



**UNIVERSIDAD
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Regulations on electronics

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V 1.0

Introduction

- Professional activities are subject to the compliance with multiple regulations.
- The different aspects of electronics are not an exception.
- Electronic design and manufacturing are affected by a broad and diverse regulatory framework.
- The engineer must be aware of the regulations concerning his work and apply them correctly.
- There are a number of accredited organisms aimed to verify that electronic products (among others) comply with the existing regulations.
- Products and services acquired must comply with regulations as well.

General concepts

- Standardization: unification work applicable to products and processes.
- Tolerance: admissible error margins on a nominal value.
- Reliability: probability of failure.
 - ❖ Failure: the device does not work within the expected parameters.

Standardization

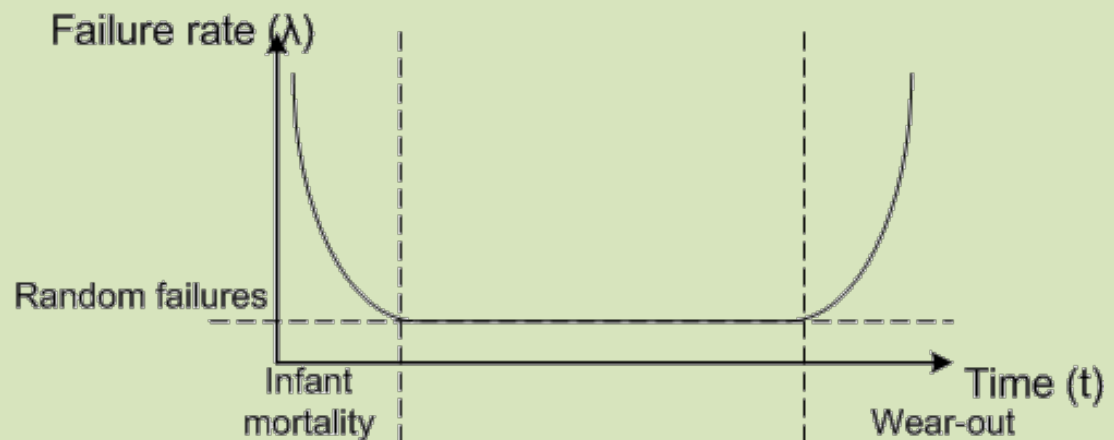
- Types of regulations:
 - ❖ National: concerning the issuing country.
 - ❖ International: accepted by multiple countries.
- Standardization organizations:
 - ❖ National: AENOR, ANSI.
 - ❖ International: ISO, IEC (International Electrotechnical Commission).
 - ❖ Private: IEEE (Institute of Electrical and Electronics Engineers), IPC (Institute for Printed Circuits), EIA – JEDEC (Electronic Industries Alliance).

Tolerance

- It is stated as:
 - ❖ Maximum and minimum values.
 - ❖ Variation percentage.
 - ❖ Absolute variation value.
- Affects:
 - ❖ Nominal values.
- Is affected by:
 - ❖ Environmental factors such as temperature, time span, etc.

Reliability

- Mean time between failures: $MTBF = \frac{\sum_{i=1}^N t_{fail_i}}{N}$
- Failure rate: pace of failure occurrence (bathtub curve).
- Types of failures:
 - ❖ Infant mortality.
 - ❖ Random.
 - ❖ Wear-out.
- Failure processes:
 - ❖ Sudden.
 - ❖ Drifts.





Hierarchy of regulations

- Basic standards: define and describe the problems and the test and measure procedures, along with the instruments and accessories required . E.g. EN 61000.
- Generic standards: affect all types of products unless product family or product standards apply. E.g. EN 50081 & 50082.
- Product family standards: affect all equipment within a common family unless product standards apply. E.g. EN 55011 , EN 55014, EN 55015, EN 55022.
- Product standards: affect specific products. These standards prevail over the rest. E.g. EN 60669.

The standards in the examples are related to electromagnetic compatibility.

Standards for electronics

- Electronic components.
 - ❖ Symbols.
 - ❖ Standardized values.
 - ❖ Marking.
 - ❖ Packaging.
- Printed circuit design and manufacturing.
- Electromagnetic compatibility.
- Environmental sustainability.
- CE Marking.

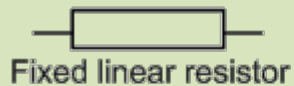


Electronic components – Symbols

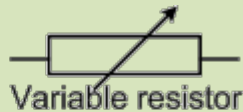
IEC 60617

Passive components:

UNE – EN 60617 -4.



