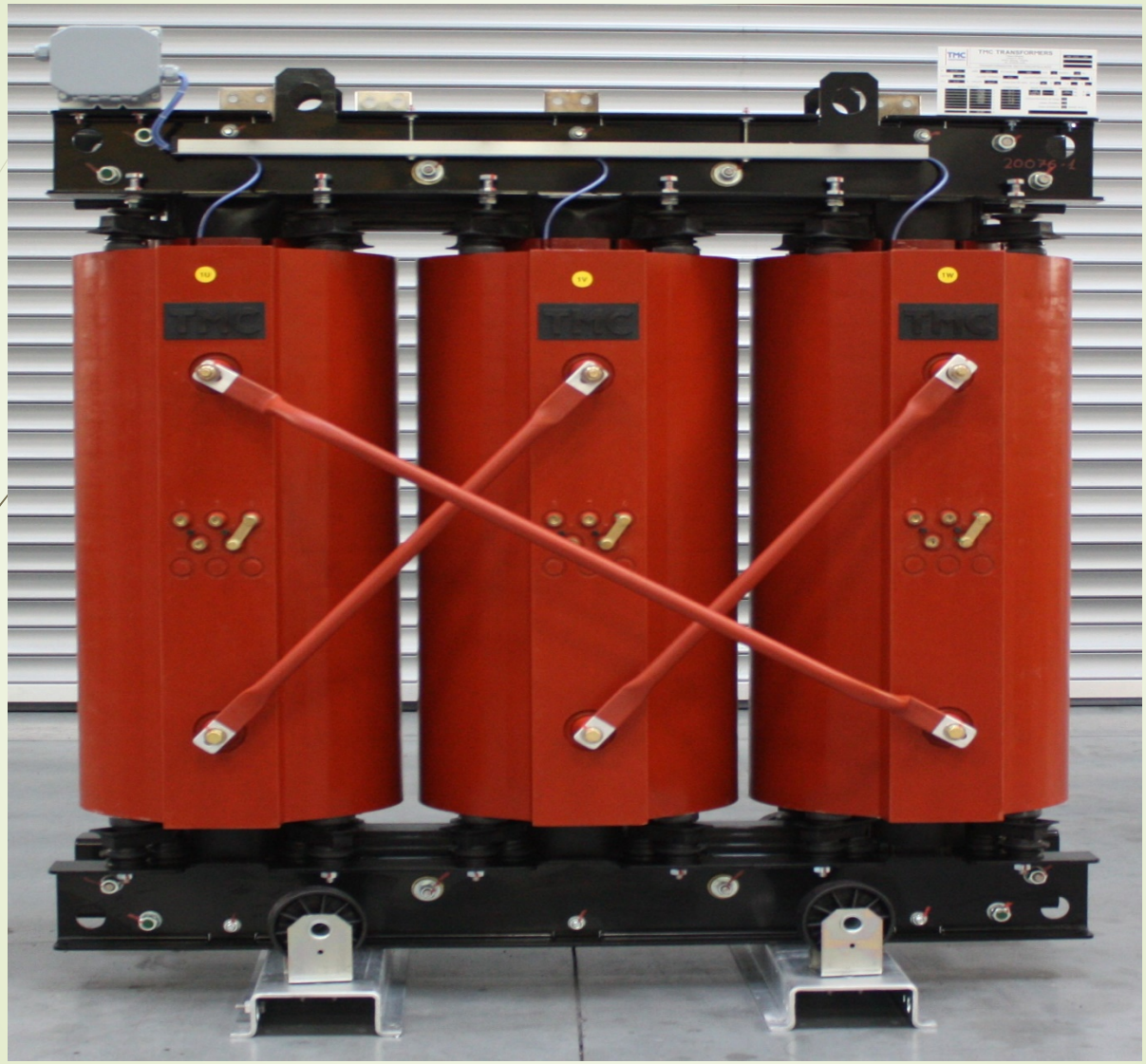
TMC

Product & Technology Presentation

TMC Transformers



TMC Transformers

Cast Resin Transformer (CRT) History

- Cast resin transformers first appeared in Germany during the 1960s**.** This new style of dry type transformer was developed with HV windings cast under vacuum in an epoxy resin compound filled with inert silica.

- The main advantages of this cast epoxy resin transformer included its **self-extinguishing characteristics** in case of fire, an **increased electrical insulation level** and the **absence of special installation procedures** when compared to the typical dry type transformer.

- The new transformer immediately became **an ideal alternative** to dry machines with “open” windings, and from the beginning it demonstrated a high reliability. By the early 1980s, cast resin transformers were being produced in large numbers and in a few years, they surpassed all other solutions in installations where fire risk was of paramount concern.

- Nowadays **the cast resin transformer is the most widely specified solution** for installations in fire risk areas, because there are no pollution or flammability risks from any liquid spillage.

- Other main advantages of using a cast resin transformer are its **high reliability, safety, and minimum maintenance requirements**.

- The best indication of their **reliability** is demonstrated by the millions of cast resin transformers installed worldwide in the most sensitive plants and installations such as nuclear plants, petroleum platforms, ships, petrochemical plants, civil and military structures, harbours, airports, underground mines - **wherever safety is paramount**.

