Application Note No. 09

Renac Inverter Temperature De-rating

Version History

- Version 01 (2022-01-12)

  Initial Release

1. What is temperature derating?

Derating is the controlled reduction of the inverter power. In normal operation, inverters operate at their maximum power point. At this operating point, the ratio between PV voltage and PV current results in the maximum power. The maximum power point changes constantly depending on solar irradiation levels and PV module temperature.

Temperature derating prevents the sensitive semiconductors in the inverter from overheating. Once the permissible temperature on the monitored components is reached, the inverter shifts its operating point to a reduced power level. The power is reduced in steps. In some extreme cases, the inverter will shut down completely. As soon as the temperature of the sensitive components falls below a critical value again, the inverter will return to the optimum operating point.

All Renac products operate at full power and full currents up to a certain temperature, above which they may operate with reduced ratings to prevent device damage. This technical note summarizes the de-rating properties of Renac inverters what causes temperature derating and what can be done to prevent it.

NOTE
All temperatures in the document refer to ambient temperature.

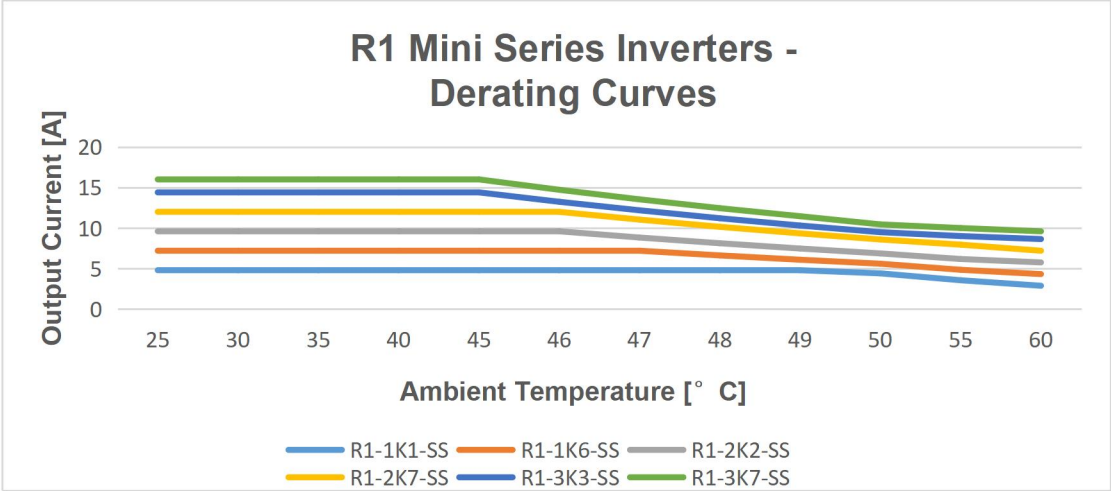
2. De-rating properties of Renac inverters

