TRANSFORMER SAFETY, UPDATES ON IEC-61558 STANDARD

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WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

TRANSFORMER SAFETY, UPDATES ON IEC-61558 STANDARD

Outline

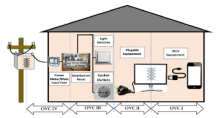
- Introduction to transformer safety
- How to acheive safety according to IEC-61558-1 standard
- Practical construction examples designed to meet IEC-61558-1
- Questions and discussions

Transformer safety standards and approvals are seen by customers / engineers as

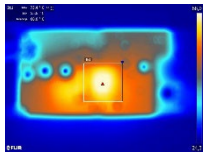
HUGE PROBLEMS

INTRODUCTION TO TRANSFORMER SAFETY

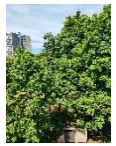
Electrical



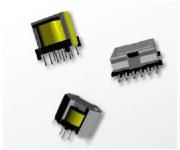
Thermal



Environment



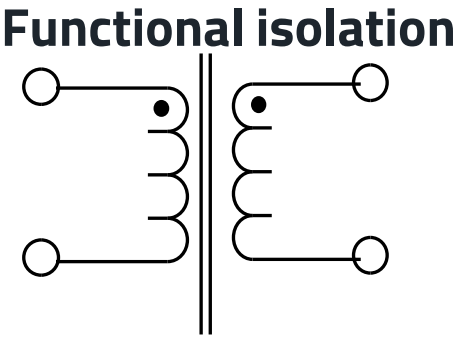
Mechanical



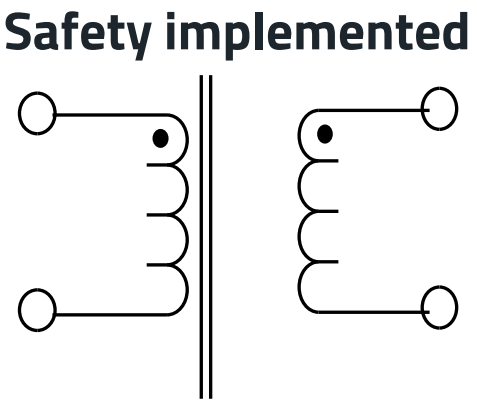
Factors affecting safety

INTRODUCTION TO TRANSFORMER SAFETY - INSULATION

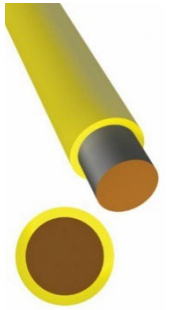
- **Functional Insulation** - Is only necessary for the correct functioning of equipment



- **Basic Insulation** - Insulation applied to live parts to provide protection against electric shock in the absence of any equipment safeguard.
- **Supplementary Insulation** - Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.
- **Double Insulation** - Comprising both basic insulation and supplementary insulation.
- **Reinforced Insulation** - Single insulation system applied to live parts which provides a degree of protection against electric shock equivalent to double insulation.



HOW CAN WE ACHIEVE SAFETY DISTANCE?



Basic insulation

- Insulation to provide basic protection against electric shock

Supplementary insulation

- Independent insulation applied in addition to BASIC INSULATION in order to reduce the risk of electric shock in the event of a failure of the BASIC INSULATION

Reinforced insulation

- Three independent layers of INSULATION

INTRODUCTION TO TRANSFORMER SAFETY

IEC 61558-2-16	Updated: 5/22/2025	☐ show hidden columns
PART NUMBER:		
ENTER RMS WORKING VOLTAGE:	265	Vrms
ENTER PEAK WORKING VOLTAGE:	375	Vpk
ENTER FREQUENCY:	100	kHz.
SELECT MATERIAL GROUP:	IIIb (100 ≤ CTI < 175)	
SELECT INSULATION GRADE:	reinforced (with TIW)	☐ SHOW FIW WIRE TABLE
SELECT OVERVOLTAGE CATEGORY:	II	
SELECT POLLUTION DEGREE:	2	
POTTED / NON-POTTED:	non-potted	
ALTITUDE:	2000	
DIELECTRIC TYPE TEST:	3650	VAC for one minute
DIELECTRIC ROUTINE TEST:	2900	VAC for one second
CREEPAGE:	5.4	mm
CLEARANCE:	3	mm
PD INCEPTION/EXTINCTION:	469/375	Vpk
SURGE/IMPULSE TEST:	4923	Vpk, 1.2/50usec ±3 reps

DESIGN RULES:

-one layers of tape between magnet wire windings and TIW wire windings

-Thin sheet insulation (tape) must meet distance through insulation based on wattage of transformer. 26.3.2.

-TIW wire cannot touch magnet wire if it is providing reinforced insulation

-Refer to 19.12.3 for more information on various allowed constructions

-Partial discharge type testing required for all 61558-2-16 designs (18.3.1, 18.3.1.101)

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MIDCOM RULES:

-insulate all insulated wire dragbacks (anything except magnet wire)

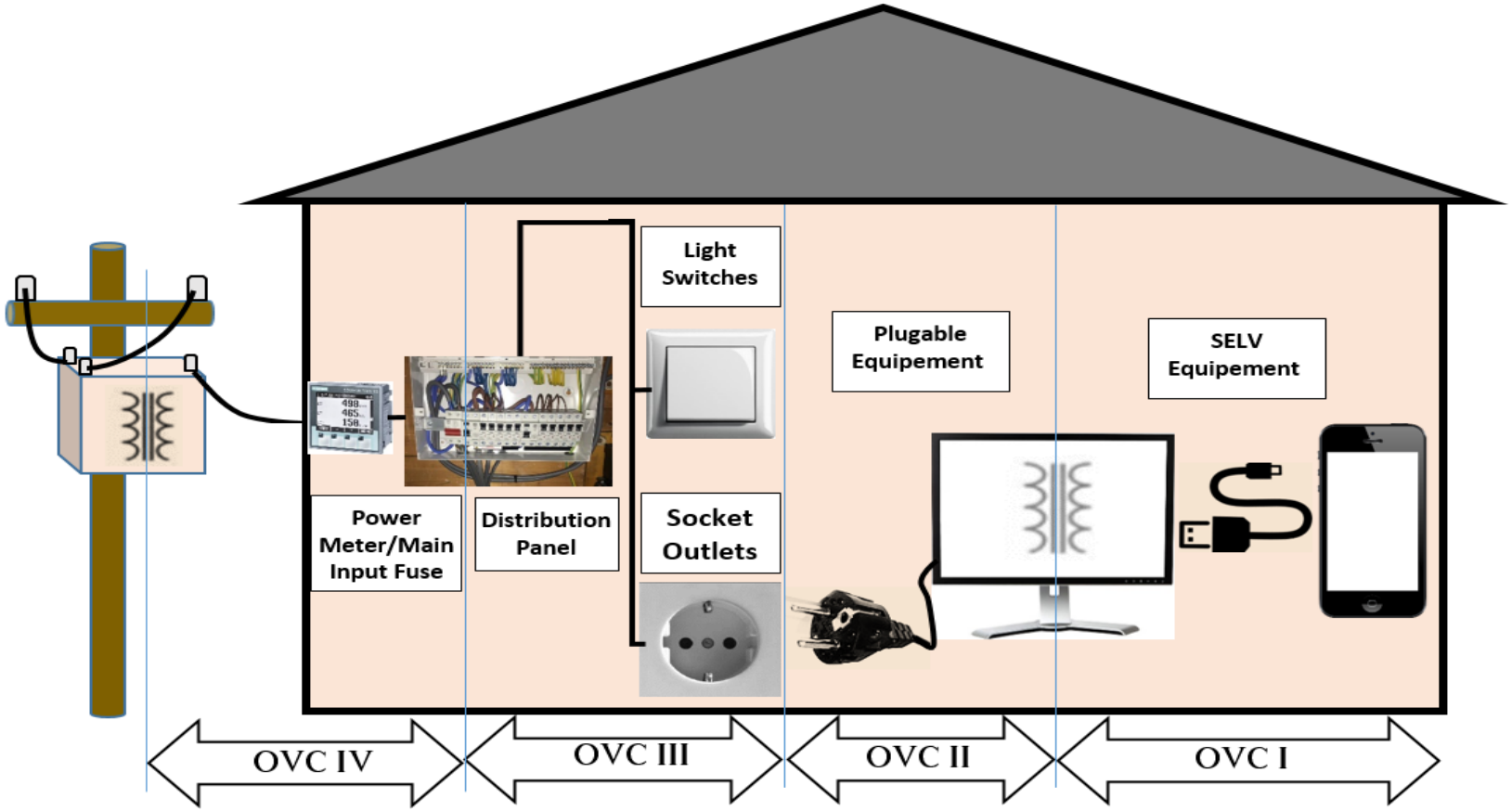
-split winding, or use interlayer tape in any magnet wire winding over 200V, and ensure leadouts don't touch

-crossover tape anywhere reinforced wire crosses magnet wire

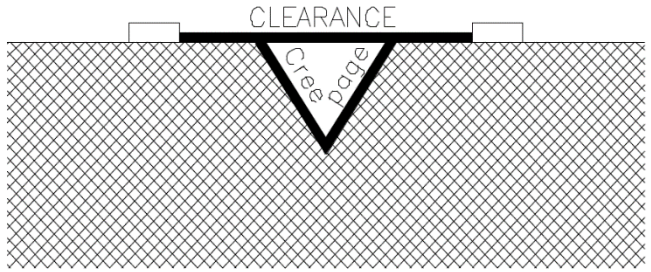
Clearance distances now calculated with rated supply voltage according to the 2021-version

