Step-up Transformer Substation

Catalogue

2024

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General

Content

Function & Features

Function

The step-up substation converts low-voltage AC power generated by the PV inverter into medium-voltage AC power and feeds the power into the power grid.

The step-up substation integrates the ring main unit, transformer, low-voltage cabinet, and auxiliary power supply into a steel-structure container to provide a highly integrated power transformation and distribution solution for ground-based PV plants in medium-voltage grid-tied application.

Features

Intelligent

- Detects the operating status of the ring main unit, transformer, and low-voltage switchboard in real time.
- Detects power parameters online, with the current and voltage detection accuracy.
- Supports the remote control of the general circuit breaker for the low-voltage switchboard and ring main unit as well as the remote query of the running information about the complete step-up substation.

Prefabricated

- Internal equipment has been prefabricated and installed.
- 20-feet container structure that facilitates transportation and installation.

Reliable

- Solid and reliable structure design
- IP54 rating of medium-voltage/low-voltage rooms

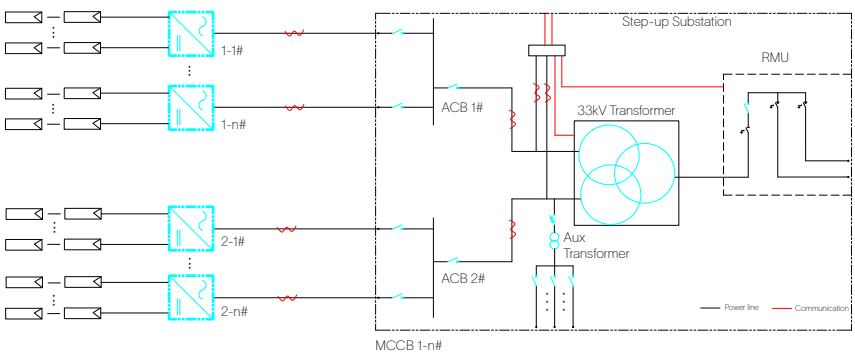
Fast

- Fast deployment can be implemented.
- Only low-voltage cables need to be routed in and medium-voltage cables need to be routed out onsite.

Application

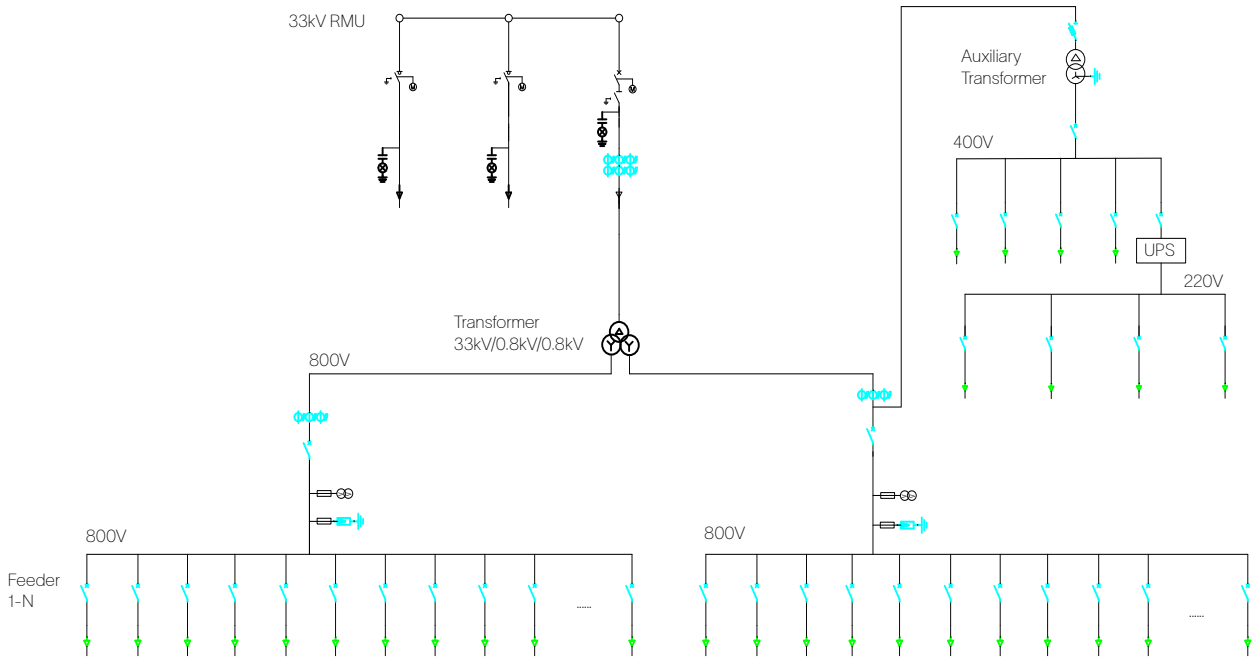
The step-up substation applies to the grid-tied systems in large PV plants.

