

## Transformer Specialists



# 50Hz

## Cast Resin Distribution Transformers



2022 Edition

# TMC

## TRANSFORMERS

ESTABLISHED 1936

## FOR MORE THAN 80 YEARS

Transformers Manufacturing Company Pty Ltd - the original TMC - was established in Melbourne, Australia in 1936 as a manufacturer of oil cooled and dry type transformers.

Following rapid technological developments in the field of epoxy resins during the 1980s, TMC began specialising in vacuum cast epoxy resin transformers.

Over the ensuing decades TMC has evolved as a top tier supplier to both domestic and international markets with products that enjoy a reputation for high quality and reliability.

By focusing solely on transformers for more than eight decades, TMC has developed specialist design knowledge and manufacturing expertise in its production plants in Australia and Spain.

The technical and production expertise of TMC Australia and TMC Spain combine synergistically to facilitate the design and manufacture of a broad range of products ranging from standard distribution transformers to complex, highly sophisticated transformers and reactors - in a highly efficient and cost-effective manner.



WIND

MEDICAL

INFRASTRUCTURE

MARINE

## TMC CAST RESIN TRANSFORMERS

### Negligible Partial Discharge

Internal partial discharge, which is a major cause of erosion and failure in insulation systems at voltages greater than 12kV, are effectively eliminated in TMC cast resin transformers, significantly extending the service life.

### Environmentally Safe

TMC cast resin transformers contain no liquid to pollute the ground or water supplies, and no special measures are required to guard against spillage.

### Fire and Flame Resistant

The resin formulations used in TMC cast resin transformers are self-extinguishing thus increasing safety and reducing the risk to life and property in the event of a fire.

### Lightning Impulse Withstand Voltage (BIL)

TMC cast resin transformers are designed to withstand lightning impulse voltages even in the absence of surge protection devices.

### High Thermal Conductivity

TMC cast resin transformers are mechanically resistant and thermally tolerant to short term overloads.

### Inherent Superior Dynamic Strength

Increased ability to withstand short circuit is inherent in a foil wound cast resin transformer.

### Superior Plant and Manufacturing Practices

State-of-the-art foil winding machines enable insulation and conductor materials to be wound simultaneously, resulting in a very compact winding, capable of resisting radial and short circuit forces.

A further major electrical advantage over conventional wire or strip windings is that the interlayer voltage never exceeds the individual voltage of each turn. This results in lower internal electrical stress and a more reliable product than that of competitors using less sophisticated wire winding technologies.

### International Standards

TMC transformers are manufactured in Spain and Australia in accordance with strict international standards.



SOLAR

MINING

EV FAST  
CHARGING

TRACTION

DISTRIBUTION

INDUSTRY

## STANDARD COMPONENTS

### Lifting Lugs

Four lifting lugs are provided on the top core clamps.

### Three-limb Core

The core is manufactured from prime quality, low loss, grain oriented ferro-silicon steel laminations, individually coated with high temperature, inorganic insulation. The completed core is treated with a high temperature, electrically stable coating, to prevent corrosion in service.

### High Voltage (HV) Windings

HV windings consist of vacuum cast, fibreglass reinforced aluminium or copper foil. The foil is edge conditioned and wound in continuous discs onto a precision former. This system of winding guarantees the accuracy required for close tolerance casting in precision moulds.

### Epoxy Resin Insulation

The windings are reinforced with fibreglass mesh and vacuum cast in high temperature epoxy resin. The resin ensures the transformer is maintenance-free, moisture-free, tropicalised, flame-resistant and self-extinguishing.

### High Voltage Terminals

HV terminals are available with variable arrangements to permit optimum installation.

### High Voltage Tappings

For off-circuit adaptation to the supply network.



### Low Voltage (LV) Windings

LV windings are produced with aluminium or copper foil covering the full winding length. The foil conductor edges are conditioned prior to winding and each LV turn is insulated with three-ply, resin impregnated high temperature film laminate.

After winding, vacuum pressure impregnation and final oven hardening fully protect the coil from infiltration of moisture.

### Low Voltage Terminals

Tinned aluminium or copper

### Low Voltage Terminal Insulator

Strengthens LV terminal palms against mechanical forces.

### Resilient Supports

Provide insulation for core and windings against mechanical vibrations.

### Temperature Monitoring

Detectors in the LV winding.

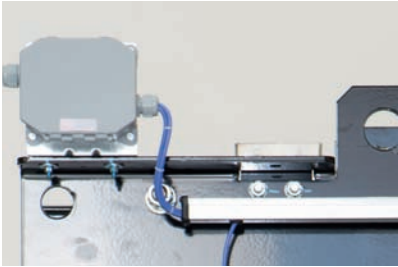
### Bi-directional Metallic Wheels

### Hot Dipped Galvanised Steel Core Feet



## OPTIONAL ACCESSORIES

TMC designs and manufactures transformers with a range of accessories according to the customer's technical specifications including:



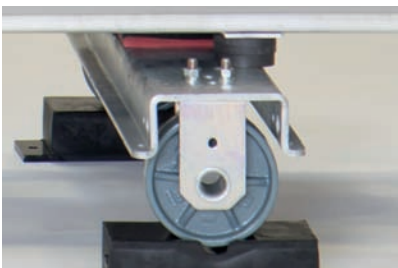
Temperature Measuring Device  
Marshalling Boxes



Analogue Temperature Monitors



Digital Temperature Monitors



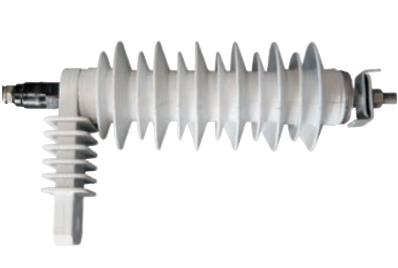
Wheel Type Vibration Dampeners



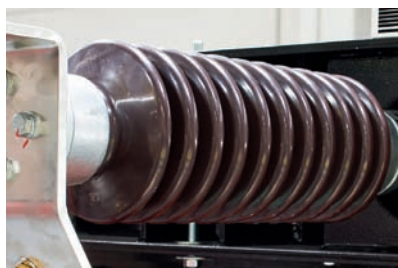
Cooling Fans



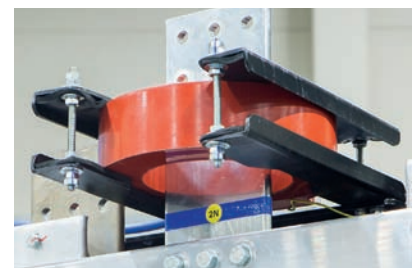
Cooling Fan Controllers



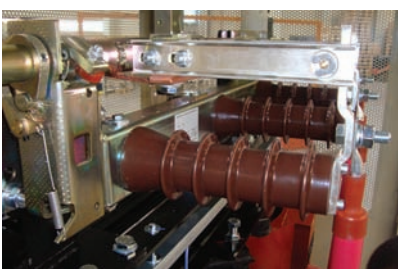
Surge Arresters



HV Bushings



HV & LV Current Transformers



HV & LV Earthing Switches



Earthing Spheres



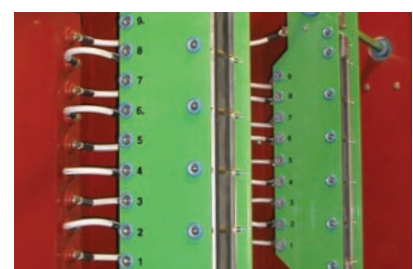
HV Separable Connectors



Seismic Reinforcement



Air to Water Cooling Systems



On-load Tap Changers

## STANDARD CHARACTERISTICS

The following characteristics are standard for the transformers depicted in this brochure. Tailored options and configurations are available upon request.

<b>International Standard</b>	<b>:</b>	<b>IEC 60076-11</b>
<b>High Voltage Classes</b>	<b>:</b>	<b>12kV, 17.5kV, 24kV and 36kV</b>
<b>Low Voltage Class</b>	<b>:</b>	<b>1.1kV</b>
<b>Frequency</b>	<b>:</b>	<b>50Hz</b>
<b>Vector Group</b>	<b>:</b>	<b>Dyn or Yyn</b>
<b>Insulation Temperature Class</b>	<b>:</b>	<b>F (155°C) or H (180°C)</b>
<b>Winding Material</b>	<b>:</b>	<b>Aluminium or Copper</b>
<b>Installation Altitude</b>	<b>:</b>	<b>≤ 1000 mamsl</b>
<b>Maximum Ambient Temperature</b>	<b>:</b>	<b>40°C</b>
<b>Type of Cooling</b>	<b>:</b>	<b>AN</b>

Separate brochures are available for the following product options:

- 50Hz EN50588-1
- 60Hz DOE/CSA
- 60Hz IEC/ANSI
- Dry Type (VPI) Transformers
- Cast Resin Earthing Transformers
- High Power Transformers

## MANUFACTURING OPTIONS

- High efficiency (reduced losses)
- Reduced temperature rise
- Multiple primary voltage windings
- Multiple secondary windings
- Hybrid aluminium / copper windings
- Particular vector groups
- Low voltage / low voltage
- Sealed or cast low voltage windings
- Galvanised core clamps
- Seismic reinforcement
- Different location options of high and low voltage connection terminals
- Variable speed drive, rectifier and excitation transformers (6, 12, 18 and 24 pulse)
- Winding coupling factor from 0.15 to 0.9
- Enclosures – IP, NEMA and CSA rated

## PACKAGING OPTIONS

Type A Plastic Wrap on Timber Pallet (standard)

Type B Vacuum Bag on Timber Pallet

Type C Plastic Wrap in Open Timber Crate

Type D Vacuum Bag in Open Timber Crate

Type E Vacuum Bag in Closed Timber Case



Vacuum Bag



Timber Crate



Timber Case

## ROUTINE TESTS (IN HOUSE)

The following routine tests are conducted by qualified, experienced personnel in TMC internal Test Laboratories on all dry-type transformers in accordance with the requirements of International Standard IEC 60076-11 “Dry-type Transformers”:

1. Measurement of voltage ratio and check of phase displacement
2. Measurement of winding resistance
3. Measurement of DC insulation resistance
4. Separate-source AC voltage withstand test
5. Induced AC voltage withstand test
6. Partial discharge measurement
7. Measurement of no-load loss and current
8. Measurement of short-circuit impedance and load loss
9. Insulation of auxiliary wiring

## TYPE TESTS (IN HOUSE)

The following type tests can be carried out in-house at additional cost:

1. Sound Level
2. Impulse Voltage
3. Zero Phase Sequence Impedance
4. Temperature Rise
5. Harmonic Analysis
6. Winding Capacitance

## SPECIAL TESTS (BY INDEPENDENT LABORATORIES)

TMC has a comprehensive library of previously conducted and independently audited special tests confirming the performance and quality of TMC’s transformers including:

**Climatic Test C2  
Environmental Test E2  
Fire Behaviour Test F1** : **CESI Testing & Certification Division, Milan Italy**

**Climatic Test C2  
Environmental Test E3** : **Tecnalia Electrical Equipment Laboratory, Bilbao Spain**

**Short Circuit Withstand Test** : **Tecnalia Electrical Equipment Laboratory, Bilbao Spain  
Testing & Certification, Sydney Australia**

**Seismic Qualification** : **Earthquake & Engineering Laboratory, Bristol UK**

**DNV GL Offshore Standard OS-D201** : **DNV GL, Oslo Norway**

## INTERNATIONAL ACCREDITATION



ISO 9001  
Quality  
Assurance



ISO 14001  
Environmental  
Management



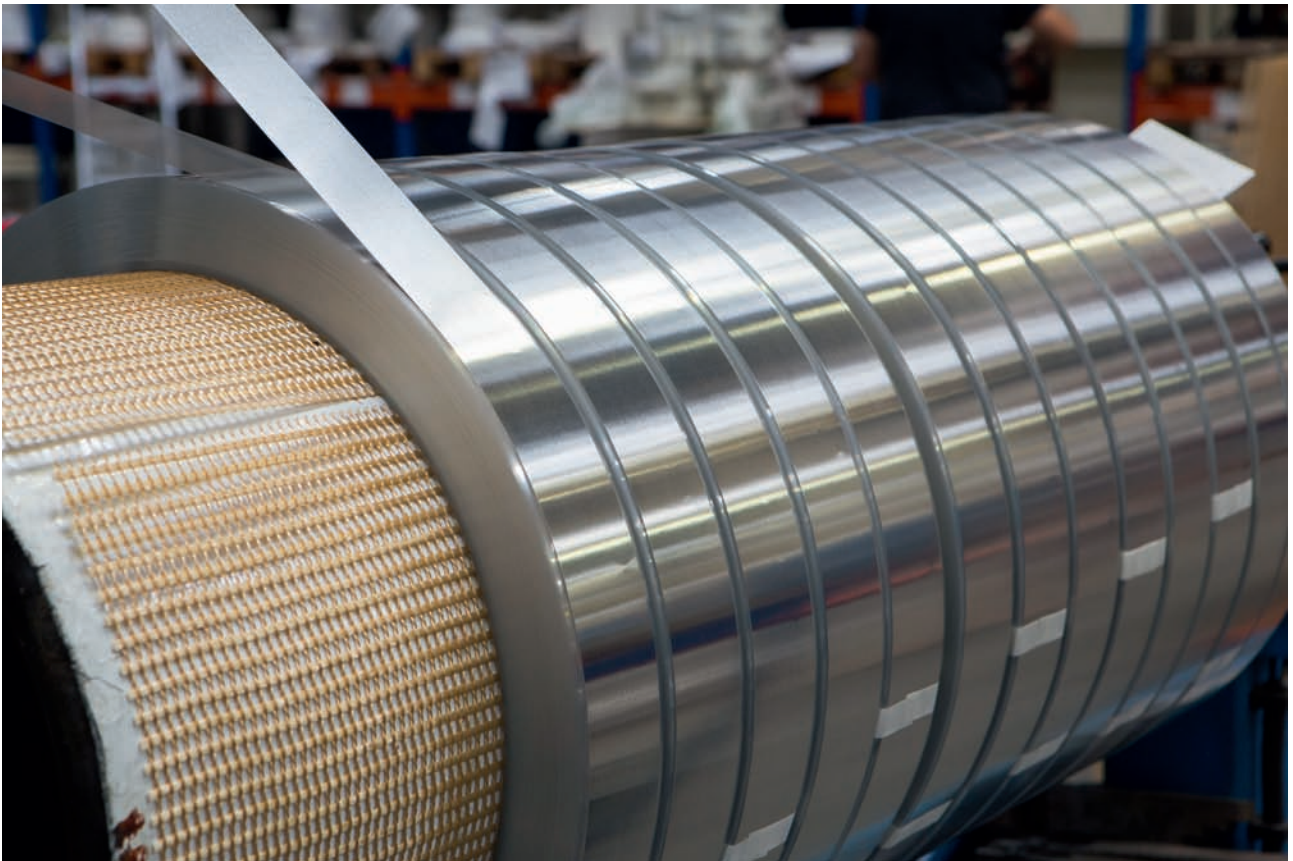
OHSAS 18001  
Occupational  
Health and Safety

