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**TECHNICAL**  
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Application of transformer  
stations in photovoltaic system



In utility-scaled projects, large distributed industrial and commercial projects and energy storage projects, MV station will be used according to the different grid-connected voltage level. MV station as a system of transformer, distribution and ring main unit, the product needs to guarantee the operational safety of the system and the reliability of the power supply.

## 1 MV station

MV station is a kind of power station product that combines the transformer, low-voltage distribution cabinet, high-voltage switchgear and other auxiliary equipment reasonably together, installed in a corresponding protection capacity, can be sealed or semi-enclosed, also can be moved as a whole part. MV station equipment is commonly used in urban power distribution, industrial power distribution and new energy generation systems of 10kV and above voltage levels. The advantages of MV station are compact and simple structure, which can reduce the cost of land and civil construction, and the prefabricated way in the factory can speed up the project installation and commissioning progress. Meanwhile, the system and structure design can be customized according to the project demand, which can meet the use demand under various environmental conditions.

## 2 Types and differences of MV station

### A Types of MV station

At present, from the development of the MV station, structure design, primary equipment configuration is mainly divided into American-style MV station, European-style MV station, Chinese-style MV station. There is a big difference in the appearance in the three types. The European MV station combines MV switchgear, LV switchgear and power transformer in the container, the volume is larger. For American and Chinese MV stations, the power transformers are designed outside the container, so it's smaller and compact. Circuit breaker in Chinese-style MV stations are installed in the high-voltage cabinet, the load switch is installed inside transformer for America-style MV station, so for American-style MV station, the HV part is compact. For Chinese-style MV station is bigger in volume.



Figure 1 European-style MV station



Figure 2 Chinese-style MV station



Figure 3 American-style MV station

## B Differences in Equipment Configuration

American-style MV stations combine the transformer body, high-voltage load switch, fuse, and ring main unit inside the oil tank. The high-voltage side uses a fuse for transformer short-circuit and overload protection, while the low-voltage side uses a frame circuit breaker for overload delay protection, short-circuit protection, and ground fault protection. The MV station is equipped with a pressure release valve, oil temperature gauge, and temperature controller to achieve non-electrical protection.

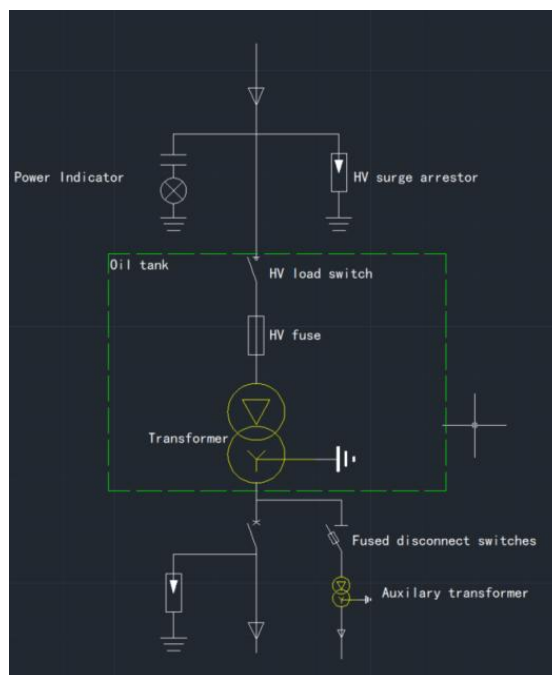
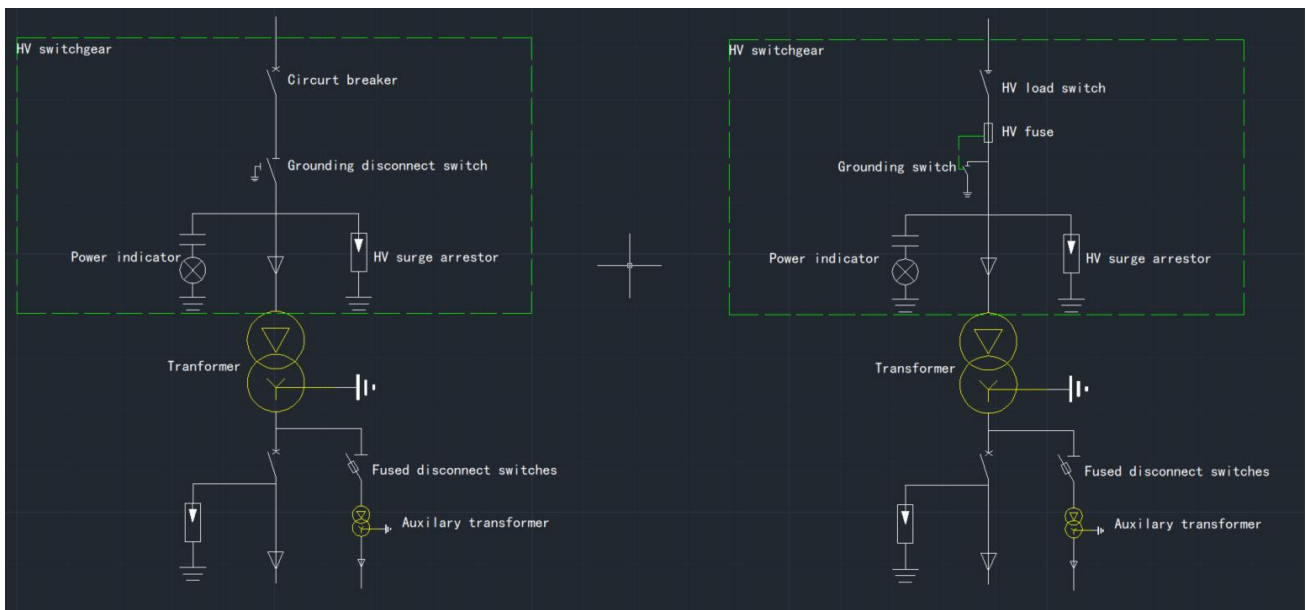