Network application



Application

Example for 9MVA step-up substation

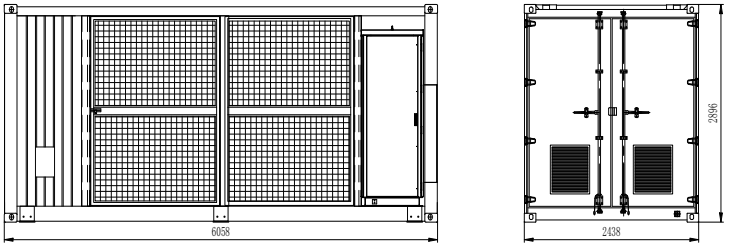


Content

Product description

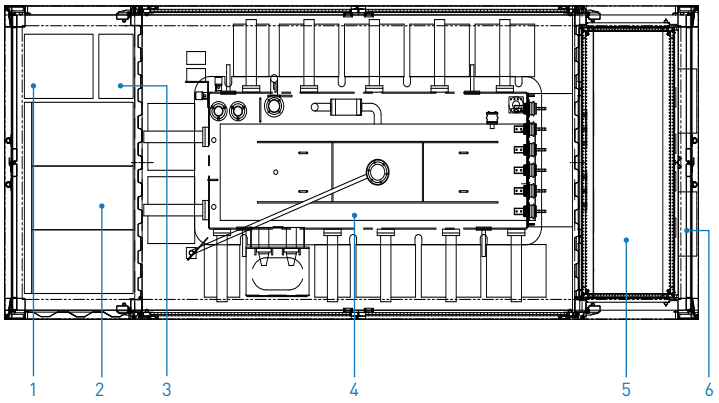
Appearance

Exterior dimensions



Considering easy for transportation, the substation keeps same dimension as 20FT container, that is W 6,058mm*H 2,896mm* D 2,438mm.

Internal composition



1 Auxiliary transformer
2 MV switchgear RMU
3 UPS cabinet and communcation box
4 Transformer
5 LV cabinet
6 Air conditioning

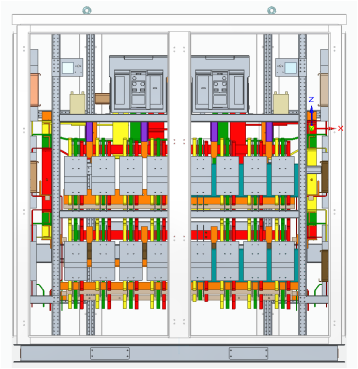
Technical data

Type	3,000kVA	6,000kVA	9,000kVA
Transformer			
Transformer type	Oil Transformer		
Rated power	3,000 kVA @ 40°C[1]	6,000 kVA @ 40°C[1]	9,000 kVA @ 40°C[1]
Max. power	3,400 kVA @ 30°C	6,800 kVA @ 30°C	10,000 kVA @ 30°C
Vector group	Dy11	Dy11y11	Dy11y11
LV / MV voltage	0.8 kV / 20 – 35 kV	0.8kV/0.8 kV / 20 – 35 kV[2]	
Maximum input current at nominal voltage	2,500 A * 1	2,500 A * 2	4,000 A * 2
Frequency	50Hz		
Tapping on HV	0, ±2×2.5%		
Efficiency	≥99%		
Cooling type	ONAN (Oil Natural Air Natural)	ONAN (Oil Natural Air Natural)	ONAN (Oil Natural Air Natural)
Impedance	6.5% (±10%)	6.5% (±10%)	9.5% (±10%)
Oil type	Mineral oil (PCB free)		
Winding material	Al / Al		
Insulation class	A		
MV switchgear			
Insulation type	SF6		
Rate voltage	24 – 36 kV[2]		
Rate current	630 A		
Internal arcing fault	IAC AFLR 25kA/1s		
Qty. of feeder	2-3 feeders		
MV surge arrester for VCB	Optional[3]		
LV panel			
ACB specification	2,900 A / 800 Vac / 3P, pcs	2,900 A / 800 Vac / 3P, 2 pcs	4,000 A / 800 Vac / 3P, 2 pcs
MCCB specification	320 A / 800 Vac / 3P, 1*11 pcs	320 A / 800 Vac / 3P, 2*11 pcs	320 A / 800 Vac / 3P, 2*15 pcs
Protection			
AC input protection	Circuit-breaker		
Transformer protection	Oil-temperature, oil-level, oil-pressure		
Relay protection	50/51, 50N/51N		
LV overvoltage protection	AC Type II (optional: AC Type I + II)		
Anti-rodent Protection	C5-Medium		
General data			
Dimensions(W*H*D)	6,058mm x 2,896mm x 2,438mm		
Approximate weight	≤ 17 T	≤ 22 T	≤ 28 T
Operating temperature range	-25°C ~ 60°C[4]		
Auxiliary power supply	5 kVA / 400 V (optional: max. 40 kVA)		
2kVA UPS	Optional[3]		
Degree of protection	IP54		
Allowable relative humidity range (non-condensing)	0 – 95 %		
Operating altitude	1,000[5] m (standard) / > 1,000 m (optional)		
Communication	RS485, Ethernet, Optical fiber		
Compliance	IEC 60076, IEC 62271-200, IEC 62271-202, IEC 61439-1, EN50588-1		

