IEC 62822-2

Edition 1.0 2016-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz) – Part 2: Arc welding equipment

Matériels de soudage électrique – Évaluation des restrictions relatives à l'exposition humaine aux champs électromagnétiques (0 Hz à 300 GHz) – Partie 2: Matériels de soudage à l'arc

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CONTENTS

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ELECTRIC WELDING EQUIPMENT – ASSESSMENT OF RESTRICTIONS RELATED TO HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (0 Hz to 300 GHz) –

Part 2: Arc welding equipment

FOREWORD

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International Standard IEC 62822-2 has been prepared by IEC technical committee 26: Electric welding.

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

FDIS	Report on voting
26/584/FDIS	26/591/RVD

Full information on the voting for the approval of this standard 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 62822 series, published under the general title *Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz)*, 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- withdrawn,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
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ELECTRIC WELDING EQUIPMENT – ASSESSMENT OF RESTRICTIONS RELATED TO HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS (0 Hz to 300 GHz) –

Part 2: Arc welding equipment

1 Scope

This part of IEC 62822 applies to equipment for arc welding and allied processes designed for occupational use by professionals and for use by laymen.

NOTE 1 Typical allied processes are electric arc cutting and arc spraying.

This standard specifies procedures for the assessment of human exposure to magnetic fields produced by arc welding. It covers non-thermal biological effects in the frequency range from 0 Hz to 10 MHz and defines standardized test scenarios.

NOTE 2 The general term “field” is used throughout this document for “magnetic field”.

NOTE 3 For the assessment of exposure to electric fields and thermal effects, the methods specified in the Generic Standard IEC 62311 apply.

This standard does not define methods for workplace assessment regarding the risks arising from electromagnetic fields (EMF). However, the EMF data that results from the application of this standard can be used to assist in workplace assessment.

Other standards may apply to products covered by this standard. In particular this standard cannot be used to demonstrate electromagnetic compatibility with other equipment. It does not specify any product safety requirements other than those specifically related to human exposure to electromagnetic fields.

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 60050-851:2008, *International Electrotechnical Vocabulary – Part 851: Electric welding*

IEC 60974-1, *Arc welding equipment – Part 1: Welding power sources*

IEC 60974-6, *Arc welding equipment – Part 6: Limited duty equipment*

IEC 61786-1, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 1: Requirements for measuring instruments*

IEC 61786-2, *Measurement of DC magnetic, AC magnetic and AC electric fields from 1 Hz to 100 kHz with regard to exposure of human beings – Part 2: Basic standard for measurements*

IEC 62822-1, *Electric welding equipment – Assessment of restrictions related to human exposure to electromagnetic fields (0 Hz to 300 GHz) – Part 1: Product family standard*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-851 on electric welding, in IEC 60974-1 and IEC 60974-6, as well as the following, apply.

3.1.1
basic restrictions
exposure limit value
restrictions on exposure to electric, magnetic and electromagnetic fields that are based directly on established health effects and biological considerations

3.1.2
exposure index
EI
result of the evaluation of exposure to (both sinusoidal and non-sinusoidal) EMF, expressed as a fraction or percentage of the permissible values

Note 1 to entry: Fractions higher than 1 (100 %) represent exceeding the permissible values.

3.1.3
general public
individuals of all ages and of varying health conditions

Note 1 to entry: Varying ages and health conditions can increase the individuals susceptibilities to EMF.

3.1.4
general public exposure
the exposure of members of the general public to EMF

Note 1 to entry: In many cases, members of the general public are unaware of their exposure to EMF.

3.1.5
health effects
adverse effects, such as thermal heating or stimulation of nerve and muscle tissue as a result of human exposure to EMF

3.1.6
intracorporeal
situated or occurring within the body

3.1.7
layman
operator who does not weld in the performance of his profession and may have little or no formal instruction in welding

[SOURCE: IEC 60050-851:2008, 851-11-14, modified – "arc welding" was replaced by "welding"]

3.1.8
non-thermal effects
the stimulation of muscles, nerves or sensory organs as a result of human exposure to EMF

3.1.9
occupational exposure
the exposure of workers to EMF at their workplaces, generally under known conditions, and as a result of performing their regular or assigned job activities

Note 1 to entry: A worker is any person employed by an employer, including trainees and apprentices.

