GOODWE SOLAR ACADEMY

Intelligent DC switch protection and application prospects

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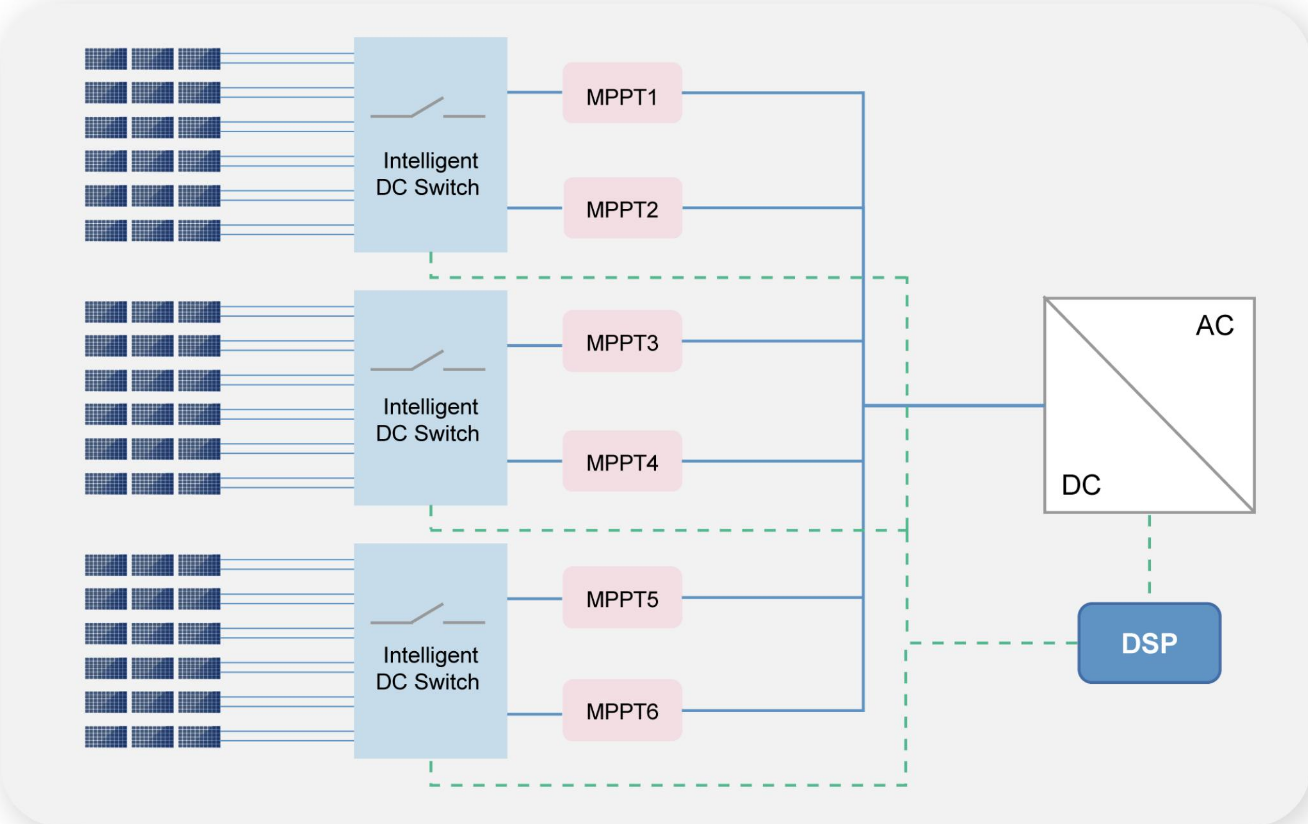
As the overall voltage and current of the PV system increases, higher demands are placed on the electrical safety within the entire system. For example, the DC system voltage is increased to 1500V, and 210mm modules with higher current. As we all know, after the system voltage is increased, it brings challenges to the insulation and safety of the system, increasing the risk of insulation breakdown within the system such as modules, inverter wiring, and internal circuits. This also requires timely and effective protection measures to isolate faults in the event of corresponding failures.