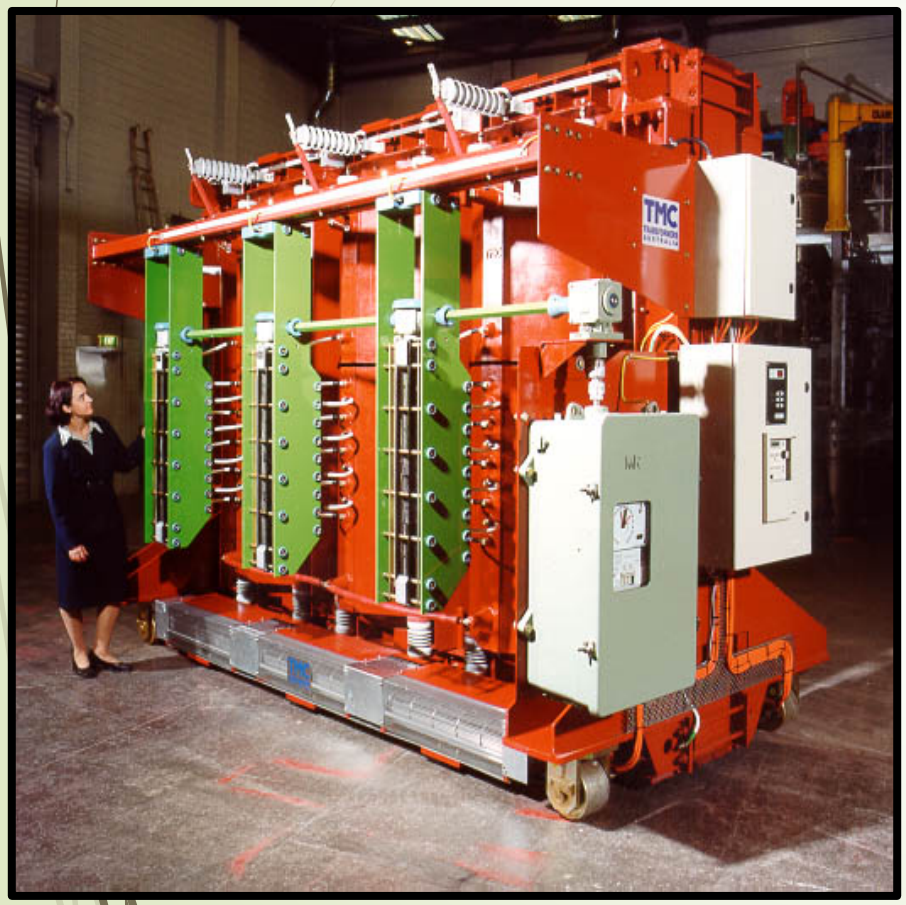
TMC Transformers

History of TMC

- TMC was established in Australia in 1936 as a specialist manufacturer of high voltage transformers. In 2014 its manufacturing facilities in Spain and Australia are endowed with over 75 years of uninterrupted experience in the manufacture of a wide range of electrical induction equipment.
- The group has excelled at providing high quality products to the electrical power industry worldwide, with an emphasis on meeting exacting specifications and standards, whilst minimising cost.
- TMC is fully accredited to the international quality standard ISO9001, and continues to build on a tradition of product excellence and customer focus and satisfaction.

TMC Transformers

Range and Standard Designs



- Rated Power from 100 to 30000 kVA
- Rated Voltage to class 72 kV
- HV windings vacuum cast in moulds
- LV windings vacuum/pressure cast
- Designs for Special Applications
- Designs for extreme ambient conditions
- High resistance to short circuit stress
- High resistance to seismic phenomena
- Linear lightning impulse distribution in windings
- Three or single phase construction
- Multi winding transformers

TMC Transformers

Application List

- Distribution transformers
- Traction transformers
- Marine and offshore transformers
- Sub-station transformers with on-load tap changer
- Renewable energy transformers (Wind Farms / Photovoltaic)
- Rectifier transformers (12, 18, 24, 36, 72, 144 pulse and up)
- Transformers for paint plant (silicone free on demand)
- Induction oven transformers
- Earthing transformers
- Autotransformers

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Cast Resin Transformer Application List

- Power and Distribution
- Rectifier
- Earthing
- Motor Starting

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Reactor Application List

- Shunt
- Current Limiting
- Damping (Inrush)
- Tuning (Filtering)
- Smoothing
- Neutral Earthing

TMC Transformers

Product Comparisons

CHARACTERISTICS	OIL TRANSFORMERS	DRY TYPE	CAST RESIN
Flammability	YES	NO	NO
Self-extinguishing in case of electrical damage or failure	NO	YES	YES
Necessity of anti-fire structures such as oil bunds and fire walls	YES	NO	NO
Hygroscopicity of insulating materials	NO	YES	NO
Environmental pollution	YES	NO	NO
Resistance stability to short circuit phenomena	NO	NO	YES
Energizing special procedures	NO	YES	NO
Maintenance required	YES	YES	NO
Environmental pollution risk due to liquid losses	YES	NO	NO
Ability to withstand humid, saline and tropical environments	YES	NO	YES
Installation close to the load-centre and consequent reduction of plant and management costs	NO	NO	YES
Reliability without maintenance and minimal requirement for specialised labour for installation.	NO	NO	YES
Finished Products to withstand high, immediate and short overloads owing to reduced current density and high thermal factor (excellent for Rail application)	NO	NO	YES

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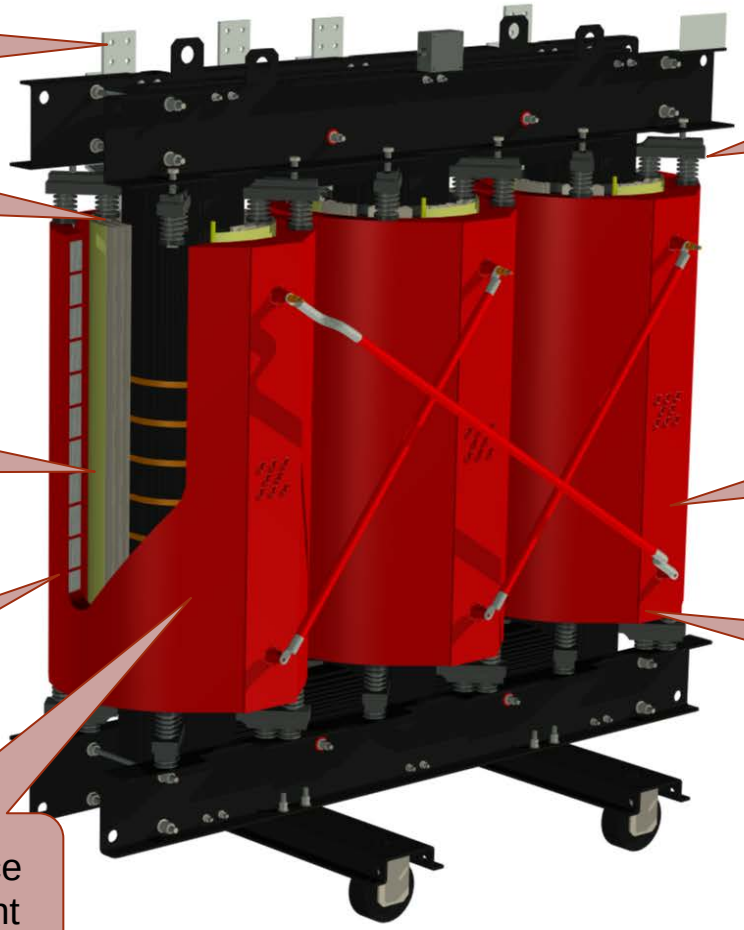
Main Characteristics of Cast Resin Transformers



- Tinned LV busbar terminals
- Efficient cooling of LV winding
- High short circuit withstand
- High Impulse withstand
- High resistance to cold ambient
- Special resilient coil supports
- Low PD level in windings
- High mechanical resistance