3.1.10
reference levels
action levels
directly measurable quantities, derived from basic restrictions, provided for practical exposure assessment purposes

Note 1 to entry: Respect of the reference levels will ensure respect of the relevant basic restriction. If the reference levels are exceeded, it does not necessarily follow that the basic restriction will be exceeded.

3.1.11
sensory effects
transient disturbed sensory perceptions and minor changes in brain functions as a result of human exposure to EMF

3.2 Quantities and units

The internationally accepted SI units are used throughout this document.

Physical quantity	Symbol	Unit	Dimension
Current density	J	Ampere per square metre	A m^{-2}
Electric conductivity	σ	Siemens per metre	S m^{-1}
Electric current	I	Ampere	A
Electric field strength	E	Volt per metre	V m^{-1}
Frequency	f	Hertz	Hz
Magnetic flux density	B	Tesla	T (Vs m^{-2})
Permeability	μ	Henry per metre	H m^{-1}

3.3 Constants

Physical constant	Symbol	Magnitude	Dimension
Permeability of free space	μ_0	$4 \cdot \pi \cdot 10^{-7}$	H m^{-1}

4 Requirements

Equipment shall be assessed as defined in Clause 7, using the methods given in Clause 5 and the conditions defined in Clause 6. The results shall be reported as specified in Clause 7.

5 Assessment methods

5.1 General considerations

5.1.1 Time averaging

Time averaging of exposure is not permitted for non-thermal effects unless the applied national or international requirements explicitly specify time averaging procedures.

5.1.2 Spatial averaging of external field values

Reference levels are typically based on spatial averaging over the relevant part of the body. If spatial averaging of exposure is not excluded and no specific procedures are defined in applicable national and international requirements, the procedures detailed in the relevant subclauses of 6.1 shall be applied.

5.1.3 Spatial averaging of intracorporeal values

If spatial averaging of exposure is not excluded and no specific procedures are specified in applicable national and international requirements, the procedures detailed in the relevant subclauses of 5.3 and 6.1 shall be applied.

5.1.4 Equipment with pulsed or non-sinusoidal welding current

5.1.4.1 General

Several methods for the assessment of pulsed and non-sinusoidal fields are available. For the purpose of this standard, only the weighted peak methods as given in 5.1.4.2 and 5.1.4.3 are applicable. For additional information, see IEC 61786-2. The result of these calculation methods is the exposure index (EI).

NOTE Applications of the weighted peak method in time domain or frequency domain are mathematically equivalent and give exactly the same results, if applied correctly. For some cases, e.g. when large numbers of spectral components have to be considered for the complete analysis of a signal, the application of the time domain method can be less complex.

Phase angles used for the weighted peak methods are given in Table 1.

Table 1 – Phase angles of weighting function or summation function

proportionality p_A [a]	$1/f^2$	$1/f$	f^0 (constant)	f
phase angle φ_I [b]	180°	90°	0°	-90°

[a] p_A is the proportionality factor defining the variation of the basic restriction/reference level as specified in the applicable national and international requirements.

[b] φ_I is the phase angle of the weighting function or summation function.

5.1.4.2 Weighted peak method in the time domain

For time domain evaluation, an evaluation system which incorporates a weighting function is applicable. The evaluation shall be based on the peak value of the weighted signal. This method can be used for both external field levels and intracorporeal metrics.

For comparison with the given exposure levels, the weighting function shall have a frequency response which matches the applicable national and international requirements, so that the weighting and summation of spectral components occurs in the time domain.

Further information on this method is given in IEC 62311.