Fixed linear resistor



Variable resistor



Capacitor



Polarized capacitor



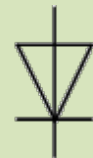
Inductor



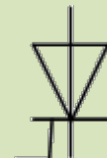
Inductor with magnetic core

Active components:

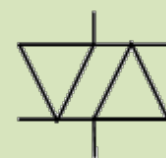
UNE – EN 60617 -5.



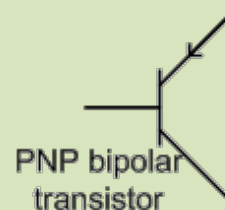
Diode



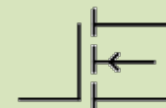
Thyristor



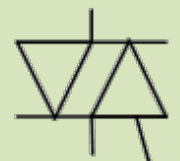
Diac



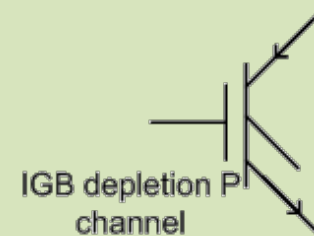
PNP bipolar transistor



N channel enhancement FET



Triac



IGB depletion P channel



Electronic components – Standardized values IEC 60063 UNE 20531

Preferred values are described related to: resistors, capacitors, inductors & zener diodes.

Standardized values are set for decade and classified according to tolerance.

Series	Tol	Values																							
E-12	10%	10	12	15	18	22	27	33	39	47	56	68	82												
E-24	5%	10	11	12	13	15	16	18	20	22	24	27	30	33	36	39	43	47	51	56	62	68	75	82	91

Other series:

E-6 (20%) E- 48 (2%) E-96 (1%) E-192 (0.5%)



Electronic components – Marking

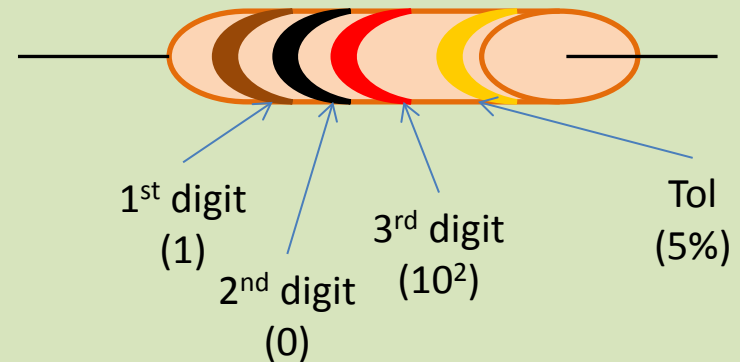
IEC 60062 UNE-EN 60062

Marking codes for resistors and capacitors.

What is coded: standardized values, tolerance, temperature coefficient, fabrication date, dielectric material.

Color	Value	Mult. Coef.	Tol	Temp. Coef.
Black	0	1	-	$\pm 250 (10^{-6}/K)$
Brown	1	10	1%	$\pm 100 (10^{-6}/K)$
Red	2	10^2	2%	$\pm 50 (10^{-6}/K)$
Orange	3	10^3	0.05%	$\pm 15 (10^{-6}/K)$
Yellow	4	10^4	-	$\pm 25 (10^{-6}/K)$
Green	5	10^5	0.5%	$\pm 20 (10^{-6}/K)$
Blue	6	10^6	0.25%	$\pm 10 (10^{-6}/K)$
Violet	7	10^7	0.1%	$\pm 5 (10^{-6}/K)$
Grey	8	10^8	-	$\pm 1 (10^{-6}/K)$
White	9	10^9	-	-
Silver	-	10^{-2}	10%	-
Gold	-	10^{-1}	5%	-

Color code for resistors



$$R = 10 \times 10^2 = 1.000\Omega = 1k\Omega$$



There cloud be a third significant digit



Although not in the standard, manufacturers put the code also on capacitors



Electronic components – Marking

IEC 60062 UNE-EN 60062

Letter code for resistors and capacitors: the unit of measurement (or its multiplier and dividers) to mark the decimal point.

R10 = 0.10Ω 10R = 10Ω 4k7 = 4.7kΩ 10M = 10MΩ p10 = 0.10pF 5n9 = 5.9nF 10μ = 10μF

A 3 character system, analogous to the color code can be used.

R10 = 0.10Ω 100 = 10Ω 472 = 4.7kΩ 106 = 10MΩ



Although not in the standard, manufacturers extend this system to capacitors.