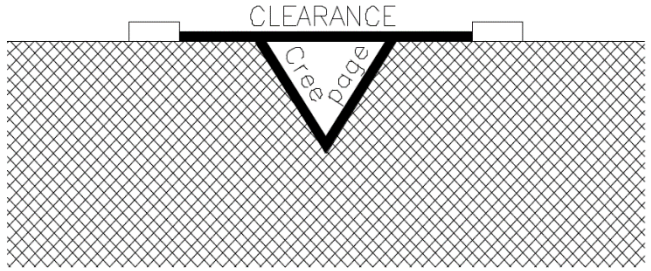
Microsoft Excel
cro-Enabled Temp

OVERVOLTAGE CATEGORY



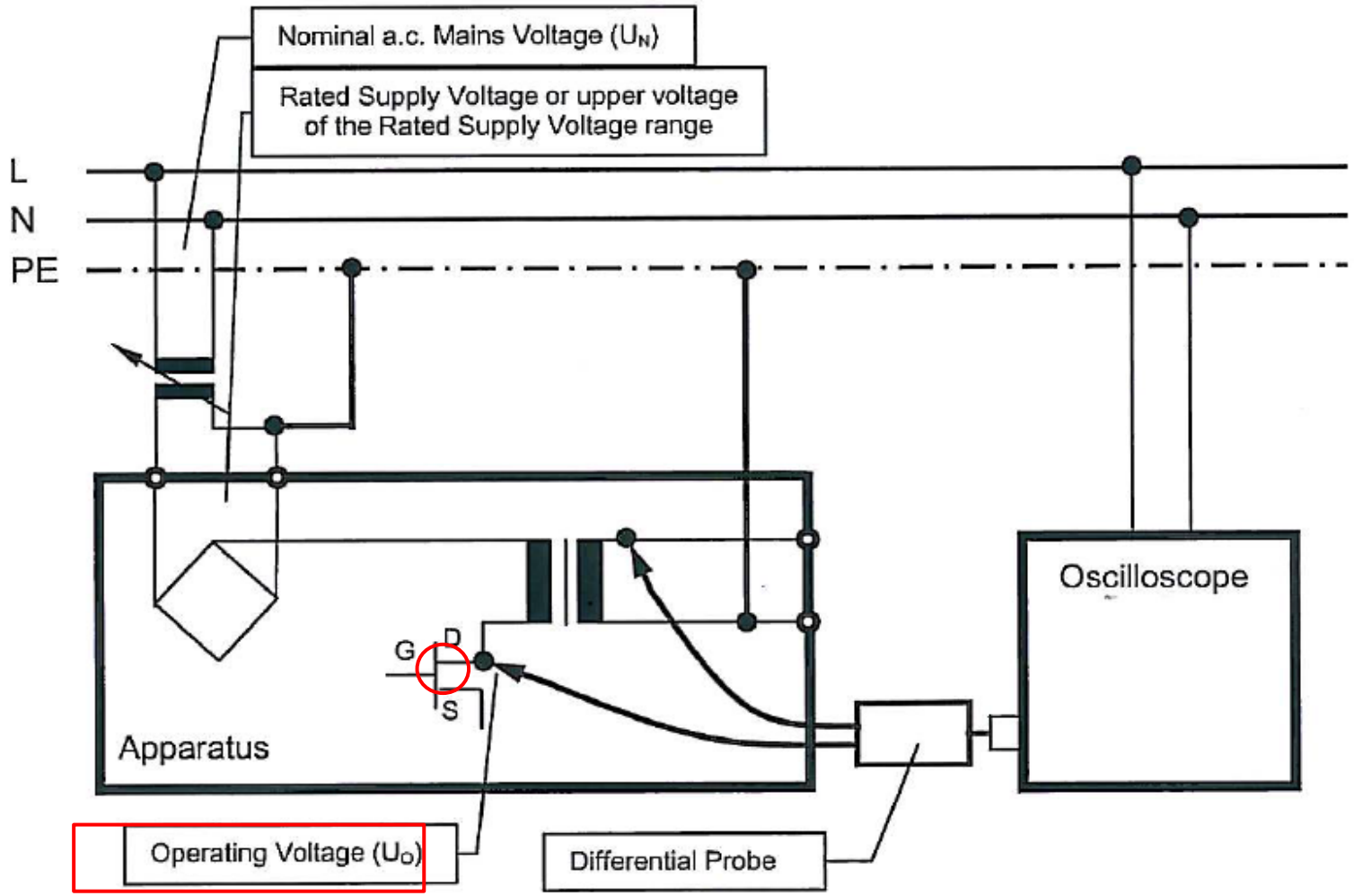
Insert animation for Cr & Cl





WORKING VOLTAGE

The highest voltage across any insulation @ the rated input voltage & under normal operating conditions. Need RMS & Peak of the working voltage.



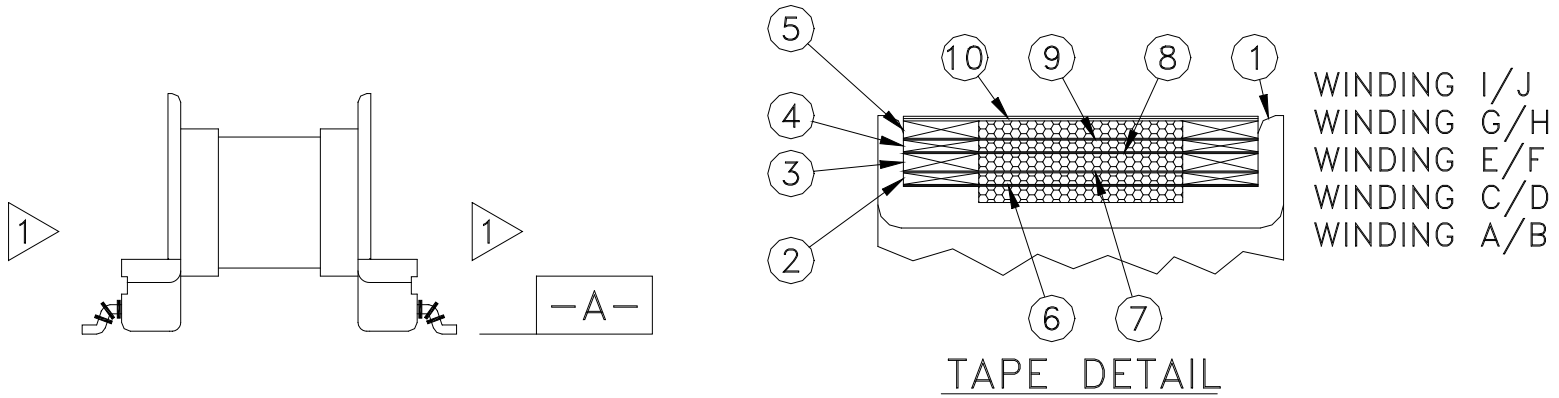
VDE: Instruction – Operating voltage (2010:1)

Outline

- Introduction to transformer safety
- **How to acheive safety according to IEC-61558-1 standard**
- **Practical construction examples designed to meet IEC-61558-1**
- **Questions and discussions**

HOW CAN WE ACHIEVE SAFETY DISTANCE?

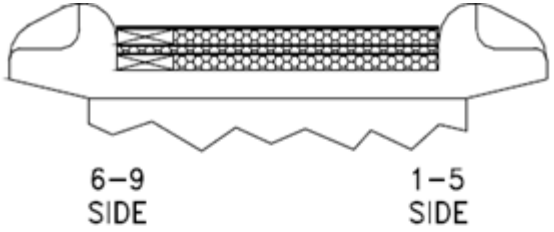
- Shelf (margin) tape

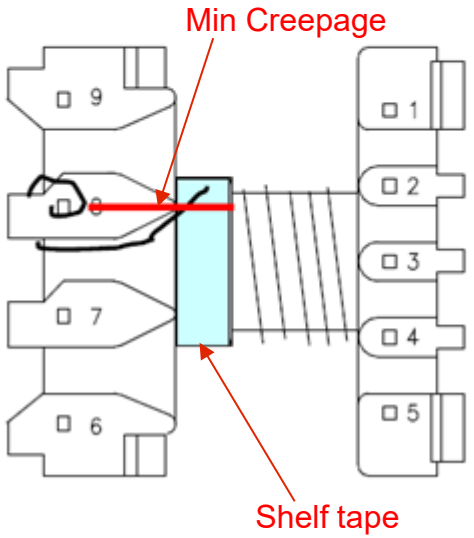


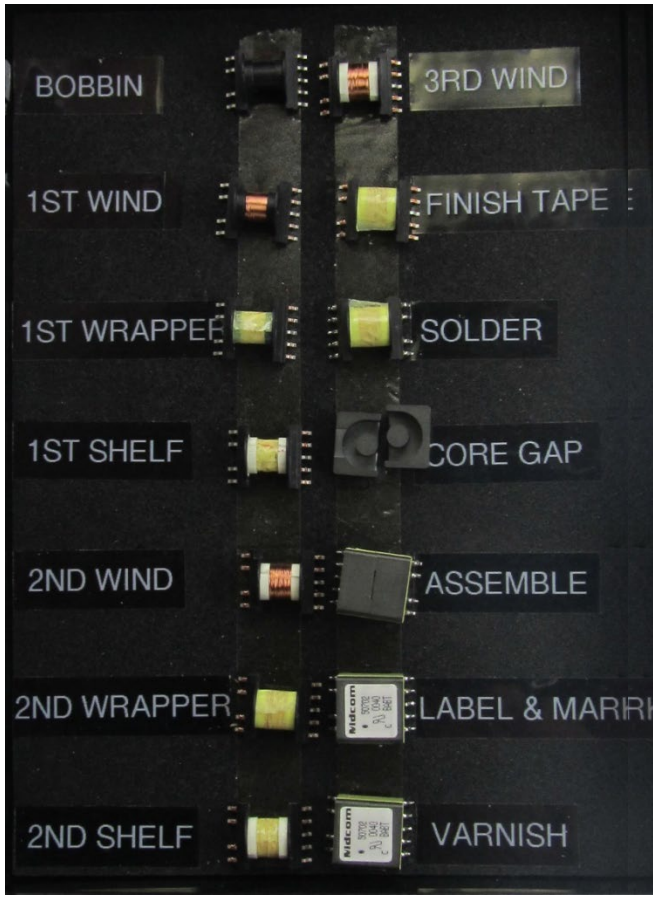
HOW CAN WE ACHIEVE SAFETY DISTANCE?