The attenuation and phase angles of the weighting functions can be approximated with electronic or digital filters. The attenuation shall not deviate more than 3 dB and the phase angles not more than 90° from the piecewise linear frequency response. The piecewise linear values for phase angles are given in Table 1.

5.1.4.3 Weighted peak method in the frequency domain

For frequency domain evaluation, a phase corrected summation of the weighted spectral components of the signal is applicable. The evaluation shall be based on the peak value of the weighted signal as given in Equation (1).This method can be used for both external field levels and intracorporeal metrics.

The sum of the weighted spectral components shall not exceed 1 at any time t within the evaluation interval, which shall be one period of the pulsed or non-sinusoidal signal. The time increments used for evaluation shall be less than or equal to 1/10 of the period of the highest relevant spectral component, as defined in 5.1.5.4.

$$\left| \sum_i \frac{A_i}{L_i} \cos(2 \times \pi \times f_i \times t + \theta_i + \varphi_i) \right| \leq 1 \quad (1)$$

where

A_i is the amplitude of the spectral component at frequency f_i;

L_i is the applicable limit at frequency f_i

f_i is the frequency of the spectral component i;

θ_i is the phase angle of the spectral component at frequency f_i;

φ_i is the phase angle of the summation function at frequency f_i, see Table 1.

The amplitudes and phase angles of the limit values can be approximated with electronic or digital filters. The amplitudes shall not deviate more than 3 dB and the phase angles not more than 90° from the piecewise linear frequency response. The piecewise linear values for phase angles are given in Table 1.

Approximation of the piecewise linear values of limits L_i at frequencies f_i shall be done using complex functions such as Equation (2). The initial amplitude V_0, the number of corner frequencies and the position of the relevant terms are dependent on the applicable limits.

$$L_i = \left| V_0 \frac{(1 + s_i/\omega_1)(1 + s_i/\omega_2)(1 + s_i/\omega_3)}{(1 + s_i/\omega_4)(1 + s_i/\omega_5)(1 + s_i/\omega_6)} \right| \quad (2)$$

where

s_i is calculated as $j\ 2\ \pi\ f_i$;

ω_n is ω at the n^{th} corner frequency $f_{c\,n}$;

$f_{c\,n}$ is the n^{th} corner frequency.

An example for a piecewise linear limit and the derived approximation is shown in Figure 1. The example shows the combined reference levels for sensory and health effects in the head as specified in the European EMF Workers Directive 2013/35/EU [2][1].

