IEC 60063

Edition 3.0 2015-03

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Preferred number series for resistors and capacitors

Séries de valeurs normales pour résistances et condensateurs

IEC 60063:2015-03(en-fr)

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PREFERRED NUMBER SERIES FOR RESISTORS AND CAPACITORS

FOREWORD

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International Standard IEC 60063 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 1963 and constitutes a technical revision.

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

– revision of the information on a relationship between an E Series and the tolerance of a resistance or capacitance value of a respective component;
– introduction of advice on a possible deduction from the marking of a component to an associated E Series and also to an associated tolerance;
– complete editorial revision.

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

FDIS	Report on voting
40/2340A/FDIS	40/2370/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.

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- withdrawn,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.

PREFERRED NUMBER SERIES FOR RESISTORS AND CAPACITORS

1 Scope

This International Standard provides series of preferred values for the resistance of resistors and for the capacitance of capacitors.

The definition of such series with a defined numeric resolution is a basic prerequisite for the marking and coding of capacitors and resistors with their respective capacitance or resistance values as described in IEC 60062.

NOTE The number series defined in this standard are based on progressive ratios of $\sqrt[i]{10}$, with $r = 3 \cdot 2^i$, and i being a whole number in the range of 0 to 6, hence e.g. of $\sqrt[12]{10}$.

This system of progressive ratios had been established prior to the 1952 release of the first edition of this standard[1] as a consequence of the standardisation of tolerances at ±5 %, ±10 % and ±20 % and the related commercial practice. An adoption of the ISO practice, based on a $\sqrt[10]{10}$ system, was never considered achievable.

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 60062, *Marking codes for resistors and capacitors*

3 Terms and definitions

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

3.1
E series
infinite series of numeric values with a given number of elements per decade, rounded or derived from the elements of a geometric series

Note 1 to entry: The number of elements within a decade, r, is given in the designation of the E series, Er, e.g. E24 for a number series with 24 values per decade.

4 Number series

4.1 Number series with two significant digits

The series E24, E12, E6 and E3 with two significant digits are the decimal multiples and sub-multiples of the respective values given in Table 1.

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1 IEC 60063:1952, *Series of preferred values and their associated tolerances for resistors and capacitors*

Table 1 – Number series with two significant digits

E24	E12	E6	E3
10	10	10	10
11			
12	12		
13			
15	15	15	
16			
18	18		
20			
22	22	22	22
24			
27	27		
30			
33	33	33	
36			
39	39		
43			
47	47	47	47
51			
56	56		
62			
68	68	68	
75			
82	82		
91			

The E24 series is derived from a geometric series composed of values, rounded to two significant digits, of the theoretical numbers

$$v = \left(\sqrt[24]{10}\right)^n$$

where

v is a value of the E24 series, and

n is a whole positive or negative number.

NOTE The values of the E24 series in the range of 27 through 47, and the value 82, divert from the exact mathematical rule. However, a correction of this deviation has never seemed appropriate in light of the historical relevance of this series, having been established prior to the 1952 release of the first edition of this standard.

The E12 series is derived from the E24 series by omitting every second term, and likewise is the E6 series derived from the E12 series and the E3 series derived from the E6 series by omitting every second term thereof.

4.2 Number series with three significant digits

The series E192, E96 and E48 with three significant digits are the decimal multiples and sub-multiples of the respective values given in Table 2.

