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Measurement method for the output of electroshock weapons

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FOREWORD

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This commented version (CMV) of the official standard IEC 62792:2026 edition 2.0 allows the user to identify the changes made to the previous IEC 62792:2015 edition 1.0. Furthermore, comments from IEC TC 85 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 62792 has been prepared by IEC technical committee 85: Measuring equipment for electrical and electromagnetic quantities. It is an International Standard.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of a new clause describing a method for measuring the high voltage arcing charge delivery distance; and
b) an annex describing an impedance matching network that is necessary to calibrate the measurement system.

The text of this International Standard is based on the following documents:

Draft	Report on voting
85/988/FDIS	85/995/RVD

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 International Standard 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/publications.

Words in *italics* in the text are defined in Clause 3.

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.

INTRODUCTION

Manufacturers, medical researchers, policy makers, users, and other interested parties involved with different aspects of *electroshock weapons* (*ESW*s) use a variety of different measurement methods, different terminologies, and different *parameters* to measure and describe the performance of an *ESW*. These differences generate confusion and misunderstanding within this stakeholder community, and this impacts the ability to perform accurate, reliable, and reproducible measurement comparisons. By developing a generally-accepted terminology, set of performance *parameters*, and test methods, this document will facilitate accurate and precise communication for the *parameters* that describe the electrical outputs, current and *high voltage*, of *ESW*s. This improved communication will aid this stakeholder community in collectively developing uniform methods for describing the *ESW* output and its effect on human physiology consistently and accurately, thereby enabling the development of safe use performance standards~~/~~ or regulations by the appropriate standardization body. 1

1 Scope

This document specifies a method for measuring the electrical outputs, current and *high voltage*, from *electroshock weapons* (*ESW*s) that deliver an electrical stimulus to humans. This document is applicable to any and all *ESW*s. This document describes *ESW* measurement systems to help guide the user of this document in developing their own *ESW* measurement system. It includes methods for measuring or computing a variety of *parameters* that can be used to characterize the electrical output of the *ESW*. The user of this document will select those *parameters* that are appropriate for their applications and stakeholders.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60469:2013, *Transitions, pulses and related waveforms - Terms, definitions and algorithms*

~~IEEE Std. 1057-2007, *IEEE Standard for digitizing waveform recorders*~~

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

BIPM, *The International System of Units (SI)*, ~~8th~~9th Edition, ~~2006~~2019

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

– IEC Electropedia: available at https://www.electropedia.org/

– ISO Online browsing platform: available at https://www.iso.org/obp

NOTE The *parameters* included here and suggested for use in describing the performance of an *ESW* are those typically used to describe the *waveforms* of pulse-like *signals* that are produced by pulse generators, such as an *ESW*, and the step-response or impulse-response of *waveform recorders* that are used to measure these pulse-like *signals*.

3.1
aggregate current **2**
flow of charge per second delivered by the *ESW pulse train*

3.2
impulse amplitude
difference between the specified *level* corresponding to the *maximum peak* (*minimum peak*) of the positive (negative) *impulse-like waveform and the level of the state preceding the first transition of that impulse-like waveform*

[SOURCE: IEC 60469:2013, 3.2.3.1]

3.3
correction
operation combining the results of the conversion operation with the transfer function information to yield a *waveform* that is a more accurate representation of the *signal*

Note 1 to entry: Correction may be ~~effected~~ affected by a manual process by an operator, a computational process, or a compensating device or apparatus. Correction ~~must~~ shall be performed to an accuracy that is consistent with the overall accuracy desired in the *waveform measurement process*.

[SOURCE: IEC 60469:2013, 3.2.4, modified – Note 2 to entry has been deleted.]

~~**3.3**~~
~~**effective number of bits**~~
~~**ENOB**~~
~~for an input sinewave of specified frequency and amplitude, the number of bits of an ideal *waveform recorder* for which the root-mean-square (r.m.s.) quantization error is equal to the r.m.s. noise and distortion of the *waveform recorder* under test~~

~~[SOURCE: IEEE Std. 1057-2007, 3.1.29]~~

3.4
electroshock weapon
ESW
weapon that generates a *high-voltage transient* electrical *signal* that is transmitted to a person

Note 1 to entry: The *ESW* comprises, at a minimum, a *signal* generator located in the body of the *ESW* and a pair of electrical contacts to make electrical connection between the generator and a person.

3.4.1
long-range wired ESW
ESW that uses propelled, tethered, skin-penetrating or adhering (for example, to clothing) barbed darts as the electrical contacts

Note 1 to entry: See Figure 1.

