with harmonics that just pass the limits.....	31
9.9.1 Rationale	31
9.9.2 Test procedure	31
9.10 Test no. 6 – Class C at ~560 W with harmonics that fail the limits	33
9.10.1 Rationale	33
9.10.2 Test procedure	33
9.11 Test no. 7 – Class D at ~540 W with harmonics that pass the limits	35
9.11.1 Rationale	35
9.11.2 Test procedure	35
9.12 Test no. 8 – Class D at ~380 W with harmonics that fail the limits	38
9.12.1 Rationale	38
9.12.2 Test procedure	38
9.13 Test no. 9 – Class D at ~540 W with harmonics that pass the POHC limit	40
9.13.1 Rationale	40
9.13.2 Test procedure	40

9.14	Test no. 10 – Class A test at ~680 W with higher order harmonics failing the POHC limit.....	42
9.14.1	Rationale	42
9.14.2	Test procedure	42
9.15	Test no. 11 – Class A at ~740 W to test analyzer and source dynamic range	44
9.15.1	Rationale	44
9.15.2	The following list details the test procedure	45
9.16	Test no. 12 – Class A at 1 400 W with > 30 A peak current	47
9.16.1	Rationale	47
9.16.2	Test procedure	47
10	Spreadsheet support program to compute harmonics and user guide	50
Annex A (informative)	Test setup and requirements for external equipment	51
A.1	Example test setup for calibration and verification waveforms.....	51
A.2	Sine wave test	52
A.3	Load modulation to generate interharmonics	52
A.4	Using a square wave to test analysis functions	53
A.5	Requirements for external test equipment to verify accuracy.....	55
Annex B (informative)	Error analysis of the methods specified in this Technical Report	57
Bibliography.....		59
Figure 1 – Waveform and harmonics versus Class A limits for test 1	18	
Figure 2 – Waveform and spectrum for test 2.....	22	
Figure 3 – Waveform and spectrum for tests 3a and 3b	25	
Figure 4 – Spectrum for test 3b passing Class B	27	
Figure 5 – Waveform and spectrum for test 4.....	29	
Figure 6 – Waveform and spectrum for test 5 passing Class C limits.....	32	
Figure 7 – Waveform and spectrum for test 6 failing Class C limits	34	
Figure 8 – Spectrum of test 7 just passing Class D	36	
Figure 9 – Waveform and spectrum for test 8 failing Class D	38	
Figure 10 – Waveform and spectrum for test 9 passing POHC	41	
Figure 11 – Waveform and spectrum for test 10 failing POHC for Class A.....	43	
Figure 12 – Waveform and spectrum for test 11	45	
Figure 13 – Calculated ideal waveform and spectrum for test 12	48	
Figure 14 – Waveform and spectrum for test 12, showing slightly distorted source voltage.....	48	
Figure A.1 – Typical test setup for tests no. 1 to 12	51	
Figure A.2 – Sinusoidal calibration waveform at 1,000 A	52	
Figure A.3 – A modulated load showing side-bands that can be used to test inter-harmonics	53	
Figure A.4 – 1,11 V square wave and the associated spectrum up to H ₃₉	54	
Figure A.5 – Spectrum data for a 9 V square wave compared against compatibility values	55	
Table 1 – Summary of tests to verify/calibrate harmonics analysis systems	12	
Table 2 – Harmonics and data for test 1 – General Class A with harmonics that pass the limits	18	

Table 3 – Spectrum of test 1 for 80,8 Ω	21
Table 4 – Spectrum and data of test 2 for 61 Ω , at 45° to 135°.....	23
Table 5 – Spectrum and data of test 3 for 17 Ω , at 4° to 166°	25
Table 6 – Spectrum and data of test 3b for 17 Ω , at 4° to 166°	27
Table 7 – Spectrum and data for test 4 for 41 Ω , at 60° to 155°	30
Table 8 – Spectrum and data of test 5 for 80 Ω , at 7° to 148°	32
Table 9 – Spectrum and data of test 6 for 80 Ω , at 54° to 160°.....	34
Table 10 – Spectrum and data of test 7 for 80 Ω , at 45° to 135°.....	36
Table 11 – Spectrum and data of test 8 for 80 Ω , at 45° to 106°.....	39
Table 12 – Spectrum and data of test 9 for 80 Ω , at 20° to 122°.....	41
Table 13 – Spectrum and data of test 10 for 80 Ω linear and 80 Ω controlled load, at 55° to 59°	43
Table 14 – Spectrum data of test 11 for 80 Ω linear and 41 Ω controlled load, at 66° to 72°	46
Table 15 – Spectrum data of test 12 for 41 Ω linear and 32 Ω controlled load, at 66° to 72°	49
Table A.1 – Ideal spectrum data and minimum and maximum measured values during stability test	55
Table B.1 – Errors in harmonic current values due to incorrect applied voltage or load impedance, or phase errors	57