TMC Transformers

Components

- CORE
- HV WINDING
- LV WINDING
- CASTING
- ENCLOSURE

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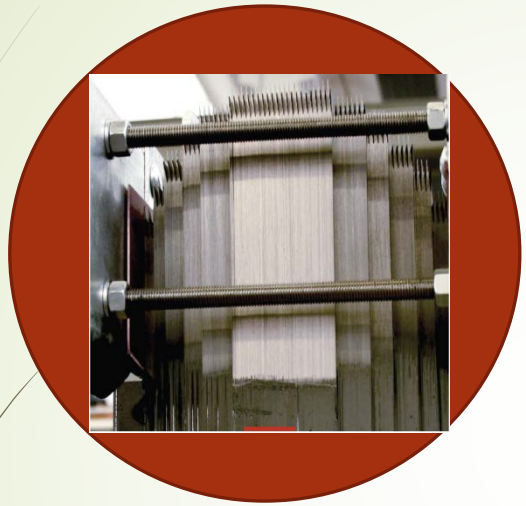
Core



- TMC magnetic cores are manufactured using high-permeability and low-loss grain-oriented silicon steel sheets. The insulated surface of these sheets minimizes power loss due to stray currents.
- The core components are assembled on special workbenches in order to prevent any deformation of the individual sheets, and assure perfect core alignment.
- The joints are mitre cut at 45° and laminations are stacked step–lap type to minimize stray-flux losses and to prevent joint vibration, which is one of the primary causes of noise. The overlap of each single lamination results in high mechanical strength and consequent reduction of noise level.
- Corrosion protection of the assembled core against the effects of external environmental agents is obtained by a final application of a full coating of bi-component epoxy resin.

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HV Winding Characteristics

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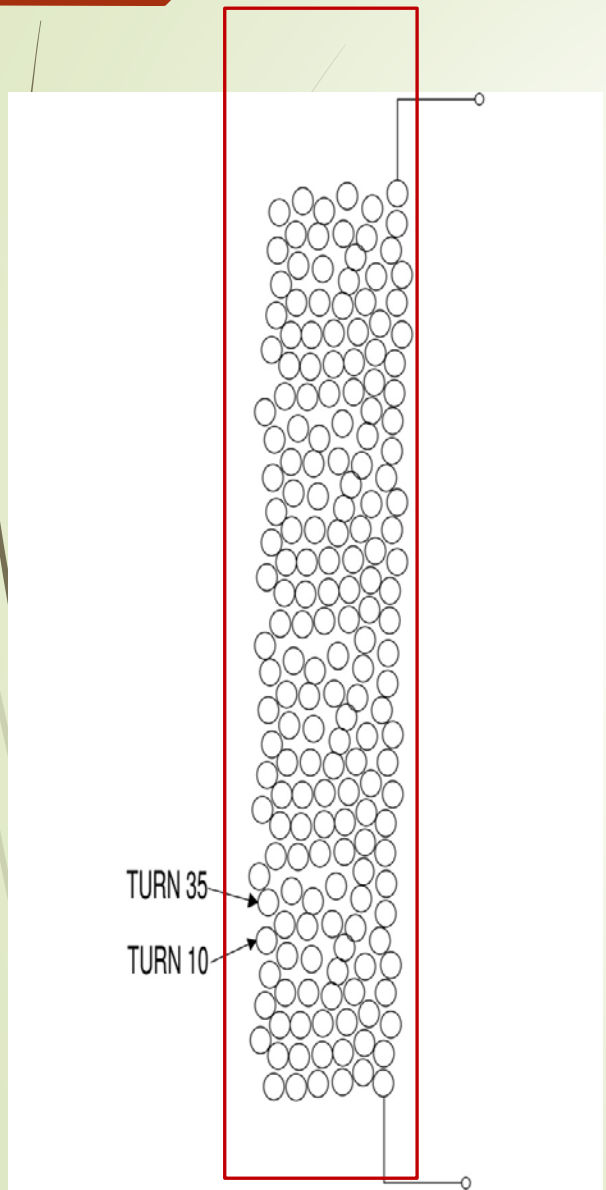
Random Type Winding (non TMC Product)



- Reduced space
- Fast production
- Poor impulse distribution
- Not ideal for filling with cast resin
- Possible high voltage stress between adjacent turns

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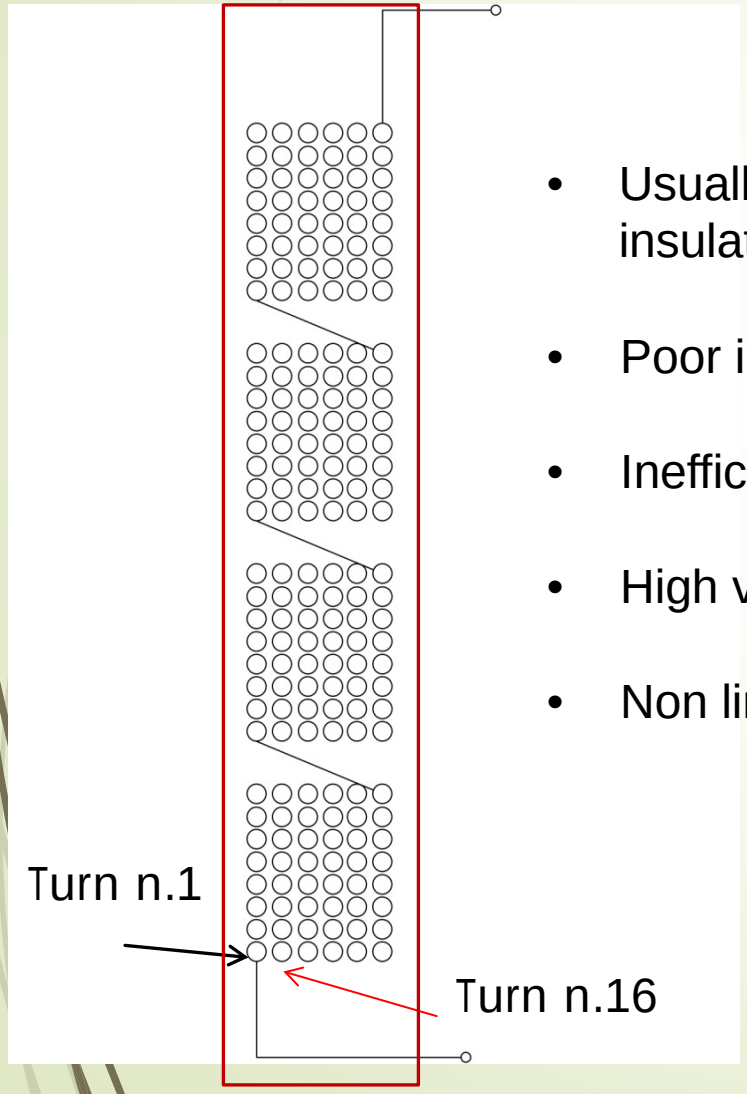
Wire disc type winding (non TMC product)



- Usually reduced number of discs (wire has is own insulation on surface)
- Poor impulse distribution
- Inefficient to fill with cast resin
- High voltage between layers in normal operation
- Non linear voltage between turns during impulse

