

Oil immersed  
**Transformer**



# History



## Fuji Electric (T&D Business)

- 1923** Established Fuji Electric Manufacturing Co.,Ltd.
- 1962** Started operation of Chiba factory (transformer)
- 1968** Started operation of Kobe factory (switchboard)
- 1971** Started manufacturing rectifier transformer units
- 1974** Started manufacturing cast resin transformers
- 1984** Changed company name and logo to Fuji Electric Co.,Ltd.
- 1985** Delivered the first 800kV transformers
- 1990** Delivered the first 1,100MVA transformer
- 1996** Delivered the first 8300kV Gas Insulated Switchgear
- 2002** Introduced new company symbol mark
- 2009** Delivered the first 1,750V DC, 87.5kA power supply equipment

## TUSCO

- 1981** Founded Tusco Group  
Established Theparak Supply Shop
- 1982** Started Manufacturing of Low Voltage & Medium Voltage Switchboards
- 1984** Founded Theparak Transformer Co., Ltd.
- 1990** Founded Thai Union Switchboard Co., Ltd.
- 1996** Established Tusco Trafo Co., Ltd. and Thai Corrugate Co., Ltd. Technical Assignment and Manufacturing Contract for switchboards with Fuji Electric Co., Ltd.
- 2007** Production lines of power transformers were Increased
- 2012** Grand opening of new transformer factory



**Fuji Tusco has started in 2013**



บริษัท ฟุจิ ทัสโก้ จำกัด  
Fuji Tusco Co., Ltd.

Fuji Tusco transformers are the result of an extensive engineering effort over many years along with the most advanced and greatly dependable techniques of Fuji Tusco plus the technological skills of Fuji Electric in Japan. The transformers are made in the excellent workshop equipped with new facilities including computer, dust proof air-conditioning equipment, etc. The techniques of Fuji Tusco have made these transformers superior to those of other firms.

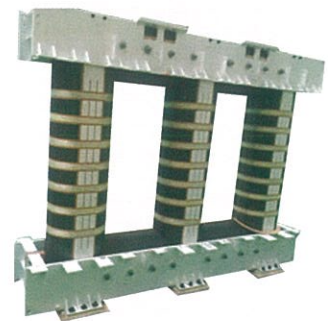
The features are as follows.

## Well arranged core construction

The core is made of top-class Hi-B (high magnetic flux density) oriented silicon steel plate with improved exciting characteristics such as core loss, exciting current, magnetostriction, etc. The core is tightened uniformly with tempered plastic bands and also a core election equipment is employed, thus making it small-sized and lightweight together with low noise level.

### In details:

- Since there are no holes in the core plate, it provides for easy machining and improve the characteristics.
- The core tightening bolts are cooled directly by insulation oil since they pass through the oil duct.
- Because of using the tempered plastic bands, the core plate ends can be tightened securely.
- As a result of improving the space factor of core, the transformer can be made compact and lightweight.



Core construction

## Winding construction

Various windings have been developed in addition to the conventional twin coil disc winding, and according to the purpose of use, the optimum winding is selected from those listed below so that the specific characteristics can be fully utilized.

- For low voltage and large current;  
Cylindrical layer winding (using transposed conductor)
- Helical winding
- For high voltage and surge protection;  
High series capacitance disc winding
- For wide-range tap;  
Multi-parallel cylindrical tap winding

### ◆ Highly reliable insulation

For the windings of extra high voltage transformers, a high series capacitance disc winding, in which potential oscillation in the winding is suppressed to a minimum when impulse voltage is applied. The insulation in the windings, across windings and across winding and ground has been made very reliable as a result of numerous fundamental experiments and improvement of potential distribution and insulation strength by utilizing a computer. Also, extra high voltage are given a partial discharge test to verify the insulation reliability before leaving the plant.

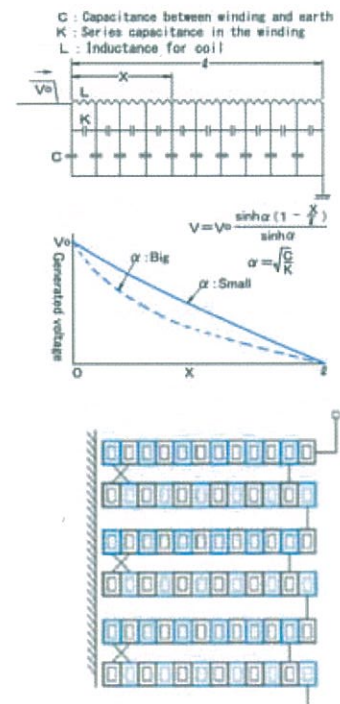


Fig. 1 High series capacitance disc winding

## ◆ Loss reduction technology

As the winding conductor, a transposed conductor has been employed besides the rectangular copper wire to cope with the increase in transformer capacity.

