

Trasfor 3E Series

Reliable Answers to Your Questions

 Made in Switzerland



trasfor.ch

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What is the 3E Series?

3E is the new range of cast resin transformers developed by Trasfor for utilization within the electricity distribution sector. The key features of the 3E series transformers are embodied in the name of the range itself. 3E transformers are clearly defined for being:

Efficient

No-load losses and load losses are reduced and able to satisfy the most demanding requirements. Transformers are capital goods with a service life of decades and as such costs arising from losses represent the major part of their through life cost. Reducing transformer losses is Trasfor's commitment to help its customers reduce their long term running costs.

Ecological

All materials used to manufacture the 3E transformers are completely recyclable and eco-compatible. The absence of dielectric fluids and potentially pollutant substances make these products environmentally friendly. This is Trasfor's commitment to protect the environment not only for people today but for generations to come.

Economical

Trasfor understands the value of money. The 3E range represents great economic value whilst delivering outstanding quality and performance. Trasfor's experience in the design and manufacturing of specialised cast resin transformer over the last 35 years places the company in a unique position. The ability to utilise technologies and materials developed during this period allows us to deliver the very highest quality product at a very competitive price.

Trasfor's 3E series transformers are designed and manufactured in accordance with the standard **IEC60076-11**, Ed. 1-0 May **2004**.

All 3E transformers comply with:

- » Environmental class **E2**: capable to be used in the presence of frequent condensation and heavy pollution
- » Climatic class **C2**: suitable for operation, transport and storage at ambient temperatures down to -25°C
- » Fire behaviour class **F1**: self-extinguishing, free from halogens, with no emission of toxic substances and opaque smoke.





Why Cast Resin Transformers?

Cast resin transformers are the natural choice for the distribution of electrical energy.

There are numerous advantages in the selection of a cast resin transformer over the traditional fluid cooled transformer design.

Low Fire Risk

- » Dry insulation system. No flammable or high flame point fluids
- » Materials are self extinguishing
- » Materials are Low Smoke/Zero Halogen
- » No need for security devices for fire survey

Environmentally Friendly

- » No danger of liquid spillage
- » All materials recyclable
- » Eco-friendly materials and manufacturing processes

Reduced Installation and Construction Costs

- » Installed indoors, close to the load centre
- » Shorter LV cable runs: reduced cable and installation costs
- » Reduced construction costs (no leakage containment or blast wall required)

Overload capability

- » Excellent short time overload capability due to the low current density in the windings and the high time constant of the coils
- » Overloads to IEC60905 - Loading Guide for Dry Type Transformers

Increase in performance

- » Increased ratings to match 'unforeseen' higher demand using cooling fans.
- » Forced air cooling fans easily retro fitted to provide extra capacity

Designed for Reliability

- » Excellent dielectric strength
- » Optimised short circuit withstand strength
- » Good resistance to humidity and atmospheric pollution
- » Resistance to shock and vibration

Maintenance

- » Practically maintenance free
- » Designed for a minimum 25 year life expectancy.

Shopping malls, hospitals, civil and sport facilities, airports, barracks, museums, public and private office blocks: these are only some examples of the wide field of applications of Trasfor's 3E Series transformers.

Magnetic core

No-load losses, noise and no-load currents: these are crucial features of a high-quality transformer and they depend on the magnetic core. As a result, the choice of a high-quality core is vital. This is what underlies design and manufacturing of all the 3E Series transformers cores.

- » High-permeability and low-loss grain-oriented steel sheets
- » Pre-coating with a high temperature inorganic insulating material, which minimises losses due to eddy currents

- » 45° step-lap assembling of the sheets, which minimises stray-flux losses and prevents joint vibrations
- » Final coating of the complete assembly by spray painting, which gives protection to the core against corrosion and, by infiltrating between the individual core sheets, sticks them together with benefits in terms of noise emission and resistance to vibrations.