472 = 4.7pF

Letters can also be used to code tolerance and temperature coefficients.

F = 1% G = 2% J = 5% K = 10% M = 20%

G = 0.1 (10⁻⁶/K) J = 0.5 (10⁻⁶/K) K = 1 (10⁻⁶/K)



Electronic components – Marking Semiconductors PROELECTRON

Code comprises 2 letters and a serial number that can include a third letter.

1 st letter: material (gap width)		2 nd letter: function	
A	0.6 -1.0 eV (germanium)	A	Signal diode
B	1.0 – 1.3 eV (silicon)	C	Audio signal transistor
C	> 1.3 eV	D	Audio power transistor
D	Ceramic	F	High frequency signal transistor
R	Composite materials	N	Optocoupler
		Z	Zener

JEDEC proposes a different marking system based upon 1 digit, 1 letter and a serial number. E.g.: 1N4007.



Electronic components – Marking Integrated circuits

PROELECTRON code is integrated by 3 letters and a serial number.

1 st letter: device type		2 nd letter: funtion	
F	Device belonging to a logic family		Logic familiy
S	Stand alone digital circuit		Part of the serial number
T	Analogic integrated circuit		
U	Mixed signal (analog/digital)		
M	Microprocessor		Type of processor or related element
N	Others		

Major vendors such as Texas Instruments propose their own marking codes:
Manufacturer + temperature margin + subfamily + serial number + suffixes.

SN74LS04: Texas Instruments + Commercial temperature margin+ subfamily LS + 6 NOT gates



Electronic components – Packaging

JEDEC - JESD30-B

Describes packages for discrete semiconductors and integrated circuits.

Different types of packages are included. It does not refer to specific packages.

Code					
Features	Material	Position	Package type	Terminal shape	Number of terminals

The field “Package type” is the only mandatory one.





PCB design. IPC 221

Includes recommendations concerning multiple aspects of PCB design:
Materials, sizes, distances, routing, etc...

$$\text{E.g. : } I = k\Delta T^{0.44} A^{0.725}$$

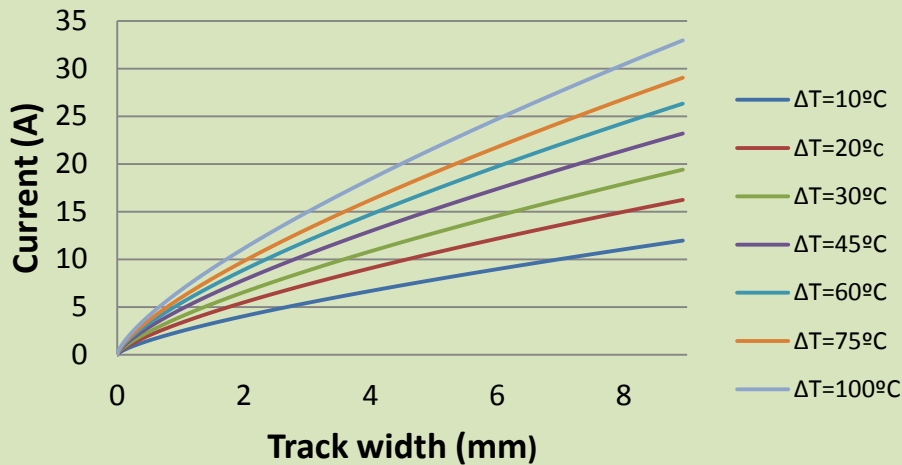
I: current in amps.

A: conductor cross section in square mils.

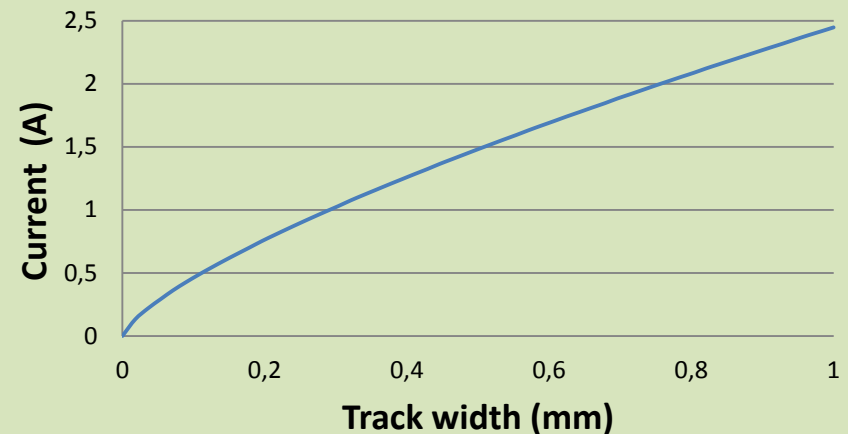
ΔT : temperature increase in $^{\circ}\text{C}$

K=0.048 for external layers, 0.024 for internal layers

Copper thickness = $35\mu\text{m}$



$\Delta T = 10^{\circ}\text{C}$ Copper thickness = $35\mu\text{m}$



PCB manufacturing. IPC 4101

Rigid circuit boards are composed of a base material + binding resin. The standard defines the different combinations and their properties.