- **Use extended rail bobbin and / or Shelf (margin) tape to increase distance from SEC pins to PRI winding**

Triple Insulated Wire on SEC to insulate windings



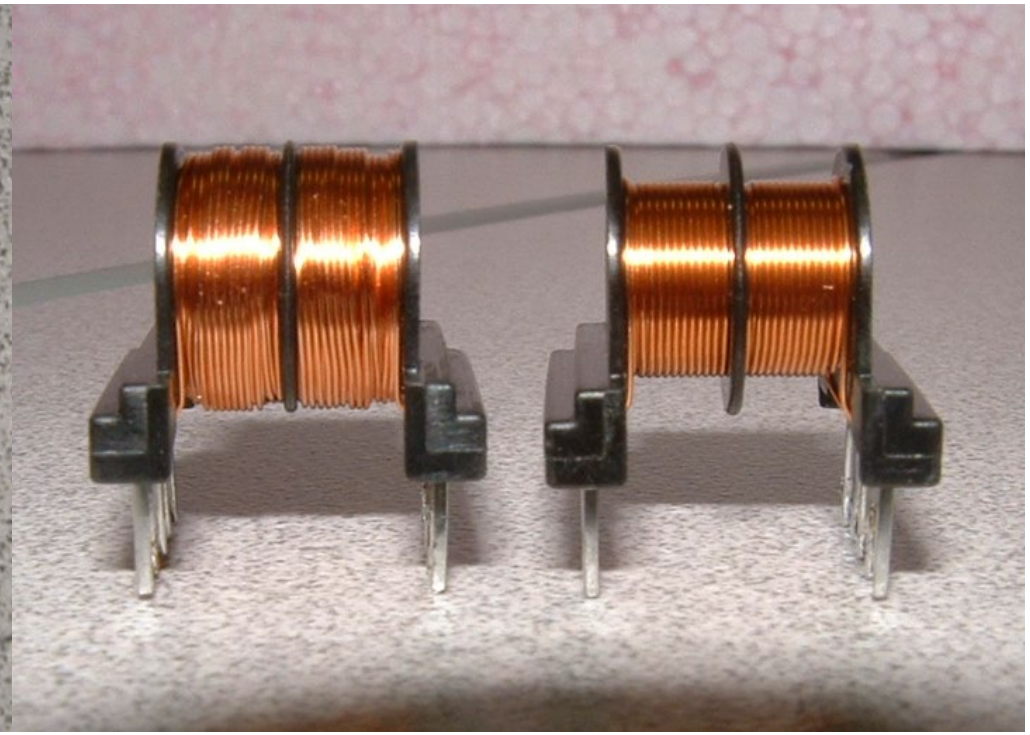




HOW CAN WE ACHIEVE SAFETY DISTANCE?

- 2– Section bobbin （EP13）

  One has full coil while the other has a low coil build.



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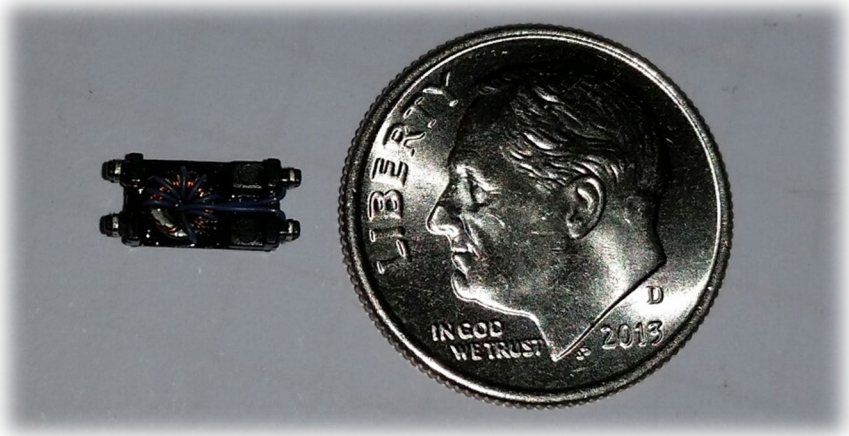