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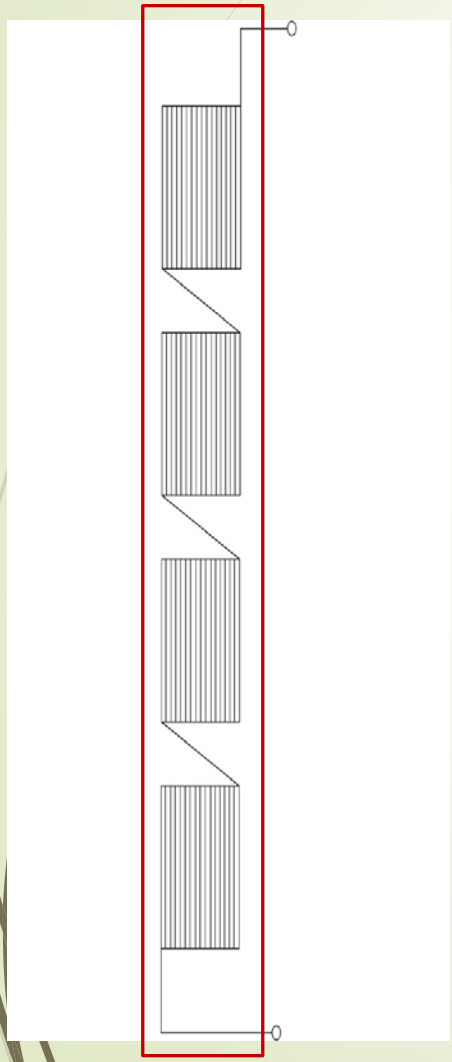
Foil discs type winding (TMC Standard)



- Continuous turns distributed along coil
- Excellent linear impulse distribution
- Ideal for filling with cast resin
- Low voltage between turns in normal operation
- Low voltage between turns during impulse

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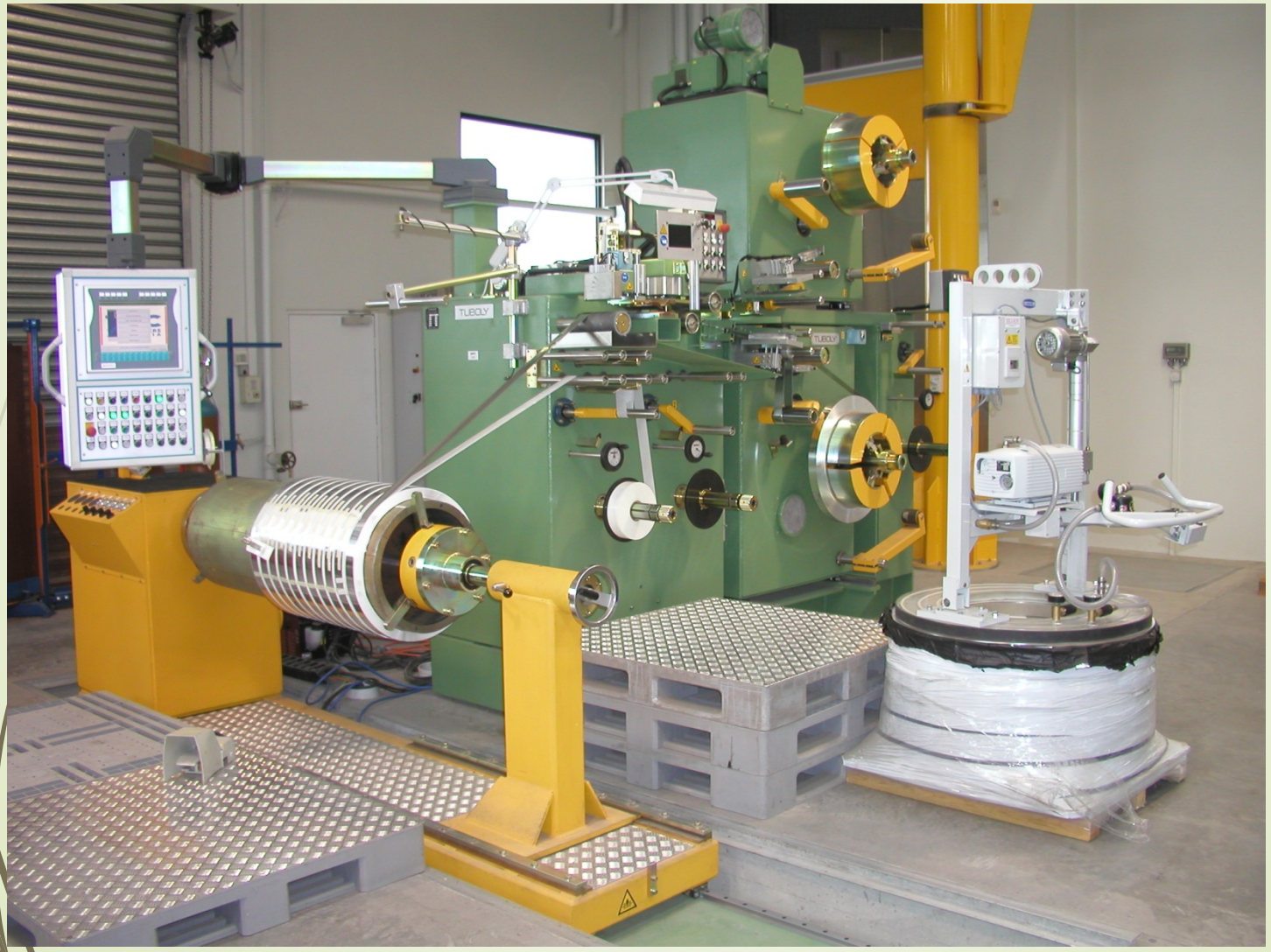
TMC Foil disc type winding machine