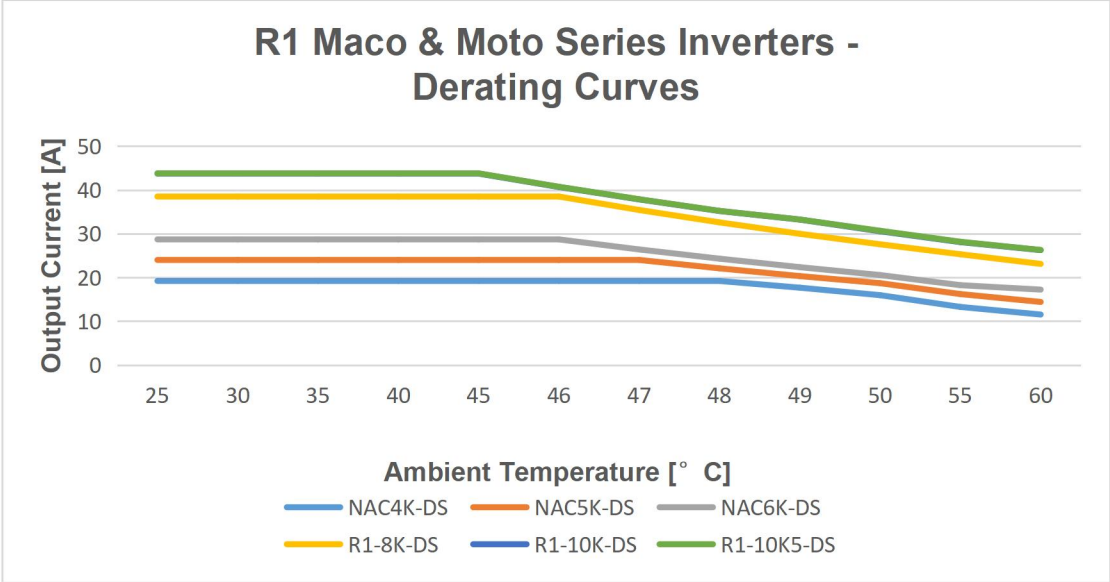
Single Phase Inverters

The following inverter models operate at full power and full currents up to the temperatures listed in the table below and operate with reduced ratings up to 113°F/45°C according to the graphs below. The graphs describe the reduction in current in relation to temperature. The actual output current will never be higher than

the maximum current specified in the inverter datasheets and might be lower than described in the graph below due to specific inverter model ratings per country and grid.

Inverter Model	Temperature
R1-1K1-SS, R1-1K6-SS, R1-2K2-SS R1-2K7-SS, R1-3K3-SS, R1-3K7-SS NAC4K-DS, NAC5K-DS, NAC6K-DS R1-8K-DS, R1-10K-DS, R1-10K5-DS	113℉/45℃