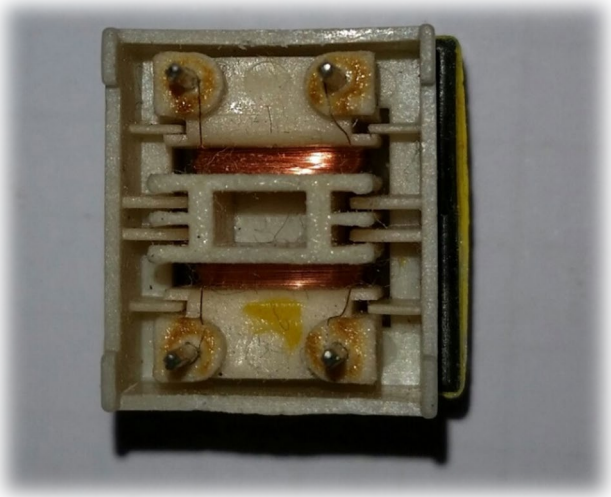

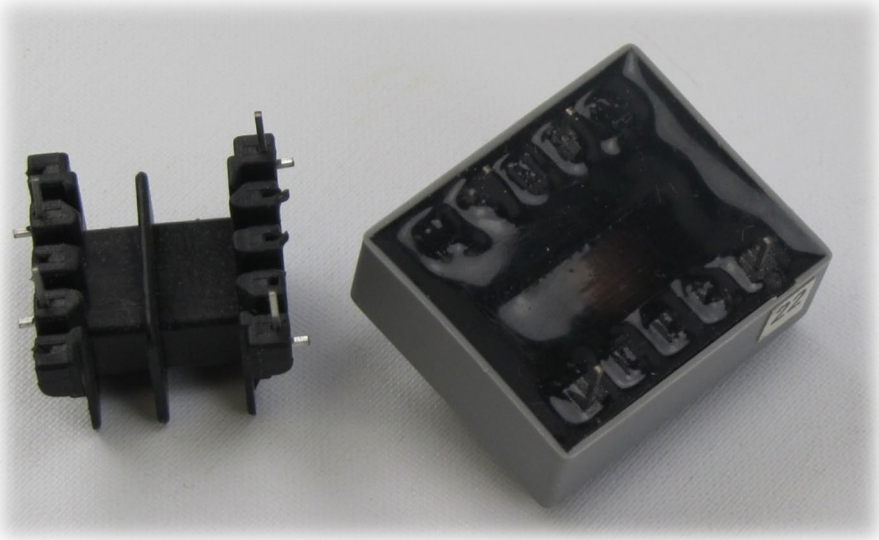

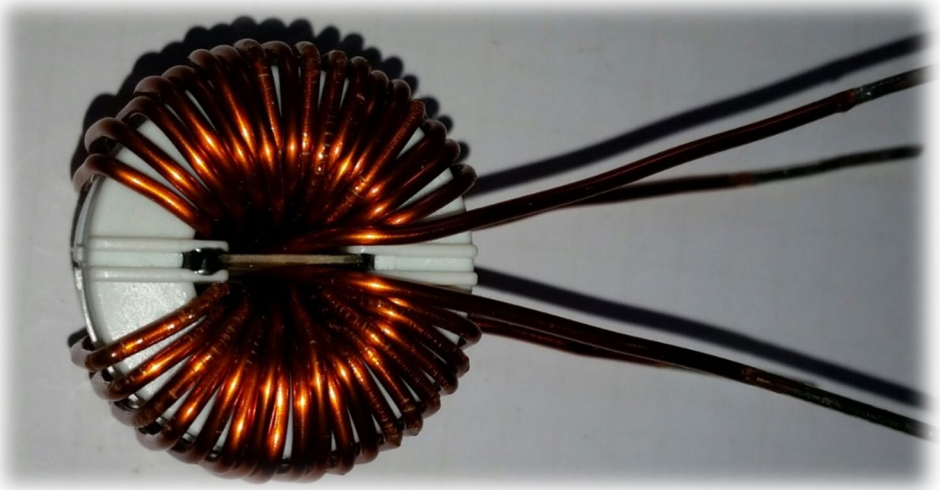

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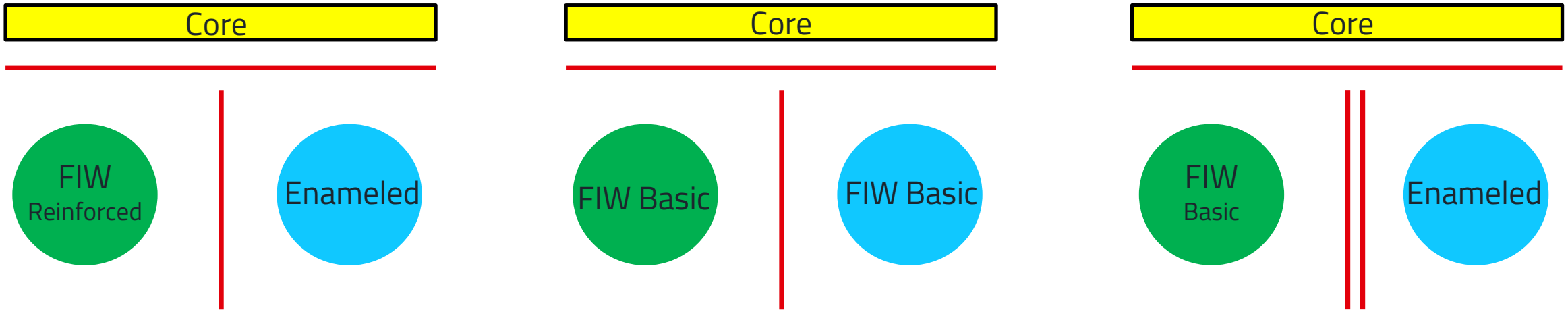
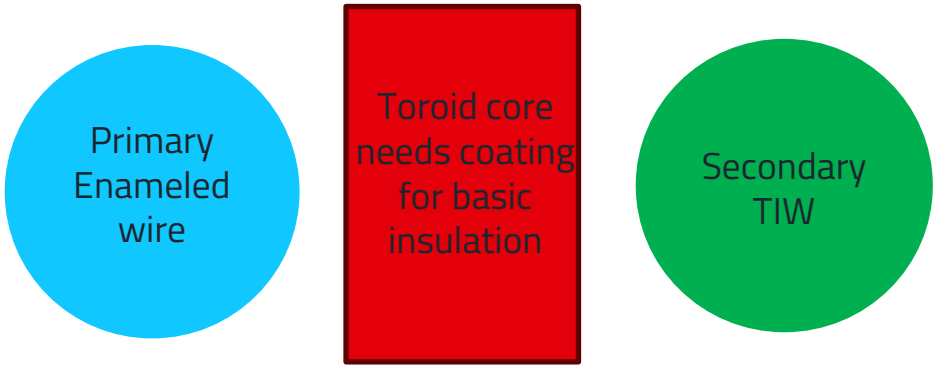
PRACTICAL CONSTRUCTION EXAMPLES OF SAFETY

Examples of reinforced Isolation using Fully insulated wires (FIW)



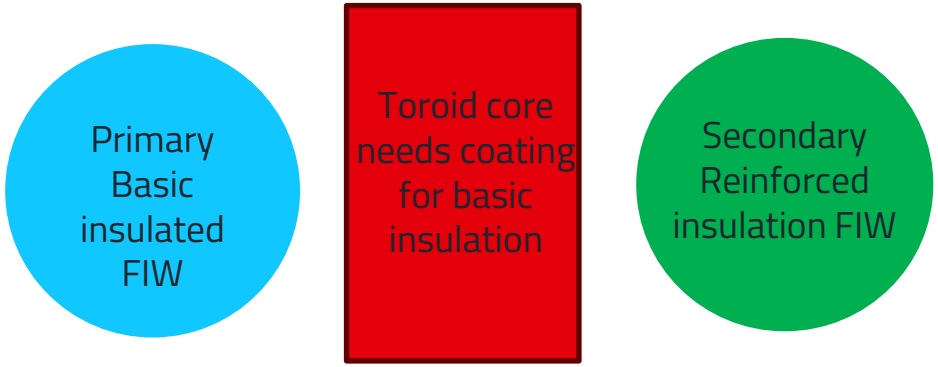
PRACTICAL CONSTRUCTION EXAMPLES OF SAFETY

Construction with toroidal core and TIW
For double / reinforced insulation



Mechanical separation for basic insulation

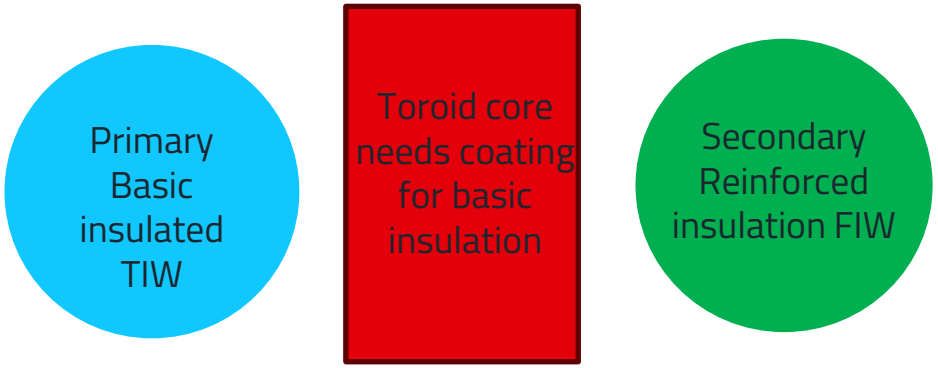
Construction with toroidal core and FIW
For double / reinforced insulation



Mechanical separation for basic insulation

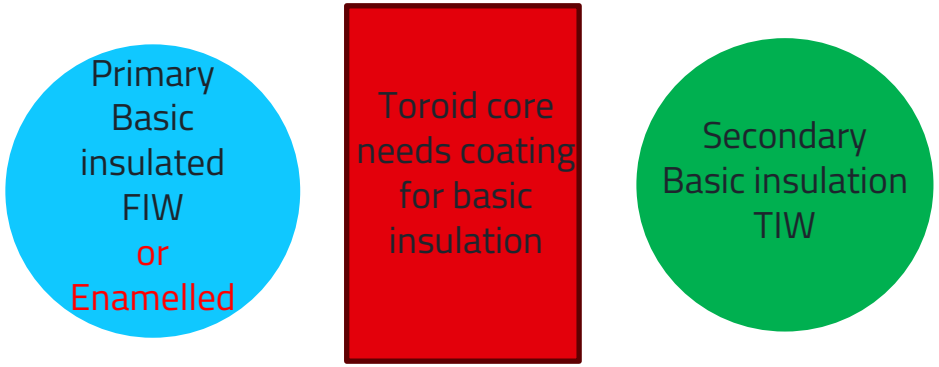
PRACTICAL CONSTRUCTION EXAMPLES OF SAFETY

Construction with toroidal core and TIW/FIW
For double / reinforced insulation



Mechanical separation for basic insulation

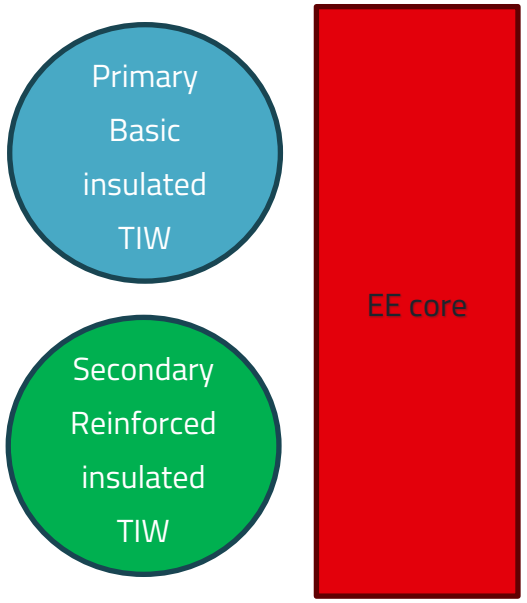
Construction with toroidal core and TIW/FIW
For basic insulation



Mechanical separation for basic insulation

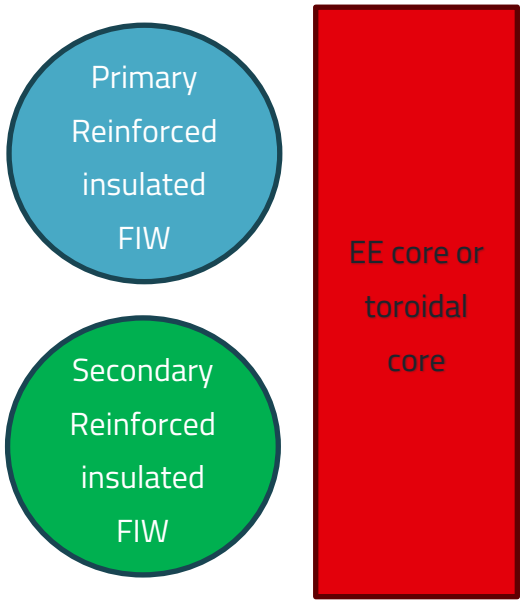
PRACTICAL CONSTRUCTION EXAMPLES OF SAFETY

Construction with EE core and TIW
For double or reinforced insulation



Mechanical separation for basic insulation between core and wire needed (EE bobbin)