The transposed conductor is made as follows;

With the finely divided rectangular conductors each insulated with synthetic resin consisting mainly of polyvinyl formal, the odd-numbered conductors are arranged in two rows as shown in Fig.2, the mutual positions of conductors are transposed in turn at a certain pitch, and with these conductors put together as a unit, the same electric insulation Kraft paper as used for ordinary rectangular copper wires is wound thereon for insulation. When this transposed conductor is used, the following merits are available:

1. Reduction in stray load loss in winding
2. Prevention of local overheat in winding
3. Improvement in characteristics, and
4. Accomplishment of lightweight and compact transformers
5. Decrease in the number of connecting parts in winding

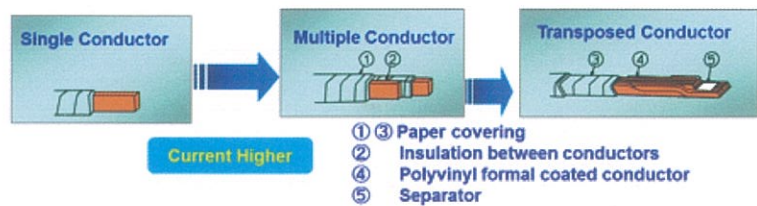


Fig.2 Transposed conductor

## ◆ Great short-circuit resistance of windings

The windings have been designed based on experience including short-circuit tests with a number of actual transformers, and by accurate computer calculation of electromagnetic mechanical force during external short-circuit. Beside, these windings are tightened securely with a tightening torque corresponding to the electromagnetic mechanical force, together with pre-tightening treatments.

Thus, sufficient short-circuit resistance can be maintained over a long time.



Fig.3 Short circuit withstand test as per IEC 60076-5 for FTU transformers have been performed by KEMA successfully.

## ◆ Cooling system

The optimum cooling system will be selected out of following according to the customer 's requirements and also taking into account the transformer capacity and circumstances at the installation site.

- 1) ONAN, 2) ONAF, 3) ODAN, 4) ODAF, 5) OFOW
- In a large core, the core internal temperature rise is kept under the limit by providing a cooling oil duct at right angles to the steel plate stacking direction. For the winding, an oil duct is installed in the coil as required for obtaining a high cooling effect.

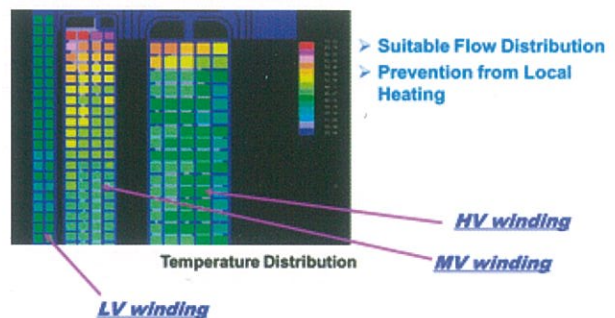


Fig.4 Hydraulic Flow Analysis

As a strategic company of Fuji Electric group, Fuji Tusco manufacture various type of transformers.

## Distribution Transformers

- Oil Immersed Transformers up to 36kV
- Single Phase up to 1000kVA
- Three Phase up to 30MVA

