

GREEN.THE high efficiency transformers



Global strength

built on local knowledge

Legrand is the global specialist in electrical and digital building infrastructures. Innovation is the driving force behind its development. With an increasing investment in research and development (circa 5% of sales) and more than 4,000 active patents, the Legrand Group is focused on maintaining a high rate of new product launches that present innovative solutions to the market.

WIDE REACHING POWER DISTRIBUTION SOLUTIONS

From Zucchini transformers through high power distribution and rising main busbars to Electrak's powertrack, desk modules and lighting control, Legrand's power distribution business unit provides market leading solutions to the increasing demands of today's buildings.

Find out more at:
www.legrand.co.uk/power-distribution





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MEETING THE STANDARD

The EN 50541-1 Standard requires that distribution transformers are built with the objective of ensuring high energy efficiency, while reducing the impact on the environment.

Legrand is committed to contributing to sustainable technological development and fulfils the requirements of the EN 50541-1 standard by introducing, within its Zucchini cast resin transformer range, the new GREEN TRANSFORMER HIGH EFFICIENCY (Green T.HE).

These transformers ensure a consistent reduction in energy consumption, resulting in financial savings, and a decrease of CO₂ emissions released into the atmosphere.

The EN 50541-1 Standard applies to 50 Hz, 100 kVA to 3150 kVA three-phase dry-type distribution transformers with maximum voltage per component not exceeding 36 kV. It replaces the following Standards: HD 538.1 S1:1992 + A1:1995 and HD 538.2 S1:1995 which were superseded on 02-01-2014.





CLASSIFICATION

The classification of a cast resin transformer depends on the value of the no-load losses (P_0), as well as the load losses (P_k), characteristics of the machine.

More precisely, P_0 losses are independent from the load, and remain constant for the whole period the transformer is connected to the electric power network. On the other hand, P_k losses only occur when the transformer is connected to a load, and are proportional to the square of the load itself.

STANDARDS

The EN 50541-1 Standard provides new loss level classifications for transformers; 3 of these apply to no-load losses, and 2 to load losses. The letter A identifies the most virtuous and economic level for both types of losses.

NO-LOAD LOSSES (P_0)	LOAD LOSSES (P_k)
A ₀	A _k
B ₀	
C ₀	B _k

CERTIFICATIONS AND ACCEPTANCE TESTS

Prior to being supplied to the customer, Zucchini cast resin transformers are individually inspected and must pass the acceptance and, when necessary, type tests, if they are required at the time of order.

At the end of the acceptance tests a specific inspection certificate is delivered with each transformer.

ACCEPTANCE TESTS

■ Measurement of winding resistance	IEC 60076-1
■ Measurement of transformation ratio and check of polarity and connections	IEC 60076-1
■ Measurement of short-circuit voltage and losses due to load	IEC 60076-1
■ Measurement of no-load losses and no-load current	IEC 60076-1
■ Insulation test with applied voltage	IEC 60076-3
■ Insulation test with induced voltage	IEC 60076-3
■ Measurement of partial discharges	IEC 60076-11

TYPE TESTS (on request)

■ Atmospheric impulse test	IEC 60076-3
■ Temperature rise test	IEC 60076-2

SPECIAL TESTS (on request)

■ Measurement of sound level	IEC 60076-10
■ Short-circuit withstand test	IEC 60076-11

LESS IS MORE

Reducing energy consumption not only reduces the impact on the environment it also has a significant impact on operating costs, providing ongoing benefits throughout the life of the building

EXAMPLE OF POTENTIAL SAVINGS OBTAINED USING A GREEN T.HE TRANSFORMER

		Class N transformer	Class AA Green T.HE
EUROPE			
Rated power (SR): 1000 kVA	Purchase price	£11,200	£14,800
Primary no-load voltage (V10): 20 kV	Operating cost (20 years)	£40,777	£30,338
Secondary no-load voltage (V20): 400 V	TOTAL COST	£51,977	£45,138
Uk: 6%			
Transformer lifetime: 20 years			
<p>In this example, the extra £3,600 required to purchase the Green T.HE transformer is recovered in less than six years, while the total saving for the 20 year period will be approximately £6,800</p>		<p>FINANCIAL SAVING £6,839</p>	<p>SAVING IN TERMS OF CO₂ EMISSIONS 112 Tonnes CO₂</p>

Note: Financial savings have been calculated taking into account the electric power supply costs listed on the EUROSTAT website.

EU-27: Cost of energy 0.0936 €/kWh. Equivalence 0,5778 kgCO₂/kWh. GBP/EUR = 1.25 as at 30/06/2014.

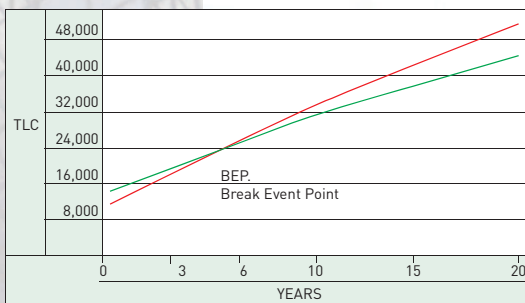


LIFETIME COSTS... UNDERSTANDING THE BIGGER PICTURE

The purchase price of the transformer is only a marginal part of the Total Lifetime Cost (TLC) of the machine, while the operating cost (mainly connected with losses), represents over 80% of the total cost. This means that in a relatively short time it will be possible to recover the extra cost invested for the purchase of a Green T.HE transformer, compared with the cost of a standard loss transformer.

The example below compares the no-load losses (P_o) and the load losses (P_k) of a Class N transformer as per standards: HD 538.1 S1:1992 + A1:1995 and HD 538.2 S1:1995 (which were superseded 02-01-2014), with transformers as per the EN 50541-1 Standard.

Typical 11kV-433V transformer	N		B_oB_k		B_oA_k		A_oB_k		A_oA_k	
	P_o (W)	P_k (W) at 120°C	P_o (W)	P_k (W) at 120°C	P_o (W)	P_k (W) at 120°C	P_o (W)	P_k (W) at 120°C	P_o (W)	P_k (W) at 120°C
630kVA	1450	7600	1050	7600	1150	7100	1000	7300	1000	7100
800kVA	1750	9400	1350	9400	1300	8000	1100	9000	1100	8000
1000kVA	2000	10000	1550	10000	1500	9000	1300	10000	1300	9000
1250kVA	2300	12700	1900	12700	1800	11000	1500	12000	1500	11000
1600kVA	2800	14000	2200	14000	2200	13000	1800	14500	1800	13000
2000kVA	3300	18000	2800	18000	2600	16000	2200	18000	2200	15500
2500kVA	4300	21000	3300	21000	3200	19000	2600	21000	2600	18500



Note: The time required to reach the break even point changes depending on energy costs, and therefore the country in which the analysis is carried out. This chart takes in to account Europe, and an energy cost of 0.0936 £/kWh
 TLC (Total Lifetime Cost) = PURCHASE COST + OPERATING COST of the transformer



Once the transformer has exhausted its own operating cycle, all of the accompanying materials can be easily recycled or disposed of, as indicated in the PEP (Product Environmental Profile) document, which describes the environmental impact of a product during its lifecycle (from the extraction of the raw materials needed for its construction, through to its disposal). Available on request.