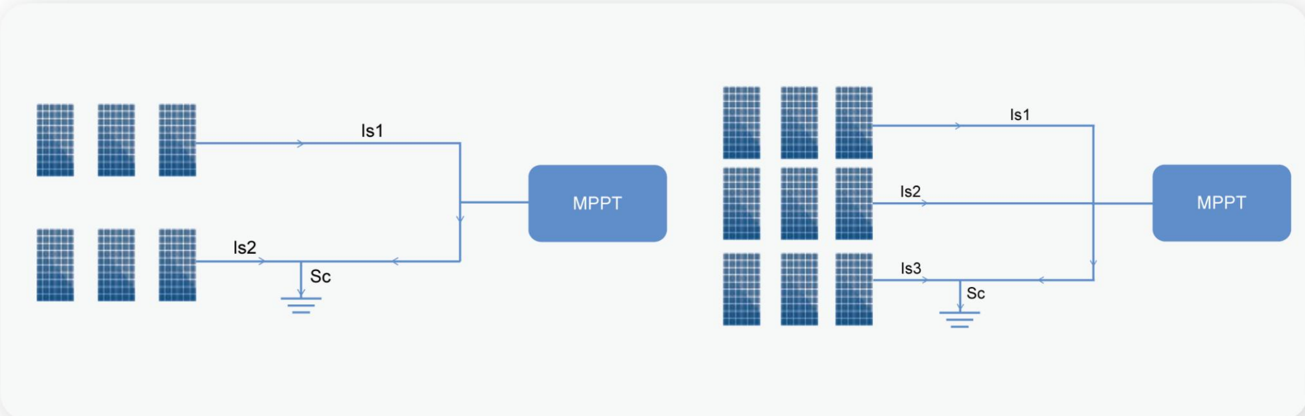
In order to be compatible with the increase in module's current and voltage, inverter manufacturers have also been increasing the string current from 15A to 20A, which also puts higher requirements on the overall component design of the inverter. In solving the 20A current problem, many inverter manufacturers have optimized the internal design of the MPPT, noticing that there are designs that use 3, 4, or 5 strings per MPPT. In dealing with the problem of current backfilling, while avoiding the use of built-in and external fuses, the use of "intelligent DC shutdown" also came into being.



The difference between traditional string inverter isolation switch and "intelligent

First, for traditional DC disconnect switches, usually they meet IEC 60947-3 (load switch, Isolating switch, and load switch-fuse combination apparatus, etc.), the standard is mainly for load switch, isolating switch, load switch-fuse combination apparatus. Usually for the understanding of this kind of switch, can disconnect the rated current, such as the nominal is 15A, then you can break within 15A under the rated voltage. Of course, the manufacturer for the isolation switch or load switch can also be a certain overload ability on breaking the nominal current, but the isolation or load switch usually can not disconnect the short-circuit current. The biggest difference between the circuit breaker and load switch is that the circuit breaker has the ability to open and close the short-circuit current, which is generally much larger than the rated current of the circuit breaker, but given that the DC side of the PV short-circuit current is usually about 1.2 times the rated current, some isolation or load switches are also able to open and close the DC side short-circuit current in the PV area.

According to IEC 62548, PV arrays-Design requirements, PV array switch disconnector and overcurrent protection device should be installed on the DC side under certain circumstances. When short circuit happened on the DC side of a PV plant, overcurrent protection is necessary if there are more than 2 strings per MPPT. As we can see in the figure below. If S2 is short circuited to the ground, I_{s1} will go through the connection point of these two stings and to point Sc. However, if S3 is short circuited to the ground in the second picture, the current goes to the point Sc will be $I_{s1}+I_{s2}$. The current on string 3 will double in this case, and the fuse will blown preventing fires in the PV area.



The current Goodwe GW250KN-HT is equipped with an intelligent DC switch, the switch itself meets IEC60947-3 standard, and the inverter (control + switch system) also meets a certain capacity of overcurrent breaking ability. The breaking current of the DC side switch can exceed the rated current and break the overcurrent faults within the nominal short-circuit current range. It effectively solves the problem of overcurrent decoupling when the current is backfilled, and the overcurrent protection and short-circuit protection are realized with the DSP and decoupling unit.