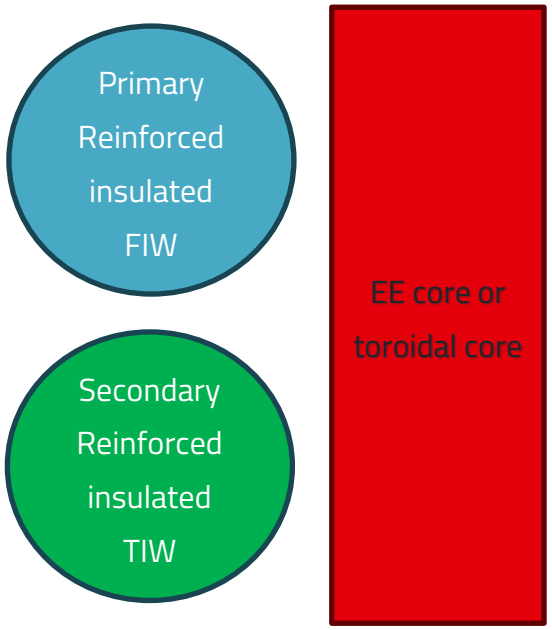
Construction with EE core and FIW
For double or reinforced insulation



Mechanical separation for basic insulation between core and wire needed (EE bobbin)

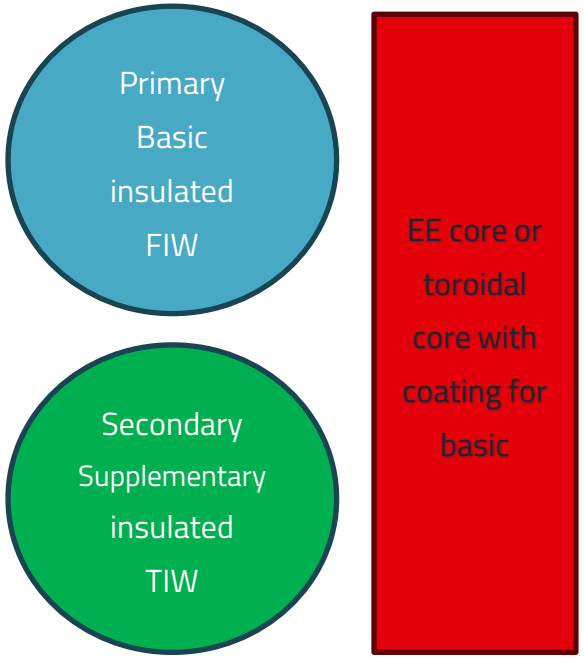
PRACTICAL CONSTRUCTION EXAMPLES OF SAFETY

Construction with EE core and FIW
For double or reinforced insulation



Mechanical separation for basic insulation between core and wire needed (EE bobbin)

Construction with EE core and TIW/FIW
For double or reinforced insulation



Mechanical separation for basic insulation between core and wire needed (EE bobbin)

Questions

& Answers

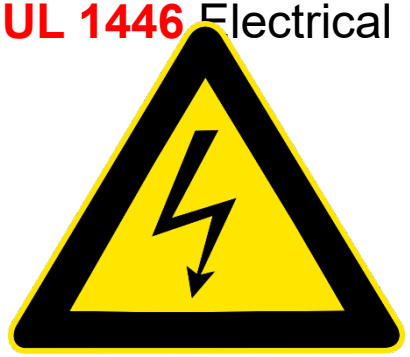
We are here for you now!

COMMON SAFETY STANDARDS

- **IEC 62368-1 -> Audio Video and information technology equipment**

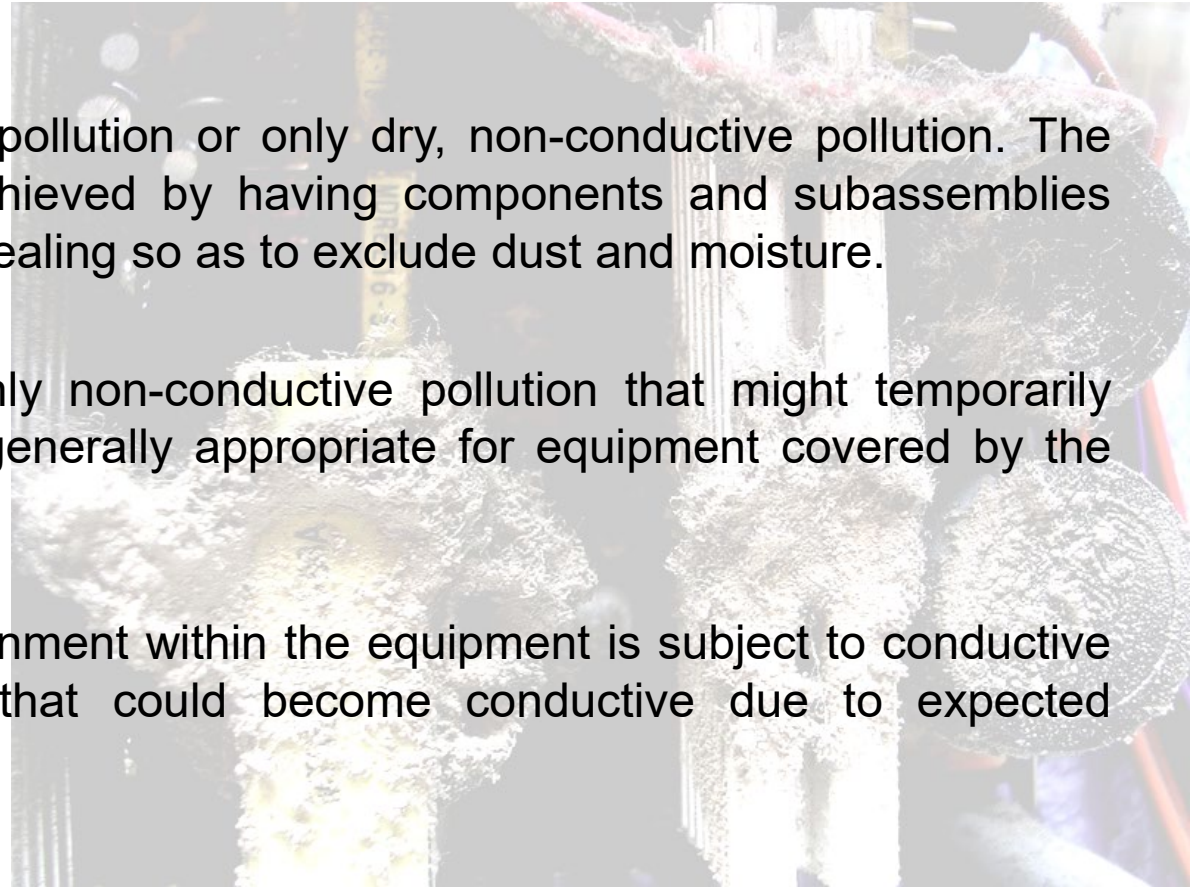
  (Safety standard replacing IEC 60950 & IEC 60065)

- **IEC 60950-1** Safety of information Technology Equipment *(Obsolete end 2020)*
- **IEC 61558-1 Safety of Power transformers and Power Supplies**.
- **IEC 60601-1** Safety of Medical Electrical Equipment
- **IEC 61010-1** Safety of Measurement Control and Laboratory Equipment
- **UL 1446** Electrical Insulation Systems (T[illegible]ss only)



POLLUTION DEGREE

IEC 62368-1 defines pollution degree as below:



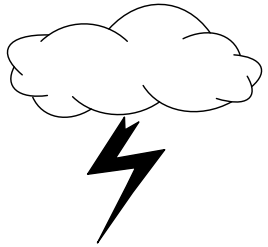
- **Pollution Degree 1** applies where there is no pollution or only dry, non-conductive pollution. The pollution has no influence. Normally, this is achieved by having components and subassemblies adequately enclosed by enveloping or hermetic sealing so as to exclude dust and moisture.

- **Pollution Degree 2** applies where there is only non-conductive pollution that might temporarily become conductive due to condensation. It is generally appropriate for equipment covered by the scope of this standard.

- **Pollution Degree 3** applies where a local environment within the equipment is subject to conductive pollution, or to dry non-conductive pollution that could become conductive due to expected condensation.

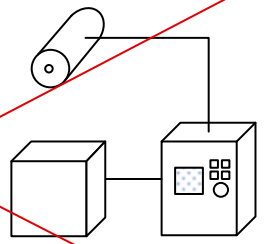
OVERVOLTAGE CATEGORY

- **Natural phenomena (eg: lightning strikes)**



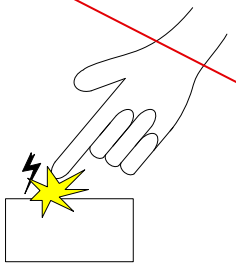
- **EN 61000-4-5**
  High Energy Surges

- **Industrial discharge (eg: switching off inductive loads)**



- **EN 61000-4-4**
  E.F.T.
  Electrical Fast Transients

- **Electro-static discharge (eg: between humans and objects)**



- **EN 61000-4-2**
  E.S.D.