## Cast Resin Transformers (Dry type transformers)

Up to 2.5MVA and 24kV

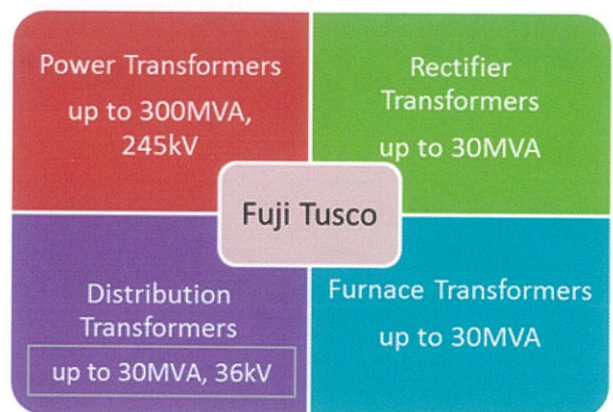
### Synergy with FE

#### Power Transformers

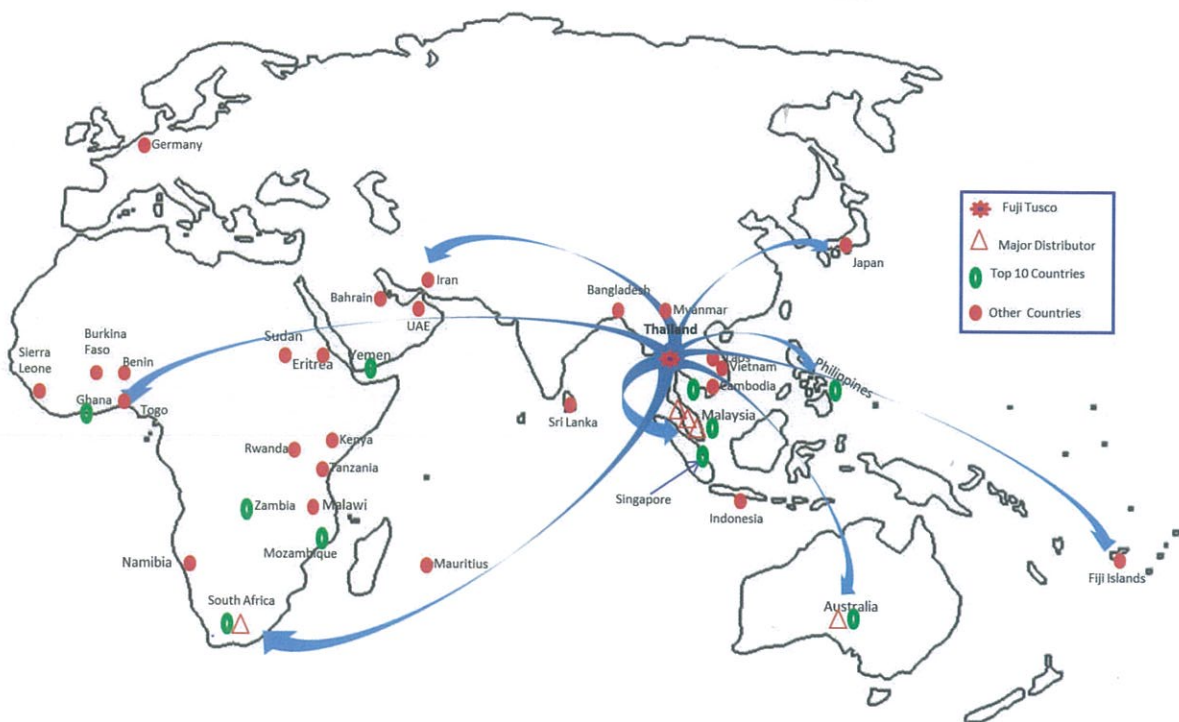
- Oil Immersed Transformers up to 245kV
- Single & Three Phase up to 300MVA

#### Special Transformers

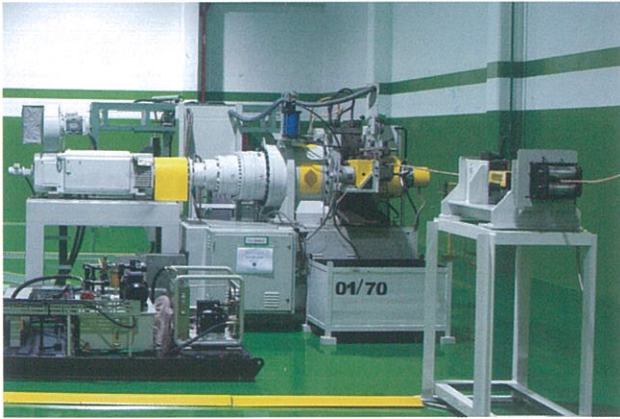
- Rectifier Transformer up to 30MVA
- Furnace Transformer up to 30MVA
- Testing Transformer up to 300kV
- Unit or Miniature Substation up to 36kV
- Made to Order Transformers



## Global Supply by Fuji Tusco (FTU)



Fuji Tusco transformers are made in the excellent workshop equipped with new facilities including computer, dust proof air-conditioning equipment, etc.



Rectangular Wire Conforming Line



Up-Casting Introduction Furnace



Vertical Winding Machine



High precision cut to length machine



Laser Cutting Machine



Automatic Vapor Phase Drying System

## ISO 9001: Quality Management System

We have been maintaining our high level of quality control through periodic inspections by external organizations and our internal audits since the introduction of the quality management system (QMS) in accordance with the international ISO 9001 standard in 1999.

In addition, we are promoting various activities to enhance our staff's awareness of quality and eventually improve the quality of our products.

## ISO 14001: Environmental Management System

We will fulfill our social obligations by endeavoring in preservation of the environment and contributing to society through promotion of creation of environmental-friendly products aiming at reduction of environmental load, to materialize "sustainable society" through our business activities, product and service.

## OHSAS 18001-2007

We have been certified OHSAS 18001 since 2014 to address occupational health and safety of personnel and processes, we establish a positive health and safety culture, provision of safe and healthy work environment, thus setting the path towards sustainable development.