Green T.HE MV/LV cast resin transformers

12 kv insulation class

Technical information p. 10-20

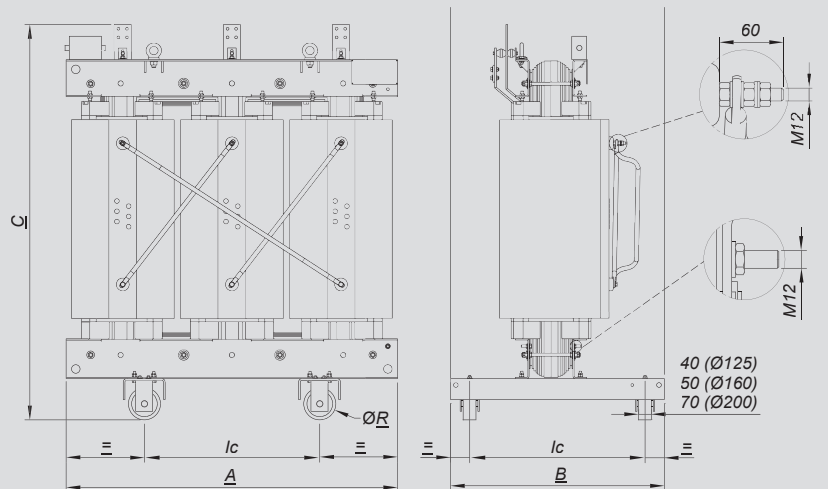
Compliance with standard : IEC 60076-11 / EN 50541-1
 Frequency (Hz) : 50
 Adjustment, MT side : $\pm 2 \times 2.5\%$
 Vectorial group : Dyn11
 Thermal class of the insulating system : 155 °C (F) / 155 °C (F)
 Temperature rise : 100/100 K
 Class of use : E2-C2-F1 Certified CESI A9032391 IEC 60076-11
 Tolerances : according to IEC/CEI
 BIL : 75 kV

S _r [kVA]	Series	U _k [%]	Primary voltage [kV]	Secondary voltage [V] Insulation class 1-1 kV	P _o [W]	P _k [W] at 120°C	I _o [%]	LwA- Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	Ic - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	BOX type
100	AoAk	6	11	400 / 417 / 433	260	1800	2.0	51	1300	600	1300	520	125	800	1
	AoBk	6	11	400 / 417 / 433	260	2000	2.0	51	1300	600	1300	520	125	800	1
	BoAk	6	11	400 / 417 / 433	330	1800	2.0	51	1300	600	1300	520	125	800	1
	BoBk	6	11	400 / 417 / 433	320	2000	1.8	51	1000	600	1100	520	125	570	1
160	AoAk	6	11	400 / 417 / 433	350	2600	1.7	54	1300	640	1400	520	125	870	2
	AoBk	6	11	400 / 417 / 433	350	2700	1.7	54	1300	640	1400	520	125	870	2
	BoAk	6	11	400 / 417 / 433	450	2600	1.7	54	1300	640	1400	520	125	870	2
	BoBk	6	11	400 / 417 / 433	440	2700	1.7	54	1050	600	1140	520	125	800	1
200	AoAk	6	11	400 / 417 / 433	425	3000	1.5	56	1350	640	1450	520	125	980	2
	AoBk	6	11	400 / 417 / 433	425	3100	1.5	56	1350	640	1450	520	125	920	2
	BoAk	6	11	400 / 417 / 433	530	3000	1.5	56	1350	640	1450	520	125	920	2
	BoBk	6	11	400 / 417 / 433	540	3150	1.5	56	1150	620	1190	520	125	900	1
250	AoAk	6	11	400 / 417 / 433	500	3400	1.3	57	1400	640	1500	520	125	1140	3
	AoBk	6	11	400 / 417 / 433	500	3500	1.3	57	1400	640	1500	520	125	1090	3
	BoAk	6	11	400 / 417 / 433	610	3400	1.3	57	1400	640	1500	520	125	1090	3
	BoBk	6	11	400 / 417 / 433	580	3700	1.3	57	1250	630	1220	520	125	1000	2
315	AoAk	6	11	400 / 417 / 433	600	3950	1.2	59	1450	750	1550	670	125	1230	3
	AoBk	6	11	400 / 417 / 433	600	4050	1.2	59	1450	750	1550	670	125	1180	3
	BoAk	6	11	400 / 417 / 433	740	3950	1.2	59	1450	750	1550	670	125	1180	3
	BoBk	6	11	400 / 417 / 433	700	4600	1.0	59	1250	750	1250	670	125	1200	2
400	AoAk	6	11	400 / 417 / 433	700	4500	1.1	60	1500	750	1600	670	125	870	4
	AoBk	6	11	400 / 417 / 433	700	4900	1.1	60	1500	750	1600	670	125	870	4
	BoAk	6	11	400 / 417 / 433	880	4500	1.1	60	1500	750	1600	670	125	870	4
	BoBk	6	11	400 / 417 / 433	790	5400	1.6	60	1050	600	1140	520	125	1350	3
500	AoAk	6	11	400 / 417 / 433	850	5800	1.1	61	1650	750	1750	670	125	1730	4
	AoBk	6	11	400 / 417 / 433	850	5900	1.1	61	1600	750	1700	670	125	1630	4
	BoAk	6	11	400 / 417 / 433	795	5800	1.1	61	1600	750	1700	670	125	1630	4
	BoBk	6	11	400 / 417 / 433	920	6700	0.8	61	1300	750	1500	670	125	1500	3
630	AoAk	6	11	400 / 417 / 433	1000	7100	1.0	62	1650	850	1750	670	160	1980	5
	AoBk	6	11	400 / 417 / 433	1000	7300	1.0	62	1600	850	1750	670	160	1890	5
	BoAk	6	11	400 / 417 / 433	1150	7100	1.0	62	1600	850	1750	670	160	1890	5
	BoBk	6	11	400 / 417 / 433	1050	7600	0.7	62	1500	850	1590	670	160	1800	4
800	AoAk	6	11	400 / 417 / 433	1100	8000	0.9	64	1700	850	1950	670	160	2480	5
	AoBk	6	11	400 / 417 / 433	1100	9000	0.9	64	1650	850	1900	670	160	2330	5
	BoAk	6	11	400 / 417 / 433	1300	8000	0.9	64	1650	850	1900	670	160	2330	5
	BoBk	6	11	400 / 417 / 433	1350	9400	0.7	64	1500	850	1740	670	160	2100	4

S _R [kVA]	Series	U _k [%]	Primary voltage [kV]	Secondary voltage [V] Insulation class 1-1 kV	P _o [W]	P _k [W] at 120°C	l _o [%]	LwA-Acoustic power [dB (A)]	Length (A) [mm]	Width (B) [mm]	Height (C) [mm]	l _c - wheel centre line [mm]	R - wheel diameter [mm]	Weight [kg]	BOX type
1000	AoAk	6	11	400 / 417 / 433	1300	9000	0.8	65	1650	1000	2100	820	160	2670	6
	AoBk	6	11	400 / 417 / 433	1300	10000	0.8	65	1650	1000	2100	820	160	2670	6
	BoAk	6	11	400 / 417 / 433	1500	9000	0.8	65	1650	1000	2050	820	160	2670	6
	BoBk	6	11	400 / 417 / 433	1550	10000	0.6	65	1550	1000	1820	820	160	2500	5
1250	AoAk	6	11	400 / 417 / 4330	1500	11000	0.7	67	1850	1000	2200	820	160	3370	6
	AoBk	6	11	400 / 417 / 433	1500	12000	0.7	67	1850	1000	2150	820	160	3130	6
	BoAk	6	11	400 / 417 / 433	1800	11000	0.7	67	1850	1000	2150	820	160	3320	6
	BoBk	6	11	400 / 417 / 433	1900	12700	0.5	67	1550	1000	2000	820	160	2950	5
1600	AoAk	6	11	400 / 417 / 433	1800	13000	0.6	68	1950	1000	2200	820	160	3900	6
	AoBk	6	11	400 / 417 / 433	1800	14500	0.6	68	1950	1000	2150	820	160	3760	6
	BoAk	6	11	400 / 417 / 433	2200	13000	0.6	68	1950	1000	2150	820	160	3760	6
	BoBk	6	11	400 / 417 / 433	2200	14000	0.4	68	1650	1000	2180	820	160	3550	6
2000	AoAk	6	11	400 / 417 / 433	2200	15500	0.5	70	2000	1310	2400	1070	200	4560	7
	AoBk	6	11	400 / 417 / 433	2200	18000	0.5	70	2000	1310	2250	1070	200	4420	7
	BoAk	6	11	400 / 417 / 433	2600	16000	0.5	70	2000	1310	2250	1070	200	4420	7
	BoBk	6	11	400 / 417 / 433	2800	18000	0.4	70	1800	1310	2260	1070	200	4300	6
2500	AoAk	6	11	400 / 417 / 433	2600	18500	0.4	71	2150	1310	2450	1070	200	5470	7
	AoBk	6	11	400 / 417 / 433	2600	21000	0.4	71	2100	1310	2350	1070	200	5370	7
	BoAk	6	11	400 / 417 / 433	3200	19000	0.4	71	2100	1310	2350	1070	200	5420	7
	BoBk	6	11	400 / 417 / 433	3300	21000	0.3	71	2050	1310	2390	1070	200	5250	7
3150	AoAk	6	11	400 / 417 / 433	3150	22000	0.4	74	2250	1400	2550	1070	200	6010	8
	AoBk	6	11	400 / 417 / 433	3150	26000	0.4	74	2200	1400	2550	1070	200	5800	8
	BoAk	6	11	400 / 417 / 433	3800	22000	0.4	74	2250	1400	2550	1070	200	6050	8
	BoBk	7	11	400 / 417 / 433	3950	26000	0.3	74	2150	1310	2400	1070	200	6250	7