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTROMAGNETIC COMPATIBILITY (EMC) –**Part 4-37: Testing and measurement techniques – Calibration and verification protocol for harmonic emission compliance test systems****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) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 61000-4-37, which is a Technical Report, has been prepared by subcommittee 77A: EMC-Low frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This publication contains attached files in the form of an xls document and a user guide. These files are intended to be used as a complement and do not form an integral part of the standard. They may be updated from time to time.

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

Enquiry draft	Report on voting
77A/907/DTR	77A/919/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

- 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 publication using a colour printer.

INTRODUCTION

Harmonic current analysis systems are used to measure emissions from equipment that is tested in accordance with various standards. The IEC (International Electrotechnical Commission) adopted measurement and evaluation techniques that are specified in IEC 61000-4-7, but limits, limit comparisons, certain exclusions, and test conditions for a variety of products are specified in IEC 61000-3-2 (for 16 A per phase and below) and IEC 61000-3-12 (from 16 A to 75 A per phase). This Technical Report provides test patterns for IEC 61000-3-2, but will be expanded in future editions to also include specific tests per IEC 61000-3-12 for currents above 16 A per phase. The methodology described in this Technical Report can also be expanded to provide fluctuating harmonics, along with inter-harmonics.

This Technical Report is neither intended as a type test nor as an exhaustive test of all required analyzer capabilities according to IEC 61000-3-2, IEC 61000-3-12, and IEC 61000-4-7. The primary objective is to verify on a periodic basis (for example for renewal of accreditation) that the harmonic analysis test system, consisting of a previously type tested analyzer and a suitable power source, performs correctly, and the performance of the system is not adversely affected by the system integration, nor has changed over a period of time.

The purpose of the harmonic current analysis systems is to evaluate harmonic current emissions, the power factor, and other parameters, in accordance with the requirements of the above mentioned standards. In addition to the harmonics measurement, the harmonic analyzer 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 61000-3-2 and/or IEC 61000-3-12.

The primary purpose of this test, verification and calibration procedure in this Technical Report, is to establish methods that may be used to verify that a given harmonic analysis system measures and evaluates common harmonic current emission patterns in accordance with the requirements of the standards, and thus allows the user to perform a correct pass/fail analysis of the tested product. Additional capabilities of the analyzer or test system may also be tested using some of the tests described in this Technical Report.

The tests as summarized in Clause 4 may also be used to improve or optimize the accuracy of the harmonics measurement system. This can be done either via the r.m.s. current – if so required by using external reference equipment, and/or by adjusting the frequency response – provided the harmonics analysis system has either hardware or software adjustments to permit the parameter accuracies to be optimized.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-37: Testing and measurement techniques – Calibration and verification protocol for harmonic emission compliance test systems

1 Scope

This part of IEC 61000, which is a Technical Report, outlines a typical test procedure for harmonic analysis in systems comprising

- tests apparatus designed to comply with IEC 61000-4-7, and
- products designed to comply with IEC 61000-3-2 and/or IEC 61000-3-12.

The test procedure is intended to provide a systematic guidance suitable for use by manufacturers, end users, independent test laboratories and other bodies, for the purpose of determining the applicable compliance status within a wide range of harmonic current emissions.

The test procedure is derived from conditions observed in actual product testing and simulates closely conditions that can reasonably be expected.

The accuracy of harmonic analyzers and complete test systems having adjustments or procedures, either hardware or software-based, may be optimized using external reference equipment of sufficient accuracy and the methodology in this Technical Report.

This Technical Report is not intended as a replacement for type testing of harmonic analyzers, nor does it check all of the parameters specified in IEC 61000-4-7, IEC 61000-3-2, and IEC 61000-3-12.

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 61000-3-2:2014, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-12, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current > 16 A and ≤ 75 A per phase*

IEC 61000-4-7:2002, *Electromagnetic compatibility (EMC) – Part 4-7: Testing and measurement techniques – General guide on harmonics and interharmonics measurements and instrumentation, for power supply systems and equipment connected thereto*
IEC 61000-4-7:2002/AMD1:2008

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