ISO 9001-2008



ISO 14001-2004



OHSAS 18001-2007



## Testing for international quality standards

### For Transformer measurement system

#### Control rack



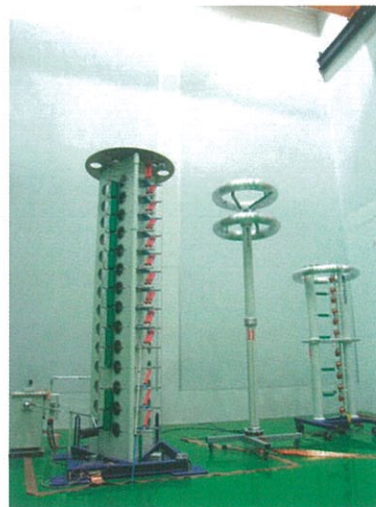
Control rack and Control desk  
TMS 580, 100kV 2000A

#### Measuring instrument



Standard Current and Voltage transducers  
TMS 580, 100kV 2000A

### For Impulse withstand voltage test



Impulse generator  
1400kV 140kJ  
(SGDA 1400140)

Impulse voltage  
Divider 1400kV  
(CR 1400-525)

Multiple  
Chopping gap  
(MAFS 1200)



230kV Power Transformer (Left)  
400kV Testing Transformer (Right)



132/33kV 90/125MVA Power Transformer

Step-down transformers in substations and step-up transformers in power stations are essential components in those facilities. These transformers cover the electric power for many of electricity consumers, so highly reliable transformers are required.

Fuji Tusco will make transformers to provide the highest efficiency within the limits where economy is not lost. Because of well arranged core construction, no-load loss is reduced.

In relation, to the load loss occupying the majority of total loss, as a result of employing a transposed conductor, achieving non-magnetization of metal adjacent to the winding, and providing a magnetic shielding of tank inner wall, stray-load loss has been reduced significantly whereby transformers with high efficiency and little loss have been created.

## Standard Features for Conservator Type

- High and Low voltage bushings
- Off-circuit tap changer
- Lifting lugs
- Earthing terminals
- Buchholz relay
- Dehydrating breather
- Pressure relief device
- Dial type thermometer
- Oil level gauge / Oil level indicator
- Filling lug
- Skid base
- Drain valve
- Rating plate

## Options and accessories

- On load tap changer
- Plug-in bushings on HV
- Galvanized tank
- Rubber bag
- Dual voltage
- Winding temperature Indicator
- Cooling fans and pumps
- Cable boxes
- Wheels



<b>Rating</b>	1000kVA up to 30,000kVA
<b>Primary voltage</b>	36 kV and below
<b>Secondary voltage</b>	36kV and below
<b>Model</b>	Hermetically Sealed Type Sealed Type Conservator Type
<b>Tank Design</b>	Corrugated Wall (up to 3MVA) Radiator Fin



Medium and large distribution transformers, installed in substations near to the consumer's side, receive high voltage electric power from the grid, reduce its voltage, and distribute electricity to consumers and lower voltage substations.

Fuji Tusco provides distribution transformers up to 30MVA capacity and up to 36kV primary/secondary voltage. And necessary accessories are available if requested. The most suitable one will be delivered in accordance with customer's requirements.

## Standard Features for Conservator Type

- High and Low voltage bushings
- Off-circuit tap changer
- Lifting lugs
- Earthing terminals
- Buchholz relay
- Dehydrating breather
- Pressure relief device
- Dial type thermometer
- Oil level gauge / Oil level indicator
- Filling lug
- Skid base
- Drain valve
- Rating plate

## Options and accessories

- On load tap changer
- Plug-in bushings on HV
- Galvanized tank
- Rubber bag
- Dual voltage
- Winding temperature Indicator
- Cooling fans and pumps
- Cable boxes
- Wheels



630kVA Transformer



Pole transformer



Unit substation

<b>Installation</b>	Pole or Ground Mounted
<b>Rating</b>	30kVA up to 1,000kVA
<b>Primary voltage</b>	36 kV and below
<b>Secondary voltage</b>	600V and below
<b>Model</b>	Hermetically Sealed Type Sealed Type Conservator Type
<b>Tank Design</b>	Plain Tank (up to 50 kVA) Corrugated Wall (up to 3 MVA) Radiator Fins

Small distribution transformers, installed on utility poles or on concrete pads, act as the last transformers providing the final utilization voltage (100V~600V) at the consumer's facilities. So, there is the variety of requirements, installation type, electrical ratings, tank design, accessories, and so on.

Fuji Tusco has many experiences of delivering these transformers for domestic customers in Thailand and also for various other countries. Small distribution transformers of Fuji Tusco are available up to 1,000kVA capacity and up to 36kV primary voltage. Each type of pole-mounted/pad-mounted installation, hermetically-sealed/conservator-type design, and plain/corrugated-wall/radiator-fins tank construction, is standardized and able to be supplied.