Other insulation classes, such as 17.5, 24 and 36 kV, available on request along with other primary voltages, such as 6.6 kV, please contact us on +44 (0) 845 600 6266

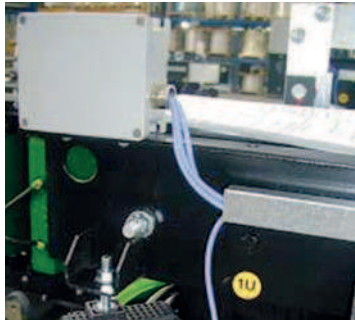
Technical dimensions



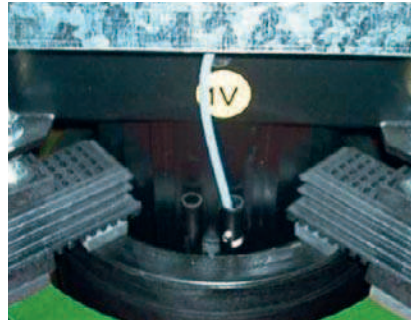
Values are for reference only. Construction drawings must be used for design
Data provided may be modified without warning for reasons of technical production or product improvement

Green T.HE MV/LV cast resin transformers

installation accessories



IP 65 junction box



Pt100 temperature measurement sensor

Selection charts **p. 6-7**
 Technical information and dimensions **p. 10-20**

Pack	Cat. Nos.	Temperature measurement sensors				
		Temperature measurement sensors are supplied mounted on to the transformer and wired to aluminium IP 65 junction box				
		Type	Range (kVA)	No.	Δt (°C)	Installation
3	200073	Pt100	≤ 2000	3	–	on the LV (3) windings
3	200074	Pt100	> 2500	3	–	on the LV (3) windings
4	200137	Pt100	≤ 2000	3 + 1	–	on the LV (3) windings + on the core (1) on the LV (3) windings
4	200138	Pt100	> 2500	3 + 1	–	on the LV (3) windings + on the core (1) on the LV (3) windings
6	CB00120	PTC	–	3 x 2	130-140	on the LV (3 pairs) windings for alarm and release
6	CB02400	PTC	–	3 x 2	110-120	on the LV (3 pairs) windings for alarm and release

Pack	Cat. Nos.	Surge arrester kit
		Supplied mounted on the transformer
		Fitting of surge arresters increases warranty to 24 months
		Voltage V_n (kV)
1	130054D	11
1	130055D	15
1	130056D	20

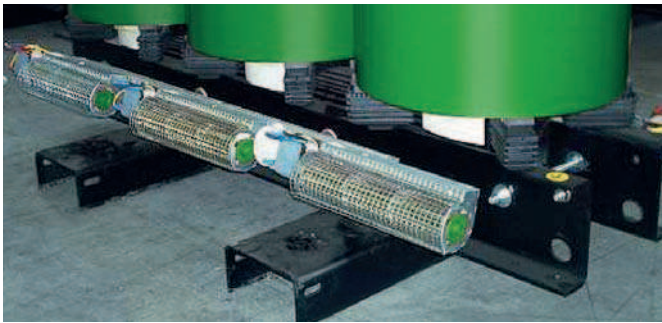
Pack	Cat. Nos.	Surge arrester kit
		4 anti-vibration pads for mounting under transformer casters
		Range kVA
1	170019	100-1600
1	170020	2000-3150

Pack	Cat. Nos.	Temperature control devices	
		Central units are supplied unassembled	
		Type	Description
1	220035	VRT200	Fan control
1	220002	T154	Temperature control for 4 Pt100 probes
1	220023	MT200L	Temperature control for 4 Pt100 probes
1	220010	T119 DIN	Temperature control for 6 PTC probes, preset for DIN rail mounting
1	220004	T119	Temperature control for 6 PTC probes

For details of corresponding connection interfaces for the SCP busbar range see p. 19

Pack	Cat. Nos.	Non-magnetic thermometer
		Both thermometer and support bracket must be ordered
1	250662	Thermometer (supplied without supporting bracket)
1	250005	Thermometer support bracket (must be ordered alongside thermometer)

Green T.HE MV/LV cast resin transformers installation accessories (continued) and enclosures



Ventilation bars

Selection charts **p. 6-7**
Technical information and dimensions **p. 10-20**



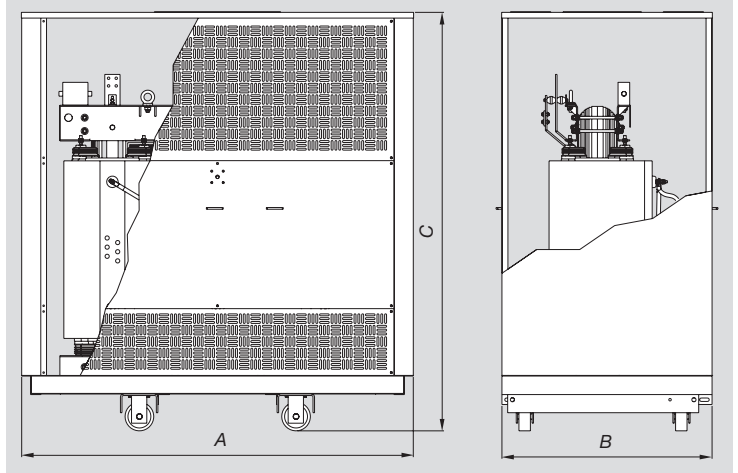
Transformer enclosure colour RAL 7035
AREL door lock on the enclosure, Cat. No. 230076

Pack	Cat. Nos.	Ventilation bars		
		Ventilation bars allow a temporary increase of the rated power (at rated operation conditions) :		
		1. When ordering an AN/AF transformer, the ventilation bars will be supplied fitted to the transformer		
		2. When ordering a transformer, and the AN to AN/AF conversion (within the limits indicated in the table below) is completed after delivery, the purchaser will have to return the original data plate to the manufacturer, who shall then supply a new data plate and the corresponding assembly instructions		
		Range (kVA)	ΔPower (%)	Notes
1	CB02443	100-250	+30	A temporary increase in rated conditions
1	CB02453	315-800	+30	
1	CB02463	1 000-1 250	+30	
1	CB01413	1 600-2 500	+30	
1	CB01411	3 150	+30	
1	CB02444	100-250	+40	
1	CB02454	315-800	+40	
1	CB02464	1 000-1 250	+40	
1	CB01414	1 600-2 500	+40	
1	CB01412	3 150	+40	

Pack	Cat. Nos.	Enclosures					Weight (kg)
		Insulation Class 12 / 17.5 / 24 kV					
		Degree of protection : IP 21 / IP 23 / IP 31					
		Colour RAL 7035					
		Boxes can be supplied or assembled on the transformer					
		For a pre-assembled box add the 'M' suffix to the Cat. No. (e.g. Cat. No. 231043M)					
		Box type	IP degree	Length (A)	Dimensions (mm)		
					Width (B)	Height (C)	
1	230316	1	IP21	1 600	900	1 470	120
1	230288	1	IP31	1 600	900	1 470	130
1	230353	1	IP23	1 600	900	1 470	120
1	230211	2	IP21	1 700	950	1 580	140
1	230273	2	IP31	1 700	950	1 580	140
1	230263	2	IP23	1 700	950	1 580	140
1	230212	3	IP21	1 800	1 000	1 680	160
1	230215	3	IP31	1 800	1 000	1 680	170
1	230234	3	IP23	1 800	1 000	1 680	160
1	230204	4	IP21	1 900	1 050	1 950	180
1	230277	4	IP31	1 900	1 050	1 950	200
1	230222	4	IP23	1 900	1 050	1 950	180
1	230213	5	IP21	2 050	1 100	2 200	210
1	230221	5	IP31	2 050	1 100	2 200	230
1	230223	5	IP23	2 050	1 100	2 200	210
1	230214	6	IP21	2 300	1 310	2 500	280
1	230267	6	IP31	2 300	1 310	2 500	340
1	230249	6	IP23	2 300	1 310	2 500	280
1	230287	7	IP21	2 500	1 310	2 700	300
1	230309	7	IP31	2 500	1 310	2 700	360
1	230371	7	IP23	2 500	1 310	2 700	300
1	231042	8	IP21	2 700	1 400	2 800	320
1	231043	8	IP31	2 700	1 400	2 800	380
1	231044	8	IP23	2 700	1 400	2 800	320