1. More detailed AC power, please refer to the de-rating curve.
2. Rated output voltage from 20 kV to 36 kV, more available upon request
3. Extra expense needed for optional features which standard product doesn't contain, more options upon request.
4. When ambient temperature ≥55°C, extension roof shall be equipped for substation on site by customer.
5. For higher operating altitude, pls consult with Brunstock.

Product design

A transformer substation container consists of three parts: low-voltage room, transformer room, and medium-voltage room.



Low-voltage room

The LV cabinet is located at the LV room inside the step-up substation. It is used to converge and transmit low voltage from the inverter to the step-up transformer and feed it into the MV grid.

The LV cabinet consists of LV Air Circuit-Breaker(ACB), Moulded Case Circuit-Breaker (MCCB), and other electric components.

Taking the 9,000kVA as an example, the figure below shows the internal components of the LV cabinet.

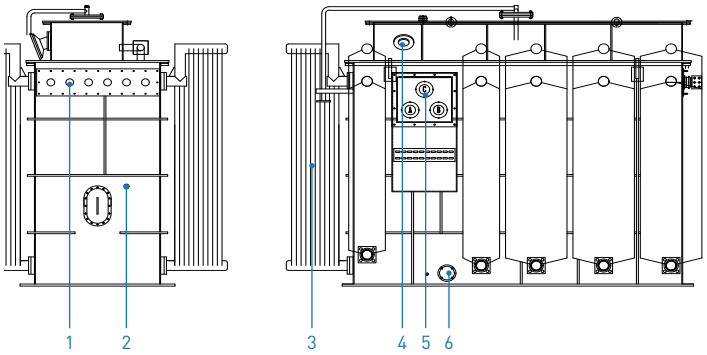
Low-voltage switchgear		
Type		**Description**
Standard compliance		IEC61439
Rated voltage	V	AC800
Insulation voltage	V	AC1,000
Ingress protection	IP	IP65
Rated short circuit withstand current Icw	kA	50/1
Impulse withstand voltage Uimp	kV	12 for incoming / 8 for feeders
Main switch-ACB		Fixed, manual/electric operation, Ui=1,250V, Uimp=12kV, Ue-800V, In=4,000A, Icu=75kA at 800Vac, Icw=75kA-1s, TMD
Branch-MCCB		Fixed, manual operation, Ui=1,000V, Uimp=8kV, Ue=800V, In=320A, Icu=50kA at 800Vac, TMD
Branch-MCCB		Fixed, manual operation, Ui=1,000V, Uimp=8kV, Ue=800V, In=250A, Icu=50kA at 800Vac, TMD
Input AC cable terminal		Screw connector, Cu or Al, max 300mm2
Cable entry		Based on specific design
SPD		Uc=1,500V
Power meter		Current, voltage, active and reactive power, etc
Air conditioner	Unit	2
Dimension	mm	L2,240 x D1,040 x H2,400

Product design

Transformer room

The transformer room mainly includes a transformer inside, it is used to convert the low-voltage AC power into the medium-voltage AC power.

The transformer integrates accessories such as pressure relief valve, tap changer, oil level indicator, pressure gauge, oil temperature indicator, oil filling valve, and oil drain valve. See the detailed location as below.



1 LV bushing
2 Tap changer
3 Heat sink
4 Oil level meter
5 HV bushing
6 Oil drain valve

The structure of 9,000kVA is shown in Fig. The oil-cooled transformer adopts natural heat dissipation, and the top is not covered.