## Standard Features for Hermetically Sealed Type

- High and Low voltage bushings
- Off-circuit tap changer in 5 positions
- Lifting lugs
- Earthing terminals
- Pressure relief device
- Thermometer pocket
- Filling lug
- Skid base
- Drain valve
- Rating plate

## Options and accessories

- Plug-in bushings on HV
- Dual voltage transformer
- Galvanized tank
- Surge arrestor, CSP-type version
- Max. thermometer
- Dial type thermometer with two contacts
- Oil level indicator
- Arcing horns, Bird guard
- Integrated pole brackets on tank
- Bi-directional rollers
- Skid base
- Cable boxes

For arc furnace applications and rectifier applications in the field of industry, low voltage and large current transformers are applied.

Fuji Tusco is able to deliver the fittest transformer up to 30MVA at client's request.



Rating 8.5MVA  
Primary voltage 20kV  
Secondary voltage 2x0.75kV  
Yy6d5, OFWF



Rating 7.2MVA  
Primary voltage 20kV  
Secondary voltage 2x0.775kV  
Y (+7.5)y6d5 and Y(-7.5)y6d5 OFWF

## Rectifier Transformer

Range: Up to 30MVA

Voltage: Up to 77kV

Cooling Type: OFWF, OFAF, ONAN, ONAF

### Features

Reasonable core construction.

### Low Loss

Winding are made of common insulated and continuous transposed conductor  
Non-magnetic materials and tank shield

- Low noise
- Very high current levels

## Arc Furnace Transformer

Range: Up to 30MVA

Voltage: Up to 77kV

Cooling Type: OFWF, OFAF, ONAN, ONAF

### Features

- Reasonable core construction.
- Winding constructed for low voltage and heavy currents
- Winding construction with highly reliable insulations
- Great short-circuit resistance of winding
- Highly reliable high quality transformer
- Vacuum switch type on-load tap changer
- Optimal devices to prevent oil deterioration is provided

# Fuji Tusco standard distribution Transformers

Hermetically Sealed Fully with Mineral oil type

## 1. Specifications (Technical Data are subjected to change without notice.)

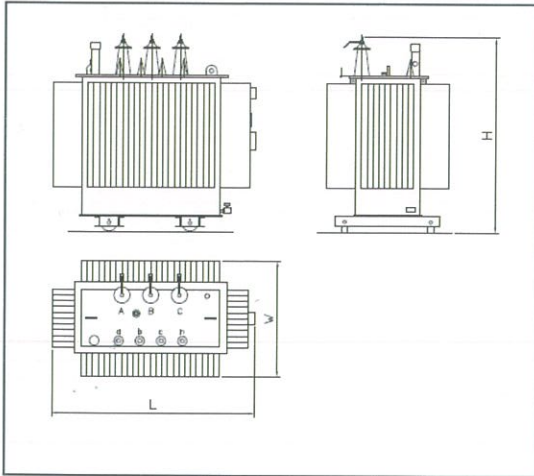
### 1-1. 22kV - 400/230V & 24kV - 416/240V

Item	Capacity	No load	Load loss (75oC)	Impedance	Dimensions (mm)			Total weight	Oil
	kVA	Watt	Watt	%	Height	Length	Width	kg	Liter
1	50	160	950	4	1,100	1,000	700	500	135
2	100	250	1,550	4	1,250	1,050	750	750	200
3	160	360	2,100	4	1,300	1,150	750	990	250
4	250	500	2,950	4	1,350	1,200	750	1300	300
5	315	800	3,900	4	1,400	1,400	800	1300	350
6	400	960	4,600	4	1,400	1,500	850	1550	380
7	500	1,150	5,500	4	1,500	1,550	900	1750	430
8	630	1,350	6,500	4	1,550	1,600	850	2,150	450
9	800	1,600	11,000	6	1,600	1,800	1,100	2,500	650
10	1,000	1,950	13,500	6	1,750	1,900	1,100	3,200	700
11	1,250	2,300	16,400	6	1,850	2,000	1,150	4,000	850
12	1,500	2,800	19,800	6	1,950	2,100	1,250	4,150	1,150
13	2,000	3,250	24,000	6	2,050	2,250	1,350	5,650	1,450
14	2,500	3,500	28,500	6	2,150	2,450	1,450	6,450	1,750

