40.5kV ET2 Removable AC Metal-enclosed Switchgear

Powering Business Worldwide

Powering business worldwide

Eaton delivers the power inside hundreds of products that are answering the demands of today's fast changing world.

We help our customers worldwide manage the power they need for buildings, aircraft, trucks, cars, machinery and entire businesses. And we do it in a way that consumes fewer resources.

Next generation transportation

Eaton is driving the development of new technologies – from hybrid drivetrains and emission control systems to advanced engine components – that reduce fuel consumption and emissions in trucks and cars.

Higher expectations

We continue to expand our aerospace solutions and services to meet the needs of new aviation platforms, including the high-flying light jet and very light jet markets.

Building on our strengths

Our hydraulics business combines localized service and support with an innovative portfolio of fluid power solutions to answer the needs of global infrastructure projects, including locks, canals and dams.

Powering Greener Buildings and Businesses

Eaton's Electrical Group is a leading provider of power quality, distribution and control solutions that increase energy efficiency and improve power quality, safety and reliability. Our solutions offer a growing portfolio of "green" products and services, such as energy audits and real-time energy consumption monitoring. Eaton's Uninterruptible Power Supplies (UPS), variable-speed drives and lighting controls help conserve energy and increase efficiency.

MV Switchgear Technology is in our DNA

Eaton Corporation is a worldwide leader in the design, manufacture, and sale of safe, reliable and high-performance medium voltage power distribution equipment in accordance with GB and ANSI standards.

Complete Global Medium Voltage Switchgear Solutions

Eaton, a premier leader in designing and manufacturing power distribution and protection equipment in the electrical industry, offers a comprehensive range of medium voltage (MV) solutions to meet the needs of virtually every application. From products that feature cutting-edge design that allow for easy access, maintenance and space savings, to arc-resistant products that enhance safety, Eaton's medium voltage solutions provide a variety of products for every need. Additionally, Eaton's global service network provides maximum customer support in all regions of the world.

As one of the few completely vertically integrated and diversified industrial manufacturers in the world, Eaton designs not only MV assemblies, but also the key components that comprise the MV solutions – from steel housing and circuit breaker compartments to vacuum interrupters, circuit breakers, bus systems and fuses.

Eaton's MV heritage, strengthened by acquisitions such as Westinghouse DCBU, Cutler Hammer, MEM and Holec, has resulted in breakthrough MV technologies and numerous international patents over the years.

Integral to Eaton's complete electrical PowerChain Solutions – which help businesses increase reliability, efficiency and safety – Eaton's medium voltage equipment meets all applicable standards and certifications such as NEMA / ANSI, GB, UL, IEEE, KEMA and CSA.

When it comes to medium voltage solutions, you can trust the one name with a long history of proven performance: Eaton.

40.5kV ET2 Removable AC Metal-enclosed Switchgear

ET2 safe and reliable switchgear

- Completely metal-clad and totally enclosed
- Each small compartment in the switchgear is separated and independent from each other
- Quick-closing earthing switch is used for earthing and manual short circuit
- Reliable Five-Prevention interlock can effectively prevent from mal-operation and entrance into energized compartments.
- All the operations on the device can and also should be conducted on the condition of completely closed door, including opening/closing of circuit breaker, racking in/out of circuit breaker's trolley, opening/closing of earthing switch.
- Easily view circuit breaker's position , its opening/closing and energy charged status, via front door observation window
- In accordance with GB3906 standard, the switchgear passes each type test by National Center for Quality
- Supervision & Testing of High voltage Apparatus
  Higher level of technical performance with long creepage distance and compound insulation

ET2 highly practicable switchgear

- Totally enclosure can prevent dirt and small animals from entrance
- Operation on completely closed door condition maximizes personal safety for operating staff
- Trolley for vacuum circuit breaker is maintenance free, with the matched operating mechanism requiring minimum maintenance
- Trolley for vacuum circuit breakers has good interchangeability, providing easy replacement of circuit breakers
- Wiring for secondary circuit is in sufficient sized ducts, stylish looking and easy to check
- Sufficient space is provided, easy for cable connection

ET2 widely applicable switchgear

- Equipped with standard transformers
- Various cable termination can be used
- Adaptable to incoming and outgoing of cable or busbar, or mixed incoming and outgoing of cable and busbar