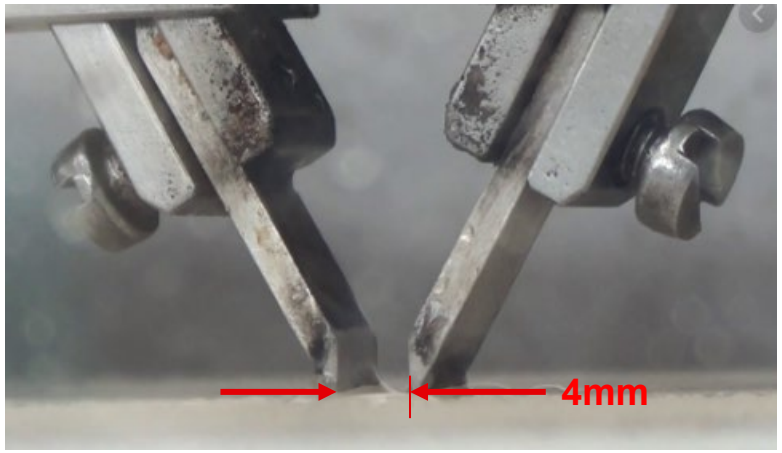
EU's transient immunity standards for commercial products

The product must continue to operate as intented, without degradation of loss of function after the transient immunity test

MATERIAL GROUP – TRACKING INDEX

- The voltage which causes tracking after 50 drops of 0.1% ammonium chloride solution have fallen on the material. The results of testing at 3 mm thickness are considered representative of the material's performance in any thickness.

- Tracking is an electrical breakdown on the surface of an insulating material. A large voltage difference gradually creates a conductive leakage path across the surface of the material by forming a carbonized track.



Best material →

IEC rating(Material Group)	UL rating (PLC)	Comparative Tracking Index (volts)
I	0	≥ 600V
II	1	400V ≤ CTI < 600V
IIIa	2	250V ≤ CTI < 400V
	3	175V ≤ CTI < 250V
IIIb	4	100V ≤ CTI < 175V
None	5	0V ≤ CTI < 100V

OVERVOLTAGE CATEGORY

- **Overvoltage categories by IEC 62368-1** **CHECK if 62368 is Ükat III + IV**

Overvoltage category	Equipment and its point of connection to the AC mains	Examples of equipmen
IV	Equipment that will be connected to the point where the **mains** supply enters the building	• Electricity meters • Communications ITE for remote electricity metering
III	Equipment that will be an integral part of the building wiring	• Socket outlets, fuse panels and switch panels • Power monitoring equipment
II	Pluggable or **permanently connected equipment** that will be supplied from the building wiring	• Household appliances, portable tools, home electronics • Most ITE used in the building
I	Equipment that will be connected to a special **mains** in which measures have been taken to reduce transients	• ITE supplied via an external filter or a motor driven generator

OVERVOLTAGE CATEGORY

62368!

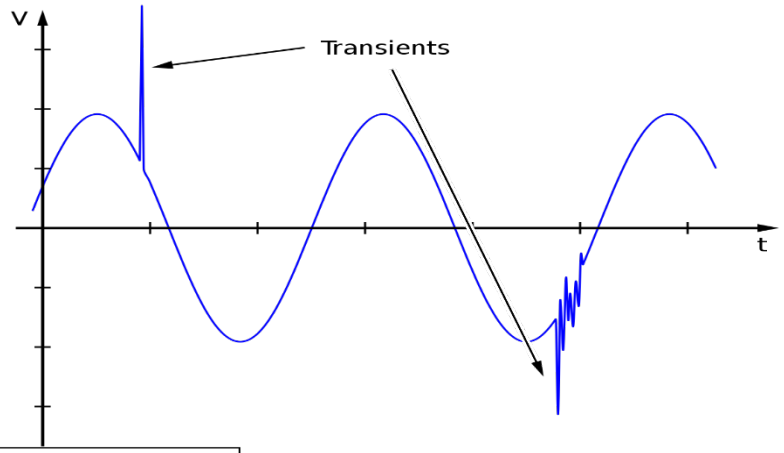


Table 12 – Mains transient voltages

AC mains voltage [a] up to and including V RMS	Mains transient voltage [b] V peak			
	Overvoltage Category			
	I	II	III	IV
50	330	500	800	1 500
100 [c]	500	800	1 500	2 500
150 [d]	800	1 500	2 500	4 000
300 [e]	1 500	2 500	4 000	6 000
600 [f]	2 500	4 000	6 000	8 000

230Vac

[a] For equipment designed to be connected to a three-phase 3-wire supply, where there is no neutral conductor, the AC **mains** supply voltage is the line-to-line voltage. In all other cases, where there is a neutral conductor, it is the line-to-neutral voltage.

[b] The **mains transient voltage** is always one of the values in the table. Interpolation is not permitted.

[c] In Japan, the value of the **mains transient voltages** for the nominal AC **mains** supply voltage of 100 V is determined from columns applicable to the nominal AC **mains** supply voltage of 150 V.

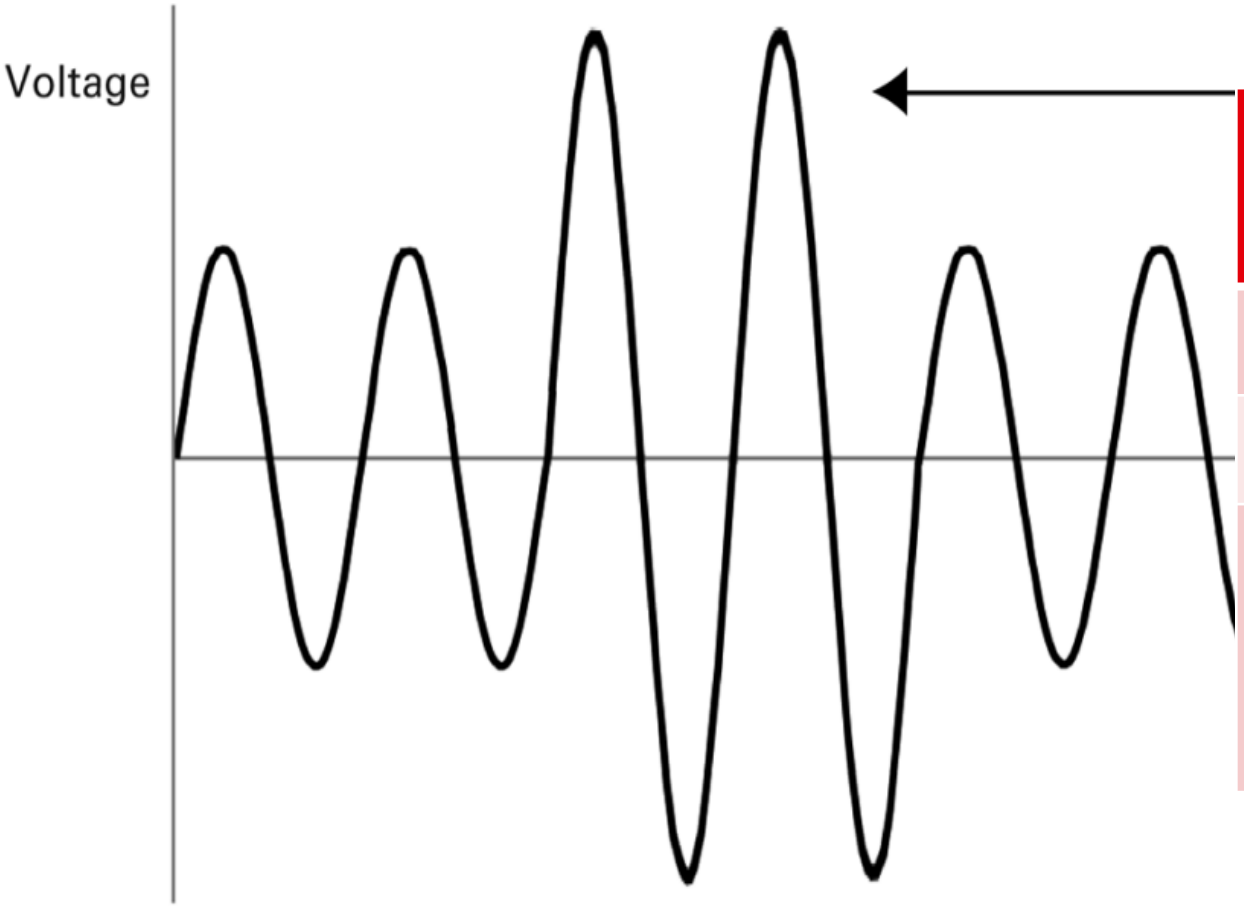
[d] Including 120/208 V and 120/240 V.

[e] Including 230/400 V and 277/480 V.

[f] Including 400/690 V.

