

# BEST-PERFORMANCE PV DESIGN

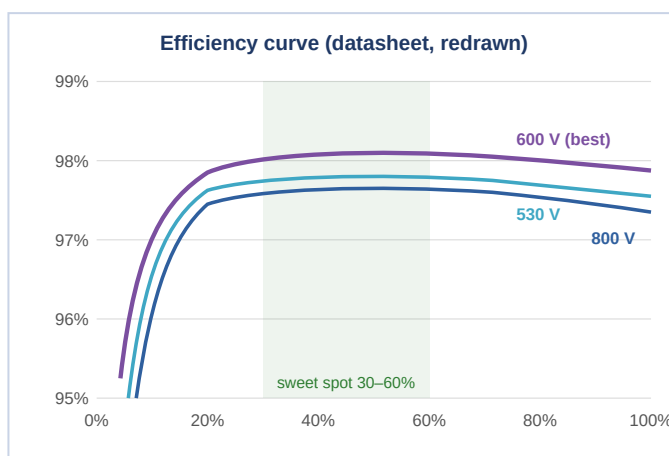
**Huawei SUN2000-50KTL-M3 with LONGi Hi-MO X10 LR8-66HVD-650M Anti-Glare (650 Wp, bifacial), matched to the inverter's MPPT sweet spot**

**Result.** The SUN2000-50KTL-M3 is most efficient at an MPPT voltage of about **600 V** and at 30–60% load. With this panel, **15–16 panels per string** keep the operating voltage at 580–620 V for most of the day. Two designs come out best:

- **Best performance:** 8 strings × 15 panels = 120 panels, 78.0 kWp (DC/AC 1.56) — about 111,000 kWh/year, total current-limit and clipping loss under 1%.
- **Highest efficiency:** 6 strings × 16 panels = 96 panels, 62.4 kWp (DC/AC 1.25) — about 89,300 kWh/year, the highest yield per kWp, no clipping.

## 1. Where the M3 works best

| SUN2000-50KTL-M3                    | Value               |
|-------------------------------------|---------------------|
| Max. / European efficiency          | 98.5% / 98.0%       |
| Rated input voltage                 | <b>600 V</b>        |
| MPPT range / start voltage          | 200–1,000 V / 200 V |
| Max. input voltage                  | 1,100 V             |
| MPPTs / inputs                      | 4 / 8 (2 per MPPT)  |
| Max. current per input              | 20 A                |
| Max. current per MPPT               | 30 A (all four)     |
| Max. short-circuit current per MPPT | 40 A                |
| Rated / max. AC power               | 50 kW / 55 kW       |



Read from the datasheet curve: at 600 V the M3 peaks at about 98.3%. At 530 V and 800 V it runs about 0.4–0.6% lower. Efficiency is flat between 30% and 60% load and drops below 15% load. The design goal is therefore an operating MPPT voltage close to 600 V, and an array large enough that the inverter spends most daylight hours above 30% load.

## 2. Matching the panel to the MPPT point

| Panels per string | Voc at 0 °C (limit 1,100 V) | Vmp at 70 °C (hot noon) | Vmp at 45 °C (typical operation) | Vmp at 25 °C | Daytime average Vmp | Fit to 600 V                          |
|-------------------|-----------------------------|-------------------------|----------------------------------|--------------|---------------------|---------------------------------------|
| 14                | 731 V                       | 509 V                   | 545 V                            | 574 V        | 545 V               | Slightly low                          |
| 15                | 783 V                       | 546 V                   | 584 V                            | 615 V        | 583 V               | Excellent                             |
| 16                | 835 V                       | 582 V                   | 623 V                            | 656 V        | 622 V               | Excellent                             |
| 18                | 940 V                       | 655 V                   | 700 V                            | 738 V        | 700 V               | Good (–0.2%)                          |
| 20                | 1,044 V                     | 727 V                   | 778 V                            | 820 V        | 778 V               | Far from 600 V; little voltage margin |

Panel data: Voc 49.72 V, Vmp 40.98 V, Imp 15.86 A, Isc 16.54 A; Voc –0.20 %/°C, Vmp –0.25 %/°C. "Daytime average Vmp" is weighted by irradiance over a modelled Chiang Rai year. 15- and 16-panel strings sit on both sides of 600 V, so the inverter runs on its best efficiency curve most of the time.

### 3. Current check (M3 limits are tighter than the MC0)

| Item                                                                        | Limit | 1 string    | 2 strings | Comment                                                                                                                          |
|-----------------------------------------------------------------------------|-------|-------------|-----------|----------------------------------------------------------------------------------------------------------------------------------|
| Operating current per MPPT (Imp, +10% rear gain at 1,000 W/m <sup>2</sup> ) | 30 A  | 17.4 A      | 34.9 A    | Two strings exceed 30 A only above about 860 W/m <sup>2</sup> , a few midday hours on clear days: estimated loss 0.3–0.5% a year |
| Short-circuit current per MPPT, roof / normal ground                        | 40 A  | 18.6 A      | 37.2 A    | OK                                                                                                                               |
| Short-circuit current per MPPT, carport / light ground                      | 40 A  | 20.3 A      | 40.6 A    | Two strings not allowed: use one string per MPPT                                                                                 |
| Current per input                                                           | 20 A  | 15.9–17.4 A | —         | OK in normal operation                                                                                                           |