## INTERNATIONAL CERTIFICATION



TMC transformers are listed by Canadian Standards Association (CSA) Group as certified up to 5MVA 25kV class and NEMA 3R enclosure. CSA Record No. 271663

# ALUMINIUM WINDINGS



# 4% Ucc

# Insulation Class 12kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	440	1800	2000	1.8	46	59	1150	600	700	1160	520	125	40	700	A	1B/1C
	Low	330	1800	2000	1.6	45	58	1150	600	700	1160	520	125	40	750	A	1B/1C
	Very Low	260	1620	1800	1.5	43	56	1200	600	700	1240	520	125	40	900	A	1B/1C
150	Standard	580	2320	2580	1.6	49	62	1150	600	700	1220	520	125	40	850	A	1B/1C
	Low	430	2320	2580	1.5	47	60	1200	600	700	1240	520	125	40	900	A	1B/1C
	Very Low	330	2140	2380	1.3	46	59	1200	600	700	1340	520	125	40	1100	A	1B/1C
160	Standard	610	2430	2700	1.6	49	62	1150	600	700	1220	520	125	40	850	A	1B/1C
	Low	450	2430	2700	1.4	47	60	1200	600	700	1240	520	125	40	900	A	1B/1C
	Very Low	350	2250	2500	1.3	46	59	1200	600	700	1360	520	125	40	1100	A	1B/1C
200	Standard	700	2750	3050	1.5	50	63	1200	750	750	1300	670	125	40	950	B	1B/1C
	Low	520	2750	3050	1.3	49	62	1200	750	750	1320	670	125	40	1000	B	1B/1C
	Very Low	410	2530	2810	1.2	47	60	1250	750	750	1400	670	125	40	1250	B	1B/1C
250	Standard	820	3150	3500	1.4	52	65	1200	750	750	1380	670	125	40	1050	B	1B/1C
	Low	610	3150	3500	1.3	50	63	1200	750	750	1420	670	125	40	1100	B	1B/1C
	Very Low	500	2880	3200	1.1	49	62	1300	750	800	1420	670	125	40	1350	B	1B/1C
315	Standard	960	3690	4100	1.3	53	66	1250	750	800	1440	670	125	40	1200	B	1B/1C
	Low	720	3690	4100	1.2	52	65	1250	750	800	1460	670	125	40	1250	B	1B/1C
	Very Low	580	3380	3760	1.0	50	63	1350	750	800	1500	670	125	40	1550	B	1B/1C
400	Standard	1150	4410	4900	1.2	55	68	1300	750	800	1500	670	125	40	1350	B	2B/2C
	Low	880	4410	4900	1.1	53	66	1300	750	800	1500	670	125	40	1350	B	2B/2C
	Very Low	700	4050	4500	1.0	51	65	1350	750	800	1600	670	125	40	1700	B	2B/2C
500	Standard	1300	5340	5940	1.1	56	69	1350	750	850	1620	670	125	40	1600	C	2B/2C
	Low	990	5340	5940	1.0	55	68	1350	750	850	1620	670	125	40	1600	C	2B/2C
	Very Low	830	4910	5450	0.9	52	66	1450	750	850	1680	670	125	40	2000	C	2B/2C
630	Standard	1500	6570	7300	1.1	57	71	1400	850	850	1740	670	125	40	1900	D	2B/2C
	Low	1150	6570	7300	1.0	55	69	1400	850	850	1740	670	125	40	1900	D	2B/2C
	Very Low	1000	6030	6700	0.9	53	67	1500	850	850	1740	670	125	40	2350	D	2B/2C

ALUMINIUM WINDINGS

# 4% Ucc

# Insulation Class 24kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	400	1570	1750	1.9	47	60	1250	600	700	1300	520	125	40	850	A	1B/1C
	Low	360	1570	1750	1.9	46	59	1300	600	700	1300	520	125	40	900	A	1B/1C
	Very Low	330	1210	1350	1.8	44	57	1300	600	700	1360	520	125	40	950	A	1B/1C
150	Standard	550	2130	2370	1.7	50	63	1250	600	700	1400	520	125	40	950	A	1B/1C
	Low	460	2130	2370	1.8	48	61	1300	600	700	1400	520	125	40	1000	A	1B/1C
	Very Low	430	1550	1720	1.6	47	60	1350	600	750	1440	520	125	40	1200	A	1B/1C
160	Standard	580	2250	2500	1.7	50	63	1250	600	700	1400	520	125	40	950	A	1B/1C
	Low	490	2250	2500	1.7	48	61	1250	600	700	1420	520	125	40	1000	A	1B/1C
	Very Low	450	1620	1800	1.6	47	60	1350	600	750	1440	520	125	40	1200	A	1B/1C
200	Standard	670	2630	2920	1.6	51	64	1300	750	750	1440	670	125	40	1100	B	1B/1C
	Low	560	2630	2920	1.6	50	63	1300	750	750	1440	670	125	40	1150	B	1B/1C
	Very Low	530	1980	2200	1.5	48	61	1350	750	800	1480	670	125	40	1300	B	1B/1C
250	Standard	800	3100	3450	1.5	53	66	1300	750	800	1460	670	125	40	1200	B	1B/1C
	Low	660	3100	3450	1.5	51	64	1300	750	800	1460	670	125	40	1250	B	1B/1C
	Very Low	640	2430	2700	1.4	50	63	1350	750	800	1520	670	125	40	1400	B	1B/1C
315	Standard	930	3670	4070	1.4	54	67	1350	750	800	1500	670	125	40	1400	B	1B/2C
	Low	790	3670	4070	1.5	53	66	1350	750	800	1500	670	125	40	1400	B	1B/2C
	Very Low	730	2850	3170	1.2	51	64	1400	750	850	1600	670	125	40	1600	B	1B/2C
400	Standard	1100	4410	4900	1.3	56	69	1400	750	800	1540	670	125	40	1550	B	2B/2C
	Low	970	4410	4900	1.4	54	67	1400	750	800	1540	670	125	40	1550	B	2B/2C
	Very Low	850	3420	3800	1.1	52	66	1450	750	850	1660	670	125	40	1850	B	2B/2C
500	Standard	1310	5190	5760	1.2	57	70	1450	750	850	1660	670	125	40	1800	C	2B/2C
	Low	1100	5190	5760	1.2	56	69	1450	750	850	1660	670	125	40	1850	C	2B/2C
	Very Low	1020	4000	4450	1.1	53	67	1500	750	900	1740	670	125	40	2100	C	2B/2C
630	Standard	1600	6210	6900	1.1	58	72	1450	850	850	1800	670	125	40	2050	D	2B/3C
	Low	1270	6210	6900	1.1	56	70	1450	850	900	1800	670	125	40	2150	D	2B/3C
	Very Low	1250	4770	5300	1.0	54	68	1550	850	900	1840	670	125	40	2400	D	2B/3C

ALUMINIUM WINDINGS

# 6% Ucc

# Insulation Class 12kV

ALUMINIUM WINDINGS

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	440	1800	2000	1.8	46	59	1150	600	700	1120	520	125	40	600	A	1B/1C
	Low	330	1800	2000	1.6	45	58	1150	600	700	1140	520	125	40	650	A	1B/1C
	Very Low	260	1620	1800	1.5	43	56	1200	600	700	1140	520	125	40	700	A	1B/1C
150	Standard	580	2320	2580	1.6	49	62	1200	600	700	1200	520	125	40	800	A	1B/1C
	Low	430	2320	2580	1.5	47	60	1250	600	700	1200	520	125	40	800	A	1B/1C
	Very Low	330	2210	2460	1.3	46	59	1250	600	700	1200	520	125	40	850	A	1B/1C
160	Standard	610	2430	2700	1.6	49	62	1200	600	700	1200	520	125	40	800	A	1B/1C
	Low	450	2430	2700	1.4	47	60	1250	600	700	1200	520	125	40	800	A	1B/1C
	Very Low	350	2340	2600	1.3	46	59	1250	600	700	1200	520	125	40	850	A	1B/1C
200	Standard	700	2750	3050	1.5	50	63	1250	750	750	1300	670	125	40	900	B	1B/1C
	Low	520	2750	3050	1.3	49	62	1250	750	750	1300	670	125	40	900	B	1B/1C
	Very Low	410	2650	2950	1.2	47	60	1300	750	750	1300	670	125	40	1000	B	1B/1C
250	Standard	820	3150	3500	1.4	52	65	1250	750	750	1400	670	125	40	1000	B	1B/1C
	Low	610	3150	3500	1.3	50	63	1250	750	750	1400	670	125	40	1000	B	1B/1C
	Very Low	500	3060	3400	1.1	49	62	1300	750	800	1400	670	125	40	1100	B	1B/1C
315	Standard	960	3690	4100	1.3	53	66	1350	750	800	1440	670	125	40	1200	B	1B/1C
	Low	720	3690	4100	1.2	52	65	1350	750	800	1440	670	125	40	1200	B	1B/1C
	Very Low	580	3480	3870	1.0	50	63	1400	750	800	1480	670	125	40	1300	B	1B/1C
400	Standard	1150	4410	4900	1.2	55	68	1400	750	800	1460	670	125	40	1350	B	2B/2C
	Low	880	4410	4900	1.1	53	66	1400	750	800	1460	670	125	40	1400	B	2B/2C
	Very Low	700	4050	4500	1.0	51	65	1450	750	800	1560	670	125	40	1550	B	2B/2C
500	Standard	1300	5340	5940	1.1	56	69	1450	750	850	1520	670	125	40	1550	C	2B/2C
	Low	990	5340	5940	1.0	55	68	1450	750	850	1520	670	125	40	1600	C	2B/2C
	Very Low	830	5060	5630	0.9	52	66	1500	750	850	1580	670	125	40	1750	C	2B/2C
630	Standard	1500	6570	7300	1.1	57	71	1450	850	850	1580	670	125	40	1800	D	2B/2C
	Low	1150	6570	7300	1.0	55	69	1450	850	850	1580	670	125	40	1800	D	2B/2C
	Very Low	1000	6390	7100	0.9	53	67	1500	850	850	1580	670	125	40	1900	D	2B/2C
750	Standard	1710	7650	8500	1.0	58	72	1550	850	850	1680	670	125	40	2050	E	3B/3C
	Low	1250	7650	8500	0.9	56	70	1550	850	850	1680	670	125	40	2050	E	3B/3C
	Very Low	1070	6950	7730	0.8	55	69	1550	850	850	1740	670	125	40	2300	E	3B/3C
800	Standard	1800	8100	9000	1.0	58	72	1550	850	850	1720	670	125	40	2100	E	3B/3C
	Low	1300	8100	9000	0.9	57	71	1550	850	850	1720	670	125	40	2100	E	3B/3C
	Very Low	1100	7200	8000	0.8	55	69	1550	850	850	1800	670	125	40	2400	E	3B/3C
1000	Standard	2100	9000	10000	0.9	60	74	1600	1000	1000	1800	820	125	40	2500	F	3B/3C
	Low	1500	9000	10000	0.8	58	72	1600	1000	1000	1820	820	125	40	2500	F	3B/3C
	Very Low	1300	8100	9000	0.8	56	70	1650	1000	1000	1840	820	125	40	2850	F	3B/3C
1250	Standard	2500	10800	12000	0.9	61	75	1650	1000	1000	1980	820	160	50	2950	G	4B/4C
	Low	1800	10800	12000	0.8	59	73	1650	1000	1000	2000	820	160	50	2950	G	4B/4C
	Very Low	1500	9900	11000	0.7	57	72	1700	1000	1000	2080	820	160	50	3550	G	4B/4C
1500	Standard	2710	12400	13780	0.8	61	76	1750	1000	1000	2080	820	160	50	3450	H	4B/4C
	Low	2080	12400	13780	0.8	60	75	1750	1000	1000	2100	820	160	50	3450	H	4B/4C
	Very Low	1710	11170	12420	0.7	58	73	1800	1000	1000	2180	820	160	50	4050	H	4B/4C
1600	Standard	2800	13050	14500	0.8	62	77	1750	1000	1000	2120	820	160	50	3650	H	4B/4C
	Low	2200	13050	14500	0.7	60	75	1750	1000	1000	2120	820	160	50	3650	H	4B/4C
	Very Low	1800	11700	13000	0.7	58	73	1800	1000	1000	2220	820	160	50	4250	H	4B/4C
2000	Standard	3600	16200	18000	0.8	63	78	1900	1310	1310	2160	1070	200	70	4350	I	5B/5C
	Low	2600	16200	18000	0.7	61	76	1900	1310	1310	2160	1070	200	70	4400	I	5B/5C
	Very Low	2200	13950	15500	0.6	60	75	1900	1310	1310	2320	1070	200	70	5000	I	5B/5C
2500	Standard	4300	18900	21000	0.7	65	80	1950	1310	1310	2380	1070	200	70	5250	J	5B/5C
	Low	3200	18900	21000	0.7	62	78	2000	1310	1310	2380	1070	200	70	5450	J	5B/5C
	Very Low	2600	16650	18500	0.6	60	76	2000	1310	1310	2400	1070	200	70	5900	J	5B/5C
3000	Standard	5060	22360	24840	0.7	65	81	2100	1310	1310	2480	1070	200	70	6250	K	6B/6C
	Low	3660	22360	24840	0.6	63	79	2100	1310	1310	2500	1070	200	70	6400	K	6B/6C
	Very Low	3020	19070	21190	0.6	61	77	2200	1310	1310	2560	1070	200	70	7750	K	6B/6C
3150	Standard	5300	23400	26000	0.7	65	81	2100	1310	1310	2500	1070	200	70	6500	K	6B/6C
	Low	3800	23400	26000	0.6	63	79	2100	1310	1310	2520	1070	200	70	6650	K	6B/6C
	Very Low	3150	19800	22000	0.5	61	77	2250	1310	1310	2600	1070	200	70	8300	K	6B/6C
3500	Standard	5750	25430	28260	0.7	66	82	2250	1440	1440	2560	1200	200	70	7350	K	7B/7C
	Low	4170	25430	28260	0.6	64	80	2250	1440	1440	2620	1200	200	70	7850	K	7B/7C
	Very Low	3390	21270	23640	0.5	62	78	2350	1440	1440	2780	1200	200	70	9200	K	7B/7C
4000	Standard	6400	28350	31500	0.6	67	83	2350	1440	1440	2640	1200	200	70	8450	K	7B/7C
	Low	4700	28350	31500	0.6	65	81	2450	1440	1440	2740	1200	200	70	9500	K	7B/7C
	Very Low	3750	23400	26000	0.5	63	79	2450	1440	1440	3000	1200	200	70	10400	K	7B/7C

