

MPPT OVER-VOLTAGE RISK ASSESSMENT

Huawei SUN2000-50K-MC0 / SUN2000-50KTL-M3 with LONGi LR8-66HVD-650M Anti-Glare, Chiang Rai

Result. With the recommended **16-panel** strings (or 15–18 panels), the chance of DC over-voltage is **effectively zero**: the cell would have to be colder than about -70°C to reach the 1,100 V limit. The risk only becomes real at **20 panels** (about 2% margin once panel tolerance is included) and is **likely at 21 panels or more**, which must not be used.

1. The two voltage limits

Limit (both inverters)	Value	Which voltage it applies to	What happens if exceeded
Maximum DC input voltage	1,100 V	String open-circuit voltage (Voc) on a cold, bright morning before the inverter starts	Can damage the inverter and void the warranty
Upper MPPT operating voltage	1,000 V	Operating voltage at maximum power (Vmp)	No damage; the inverter cannot track the panels until the voltage falls, so energy is lost

2. Assumptions (worst case)

- Panel Voc 49.72 V at 25°C (LONGi datasheet); temperature coefficient of Voc $-0.20\%/^{\circ}\text{C}$, so Voc rises as the panel gets colder.
- Coldest design cell temperature **0 °C** at sunrise. Chiang Rai's coldest mornings rarely fall below about 5°C , so 0°C is already conservative.
- Panel tolerance **+3%** on Voc added on top (the datasheet's test uncertainty), as a second safety layer.
- Rear-side gain barely changes Voc (49.62–49.72 V at every gain level in the LONGi datasheet), so bifacial operation adds no voltage risk.
- Vmp at 0°C uses $-0.30\%/^{\circ}\text{C}$ (Vmp 40.98 V at 25°C).

3. Over-voltage risk by string length

Panels per string	Voc at 25°C	Voc at 0°C	Voc at $0^{\circ}\text{C} +3\%$	Margin to 1,100 V (with +3%)	Cell temp. needed to reach 1,100 V (with +3%)	Likelihood in Chiang Rai
15	746 V	783 V	807 V	27%	-212°C (-191°C)	None
16 (recommended)	796 V	835 V	860 V	22%	-166°C (-146°C)	None
17	845 V	888 V	914 V	17%	-126°C (-107°C)	None
18	895 V	940 V	968 V	12%	-90°C (-72°C)	None
19	945 V	992 V	1,022 V	7%	-57°C (-40°C)	Practically none
20	994 V	1,044 V	1,075 V	2%	-28°C (-12°C)	Very unlikely, but no safety margin
21	1,044 V	1,096 V	1,129 V	over	-2°C ($+14^{\circ}\text{C}$)	Likely on cool Dec–Feb mornings: do not use
22	1,094 V	1,149 V	1,183 V	over	$+22^{\circ}\text{C}$ ($+37^{\circ}\text{C}$)	Almost every morning: never use

“Cell temperature needed” is the panel temperature at which the string’s Voc would reach 1,100 V; the value in brackets includes the +3% panel tolerance. A negative value far below Chiang Rai’s lowest temperatures means the limit cannot be reached in practice.

4. MPPT operating ceiling (1,000 V)

Panels per string	16	18	20	22	23
Vmp at 0 °C (highest operating voltage)	705 V	793 V	881 V	969 V	1,013 V
Within 1,000 V?	Yes	Yes	Yes	Yes	No

The MPPT ceiling would only be exceeded with 23 or more panels per string, so it is never a factor for these designs. The 1,100 V input limit (Section 3) is always the stricter one.

5. Practical causes of over-voltage and how to prevent them

Cause	Likelihood	Prevention
Wrong string length (e.g. 21 panels instead of 16)	Possible during installation	Label each string; count panels before connecting; measure each string’s Voc before closing the DC switch
Two strings accidentally connected in series	Possible during installation	Check polarity and voltage at every input; one string per inverter input only
Mixing panel models in one string (e.g. a higher-Voc panel added later)	Possible during repairs or expansion	Use only LR8-66HVD panels of the same power class in a string; record serial numbers
Lightning or switching surges	Handled by protection	MC0 has built-in Type I+II DC surge protection (M3: Type II); add an external DC SPD at the array for long cable runs or exposed sites
Extreme cold below design temperature	Not possible in Chiang Rai	Design already uses 0 °C plus 3% tolerance

6. Commissioning check

Measure each string’s open-circuit voltage with the DC switch open and compare it with the expected value at the measured panel temperature:

16-panel string, panel temperature	25 °C	35 °C	45 °C	55 °C
Expected Voc (±3%)	796 V	780 V	764 V	748 V

A reading about 50 V higher than expected usually means one extra panel in the string; about 50 V lower means one panel is missing or a bypass diode has failed. Investigate any string that differs from the others by more than 3%.

7. Recommendation

- Use **15–18 panels per string**; the recommended 16-panel string has a 22% safety margin even in the worst case.
- Do not exceed 19 panels without an engineer’s sign-off; never use 21 or more.
- Prevent installation errors with string labelling and the Voc commissioning check above.

Sources: Huawei SUN2000-50K-MC0 and SUN2000-50KTL-M3 datasheets; LONGi Hi-MO X10 Anti-Glare LR8-66HVD 640–665M datasheet.