ET2 advanced technology switchgear

- D type main busbar with insulation vulcanization treatment on the surface and optimum electric field distribution result in increased busbar heat dissipation capability
- Integrated design for moving in and out guide rail to ensure operations of circuit breakers and high positioning precision
- Shutter driven mechanism is Eaton's unique patented design with features of compactness, precise positioning, reliable earthing, flexible and convenient operations
- Analog computation by computers towards conductor electric field and heating to provide a perfect design

General

ET2 removable metal-enclosed switchgear (hereafter called as the switchgear) is the latest generation of indoor complete power distribution equipment developed by Eaton, with three phase AC 50Hz, 40.5 kV single busbar section system. It is mainly used in power plant, substation, industrial and mining factories, as well as high-rise buildings, for power reception and power distribution, with functions of controlling, protecting and detecting electric circuits.

The switchgear can be fitted with Eaton's 405 W-VACi draw-out type vacuum circuit breakers. This complete equipment can meet requirements of China Grid towards medium-voltage switchgears, and also meet special requirements of "Five-Prevention" and operations on the condition of completely closed door, perfect sealing, complete isolation, complete insulation and perfect working conditions.
Structure diagram for cable incoming and outgoing sections as Figure 2.

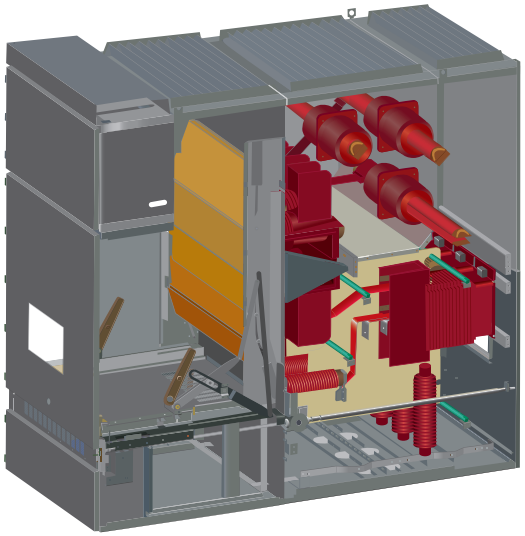


Figure 1 Product picture

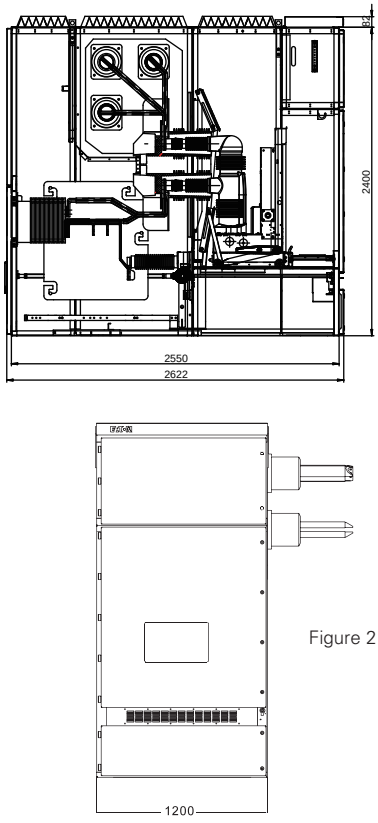


Figure 2

Standards applied

GB3906-2006
GB/T11022-1999

Switchgear design report

Technical parameters
Table 1 Technical parameters of the switchgear

Type		ET2
Rated voltage	kV	40.5
Rated power frequency withstand voltage(1min)	kV	95
Rated lightning impulse withstand voltage(BIL)	kV	185
Rated frequency	Hz	50
4s thermal withstand current (RMS)	kA	25，31.5
Rated peak withstand current (peak)	kA	63，80
Main busbar rated current	A	2500
Branch busbar rated current	A	630，1250，1600，2000，2500
Cubicle width (W)	mm	1200
Cubicle depth (D)	mm	2550
Cubicle height (H)	mm	2400
Protection degree		IP4X for metal enclosure (IP2X for opened compartment door of circuit breaker)
Weight	kg	approximately 1500 (with circuit breaker excluded)