**6% Ucc****Insulation Class 17.5kV**

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	460	1840	2050	1.9	47	60	1200	600	700	1220	520	125	40	650	A	1B/1C
	Low	340	1840	2050	1.7	46	59	1200	600	700	1220	520	125	40	650	A	1B/1C
	Very Low	280	1620	1800	1.6	44	57	1300	600	700	1320	520	125	40	850	A	1B/1C
150	Standard	610	2480	2750	1.7	50	63	1200	600	700	1340	520	125	40	850	A	1B/1C
	Low	450	2480	2750	1.6	48	61	1200	600	700	1340	520	125	40	850	A	1B/1C
	Very Low	380	2220	2460	1.4	47	60	1300	600	700	1400	520	125	40	950	A	1B/1C
160	Standard	650	2610	2900	1.7	50	63	1200	600	700	1360	520	125	40	850	A	1B/1C
	Low	480	2610	2900	1.5	48	61	1200	600	700	1360	520	125	40	850	A	1B/1C
	Very Low	400	2340	2600	1.4	47	60	1300	600	700	1400	520	125	40	950	A	1B/1C
200	Standard	750	2970	3300	1.6	51	64	1250	750	750	1420	670	125	40	1000	B	1B/1C
	Low	550	2970	3300	1.4	50	63	1250	750	750	1420	670	125	40	1000	B	1B/1C
	Very Low	450	2660	2950	1.3	48	61	1350	750	750	1440	670	125	40	1150	B	1B/1C
250	Standard	880	3420	3800	1.5	53	66	1300	750	800	1480	670	125	40	1100	B	1B/1C
	Low	650	3420	3800	1.3	51	64	1300	750	800	1480	670	125	40	1100	B	1B/1C
	Very Low	520	3060	3400	1.2	50	63	1400	750	800	1480	670	125	40	1300	B	1B/1C
315	Standard	1010	4080	4530	1.4	54	67	1350	750	800	1480	670	125	40	1250	B	1B/2C
	Low	770	4080	4530	1.3	53	66	1350	750	800	1480	670	125	40	1250	B	1B/2C
	Very Low	610	3480	3870	1.1	51	64	1450	750	800	1560	670	125	40	1500	B	1B/2C
400	Standard	1200	4950	5500	1.3	56	69	1400	750	800	1480	670	125	40	1350	B	2B/2C
	Low	940	4950	5500	1.2	54	67	1400	750	800	1480	670	125	40	1350	B	2B/2C
	Very Low	750	4050	4500	1.0	52	66	1450	750	800	1620	670	125	40	1700	B	2B/2C
500	Standard	1390	5770	6410	1.2	57	70	1450	750	850	1560	670	125	40	1600	C	2B/2C
	Low	1070	5770	6410	1.1	56	69	1500	750	850	1560	670	125	40	1600	C	2B/2C
	Very Low	900	5060	5630	1.0	53	67	1550	750	850	1640	670	125	40	1900	C	2B/2C
630	Standard	1650	6840	7600	1.1	58	72	1500	850	850	1640	670	125	40	1850	D	2B/3C
	Low	1250	6840	7600	1.0	56	70	1550	850	850	1640	670	125	40	1900	D	2B/3C
	Very Low	1100	6390	7100	0.9	54	68	1600	850	850	1660	670	125	40	2100	D	2B/3C
750	Standard	1890	7980	8870	1.1	59	73	1550	850	850	1780	670	125	40	2150	E	3B/3C
	Low	1420	7980	8870	1.0	57	71	1600	850	850	1780	670	125	40	2150	E	3B/3C
	Very Low	1240	6960	7730	0.9	56	70	1600	850	850	1780	670	125	40	2350	E	3B/3C
800	Standard	2000	8460	9400	1.1	59	73	1550	850	850	1820	670	125	40	2250	E	3B/3C
	Low	1500	8460	9400	1.0	58	72	1600	850	850	1820	670	125	40	2250	E	3B/3C
	Very Low	1300	7200	8000	0.9	56	70	1600	850	850	1820	670	125	40	2400	E	3B/3C
1000	Standard	2300	9900	11000	1.0	61	75	1600	1000	1000	1880	820	125	40	2600	F	3B/4C
	Low	1800	9900	11000	0.9	59	73	1650	1000	1000	1880	820	125	40	2600	F	3B/4C
	Very Low	1550	8100	9000	0.8	56	71	1700	1000	1000	1900	820	125	40	2900	F	3B/4C
1250	Standard	2800	11700	13000	0.9	62	76	1650	1000	1000	2000	820	160	50	3050	G	4B/4C
	Low	2100	11700	13000	0.8	60	74	1700	1000	1000	2000	820	160	50	3100	G	4B/4C
	Very Low	1800	9900	11000	0.8	58	73	1750	1000	1000	2080	820	160	50	3450	G	4B/4C
1500	Standard	3010	13620	15140	0.9	62	77	1800	1000	1000	2100	820	160	50	3550	H	4B/5C
	Low	2310	13620	15140	0.8	61	76	1800	1000	1000	2100	820	160	50	3600	H	4B/5C
	Very Low	2080	11180	12420	0.7	59	74	1850	1000	1000	2160	820	160	50	3900	H	4B/5C
1600	Standard	3100	14400	16000	0.9	63	78	1800	1000	1000	2140	820	160	50	3750	H	4B/5C
	Low	2400	14400	16000	0.8	61	76	1800	1000	1000	2140	820	160	50	3750	H	4B/5C
	Very Low	2200	11700	13000	0.7	59	74	1850	1000	1000	2180	820	160	50	4050	H	4B/5C
2000	Standard	4000	16200	18000	0.8	64	79	1900	1310	1310	2220	1070	200	70	4500	I	5B/5C
	Low	3000	16200	18000	0.7	62	77	1900	1310	1310	2220	1070	200	70	4500	I	5B/5C
	Very Low	2600	14400	16000	0.7	60	76	1950	1310	1310	2280	1070	200	70	4800	I	5B/5C
2500	Standard	5000	20700	23000	0.8	66	81	1950	1310	1310	2420	1070	200	70	5400	J	5B/6C
	Low	3600	20700	23000	0.7	63	79	2000	1310	1310	2420	1070	200	70	5550	J	5B/6C
	Very Low	3100	17100	19000	0.6	61	77	2000	1310	1310	2460	1070	200	70	5750	J	5B/6C
3000	Standard	5760	24160	26840	0.7	66	82	2100	1310	1310	2500	1070	200	70	6200	K	6B/6C
	Low	4130	24160	26840	0.7	64	80	2100	1310	1310	2500	1070	200	70	6250	K	6B/6C
	Very Low	3630	19170	21300	0.6	62	78	2200	1310	1310	2540	1070	200	70	7250	K	6B/6C
3150	Standard	6000	25200	28000	0.7	66	82	2100	1310	1310	2520	1070	200	70	6400	K	6B/6C
	Low	4300	25200	28000	0.7	64	80	2100	1310	1310	2520	1070	200	70	6400	K	6B/6C
	Very Low	3800	19800	22000	0.6	62	78	2250	1310	1310	2560	1070	200	70	7650	K	6B/6C
3500	Standard	6280	27050	30050	0.7	67	83	2250	1440	1440	2600	1200	200	70	7200	K	7B/7C
	Low	4710	27050	30050	0.6	65	81	2250	1440	1440	2600	1200	200	70	7200	K	7B/7C
	Very Low	4150	21650	24050	0.6	63	79	2350	1440	1440	2760	1200	200	70	8200	K	7B/7C
4000	Standard	6700	29700	33000	0.7	68	84	2350	1440	1440	2700	1200	200	70	8300	K	7B/7C
	Low	5300	29700	33000	0.6	66	82	2350	1440	1440	2700	1200	200	70	8300	K	7B/7C
	Very Low	4650	24300	27000	0.5	64	80	2400	1440	1440	3020	1200	200	70	8950	K	7B/7C

**ALUMINIUM WINDINGS**

# 6% Ucc

# Insulation Class 24kV

ALUMINIUM WINDINGS

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	460	1840	2050	1.9	47	60	1300	600	700	1240	520	125	40	750	A	1B/1C
	Low	340	1840	2050	1.7	46	59	1300	600	700	1260	520	125	40	800	A	1B/1C
	Very Low	280	1620	1800	1.6	44	57	1300	600	700	1320	520	125	40	850	A	1B/1C
150	Standard	610	2480	2750	1.7	50	63	1300	600	700	1360	520	125	40	900	A	1B/1C
	Low	450	2480	2750	1.6	48	61	1300	600	700	1360	520	125	40	900	A	1B/1C
	Very Low	380	2220	2460	1.4	47	60	1300	600	700	1400	520	125	40	950	A	1B/1C
160	Standard	650	2610	2900	1.7	50	63	1300	600	700	1380	520	125	40	900	A	1B/1C
	Low	480	2610	2900	1.5	48	61	1300	600	700	1380	520	125	40	900	A	1B/1C
	Very Low	400	2340	2600	1.4	47	60	1300	600	700	1400	520	125	40	950	A	1B/1C
200	Standard	750	2970	3300	1.6	51	64	1300	750	750	1440	670	125	40	1000	B	1B/1C
	Low	550	2970	3300	1.4	50	63	1300	750	750	1440	670	125	40	1000	B	1B/1C
	Very Low	450	2660	2950	1.3	48	61	1350	750	750	1440	670	125	40	1100	B	1B/1C
250	Standard	880	3420	3800	1.5	53	66	1300	750	800	1480	670	125	40	1050	B	1B/1C
	Low	650	3420	3800	1.3	51	64	1300	750	800	1480	670	125	40	1100	B	1B/1C
	Very Low	520	3060	3400	1.2	50	63	1400	750	800	1480	670	125	40	1250	B	1B/1C
315	Standard	1010	4080	4530	1.4	54	67	1400	750	800	1500	670	125	40	1250	B	1B/2C
	Low	770	4080	4530	1.3	53	66	1400	750	800	1500	670	125	40	1300	B	1B/2C
	Very Low	610	3480	3870	1.1	51	64	1450	750	800	1560	670	125	40	1450	B	1B/2C
400	Standard	1200	4950	5500	1.3	56	69	1450	750	800	1500	670	125	40	1400	B	2B/2C
	Low	940	4950	5500	1.2	54	67	1450	750	800	1500	670	125	40	1450	B	2B/2C
	Very Low	750	4050	4500	1.0	52	66	1450	750	800	1620	670	125	40	1650	B	2B/2C
500	Standard	1390	5770	6410	1.2	57	70	1500	750	850	1580	670	125	40	1650	C	2B/2C
	Low	1070	5770	6410	1.1	56	69	1500	750	850	1580	670	125	40	1700	C	2B/2C
	Very Low	900	5060	5630	1.0	53	67	1550	750	850	1640	670	125	40	1850	C	2B/2C
630	Standard	1650	6840	7600	1.1	58	72	1550	850	900	1640	670	125	40	1950	D	2B/3C
	Low	1250	6840	7600	1.0	56	70	1550	850	900	1640	670	125	40	1950	D	2B/3C
	Very Low	1100	6390	7100	0.9	54	68	1600	850	900	1660	670	125	40	2100	D	2B/3C
750	Standard	1890	7980	8870	1.1	59	73	1550	850	900	1780	670	125	40	2200	E	3B/3C
	Low	1420	7980	8870	1.0	57	71	1600	850	900	1780	670	125	40	2200	E	3B/3C
	Very Low	1240	6960	7730	0.9	56	70	1600	850	900	1780	670	125	40	2350	E	3B/3C
800	Standard	2000	8460	9400	1.1	59	73	1550	850	900	1820	670	125	40	2250	E	3B/3C
	Low	1500	8460	9400	1.0	58	72	1600	850	900	1820	670	125	40	2300	E	3B/3C
	Very Low	1300	7200	8000	0.9	56	70	1600	850	900	1820	670	125	40	2450	E	3B/3C
1000	Standard	2300	9900	11000	1.0	61	75	1650	1000	1000	1880	820	125	40	2650	F	3B/4C
	Low	1800	9900	11000	0.9	59	73	1650	1000	1000	1880	820	125	40	2650	F	3B/4C
	Very Low	1550	8100	9000	0.8	56	71	1700	1000	1000	1900	820	125	40	2900	F	3B/4C
1250	Standard	2800	11700	13000	0.9	62	76	1700	1000	1000	2000	820	160	50	3150	G	4B/4C
	Low	2100	11700	13000	0.8	59	74	1700	1000	1000	2000	820	160	50	3150	G	4B/4C
	Very Low	1800	9900	11000	0.8	58	73	1750	1000	1000	2080	820	160	50	3400	G	4B/4C
1500	Standard	3010	13620	15140	0.9	62	77	1800	1000	1000	2100	820	160	50	3600	H	4B/5C
	Low	2310	13620	15140	0.8	61	76	1800	1000	1000	2100	820	160	50	3600	H	4B/5C
	Very Low	2080	11180	12420	0.7	59	74	1850	1000	1000	2160	820	160	50	3850	H	4B/5C
1600	Standard	3100	14400	16000	0.9	63	78	1800	1000	1000	2140	820	160	50	3750	H	4B/5C
	Low	2400	14400	16000	0.8	61	76	1800	1000	1000	2140	820	160	50	3750	H	4B/5C
	Very Low	2200	11700	13000	0.7	59	74	1850	1000	1000	2180	820	160	50	4000	H	4B/5C
2000	Standard	4000	16200	18000	0.8	64	79	1900	1310	1310	2220	1070	200	70	4550	I	5B/5C
	Low	3000	16200	18000	0.7	62	77	1900	1310	1310	2220	1070	200	70	4550	I	5B/5C
	Very Low	2600	14400	16000	0.7	60	76	1950	1310	1310	2280	1070	200	70	4800	I	5B/5C
2500	Standard	5000	20700	23000	0.8	65	81	2000	1310	1310	2440	1070	200	70	5500	J	5B/6C
	Low	3600	20700	23000	0.7	63	79	2000	1310	1310	2440	1070	200	70	5550	J	5B/6C
	Very Low	3100	17100	19000	0.6	61	77	2050	1310	1310	2440	1070	200	70	5650	J	5B/6C
3000	Standard	5760	24160	26840	0.7	66	82	2150	1310	1310	2480	1070	200	70	6400	K	6B/6C
	Low	4130	24160	26840	0.7	64	80	2150	1310	1310	2480	1070	200	70	6400	K	6B/6C
	Very Low	3630	19170	21300	0.6	62	78	2200	1310	1310	2580	1070	200	70	6900	K	6B/6C
3150	Standard	6000	25200	28000	0.7	66	82	2150	1310	1310	2480	1070	200	70	6650	K	6B/6C
	Low	4300	25200	28000	0.7	64	80	2150	1310	1310	2480	1070	200	70	6650	K	6B/6C
	Very Low	3800	19800	22000	0.6	62	78	2200	1310	1310	2600	1070	200	70	7250	K	6B/6C
3500	Standard	6280	27050	30050	0.7	67	83	2250	1440	1440	2580	1200	200	70	7500	K	7B/7C
	Low	4710	27050	30050	0.6	65	81	2300	1440	1440	2600	1200	200	70	7700	K	7B/7C
	Very Low	4150	21650	24050	0.6	63	79	2350	1440	1440	2740	1200	200	70	8100	K	7B/7C
4000	Standard	6700	29700	33000	0.7	68	84	2350	1440	1440	2720	1200	200	70	8700	K	7B/7C
	Low	5300	29700	33000	0.6	66	82	2450	1440	1440	2740	1200	200	70	9100	K	7B/7C
	Very Low	4650	24300	27000	0.5	64	80	2450	1440	1440	2940	1200	200	70	9300	K	7B/7C