### 4. Design options compared

| Layout (strings on MPPT 1/2/3/4)      | Panels | kWp  | DC/AC | Avg. Vmp | Est. kWh / year | kWh per kWp | Current-limit loss | AC clipping |
|---------------------------------------|--------|------|-------|----------|-----------------|-------------|--------------------|-------------|
| 4 × 20 (1/1/1/1)                      | 80     | 52.0 | 1.04  | 778 V    | 74,300          | 1,430       | 0%                 | 0%          |
| 6 × 16 (1/2/2/1) — highest efficiency | 96     | 62.4 | 1.25  | 622 V    | 89,300          | 1,431       | 0.3%               | 0%          |
| 6 × 18 (1/2/2/1)                      | 108    | 70.2 | 1.40  | 700 V    | 100,200         | 1,427       | 0.3%               | 0%          |
| 8 × 15 (2/2/2/2) — best performance   | 120    | 78.0 | 1.56  | 583 V    | 111,000         | 1,423       | 0.5%               | 0.3%        |
| 8 × 16 (2/2/2/2)                      | 128    | 83.2 | 1.66  | 622 V    | 117,200         | 1,409       | 0.5%               | 1.3%        |
| 8 × 18 (2/2/2/2)                      | 144    | 93.6 | 1.87  | 700 V    | 127,900         | 1,367       | 0.5%               | 4.0%        |

Estimated with a simplified model of Chiang Rai sunshine (about 1,430 kWh/kWp/year), roof or normal-ground mounting (+10% rear gain), the M3's 30 A MPPT limit, the voltage and part-load shape of the datasheet efficiency curve, and the 55 kW AC limit. Not based on site weather data; use the figures to compare designs. The 4 × 20 layout has no current loss but runs far from 600 V and lightly loads the inverter; its yield per kWp only matches because the model's voltage penalty is small.

### 5. Recommended layouts

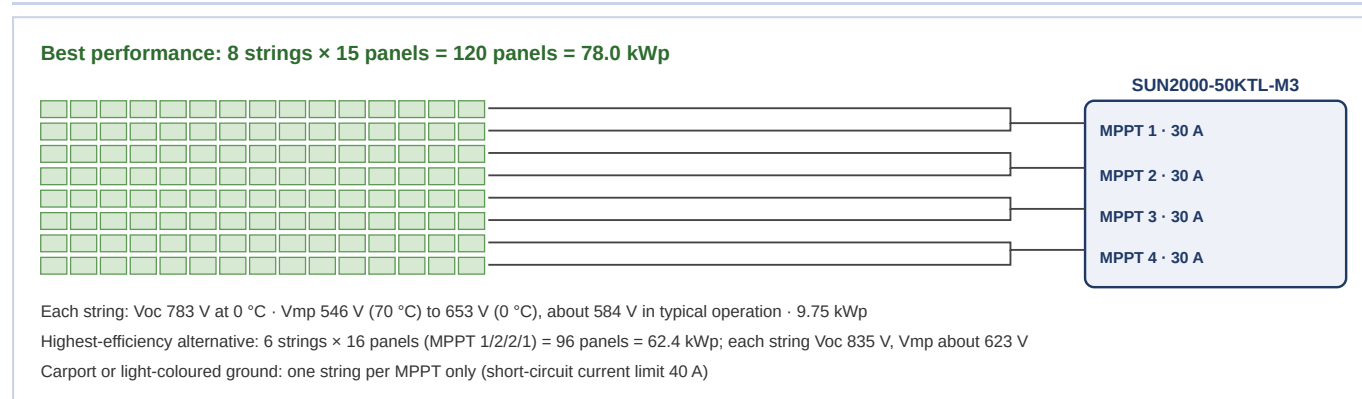


Figure 2 — Best-performance string layout. Each pair of strings joins at the inverter's own two inputs per MPPT.

## 6. Recommendation

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- **Best performance: 8 strings × 15 panels = 120 panels (78.0 kWp).** The MPPT voltage sits right at the inverter's 600 V sweet spot, the inverter spends most of the day in its 30–60% high-efficiency band, and current-limit plus clipping losses stay under 1%.
- **Highest efficiency per panel: 6 strings × 16 panels = 96 panels (62.4 kWp).** Choose this when space or budget is limited; it also leaves two inputs free (MPPT 1 and 4) to add two more 16-panel strings later.
- Avoid 20-panel strings on the M3: they run far above 600 V and leave little margin to the 1,100 V limit.
- On a carport or light-coloured ground, the M3 allows only one string per MPPT (short-circuit current over 40 A with two). Use the MC0 there instead, which allows 44 A on MPPT 2 and 3.
- Strings on the same MPPT must have the same panel count, orientation and tilt. Ask our supplier to confirm that Huawei's warranty covers DC/AC 1.56; for a grid-connected system, also check PEA's requirements.

**Sources:** Huawei SUN2000-50KTL-M3 datasheet (technical specification and efficiency curve); LONGi LR8-66HVD-650M specifications. Energy figures are model estimates; confirm the final design against the latest datasheets and site conditions.