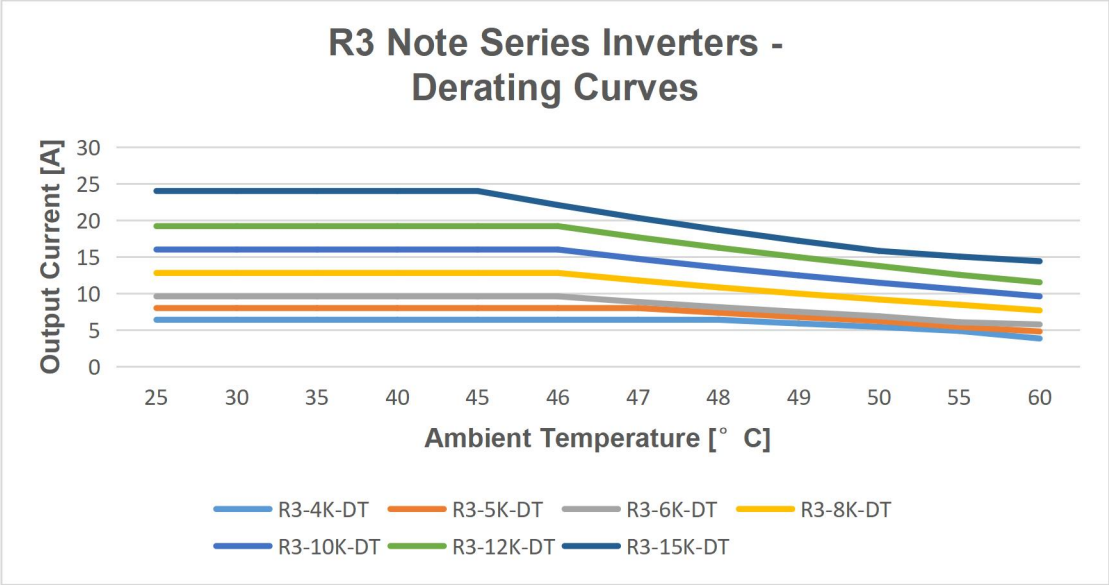


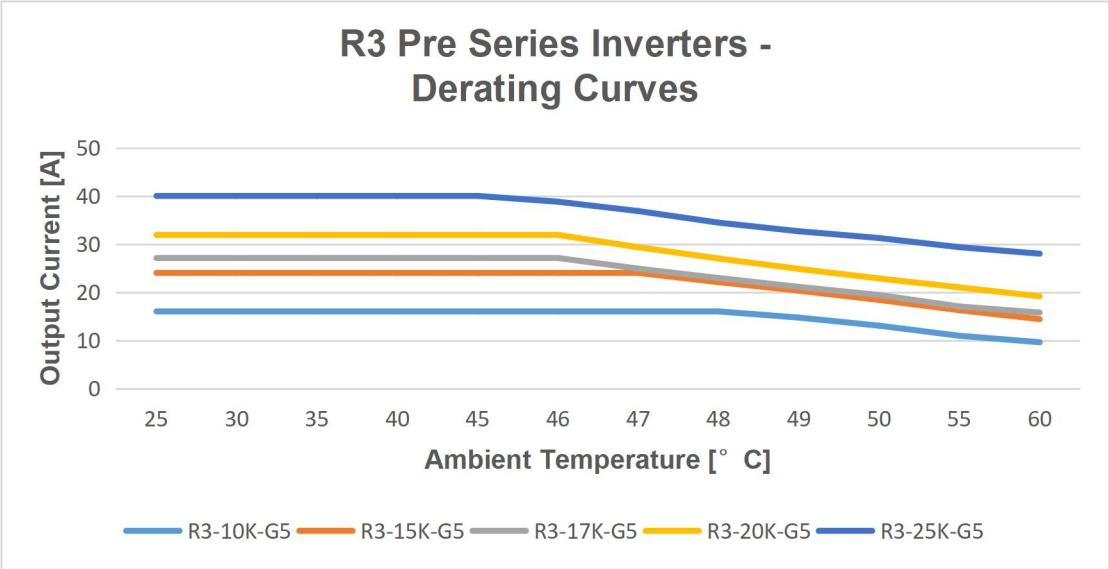


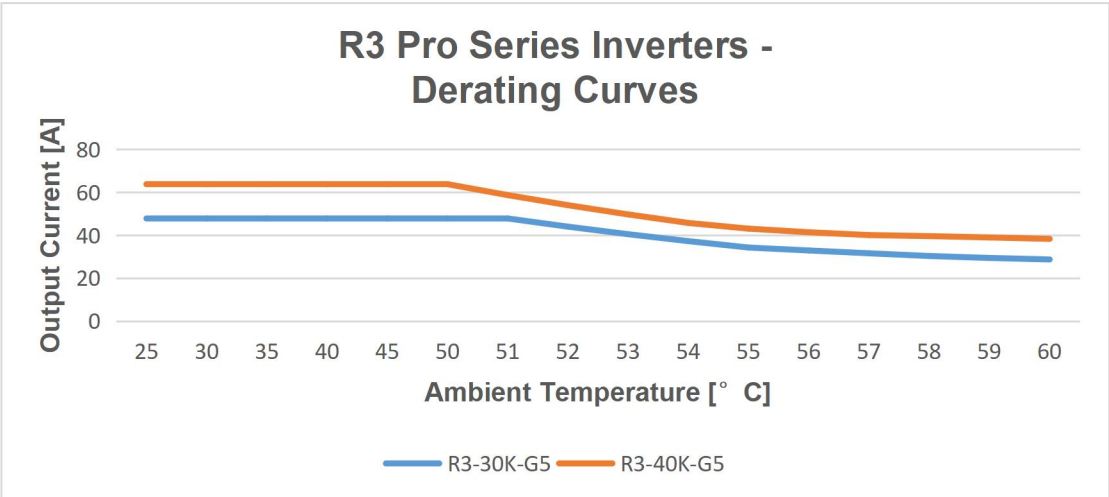
Three Phase Inverters

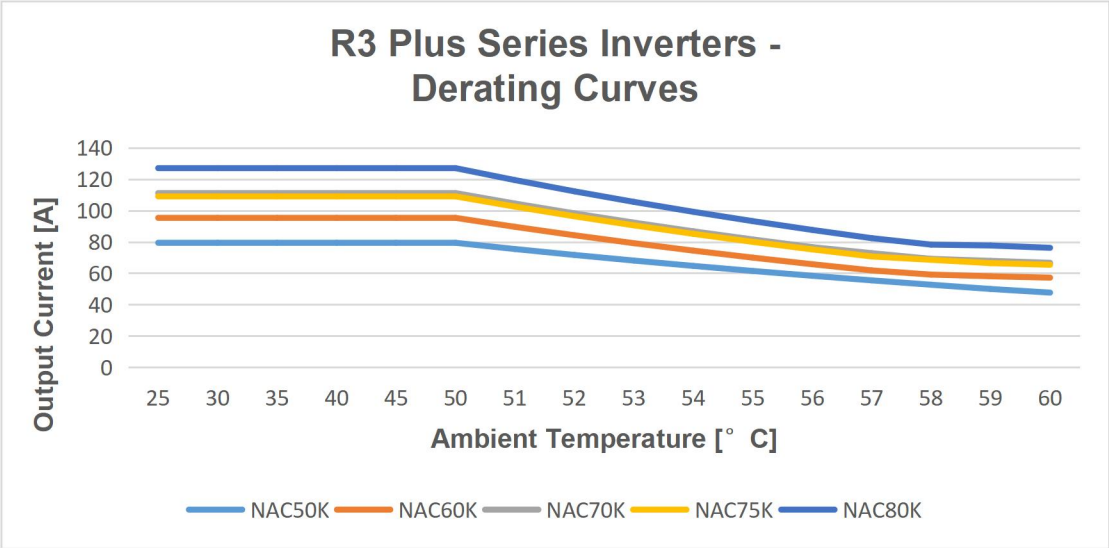
The following inverter models operate at full power and full currents up to the temperatures listed in the table below and operate with reduced ratings up to 