# 6% Ucc

# Insulation Class 36kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	780	1800	2000	2.1	48	62	1600	750	900	1640	670	125	40	1250	A	11B/11C
	Low	800	1800	2000	1.8	46	60	1600	750	900	1640	670	125	40	1250	A	11B/11C
	Very Low	750	1620	1800	1.6	45	59	1600	750	900	1640	670	125	40	1250	A	11B/11C
150	Standard	930	2320	2580	1.9	51	65	1600	750	900	1660	670	125	40	1350	A	11B/11C
	Low	880	2320	2580	1.6	49	63	1600	750	900	1660	670	125	40	1350	A	11B/11C
	Very Low	830	2140	2380	1.4	48	62	1600	750	900	1660	670	125	40	1350	A	11B/11C
160	Standard	960	2430	2700	1.8	51	65	1600	750	900	1660	670	125	40	1350	A	11B/11C
	Low	900	2430	2700	1.6	49	63	1600	750	900	1660	670	125	40	1350	A	11B/11C
	Very Low	850	2250	2500	1.4	48	62	1600	750	900	1660	670	125	40	1350	A	11B/11C
200	Standard	1100	2870	3180	1.7	52	66	1650	750	900	1680	670	125	40	1500	B	11B/11C
	Low	980	2870	3180	1.5	51	65	1650	750	900	1680	670	125	40	1500	B	11B/11C
	Very Low	910	2650	2940	1.3	49	63	1650	750	900	1700	670	125	40	1500	B	11B/11C
250	Standard	1280	3420	3800	1.6	54	68	1650	750	900	1700	670	125	40	1600	B	11B/11C
	Low	1100	3420	3800	1.4	52	66	1650	750	900	1700	670	125	40	1600	B	11B/11C
	Very Low	1000	3150	3500	1.2	51	65	1650	750	900	1720	670	125	40	1650	B	11B/11C
315	Standard	1440	4040	4490	1.5	55	69	1700	750	900	1740	670	125	40	1800	B	11B/11C
	Low	1180	4040	4490	1.3	54	68	1700	750	900	1740	670	125	40	1800	B	11B/11C
	Very Low	1080	3730	4150	1.2	52	66	1700	750	900	1740	670	125	40	1850	B	11B/11C
400	Standard	1650	4860	5400	1.4	57	71	1700	750	900	1760	670	125	40	2050	B	12B/12C
	Low	1300	4860	5400	1.2	55	69	1700	750	900	1760	670	125	40	2050	B	12B/12C
	Very Low	1200	4500	5000	1.1	54	68	1750	750	900	1760	670	125	40	2100	B	12B/12C
500	Standard	1880	5680	6310	1.3	59	73	1750	850	950	1840	670	125	40	2350	C	12B/12C
	Low	1430	5680	6310	1.1	57	71	1800	850	950	1840	670	125	40	2350	C	12B/12C
	Very Low	1280	5280	5860	1.0	55	69	1850	850	950	1880	670	125	40	2650	C	12B/12C
630	Standard	2200	6750	7500	1.2	60	74	1800	850	1000	1900	670	125	40	2700	D	12B/12C
	Low	1600	6750	7500	1.1	57	72	1850	850	1000	1900	670	125	40	2700	D	12B/12C
	Very Low	1400	6300	7000	0.9	56	71	1950	850	1000	2000	670	125	40	3350	D	12B/12C
750	Standard	2550	7700	8550	1.2	60	75	1850	850	1000	1980	670	125	40	2950	E	13B/13C
	Low	1810	7700	8550	1.0	59	74	1850	850	1000	2000	670	125	40	3000	E	13B/13C
	Very Low	1570	7180	7980	0.9	57	72	1950	850	1000	2080	670	125	40	3550	E	13B/13C
800	Standard	2700	8100	9000	1.2	61	76	1850	850	1000	2000	670	125	40	3050	E	13B/13C
	Low	1900	8100	9000	1.0	59	74	1850	850	1000	2020	670	125	40	3100	E	13B/13C
	Very Low	1650	7560	8400	0.9	57	72	1950	850	1000	2100	670	125	40	3600	E	13B/13C
1000	Standard	3100	9900	11000	1.1	62	77	1950	1000	1050	2060	820	125	40	3500	F	14B/14C
	Low	2250	9900	11000	0.9	60	75	1950	1000	1050	2060	820	125	40	3500	F	14B/14C
	Very Low	1900	9000	10000	0.8	59	74	2000	1000	1100	2200	820	125	40	4300	F	14B/14C
1250	Standard	3600	11700	13000	1.0	64	79	1950	1000	1100	2200	820	160	50	3950	G	15B/15C
	Low	2600	11700	13000	0.9	62	77	1950	1000	1100	2220	820	160	50	4000	G	15B/15C
	Very Low	2200	10800	12000	0.8	60	75	2050	1000	1100	2340	820	160	50	4750	G	15B/15C
1500	Standard	4020	13620	15140	1.0	65	80	2050	1000	1100	2320	820	160	50	4600	H	15B/15C
	Low	2880	13620	15140	0.8	63	78	2050	1000	1100	2320	820	160	50	4750	H	15B/15C
	Very Low	2450	12080	13420	0.7	61	76	2150	1000	1100	2520	820	160	50	5500	H	15B/15C
1600	Standard	4200	14400	16000	1.0	65	80	2050	1000	1100	2360	820	160	50	4800	H	15B/15C
	Low	3000	14400	16000	0.8	63	78	2050	1000	1100	2360	820	160	50	5000	H	15B/15C
	Very Low	2550	12600	14000	0.7	62	77	2150	1000	1100	2580	820	160	50	5800	H	15B/15C
2000	Standard	5000	16650	18500	0.9	66	82	2100	1310	1310	2520	1070	200	70	5650	I	15B/15C
	Low	3500	16650	18500	0.8	64	80	2100	1310	1310	2540	1070	200	70	5850	I	15B/15C
	Very Low	3000	15300	17000	0.7	62	78	2250	1310	1310	2640	1070	200	70	7000	I	15B/15C
2500	Standard	5800	20250	22500	0.8	67	83	2250	1310	1310	2600	1070	200	70	6700	J	15B/15C
	Low	4200	20250	22500	0.7	65	81	2250	1310	1310	2620	1070	200	70	6750	J	15B/15C
	Very Low	3500	18000	20000	0.6	64	80	2350	1310	1310	2740	1070	200	70	8050	J	15B/15C
3000	Standard	6490	23710	26340	0.8	68	84	2450	1310	1310	2680	1070	200	70	8000	K	16B/16C
	Low	4810	23710	26340	0.7	67	83	2450	1310	1310	2700	1070	200	70	8300	K	16B/16C
	Very Low	3960	21460	23840	0.6	65	81	2500	1310	1310	2880	1070	200	70	9150	K	16B/16C
3150	Standard	6700	24750	27500	0.8	69	85	2450	1310	1310	2680	1070	200	70	8350	K	16B/16C
	Low	5000	24750	27500	0.7	67	83	2500	1310	1310	2700	1070	200	70	8750	K	16B/16C
	Very Low	4100	22500	25000	0.6	65	81	2500	1310	1310	2920	1070	200	70	9450	K	16B/16C
3500	Standard	6960	26600	29550	0.8	69	85	2450	1440	1440	2880	1200	200	70	9000	K	17B/17C
	Low	5390	26600	29550	0.7	68	84	2550	1440	1440	2900	1200	200	70	9450	K	17B/17C
	Very Low	4470	24530	27260	0.6	66	82	2550	1440	1440	3040	1200	200	70	10150	K	17B/17C
4000	Standard	7350	29250	32500	0.7	70	86	2450	1440	1440	3140	1200	200	70	9850	K	17B/17C
	Low	5950	29250	32500	0.6	68	84	2550	1440	1440	3160	1200	200	70	10450	K	17B/17C
	Very Low	5000	27450	30500	0.6	66	83	2600	1440	1440	3180	1200	200	70	11150	K	17B/17C

ALUMINIUM WINDINGS

# ALUMINIUM vs COPPER WINDINGS

## Historical Preference

A preference for copper windings in transformers is largely based on historical factors. At the turn of the 20th Century when the electrical engineering industry was in its infancy, copper was the conductor of choice because, of all the metals with a high electrical conductivity available at that time, copper was the most widely known with the lowest price.

During World War II, copper shortages drove innovation in aluminium and early technical problems in aluminium transformer windings were overcome. Since the 1970s, aluminium has been used extensively and today is overwhelmingly the material of choice in the world's leading markets.

In the 21st Century, world production and reserves of aluminium are substantially greater than those of copper, leading to lower and more stable prices.

## Technical Considerations

### General Design and Electrical Characteristics:

- Aluminium volume = 1.8 x copper volume
- Aluminium surface area = 1.3 x copper surface area
- Aluminium mass = 0.55 x copper mass
- Aluminium specific heat = 2.43 x copper specific heat
- Aluminium core mass = 1.15 x copper core mass
- Aluminium transformer is marginally larger than copper transformer
- Aluminium transformer mass is practically equal to copper transformer mass

### Effect on Thermal Properties:

- Given the larger surface area of aluminium over copper, for equal losses, the aluminium to air temperature gradient will be lower than the copper to air gradient.
- Given the higher specific heat of aluminium over copper and taking into account the reduced mass of aluminium, the temperature rise in aluminium will be limited to 75% of that in copper in case of short-circuit or overload conditions. This represents a highly significant advantage for the life of the insulating materials.

### Effect on Mechanical Properties:

- In the case of transformers with coils encapsulated in epoxy resin, it is very important that the coefficient of thermal expansion of the conductor be as closely matched as possible to that of the resin mix so as to avoid internal stresses from repetitive thermal cycling over the life of the transformer.
- The respective linear coefficients of expansion for copper and aluminium are 40% and 60% of that for epoxy resin. The closer proximity of the coefficient of expansion for aluminium to that of the encapsulated resin results in aluminium coils being less likely to develop cracks than copper coils.

### Dielectric Considerations

- The larger surface area of aluminium conductors leads to an improvement in the series capacitance of the winding which is favourable from an impulse voltage withstand point of view.



## Manufacturing Considerations

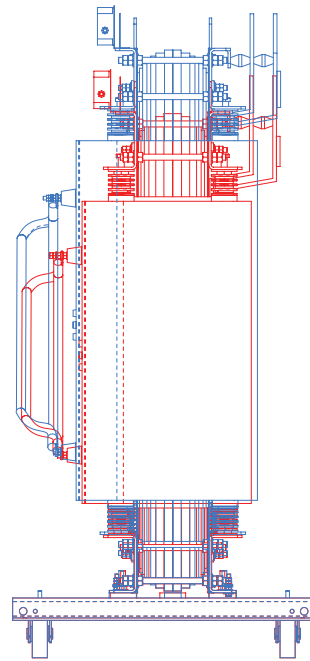
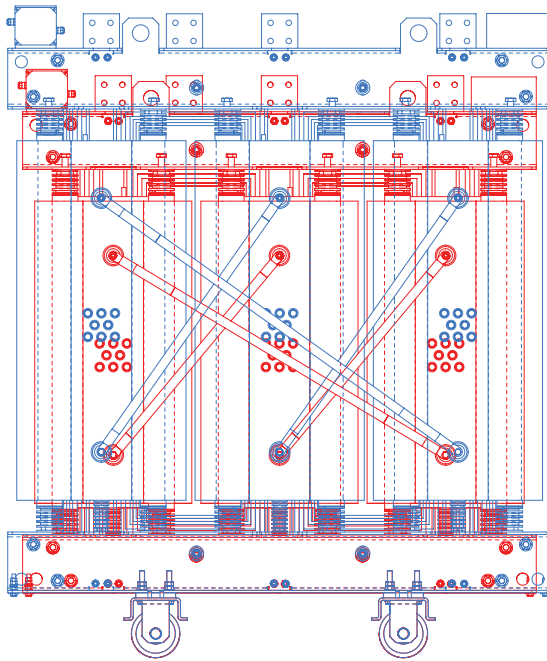
Manufacture of aluminium windings does not present any difficult technological challenges. Past concerns about joining and terminating aluminium either to itself or to copper were overcome decades ago.