Table 2 Key technical data for 405 W-VACi vacuum circuit breakers

Type		405W-VACi
Rated voltage	kV	40.5
Rated power frequency withstand voltage(1min)	kV	95
Rated lightning impulse withstand voltage(BIL)	kV	185
Rated frequency	Hz	50
Rated current	A	630，1250，1600，2000，2500
Rated short circuit breaking current(RMS)	kA	25，31.5
Rated short circuit making current (peak)	kA	63，80
Breaking current DC component		40%
4s thermal withstand current (RMS)	kA	25，31.5
Closing time	ms	35~70
Opening time	ms	20~50
Mechanical life	次	10000
Automatic reclosing operation sequence		O-0.3s-CO-180s-CO
Energy charging motor power	W	80
Energy charging motor voltage (DC/AC)	V	110/220
Energy charging time of motor	s	≤15
Opening/closing coil voltage (DC/AC)	V	110/220

Features of 405 W-VACi circuit breakers

- Using the latest EATON encapsulated pole and vacuum interrupter
- Ideal contact material and shape ensuring the chopping current below 3A and stable resistance value
- Ideal switching resistance load, inductive load and capacitive load
- Light weight
- Motor operation for both DC and AC applications
- Maintenance free

Frame

- Main materials for cubicles use 2.0mm zinc-aluminum-magnesium steel sheet or aluminum-zinc coating steel sheet, and adopt double-bender technology with features of high strength, good anti-corrosion and good anti-oxygenic property. No need for surface treatment. Parts assembling uses high strength bolts or rivet connection with features of high precision and good rigidity for fitting
- Enclosing and isolation of low voltage compartment, service trolley compartment, busbar compartment and cable compartment adopts steel sheet separation. Independent pressure releasing channel is provided in all compartments except for low-voltage compartment.
- No welding points for the frame. Special rivets are used in assembling, ensuring very high assembling precision
- VCB trolley compartment is designed with metal shutter to meet requirements of simultaneously automatic isolation between circuit breaker and busbar side
- VCB trolley compartment is fitted with special guide rail to facilitate service trolley to push in or draw out easily
- Each functional unit is fitted with doors possessing lock and hinge. Distance between hinges ⩽330mm
- The frame is tidy, firm and aesthetically looking after processing and assembling
- The protection degree for the switchgear shell can reach IP4X after enclosed

Surface treatment

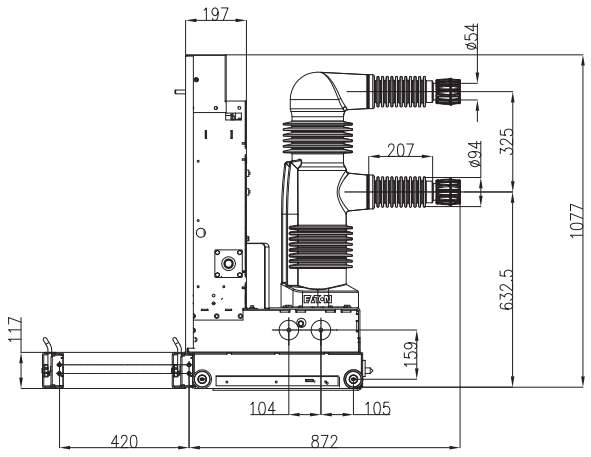
- Door and terminal blanking plates apply epoxy resin power spray coating, while the cubicles of the switchgear use zinc-aluminum-magnesium steel sheet or aluminum-zinc coating steel sheet. The above adopted treatment methods and materials ensure a very strong anti-corrosion capacity for the switchgear housing
- In consideration of requirement for temperature rise, the related busbar compartment parts need to be sprayed with matt black paint.

Bus and auxiliary wire

- Designed in accordance with GB standard.Busbar materials inside the cubicle are all of high quality electro-refined copper
- The maximum dimension for branch busbar of each phase is two pieces of 100*10mm^2 busbar with maximum continuous load current of 2500A. The selected busbar section can meet the requirements of system short circuit dynamic stability 80kA and 4s thermal stability 31.5kA. In the case of abnormal environmental climates, the section can ensure system to work normally.
- Busbar is pre-drilled with four sides as R5mm rounded corners before delivery.
- Fixing bolts of busbar use 8.8 class high strength steeliness bolts, allowing busbar to mount in an easy, smooth and very solid way
- Busbar sequence is in accordance with GB3906 standards
- Earthing busbar size is commonly 60*5mm^2.
- Earthing busbar is pre-drilled before delivery.