113°F/45°C, 95℉/35℃ or 120°F/50°C according to the graphs below. The graphs describe the reduction in current (power) in relation to temperature. The actual output current will never be higher than the maximum current specified in the inverter datasheets and might be lower than described in the graph below due to specific inverter model ratings per country and grid.

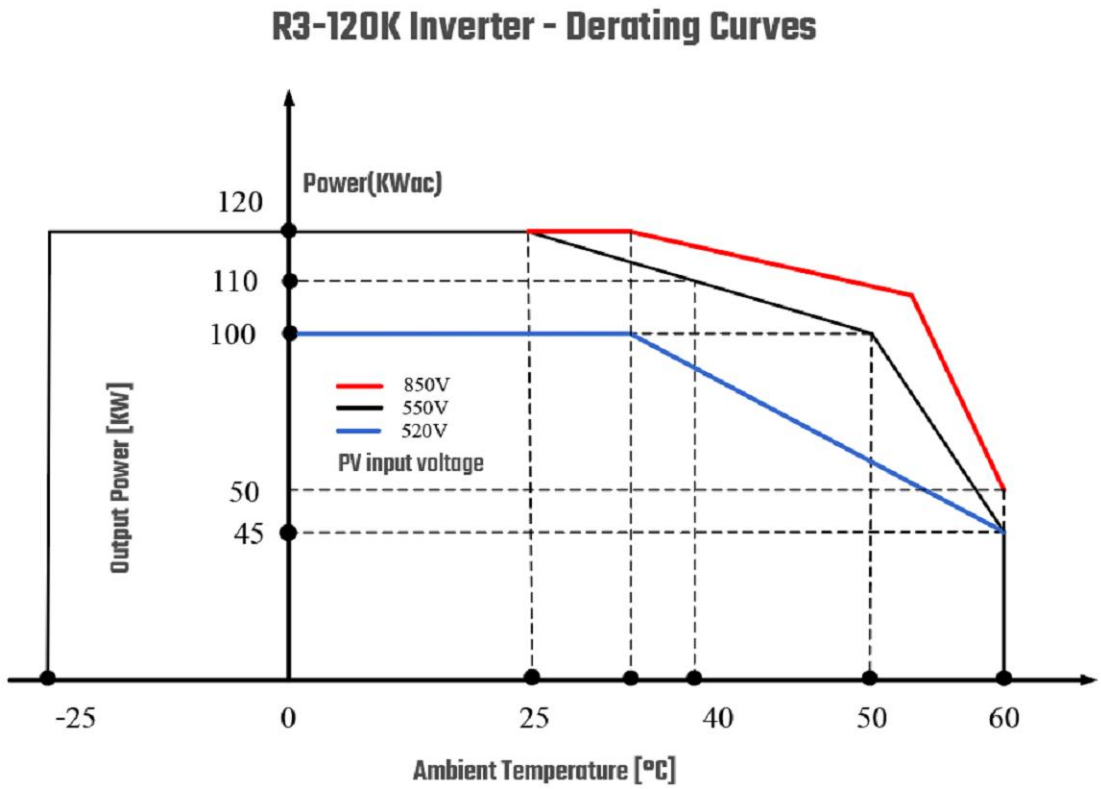
Inverter Model	Temperature
R3-4K-DT, R3-5K-DT, R3-6K-DT R3-8K-DT, R3-10K-DT, R3-12K-DT R3-15K-DT R3-10K-G5, R3-15K-G5, R3-17K-G5 R3-20K-G5, R3-25K-G5	113℉/45℃
R3-30K-G5, R3-40K-G5 NAC50K, NAC60K, NAC70K, NAC75K, NAC80K	120℉/50℃
R3-120K	520V 95℉/35℃ 550V 77℉/25℃ 850V 95℉/35℃
R3-150K-HV	550V 77℉/25℃