Current day techniques for completely reliable aluminium joints include bolting, crimping and arc welding under inert gas without refractory electrodes (TIG and MIG methods). TMC employs the TIG method which has been well tested and has been proven successful over decades in service.

## Conclusions

TMC recognises that its customers may have a traditional preference for copper over aluminium. For this reason, TMC offers the choice of both metals. However it is the view of TMC, well supported by many years of experience, that aluminium offers superior performance when cast in resin, with the added advantage of a greatly reduced cost of ownership for the finished transformer.

### Comparative Dimensions And Mass 1000kVA

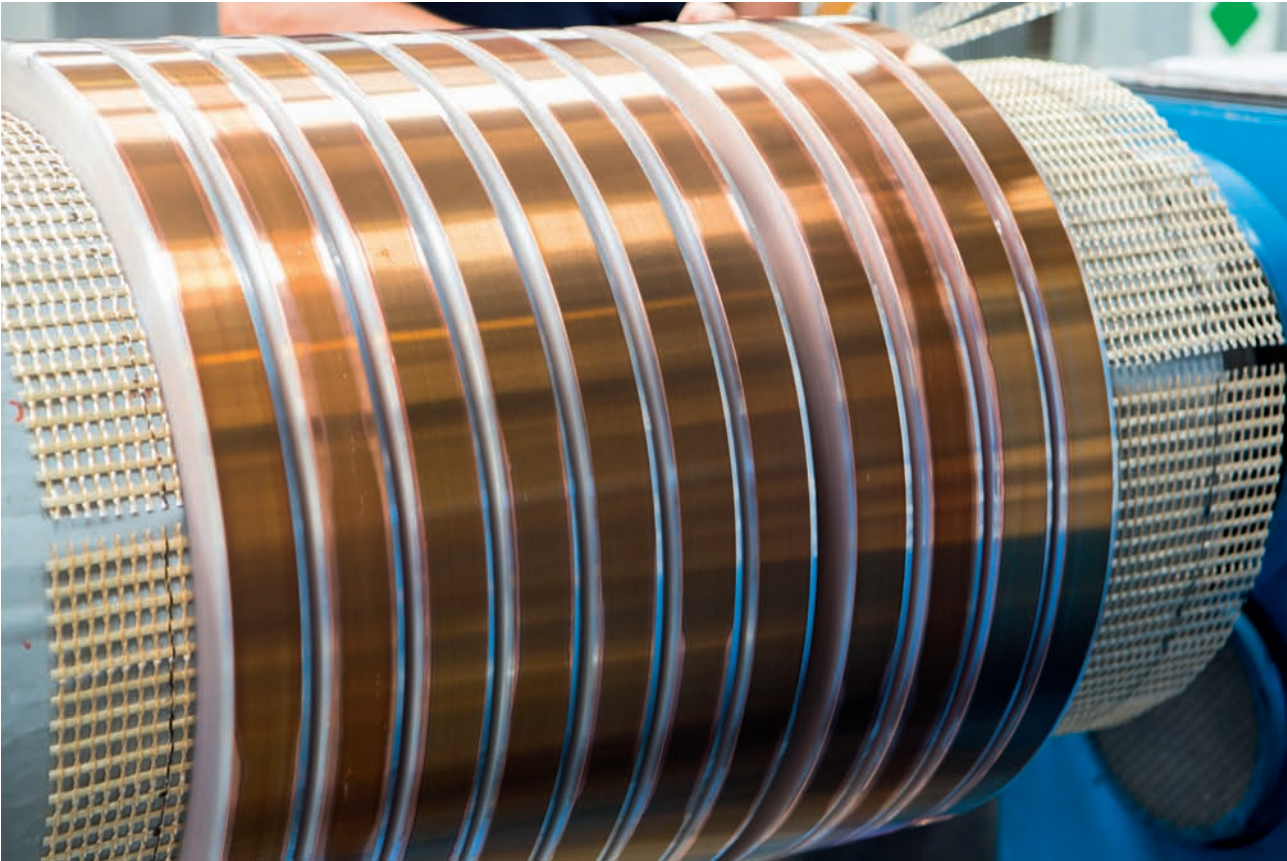


**ALUMINIUM**  
1650 x 1000 x 1880mm vs 1600 x 1000 x 1780mm  
2650kg

**COPPER**  
1600 x 1000 x 1780mm  
3000kg



# COPPER WINDINGS



# 4% Ucc

# Insulation Class 12kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	440	1800	2000	1.8	46	59	1100	600	650	1140	520	125	40	750	A	1B/1C
	Low	330	1800	2000	1.6	45	58	1150	600	700	1160	520	125	40	850	A	1B/1C
	Very Low	260	1620	1800	1.5	43	56	1150	600	700	1200	520	125	40	950	A	1B/1C
150	Standard	580	2320	2580	1.6	49	62	1150	600	700	1180	520	125	40	900	A	1B/1C
	Low	430	2320	2580	1.5	47	60	1150	600	700	1200	520	125	40	950	A	1B/1C
	Very Low	330	2140	2380	1.3	46	59	1250	600	700	1240	520	125	40	1200	A	1B/1C
160	Standard	610	2430	2700	1.6	49	62	1150	600	700	1180	520	125	40	900	A	1B/1C
	Low	450	2430	2700	1.4	47	60	1150	600	700	1200	520	125	40	950	A	1B/1C
	Very Low	350	2250	2500	1.3	46	59	1250	600	700	1240	520	125	40	1200	A	1B/1C
200	Standard	700	2750	3050	1.5	50	63	1200	750	750	1240	670	125	40	1050	B	1B/1C
	Low	520	2750	3050	1.3	49	62	1200	750	750	1240	670	125	40	1100	B	1B/1C
	Very Low	410	2530	2810	1.2	47	60	1250	750	750	1320	670	125	40	1300	B	1B/1C
250	Standard	820	3150	3500	1.4	52	65	1200	750	750	1280	670	125	40	1200	B	1B/1C
	Low	610	3150	3500	1.3	50	63	1200	750	750	1280	670	125	40	1200	B	1B/1C
	Very Low	500	2880	3200	1.1	49	62	1200	750	750	1380	670	125	40	1350	B	1B/1C
315	Standard	960	3690	4100	1.3	53	66	1250	750	750	1360	670	125	40	1350	B	1B/1C
	Low	720	3690	4100	1.2	52	65	1250	750	750	1360	670	125	40	1350	B	1B/1C
	Very Low	580	3380	3760	1.0	50	63	1250	750	800	1440	670	125	40	1550	B	1B/1C
400	Standard	1150	4410	4900	1.2	55	68	1250	750	750	1440	670	125	40	1500	B	2B/2C
	Low	880	4410	4900	1.1	53	66	1250	750	750	1440	670	125	40	1500	B	2B/2C
	Very Low	700	4050	4500	1.0	51	65	1300	750	800	1480	670	125	40	1750	B	2B/2C
500	Standard	1300	5340	5940	1.1	56	69	1350	750	800	1500	670	125	40	1800	C	2B/2C
	Low	990	5340	5940	1.0	55	68	1350	750	800	1500	670	125	40	1800	C	2B/2C
	Very Low	830	4910	5450	0.9	52	66	1400	750	850	1560	670	125	40	1950	C	2B/2C
630	Standard	1500	6570	7300	1.1	57	71	1400	850	850	1560	670	125	40	2100	D	2B/2C
	Low	1150	6570	7300	1.0	55	69	1400	850	850	1560	670	125	40	2150	D	2B/2C
	Very Low	1000	6030	6700	0.9	53	67	1450	850	850	1640	670	125	40	2200	D	2B/2C

COPPER WINDINGS

# 4% Ucc

# Insulation Class 24kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	400	1570	1750	1.9	47	60	1300	600	700	1300	520	125	40	1150	A	1B/1C
	Low	360	1570	1750	1.9	46	59	1350	600	700	1320	520	125	40	1200	A	1B/1C
	Very Low	330	1210	1350	1.8	44	57	1350	600	750	1320	520	125	40	1200	A	1B/1C
150	Standard	550	2130	2370	1.8	50	63	1300	600	700	1320	520	125	40	1150	A	1B/1C
	Low	460	2130	2370	1.8	48	61	1350	600	700	1340	520	125	40	1200	A	1B/1C
	Very Low	430	1550	1720	1.6	47	60	1350	600	750	1360	520	125	40	1300	A	1B/1C
160	Standard	580	2250	2500	1.7	50	63	1300	600	700	1320	520	125	40	1150	A	1B/1C
	Low	490	2250	2500	1.7	48	61	1350	600	700	1340	520	125	40	1150	A	1B/1C
	Very Low	450	1620	1800	1.6	47	60	1350	600	750	1360	520	125	40	1300	A	1B/1C
200	Standard	670	2630	2920	1.6	51	64	1300	750	750	1360	670	125	40	1250	B	1B/1C
	Low	560	2630	2920	1.6	50	63	1350	750	750	1380	670	125	40	1250	B	1B/1C
	Very Low	530	1980	2200	1.5	48	61	1350	750	800	1400	670	125	40	1350	B	1B/1C
250	Standard	800	3100	3450	1.5	53	66	1300	750	800	1400	670	125	40	1300	B	1B/1C
	Low	660	3100	3450	1.5	51	64	1350	750	800	1420	670	125	40	1350	B	1B/1C
	Very Low	640	2430	2700	1.4	50	63	1350	750	800	1440	670	125	40	1400	B	1B/1C
315	Standard	930	3670	4070	1.5	54	67	1350	750	800	1460	670	125	40	1500	B	1B/2C
	Low	790	3670	4070	1.5	53	66	1400	750	800	1460	670	125	40	1550	B	1B/2C
	Very Low	730	2850	3170	1.2	51	64	1400	750	800	1480	670	125	40	1650	B	1B/2C
400	Standard	1100	4410	4900	1.4	56	69	1400	750	800	1500	670	125	40	1750	B	2B/2C
	Low	970	4410	4900	1.4	54	67	1400	750	800	1500	670	125	40	1750	B	2B/2C
	Very Low	850	3420	3800	1.1	52	66	1400	750	800	1500	670	125	40	1900	B	2B/2C
500	Standard	1310	5190	5760	1.2	57	70	1450	750	850	1600	670	125	40	2000	C	2B/2C
	Low	1100	5190	5760	1.2	56	69	1450	750	850	1600	670	125	40	2000	C	2B/2C
	Very Low	1020	4000	4450	1.1	53	67	1450	750	850	1600	670	125	40	2200	C	2B/2C
630	Standard	1600	6210	6900	1.1	58	72	1450	850	850	1700	670	125	40	2250	D	2B/3C
	Low	1270	6210	6900	1.1	56	70	1450	850	850	1700	670	125	40	2300	D	2B/3C
	Very Low	1250	4770	5300	1.0	54	68	1500	850	900	1700	670	125	40	2500	D	2B/3C