Low voltage windings

- » The Low Voltage coils utilised in Trasfor 3E Distribution Transformers are produced using concentrically wound aluminium foil. This technique produces a very compact and mechanically strong coil
- » The width of the foil equals the length of the coil. Under load conditions the temperature within the LV winding distributes itself uniformly along the axial length of the coil and helps to reduce hot spot conditions
- » The insulation material used throughout the winding is Class F, suitable for a designed average winding rise of 100°C for use in a 40°C peak ambient environment

- » The whole winding is impregnated in a bath of epoxy resin
- » The complete LV coil assembly is processed under vacuum conditions providing outstanding resistance against contamination from normal atmospheric pollution and excellent mechanical strength under short circuit conditions.
- » LV terminations are located at the top of the coil and are drilled with a number of holes relating to the transformer rating.



High voltage windings

- » The High Voltage coils utilised in Trasfor 3E Distribution Transformers are produced using concentrically wound aluminium foil conductor
- » The complete HV winding assembly is cast under vacuum using a Class F epoxy resin
- » The vacuum process removes air from within the winding and the resin which in turn eliminates small voids or air 'bubbles' within the finished casting
- » The HV casting can now be considered to be essentially 'discharge free' and will greatly enhance the long term reliability of the complete transformer
- » The insulation material used throughout the winding is Class F with a designed average winding rise of 100°C for use in a 40°C peak ambient environment
- » The coils are provided with high voltage off-circuit regulating taps, normally set at $\pm 2 \times 2,5\%$
- » HV terminations are located at the top of the coil and are drilled with 1 fixing hole.

Why HV Foil Windings?

There are a number of major advantages:

- » The HV foil winding technique produces 'inter-coil' voltage stresses significantly lower than those of a comparable traditional design. In a conventional wire winding, the inter-layer voltage can be much higher than the inter-turn voltage, as two facing conductors belonging to two adjacent layers can belong to two distant turns (the interval between them can be of several intermediate turns). In a foil winding the inter-layer voltage is equal to the single inter-turn voltage.
- » The HV foil design has excellent dielectric performance. The capacitive nature of the foil design provides almost uniform voltage distribution of any transient surges and avoids unnecessary dielectric stress during switching operations.
- » The flat surface of the foil ensures a superior and more homogeneous resin penetration, favouring the total absence of any void inside the casting.
- » The combination of the cast resin system together with HV foil winding technology produces a high mechanical 'hoop' strength and resistance to radial forces under short circuit conditions.



Why Aluminium instead of Copper?

Trasfor has for many years produced transformers for a wide range of markets utilising both aluminium and copper winding conductors. We have the knowledge and experience to be objective with either conductor material. Both winding materials provide low loss, highly reliable transformers of equal technical performance. However there are two key advantages in using aluminium: one technical and one economical.

Technically the coefficient of expansion of aluminium is more closely matched to that of the more commercially available epoxy casting resins. This is particularly relevant if the transformer is subjected to rapid changes of load during the duty cycle or significant overloads.

Secondly there is the economic consideration. For the same current carrying capacity an aluminium conductor

would need to be circa 64% larger in cross section than the equivalent copper conductor. This results in a copper transformer being marginally smaller but slightly heavier than the aluminium equivalent. However the density of aluminium compared with copper means that the mass of the aluminium winding is still 50% lower than the equivalent copper design. This, in turn, results in a very significant difference in the cost of the winding conductor material and in the finished transformer. It is for this very reason that aluminium is the chosen winding conductor for the vast majority of cast resin manufacturers in the world today. Commodity prices for aluminium and copper vary from year to year but the copper transformer will always be significantly more expensive than the equivalent aluminium design – With no technical difference in performance!



What tests are performed on the 3E series transformers?

At the end of the manufacturing process each 3E transformer produced is subjected to a complete cycle of **Routine Tests** in our laboratory.

These tests ensure:

- » Full compliance with IEC60076-11 international standard
- » Long term reliability
- » Compliance with individual customer specifications
- » Confirmation of requested technical performance.

Additionally these tests and the results achieved give Trasfor the feedback and statistical data necessary to continuously improve its design and manufacturing processes.