Note 2 to entry: Adhering darts attach sufficiently close to the surface of the person to complete a circuit capable of delivering an electrical charge to that person. These barbed darts are tethered to the *ESW cartridge* that is mechanically attached to the body of the *ESW* and travel away from the cartridge when deployed. The *ESW cartridge* is often used to convert a *contact ESW* to a *long-range wired ESW*.

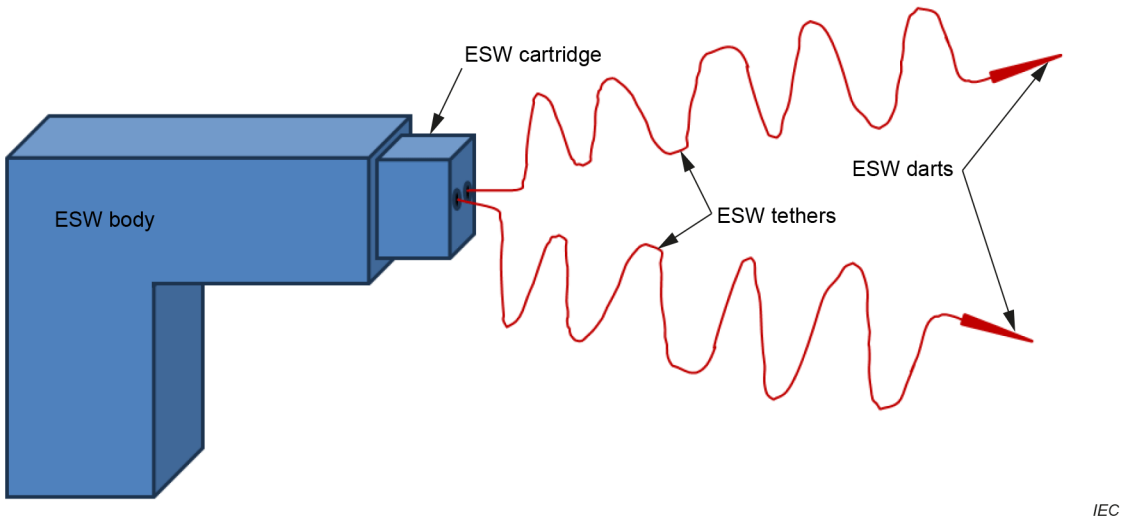

Figure 1 –*Long-range wired ESW* showing components

~~**3.4.2**~~
~~**long-range wireless ESW**~~
~~*ESW* that is compact in size and that is fired or launched from a separate and independent firearm, device, or apparatus and to which there is no physical connection between the *ESW* and the firearm, device, or apparatus after it is fired or launched~~

3.4.2
~~**ESW**~~ **contact ESW**
ESW that uses fixed metal electrodes located on the body or cartridge of the *ESW* as the electrical contacts

3.4.3
ESW cartridge
component of the *long-range wired ESW* that contains the tethered skin-penetrating or adhering barbed darts (*ESW darts*) and mechanically attaches and electrically connects to the body of the *ESW* to complete the circuit and facilitate the delivery of electrical charge

Note 1 to entry: The *ESW cartridge* is often used to convert a *contact ESW* to a *long-range wired ESW.*

3.4.4
ESW dart
probe
component of the *long-range wired ESW* that is connected to the *ESW tether* and makes electrical contact to the target by penetrating the skin of the target or adhering to the clothing of the target

3.4.5
ESW tether
conductive wire providing electrical contact between the *ESW dart* and the *ESW cartridge* of the *long-range wired ESW* as the *ESW dart* travels from the *ESW* to the target

3.5
high voltage
voltage having a value above a conventionally adopted limit

Note 1 to entry: For *ESW*, this conventionally adopted limit ~~shall be~~ is specified by the user of this document.

[SOURCE: IEC 60050-151:2001,151-15-05, modified – Note 1 to entry has been ~~added~~ been adapted for *ESW*.]

3.6
impulse response
time response of a linear time-invariant system to an impulse excitation~~, which initially is in steady state U_0, V_0, produced by application of an impulse function $\Delta u_\delta(t) = K_\delta\delta(t)$ to one of the input variables, where $\Delta v_\delta(t) = v(t) - V_0$ and $\Delta u_\delta(t) = u(t) - U_0$~~

3.7
instant
particular time value within a *waveform* epoch that, unless otherwise specified, is referenced to the *initial instant* of that *waveform epoch*

[SOURCE: IEC 60469:2013, 3.2.13]

3.7.1
final instant
last *sample instant* in the *waveform*

[SOURCE: IEC 60469:2013, 3.2.13.1]

3.7.2
initial instant
first *sample instant* in the *waveform*

[SOURCE: IEC 60469:2013, 3.2.13.3]

3.8
interval
set of all values of time between a first *instant* and a second *instant*, where the second *instant* is later in time than the first

Note 1 to entry: These first and second *instants* are called the endpoints of the *interval*. The endpoints, unless otherwise specified, are assumed to be part of the *interval*.

