

# Disassembling Growatt Max A Closer Look at Its "Outside" and "Inside"

Below is a product teardown shared by one of our customer, who is an inverter enthusiast with 5 years' experience in the PV industry. It identifies the component parts and system functionality of Growatt Max and helps you to understand the product better with a closer look at its "outside" and "inside".

Recently the industrial and commercial solar system is very hot in my area. I've been working in PV industry for more than 5 years, focusing on the residential market. But now I want to begin with a small commercial system. Small and medium-size industrial and commercial solar system is very different from household solar system. Because of the larger investment, the owners will pay more attention to the efficiency and stability of power generation and return on investment. The inverter is the core component of photovoltaic plants, and the selection of inverter is as important as the selection of PV modules. Not only must we consider the appearance and easier installation of the products, but also consider the 'core' inside. The "outside" and "inside" are equally important.

Recently I signed a project of about 160kW, so I ordered two Growatt MAX 80KW inverters, which is the only 80K inverter with 6 MPPTs and 400 VAC on the market now. And that is why I choose Growatt. The two inverters arrived three days after payment, and I wanted to explore the "outside" and "inside" of the commercial inverters because I was new in this commercial sector. So I decided to take a good look at the MAX 80KW inverter, and evaluate it from my perspective as an inverter enthusiast.

Here are the two inverters:



The product packaging is very standard, Growatt logo, product model, nameplate, warning sign and QC label.

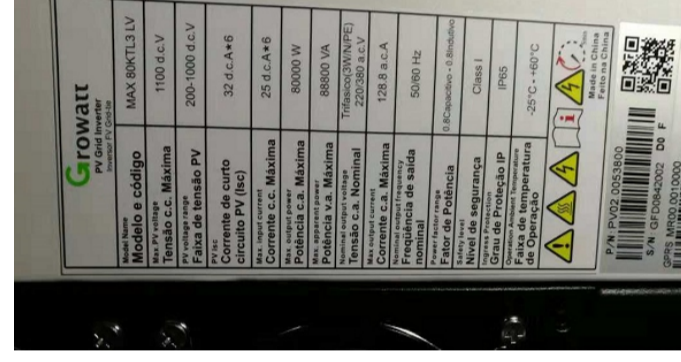
Open the box and you'll see the bracket, accessory pockets and user manual.



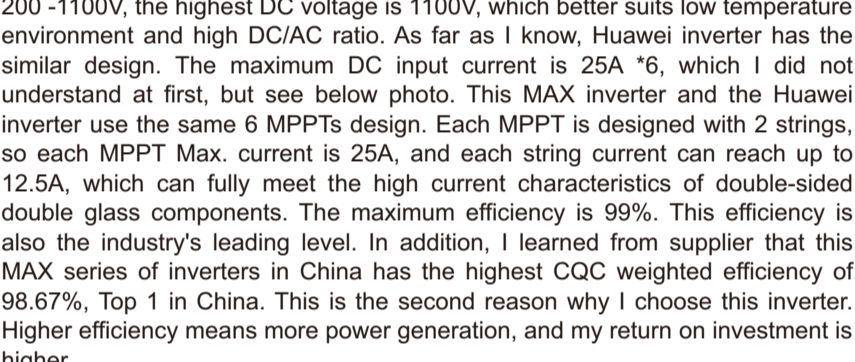
The accessory bags contain expansion bolts for wall mounting installation, anti-theft screws, AC cable lug, MC4 terminal, external antenna, MC4 removal tool and MC4 rubber plug. The rubber plug is very user-friendly and it's easy to disconnect DC connector or to block the unused DC terminals.



After removing the upper foam packaging material and plastic bag, a brand-new inverter is revealed. The overall design of the Growatt 80KW inverter looks simple but elegant. It has the industrial gray and white color, but no traditional LCD screen. Instead there is a LED indicator panel like the dashboard of the car, the green leaf as the pointer , plus the design of the outer ring elliptical runway. I guess the designer wants to convey the idea that the inverter will run efficiently on the green energy track. Not sure if there is any misinterpretation. Anyway, I think that the design is quite innovative.