Figure 4 SLD of American-style MV station

European-style MV stations have two configurations for the high-voltage side: one is to configure a load switch with a current-limiting fuse, and the other is to configure a circuit breaker device. The low-voltage side usually uses a load switch with a fuse. When a European-style MV station uses a load switch and a fuse on the high-voltage side, its high and low voltage protection functions are the same as those of American-style MV stations. When a circuit breaker is configured on the high-voltage side, it adds protection for overcurrent, overload, single-phase grounding, and other faults. The basic protection functions are the same as those of American-style MV stations. Small-capacity European-style MV stations often use dry-type transformers, which only need to be equipped with over-temperature trip protection functions. Large-capacity European-style MV stations use oil-immersed transformers and are often equipped with non-electrical protection functions such as pressure, gas, and oil level.



*Figure 5 SLD of European-style MV station*

Chinese-style MV stations mainly use air-insulated ring main unit on the high-voltage side, which are equipped with isolation switches, vacuum circuit breakers, current transformers, zinc oxide surge arresters, cable heads, grounding switches, and live display devices. The low-voltage side is equipped with frame circuit breakers or load switches. The transformers used are mostly oil-immersed. The protection functions of Chinese-style MV stations include overcurrent speed break protection, overcurrent protection, overload protection, and single-phase grounding protection. Non-electrical protection functions include heavy gas, light gas, oil level, and oil temperature protection.

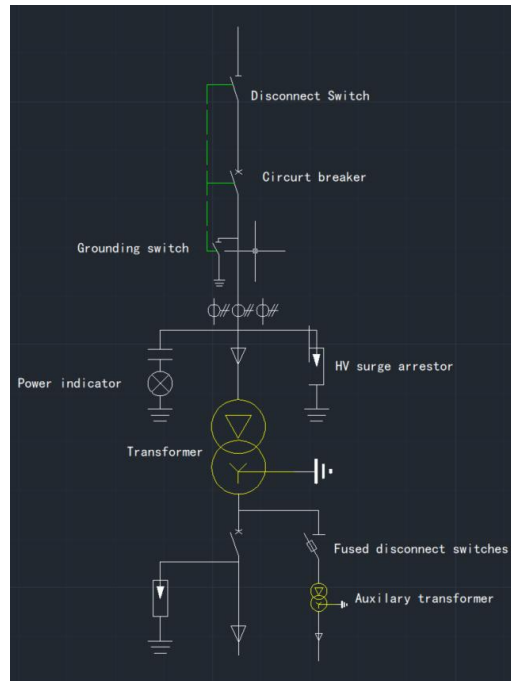


Figure 6 SLD of Chinese-style MV station

## C Key Equipment Used in MV stations

### 1. Measurement and Control Unit

Measurement and control units are installed on the low-voltage side of the MV station and are used for analog signal acquisition of the transformer, electrical protection, non-electrical protection, remote control, and communication functions. They enable remote management and automatic monitoring of the MV station by the substation, meeting the operational management requirements of "unmanned operation and few people on duty" for the MV station. The measurement and control units can select the corresponding measurement and control functions based on the project's actual application and design configuration.