OVERVOLTAGE CATEGORY

Temporary Overvoltage



AC Mains	Temporary Overvoltage
≤ 250Vac	2000V
>250Vac ≤ 600Vac	2500V
Alternatively calculation according IEC 60664-1:2007 permitted. Clause 5.3.3.2.3	

CL&CR

Dimensioning of clearances

IEC 61558-1:2017 © IEC 2017 – 115 –

Table 20 – Clearances in mm

Overvoltage category	Insulation of the conductive part	Pollution degree	Working voltage [V] ≥ 25 ≤ 50	100	150	300	600	1 000
OVC I	Basic insulation	P1	-	-	-	-	-	-
		P2	0,2	0,2	0,2	0,5	1,5	3,0
		P3	0,8	0,8	0,8	0,8	1,5	3,0
	Supplementary insulation	P1	-	-	-	-	-	-
		P2	0,2	0,2	0,2	0,5	1,5	3,0
		P3	0,8	0,8	0,8	0,8	1,5	3,0
	Double or reinforced insulation	P1	-	-	-	-	-	-
		P2	0,2	0,2	0,5	1,5	3,0	5,5
		P3	0,8	0,8	0,8	1,5	3,0	5,5
OVC II	Basic insulation	P1	-	-	-	-	-	-
		P2	0,2	0,2	0,5	1,5	3,0	5,5
		P3	0,8	0,8	0,8	1,5	3,0	5,5
	Supplementary insulation	P1	-	-	-	-	-	-
		P2	0,2	0,2	0,5	1,5	3,0	5,5
		P3	0,8	0,8	0,8	1,5	3,0	5,5
	Double or reinforced insulation	P1	-	-	-	-	-	-
		P2	0,2	0,5	1,5	3,0	5,5	8,0
		P3	0,8	0,8	1,5	3,0	5,5	8,0
OVC III	Basic insulation	P1	-	-	-	-	-	-
		P2	0,2	0,5	1,5	3,0	5,5	8,0
		P3	0,8	0,8	1,5	3,0	5,5	8,0
	Supplementary insulation	P1	-	-	-	-	-	-
		P2	0,2	0,5	1,5	3,0	5,5	8,0
		P3	0,8	0,8	1,5	3,0	5,5	8,0
	Double or reinforced insulation	P1	-	-	-	-	-	-
		P2	0,5	1,5	3,0	5,5	8,0	14,0
		P3	0,8	1,5	3,0	5,5	8,0	14,0

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Dimensioning of clearances - altitude

The **clearances** given are valid up to 2 000 m.

For altitudes above 2 000 m, Table A.2 (IEC 60664-1) should be used to determine the altitude correction factors for **clearance** correction.

Linear interpolation is acceptable between two adjacent values of Table A.2.

Table A.2 – Altitude correction factors for clearance correction

Altitude m	Normal barometric pressure kPa	Multiplication factor k_d for clearances
2 000	80,0	1,00
3 000	70,0	1,14
4 000	62,0	1,29
5 000	54,0	1,48
6 000	47,0	1,70
7 000	41,0	1,95
8 000	35,5	2,25
9 000	30,5	2,62
10 000	26,5	3,02
15 000	12,0	6,67
20 000	5,5	14,5

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Dimensioning of clearances

- For **functional insulation** no **clearances** are required
- Values of **clearances** may not be interpolated between the values in the table (different in past)
- Also locations are not defined anymore (next slides)

Heute über Bemessungsnetzspannung ermitteln

Dimensioning of creepages (IEC 61558-1:2017)

– 116 – IEC 61558-1:2017 © IEC 2017

Table 21 – Creepage distances in mm

Material group (CTI-value)	Insulation of the conductive part	Pollution degree	Working voltage [V] ≥ 25 ≤ 50	100	150	300	600	1 000
I (CTI ≥ 600)	Basic insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	0,6	0,7	0,8	1,5	3,0	5,5
		P3	1,5	1,8	2,0	3,9	7,7	12,5
	Supplementary insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	0,6	0,7	0,8	1,5	3,0	5,5
		P3	1,5	1,8	2,0	3,9	7,7	12,5
	Double or reinforced insulation	P1	0,25	0,4	0,7	1,7	4,0	7,5
		P2	0,7	1,0	1,6	3,0	6,0	10,0
		P3	1,8	2,5	4,2	7,7	15,0	25,0
II (400 ≤ CTI < 600)	Basic insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	0,9	1,0	1,1	2,1	4,3	7,1
		P3	1,7	2,0	2,2	4,2	8,6	14,0
	Supplementary insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	0,9	1,0	1,1	2,1	4,3	7,1
		P3	1,7	2,0	2,2	4,2	8,6	14,0
	Double or reinforced insulation	P1	0,25	0,4	0,7	1,7	4,0	7,5
		P2	1,0	1,4	2,0	4,3	8,6	14,0
		P3	2,0	2,8	4,2	8,6	17,2	28,0
IIIa (175 ≤ CTI < 400)	Basic insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	1,2	1,4	1,6	3,0	6,0	10,0
		P3	1,9	2,2	2,5	4,7	9,5	16,0
	Supplementary insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	1,2	1,4	1,6	3,0	6,0	10,0
		P3	1,9	2,2	2,5	4,7	9,5	16,0
	Double or reinforced insulation	P1	0,25	0,4	0,7	1,7	4,0	7,5
		P2	1,4	2,0	3,0	6,0	12,0	20,0
		P3	2,2	3,0	4,7	9,5	19,2	32,0
IIIb (100 ≤ CTI < 175)	Basic insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	1,2	1,4	1,6	3,0	6,0	10,0
		P3	1,9	2,2	2,5	4,7	9,5	16,0
	Supplementary insulation	P1	0,18	0,25	0,3	0,7	1,7	3,2
		P2	1,2	1,4	1,6	3,0	6,0	10,0
		P3	1,9	2,2	2,5	4,7	9,5	16,0

For **functional insulation** no **creepage distance** values are required.

Values of **creepage distances** may be found for intermediate values of **working voltages** by linear interpolation between the values in the table.

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Dimensioning of creepages (IEC 61558-2-16:2009 + A1:2013)

Table 105 – Basic or supplementary insulation – Minimum values of creepage distances for different frequency ranges (pollution degree 1)

Working-voltage U_{peak}/U_{RMS} [a]	Creepage distance (mm) 30 kHz<f<100 kHz	f<150 kHz	f<200 kHz	f<300 kHz	f<400 kHz	f<500 kHz	f<600 kHz	f<700 kHz	f<800 kHz	f<900 kHz	f<1 MHz	f<2 MHz	f<3 MHz
0,1	0,02	-	-	-	-	-	-	-	-	-	-	-	0,30
0,2	0,04	-	-	-	-	-	-	-	-	-	-	0,15	2,80
0,3	0,08	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,09	0,80	20,00
0,4	0,13	0,13	0,13	0,14	0,15	0,16	0,18	0,19	0,24	0,30	0,35	4,50	-
0,5	0,18	0,19	0,19	0,22	0,25	0,30	0,35	0,40	0,77	1,13	1,50	20,00	-
0,6	0,27	0,27	0,27	0,34	0,40	0,55	0,70	0,85	2,23	3,62	5,00	-	-
0,7	0,36	0,37	0,38	0,53	0,68	1,09	1,49	1,92	7,93	13,97	20,00	-	-
0,8	0,45	0,50	0,55	0,83	1,10	2,00	2,90	3,80	-	-	-	-	-
0,9	0,53	0,67	0,82	1,36	1,90	4,17	6,43	8,70	-	-	-	-	-
1	0,60	0,88	1,15	2,08	3,00	8,00	13,00	18,00	-	-	-	-	-
1,1	0,68	1,19	1,70	3,36	5,00	-	-	-	-	-	-	-	-
1,2	0,85	1,53	2,40	5,30	8,20	-	-	-	-	-	-	-	-
1,3	1,20	2,33	3,90	-	-	-	-	-	-	-	-	-	-
1,4	1,65	3,33	5,00	-	-	-	-	-	-	-	-	-	-
1,5	2,30	4,80	7,30	-	-	-	-	-	-	-	-	-	-
1,6	3,15	-	-	-	-	-	-	-	-	-	-	-	-
1,7	4,40	-	-	-	-	-	-	-	-	-	-	-	-
1,8	6,10	-	-	-	-	-	-	-	-	-	-	-	-

[a] The voltage in this column is the highest peak voltage of the high frequency voltage. This voltage may occur across the insulation between the input and output circuit at rated supply voltage and under normal operations. The output circuit is earthed for the measurement of this voltage. Transients are included.