Table 2 – Number series with three significant digits

E192	E96	E48	E192	E96	E48	E192	E96	E48	E192	E96	E48
100	100	100	178	178	178	316	316	316	562	562	562
101			180			320			569		
102	102		182	182		324	324		576	576	
104			184			328			583		
105	105	105	187	187	187	332	332	332	590	590	590
106			189			336			597		
107	107		191	191		340	340		604	604	
109			193			344			612		
110	110	110	196	196	196	348	348	348	619	619	619
111			198			352			626		
113	113		200	200		357	357		634	634	
114			203			361			642		
115	115	115	205	205	205	365	365	365	649	649	649
117			208			370			657		
118	118		210	210		374	374		665	665	
120			213			379			673		
121	121	121	215	215	215	383	383	383	681	681	681
123			218			388			690		
124	124		221	221		392	392		698	698	
126			223			397			706		
127	127	127	226	226	226	402	402	402	715	715	715
129			229			407			723		
130	130		232	232		412	412		732	732	
132			234			417			741		
133	133	133	237	237	237	422	422	422	750	750	750
135			240			427			759		
137	137		243	243		432	432		768	768	
138			246			437			777		
140	140	140	249	249	249	442	442	442	787	787	787
142			252			448			796		
143	143		255	255		453	453		806	806	
145			258			459			816		
147	147	147	261	261	261	464	464	464	825	825	825
149			264			470			835		
150	150		267	267		475	475		845	845	
152			271			481			856		
154	154	154	274	274	274	487	487	487	866	866	866
156			277			493			876		
158	158		280	280		499	499		887	887	
160			284			505			898		
162	162	162	287	287	287	511	511	511	909	909	909
164			291			517			920		
165	165		294	294		523	523		931	931	
167			298			530			942		
169	169	169	301	301	301	536	536	536	953	953	953
172			305			542			965		
174	174		309	309		549	549		976	976	
176			312			556			988		

The E192 series is a geometric series composed of values, rounded to three significant digits, of the theoretical numbers

$$v = \left(\sqrt[192]{10}\right)^n$$

where

v is a value of the E192 series, and

n is a whole positive or negative number.

The E96 series is derived from the E192 series by omitting every second term, and similarly, the E48 series is derived from the E96 series by omitting every second term thereof.

5 Application of an E series

5.1 Relationship between E series and tolerances

A sequential range of components is usually established in a way that a tolerance range of any given value, i.e. the range defined by that given value minus and plus the given tolerance, does not significantly overlap with the tolerance range of the next succeeding value. This consideration suggests a fixed relationship between the tolerance and the progression ratio of any range of components.

Table 3 gives the recommended assignment of the E series and the tolerance for components with symmetrical tolerances.

Table 3 – Tolerances and recommended E series

Tolerance %	E series
wider than ±20	E3
±20	E6
±10	E12
±5	E24
±2	E48
±1	E96
tighter than ±1	E192

The relationships shown in Table 3 apply to resistors without restriction.

For capacitors, however, where it is not common to use more than two significant digits for the definition of any capacitance value, the E series like E48 or above are typically not applied, and therefore the tightest customary tolerance of ±1 % is used with values of the E24 series.

Similar considerations may apply to components with asymmetrical tolerances.

NOTE The use of tolerances much tighter than ±1 % might suggest the definition of an E series with even more than 192 elements per decade, e.g. a hypothetical series with 384 elements. However, the definition of numeric values with three significant digits does not offer a sufficiently fine resolution for the establishment of such larger series. Furthermore, all established and practical coding and marking systems are limited to a resolution of three significant digits and thus pose a constraint to the use of numeric values with more than three significant digits.

5.2 Deduction from the marking and coding of values

There are marking and coding systems established in IEC 60062 for values with two and with three significant digits. These marking and coding systems also permit the indication of the tolerance.

In many cases however, the space available on a component for application of a marking is not sufficient to permit the additional tolerance information. In such cases it has become common practice to apply the reverse of the relationship shown in Table 3, by concluding from the numerical resolution of a coding to the feasible E series and then to the feasible tolerance, like

– a three-character coding only represents values with two significant digits, hence from an E series up to E24, which in turn is related to a tolerance of not tighter than ±5 %; or
– a four-character coding only represents values with three significant digits, hence from an E series of E48 or higher, which in turn is related to a tolerance of ±2 % or tighter.

It is obvious from this illustration that the conclusion may be ambiguous by itself, and therefore shall not be assumed as a general relationship. It only supports the distinction between pre-defined options, like e.g. E24 and ±5 % versus E96 and ±1 %, and hence depends on a precise and suitable documentation and specification of the respective components.