#### (1) Protection Function

The main protection functions include overcurrent, overload, over/under voltage protection functions, and non-electrical protection functions such as heavy gas, light gas, ultra-high temperature, high temperature, low oil level, abnormal oil pressure, etc.

#### (2) Measurement and Control Function

Measurement and control functions include measuring the remote telemetered values of the current, voltage, active power, reactive power, power factor of each phase line, telemetered values of forward and reverse electric energy data, signals of protective actions and remote signals of circuit breaker position information, and remote control functions such as jumping/closing switches of remote control switches, the operation of the pressure plate, and modification of protective settings.

**(3) Communication Function**

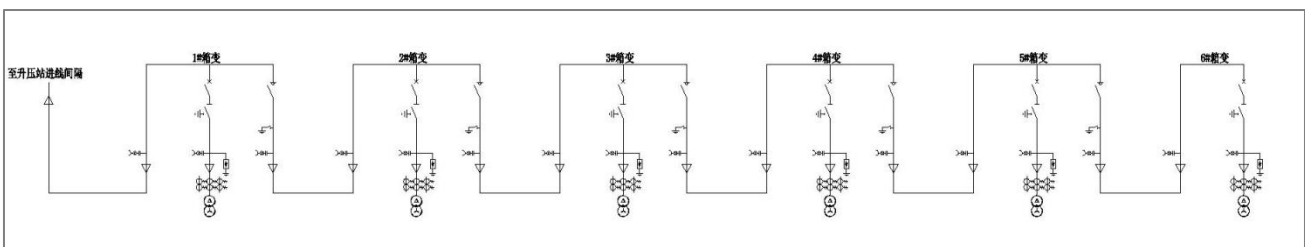
The measurement and control units are equipped with fiber optic interfaces, Ethernet communication interfaces, and RS485 communication interfaces, compatible with various communication protocols, which are more economical and convenient for communication networking and can be directly connected to the station control for communication.

**2. Auxiliary Transformer**

The auxiliary transformer configured inside the box transformer is mainly used to provide power for the MV station during the main transformer's fault or maintenance period. It maintains the illumination of the substation, the operation of high and low voltage switches, the operation of the outgoing cabinet, and provides power to the instrument and control systems. The commonly used auxiliary transformers are small three-phase transformers with a capacity of around 5-50KVA and a low-voltage side voltage of 0.4kV. Matching auxiliary transformer equipment can also be customized based on the power and characteristics of the MV station's own power load.

**D The Application of MV stations in Photovoltaic**

MV stations are commonly used as voltage boosters and convergence collectors in commercial and utility-scale projects that require voltage boosting. Due to the fact that the capacity and structural form of MV stations can be customized according to the actual situation of the project, single or multiple MV stations are used in commercial projects to enter the incoming cabinet of the substation after voltage boosting. In utility-scale projects, MV stations are often used to collect the convergence network of the sub-array to reduce the cost of AC cables, substation incoming interval construction, and civil construction, as the photovoltaic area is scattered and relatively far apart.



The use of MV stations in photovoltaic systems can shorten the construction period of the project. The construction of an ordinary substation takes about 60 days. The use of MV stations can enable photovoltaic systems to generate revenue as soon as possible. MV stations can also reduce the overall investment cost of the project. Compared with traditional distribution rooms, the cost of MV stations can be reduced by about 40% in terms of land area, civil construction, and other aspects. At the same time, the high automation of MV stations enables dispatching to monitor and control the load of each incoming and outgoing line of the photovoltaic MV station in real-time, realizing unmanned management. After having automation functions, the time for maintenance power outages and accident handling will also be shortened, thus improving the quality and reliability of power supply. The automation of various operations in photovoltaic MV stations greatly reduces manual labor, thereby reducing the cost and expenses of operation and maintenance, and improving the overall economic benefits.

### Summary:

The MV station is an integrated type of substation equipment that can be used in industrial power transformation, household power distribution, and new energy industry. Its high integration, reliability, mobility, and convenience of installation and maintenance can meet the needs of various customers. With the improvement of the reliability and rated capacity of load switches, fuses, circuit breakers, transformers, and other components, the capacity of MV stations is no longer limited to conventional capacity and structural forms. Products can also be combined with components or integrated structures according to customer needs to fully meet different power consumption requirements.

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