For 36 kV enclosures' dimensions and weights, please contact us on +44 (0) 845 600 6266

Technical dimensions



Green T.HE MV/LV cast resin transformers

constructional characteristics

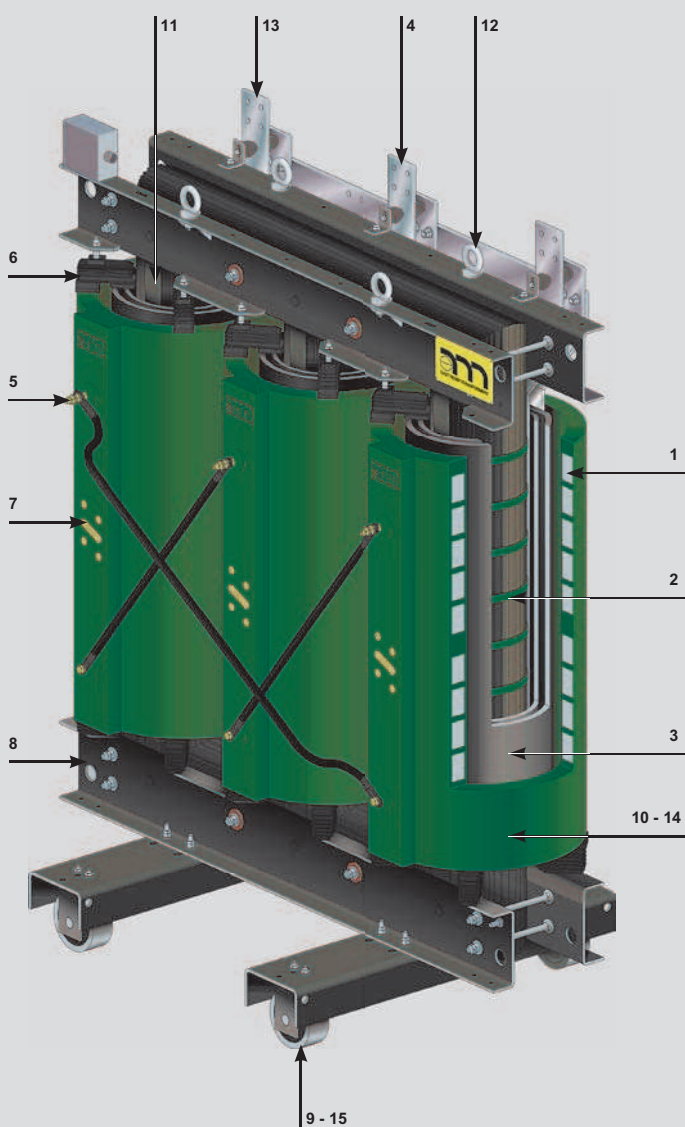
■ Installing a Zucchini cast resin transformer

Zucchini cast resin transformers are distinguished by their high quality production. Using state-of-the-art constructional techniques and equipment, quality is assessed throughout the production process and via a rigorous checking process in the final phase, resulting in a high quality, reliable product.

Zucchini cast resin transformers can be installed quickly and easily.

With no additional construction or building activities necessary, safe installation is ensured by following a few simple steps :

- Standard execution – indoor installation, in dry / clean environments, protected from direct sunlight, with no possibility of water ingress
- Altitude no higher than 1000 m above sea level (for higher installations, contact us on +44 (0) 845 600 6266)
- Room temperature with transformer in operation (for higher values, contact us on +44 (0) 845 600 6266) :
 - T minimum – 25°C
 - T maximum + 40°C
- With a standard execution, transformers are designed in accordance with IEC Standard 60076-11 for the following room air temperatures :
 - 40°C at peak times
 - 30°C as a monthly average in the warmest month
 - 20°C as a yearly average
- To protect the transformers from external environment impacts and/or people from the risk of having direct contact, a set of standard enclosures is available with different degrees of protection : IP 21 / IP 31 / IP 23



- 1 MV windings in aluminium strip coils, cast in resin under vacuum
- 2 Core in three columns in magnetic lamination with high-permeability oriented crystals, also available with low losses
- 3 LV windings in aluminium plate/sheet and vacuum-cast impregnated insulation material
- 4 LV connections upwards (standard) or downwards version (on request)
- 5 MV connections upwards (standard) or downwards version (on request)
- 6 Rubber inserts attenuate the transmission of vibrations between core and windings, and reduce operating noise generated by the transformer to a minimum, as well as absorbing the thermal expansion of the components
- 7 Off load links on the MV side to adapt the primary voltage to the mains, which can be set with transformer switched OFF
- 8 Structure, armatures and carriage, manufactured from strong painted sheet steel
- 9 Carriage with bi-directional castors
- 10 The epoxy resin insulation makes the transformer low maintenance
- 11 The operating temperature is checked by Pt100 sensor or PTC in the LV windings
- 12 Lifting eyebolts conform to the DIN-580 UNI-2947 standards with safety hooking at 4 points
- 13 Optional pre-equipment for connection of the LV connection to Zucchini busbar trunking system
- 14 Class F insulating material, at 155°C, allowing for a temperature rise of 100°K. (100°C)
- 15 The carriage allows safe movement and is pre-equipped for mounting IP reinforced boxes

Green T.HE MV/LV cast resin transformers

technical information

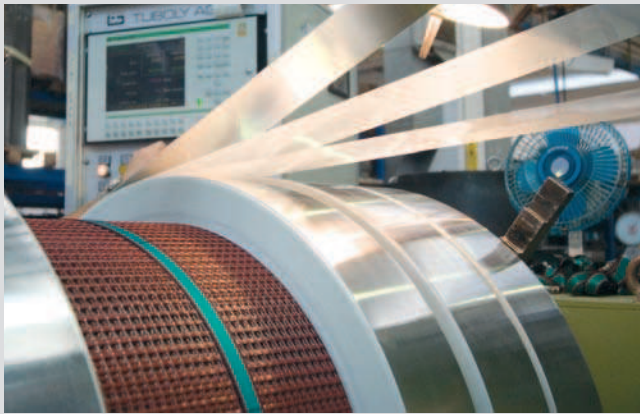
■ Medium voltage (MV) winding

The medium voltage winding, made by highly automated winding machines, is constructed with the continuous disk technique and made in aluminium strip, interleaved with double insulation

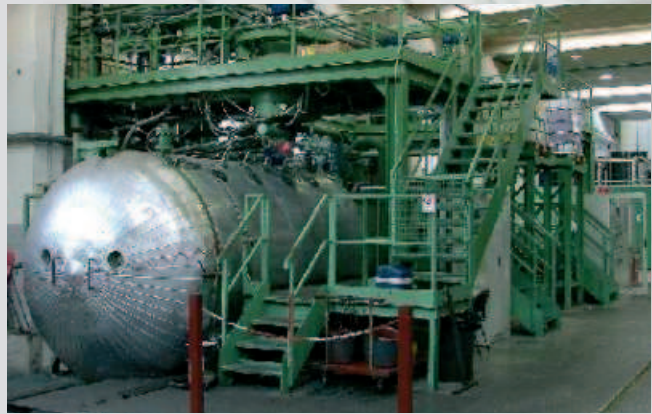
This type of working produces uniformity of the internal and external thickness of the resin and guarantees uniform resistance to the dielectric stresses to which the transformer will be subjected in the inspection phase or during its operation at the place of installation

The primary winding has off load links to adjust the primary voltage equal to the value $\pm 2 \times 2.5\%$, made with brass bushes protruding from the resin, and brass nuts and bolts with indelible numbering (not with adhesive labels)

The thermal class of the insulating materials used corresponds to class F, with the temperature rises allowed by standard IEC 60076-11