Each transformer is subjected to the following tests:

- » Measurement of winding resistance
- » Measurement of voltage ratio and check of phase displacement

- » Measurement of short-circuit impedance and load loss
- » Measurement of no-load loss and current
- » Separate-source AC withstand voltage test
- » Induced AC withstand voltage test
- » Partial discharge measurement

On request the following **Type Tests** can be carried out:

- » Lightning impulse test
- » Temperature-rise test

It is also possible to carry out also the following **Special Tests**, either inside our laboratories or at external third party certified test centres:

- » Measurement of sound level
- » Short-circuit test

Each transformer is supplied with a test certificate detailing the tests conducted and the results achieved.



What accessories are available?

The 3E Series transformers are designed for indoor use and can be supplied as open style (IP00) construction or enclosed in sheet steel enclosures providing improved safety to personnel or offering environmental protection. Standard protection degrees are IP21, IP23 or IP31.

Special enclosure designs can be made available on request for higher protection degrees or for specific outdoor applications.

Standard accessories

Standard fittings for all open style (IP00) 3E transformers:

- » 6 PTC thermal sensors (2 each phase) or 3 PT100 thermal sensors (1 each phase), installed in the LV windings and terminated in a centralized auxiliary circuit box
- » 4 bi-direction rollers
- » 4 lifting lugs
- » 2 earthing terminals
- » 1 rating plate
- » $\pm 2,5\%$ and $\pm 5\%$ HV tapplings (via off-circuit removable bolted links)
- » 3 HV aluminium connection terminals (top mounted for cable entry from above)
- » 4 LV aluminium connection bars (top mounted for cable entry from above)
- » 1 routine test certificate
- » 1 installation and maintenance manual

Optional accessories

Options available on demand:

- » Additional PTC thermal sensors or PT100 thermal sensors, installed in the LV windings and cabled in a centralized auxiliary circuit box
- » Thermal relay for PTC thermal sensors (without temperature display)
- » Temperature monitor relay for PT100 thermal sensors (with digital temperature display)
- » Temperature monitor relay with analogue output 4-20 mA or digital output ModBus for remote temperature control
- » Set of forced ventilation cooling fans (6 radial fans)
- » Control relay for forced ventilation cooling fans
- » Set of 3 HV cast terminations (for use with separable 'elbow' connectors supplied by others)
- » Set of 4 anti-vibration mounts (for mounting under bi-directional rollers)
- » Electrostatic shield between primary and secondary windings
- » Protection housing IP21, IP23 or IP31 for indoor installation
- » Set of 3 HV Surge arresters
- » Earthing kit equipment (ball bolts and earth connecting bars).

For further additional accessory not listed above please contact Trasfor.

Which transformers are available?