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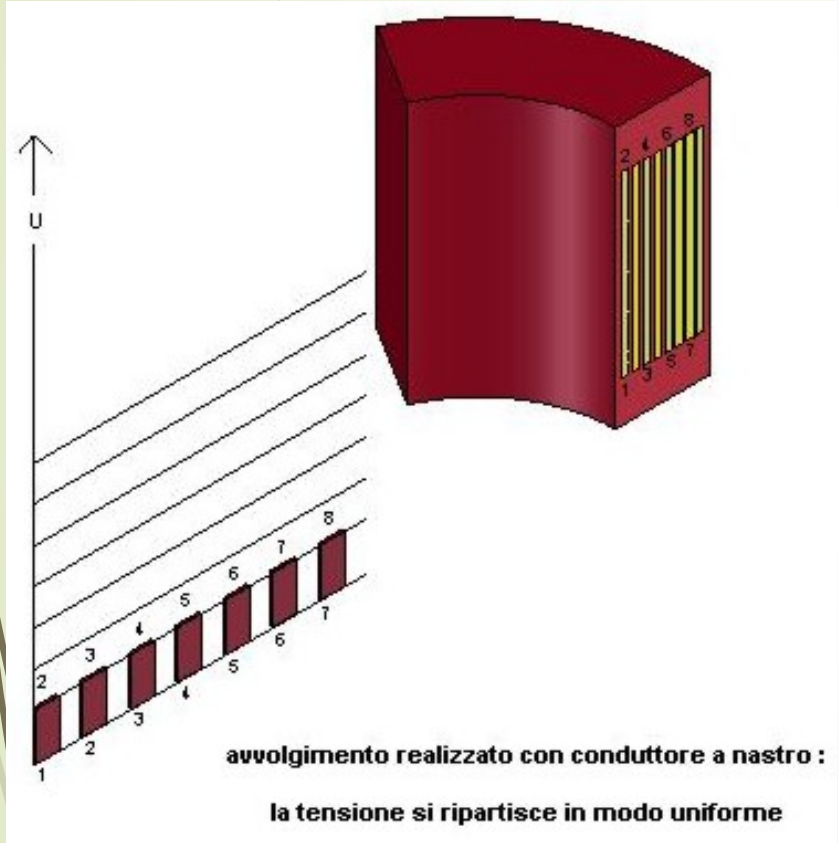
HV Coil Voltage Distribution



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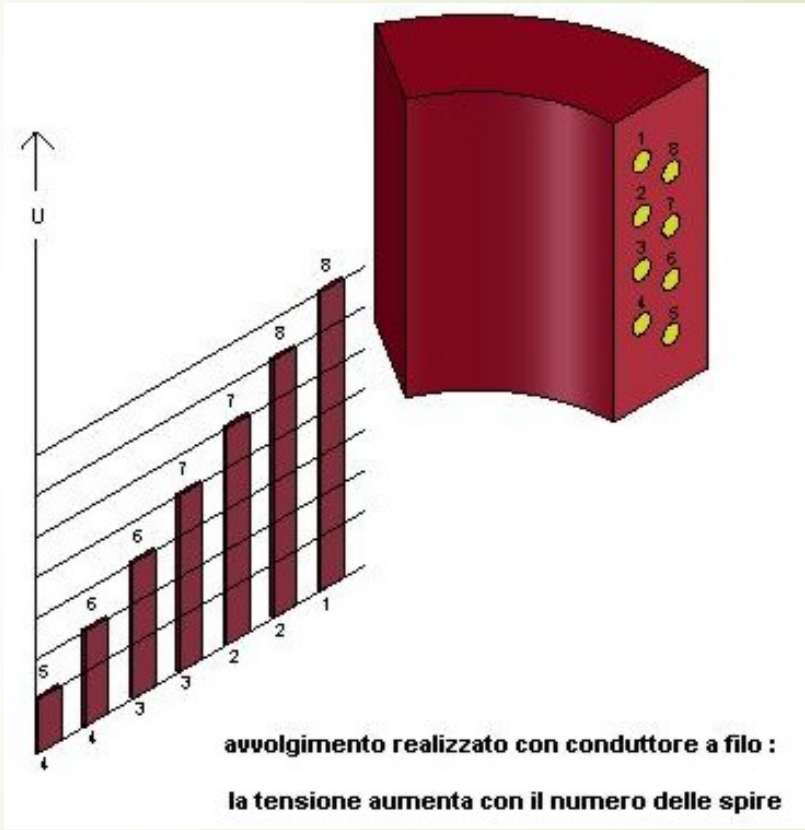
Homogeneous distribution



Wire type
Non Homogeneous distribution

TMC Transformers

HV Voltage Tappings

- To be adjusted with transformer de-energized
- Typical regulation of HV voltage is with 5 steps
- Usually these steps are ± 2 x 2,5%
- With TMC standard moulds up to 9 steps are possible

Casting Process

- Pre-heating to remove humidity
- Three steps processing of resin to blend the components (filler, hardener, resin, alumina)
- Casting under vacuum
- Gelling procedure (vacuum plant and oven)
- Hardening procedure (oven)

Physical parameters of all steps are traced and recorded

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Casting Plant

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Casting Plant

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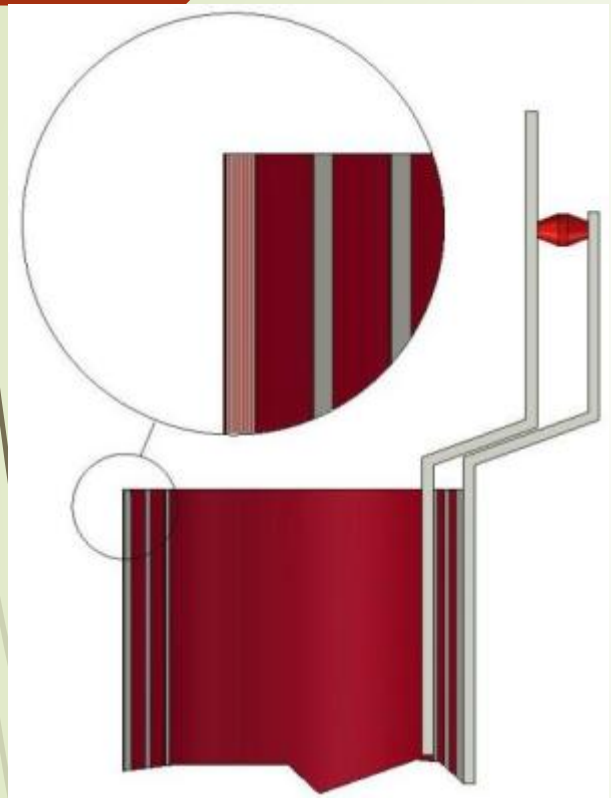
LV Winding Characteristics (TMC Standard)



LV Winding:

- Winding conductor is high conductivity aluminium foil
- Busbar terminals are fusion welded during the winding process
- Finished coil is vacuum impregnated in two pack high temperature polyester resin

The Advantages:

- Insulation against humidity
- Withstand high short circuit
- Optimal temperature distribution in the coil
- Reduction of additional losses

LV Winding Characteristics (TMC Optional)

LV winding cast in moulds in epoxy resin:

- Compact and strong
- Terminals welded during transformer assembly
- Ultimate insulation against humidity
- Ultimate short circuit and seismic withstand strength
- Satisfactory temperature distribution