Auxiliary circuit

- Conductor section specification:
  current circuit⩾2.5mm^2
  voltoge circuit⩾1.5mm^2
- Insulation degree: 2000V
- Connection mode:
  Fixed terminal block groups
  The amount of terminal block groups shall satisfy circuit demand, reserving 10% as backup and with available linking plates



Outline of 405 W-VACi circuit breaker

Figure 3

40.5kV ET2 Removable AC Metal-enclosed Switchgear

Circuit breaker trolley

- Circuit breaker trolley is a central type with its design conforming to GB1984 standard.
- The circuit breaker with same type and rated capacity rate is fully exchangeable.
- The mechanical interlock unit for mal-operation is installed between circuit breaker trolley and the switchgear.
- When circuit breaker is closing, the trolley can not push in or draw out. Only when trolley is in SERVICE or TEST position, circuit breaker can be closing.
- The moving contact is in tulip type with silver plating surface. Flexible connection permits higher tolerance allowance. The good contact causes smaller resistance of the main circuit and low temperature rise.
- Mechanical life (times): 10000 times
- Allowable breaking times under rated current: 10000 times.
- The operation mechanism is the energy charging spring type. At the moment when the circuit breaker is opening, the spring recharges.
- Operation times of circuit breaker can be displayed by the counter on the panel.
- The circuit breaker is fitted with all kinds of indication and control devices to conduct necessary functions:
- Mechanical display for opening and closing status
- Energy charging display for energy charging motor
- Manual energy charging spring unit
- Local closing button
- Local tripping button
- The expected life of vacuum interrupter is 25 years. And the chopping current of the vacuum interrupter is limited to ⩽3A.

Circuit breaker compartment

A special guide rail is installed inside the circuit breaker compartment for circuit breaker trolley to slide and work on it. The rail has automatic positioning function so that the primary moving stationery contact can be aligned automatically when the circuit breaker pushes in. In the compartment, the trolley has SERVICE " and "TEST" positions. When the trolley is moving from "TEST" position to " SERVICE" position, the shutter is opened automatically; when trolley is moving in a negative direction, then the shutter is closed automatically to completely isolate primary contact. (See figure 5 and figure 6)

Cable compartment

The cable compartment can be fitted with current transformer, earthing switch and surge arrester. ET2 switchgear provides customers with rear panel mounting and maintenance modes. The design of the cable compartment and the switchgear can satisfy various cables in and out modes, for example, bottom in bottom out or top in top out mode.

The cable connection can connect 2400mm^2 three -core cables in parallel, easy for connection. (See figure 7). Height of cable mounting is 810mm.

Supporter adopts epoxy resin insulator with long creepage.

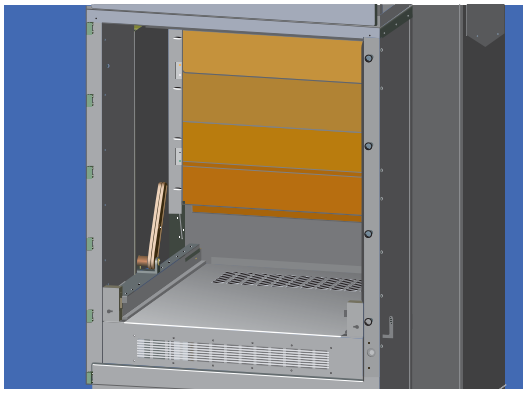


Figure 5

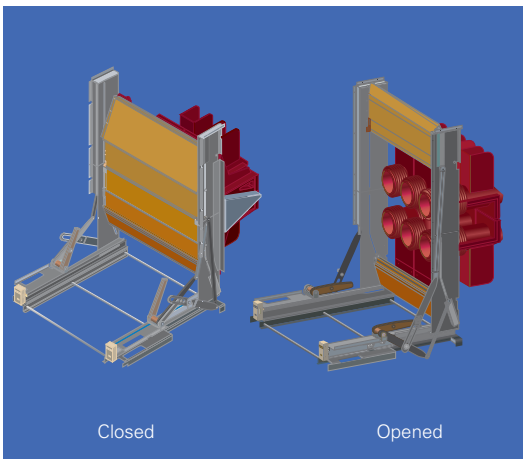


Figure 6

40.5W-VACi vacuum circuit breaker trolley
Figure 4

Bus compartment

Adjacent bus compartments adopt metal baffle plate and bushing isolation to prevent possible accident from spreading out; bus inside the cubicle adopts D type busbar vulcanization treatment. The bus lapping area is protected by insulation hood. (See figure 8)