Electrical characteristics for insulation levels 7,2kV and 12kV ⁽¹⁾⁽²⁾

Rated Power		kVA	100	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500
Rated Primary Voltage		kV	5 to 11													
No-Load Losses		W	440	610	750	820	1000	1150	1350	1500	1800	2000	2500	2800	3900	4300
Load Losses at 75°C		W	1700	2300	2800	3000	3600	4300	5200	6400	7500	8800	10500	12200	14500	19000
Load Losses at 120°C		W	1950	2600	3200	3450	4100	4900	5950	7350	8600	10100	12050	14000	16650	21850
Rated Impedance Voltage (%)		%	6	6	6	6	6	6	6	6	6	6	6	6	6	6
No-Load Current		%	1,7	1,6	1,5	1,4	1,3	1,2	1	0,8	0,75	0,75	0,7	0,65	0,65	0,6
Noise Pressure Level at 1m		dB(A)	51	53	54	55	56	57	58	58	59	61	62	63	64	65
Efficiency (%) for cos Φ = 1	at Load	100%	97,87	98,19	98,23	98,48	98,54	98,64	98,69	98,75	98,84	98,92	98,96	99,03	99,08	99,07
		75%	98,15	98,42	98,46	98,67	98,72	98,81	98,86	98,92	99,00	99,08	99,11	99,17	99,20	99,20
		50%	98,29	98,53	98,56	98,75	98,80	98,89	98,95	99,02	99,09	99,16	99,18	99,26	99,25	99,28
Efficiency (%) for cos Φ = 0,9	at Load	100%	97,58	97,94	97,99	98,27	98,34	98,45	98,51	98,58	98,66	98,77	98,82	98,90	98,95	98,94
		75%	97,91	98,22	98,26	98,50	98,56	98,66	98,72	98,78	98,87	98,95	98,99	99,06	99,09	99,10
		50%	98,08	98,35	98,38	98,60	98,65	98,76	98,82	98,90	98,97	99,06	99,08	99,16	99,16	99,19
Efficiency (%) for cos Φ = 0,8	at Load	100%	97,27	97,67	97,73	98,04	98,13	98,25	98,32	98,39	98,50	98,61	98,66	98,75	98,81	98,80
		75%	97,64	97,99	98,03	98,30	98,37	98,49	98,55	98,62	98,72	98,82	98,86	98,94	98,97	98,98
		50%	97,83	98,14	98,18	98,42	98,48	98,60	98,66	98,76	98,84	98,94	98,96	99,06	99,05	99,08
Voltage Drop (%) for cos Φ = 1	at Load	100%	1,87	1,61	1,57	1,37	1,32	1,25	1,21	1,19	1,11	1,06	1,02	0,97	0,90	0,94
		75%	1,40	1,21	1,18	1,03	0,99	0,94	0,91	0,89	0,83	0,79	0,76	0,73	0,68	0,70
		50%	0,93	0,80	0,79	0,69	0,66	0,62	0,61	0,60	0,56	0,53	0,51	0,49	0,45	0,47
Voltage Drop (%) for cos Φ = 0,9	at Load	100%	4,14	3,94	3,91	3,76	3,71	3,66	3,63	3,61	3,55	3,50	3,47	3,43	3,38	3,40
		75%	3,10	2,95	2,93	2,82	2,78	2,74	2,72	2,71	2,66	2,63	2,60	2,57	2,53	2,55
		50%	2,07	1,97	1,96	1,88	1,86	1,83	1,82	1,81	1,77	1,75	1,73	1,72	1,69	1,70
Voltage Drop (%) for cos Φ = 0,8	at Load	100%	4,88	4,72	4,69	4,57	4,53	4,48	4,46	4,45	4,39	4,35	4,33	4,30	4,25	4,27
		75%	3,66	3,54	3,52	3,42	3,40	3,36	3,35	3,33	3,29	3,27	3,25	3,22	3,19	3,20
		50%	2,44	2,36	2,35	2,28	2,26	2,24	2,23	2,22	2,20	2,18	2,16	2,15	2,12	2,14
Time Constant	T	s	0,10	0,15	0,15	0,20	0,20	0,25	0,25	0,30	0,35	0,35	0,40	0,45	0,50	0,55
		le/m	14,0	13,5	13,5	13,0	13,0	12,5	12,0	11,5	11,0	11,0	10,5	10,0	10,0	9,5

(*) 4% available on request

Common characteristics

Frequency	50Hz	Type of Cooling	AN (*)
Secondary Voltage at No Load	400 to 433V	Insulation System Temperature	F/F
HV Tappings (Off Circuit)	±2,5% ±5%	Maximum Ambient Temperature	40°C
Vector Group	Dyn (delta, star, neutral brought out)	Installation Altitude	≤1000m
Partial Discharges	≤10pC	Environmental class	E2
Winding Material	Al/Al	Climatic class	C2
Primary Winding Protection	Cast Resin	Fire behaviour class	F1
Secondary Winding Protection	Vacuum Impregnated		