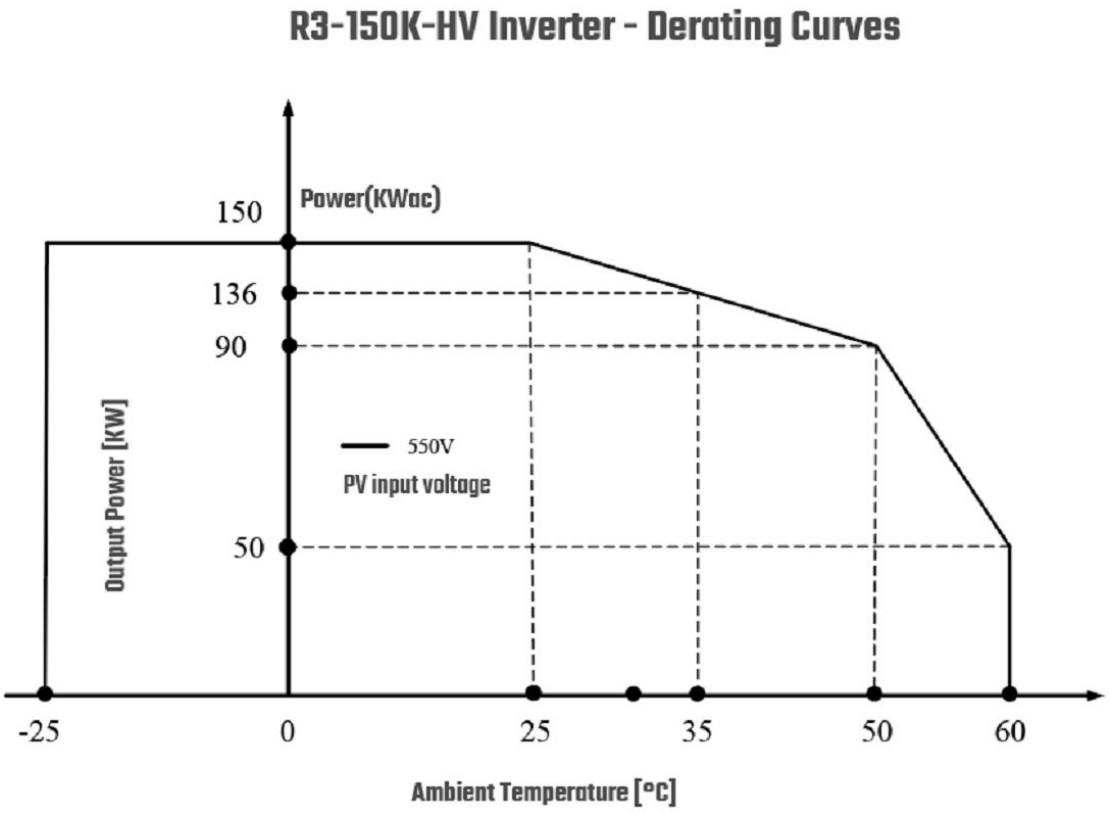

R3 Note Series Inverters - Derating Curves
Output Current [A]
30
25
20
15
10
5
0
25 30 35 40 45 46 47 48 49 50 55 60
Ambient Temperature [° C]
R3-4K-DT
R3-5K-DT
R3-6K-DT
R3-8K-DT
R3-10K-DT
R3-12K-DT
R3-15K-DT


R3 Pre Series Inverters - Derating Curves
Output Current [A]
50
40
30
20
10
0
25 30 35 40 45 46 47 48 49 50 55 60
Ambient Temperature [° C]
R3-10K-G5
R3-15K-G5
R3-17K-G5
R3-20K-G5
R3-25K-G5


R3 Pro Series Inverters - Derating Curves
Output Current [A]
80
60
40
20
0
25 30 35 40 45 50 51 52 53 54 55 56 57 58 59 60
Ambient Temperature [° C]
R3-30K-G5
R3-40K-G5


R3 Plus Series Inverters -
Derating Curves
Output Current [A]
140
120
100
80
60
40
20
0
25 30 35 40 45 50 51 52 53 54 55 56 57 58 59 60
Ambient Temperature [° C]
NAC50K NAC60K NAC70K NAC75K NAC80K

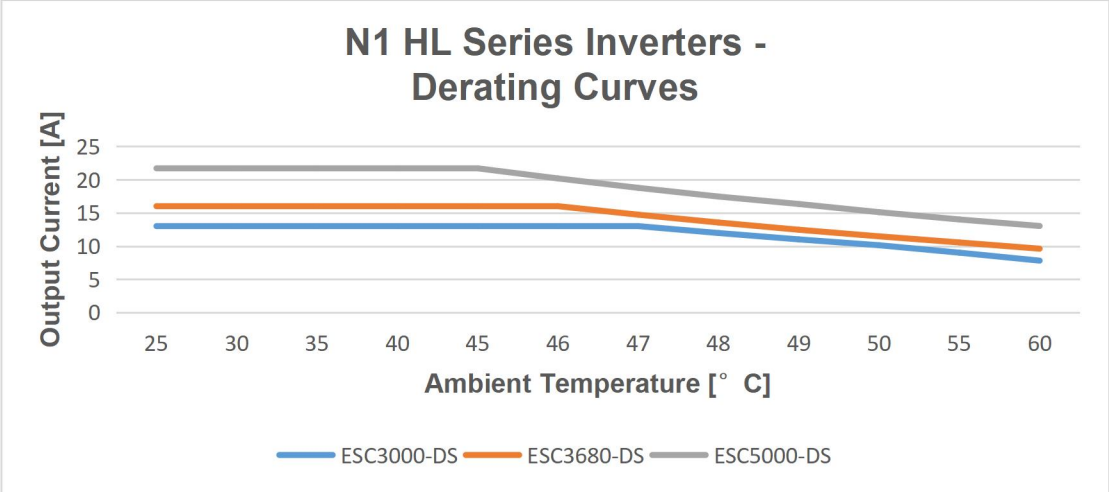

R3-120K Inverter - Derating Curves
Power(KWac)
120
110
100
50
45
Output Power [KW]
850V
550V
520V
PV input voltage
-25
0
25
40
50
60
Ambient Temperature [°C]