Low voltage compartment

Panel and inner space of low voltage compartment can be equipped with relay protective components, meters, air switch, energized display, simulation bus and various secondary components. (See figure 9).
The modular grid plate is used for mounting indoor secondary equipment. It can flexibly allocate every secondary component and facilitate secondary connection.
Fitted with advanced microprocessor-based relay, additional communication interface can be incorporated into substation integrated automation.
Microprocessor-based relay provides protective function and possesses multiple functions such as displaying, recording and alarming of substation's key information. Fitted with standard RS232 or RS485 serial interface, it can be connected with substation monitoring system

Low voltage compartment panel has following control and display units

- Local/ remote selector switch
- Signal indicator: opening/closing status, and indication of circuit breaker service trolley operation, test position, as well as earthing switch closing position
- High-voltage voltage indicator (connected with capacitor voltage divider in the cable compartment)
- All kinds of meters

Secondary connection of low voltage compartment and movable trolley adopts aviation plug. When the trolley is in "service" position, the aviation plug can not be moved out, due to mechanical interlock. Only when the trolley is in "test" position, the aviation plug can be moved down.

Safety and maintenance

Design of the switchgear can ensure safety of operators and equipment itself with convenient maintenance for China's users.

Safe operation

In order to ensure that the switchgear and the trolley operate in correct sequence, the switchgear is equipped with reliable mechanical or electrical interlock mechanism. For key measures, please se Table 3.

The switchgear can be fitted with electromagnet locking unit on earthing switch operation mechanism, to satisfy electrical interlocking requirement between earthing switch and circuit breaker trolley.

The electrical and mechanical interlock devices can be added between two route incoming switches and bus coupler switch. At any time, three switches are not allowed to close simultaneously.