1 Numbers in square brackets refer to the Bibliography.

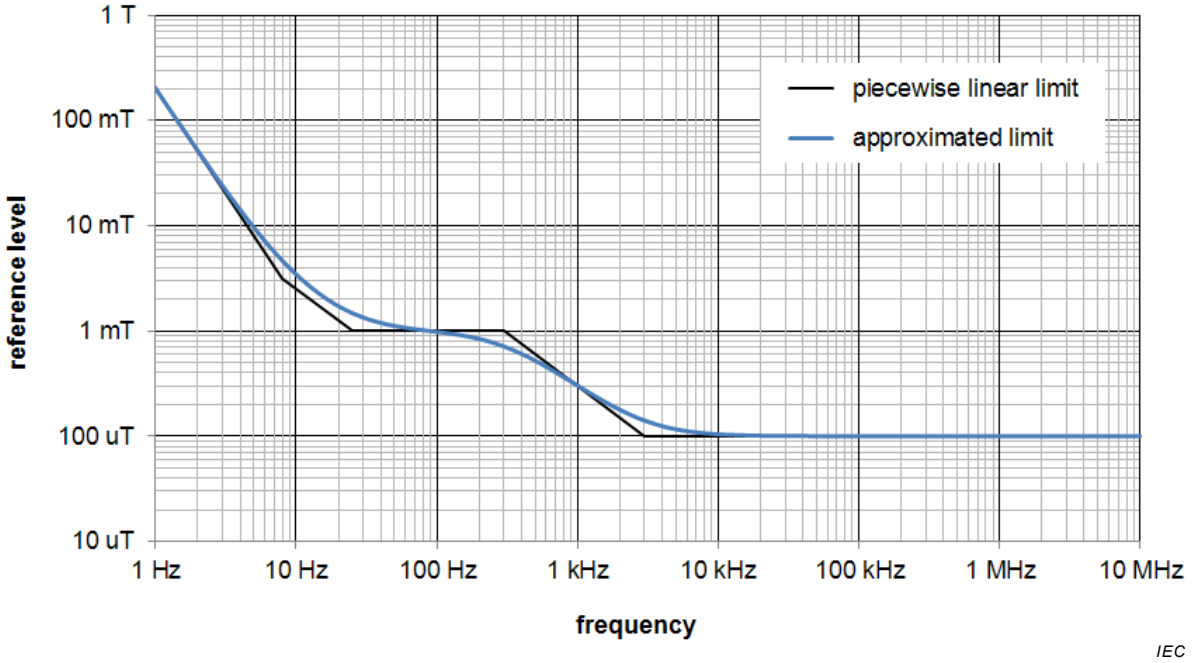

Figure 1 – Piecewise linear and approximated limit amplitudes

The phase angles φ_i of the summation function shall be calculated from the complex function for the approximated amplitudes. An example for piecewise linear phase angles and the phase angles of the derived approximation is shown in Figure 2, an example for the effect of this approximation is given in Annex C. The example in Figure 2 shows the phase angle of the combined reference levels for sensory and health effects in the head as specified in the European EMF Workers Directive 2013/35/EU [2].