(*) Al available on request

Electrical characteristics for insulation levels 17,5kV and 24kV ⁽¹⁾⁽²⁾

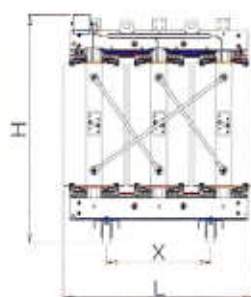
Rated Power		kVA	100	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500
Rated Primary Voltage		kV	15 to 22													
No-Load Losses		W				880	1000	1200	1400	1650	2000	2300	2700	3100	3800	4600
Load Losses at 75°C		W				3300	3900	4800	5800	6900	8000	9600	11300	13100	16000	18300
Load Losses at 120°C		W				3750	4450	5500	6650	7900	9200	11000	12950	15050	18400	21000
No-Load Current		%				1.5	1.4	1.2	0.9	0.8	0.7	0.7	0.65	0.6	0.6	0.55
Rated Impedance Voltage		%				6	6	6	6	6	6	6	6	6	6	6
Noise Pressure Level at 1m		dB(A)				55	56	57	58	58	59	61	62	63	64	65
Efficiency (%) for cos Φ = 1	at Load	100%				98.81	98.47	98.57	98.58	98.65	98.75	98.81	98.87	98.93	98.98	99.00
		75%				98.97	98.66	98.76	98.76	98.83	98.92	98.98	99.02	99.09	99.11	99.14
		50%				99.05	98.74	98.86	98.85	98.93	99.00	99.06	99.10	99.18	99.18	99.20
Efficiency (%) for cos Φ = 0.9	at Load	100%				98.15	98.26	98.37	98.39	98.46	98.58	98.65	98.71	98.79	98.84	98.86
		75%				98.39	98.49	98.60	98.60	98.68	98.78	98.84	98.89	98.97	98.99	99.02
		50%				98.50	98.59	98.72	98.70	98.80	98.88	98.95	98.98	99.08	99.06	99.10
Efficiency (%) for cos Φ = 0.8	at Load	100%				97.91	98.03	98.15	98.18	98.26	98.39	98.47	98.54	98.62	98.69	98.71
		75%				98.18	98.29	98.41	98.42	98.51	98.62	98.69	98.75	98.83	98.86	98.89
		50%				98.31	98.41	98.55	98.54	98.65	98.74	98.81	98.85	98.96	98.94	98.99
Voltage Drop (%) for cos Φ = 1	at Load	100%				1.45	1.38	1.32	1.29	1.27	1.18	1.14	1.08	1.05	0.98	0.98
		75%				1.09	1.03	0.99	0.97	0.95	0.88	0.85	0.81	0.79	0.73	0.73
		50%				0.73	0.69	0.66	0.65	0.63	0.59	0.57	0.54	0.53	0.49	0.49
Voltage Drop (%) for cos Φ = 0.9	at Load	100%				3.82	3.76	3.72	3.69	3.67	3.60	3.57	3.52	3.50	3.44	3.44
		75%				2.86	2.82	2.79	2.77	2.76	2.70	2.67	2.64	2.62	2.58	2.58
		50%				1.91	1.88	1.86	1.85	1.84	1.80	1.78	1.76	1.75	1.72	1.72
Voltage Drop (%) for cos Φ = 0.8	at Load	100%				4.25	4.57	4.53	4.51	4.50	4.44	4.41	4.37	4.35	4.30	4.30
		75%				3.19	3.43	3.40	3.39	3.37	3.33	3.31	3.28	3.26	3.22	3.22
		50%				2.12	2.29	2.27	2.26	2.25	2.22	2.20	2.19	2.18	2.15	2.15
Time Constant	T	s				0.15	0.15	0.20	0.20	0.25	0.30	0.30	0.35	0.35	0.45	0.50
		Is/In				14.0	13.0	13.0	12.5	12.0	12.0	11.5	11.0	11.0	10.5	10.0

* Preliminary data.

