# Growatt MAX inverter running steadily in harsh grid

As the saying goes:" A person of integrity can stand tests". A high quality inverter also needs to pass the harsh grid environment test. The harsher the environment, the more it can reflect the performance of a device. Let's take a look at a real case of our latest MAX series inverter working in a small industrial and commercial solar plant today:

The power plant is installed on the roof of a steel factory in Jiangsu, China. Installed capacity of the project is 60kWp, with a total of 200 pieces of 300W high-efficiency MONO modules. 20 pieces in series and total of 10 strings to connect a Growatt MAX 60KTL3 LV inverter, this inverter has up to 6 MPPTs, with string monitoring function, intelligent IV curve diagnosis capabilities and excellent grid environment adaptability.


Fig_1 MAX 60KTL3 LV on site

After on-site investigation, the actual load is mainly crane and welding machines and other steel processing equipment, as shown in the following pictures:

Fig_2 Gantry crane


Fig_3 Electric welding machine

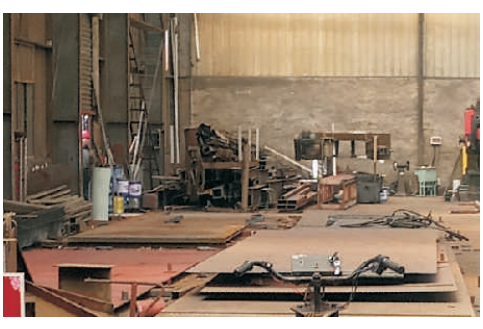

Fig_4 Field operation in the steel factory

The characteristics of the load caused very poor power quality of grid, power factor has even dropped to 0.657. In order to improve the power factor, the steel factory puts reactive power compensation device into operation, as shown below:

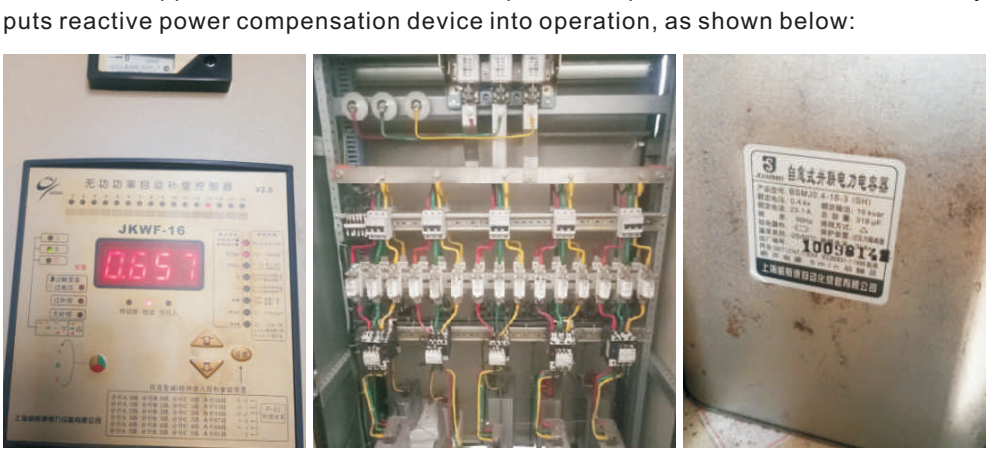


Fig_5 Reactive power compensation equipment

Actual field test showed that during load switching on/off, especially when the reactive power compensation capacitor cabinet is switched on, power grid voltage fluctuates violently far beyond the rated amplitude value during normal operation, as shown in the following figure.

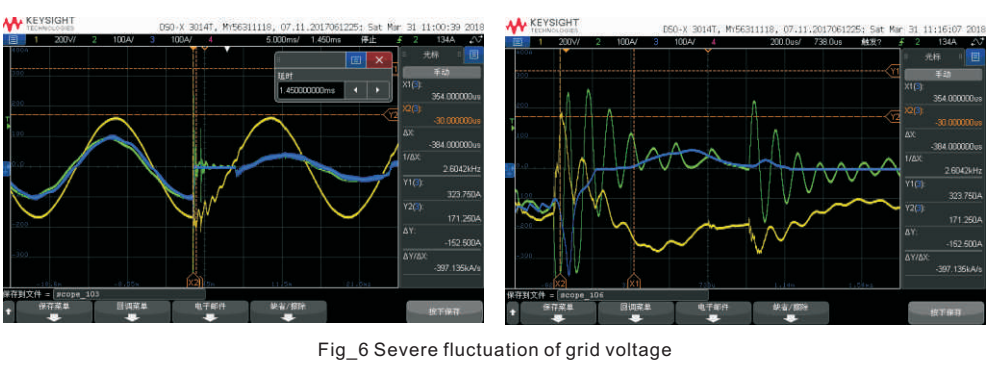


Fig_6 Severe fluctuation of grid voltage

Such a harsh grid environment will cause great surge voltage and current impact on the inverter semiconductor device, if inverter protection function does not respond quickly enough, or protection measures are improper, the inverter will disconnect frequently from grid or be damaged, while the MAX series inverter is still operating steadily with outstanding yields. The daily energy of the 60KW inverter is up to 367kWh. See picture 7 for power generation data monitoring.