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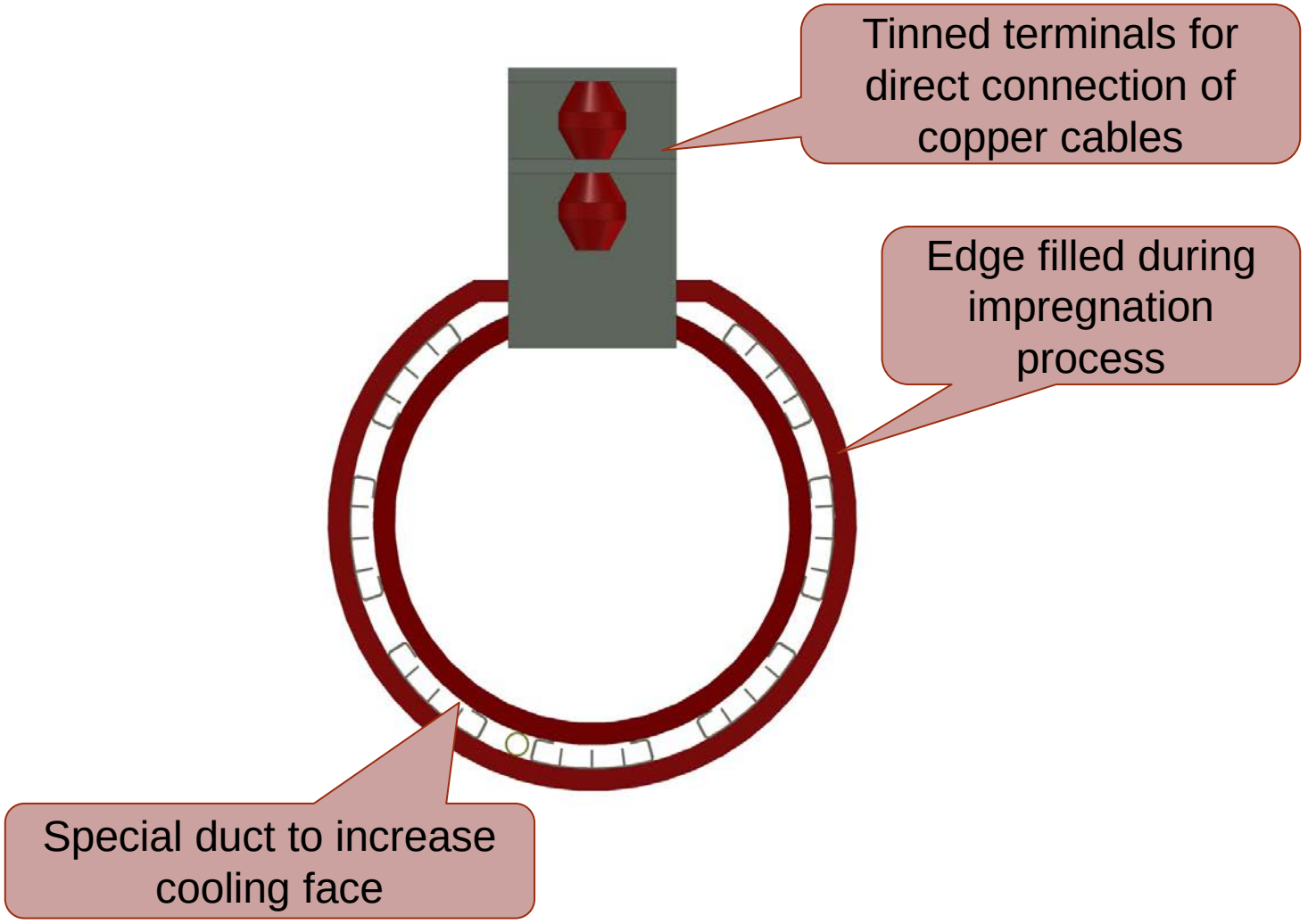
LV Winding Characteristics (TMC Standard)



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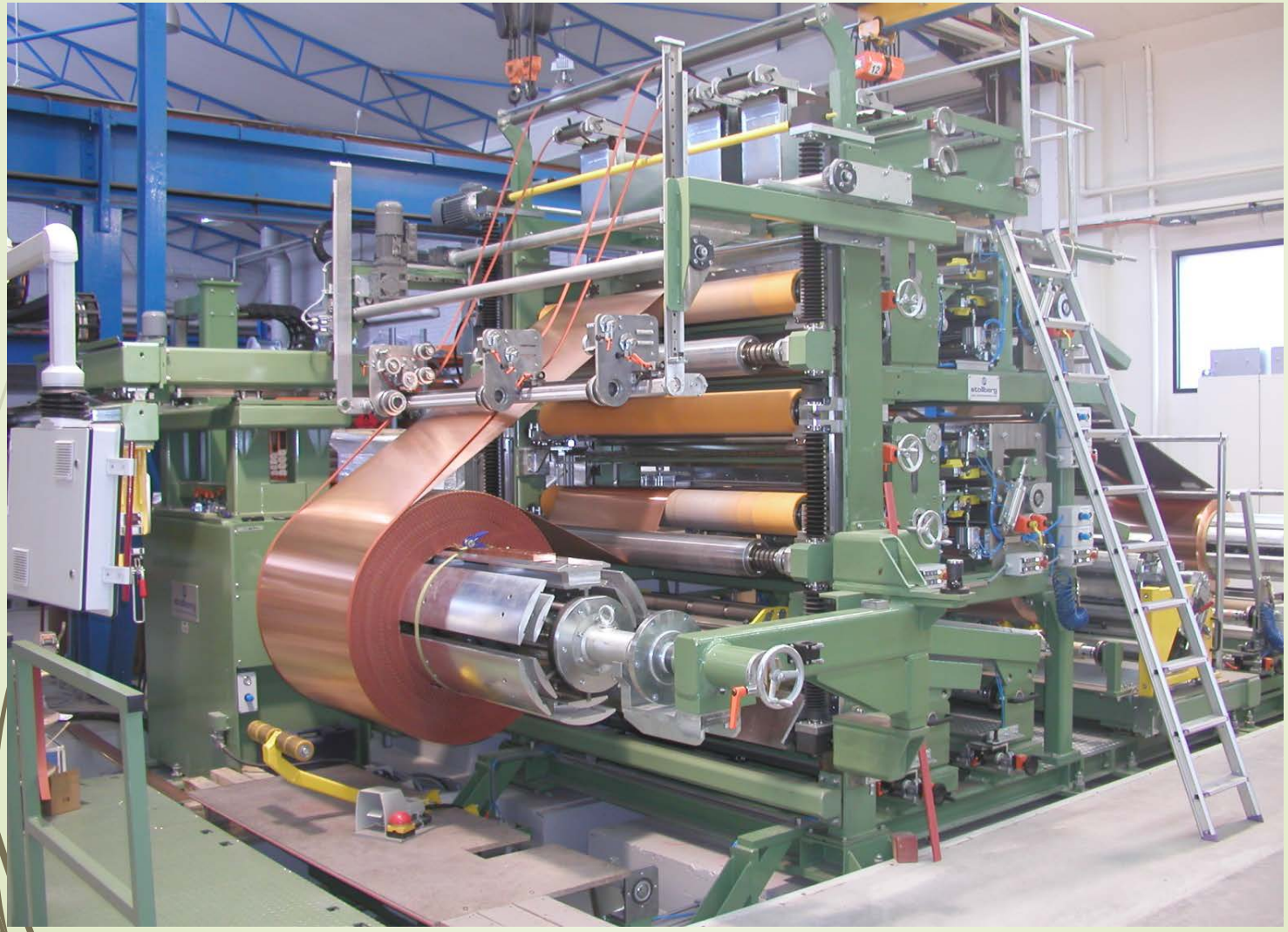
LV Winding Machine