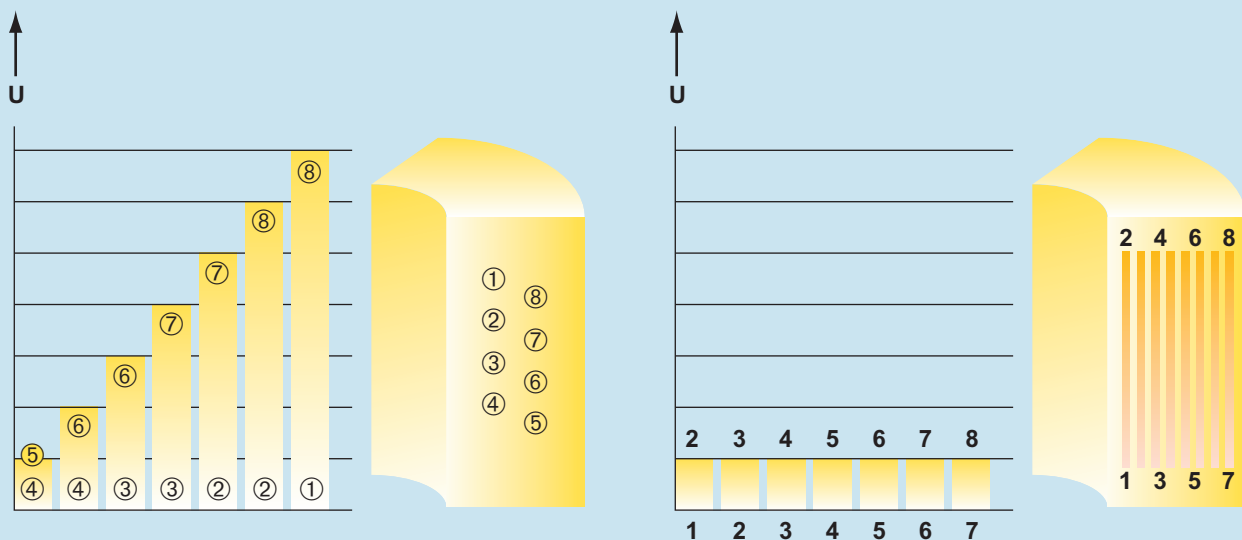
Modern electronically controlled winding machines



The pouring system under high vacuum

The technology used in making the MV windings in strips, rather than in wire, puts less stress on the insulation between the turns. In traditional windings, made with a circular-section conductor, each layer of the winding is made up of a number of turns side by side. In windings made with strip conductors, each layer is made up of just one turn. If the voltage of a single turn of a winding is denoted by u_s , in strip windings the voltage between turns belonging to two adjacent layers is always u_s , while in traditional windings this voltage assumes the maximum value of $(2n - 1) u_s$, as shown in the diagram below

Division of the voltage between the turns of the medium voltage winding



Winding made with wire conductors :
the voltage increases with the number of turns

Winding made with strip conductors :
the voltage is divided uniformly

Transformers with strip windings thus have a greater capacity of resistance to impulse voltages and at industrial frequencies, as well as a lower probability of occurrence of localised partial discharges. Strip winding also has the advantage of drastically reducing the axial forces due to short-circuit currents

Green T.HE MV/LV cast resin transformers

technical information (continued)

■ Low voltage (LV) winding

The low voltage winding is made up of a single aluminium strip, of the same mechanical height as the MV electrical winding, with an interleaved sheet of insulating material which can be Class F or Class H. Making the winding in this way guarantees a compactness which forms a single cylinder that resists any axial and radial forces that may arise from a short-circuit

All the welds of the conductor strip with the output bars are made by butt welding in an inert atmosphere and under electronic control, so as to avoid any excess of material which could, by repeated stress, affect or damage the insulation interposed between output terminal and the following turn

This winding is then impregnated with epoxy resin, under vacuum, to confer the necessary compactness and homogeneity, as well as avoiding the absorption of humidity during the transformer's lifetime, wherever it may operate

This treatment means the system meets classification at level F1 according to standards IEC 60726 and IEC 60076-11



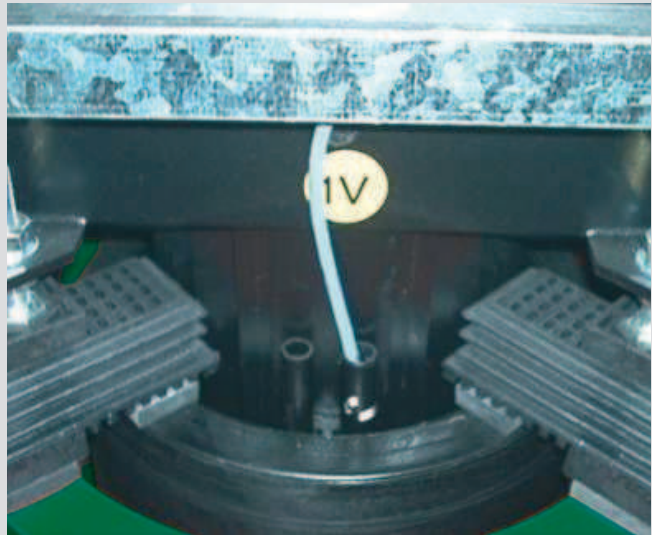
LV winding system



TIG welding in controlled atmosphere for LV connections

■ Protection against temperature rise

During its normal operation a transformer has no-load losses and load losses which fundamentally translate into dispersed thermal energy. This energy depends on the construction of the transformer itself, its power and the installation conditions. It should be remembered that the energy dispersed thermally is proportional to the transformer temperature minus the room temperature. At a given room temperature, the transformer temperature depends mainly on the load losses. As the load increases consequently the losses and the room temperature increase favouring a more rapid degradation of the insulations and thus a greater probability of failure of the dielectric. This situation could also occur when, with equal losses due to load, the room temperature and consequently the transformer temperature, increase. The IEC 60085 standard defines insulation classes which indicate the maximum temperatures that can be reached by the transformers in their normal operation and which must not be exceeded



Pt100 sensor to check the temperature

Insulation classes

Class	Transformers	Average temperature rise limits, at rated current
Class F (155°C)	resin	100° K

Temperature rises depend not only on the load and the overcurrents that may be detected by the protection devices, but also on environmental factors (inefficiency of the cooling system, fault on the forced ventilation and increase of the room temperature) which influence the dispersal of heat produced by the transformer's specific losses. For this reason electronic temperature measuring devices are normally provided. These are necessary to trigger the alarm or transformer protection. The following temperature sensors are available for Zucchini transformers: Pt100 thermosensors and PTC thermistors :

- **Pt100**: supplies a signal proportional to the temperature measured
- **PTC**: supplies an ON/OFF signal depending on whether the temperature measured is less or more than the sensor's threshold

The sensors are positioned in the hot point of the winding

Both the Pt100 and PTC signals must be processed by the temperature control unit, which does not form part of the standard equipment

On request other accessories are available to check the temperature :

- a separate temperature display, to be installed on the control panel
- an output relay for alarm and release and control of the fans

Maximum transformer alarm and release temperature values

Transformer type	Room (°C)	Alarm (°C)	Release (°C)
Resin	40	130	140

Temperature rise limits for cast resin transformers

Part	Insulating system temperature (°C)	Maximum temperature rises (K)
Windings : temperature rise measured with the heating element variation method	155 (F)	100
Core, metal parts and adjacent materials	–	In no case must the temperature reach values which would damage the core itself, other parts or adjacent materials

When combined with control sensors, the following can also be supplied, if required :

- T154 Unit or MT200 Unit : equipment used for controlling the Pt100 thermistors with temperature display, output relay for alarm, optional trip and control of the ventilation bars supplied as a detached part to be installed on the electric panel
- T119 Unit : equipment used for controlling the PTC thermistors with output relay for alarm, optional trip and control of the ventilation bars supplied for being installed on the electric panel

Ventilation accessories :

- Zucchini cast resin transformers can be equipped at the factory with special ventilation bars
These special tangential fans are designed to allow temporary and limited increase of the power delivered by the transformer, up to + 40% of the rated power

- VRT200 Unit : equipment for automatic activation and control of the fans

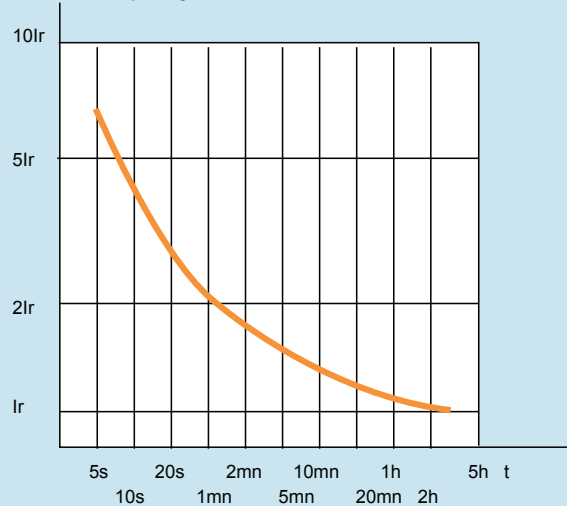
Green T.HE MV/LV cast resin transformers

technical information (continued)