### 1-2. 33kV - 400/230V

Item	Capacity	No load	Load loss (75oC)	Impedance	Dimensions (mm)			Total weight	Oil
	kVA	Watt	Watt	%	Height	Length	Width	kg	Liter
1	50	170	950	4	1,300	1,000	700	550	165
2	100	260	1,550	4	1,400	1,050	750	800	230
3	160	370	2,100	4	1,450	1,150	750	990	280
4	250	520	2,950	4	1,500	1,200	750	1450	350
5	315	850	3,900	4	1,550	1,350	800	1450	400
6	400	1000	4,600	4	1,550	1,450	850	1700	450
7	500	1,200	5,500	4	1,650	1,500	900	1900	500
8	630	1,400	6,500	4	1,700	1,650	850	2,300	550
9	800	1,700	11,000	6	1,750	1,850	1,100	2,650	700
10	1,000	2,000	13,500	6	1,900	1,950	1,100	3,350	750
11	1,250	2,350	16,400	6	2,000	2,000	1,150	4,150	900
12	1,500	2,850	19,800	6	2,100	2,100	1,250	4,300	1,200
13	2,000	3,300	24,000	6	2,200	2,250	1,350	5,800	1,450
14	2,500	3,800	28,500	6	2,350	2,450	1,450	6,600	1,750

### Distribution Transformer Outline



### Distribution Transformer



## 2. Accessories (Standard & Option)

Item	kVA		50	100	160	250	315	400	500	630	800	1000	1250	1500	2000	2500
1	Bushings		●	●	●	●	●	●	●	●	●	●	●	●	●	●
2	Arcing horn		●	●	●	●	●	●	●	●	●	●	●	●	●	●
3	Off load tap changer		●	●	●	●	●	●	●	●	●	●	●	●	●	●
4	Earth terminal		●	●	●	●	●	●	●	●	●	●	●	●	●	●
5	Lifting lug		●	●	●	●	●	●	●	●	●	●	●	●	●	●
6	Lifting eye		●	●	●	●	●	●	●	●	●	●	●	●	●	●
7	Wheel		○	○	○	○	○	○	○	○	○	●	●	●	●	●
8	Nameplate		●	●	●	●	●	●	●	●	●	●	●	●	●	●
9	Oil drain		●	●	●	●	●	●	●	●	●	●	●	●	●	●
10	Thermometer pocket		●	●	●	●	●	●	●	●	●	●	●	●	●	●
11	Marshaling box		○	○	○	○	○	○	○	○	○	●	●	●	●	●
12	Cable box		○	○	○	○	○	○	○	○	○	○	○	○	○	○
13	P'ry terminal connector	Pad type	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Clamp type	●	●	●	●	●	●	●	●	●	●	●	●	●	●
14	S'ry terminal connector	Pad type	●	●	●	●	●	●	○	○	○	○	○	○	○	○
		Clamp type	○	○	○	○	○	○	○	●	●	●	●	●	●	●
15	Oil level gauge	W/O contact	●	●	●	●	●	●	●	●	●	●	●	●	●	●
16	Thermometer	W/O contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		2 contact	○	○	○	○	○	○	○	○	○	○	●	●	●	●
17	WDG Temp.indicator	2 contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○
18	Pressure relief device	W/O contact	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		1 contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○

### Accessories List

- Standard Accessories
- Option Accessories

## 3. Remarks

- Fuji Tusco reserve the right to any changes of these information, herein.
- Distribution transformers are designed for general application uses at ambient temperature maximum 40°C at temperature raised 60°C (top oil) / 65°C (winding), which will be manufactured and tested in accordance with the latest IEC standard.

# Fuji Tusco standard distribution Transformers

## Open Type with Conservator Tank (Mineral Oil)

### 1. Specifications (Technical Data are subjected to change without notice.)

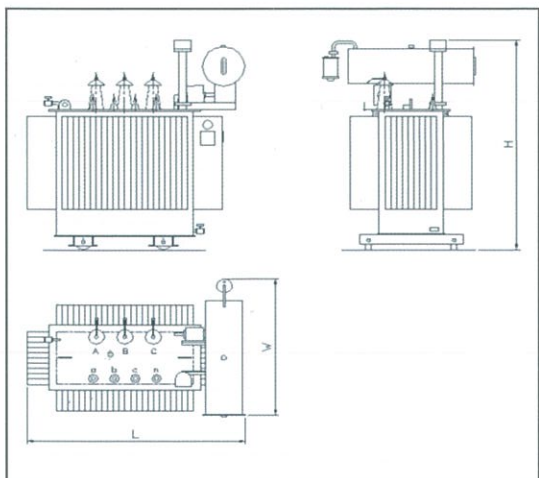
#### 1-1. Open Type with Conservator Tank 22kV – 400/230V & 24kV - 416/240V