[SOURCE: IEC 60469:2013, 3.2.15]

3.9
level
constant value having the same units as y

Note 1 to entry: y is the *signal*.

[SOURCE: IEC 60469:2013, 3.2.17, modified – the Note 1 to entry has been added.]

3.9.1
average level
pertaining to the value of the mean of the *waveform level*

If the *waveform* takes on n discrete values, y_j, all equally spaced in time, the *average level* is,

$$\overline{y} = \left(\frac{1}{n}\right)\sum_{j=1}^{n} y_j \qquad (1)$$

[SOURCE: IEC 60469:2013, 3.2.17.1, modified – The formula for the *average level* of a continuous function of time has been deleted and the notes have been deleted.]

3.9.2
average absolute level
pertaining to the mean value of the absolute *waveform* value

If the *waveform* takes on n discrete values, y_j, all equally spaced in time, the *average absolute level* is,

$$\overline{|y|} = \left(\frac{1}{n}\right)\sum_{j=1}^{n} |y_j| \qquad (2)$$

[SOURCE: IEC 60469:2013, 3.2.17.2, modified – The formula for the *average level* of a continuous function of time has been deleted and Note 1 to entry has been deleted.]

3.10
measurand
quantity intended to be measured

[SOURCE: ISO/IEC Guide 99:2007, 2.3, modified – The notes have been deleted.]

3.11
measured quantity value
measured value of a quantity
measured value
quantity value representing a measurement result

[SOURCE: ISO/IEC Guide 99:2007, 2.10, modified – The notes have been deleted.]

3.12
measurement trueness
trueness of measurement
trueness
closeness of agreement between the average of an infinite number of replicate *measured quantity values* and a reference quantity value

[SOURCE: ISO/IEC Guide 99:2007, 2.14, modified – The notes have been deleted.]

3.13
measurement uncertainty
uncertainty of measurement
uncertainty
non-negative *parameter* characterizing the dispersion of the quantity values being attributed to a *measurand*, based on the information used

[SOURCE: ISO/IEC Guide 99:2007, 2.26, modified – The notes have been deleted.]

3.14
metrological traceability
property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of calibrations, each contributing to the *measurement uncertainty*

[SOURCE: ISO/IEC Guide 99:2007, 2.41, modified – The notes have been deleted.]

3.15
offset
algebraic difference between two specified *levels*

Note 1 to entry: Unless otherwise specified, the two *levels* are *state* 1 and the *base state*.

[SOURCE: IEC 60469:2013, 3.2.18, modified – Figure references have been deleted.]

3.16
parameter
any value (number multiplied by a unit of measure) that can be calculated from a *waveform*

[SOURCE: IEC 60469:2013, 3.2.20]

3.17
maximum peak ~~(minimum)~~
pertaining to the greatest ~~(least)~~ value of the *waveform*

[SOURCE: IEC 60469:2013, 3.2.21 ~~and 3.2.22~~]

3.18
minimum peak
pertaining to the least value of the *waveform*

[SOURCE: IEC 60469:2013, 3.2.22]

3.19
peak-to-peak
pertaining to the value of the difference between the extrema of the specified *waveform*

[SOURCE: IEC 60469:2013, 3.2.23]

3.20
pulse duration
difference between the first and second *transition* occurrence *instants*

[SOURCE: IEC 60469:2013, 3.2.27, modified – Note 1 to entry and figure references have been deleted.]

3.21
pulse rate **3**
number of pulses per second within an *ESW* output *pulse train*

3.22
pulse separation
duration between the 50 % reference *level instant*, unless otherwise specified, of the second *transition* of one pulse in a *pulse train* and that of the first *transition* of the immediately following pulse in the same *pulse train*

[SOURCE: IEC 60469:2013, 3.2.28]

3.23
pulse train
repetitive sequence of *pulse waveforms*

Note 1 to entry: Unless otherwise specified, all the pulse *waveforms* in the sequence are assumed to be identical.

[SOURCE: IEC 60469:2013, 3.2.29, modified – The second part of the definition has been put into a note and the figure has been deleted.]

3.24
reconstruction
waveform deconvolution
process of removing the effect of the measurement instrument on the *acquired waveform*

Note 1 to entry: This process mathematically removes the estimated *impulse response* of the ~~test~~ measurement instrument from the *acquired waveform*.