COPPER WINDINGS

# 6% Ucc

# Insulation Class 12kV

COPPER WINDINGS

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	440	1800	2000	1.8	46	59	1150	600	700	1120	520	125	40	750	A	1B/1C
	Low	330	1800	2000	1.6	45	58	1150	600	700	1120	520	125	40	750	A	1B/1C
	Very Low	260	1620	1800	1.5	43	56	1150	600	700	1140	520	125	40	800	A	1B/1C
150	Standard	580	2320	2580	1.6	49	62	1150	600	700	1160	520	125	40	850	A	1B/1C
	Low	430	2320	2580	1.5	47	60	1150	600	700	1160	520	125	40	850	A	1B/1C
	Very Low	330	2220	2460	1.3	46	59	1200	600	700	1160	520	125	40	950	A	1B/1C
160	Standard	610	2430	2700	1.6	49	62	1150	600	700	1160	520	125	40	850	A	1B/1C
	Low	450	2430	2700	1.4	47	60	1150	600	700	1160	520	125	40	850	A	1B/1C
	Very Low	350	2340	2600	1.3	46	59	1200	600	700	1160	520	125	40	950	A	1B/1C
200	Standard	700	2750	3050	1.5	50	63	1200	750	750	1220	670	125	40	1000	B	1B/1C
	Low	520	2750	3050	1.3	49	62	1200	750	750	1220	670	125	40	1000	B	1B/1C
	Very Low	410	2660	2950	1.2	47	60	1250	750	750	1220	670	125	40	1050	B	1B/1C
250	Standard	820	3150	3500	1.4	52	65	1250	750	750	1280	670	125	40	1150	B	1B/1C
	Low	610	3150	3500	1.3	50	63	1250	750	750	1280	670	125	40	1150	B	1B/1C
	Very Low	500	3060	3400	1.1	49	62	1250	750	750	1280	670	125	40	1150	B	1B/1C
315	Standard	960	3690	4100	1.3	53	66	1300	750	800	1340	670	125	40	1300	B	1B/1C
	Low	720	3690	4100	1.2	52	65	1300	750	800	1340	670	125	40	1350	B	1B/1C
	Very Low	580	3480	3870	1.0	50	63	1300	750	800	1340	670	125	40	1350	B	1B/1C
400	Standard	1150	4410	4900	1.2	55	68	1300	750	800	1400	670	125	40	1450	B	2B/2C
	Low	880	4410	4900	1.1	53	66	1300	750	800	1400	670	125	40	1500	B	2B/2C
	Very Low	700	4050	4500	1.0	51	65	1300	750	800	1400	670	125	40	1500	B	2B/2C
500	Standard	1300	5340	5940	1.1	56	69	1350	750	850	1460	670	125	40	1700	C	2B/2C
	Low	990	5340	5940	1.0	55	68	1350	750	850	1460	670	125	40	1750	C	2B/2C
	Very Low	830	5060	5630	0.9	52	66	1350	750	850	1460	670	125	40	1750	C	2B/2C
630	Standard	1500	6570	7300	1.1	57	71	1400	850	850	1520	670	125	40	2000	D	2B/2C
	Low	1150	6570	7300	1.0	55	69	1400	850	850	1520	670	125	40	2050	D	2B/2C
	Very Low	1000	6390	7100	0.9	53	67	1400	850	850	1520	670	125	40	2050	D	2B/2C
750	Standard	1710	7650	8500	1.0	58	72	1450	850	850	1620	670	125	40	2300	E	3B/3C
	Low	1250	7650	8500	0.9	56	70	1450	850	850	1620	670	125	40	2350	E	3B/3C
	Very Low	1070	6960	7730	0.8	55	69	1450	850	850	1640	670	125	40	2400	E	3B/3C
800	Standard	1800	8100	9000	1.0	58	72	1450	850	850	1640	670	125	40	2400	E	3B/3C
	Low	1300	8100	9000	0.9	57	71	1450	850	850	1660	670	125	40	2450	E	3B/3C
	Very Low	1100	7200	8000	0.8	55	69	1450	850	850	1680	670	125	40	2500	E	3B/3C
1000	Standard	2100	9000	10000	0.9	60	74	1500	1000	1000	1740	820	125	40	2850	F	3B/3C
	Low	1500	9000	10000	0.8	58	72	1500	1000	1000	1740	820	125	40	2850	F	3B/3C
	Very Low	1300	8100	9000	0.8	56	70	1550	1000	1000	1740	820	125	40	3000	F	3B/3C
1250	Standard	2500	10800	12000	0.9	61	75	1600	1000	1000	1800	820	160	50	3350	G	4B/4C
	Low	1800	10800	12000	0.8	59	73	1600	1000	1000	1840	820	160	50	3450	G	4B/4C
	Very Low	1500	9900	11000	0.7	57	72	1600	1000	1000	1840	820	160	50	3600	G	4B/4C
1500	Standard	2710	12400	13780	0.8	61	76	1650	1000	1000	1960	820	160	50	3900	H	4B/4C
	Low	2080	12400	13780	0.8	60	75	1650	1000	1000	1960	820	160	50	3950	H	4B/4C
	Very Low	1710	11180	12420	0.7	58	73	1700	1000	1000	1960	820	160	50	4200	H	4B/4C
1600	Standard	2800	13050	14500	0.8	62	77	1650	1000	1000	2000	820	160	50	4100	H	4B/4C
	Low	2200	13050	14500	0.7	60	75	1650	1000	1000	2000	820	160	50	4150	H	4B/4C
	Very Low	1800	11700	13000	0.7	58	73	1700	1000	1000	2000	820	160	50	4400	H	4B/4C
2000	Standard	3600	16200	18000	0.8	63	78	1750	1310	1310	2140	1070	200	70	5000	I	5B/5C
	Low	2600	16200	18000	0.7	61	76	1750	1310	1310	2140	1070	200	70	5100	I	5B/5C
	Very Low	2200	13950	15500	0.6	60	75	1750	1310	1310	2140	1070	200	70	5200	I	5B/5C
2500	Standard	4300	18900	21000	0.7	65	80	1850	1310	1310	2200	1070	200	70	6050	J	5B/5C
	Low	3200	18900	21000	0.7	62	78	1900	1310	1310	2200	1070	200	70	6250	J	5B/5C
	Very Low	2600	16650	18500	0.6	60	76	1900	1310	1310	2240	1070	200	70	6400	J	5B/5C
3000	Standard	5060	22360	24840	0.7	65	81	2000	1310	1310	2320	1070	200	70	7150	K	6B/6C
	Low	3660	22360	24840	0.6	63	79	2000	1310	1310	2320	1070	200	70	7200	K	6B/6C
	Very Low	3020	19070	21190	0.6	61	77	2100	1310	1310	2320	1070	200	70	7750	K	6B/6C
3150	Standard	5300	23400	26000	0.7	65	81	2000	1310	1310	2340	1070	200	70	7450	K	6B/6C
	Low	3800	23400	26000	0.6	63	79	2000	1310	1310	2340	1070	200	70	7500	K	6B/6C
	Very Low	3150	19800	22000	0.5	61	77	2100	1310	1310	2340	1070	200	70	8150	K	6B/6C
3500	Standard	5750	25430	28260	0.7	66	82	2150	1440	1440	2440	1200	200	70	8400	K	7B/7C
	Low	4170	25430	28260	0.6	64	80	2150	1440	1440	2440	1200	200	70	8550	K	7B/7C
	Very Low	3390	21280	23640	0.5	62	78	2200	1440	1440	2520	1200	200	70	9050	K	7B/7C
4000	Standard	6400	28350	31500	0.6	67	83	2250	1440	1440	2560	1200	200	70	9550	K	7B/7C
	Low	4700	28350	31500	0.6	65	81	2250	1440	1440	2580	1200	200	70	9950	K	7B/7C
	Very Low	3750	23400	26000	0.5	63	79	2250	1440	1440	2760	1200	200	70	10250	K	7B/7C

# 6% Ucc

# Insulation Class 17.5kV

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	460	1840	2050	1.9	47	60	1200	600	700	1260	520	125	40	900	A	1B/1C
	Low	340	1840	2050	1.7	46	59	1200	600	700	1260	520	125	40	900	A	1B/1C
	Very Low	280	1620	1800	1.6	44	57	1250	600	700	1280	520	125	40	1000	A	1B/1C
150	Standard	610	2480	2750	1.7	50	63	1200	600	700	1260	520	125	40	950	A	1B/1C
	Low	450	2480	2750	1.4	48	61	1200	600	700	1280	520	125	40	950	A	1B/1C
	Very Low	380	2220	2460	1.4	47	60	1250	600	700	1300	520	125	40	1100	A	1B/1C
160	Standard	650	2610	2900	1.7	50	63	1200	600	700	1260	520	125	40	950	A	1B/1C
	Low	480	2610	2900	1.4	48	61	1200	600	700	1280	520	125	40	950	A	1B/1C
	Very Low	400	2340	2600	1.4	47	60	1250	600	700	1300	520	125	40	1100	A	1B/1C
200	Standard	750	2970	3300	1.6	51	64	1250	750	750	1320	670	125	40	1050	B	1B/1C
	Low	550	2970	3300	1.3	50	63	1250	750	750	1320	670	125	40	1100	B	1B/1C
	Very Low	450	2660	2950	1.3	48	61	1300	750	750	1360	670	125	40	1200	B	1B/1C
250	Standard	820	3420	3800	1.4	52	65	1250	750	750	1280	670	125	40	1150	B	1B/1C
	Low	650	3420	3800	1.2	51	64	1250	750	750	1360	670	125	40	1200	B	1B/1C
	Very Low	520	3060	3400	1.2	50	63	1300	750	750	1400	670	125	40	1300	B	1B/1C
315	Standard	1010	4080	4530	1.4	54	67	1300	750	800	1400	670	125	40	1350	B	1B/2C
	Low	770	4080	4530	1.1	53	66	1350	750	800	1400	670	125	40	1400	B	1B/2C
	Very Low	610	3480	3870	1.1	51	64	1400	750	800	1420	670	125	40	1500	B	1B/2C
400	Standard	1200	4950	5500	1.3	56	69	1350	750	800	1420	670	125	40	1550	B	2B/2C
	Low	940	4950	5500	1.0	54	67	1400	750	800	1420	670	125	40	1550	B	2B/2C
	Very Low	750	4050	4500	1.0	52	66	1450	750	800	1440	670	125	40	1750	B	2B/2C
500	Standard	1390	5770	6410	1.2	57	70	1400	750	850	1480	670	125	40	1800	C	2B/2C
	Low	1070	5770	6410	1.0	56	69	1450	750	850	1480	670	125	40	1800	C	2B/2C
	Very Low	900	5060	5630	1.0	53	67	1500	750	850	1500	670	125	40	1950	C	2B/2C
630	Standard	1650	6840	7600	1.1	58	72	1450	850	850	1540	670	125	40	2100	D	2B/3C
	Low	1250	6840	7600	0.9	56	70	1500	850	850	1540	670	125	40	2100	D	2B/3C
	Very Low	1100	6390	7100	0.9	54	68	1500	850	850	1540	670	125	40	2200	D	2B/3C
750	Standard	1890	7980	8870	1.1	59	73	1450	850	850	1680	670	125	40	2400	E	3B/3C
	Low	1420	7980	8870	0.9	57	71	1500	850	850	1680	670	125	40	2400	E	3B/3C
	Very Low	1240	6960	7730	0.9	56	70	1500	850	850	1680	670	125	40	2450	E	3B/3C
800	Standard	2000	8460	9400	1.1	59	73	1450	850	850	1720	670	125	40	2500	E	3B/3C
	Low	1500	8460	9400	0.9	58	72	1500	850	850	1720	670	125	40	2500	E	3B/3C
	Very Low	1300	7200	8000	0.9	56	70	1500	850	850	1720	670	125	40	2550	E	3B/3C
1000	Standard	2300	9900	11000	1.0	61	75	1550	1000	1000	1780	820	125	40	2900	F	3B/4C
	Low	1800	9900	11000	0.8	59	73	1550	1000	1000	1780	820	125	40	2950	F	3B/4C
	Very Low	1550	8100	9000	0.8	56	71	1600	1000	1000	1800	820	125	40	3050	F	3B/4C
1250	Standard	2800	11700	13000	0.9	62	76	1650	1000	1000	1900	820	160	50	3450	G	4B/4C
	Low	2100	11700	13000	0.8	60	74	1650	1000	1000	1900	820	160	50	3500	G	4B/4C
	Very Low	1800	9900	11000	0.8	58	73	1700	1000	1000	1900	820	160	50	3600	G	4B/4C
1500	Standard	3010	13620	15140	0.9	62	77	1700	1000	1000	2000	820	160	50	3950	H	4B/5C
	Low	2310	13620	15140	0.7	61	76	1700	1000	1000	2000	820	160	50	4050	H	4B/5C
	Very Low	2080	11180	12420	0.7	59	74	1700	1000	1000	2000	820	160	50	4150	H	4B/5C
1600	Standard	3100	14400	16000	0.9	63	78	1700	1000	1000	2020	820	160	50	4150	H	4B/5C
	Low	2400	14400	16000	0.7	61	76	1700	1000	1000	2020	820	160	50	4250	H	4B/5C
	Very Low	2200	11700	13000	0.7	59	74	1700	1000	1000	2020	820	160	50	4350	H	4B/5C
2000	Standard	4000	16200	18000	0.8	64	79	1800	1310	1310	2120	1070	200	70	5150	I	5B/5C
	Low	3000	16200	18000	0.7	62	77	1850	1310	1310	2140	1070	200	70	5250	I	5B/5C
	Very Low	2600	14400	16000	0.7	60	76	1850	1310	1310	2180	1070	200	70	5300	I	5B/5C
2500	Standard	3600	20700	23000	0.8	66	81	1900	1310	1310	2200	1070	200	70	6000	J	5B/6C
	Low	3600	20700	23000	0.6	63	79	1900	1310	1310	2200	1070	200	70	6050	J	5B/6C
	Very Low	3100	17100	19000	0.6	61	77	1950	1310	1310	2220	1070	200	70	6150	J	5B/6C
3000	Standard	5440	24160	26840	0.7	66	82	2000	1310	1310	2260	1070	200	70	7000	K	6B/6C
	Low	4130	24160	26840	0.6	64	80	2050	1310	1310	2280	1070	200	70	7250	K	6B/6C
	Very Low	3630	19170	21300	0.6	62	78	2100	1310	1310	2360	1070	200	70	7450	K	6B/6C
3150	Standard	6000	25200	28000	0.7	66	82	2000	1310	1310	2260	1070	200	70	7300	K	6B/6C
	Low	4300	25200	28000	0.6	64	80	2050	1310	1310	2300	1070	200	70	7550	K	6B/6C
	Very Low	3800	19800	22000	0.6	62	78	2100	1310	1310	2380	1070	200	70	7800	K	6B/6C
3500	Standard	6280	27050	30050	0.7	67	83	2100	1440	1440	2380	1200	200	70	7900	K	7B/7C
	Low	4710	27050	30050	0.6	65	81	2100	1440	1440	2400	1200	200	70	8100	K	7B/7C
	Very Low	4150	21650	24050	0.6	63	79	2150	1440	1440	2460	1200	200	70	8400	K	7B/7C
4000	Standard	6700	29700	33000	0.7	68	84	2150	1440	1440	2540	1200	200	70	8750	K	7B/7C
	Low	5300	29700	33000	0.5	66	82	2150	1440	1440	2540	1200	200	70	8850	K	7B/7C
	Very Low	4650	24300	27000	0.5	64	80	2200	1440	1440	2540	1200	200	70	9200	K	7B/7C