Protection against overloads

Overload is the phenomenon which occurs when the value of current absorbed by the system is higher than the rated value. The persistence of an overload inevitably leads to exceeding the acceptable temperature rise limits specified for the transformer, with the consequent risk of deterioration of the insulating materials. Exceptionally, in certain abnormal service conditions, it may be acceptable to exceed the overload and temperature rise thresholds, to the detriment of the transformer's expected lifetime. This situation is sometimes preferable to an interruption of service (due to a temporary power peak) which could cause considerable material and economic damage. In most cases the overloads are transient and thus generally do not affect the thermal equilibrium. The 'acceptable' overload level is a function of the user's need for service continuity and the type of system itself. For insulating-liquid transformers the circulation of the cooling oil and the shape of the radiator containment tanks allow the rapid restoration of the insulation and the reduction of partial discharges, as well as allowing the transformer to reach its operating temperature quickly

Overload capacity of an oil transformer



For cast resin transformers, the cooling component is air, and thus it takes longer to reach the operating temperature. In these conditions cast resin transformers may be more overloaded and thus may be used in systems with loads where there are frequent breakaway starting currents. This is true as long as the temperature rises on the windings do not remain above the allowable values for too long. A partial solution of the problem may be the use of radial fans affixed to the cast resin transformers, allowing a temporary transformer overload up to 150% of the rated power. It should, however, be remembered that as the power increases the losses due to load increase. As they depend on the square of the current they can reach up to 2.25 times the rated value. Radial fans should only be used in special and temporary cases to cool the windings or to have a sort of power reserve which may be used in emergency situations



Overload in public distribution

In public distribution, in the short term priority is given to continuity of service. For this reason overloads do not generally lead to switching the transformer "OFF". Again for the same reason generally low voltage circuits are always oversized and consequently an overload of the transformer never corresponds to an overload of the conductors. However, attention should be paid when the overloads repeat too frequently. In this situation the distributing organisation should replace the transformer with a model with greater power



Overload in industrial distribution

In an industrial installation, the overload can last for a short or long time. In these installations the main distribution board equipped with protective circuit breakers against overload and short-circuit is always immediately downstream of the transformers. Management of the overload is in fact delegated to the circuit breakers on the low voltage side which will detach the loads in an automatic or controlled way



Overload in service distribution

In service installations, such as offices and shopping centres, continuity of service is fundamental. In these types of application conditions of regular load, which have starting regimes or similar behaviour, rarely occur

To guarantee maximum continuity of service, even when there are overloads, it is essential that the loads considered non-priority are managed and disconnected when needed by the transformer on the low voltage side



■ **Protection against overloads by means of measuring the temperature**

As previously stated, overload is fundamentally associated to a temperature rise, which is the real component to be kept under control, because its effects could lead to the rapid deterioration of the insulation materials and to the failure of the transformer's dielectric properties. Verifying the temperature is a determining factor in protection of the transformer itself. To check the temperature therefore, cast resin transformers are generally equipped with thermoresistors, in turn connected to electronic control units, which signal or directly release the transformer when the defined thresholds are exceeded. Zucchini cast resin transformers have these thermoresistors installed near the parts which are most critical from the thermal point of view



Fan control unit



Example of installation of a Pt100 temperature control unit



Temperature control unit

Green T.HE MV/LV cast resin transformers

technical information (continued)

■ Environmental and climatic features, and fire resistance

Standard IEC 60076-11 (2004) uses an alphanumeric code to identify the environmental, climatic and fire behaviour classes of dry-type transformers

- environmental class (E0 – E1 – E2)
- climatic class (C1 – C2)
- fire behaviour class (F0 – F1)

Thanks to the use of a high-quality epoxy resin, all Zucchini transformers reduce environmental impact to a minimum and conform to the following classes :

- environmental class E2
- climatic class C2
- fire behaviour class F1

ENVIRONMENTAL TESTS

E0

No condensation on the transformer, negligible pollution, installation in a clean and dry room

E1

Occasional condensation and little pollution

E2

The transformer is subject to consistent condensation, to intense pollution, or to both phenomena

CLIMATIC TESTS

C1

The transformer will not operate at temperatures lower than -5°C, but may be exposed to -25°C during transport and storage

C2

The transformer can operate and be transported and stored at temperatures down to -25°C

FIRE RESISTANCE

F0

The risk of fire is not expected and no measures are taken to limit inflammability

F1

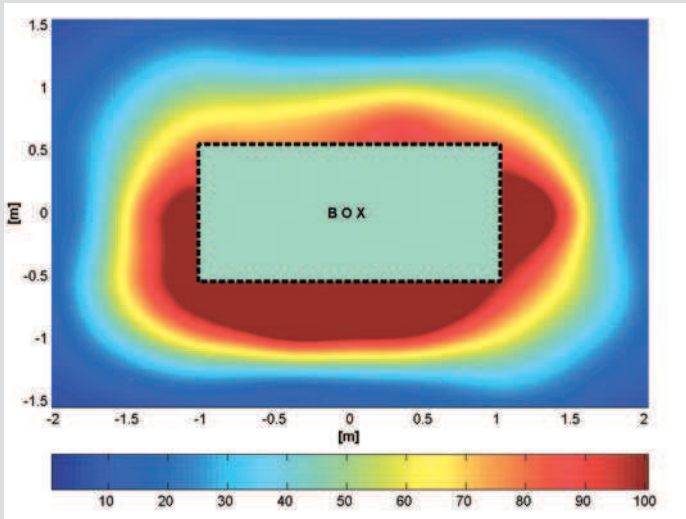
The transformer is subject to the risk of fire and reduced inflammability is required. Fire on the transformer must be extinguished within laid-down limits

The thermal class of the insulating materials used corresponds to class F and the temperature rises are those given in the specific standards for the transformer product

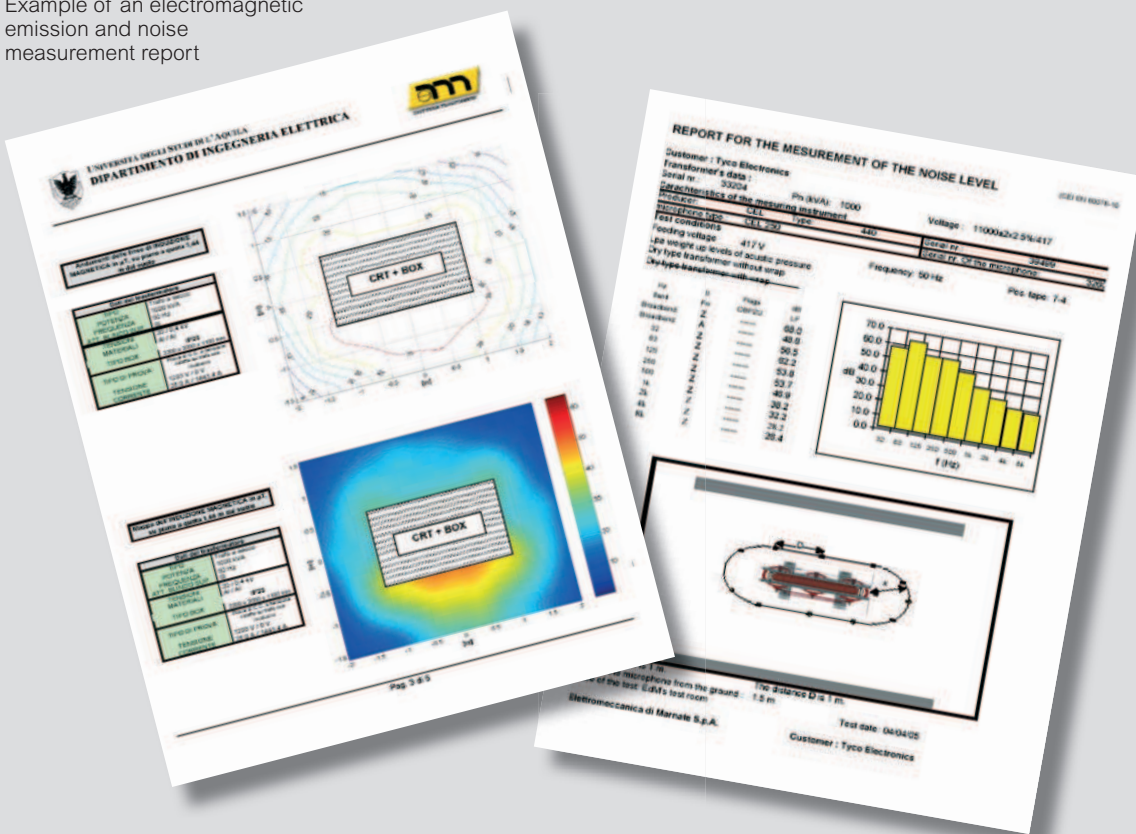
■ **CLE range (certified low electromagnetic emission)**

CLE transformers (certified low electromagnetic emissions) are specifically designed and built for reducing electromagnetic emissions. This is the ideal solution for places continuously attended by people or, for example, with particularly sensitive electronic equipment. As a result, the Zucchini cast resin CLE range is fully in compliance with the DPCM regulations of 8/7/2003 (electromagnetic emissions lower than 10 microTesla), and the Zucchini quality target is set to a threshold of 3 microTesla. Legrand provides each CLE cast resin transformer with a specific measurement ratio of the electromagnetic emissions.