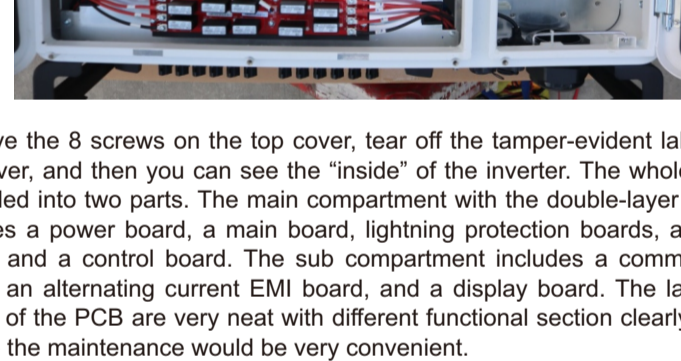
I took out the inverter and now you can see clearly that it has two floor bracket, which can be easily mounted on floor. And it looks great when I stand it up.



As an industrial and commercial inverter, a sleek appearance is obviously not enough. Let's look at the technical specifications of this inverter. The nameplate shows that the inverter model is MAX 80KTL3 LV, and the input voltage range is 200 -1100V, the highest DC voltage is 1100V, which better suits low temperature environment and high DC/AC ratio. As far as I know, Huawei inverter has the similar design. The maximum DC input current is 25A \*6, which I did not understand at first, but see below photo. This MAX inverter and the Huawei inverter use the same 6 MPPTs design. Each MPPT is designed with 2 strings, so each MPPT Max. current is 25A, and each string current can reach up to 12.5A, which can fully meet the high current characteristics of double-sided double glass components. The maximum efficiency is 99%. This efficiency is also the industry's leading level. In addition, I learned from supplier that this MAX series of inverters in China has the highest QQC weighted efficiency of 98.67%, Top 1 in China. This is the second reason why I choose this inverter. Higher efficiency means more power generation, and my return on investment is higher.

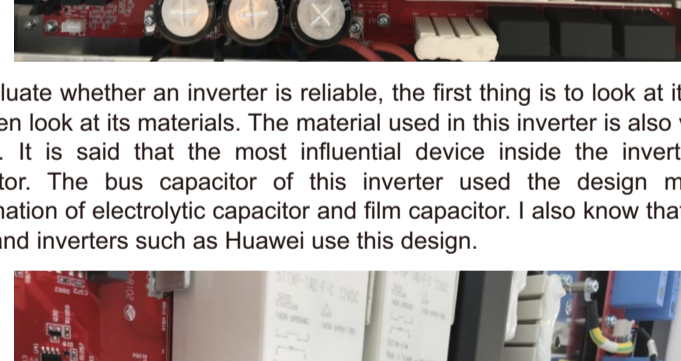


From the wiring and communication port design on the bottom of the inverter, you can peek into some internal technical designs. For example, the design of the PV inputs, you can see that this inverter has 6 MPPTs, and each MPPT has two strings. There are 2 DC switches and each controls the on and off of the 6 strings. In addition, it has got rich communication interfaces, two USB ports, two RS485 ports, and an external antenna port. The USB port can be used for local debugging, such as reading the inverter status and information and software code update programming. RS485 port is for wired online monitoring and operation, and also supports remote maintenance. The external antenna is for GPRS/4G communication, which is for wireless remote monitoring and operation as well as remote maintenance.



From the side view of the inverter, we can tell that the inverter is designed with fan cooling with horizontal air duct, where the air comes in from left side and goes out from the right side. Its three external cooling fans will ensure that the inverter won't be derated under high temperature conditions.

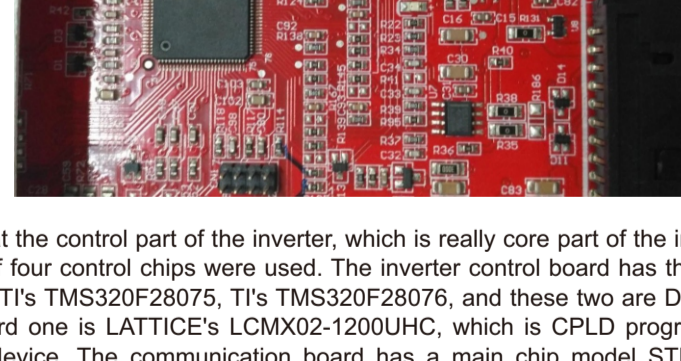
These are the appearance of the inverter that we can see. It is what we call "Outside". However, a nice looking is not enough for an inverter, and we need to look at its "inside". (The following teardown may cause damage to the inverter and it's not in the warranty of the manufacturer. Do not try this!)