Step-up transformer			
Items			9,000/33, 3 windings, oil immersed
Rated output		kVA	9,000
Vector group			Dy11y11
Type of colling			ONAN
Rated voltage	HV	kV	33
	LV	kV	0.8
	Voltage variation		±10%
Rated current	HV	A	154
	LV1	A	3,248
	LV2	A	3,248
Number of phases			3
Rated frequency		Hz	50
Frequency variation		%	±5
Conductor materials	HV		Aluminum
	LV		Aluminum
Tap changer	LV		Off circuit
	HV		±2x2.5%
Insulation level	HV	kV	LI 170/AC 70
	LV	kV	AC 5

Product design

Dimension		mm	W3,600 x D2,200 x H2,600
Weight	Core and winding	kg	8,700
	Oil	kg	4,000
	Others	kg	4,935
	Total	kg	17,635

Medium-voltage room

The medium-voltage room contains TGS type of ring main unit, each rain main unit consists of one circuit-breaker cabinet (V) and two load-breaker switch cabinets (C).

- C panel: Load-breaker switch cabinet, whose main function is to output in the ring network and connect the output of the subarray to the grid-tied point of the power grid.
- V panel: Circuit-breaker cabinet, also known as the transformer protection cabinet, which is mainly used to protect the transformer through the relay protection device.
  –When the transformer is overloaded or short-circuited, cabinet V can be reliably disconnected;
  –When the transformer experiences an overtemperature fault, heavy gas fault, or oil over pressure fault, cabinet V trips and the system is quickly protected.

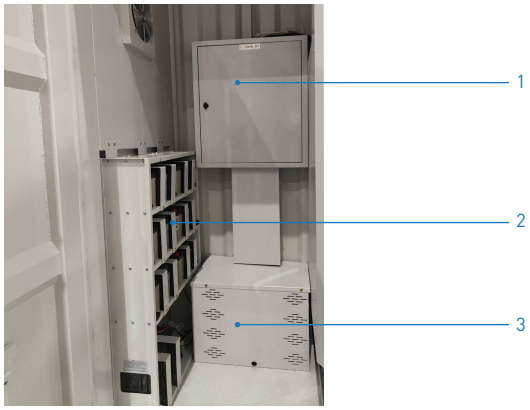
The medium voltage room also contains a communication box and a power distribution cabinet inside.

Medium-voltage switchgear			
Type			TGS-40.5
Rated voltage		kV	40.5
Rated frequency		Hz	50
1min power frequency withstand voltage (RMS) (phase to phase, to earth/across isolating distance)		kV	95/118
Lightning impulse withstand voltage (RMS) (phase to phase, to earth/across isolating distance)		kV	185/215
Rated busbar current		A	630/1,250
Rated short-circuit breaking current		kA	25
Rated short-time withstand current/ duration	Load switch	kA/s	25/3
	Circuit-breaker	kA/s	25/3
Protection degree of gas-filled compartment		IP	67
Protection degree of switchgear		IP	4X
Panel dimension without top box (W x D x H)		mm	450/500x980/1,000x1,900
Functional panel weight		kg	650~700
Extension			Top (Lateral optional)
Internal arc classification		kA/s	C: AFLR 25/1 V: AFLR 25/1

Product design

Auxiliary power supply

Auxiliary power supply consists of auxiliary transformer, auxiliary power supply box and UPS. The exterior appearance and internal components of the cabinet are optional supplied by Brunstock.



1 Auxiliary power supply box
2 UPS cabinet and communication box
3 Auxiliary transformer

Auxiliary power supply		
Auxiliary transformer		
Transformer type	KVA	15 (5~15, optional>15)
Rated voltage	V	800/400
Connection symbol		Dyn11
Auxiliary transformer enclosure dimension	mm	W400 x D400 x H500
Auxiliary transformer location		MV compartment, floor mounted
Power supply box		
Incoming MCB	Pcs	1, 63/C32A,3P, OF
Feeder MCB	Pcs	5, 63/C16/10/6A,2P, 400V
Feeder MCB	Pcs	4, 63/C32/6A,2P, 220V
Dimension	mm	W600 x D180 x H800
UPS		
UPS	Set	1 x 2kVA/ 2h, or on request
Battery	Pcs	6 x 12V/7Ah, or on request

Thermal design

Thermal design

Considering different working conditions and requirements for each compartment and component, step-up substation adopts different cooling method for different compartments:

- The ingress protection level of the LV room/cabinet is high, thus using air conditioner to take away the LV room/cabinet indoor heat;
- The MV transformer adopts ONAN mode;
- The MV switchgear and the communication & power distribution cabinet adopt the cooling method natural cooling via vents, and air intake from the bottom and air extraction by the fan above.