Furthermore, by using a modern semi-anechoic chamber located inside the Legrand laboratory, the CLE transformation systems can also be supplied with a noise measurement ratio based on different emission bands.



Example of an electromagnetic emission and noise measurement report



Green T.HE MV/LV cast resin transformers

technical information (continued)

The main vector groups of transformers

Internal windings may be connected in star, triangle or zigzag
 Depending on the connection method, the system of induced voltages on the low voltage side is out of phase with respect to the average voltage by angles which are multiples of 30°
 The winding connection method is identified by 3 letters (upper case for the primary and lower case for the secondary) :

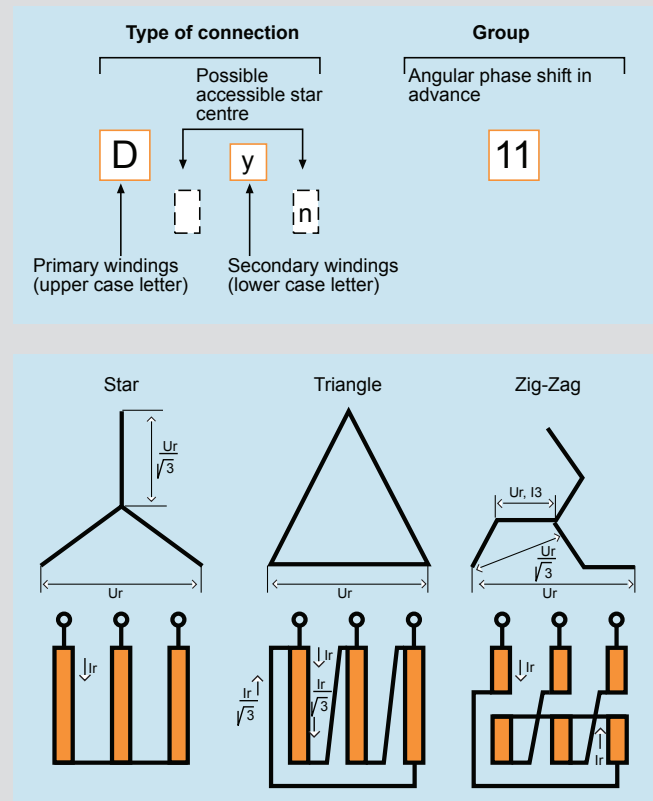
- Y** – star connection
- D** – triangle connection
- Z** – zigzag connection

Associated with these letters are identified numbers which represent the phase shift, dividing it into 4 groups :

- Group 0 – no phase shift
- Group 11 – 330°
- Group 6 – 180°
- Group 5 – 150°

The choice of the transformer switching ON unit is one of the important factors for determining the operating regime as a function of the load
 The ideal condition is when the load is balanced on all the phases, but this condition is often impossible to obtain. For this reason one must know the phase shift between primary and secondary phases

The table below shows the typical insertion diagrams



Typical insertion diagrams

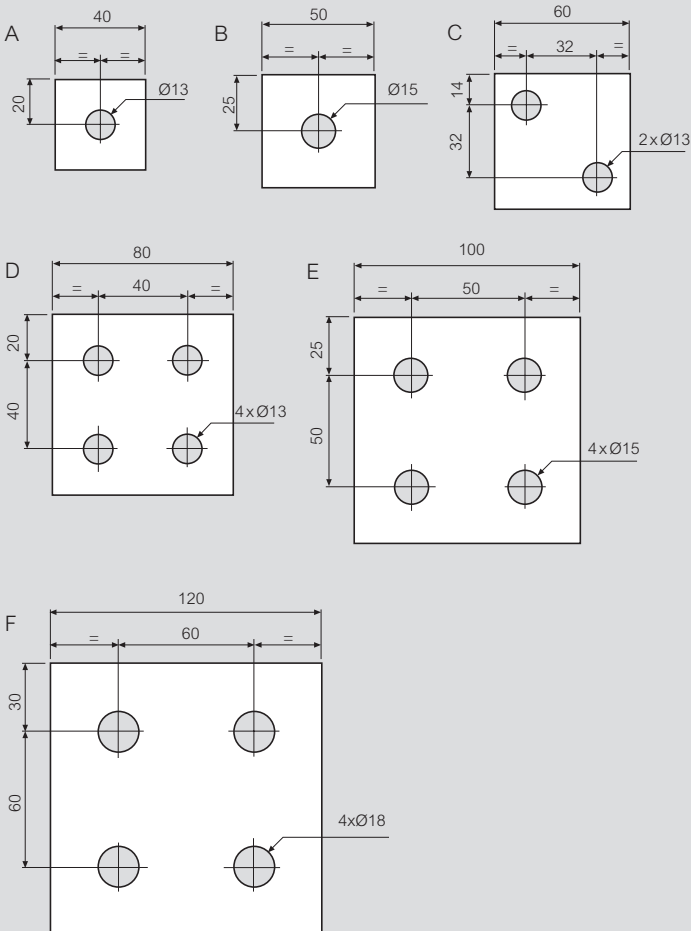
	Dd0		Dd6
	Yy0		Yy6
	Dz0		Dz6
	Dy11		Dy5
	Yd11		Yd5
	Yz11		Yz5

Standard drilling details

LV connection terminals are manufactured from aluminium
Special CUPAL bimetallic plates can be supplied for the connection of copper cables

Drawing	Range kVA	Thickness [mm]	Width [mm]	No. of holes	Ø holes [mm]
A	100	4	40	1	13
	160	4	40	1	13
B	200	5	50	1	15
	400	5	50	1	15
C	500	6	60	2	13
	630	6	60	2	13
	800	8	60	2	13
D	1000	8	80	4	13
E	1250	8	100	4	15
F	1600	10	120	4	18
	2000	12	120	4	18
	2500	16	120	4	18
	3150	20	120	4	18

All the data given can be modified without warning for reasons of technical production or product improvement



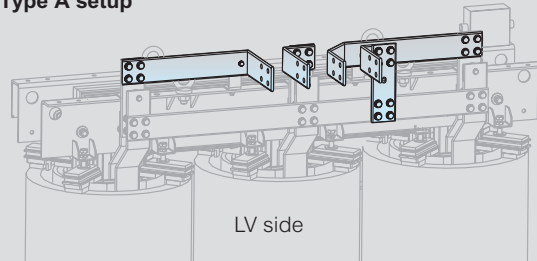
Special extended LV bar arrangements

The Legrand Group offer meets the needs of any installation
Cast resin transformers have specifically designed connections for Zucchini busbars

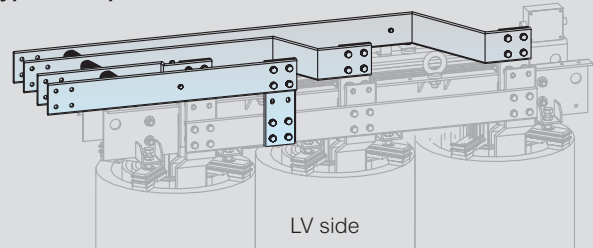
The versions shown represent some of the standardised solutions