Item	Capacity	No load	Load loss (75oC)	Impedance	Dimensions (mm)			Total weight	Oil
	kVA	Watt	Watt	%	Height	Length	Width	kg	Liter
1	50	160	950	4	1,250	1,300	850	650	150
2	100	250	1,550	4	1,350	1,300	850	750	200
3	160	360	2,100	4	1,450	1,400	850	950	250
4	250	500	2,950	4	1,550	1,500	850	1200	320
5	315	800	3,900	4	1,600	1,550	850	1250	350
6	400	960	4,600	4	1,650	1,600	900	1550	380
7	500	1,150	5,500	4	1,700	1,700	950	1800	450
8	630	1,350	6,500	4	1,750	1,800	950	2,100	600
9	800	1,600	11,000	6	1,850	1,900	1,050	2,650	650
10	1,000	1,950	13,500	6	2,050	2,050	1,150	3,200	700
11	1,250	2,300	16,400	6	2,100	2,250	1,200	4,000	900
12	1,500	2,800	19,800	6	2,250	2,250	1,350	4,200	1,100
13	2,000	3,250	24,000	6	2,350	2,300	1,400	5,500	1,200
14	2,500	3,500	28,500	6	2,500	2,500	1,550	6,500	1,800

#### 1-2. Open Type with Conservator Tank 33kV – 400/230V

Item	Capacity	No load	Load loss (75oC)	Impedance	Dimensions (mm)			Total weight	Oil
	kVA	Watt	Watt	%	Height	Length	Width	kg	Liter
1	50	170	950	4	1,450	1,400	900	700	200
2	100	260	1,550	4	1,550	1,400	900	800	250
3	160	370	2,100	4	1,650	1,500	900	1,000	300
4	250	520	2,950	4	1,750	1,600	900	1250	350
5	315	850	3,900	4	1,750	1,650	900	1350	400
6	400	1000	4,600	4	1,800	1,700	950	1650	450
7	500	1,200	5,500	4	1,850	1,800	1000	1900	500
8	630	1,400	6,500	4	1,900	1,900	1,000	2,200	650
9	800	1,700	11,000	6	2,000	2,000	1,100	2,750	700
10	1,000	2,000	13,500	6	2,200	2,150	1,200	3,500	750
11	1,250	2,350	16,400	6	2,250	2,350	1,250	4,500	950
12	1,500	2,850	19,800	6	2,400	2,350	1,400	4,800	1,150
13	2,000	3,300	24,000	6	2,500	2,400	1,450	6,200	1,250
14	2,500	3,800	28,500	6	2,650	2,600	1,600	7,200	1,850

### Distribution Transformer Outline



### Distribution Transformer



## 2. Accessories (Standard & Option)

Item	kVA		50	100	160	250	315	400	500	630	800	1000	1250	1500	2000	2500
1	Bushings		●	●	●	●	●	●	●	●	●	●	●	●	●	●
2	Arcing horn		●	●	●	●	●	●	●	●	●	●	●	●	●	●
3	Off load tap changer		●	●	●	●	●	●	●	●	●	●	●	●	●	●
4	Dehydrating breather filled with silica gel		●	●	●	●	●	●	●	●	●	●	●	●	●	●
5	Earth terminal		●	●	●	●	●	●	●	●	●	●	●	●	●	●
6	Lifting lug		●	●	●	●	●	●	●	●	●	●	●	●	●	●
7	Lifting eye		●	●	●	●	●	●	●	●	●	●	●	●	●	●
8	Wheel		○	○	○	○	○	○	○	○	○	●	●	●	●	●
9	Nameplate		●	●	●	●	●	●	●	●	●	●	●	●	●	●
10	Oil drain		●	●	●	●	●	●	●	●	●	●	●	●	●	●
11	Thermometer pocket		●	●	●	●	●	●	●	●	●	●	●	●	●	●
12	Marshaling box		○	○	○	○	○	○	○	○	○	●	●	●	●	●
13	Cable box		○	○	○	○	○	○	○	○	○	○	○	○	○	○
14	P'ry terminal connector	Pad type	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		Clamp type	●	●	●	●	●	●	●	●	●	●	●	●	●	●
15	S'ry terminal connector	Pad type	●	●	●	●	●	●	○	○	○	○	○	○	○	○
		Clamp type	○	○	○	○	○	○	●	●	●	●	●	●	●	●
16	Oil level gauge	W/O contact	●	●	●	●	●	●	●	●	●	●	●	●	●	●
17	Thermometer	W/O contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○
		2 contact	○	○	○	○	○	○	○	○	○	●	●	●	●	●
18	WDG Temp.indicator	2 contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○
19	Buchholz relay	2 contact	○	○	○	○	○	○	○	○	○	●	●	●	●	●
20	Pressure relief device	W/O contact	●	●	●	●	●	●	●	●	●	●	●	●	●	●
		1 contact	○	○	○	○	○	○	○	○	○	○	○	○	○	○