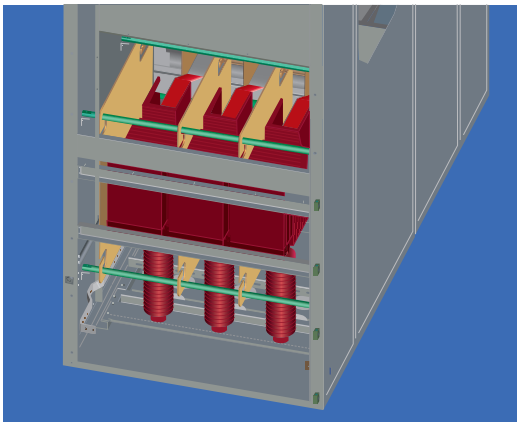


Figure 7

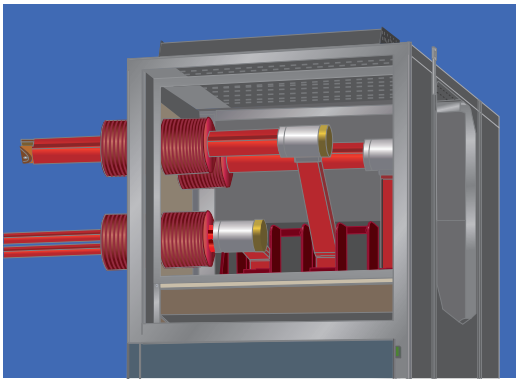


Figure 8

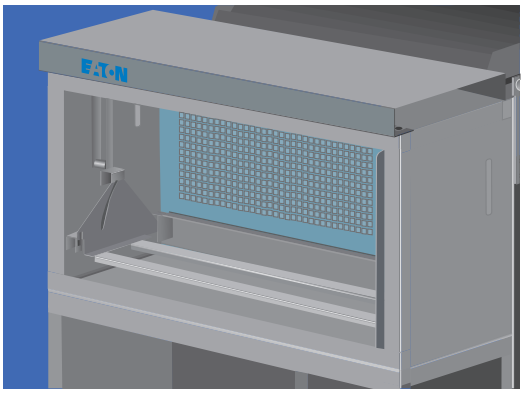


Figure 9

Table 3

Five-prevention requirement	Detailed measures
Prevent pushing and pulling trolleys with loads	If the circuit breaker is already in closing status, the interlocking rod moves backward. At this moment, movement of closing spring release plate can not raise the lever to release the lock latch. When the circuit breaker is in closing status, the trolley will be hampered and will not move if the circuit breaker trolley is pulled by mistake
Prevent circuit breakers from mal-operation	Operations on completely closed door conditions fully ensure the safety of operators. There is a mechanical interlock between circuit breaker trolley and the switchgear. Only when the circuit breaker trolley in TEST and SERVICE positions, the closing can be conducted.
Prevent switching-on earthing switch in live condition	Circuit breaker trolley is in SERVICE position. And earthing switch can not operate with mechanical interlock.
Prevent earthing switch from energizing in earth position	When earth switch is closed, then with mechanical interlock, the circuit breaker, the entrance operating can not be conducted in the circuit breaker trolley. And the trolley can not enter into SERVICE position. Then the primary circuit can not be connected. Only when earthing switch is in opening position, the trolley can rock from TEST position to SERVICE position.
Prevent from entering into energized separation	The bus compartment, trolley compartment and cable compartment are separated to each other. When the trolley is moved to TEST position or REMOVED position, the shutter will automatically close and the primary stationary contact is isolated completely. When the cable compartment is fitted with voltage indicator or mechanical interlock, the back door can open only after earthing switch is closed. If the back door is not closed, earthing switch can not open.
Secondary plug	When the trolley is in SERVICE position, the secondary plug is locked and can not be removed.

Interlock/protection for mal-operation

The switchgear is fitted with a series of Five-Prevention interlock devices, to prevent danger and corresponding mal-operations causing serious consequences. Therefore, it effectively prevents operating staff and the switchgear. The interlock device has following functions:

When circuit breaker and earthing switch are in opening position, the trolley can move from TEST/isolation position to SERVICE position. If the circuit breaker is in closing condition and is rocked, that is, the trolley tries to move from TEST/isolation position to SERVICE position and get hampered. Reverse movement has the same result (mechanical interlock).

Only when the trolley is completely engaged in TEST or SERVICE position, the circuit breaker can close (mechanical interlock).

If the trolley is in TEST or SERVICE position without control voltage, the circuit breaker can not close. It can only be manually opened (mechanical interlock).

If the trolley is in SERVICE position, the secondary plug is locked and can not be pulled out.

When the earthing switch is closed, the trolley can not move from TEST/isolation position to SERVICE position, when the trolley is in SERVICE position, the earthing switch can not be closed (mechanical interlock).

Additional interlock device such as lockout electromagnet can be mounted on the trolley and/or earthing switch operation mechanism. Customers shall make a request in ordering.

After the trolley is removed, the shutter can be locked out with padlock.

When and only when the earthing switch is closed, the cable compartment back door can be opened (mechanical interlock). If the back door is not closed, the earthing switch can not open.

In order to further satisfy requirements from specific customers, switchgear cable compartment door can be equipped with energized compulsory locking unit.

Safety of operating staff

- The switchgear is metal-enclosed and already passed Type Test for internal arcing fault
- Only when cubicle doors are closed or live parts can not be accessed, operation of circuit breakers is allowed
- When the cubicle doors are closed, it is possible to check for energizing condition in the cubicle without accessing live parts
- Switchgear cubicle and all metal separation plates are earthing with set-up special earthing terminal for connection, providing good earthing continuity.

Maintenance

Below features provide users with maintenance free or minimum maintenance

- Vacuum interrupter is ceramic housing, with vacuity $\leqslant 10^{-6}$ Pa and the guarantee of 25-year operation life
- Spring operating mechanism only needs least maintenance
- After opening switchgear's back door, the cable terminal box and current transformer can be repaired
- Standard components are adopted with available stocks, meeting user's needs

Climate and environment

ET2 switchgear is designed to fully consider factors such as customer's local climate and environmental conditions, and meet other special requirements as well..

Climate and environment condition	Normal applicable conditions	Auxiliary measures
Altitude (m)	⩽1000	
Temperature max. (℃)	40	
Temperature min. (℃)	-15	
Daily average relative humidity	95%	Heater anti-condensing is equipped
Monthly average relative humidity	90%	Heater anti-condensing is equipped
Seismic earth acceleration	Horizontal acceleration does not exceed 0.2g	
	Vertical acceleration does not exceed 0.1g	
	Safety factor＞1.67	
Housing protection degree	IP4X	Housing applies coating aluminum-zinc steel sheet or epoxy powder spray coating

Conforming to China's power standard

Based on GB standard, the switchgear applies other measures to further meet China's power standards