COPPER WINDINGS

# 6% Ucc

# Insulation Class 24kV

COPPER WINDINGS

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	460	1840	2050	1.9	47	60	1350	600	700	1260	520	125	40	1050	A	1B/1C
	Low	340	1840	2050	1.7	46	59	1350	600	700	1280	520	125	40	1100	A	1B/1C
	Very Low	280	1620	1800	1.6	44	57	1350	600	750	1300	520	125	40	1200	A	1B/1C
150	Standard	610	2480	2750	1.7	50	63	1350	600	700	1280	520	125	40	1050	A	1B/1C
	Low	450	2480	2750	1.6	48	61	1350	600	700	1280	520	125	40	1100	A	1B/1C
	Very Low	380	2220	2460	1.4	47	60	1350	600	750	1300	520	125	40	1200	A	1B/1C
160	Standard	650	2610	2900	1.7	50	63	1350	600	700	1280	520	125	40	1050	A	1B/1C
	Low	480	2610	2900	1.5	48	61	1350	600	700	1280	520	125	40	1050	A	1B/1C
	Very Low	400	2340	2600	1.4	47	60	1350	600	750	1300	520	125	40	1150	A	1B/1C
200	Standard	750	2970	3300	1.6	51	64	1350	750	750	1340	670	125	40	1150	B	1B/1C
	Low	550	2970	3300	1.4	50	63	1350	750	750	1340	670	125	40	1150	B	1B/1C
	Very Low	450	2660	2950	1.3	48	61	1350	750	800	1360	670	125	40	1250	B	1B/1C
250	Standard	880	3420	3800	1.5	53	66	1350	750	800	1380	670	125	40	1250	B	1B/1C
	Low	650	3420	3800	1.3	51	64	1350	750	800	1380	670	125	40	1250	B	1B/1C
	Very Low	520	3060	3400	1.2	50	63	1350	750	800	1420	670	125	40	1350	B	1B/1C
315	Standard	1010	4080	4530	1.4	54	67	1400	750	800	1420	670	125	40	1450	B	1B/2C
	Low	770	4080	4530	1.3	53	66	1400	750	800	1420	670	125	40	1450	B	1B/2C
	Very Low	610	3480	3870	1.1	51	64	1400	750	850	1440	670	125	40	1550	B	1B/2C
400	Standard	1200	4950	5500	1.3	56	69	1400	750	800	1440	670	125	40	1600	B	2B/2C
	Low	940	4950	5500	1.2	54	67	1400	750	800	1440	670	125	40	1650	B	2B/2C
	Very Low	750	4050	4500	1.0	52	66	1450	750	850	1440	670	125	40	1750	B	2B/2C
500	Standard	1390	5770	6410	1.2	57	70	1450	750	850	1500	670	125	40	1850	C	2B/2C
	Low	1070	5770	6410	1.1	56	69	1450	750	850	1500	670	125	40	1900	C	2B/2C
	Very Low	900	5060	5630	1.0	53	67	1500	750	900	1500	670	125	40	1950	C	2B/2C
630	Standard	1650	6840	7600	1.1	58	72	1500	850	900	1540	670	125	40	2150	D	2B/3C
	Low	1250	6840	7600	1.0	56	70	1500	850	900	1540	670	125	40	2150	D	2B/3C
	Very Low	1100	6390	7100	0.9	54	68	1500	850	900	1540	670	125	40	2200	D	2B/3C
750	Standard	1890	7980	8870	1.1	59	73	1500	850	900	1680	670	125	40	2450	E	3B/3C
	Low	1420	7980	8870	1.0	57	71	1500	850	900	1680	670	125	40	2450	E	3B/3C
	Very Low	1240	6960	7730	0.9	56	70	1500	850	900	1680	670	125	40	2500	E	3B/3C
800	Standard	2000	8460	9400	1.1	59	73	1500	850	900	1720	670	125	40	2550	E	3B/3C
	Low	1500	8460	9400	1.0	58	72	1500	850	900	1720	670	125	40	2550	E	3B/3C
	Very Low	1300	7200	8000	0.9	56	70	1500	850	900	1720	670	125	40	2600	E	3B/3C
1000	Standard	2300	9900	11000	1.0	61	75	1600	1000	1000	1780	820	125	40	3000	F	3B/4C
	Low	1800	9900	11000	0.9	59	73	1600	1000	1000	1780	820	125	40	3000	F	3B/4C
	Very Low	1550	8100	9000	0.8	56	71	1600	1000	1000	1780	820	125	40	3200	F	3B/4C
1250	Standard	2800	11700	13000	0.9	62	76	1600	1000	1000	1900	820	160	50	3450	G	4B/4C
	Low	2100	11700	13000	0.8	59	74	1650	1000	1000	1900	820	160	50	3550	G	4B/4C
	Very Low	1800	9900	11000	0.8	58	73	1700	1000	1000	1900	820	160	50	3700	G	4B/4C
1500	Standard	3010	13620	15140	0.9	62	77	1750	1000	1000	2000	820	160	50	4050	H	4B/5C
	Low	2310	13620	15140	0.8	61	76	1750	1000	1000	2000	820	160	50	4100	H	4B/5C
	Very Low	2080	11180	12420	0.7	59	74	1750	1000	1000	2000	820	160	50	4200	H	4B/5C
1600	Standard	3100	14400	16000	0.9	63	78	1750	1000	1000	2020	820	160	50	4250	H	4B/5C
	Low	2400	14400	16000	0.8	61	76	1750	1000	1000	2020	820	160	50	4300	H	4B/5C
	Very Low	2200	11700	13000	0.7	59	74	1750	1000	1000	2020	820	160	50	4350	H	4B/5C
2000	Standard	4000	16200	18000	0.8	64	79	1850	1310	1310	2140	1070	200	70	5200	I	5B/5C
	Low	3000	16200	18000	0.7	62	77	1850	1310	1310	2140	1070	200	70	5300	I	5B/5C
	Very Low	2600	14400	16000	0.7	60	76	1850	1310	1310	2180	1070	200	70	5350	I	5B/5C
2500	Standard	5000	20700	23000	0.8	65	81	1950	1310	1310	2200	1070	200	70	6200	J	5B/6C
	Low	3600	20700	23000	0.7	63	79	1950	1310	1310	2200	1070	200	70	6250	J	5B/6C
	Very Low	3100	17100	19000	0.6	61	77	1950	1310	1310	2220	1070	200	70	6350	J	5B/6C
3000	Standard	4460	24160	26840	0.7	66	82	2100	1310	1310	2280	1070	200	70	7350	K	6B/6C
	Low	4130	24160	26840	0.7	64	80	2150	1310	1310	2340	1070	200	70	7600	K	6B/6C
	Very Low	3630	19170	21300	0.6	62	78	2150	1310	1310	2360	1070	200	70	7950	K	6B/6C
3150	Standard	4300	25200	28000	0.7	66	82	2100	1310	1310	2280	1070	200	70	7650	K	6B/6C
	Low	4300	25200	28000	0.7	64	80	2150	1310	1310	2380	1070	200	70	7950	K	6B/6C
	Very Low	3800	19800	22000	0.6	62	78	2200	1310	1310	2400	1070	200	70	8400	K	6B/6C
3500	Standard	5280	27050	30050	0.7	67	83	2200	1440	1440	2400	1200	200	70	8350	K	7B/7C
	Low	4710	27050	30050	0.6	65	81	2200	1440	1440	2460	1200	200	70	8650	K	7B/7C
	Very Low	4150	21650	24050	0.6	63	79	2250	1440	1440	2480	1200	200	70	9100	K	7B/7C
4000	Standard	6700	29700	33000	0.7	68	84	2250	1440	1440	2560	1200	200	70	9300	K	7B/7C
	Low	5300	29700	33000	0.6	66	82	2250	1440	1440	2560	1200	200	70	9550	K	7B/7C
	Very Low	4650	24300	27000	0.5	64	80	2300	1440	1440	2580	1200	200	70	10100	K	7B/7C

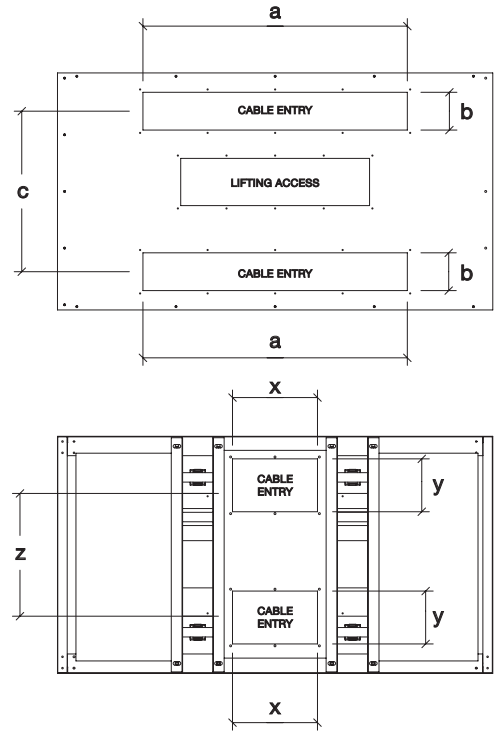
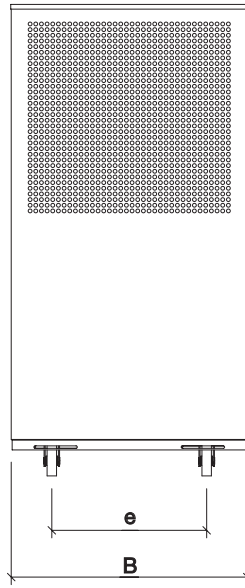
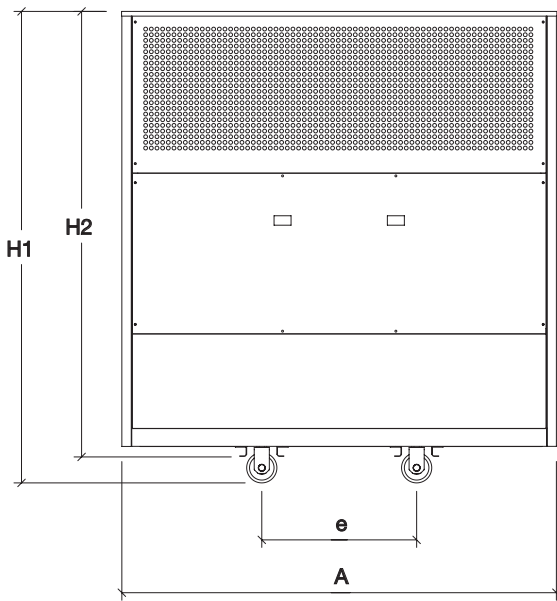
**6% Ucc****Insulation Class 36kV**

Power kVA	Loss Category	Po W	Pk75° W	Pk120° W	Io %	LpA dB(A)	LwA dB(A)	a1 mm	b1 mm	b2 mm	h1 mm	e mm	Ø mm	t mm	Mass kg	Term Type	Encl Type
100	Standard	840	1800	2000	2.1	48	62	1600	750	900	1640	670	125	40	1650	A	11B/11C
	Low	800	1800	2000	1.8	46	60	1600	750	900	1640	670	125	40	1650	A	11B/11C
	Very Low	750	1620	1800	1.6	45	59	1600	750	900	1640	670	125	40	1650	A	11B/11C
150	Standard	930	2320	2580	1.9	51	65	1600	750	900	1660	670	125	40	1650	A	11B/11C
	Low	880	2320	2580	1.6	49	63	1600	750	900	1660	670	125	40	1650	A	11B/11C
	Very Low	830	2140	2380	1.4	48	62	1600	750	900	1660	670	125	40	1650	A	11B/11C
160	Standard	960	2430	2700	1.8	51	65	1600	750	900	1660	670	125	40	1650	A	11B/11C
	Low	900	2430	2700	1.6	49	63	1600	750	900	1660	670	125	40	1650	A	11B/11C
	Very Low	850	2250	2500	1.4	48	62	1600	750	900	1660	670	125	40	1650	A	11B/11C
200	Standard	1100	2870	3180	1.7	52	66	1600	750	900	1680	670	125	40	1750	B	11B/11C
	Low	980	2870	3180	1.5	51	65	1600	750	900	1680	670	125	40	1750	B	11B/11C
	Very Low	910	2650	2940	1.3	49	63	1600	750	900	1680	670	125	40	1750	B	11B/11C
250	Standard	1280	3420	3800	1.6	54	68	1600	750	900	1700	670	125	40	1800	B	11B/11C
	Low	1100	3420	3800	1.4	52	66	1600	750	900	1700	670	125	40	1800	B	11B/11C
	Very Low	1000	3150	3500	1.2	51	65	1600	750	900	1700	670	125	40	1800	B	11B/11C
315	Standard	1440	4040	4490	1.5	55	69	1650	750	900	1740	670	125	40	2000	B	11B/11C
	Low	1180	4040	4490	1.3	54	68	1650	750	900	1740	670	125	40	2000	B	11B/11C
	Very Low	1080	3730	4150	1.2	52	66	1650	750	900	1740	670	125	40	2000	B	11B/11C
400	Standard	1650	4860	5400	1.4	57	71	1650	750	900	1760	670	125	40	2200	B	12B/12C
	Low	1300	4860	5400	1.2	55	69	1650	750	900	1760	670	125	40	2200	B	12B/12C
	Very Low	1200	4500	5000	1.1	54	68	1650	750	900	1760	670	125	40	2200	B	12B/12C
500	Standard	1880	5680	6310	1.3	59	73	1700	850	950	1800	670	125	40	2500	C	12B/12C
	Low	1430	5680	6310	1.1	57	71	1700	850	950	1800	670	125	40	2500	C	12B/12C
	Very Low	1280	5280	5860	1.0	55	69	1750	850	950	1840	670	125	40	2600	C	12B/12C
630	Standard	2200	6750	7500	1.2	60	74	1750	850	950	1820	670	125	40	2800	D	12B/12C
	Low	1600	6750	7500	1.1	57	72	1750	850	950	1820	670	125	40	2800	D	12B/12C
	Very Low	1400	6300	7000	0.9	56	71	1800	850	950	1900	670	125	40	3100	D	12B/12C
750	Standard	2550	7700	8550	1.2	60	75	1800	850	1000	1880	670	125	40	3100	E	13B/13C
	Low	1810	7700	8550	1.0	59	74	1850	850	1000	1880	670	125	40	3200	E	13B/13C
	Very Low	1570	7180	7980	0.9	57	72	1850	850	1000	1920	670	125	40	3500	E	13B/13C
800	Standard	2700	8100	9000	1.2	61	76	1800	850	1000	1900	670	125	40	3200	E	13B/13C
	Low	1900	8100	9000	1.0	59	74	1850	850	1000	1900	670	125	40	3350	E	13B/13C
	Very Low	1650	7560	8400	0.9	57	72	1850	850	1000	1920	670	125	40	3600	E	13B/13C
1000	Standard	3100	9900	11000	1.1	62	77	1850	1000	1050	2000	820	125	40	3700	F	13B/13C
	Low	2250	9900	11000	0.9	60	75	1850	1000	1050	2000	820	125	40	3800	F	13B/13C
	Very Low	1900	9000	10000	0.8	59	74	1900	1000	1050	2040	820	125	40	4100	F	13B/13C
1250	Standard	3600	11700	13000	1.0	64	79	1950	1000	1050	2040	820	160	50	4300	G	14B/14C
	Low	2600	11700	13000	0.9	62	77	1950	1000	1050	2040	820	160	50	4350	G	14B/14C
	Very Low	2200	10800	12000	0.8	60	75	2000	1000	1100	2100	820	160	50	4850	G	14B/14C
1500	Standard	4020	13620	15140	1.0	65	80	2000	1000	1100	2180	820	160	50	4850	H	14B/14C
	Low	2880	13620	15140	0.8	63	78	2000	1000	1100	2180	820	160	50	5000	H	14B/14C
	Very Low	2450	12080	13420	0.7	61	76	2050	1000	1100	2240	820	160	50	5500	H	14B/14C
1600	Standard	4200	14400	16000	1.0	65	80	2000	1000	1100	2220	820	160	50	5050	H	14B/14C
	Low	3000	14400	16000	0.8	63	78	2000	1000	1100	2220	820	160	50	5250	H	14B/14C
	Very Low	2550	12600	14000	0.7	62	77	2050	1000	1100	2280	820	160	50	5700	H	14B/14C
2000	Standard	5000	16650	18500	0.9	66	82	2100	1310	1310	2260	1070	200	70	6100	I	15B/15C
	Low	3500	16650	18500	0.8	64	80	2100	1310	1310	2280	1070	200	70	6300	I	15B/15C
	Very Low	3000	15300	17000	0.7	62	78	2200	1310	1310	2320	1070	200	70	7150	I	15B/15C
2500	Standard	5800	20250	22500	0.8	67	83	2200	1310	1310	2380	1070	200	70	7250	J	15B/15C
	Low	4200	20250	22500	0.7	65	81	2200	1310	1310	2380	1070	200	70	7300	J	15B/15C
	Very Low	3500	18000	20000	0.6	64	80	2300	1310	1310	2480	1070	200	70	8500	J	15B/15C
3000	Standard	6490	23710	26340	0.8	68	84	2350	1310	1310	2480	1070	200	70	8350	K	16B/16C
	Low	4810	23710	26340	0.7	67	83	2350	1310	1310	2480	1070	200	70	8450	K	16B/16C
	Very Low	3960	21460	23840	0.6	65	81	2350	1310	1310	2760	1070	200	70	9500	K	16B/16C
3150	Standard	6700	24750	27500	0.8	69	85	2350	1310	1310	2500	1070	200	70	8650	K	16B/16C
	Low	5000	24750	27500	0.7	67	83	2350	1310	1310	2500	1070	200	70	8750	K	16B/16C
	Very Low	4100	22500	25000	0.6	65	81	2350	1310	1310	2840	1070	200	70	9800	K	16B/16C
3500	Standard	6960	26600	29550	0.8	69	85	2350	1440	1440	2740	1200	200	70	9450	K	17B/17C
	Low	5390	26600	29550	0.7	68	84	2400	1440	1440	2740	1200	200	70	9650	K	17B/17C
	Very Low	4470	24530	27260	0.6	66	82	2400	1440	1440	2940	1200	200	70	10750	K	17B/17C
4000	Standard	7350	29250	32500	0.7	70	86	2350	1440	1440	3040	1200	200	70	10550	K	17B/17C
	Low	5950	29250	32500	0.6	68	84	2400	1440	1440	3040	1200	200	70	10850	K	17B/17C
	Very Low	5000	27450	30500	0.6	66	83	2450	1440	1440	3060	1200	200	70	12100	K	17B/17C