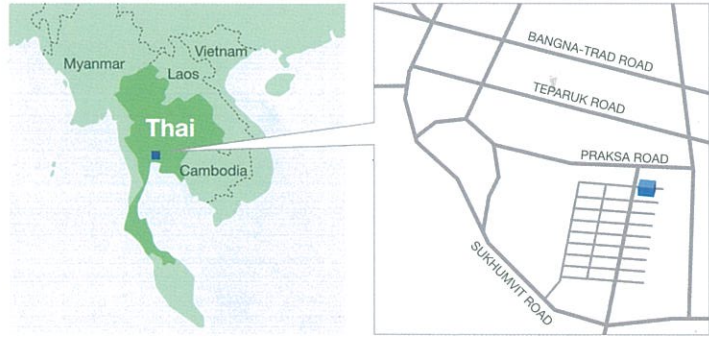
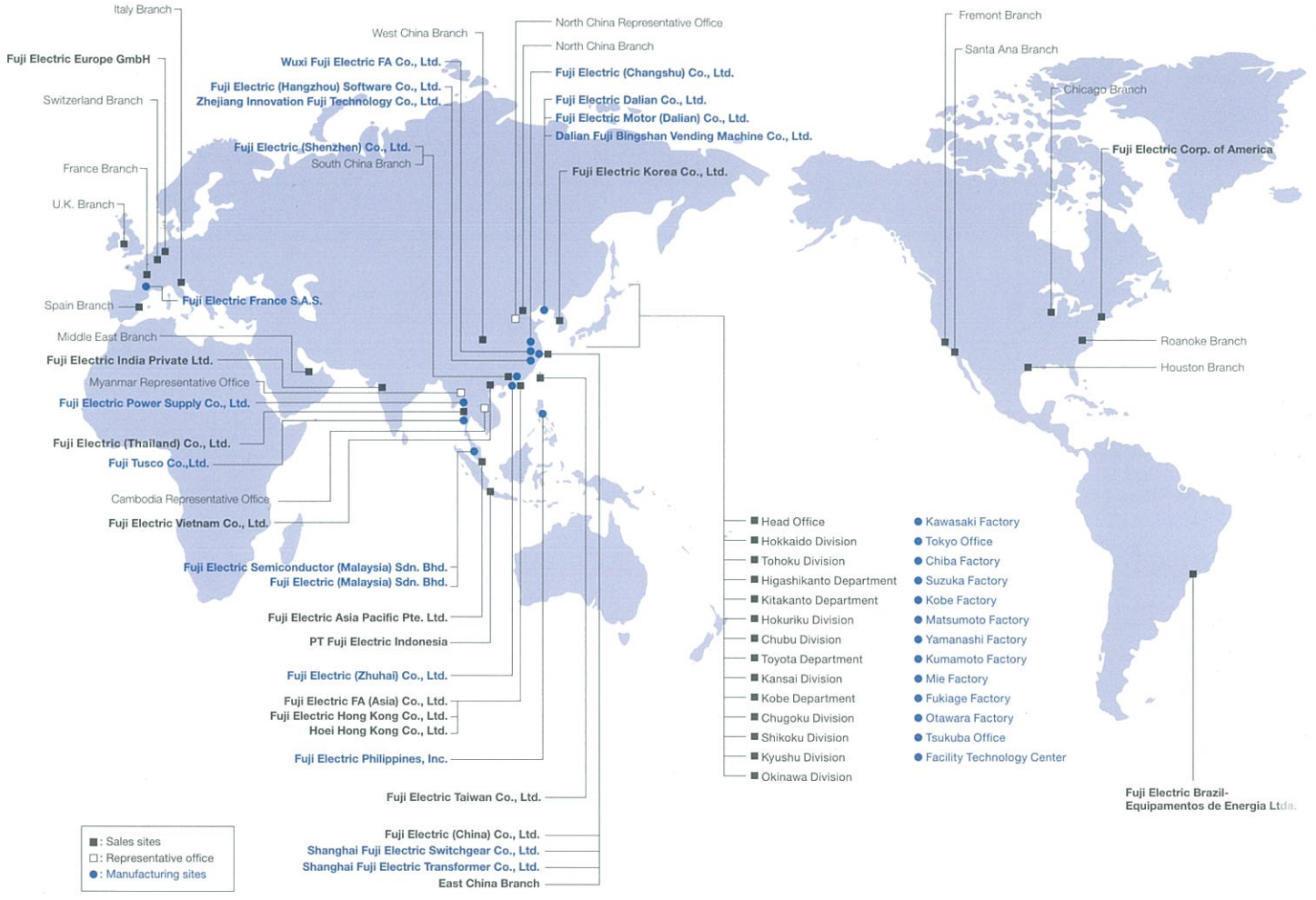
### Accessories List

- Standard Accessories
- Option Accessories

## 3. Remarks

- Fuji Tusco reserve the right to any changes of these information, herein.
- Distribution transformers are designed for general application uses at ambient temperature maximum 40°C at temperature raised 60°C (top oil) / 65°C (winding), which will be manufactured and tested in accordance with the latest IEC standard.

# Global Network



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