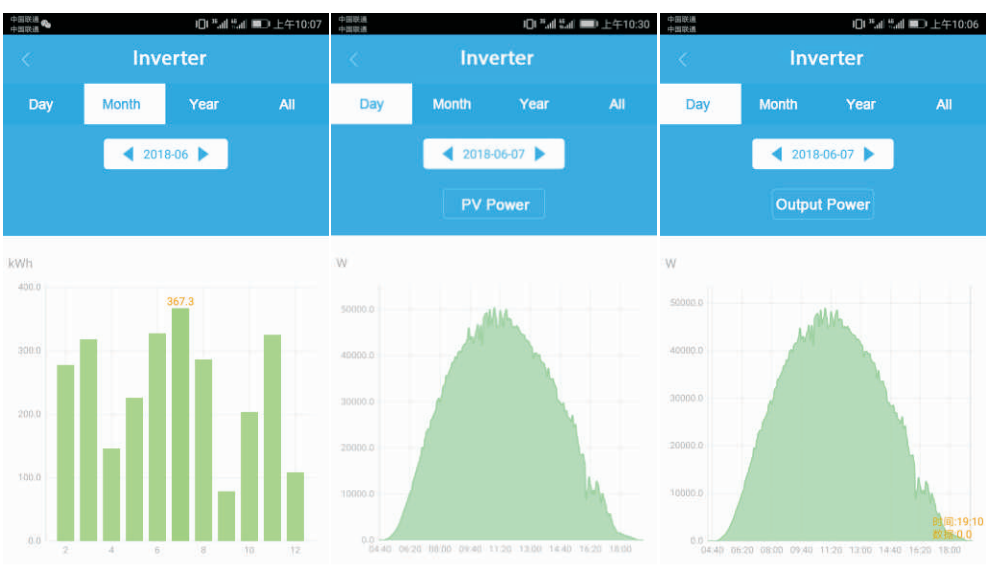


Fig_7 Power generation monitoring data

PV inverters deliver electrical energy to the grid, meanwhile the quality of the grid affects the inverter. In some metal processing factories, there is high-power equipment such as travelling crane, welding machines, gantry milling machines and electric arc furnaces, etc. During switch on/off of the equipment, electric energy changes drastically, grid can’t adjust in time, and the voltage changes between 320-480V in a very short time, accompanied by a large number of harmonics and severe electromagnetic interference.

The grid-tied inverter is a current source, due to the impedance of the circuit, the BUS voltage of the inverter is usually slightly higher than grid voltage. When large inductive equipment starts on the load side, grid voltage is pulled to very low level, then the inverter output current rises to a high level in a very short duration, the operating current of the IGBT will also rise accordingly, which leads to a high risk of over-current damage of the IGBT.

When the large inductive load stops, the grid voltage will then suddenly rise, even exceed the BUS voltage of the inverter, resulting in grid current feedback to inverter and risk of IGBT overvoltage damage.

Electromagnetic interference will affect the IGBT driver circuit of the inverter, and may cause the fault of IGBT switching sequence and the pass-through in the bridge arm, resulting in a risk of short-circuit damage to the IGBT.

Growatt R&D engineers have made many innovations in the hardware and software design of the MAX 60-100K TL3-LV/MV series inverters for harsh grid environments:


Fig_8 MAX 50-80KTL3 LV/MV

1) A dedicated high-speed CPLD for signal processing, coupled with high-precision floating-point arithmetic and fast analysis algorithms, ensures that the response speed of the inverter control is much greater than the speed of the current and voltage changes on the grid side, the inverter has enough time to handle the emergency.

2) Faster response measures are added to the IGBT driver active clamp scheme, enabling the IGBT driver to operate as quickly as possible. When a short circuit occurs, it gently turn off the IGBT to ensure that the current ramp rate is within a certain range to avoid IGBT over-current.

3) Adopt multiple measures such as high-frequency non-inductive capacitor and absorption loop to prevent IGBT overvoltage.

4) A reliable magnetic-coupled driver isolation solution ensures a very strong anti-interference capability.

Operating in a harsh grid environment, the inverter protects itself from off-grid as well as from damage by means of software and hardware coordinated control, and the maximum power point can be tracked in a few seconds when the grid voltage returns to normal. Inverter safety and power generation are guaranteed at the same time.