- For cubicle live parts, the net distance of its phase to phase and phase to earth is ⩾300mm
  * If some of the above mentioned conditions are not satisfied, then insulation shutter made by flame-retardant material is to be used..
- Power frequency withstand voltage and lightning impulse withstand voltage values meet requirements of China's power standard

Selection of switchgear

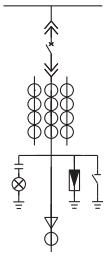
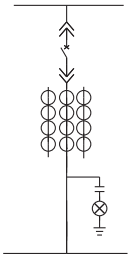
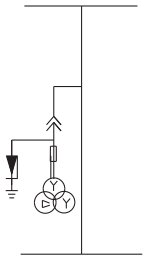
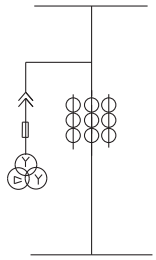
- For technical parameter and connection scheme in details, please see switchgear technical parameter table and main connection scheme table (see the attached table).
- If a customer has special requirement, please contact and consult with our Eaton's related representative

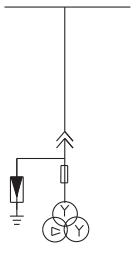
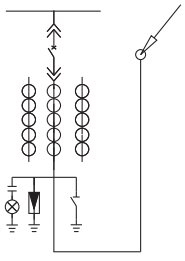
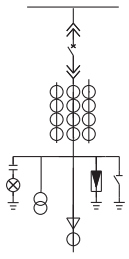
Ordering notes

Please contact us before ordering

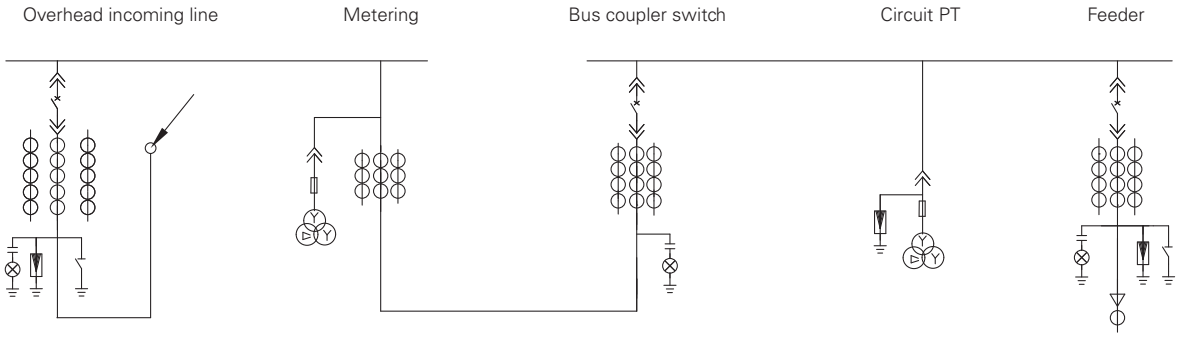
40.5kV ET2 Removable AC Metal-enclosed Switchgear

Typical primary scheme table (see attached table)