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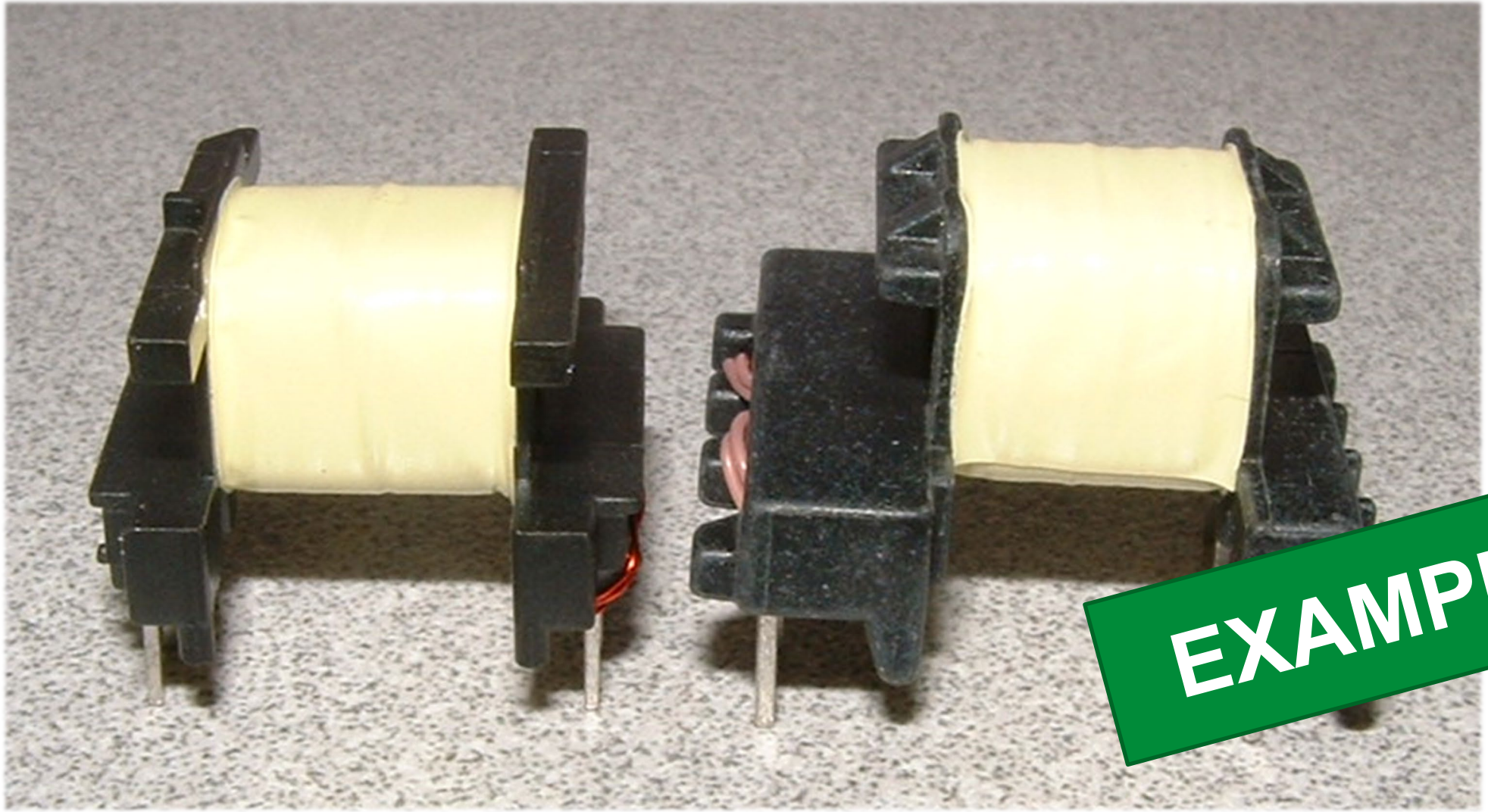
EE16/8/5 COIL COMPARISON



CREEPAGE AND CLEARANCE

- **Clearance distances (distance through air) determined by:**
  - Temporary overvoltage & recurring voltage
  - Transient voltage (from mains supply & external circuit)
  - Peak working voltage (maximum system voltage between PRI & SEC)
  - Pollution Degree
  - Frequency of the Mains & Working Voltage
  - Max operating Altitude (if higher than 2000m)
  - Insulation grade (Basic, Supplementary, Reinforced)

- **Creepage distances (distance along the surface) determined by:**
  - RMS working voltage; peak for freq>30kHz
  - Pollution Degree
  - Frequency of the working Voltage
  - Material Group (Comparative Tracking Index “CTI”)
  - Insulation grade (Basic, Supplementary, Reinforced)

COMMON INPUTS REQUIRED

- Material Group by Comparative Tracking Index (CTI)
- Insulation Grade
- Pollution Degree
- Overvoltage Category
- Input Voltage Range
- Peak & RMS Working Voltage

& WV Frequencies

- Altitude

SO... IS IT ALL ABOUT DIELECTRIC, CREEPAGE AND CLEARANCE?

- Standards also include specific construction requirements.
  - Some allow different materials: for example VDE allows FIW (magnetwire) to achieve insulation on IEC 61558-2-16 or IEC 62368-1
  - Some have special mechanical restrictions: for example IEC 62368-1 requires protection against mechanical stress for wires that cross at 45°-90°.

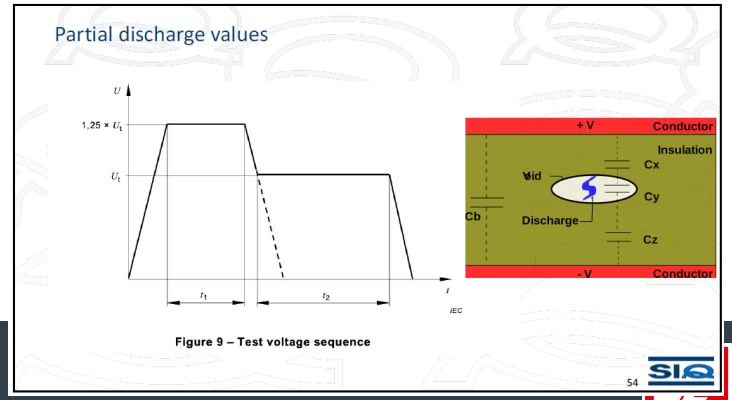
Bilder? Nachhaltigkeit Umwelt Tempertaur etc???

IEC 61558-2-16

- One layers of tape between magnet wire windings and TIW wire windings
- TIW wire cannot touch magnet wire if it is providing reinforced insulation
- When using FIW wire, wire must not touch any other magnet wire
- Partial discharge testing require for designs using FIW+TIW with peak working voltage over 750VDC (amendment 1)

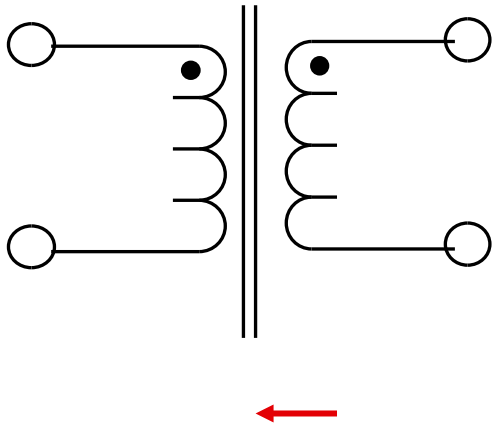
IEC 62368-1

- Production hipot test shall be 1-4s, and the test voltage may be reduced by 10% (5.4.9.2)
- All windings shall have the end turns (drag backs) retained by positive means (G.5.3.2.1)
- Protect against mechanical stress at 45° to 90° wire crossings (G.5.1.2)



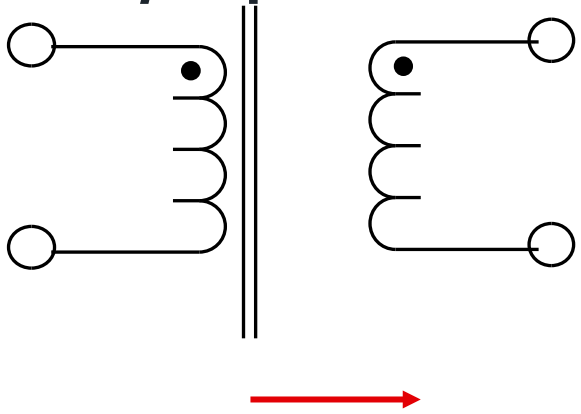
HOW CAN WE ACHIEVE SAFETY DISTANCE?

Functional isolation



- Increased efficiency
- Standard component size
- Standard cost

Safety implemented



- Reduced efficiency
- Increased component size
- Cost increase

INTRODUCTION TO TRANSFORMER SAFETY

INSULATION GRADES

- **Several grades of insulation are defined for each standard**

  - **Functional Insulation** - Is only necessary for the correct fu provide any protection against electric shock.
  - **Basic Insulation** - Insulation applied to live parts to provide basic protection against electric shock.
  - **Supplementary Insulation** - Independent insulation applied in addition to basic insulation in order to provide protection against electric shock in the event of a failure of basic insulation.
  - **Double Insulation** - Comprising both basic insulation and supplementary insulation.
  - **Reinforced Insulation** - Single insulation system applied to live parts which provides a degree of protection against electric shock equivalent to double insulation.

Distances trough insulation (IEC 61558-1:2017)

IEC 61558-1:2017 © IEC 2017 – 117 –

Table 22 – Distance through insulation in mm

Insulation of the conductive part		Working voltage [V]					
		≥ 25 ≤ 50	100	150	300	600	1 000
Basic insulation	solid	-	-	-	-	-	-
	thin layers	-	-	-	-	-	-
Supplementary insulation	solid	0,1	0,15	0,25	0,5	0,75	1,0
	thin layers	0,05	0,05	0,08	0,15	0,2	0,25
Double or reinforced insulation	solid	0,2	0,3	0,5	1,0	1,5	2,0
	thin layers	0,1	0,1	0,15	0,3	0,4	0,5

For **functional insulation** no distance through insulation (DTI) is required.

Values of distance through insulation (DTI) may be found for intermediate values of **working voltages** by linear interpolation between the values in the table.

No values for distances through insulation are required for **working voltages** below 25 V AC or 60 V DC as the dielectric strength test of Table 14 is considered sufficient.

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Solid insulation – REDUCTION OPTIONS

26.3.2 In case of solid insulation, the required values are specified in the Table 22. For classified materials in accordance to IEC 60085 and IEC 60216 (all parts), distances through insulation multiplied by 0,4 with a minimum of 0,2 mm for **reinforced insulation** and of 0,1 mm for **supplementary insulation** for **working voltage** above 25 V may

Thin sheet material – REDUCTION OPTIONS

1.) For classified materials in accordance to IEC60085 and IEC60216 (all parts), no requirements for distances through insulation are required if the test of 14.3 is fulfilled.

2.) The required values of Table 22 for thin layers shall be used as follows:

– for **transformers** having a **rated output** greater than 100 VA, the values for thin layers apply;