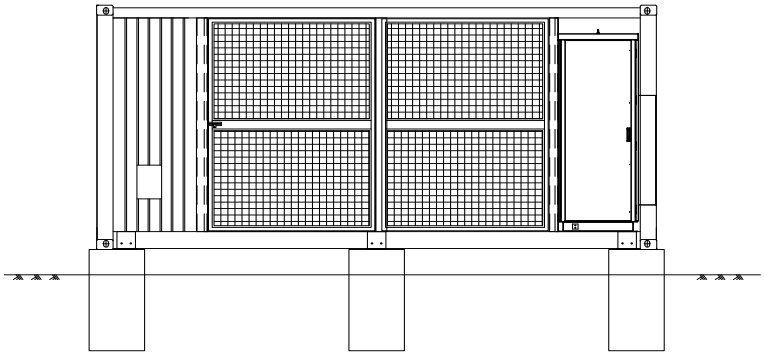
Scientific cooling structure design ensures cooling efficiency and effectively extends the service life of internal components and the entire container.

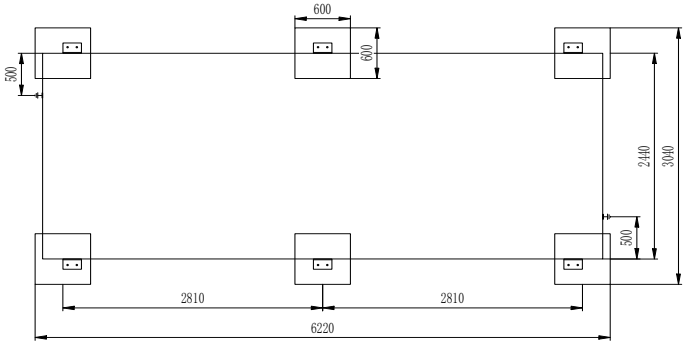
- Flow field analysis of step-up substation;
- Temperature field analysis of step-up substation.

Foundation

Foundation

Construct a foundation of the correct dimensions based on the site design drawing. This figure is for reference only.





Contact us

HEADQUARTERS
TGOOD Global Ltd.
Unit B,8/F,
Shun Ho Tower,
24-30 Ice House Street,
Central, Hong Kong
T +852 2393 8005
F +852 2393 8808
info@tgood.com

SALES AND SERVICE OFFICES

North America (Canada, USA)
TGOOD North America Inc.
#3-1101 Main Street
Penticton V2A 5E6 BC
Canada
T +1 778 476 5833
north.america@tgood.com

Africa
TGOOD Africa (Pty) Ltd.
21 Roan Crescent, Unit 2, Sultana Park
Corporate Park North, Midrand, 1683
South Africa
T +27 010 010 5706
africa@tgood.com

Asia Pacific
TGOOD Australia Pty Ltd
Unit 1, 4 Henry Street
Loganholme QLD 4129 Australia
T +61 437 536 727
T 1300 061299 (within Australia)
australia@tgood.com

Europe
TGOOD Germany GmbH
Daimler street, 2, D-41836 Hueckelhoven
T +49 2433 525662
europe@tgood.com

Middle East and North Africa
TGOOD Middle East General Trading LLC
Emirates Concorde – Office Tower, Suite #1205
Al Maktoom Street,
Rigat Al Buteen, Deira
UAE Dubai
P.O. BOX: 413884
T +971 43454596
F +971 43454504
mena@tgood.com

Central Asia
TGOOD Central Asia LLP
7th floor, BC "Pioneer-2"
Dostyk Avenue, No 134, Almaty, Kazakhstan
P.O. BOX: 050051
T +7 727 313 0168
central.asia@tgood.com

Latin America
TGOOD Latin America SAS
Calle 116 15b-26 of 407, Bogotá, Colombia
T +5717444663
latin.america@tgood.com

Southeast Asia
TGOOD Southeast Asia Sdn Bhd (1167407-T)
32A Jalan 15/22,
Taman Perindustrian Tiong Nam
Seksyen 15, 40200 Shah Alam, Selangor, Malaysia
T +603 5870 1050-1053
seasia@tgood.com

Mexico
TGOOD Mexico S. de. R.L. de C.V.
Presidente Masaryk 111 Piso 1
Col. Polanco V Sección
11560 México, D.F.
mexico@tgood.com

Energy, Fast!

TGOOD Head Office
TGOOD Global Ltd.
Unit B,8/F, Shun Ho Tower, 24-30
House Street, Central, Hong Kong
T +852 2393 8005
F +852 2393 8808
info@tgood.com
www.tgood.com

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