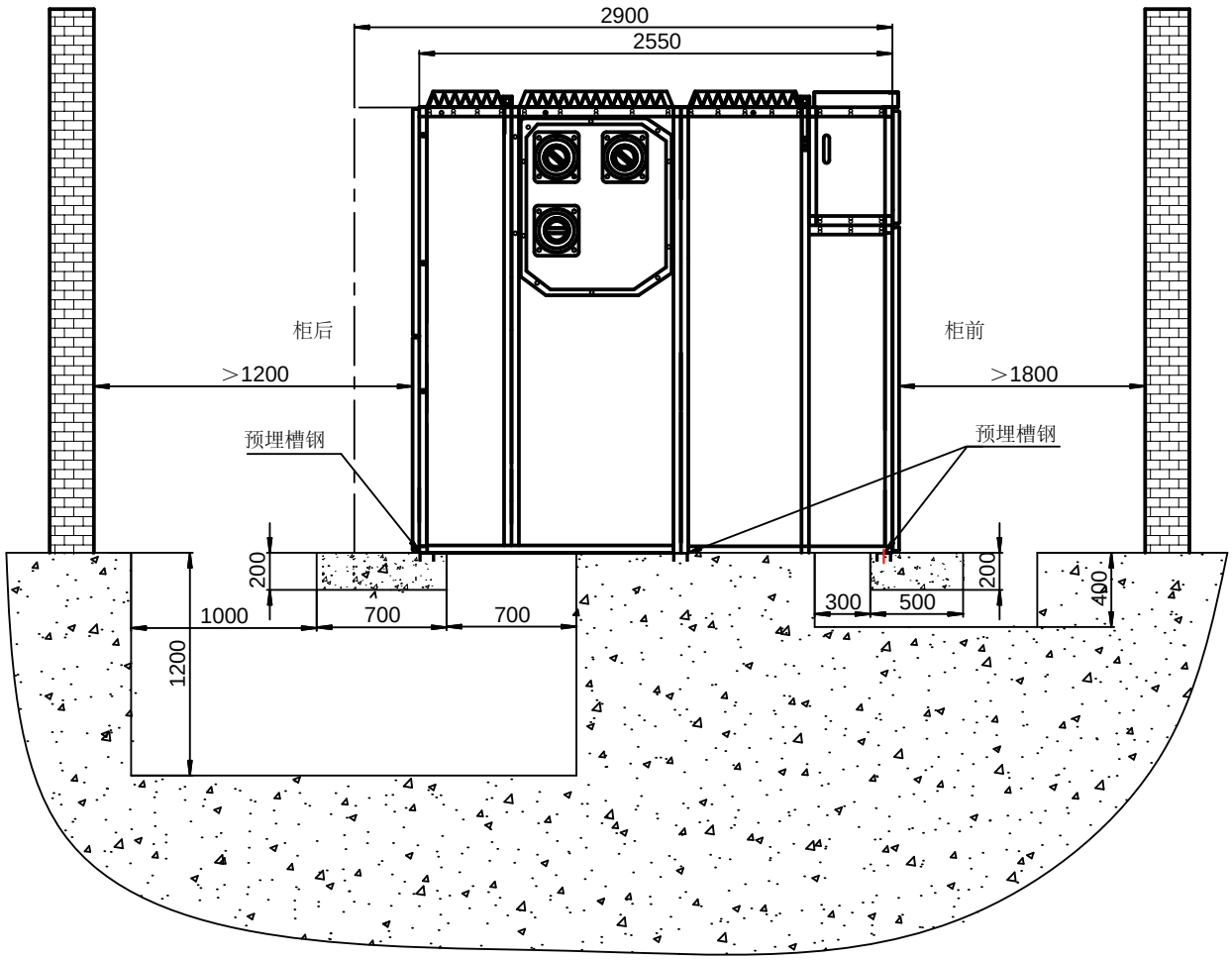
Main circuit scheme No		01	02	03	04
Main circuit schematic diagram					
	Circuit name	feeder	bus coupler switch	bus coupler PT	metering
Main component	VCB	1	1	0	0
	Voltage transformer	0	0	3	3
	Current transformer	3	3	0	3
	High voltage fuse	0	0	3	3
	Surge arrester	3	0	3	0
	Earthing switch	1	0	0	0
	Voltage indicator	1	1	0	0
	Zero sequence current transformer	1	0	0	0
	Rated current (A)	1250	1250	2500	2500
	Size (mm)	1200*2550*2400	1200*2550*2400	1200*2550*2400	1200*2550*2400

Main circuit scheme No		05	06	07
Main circuit schematic diagram				
	Circuit name	Circuit PT	Overhead incoming line	feeder
Main component	VCB	0	1	1
	Voltage transformer	3	0	1
	Current transformer	0	3	3
	High voltage fuse	3	0	0
	Surge arrester	3	3	3
	Earthing switch	0	1	1
	Voltage indicator	0	1	1
	Zero sequence current transformer	0	0	1
	Rated current (A)	1600	2500	1250
	Size (mm)	1200*2550*2400	1200*2900*2400	1200*2900*2400

Typical primary scheme diagram



ET2 installation foundation diagram



Energizing a world that demands more.

We deliver:

- **Electrical solutions** that use less energy, improve power reliability and make the places we live and work safer and more comfortable
- **Hydraulic and electrical solutions** that enable machines to deliver more productivity without wasting power
- **Aerospace solutions** that make aircraft lighter, safer and less costly to operate, and help airports operate more efficiently
- **Vehicle drivetrain and powertrain solutions** that deliver more power to cars, trucks and buses, while reducing fuel consumption and emissions

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