For the outgoing busbar run from the transformer

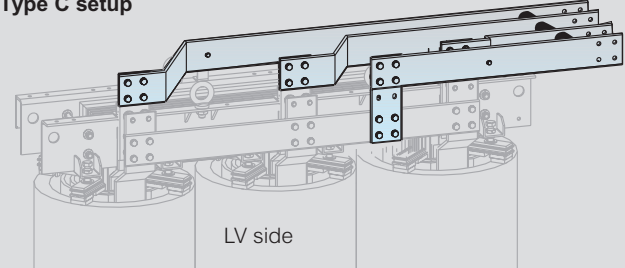
Type A setup



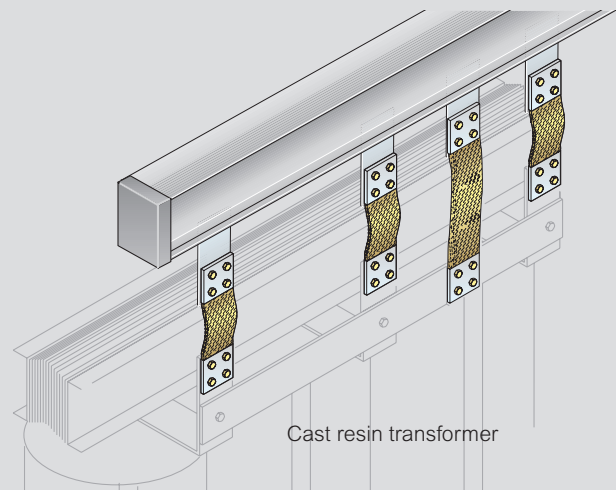
Type B setup



Type C setup



ATR connection interface



A technical drawing of the transformer is needed when creating an ATR connection interface

Extended MV bars are available on request,
contact us on +44 (0) 845 600 6266

Green T.HE MV/LV cast resin transformers

technical information (continued)

Compatibility with Zucchini SCP busbar

The Zucchini SCP busbar trunking system and cast resin transformers have been designed in perfect synergy for a direct connection. The versions shown below represent just a few of the standardised solutions.

400 V secondary voltage

Transformer				Busbar (aluminium)	
kVA (kVA)	Insulation class (kV)	400 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	910	15-20	SCP 1 000 A	60281012P
800		1 155	19-30	SCP 1 250 A	60281014P
1 000		1 444	24-10	SCP 1 600 A	60281016P
1 250		1 805	30-10	SCP 2 000 A	60281017P
1 600		2 310	38-50	SCP 2 500 A	60391014P
2 000		2 887	48-20	SCP 3 200 A	60391016P
2 500		3 609	60-20	SCP 4 000 A	60391017P

Transformer				Busbar (copper)	
kVA (kVA)	Insulation class (kV)	400 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	910	15-20	SCP 1 000 A	65281011P
800		1 155	19-30	SCP 1 250 A	65281013P
1 000		1 444	24-10	SCP 1 600 A	65281015P
1 250		1 805	30-10	SCP 2 000 A	65281016P
1 600		2 310	38-50	SCP 2 500 A	65391018P
2 000		2 887	48-20	SCP 3 200 A	65391015P
2 500		3 609	60-20	SCP 4 000 A	65391016P
3 150	4 547	75-78 ¹	SCP 5 000 A	65391018P	

1 : 7% impedance = 64-96

For full details on Legrand busbar systems see www.legrand.co.uk/zucchini

417 V secondary voltage

Transformer				Busbar (aluminium)	
kVA (kVA)	Insulation class (kV)	417 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	873	14-60	SCP 1 000 A	60281012P
800		1 108	18-50	SCP 1 250 A	60281014P
1 000		1 385	23-10	SCP 1 600 A	60281016P
1 250		1 731	28-90	SCP 2 000 A	60281017P
1 600		2 216	37-00	SCP 2 500 A	60391014P
2 000		2 770	46-20	SCP 3 200 A	60391016P
2 500		3 462	57-70	SCP 4 000 A	60391017P

Transformer				Busbar (copper)	
kVA (kVA)	Insulation class (kV)	417 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	873	14-60	SCP 1 000 A	65281011P
800		1 108	18-50	SCP 1 250 A	65281013P
1 000		1 385	23-10	SCP 1 600 A	65281015P
1 250		1 731	28-90	SCP 2 000 A	65281016P
1 600		2 216	37-00	SCP 2 500 A	65391018P
2 000		2 770	46-20	SCP 3 200 A	65391015P
2 500		3 462	57-70	SCP 4 000 A	65391016P
3 150	4 362	72-70 ¹	SCP 5 000 A	65391018P	

1 : 7% impedance = 64-20

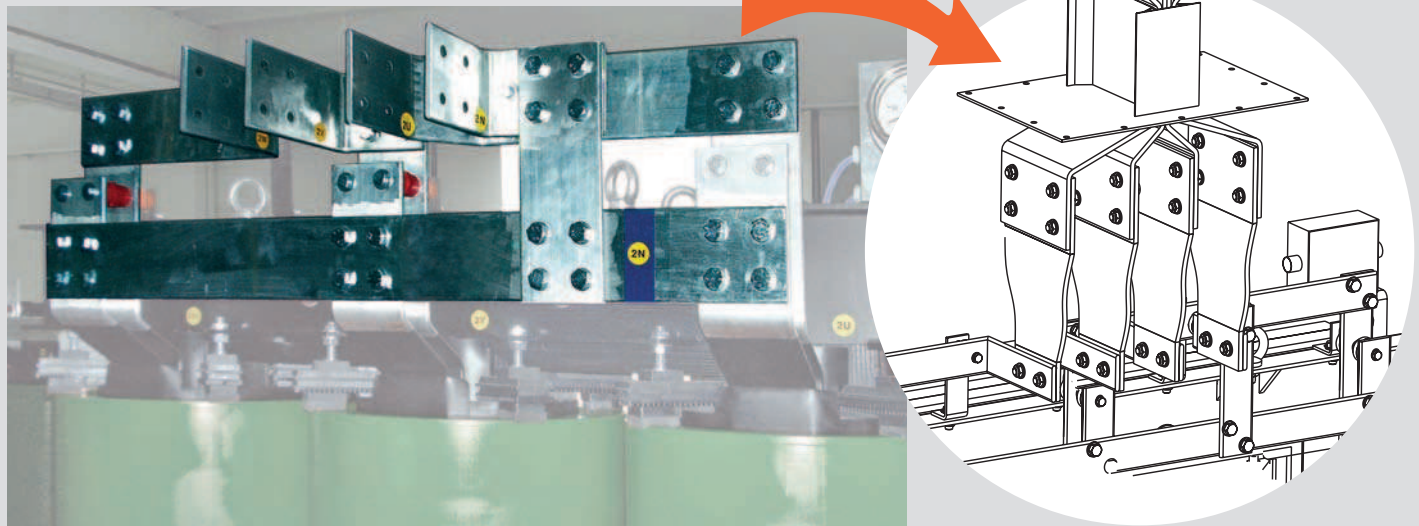
433 V secondary voltage

Transformer				Busbar (aluminium)	
kVA (kVA)	Insulation class (kV)	433 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	841	14-10	SCP 1 000 A	60281012P
800		1 067	17-80	SCP 1 250 A	60281014P
1 000		1 334	22-30	SCP 1 600 A	60281016P
1 250		1 667	27-80	SCP 2 000 A	60281017P
1 600		2 134	35-60	SCP 2 500 A	60391014P
2 000		2 667	44-50	SCP 3 200 A	60391016P
2 500		3 334	55-60	SCP 4 000 A	60391017P

Transformer				Busbar (copper)	
kVA (kVA)	Insulation class (kV)	433 V current (A)	IK 6 % (kA)	Family	Connection component
630	12, 17-5, 24, 36	841	14-10	SCP 1 000 A	65281011P
800		1 067	17-80	SCP 1 250 A	65281013P
1 000		1 334	22-30	SCP 1 600 A	65281015P
1 250		1 667	27-80	SCP 2 000 A	65281016P
1 600		2 134	35-60	SCP 2 500 A	65391018P
2 000		2 667	44-50	SCP 3 200 A	65391015P
2 500		3 334	55-60	SCP 4 000 A	65391016P
3 150	4 201	70-02 ¹	SCP 5 000 A	65391018P	

1 : 7% impedance = 60-01

Transformer to busbar connection



ZUCCHINI SCP



fast, simple
installation saves
time and money on site

INSTALLATION SIMPLICITY

Designed to work perfectly in conjunction with Zucchini's cast resin transformers, the SCP busbar range offers quick, reliable assembly with a vast combination of accessories for maximum flexibility. Conductors are available in a choice of copper or aluminium.

PLANNING SIMPLICITY

A comprehensive range of standard products is further enhanced by Legrand's technical expertise and ability to create bespoke solutions tailored to any requirements. The SCP range can be manufactured in standard, clean earth or 200% neutral versions.



TO FIND OUT MORE CALL OUR TECHNICAL SUPPORT TEAM ON
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