⁽¹⁾ Insulation levels

Highest voltage for equipment U_m (r.m.s.)	Rated short duration separate source AC withstand voltage (r.m.s.)	Rated lightning impulse withstand voltage (peak value)
kV	kV	kV
7.2	20	60
12	28	75
17.5	38	95
24	50	125

Version IP00



Version IP21, IP23, IP31

Dimensions and weights for insulation levels 7,2kV and 12kV ⁽²⁾

Rated Power		kVA	100	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500
IP00	L	mm	1070	1200	1250	1230	1320	1320	1350	1410	1500	1520	1560	1640	1730	1890
	B	mm	720	720	720	800	820	870	900	820	900	1000	1000	1000	1350	1350
	H	mm	930	1130	1180	1320	1410	1440	1560	1630	1700	1830	2060	2160	2350	2420
	Weight	kg	550	800	800	950	1150	1300	1430	1680	2000	2300	2790	3350	3950	4775
IP21 IP23 IP31	L	mm	1650	1650	1650	1650	1650	1650	1650	1800	1800	1800	1950	1950	2200	2200
	B	mm	950	950	950	950	950	950	950	1050	1050	1050	1200	1200	1350	1350
	H	mm	1800	1800	1800	1800	1800	1900	1900	2100	2100	2100	2400	2400	2800	2800
	Weight	kg	750	1000	1000	1150	1350	1500	1630	1940	2260	2560	3120	3680	4370	5195
Wheel diameter		mm	125	125	125	125	125	125	125	125	125	160	160	160	200	200
Wheel-track and distance	X	mm	520	520	520	520	520	670	670	670	670	820	820	820	1070	1070

Dimensions and weights for insulation levels 17,5kV and 24kV ⁽²⁾

Rated Power		kVA	100	160	200	250	315	400	500	630	800	1000	1250	1600	2000	2500
IP00	L	mm				1440	1440	1500	1530	1550	1590	1650	1710	1770	1850	2040
	B	mm				890	900	900	900	900	900	1000	1000	1100	1350	1350
	H	mm				1420	1500	1560	1630	1730	1850	1920	2080	2240	2420	2550
	Weight	kg				1210	1330	1500	1700	1940	2250	2600	3060	3620	4370	5340
IP21 IP23 IP31	L	mm				1950	1950	2050	2050	2050	2200	2200	2300	2300	2400	2550
	B	mm				1200	1200	1300	1300	1300	1350	1350	1400	1400	1500	1500
	H	mm				1700	1700	2000	2000	2000	2200	2200	2400	2700	2700	2900
	Weight	kg				1480	1580	1800	2000	2240	2600	2950	3440	4030	4820	5840
Wheel diameter		mm				125	125	125	125	125	125	160	160	160	200	200
Wheel-track and distance	X	mm				520	670	670	670	670	670	820	820	820	1070	1070

(2) Preliminary data.

What service can you trust?

Worldwide Consulting, Maintenance, Technical Assistance & Service. To consolidate its position Trasfor has created an additional service arm to offer a complete technical consultancy, ranging from project specific engineering studies to routine inspection and maintenance.

Trasfor Consulting offers a unique world-class service for any type of transformer, starting from commissioning, through scheduled and unscheduled maintenance and immediate intervention.

Trasfor Consulting team of qualified and certified experts is ready 24/7 to fly all over the world and face any level of emergency situation, reducing to the minimum your down time.

For more in-depth technical analysis **Trasfor Consulting**, through a pool of specialist, electrical, mechanical and structural engineers, is able to assist with specific product developments and provide solutions to the most complex technical requests.

We analyze your installation and we suggest to you a list of the most important and critical spare parts.







Quality

- » Quality as ISO certification 9001:2000
- » Quality as total respect of environment with ISO 14001-2004
- » Quality for the railway industry as IRIS - International Railways Industry Standard
- » Quality of products and person through ISO EN 3834-2, EN 15085, UL File E172880 and UL File E216928 certification
- » Certificate of conformity to GOST R

Quality through entrustment by the following certifying bodies:

ABS - American bureau of shipping

DNV - Det norske veritas

GL - Germanischer Lloyd

Standards: all int. standards such as IEC, BS, CSA, UL, VDE/DIN, ABS, BV, ANSI, DNV, LRS, etc.



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