**COPPER WINDINGS**

# INDOOR ENCLOSURES

## IEC IP21 to IP33



Dimensions Enclosure IP21 to IP33						
Encl. Type	A mm	B mm	H1 mm	H2 mm	e	Mass kg
<b>12kV 17.5kV 24kV</b>						
1B	1850	1250	1710	1610	See transformer tables	170
2B	1950	1300	2010	1910		210
3B	2050	1350	2260	2160		240
4B	2250	1400	2500	2360		310
5B	2500	1450	2850	2670		330
6B	2750	1550	3050	2870		390
7B	2900	1600	3150	3110		420
<b>36kV</b>						
11B	2400	1550	1960	1860	See transformer tables	280
12B	2500	1600	2260	2120		300
13B	2600	1650	2460	2320		330
14B	2750	1700	2700	2520		370
15B	2950	1750	3050	2870		410
16B	3050	1800	3200	3160		450
17B	3250	1850	3550	3510		490

Cable Entry Top Panel			Cable Entry Bottom Panel		
a mm	b mm	c mm	x mm	y mm	z mm
<b>12kV 17.5kV 24kV</b>					
1100	150	850	300	250	700
1200	150	700	300	300	750
1300	150	750	450	350	800
1400	200	850	450	400	850
1600	200	910	450	400	900
1900	300	950	450	400	950
1900	300	1170	450	400	1000
<b>36kV</b>					
1400	200	950	300	250	900
1400	200	950	300	300	950
1600	200	950	450	350	1000
1600	200	950	450	400	1050
1900	300	1040	450	400	1100
1900	300	1170	450	400	1150
1900	300	1170	450	400	1200



IP21



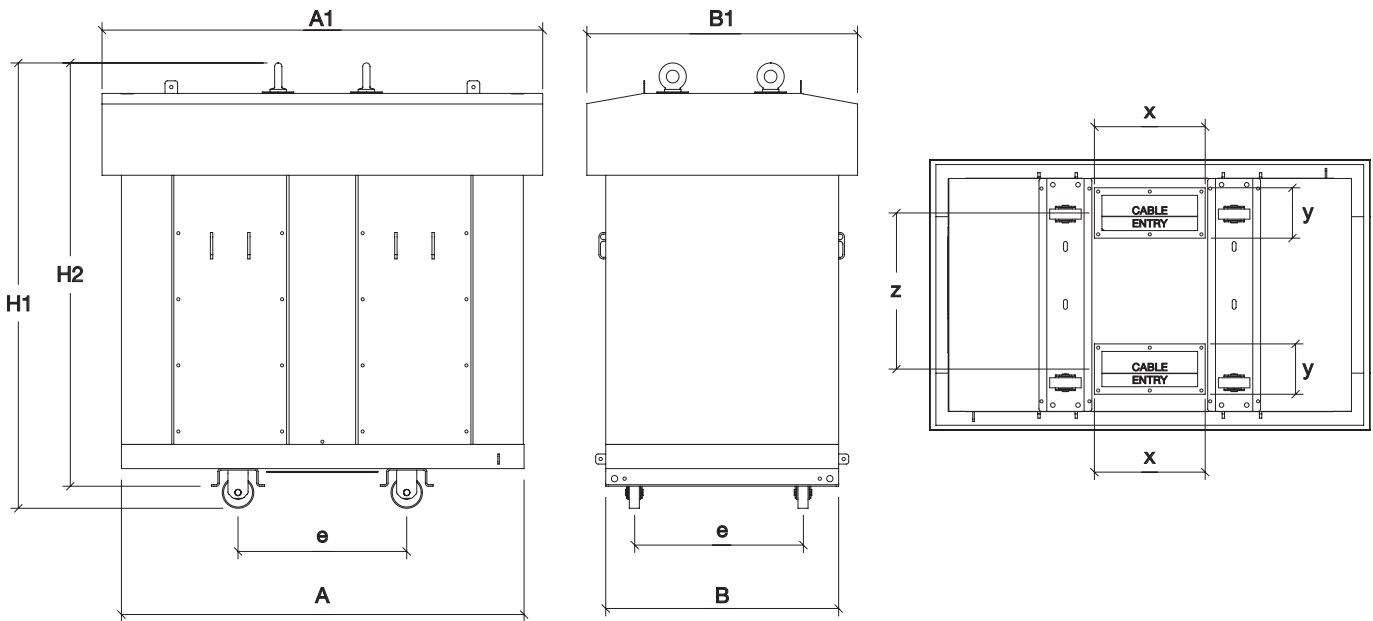
IP23



IP31

# OUTDOOR ENCLOSURES

## IEC IP43 to IP66



Dimensions Enclosure IP43								
Encl. Type	A mm	A1 mm	B mm	B1 mm	H1 mm	H2 mm	e	Mass kg
<b>12kV 17.5kV 24kV</b>								
1C	1850	2150	1450	1750	2010	1920	See transformer tables	460
2C	1950	2250	1500	1800	2220	2130		500
3C	2050	2350	1550	1850	2480	2390		580
4C	2250	2550	1600	1900	2680	2590		700
5C	2500	2800	1700	2000	3010	2890		830
6C	2750	3050	1800	2100	3250	3090		920
7C	2900	3200	1900	2100	3360	3325		1050
<b>36kV</b>								
11C	2400	2700	1750	2050	2260	2170	See transformer tables	680
12C	2500	2800	1800	2100	2480	2390		690
13C	2600	2900	1850	2100	2680	2590		780
14C	2750	3050	1900	2100	2890	2790		860
15C	2950	3250	1950	2250	3220	3100		1020
16C	3050	3350	2000	2300	3520	3250		1080
17C	3250	3550	2050	2350	3675	3640		1260

Cable Entry Bottom Panel		
x mm	y mm	z mm
<b>12kV 17.5kV 24kV</b>		
450	250	1000
450	300	1100
600	270	1100
600	370	1100
600	400	1150
600	400	1200
600	400	1250
<b>36kV</b>		
450	250	1200
450	300	1300
600	300	1300
600	400	1300
600	400	1350
600	400	1400
600	400	1450



IP43



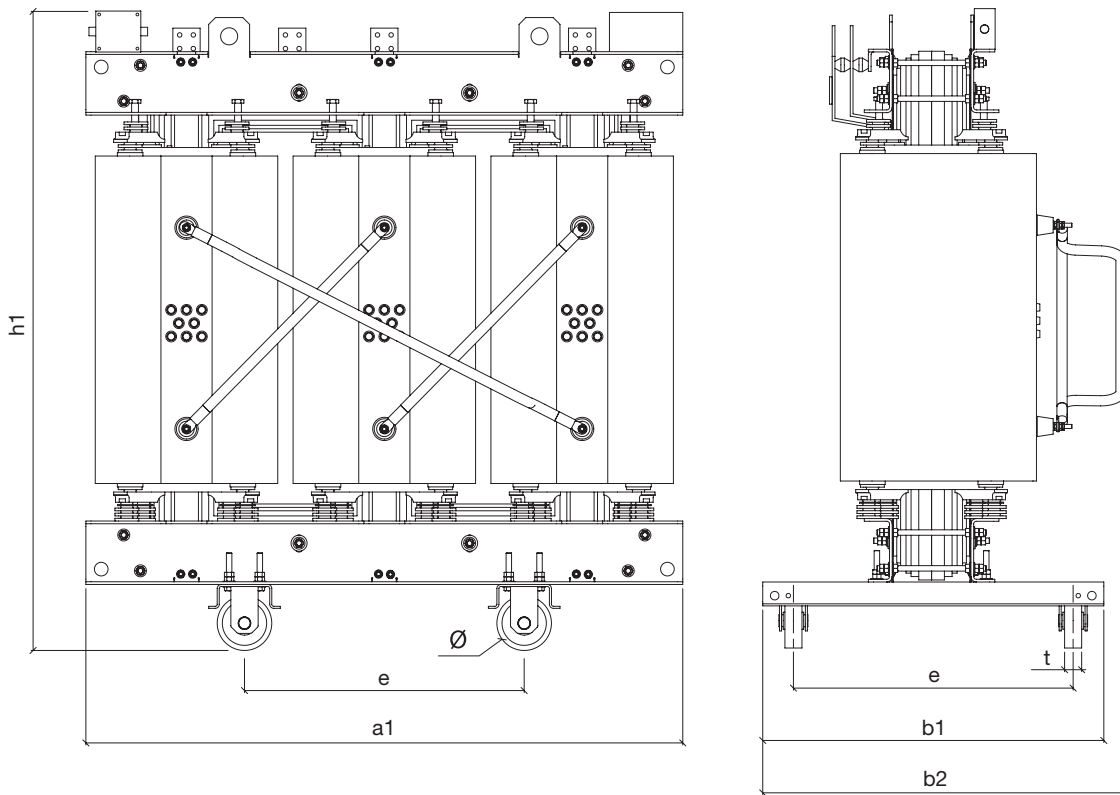
IP55



IP66

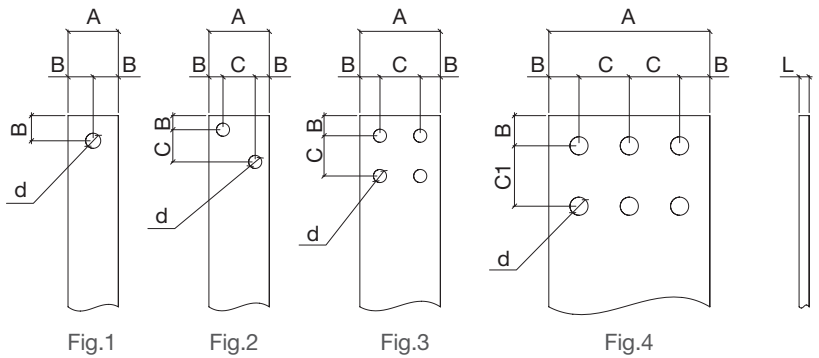
# TECHNICAL DETAILS

## IP00



## TERMINALS

LV Terminals 380V TO 480V							
Term Type	Fig.	A mm	L mm	B mm	C mm	C1 mm	d mm
A	1	30	3	15	-	-	13
B	1	50	5	25	-	-	15
C	2	60	6	14	32	-	13
D	2	60	8	14	32	-	13
E	3	80	8	20	40	-	13
F	3	100	8	25	50	-	15
G	3	120	10	30	60	-	18
H	3	120	12	30	60	-	18
I	4	160	10	30	50	60	18
J	4	160	14	30	50	60	18
K	4	160	20	30	50	60	18



HV Terminals	
All HV terminals per Fig.5 with thread dimension M12	

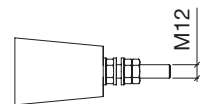


Fig.5

## TMC ENCLOSURES

TMC enclosures for use indoors are ventilated and conform to ANSI/IEC Standard 60529:2004 (Degree of Protection IP21 up to IP33).

TMC enclosures for outdoor use are either ventilated or sealed and conform to ANSI/IEC Standard 60529:2004 (Degree of Protection IP43 up to IP66).

TMC transformers installed in TMC enclosures are thermally rated in accordance with Annex DD of IEC Standard 62271-202:2014 “HV/LV Prefabricated Substation”.

TMC bespoke enclosures can be supplied in a variety of materials and finishes. Enclosure panels on Indoor Enclosures are electro-zinc coated, hot galvanized or stainless steel and epoxy powder coated.

Enclosure panels on Outdoor Enclosures are heavy gauge hot galvanized or stainless steel and powder coated with UV resistant epoxy or polyester.

The core and coil assembly and removable enclosure panels are mounted on a hot dip galvanized steel base frame fitted with bi-directional rollers.



IP21



IP43

## OPTIONAL ENCLOSURES ACCESSORIES



LV Cable Box



HV Cable Box with Bushing



External Marshalling Box



Cable Box with Infrared Windows



Space Heater



External Lifting Arrangement



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