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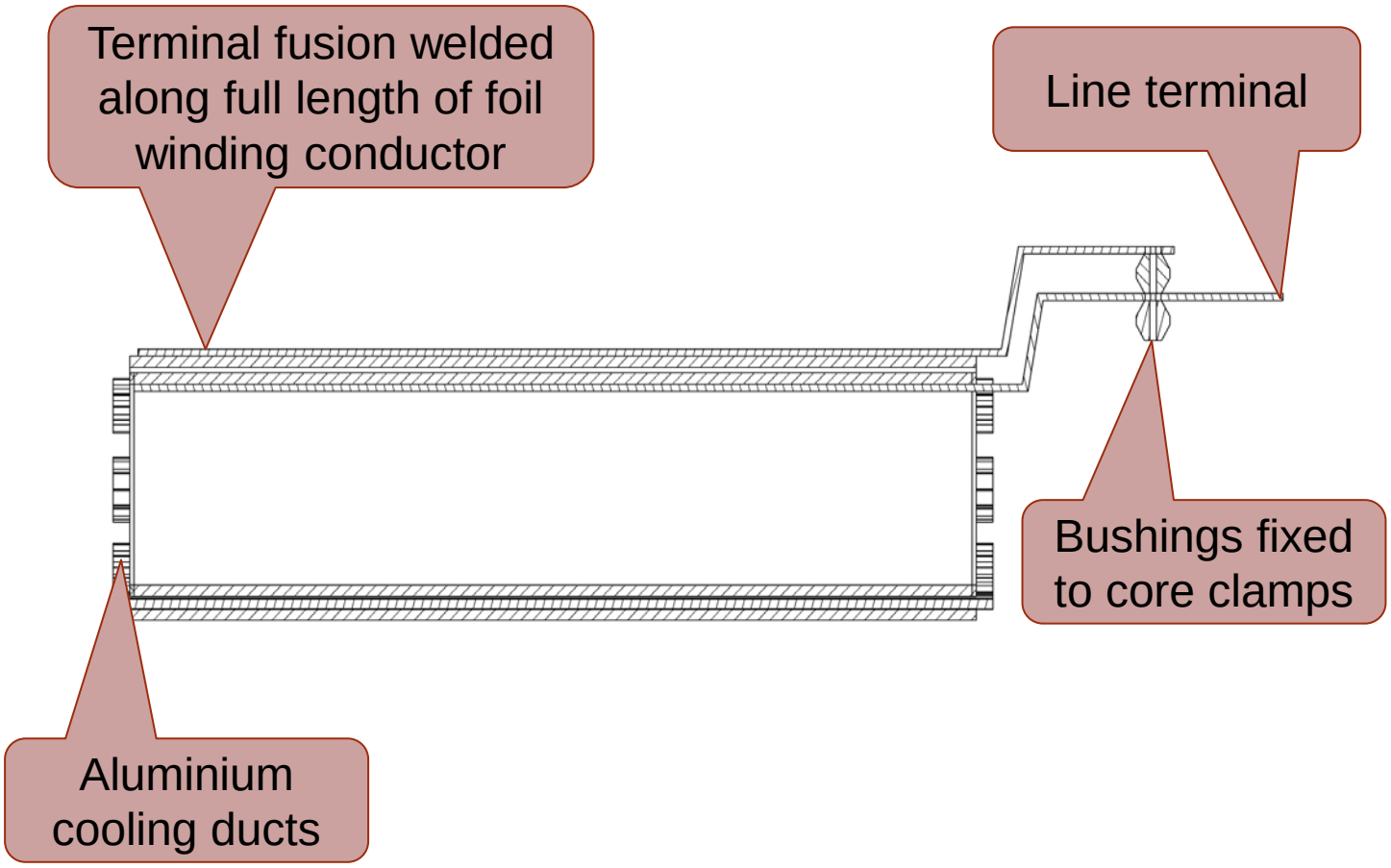
LV Winding Characteristics (TMC Standard)



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Vacuum Pressure Impregnation

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Vacuum Pressure Impregnation

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Enclosure Protection

- Degree of Protection Provided by Enclosures
- The “IP Code”
- Common requests:

IP00	No enclosure
IP21	For indoor, clean, dry environment
IP22	For extra water protection (sprinklers)
IP33	Can be used outdoor
IP43	Outdoor environment
IP54	Harsh or extreme outdoor environments
IP66	Extremely harsh environments (Nitrogen filled)

TMC Transformers

Routine Tests Performed on all Transformers

Tests prescribed from IEC 60076-11 2004 :

- Measurement of winding resistance
- Measurement of voltage ratio and check for phase displacement
- Measurement of short circuit impedance and load losses
- Measurement of no load losses and current
- Separate source AC withstand voltage test
- Induced AC withstand voltage test (2 times nominal voltage)
- Measurement of partial discharge

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Test Facility

TMC Transformers

Type Tests (on request)

- Lighting Impulse Test
- Temperature Rise Test

Special Tests (on request)

- Sound Level Measurement
  The relevant requirements of IEC 60076-10 apply.

  Sound level guarantees are based on free field conditions and apparent increases in sound level may be noted on site due to reflections from the hard building walls, floor and ceiling.
- Short Circuit Test
  (Test Performed at Ausgrid Laboratory)
- E2C2F1 – IEC 60076-11 2004
  (No longer on prototype, but on standard F-F design)

Special Test E2

Environmental Classes

Environmental conditions for dry-type transformers are identified in terms of humidity, condensation, pollution and ambient temperature.

Class E0: No condensation is expected to occur on the transformer and pollution is negligible. This is commonly achieved in a clean, dry indoor installations.

Class E1: Occasional condensation may occur on the transformer (for example, when the transformer is de-energised). Limited pollution is possible

Class E2: Frequent condensation or heavy pollution or combination of both may occur.

Special Test C2

Climatic Classes

Two climatic classes are defined:

Class C1: The transformer is suitable for operation at ambient temperature not below –5°C but may be exposed during transport and storage to ambient temperatures down to –25°C

Class C2: The transformer is suitable for operation, transport and storage at ambient temperatures down to –25°C

NOTE Transformers mounted outdoors should be housed in an adequate enclosure or be given other suitable protection.