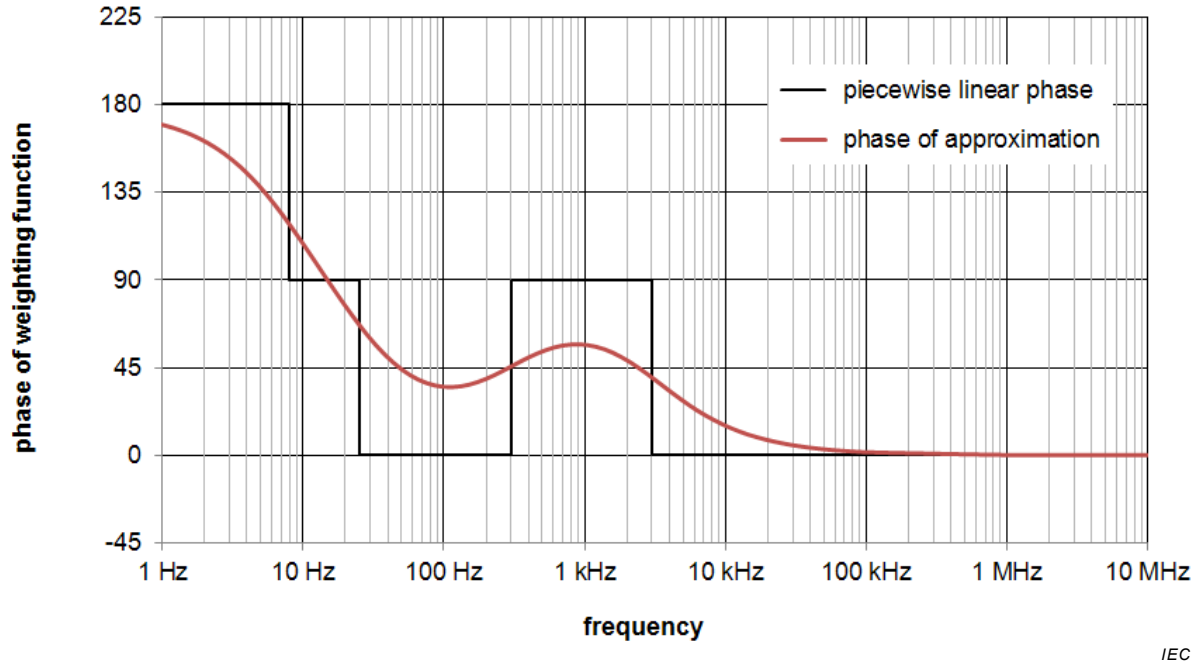

Figure 2 – Piecewise linear and approximated summation function phase angles

5.1.5 Considerations for spectral analysis

5.1.5.1 Validation

The results of spectral analyses, i.e. the amplitudes and phase angles of the spectral components of the assessed welding current or magnetic field, shall be validated. An example for validation by spectral synthesis is given in Figure 3.

NOTE The purpose of the validation is to check if major mistakes were made when performing spectral analysis (e.g. 90° errors in the phase angles) rather than checking for small deviations due to sampling rates or digitizing.

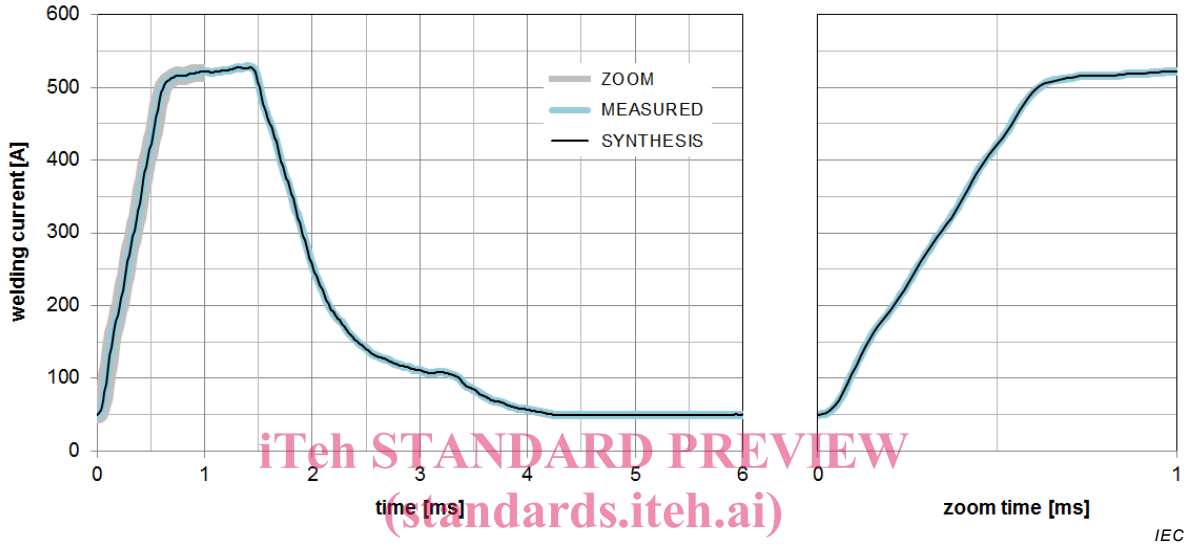

Figure 3 – Spectral synthesis for the validation of the analysis

5.1.5.2 Analysis of repetitive signals

Spectral analysis of repetitive signals (e.g. pulsed welding, a.c. welding or the welding current ripple) shall be based on one full cycle of the signal, where the amplitude at the beginning and the end of the assessment time-frame shall be equal. The number of spectral components to be calculated, i.e. the highest frequency covered by the spectral components, shall comply with the requirements given in 5.1.5.4.

5.1.5.3 Analysis of non-repetitive signals

In order to simplify the spectral analysis of non-repetitive signals (e.g. the maximum rate of change of current with respect to time (di/dt) capability of the welding power source), the constant part after the change can be replaced by a slope with a weighted value that is considerably lower than that of the change to be assessed, and does not influence the resulting value of the exposure index EI. The repetition time shall be sufficiently long to allow the EI curve to decay to zero before the end of the artificial cycle. By this, the non-repetitive signal is replaced by a repetitive signal that can be assessed as given in 5.1.5.2. See Figure 4.