Base materials are named according to the NEMA standard (National Electrical Manufacturers Association).

	Epoxy resin	Phenolic resin
Fiberglass	G10, CEM-3, FR4, FR5	
Paper	FR3	XPC, FR1, FR2
Fiberglass + paper	CEM-1	

Equivalent European standards: IEC 249 – UNE 20620-1.

Electromagnetic compatibility

It is a very complex issue and it is affected by most design and manufacturing aspects.

There are numerous standards on compatibility as already mentioned in the hierarchy of standards.

IEC 61000 – UNE-EN 61000 can be taken as starting point.

- Emitter: “Produces voltages, currents or electromagnetic fields that may potentially cause disturbance to other surrounding equipment or even to itself”.
- Victim: “its behavior can be affected by the presence of electromagnetic disturbance generated by an emitter”.
- Emission level: level of electromagnetic disturbance of a certain kind produced by a device, apparatus or system and measured in a specified manner. The maximum accepted level is considered the “emission limit”.
- Immunity level: maximum level of an electromagnetic disturbance of a certain kind that does not produce a deterioration of performance in a device, apparatus or system. The minimum required level of immunity is called the “limit of immunity”.

Environmental sustainability -RoHS

RoHS directive was published in the Official Journal of the European Union as Directive 2002/95/CE on 27 January 2003 as “*Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment*”. It was transposed to the Spanish legislation in the Royal Decree 208/2005.

The directive intends to harmonize national regulations affecting the use and disposal of hazardous materials for the environment and human health on electrical and electronic devices.

The RD 208/2005 transposes both the 2002/95 directive and the 2002/96 on electrical and electronics waste, and also the 2003/108 directive updating the former one. It bans the use of a number of hazardous materials in the fabrication of electronic equipment:

- Lead
- Mercury
- Cadmium
- Hexavalent chromium
- Polybrominated biphenyls
- Polybrominated diphenyl ethers

Some exceptions are mentioned though, affecting some specific used and with limited amounts. Basically they mean to preserve some uses for which there is no suitable replacement.



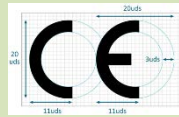
Environmental sustainability -WEEE

WEEE directive was published in the Official Journal of the European Union as Directive 2012/19/CE on 4 July 2012 as directive “on waste electrical and electronic equipment”.

It is meant to protect the environment from electrical and electronic waste.

It states that from 2016 on the collection rate must be over 45% and from 2019 on, 65%. To do so it considers various agents in the process and the way the rate must be assessed. It poses restrictions on the export of waste:

“WEEE exported out of the Union shall only count towards the fulfilment of obligations and targets set out in Article 11 of this Directive if, in compliance with Regulations (EC) No 1013/2006 and (EC) No 1418/2007, the exporter can prove that the treatment took place in conditions that are equivalent to the requirements of this Directive.”



Marking

It is based upon directive 93/68/EEC July 1993. It was effective in 1995 with a transitory period lasting to 1997.

It means “Conformité Européene”: European conformity.

It poses an obligation on manufacturers and importers of certain kinds of products (electronics among others) to comply with the applicable European directives.

Independent authorized organisms are in charge of checking the conformity when that is required by the directive.

How to find the applicable directives?

<http://www.marcado-ce.com/en/what-directive-apply-to-my-product.html>

E.g.: radiofrequency device meant to actuate on remote electrical elements.

- Low voltage (LVD, 2006/95/CEE)
- Electromagnetic compatibility (EMC, 2004/108/CE)
- Radio equipment and telecommunications terminal equipment and the mutual recognition of conformity (R&TTE, 1999/5/CE)
- Restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS, 2011/65/EU)

References

- PROELECTRON system:

http://www.eeca.eu/images/downloads/PRO%20ELECTRON_D15%20final%20version%202007_12%20ESIA%20updated%2016%2007%2010.pdf