Special Test F1

Fire Behaviour Classes

Two fire behaviour classes are defined:

Class F0: There is no special fire risk to consider. Except for the characteristics inherent in the design of the transformer, no special measures are taken to limit flammability. Nevertheless, the emission of toxic substances and opaque smoke shall be
Minimized.

Class F1: Transformer will be subject to a fire hazard. Restricted flammability is required. The emission of toxic substances and opaque smoke shall be minimized.

TMC Transformers

Finished Products

2000kVA 11000/433V Cast Resin Transformer, AN IP43 with MCCB on LV

TMC Transformers

Finished Products

2000kVA 11000/433V Cast Resin Transformer, AN IP00

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Finished Products

1500kVA 11000/433V Cast Resin Transformer, AN IP43 SS316

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Finished Products

4MVAr 33kV Capacitor Bank with 41.3mH 33kV 75A Filter Reactor , AN IP43

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Finished Products

3000kVA 11000-6600/600-600V Cast Resin Transformer, AN IP43

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Finished Products

2800kVA 22000/1700-1700V Cast Resin Transformer, AN IP21
1 of 12 in a 144 Pulse System

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Finished Products

1750kVA 6600/1910V 36 Pulse Cast Resin Transformer, AN IP00

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Finished Products

1171kW 11kV Motor Starting Auto-Transformer, AN IP00

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Finished Products

6.6kV 400A/10s ZN0 Neutral Earthing Transformer, AN IP31

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Finished Products

0.31mH 11kV 1312A Air Cored Current Limiting Reactor, AN IP43

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Finished Products

350kVAr 440V 459A Iron Shroud Reactor, AN IP21

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Finished Products

72kVAr 415V 100A Iron Cored Reactor, AN IP21

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Finished Products

415V 125A 0.17mH Air Cored Current Limiting Reactor, AN IP21

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Finished Products

1500kVA 11000/1100V Dyn11 GNAN IP66

TMC Transformers

Finished Products

1250kVA 11000/433V Dyn11 ANAN IP66 with HV Isolator

TMC Transformers

Finished Products

1500kVA 11000/433V Dyn11 ANAN IP66

TMC Transformers

Finished Products

1000kVA 11000/1000V Dyn11 GNAN IP66

TMC Transformers

Finished Products

3000kVA 11000/3300V Dyn11 GNAN IP66

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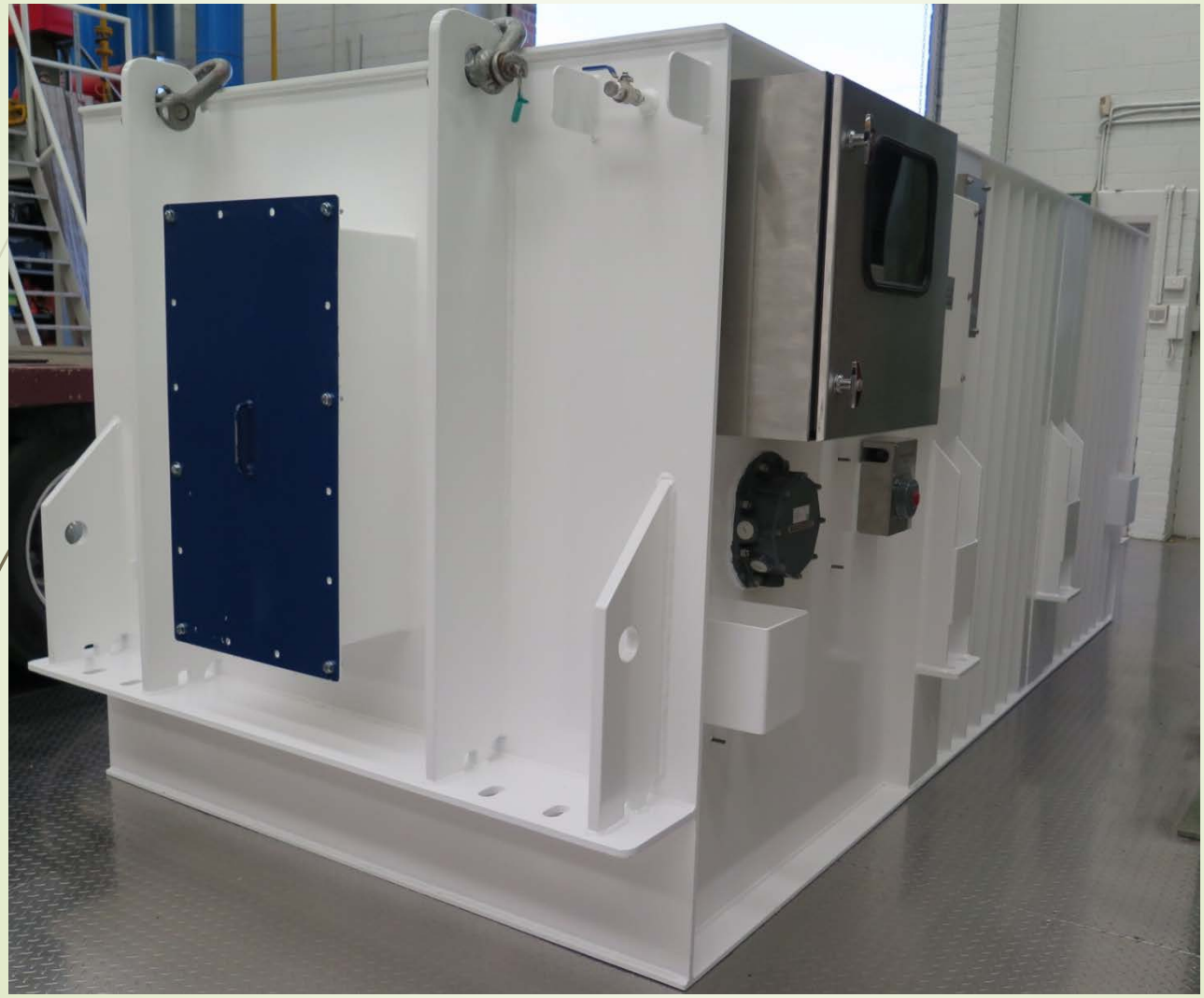
Finished Products



4500kVA 11000/3300V Dyn11 GNAN IP66

TMC Transformers

Finished Products

6000kVA 11000/33300/1100V Dyn11yn11 GNAN IP66

TMC Transformers

Installations

2000kVA 11000/690V Cast Resin Transformer, AN IP43 Material Handling Plant

TMC Transformers

Installations

2000kVA 22000/433V Cast Resin Transformer, AN IP21 Data Centre

TMC Transformers

Installations

2500kVA 11000-6600/600-600V Cast Resin Transformer AN IP43 on a Mine Shovel