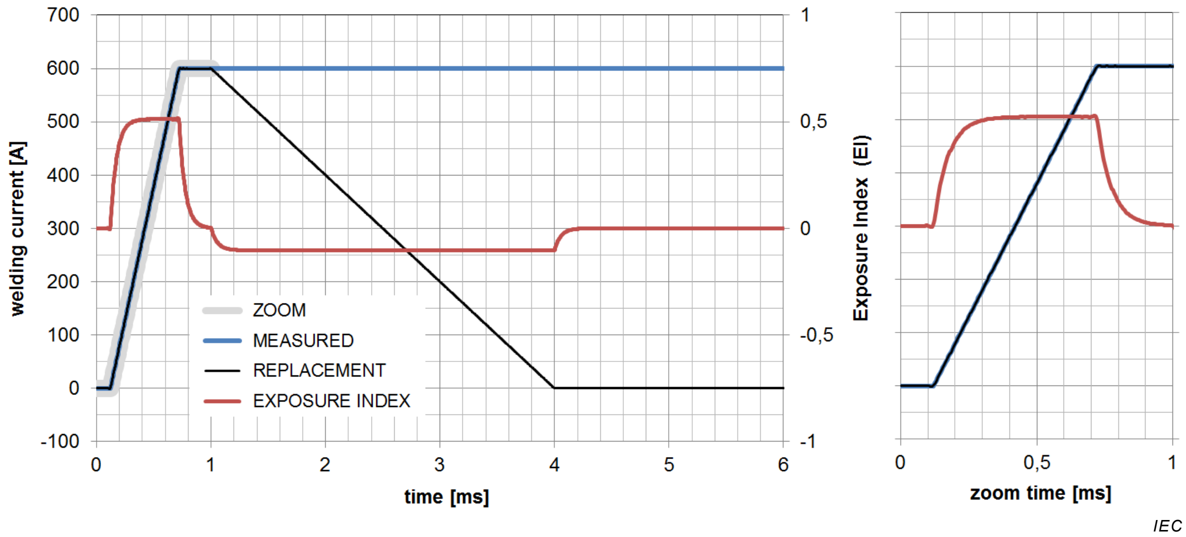

Figure 4 – Equivalent waveform for non-repetitive signals

5.1.5.4 Frequency range limitations

Assessment, dependent on the type of welding current waveform, shall be made in the relevant frequency range from 0 Hz (d.c., as applicable) to an upper frequency defined as the highest applicable value of

- 1 kHz for single phase transformer-rectifier types;
- 3 kHz for three phase transformer-rectifier types;
- 10 kHz for thyristor controlled types;
- 10 times the ripple frequency for inverter types;
- 10 times the a.c. welding current frequency;
- the frequency f_{max} defined by the minimum rise or fall time $\tau_{p\ min}$ of the maximum welding current (10 % to 90 %, from 0 A to $I_{2\ max\ pos}$ or $I_{2\ max\ neg}$).

$$f_{max} = 10 \times \frac{1}{4 \times \tau_{p\ min}} \qquad (3)$$

The maximum upper frequency within the scope of this standard is 10 MHz.

The manufacturer, based on his knowledge of the process or special techniques used in the apparatus, shall select a higher upper frequency if applicable. An example for such a case is an a.c. square-wave power source.

If the output-current ripple-amplitude meets the exclusion criteria given in IEC 62822-1, the upper frequency range boundary based on ripple frequency can be neglected.

5.1.6 Uncertainty of assessment

The expanded uncertainty of the assessment shall be calculated as defined in IEC 61786-2.

If the expanded uncertainty is higher than the value specified IEC 62822-1, and the assessment is not proven to provide conservative results (i.e. overestimates the exposure), the method to calculate penalties given in IEC 62822-1 shall be applied.