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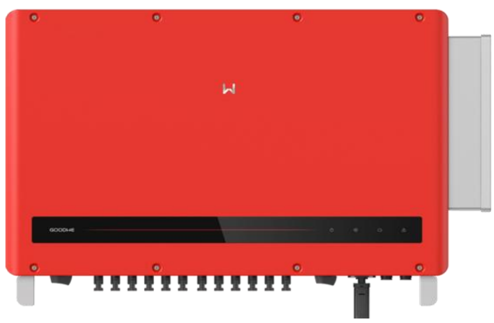
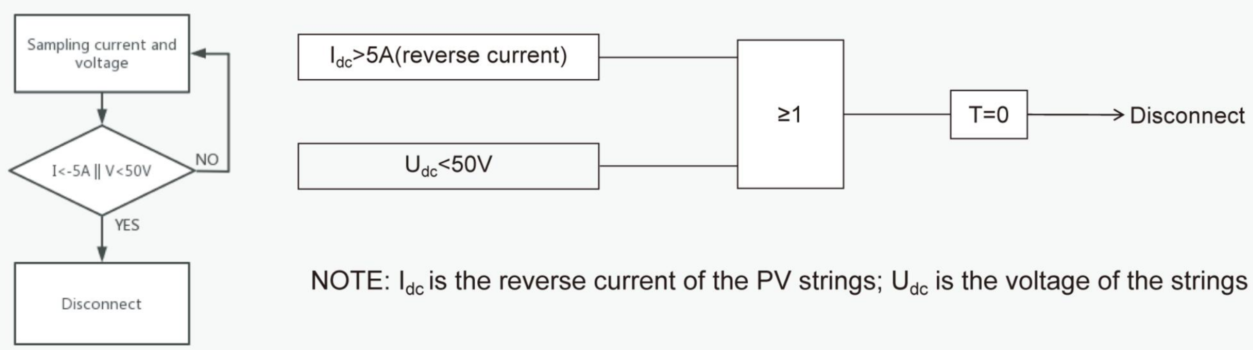
The left picture is a traditional string inverter DC disconnect switch, and the right picture is a Goodwe intelligent DC switch

Goodwe inverter + intelligent DC switch protection



Goodwe has adopted this intelligent DC switch design solution for the GW225KN-HT model inverters. When each MPPT can be connected with 3 strings, there is a risk that the current of 2 strings will back-flood to 1 string in extreme cases. In the event of such a back flow, the DC switch pops open the DC switch via a shunt trip breaker to break the circuit in time to ensure fast fault removal.



NOTE: I_{dc} is the reverse current of the PV strings; U_{dc} is the voltage of the strings

The shunt trip is essentially a breaking coil plus a striker. By adding a specified voltage to the shunt decoupling coil, the DC switch actuator can be decoupled and broken by electromagnetic suction and other actions. When the DC switch is deployed on the Goodwe inverter, the inverter DSP can issue a command to make the DC switch release and break the DC switch circuit.

It should also be noted that for inverters with shunt trip protection, due to the different internal designs of each manufacturer, when the actual scenario is applied, it is necessary to ensure that the control circuit of the shunt trip coil gets control power first before the shunt trip protection function of the main circuit can be guaranteed.

Application prospects of intelligent DC switches

At present, intelligent DC switches are mainly used in utility-scale PV power plants' inverters in solving the problem of bringing protection when one MPPT is connected to multiple channels at 20A input current. But can the advantages of automatic protection features be reflected in inverters for C&I PV plants? Is there any application value for the protection of C&I scenarios?

As the safety of the DC side of the PV is gradually gaining attention, safety features such as AFCI and RSD have been mentioned more and more recently. When a fault once occurs, the above-mentioned functions can quickly shut down the PV system. After the generation system stops its output, it reduces the current in the DC circuit to 0, but there may still be a small voltage in the DC circuit, which is a safety potential risk.

Although the RSD reduces the voltage on the DC side to below the safety value, the design that relies on the communication of the receiver and other equipment will not provide a visible break point for electrical equipment maintenance to ensure the safety of maintenance personnel if the DC switch is not manually shut down in time when maintenance is required.

If a DC switch with intelligent decoupling is used, it will be possible to realize that after AFCI or RSD action, a decoupling signal will be issued by the DSP to automatically jump open the DC disconnect switch, and the control logic will automatically form a visible breakpoint to guarantee the safety of the maintenance personnel.This effectively utilizes the remote contractility and overall control logic of the intelligent DC switch.

Based on the short electrical life of the DC switch during high current opening and closing, this application scenario opens and closes using only the mechanical life of the DC switch, which effectively protects the electrical life and arc extinguishing capability of the DC switch because it opens with zero current at each release.

In addition, this also makes it possible to achieve reliable "one-button shutdown" of inverter devices in the residential scenario. Through the linked DSP design, when an emergency occurs, the DC switch of the inverter can be shut down by a signal from the DSP, forming a reliable maintenance break point. This effectively ensures the safety of the whole application scenario of the distributed system.

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Conclusion

The intelligent protection of the DC switch brings some flexibility to the design of the inverter. With the intelligent DC switch, it is indeed possible to deal with the current backflooding problem caused by connecting more than 3 strings. However, the DC switch tripping caused by the current backflooding in this case requires the operation and maintenance personnel to go to the site for inspection and then close the switch. The application of this intelligent switch is currently a greater extent to solve the current backflow and protection problems, but whether the function of remote decoupling can be applied to other scenarios such as distributed scenarios to form a more reliable operation and maintenance guarantee and reduce the requirements for user operation level in emergency situations.