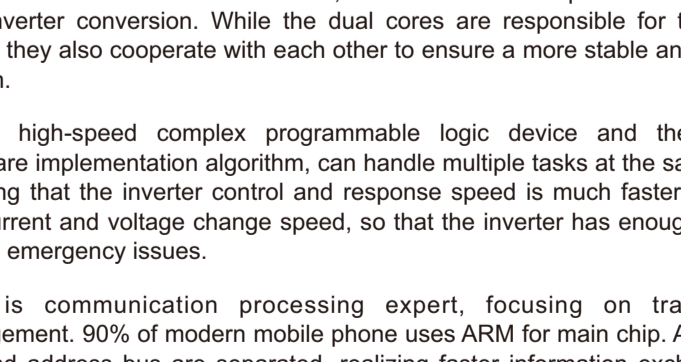
Remove the 8 screws on the top cover, tear off the tamper-evident label, open the cover, and then you can see the "inside" of the inverter. The whole inverter is divided into two parts. The main compartment with the double-layer structure includes a power board, a main board, lightning protection boards, a DC EMI board, and a control board. The sub compartment includes a communication board, an alternating current EMI board, and a display board. The layout and cables of the PCB are very neat with different functional section clearly divided, and so the maintenance would be very convenient.



To evaluate whether an inverter is reliable, the first thing is to look at its design, and then look at its materials. The material used in this inverter is also very well-known. It is said that the most influential device inside the inverter is the capacitor. The bus capacitor of this inverter used the design method of combination of electrolytic capacitor and film capacitor. I also know that the first-tier inverters such as Huawei use this design.



This inverter electrolytic capacitor brand is Nichicon from Japan, and the thin-film capacitor uses the VISHAY brand from the US. The specification design strictly refers to the 1100Vdc. For example, the electrolytic capacitor is 550V for series connection.



Look at the control part of the inverter, which is really core part of the inverter, a total of four control chips were used. The inverter control board has three main chips, TI's TMS320F28075, TI's TMS320F28076, and these two are DSPs, and the third one is LATTICE's LCMX02-1200UHC, which is CPLD programmable logic device. The communication board has a main chip model STM32F107 from the company ARM. This explains why Growatt MAX model is claimed to be a quad-core inverter, which has one more core than the other string inverters on the market!

Maybe you'll wonder why use so many chips? As far as I've learned, DSP, CPLD, and ARM are all embedded processors, all of which have basic functions of computing, storing, and processing events. Due to their different application areas, they have their own specialties.

DSP is digital signal processing expert, the most abundant software instructions, focusing on calculations. One is responsible for controlling the PV side MPPT trackers and boost circuit, the other one is responsible for the AC side inverter conversion. While the dual cores are responsible for their own duties, they also cooperate with each other to ensure a more stable and reliable system.

CPLD, high-speed complex programmable logic device and the fastest hardware implementation algorithm, can handle multiple tasks at the same time, ensuring that the inverter control and response speed is much faster than the grid current and voltage change speed, so that the inverter has enough time to handle emergency issues.

ARM is communication processing expert, focusing on transaction management. 90% of modern mobile phone uses ARM for main chip. ARM data bus and address bus are separated, realizing faster information exchange for monitoring, data storage, external communication, remote update.

I believe that after reading all these, you'll learn more about the design of this MAX inverter. And the third reason why I chose Max is its quad-core design. With this quad-core design, information collection is more comprehensive and information processing is faster. The protection function is more complete, and the product is more efficient, intelligent and reliable.

Regarding the inside of the inverter, one more point I would like to bring up to you, and that is the selection of the boost circuit and inverter power modules. In fact, Huawei has repeatedly mentioned it to their customers that the boost and inverter circuits are either single-tube design or the power module design. I did not dare to disassemble the power board, so there're no pictures of the power modules. But according to the information from the module manufacturer, only a few inverter manufacturers, such as Huawei and Growatt, use the power module design in large capacity string inverter. Most other manufacturers use single-tube for boost circuit, module for inverter circuit. There are some disadvantages of the single-tube design. If multiple single tubes are connected in parallel, the fault point and current sharing control is obviously increased, and thus the reliability of the product will inevitably decline. Again, it proved that I've made the right choice. Growatt showed us a really good design within.

In conclusion, Growatt's MAX 80KW inverter is really robust from inside out. "Outside" it looks elegant and "inside" it carries great quality.