3.25
reference measurement procedure
measurement procedure accepted as providing measurement results fit for their intended use in assessing *measurement trueness* of *measured quantity values* obtained from other measurement procedures for quantities of the same kind, in calibration, or in characterizing reference materials

[SOURCE: ISO/IEC Guide 99:2007, 2.7]

3.26
reference measurement system
reference system
ESW measurement system that is used to support a *reference measurement procedure*

3.27
sample
element of a *sampled waveform*

3.28
signal
physical phenomenon, one or more of whose characteristics may vary to represent information

Note 1 to entry: This phenomenon is a function of time.

[SOURCE: IEC 60050-701:1988, 701-01-02, modified – The note has been replaced.]

3.29
state
particular *level* or, when applicable, a particular *level* and upper and lower limits (the *upper* and *lower state boundaries*) that are referenced to or associated with that *level*

Note 1 to entry: Unless otherwise specified, multiple *states* are ordered from the most negative *level* to the most positive *level*, and the *state levels* are not allowed to overlap. The most negative *state* is called *state* 1. The most positive *state* is called *state* n. The *states* are denoted by s_1, s_2, ..., s_n; the *state levels* are denoted by *level*(s_1), *level*(s_2), ..., *level*(s_n); the upper *state boundaries* are denoted by upper(s_1), upper(s_2), ..., upper(s_n); and the lower *state boundaries* are denoted by lower(s_1), lower(s_2), ..., lower(s_n).

Note 2 to entry: *States*, *levels*, and *state boundaries* are defined to accommodate pulse metrology and digital applications. In pulse metrology, the *levels* of a *waveform* are measured and *states* (with or without associated *state boundaries*) are then associated with those *levels*. In digital applications, *states* are defined (with *state boundaries*) and the *waveform* values are determined to either lie within a *state* or not.

[SOURCE: IEC 60469:2013, 3.2.40]

3.29.1
base state
state of a *waveform* that, unless otherwise specified, possesses a *level* closest to zero

[SOURCE: IEC 60469:2013, 3.2.40.1, modified – figures references have been deleted.]

3.29.2
state boundaries
upper and lower limits of the *states* of a *waveform*

Note 1 to entry: All values of a *waveform* that are within the boundaries of a given *state* are said to be in that *state*. The *state boundaries* are defined by the user.

[SOURCE: IEC 60469:2013, 3.2.41]

3.29.3
state occurrence
contiguous region of a *waveform* that is bounded by the upper and lower *state boundaries* of a *state*, and whose duration equals or exceeds the specified minimum duration for *state* attainment

Note 1 to entry: The *state occurrence* consists of the entire portion of the *waveform* that remains within the boundaries of that *state*.

Note 2 to entry: *State occurrences* are numbered as ordered pairs (s,n), where s_i refers to the ith *state*, and n is the ~~number~~ ordered numbering of the occurrence of that particular *state* within the *waveform epoch*. In a given *waveform epoch*, when the *waveform* first enters a *state* s_1, that *state occurrence* is (s_1, 1). If and when the *waveform* exits that *state*, that *state occurrence* is over. If and when the *waveform* next enters and remains in *state* s_1, that *state occurrence* would be labeled (s_1, 2); and so on.

[SOURCE: IEC 60469:2013, 3.2.42, modified – The note to entry has been replaced.]

3.30
timebase
component of a measurement instrument that provides the unique *instant* for each *sample* in a *sampled waveform*

Note 1 to entry: The *timebase* provides a vector of sampling *instants* where each *instant* corresponds to a unique *sample* in the *waveform*.

Note 2 to entry: Often the *interval* between *sample instants* is not uniform and exhibits both systematic and random errors.

3.31
transient
any contiguous region of a *waveform* that begins at one *state*, leaves and subsequently returns to that *state*, and contains no *state occurrences*

[SOURCE: IEC 60469:2013, 3.2.46]

3.32
transition
contiguous region of a *waveform* that connects, either directly or via intervening *transients*, two *state occurrences* that are consecutive in time but are occurrences of different *states*

[SOURCE: IEC 60469:2013, 3.2.47]

3.33
transition duration
difference between the two reference *level instants* of the same *transition*

Note 1 to entry: Unless otherwise specified, these two reference *levels* are the 10 % and 90 % reference *levels*.

[SOURCE: IEC 60469:2013, 3.2.48, modified – Note 2 to entry has been deleted and figures references have been deleted.]

3.34
transition settling error
maximum error between the *waveform* value and a specified reference *level* within a user-specified *interval* relative to the 50 % reference *level instant*

[SOURCE: IEC 60469:2013, 3.2.50, modified – the words "of the waveform epoch. The interval starts at a use-specified instant" have been deleted.]