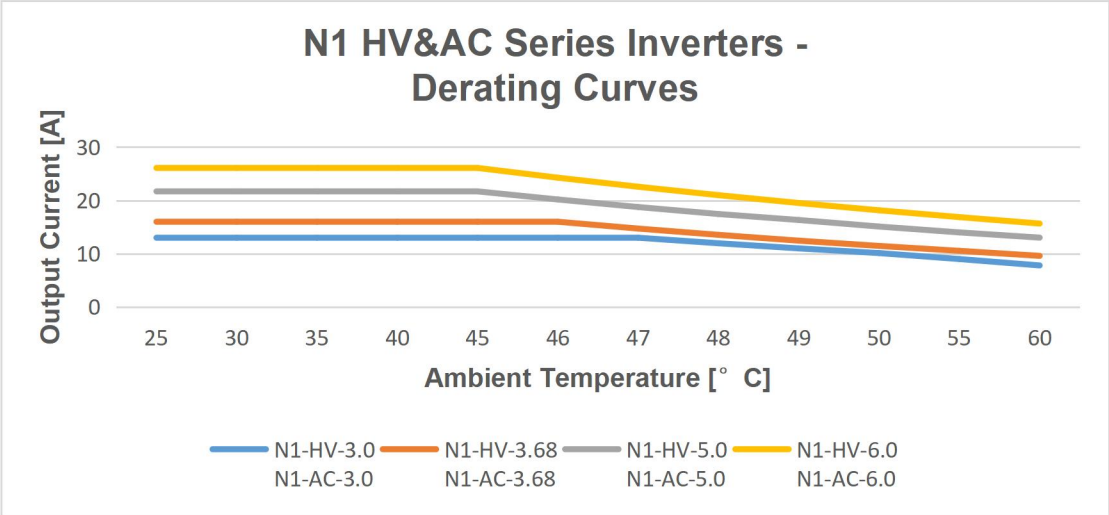


Hybrid Inverters

The following inverter models operate at full power and full currents up to the temperatures listed in the table below, and operate with reduced ratings up to 113°F/45°C according to the graphs below. The graphs describe the reduction in current in relation to temperature. The actual output current will never be higher than the maximum current specified in the inverter datasheets and might be lower than described in the graph below due to specific inverter model ratings per country and grid.

Inverter Model	Temperature
ESC3000-DS, ESC3680-DS, ESC5000-DS N1-HV-3.0, N1-HV-3.68, N1-HV-5.0, N1-HV-6.0 N1-AC-3.0, N1-AC-3.68, N1-AC-5.0, N1-AC-6.0	113°F/45℃





3. The reason for temperature derating

Temperature derating occurs for various reasons, including the following:

- The inverter cannot dissipate heat due to unfavorable installation conditions.
- The inverter is operated in direct sunlight or at high ambient temperatures that prevent adequate heat dissipation.
- The inverter is installed in a cabinet, closet, or other small enclosed area. Limited space is not conducive for inverter cooling.
- The PV array and inverter are mismatched (power of the PV array compared to the power of the inverter).
- If the installation site of the inverter is at an unfavorable altitude (e.g. altitudes in the range of the maximum operating altitude or above Mean Sea Level, see Section "Technical Data" in the inverter operating manual). As a result, temperature derating is more likely to occur since the air is less dense at high altitudes and thus less able to cool the components.
- A constantly high DC voltage (V_MPP) is present at the inverter.

4. Heat dissipation of the inverters

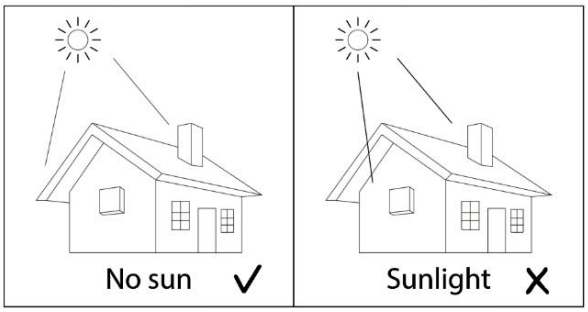
Renac inverters have cooling systems tailored to their power and design. Cool inverters dissipate heat to the atmosphere through heat sinks and fans.

As soon as the device generates more heat than its enclosure can dissipate, an internal fan switches on (the fan switches on when the heat sink temperature reaches 70℃) and draws in air through the cooling ducts of the enclosure. The fan is speed-controlled: it turns faster as the temperature rises. The advantage of cooling is that the inverter can continue to feed at its maximum power as the temperature rises. The inverter is not derated until the cooling system reaches the limits of its capacity.

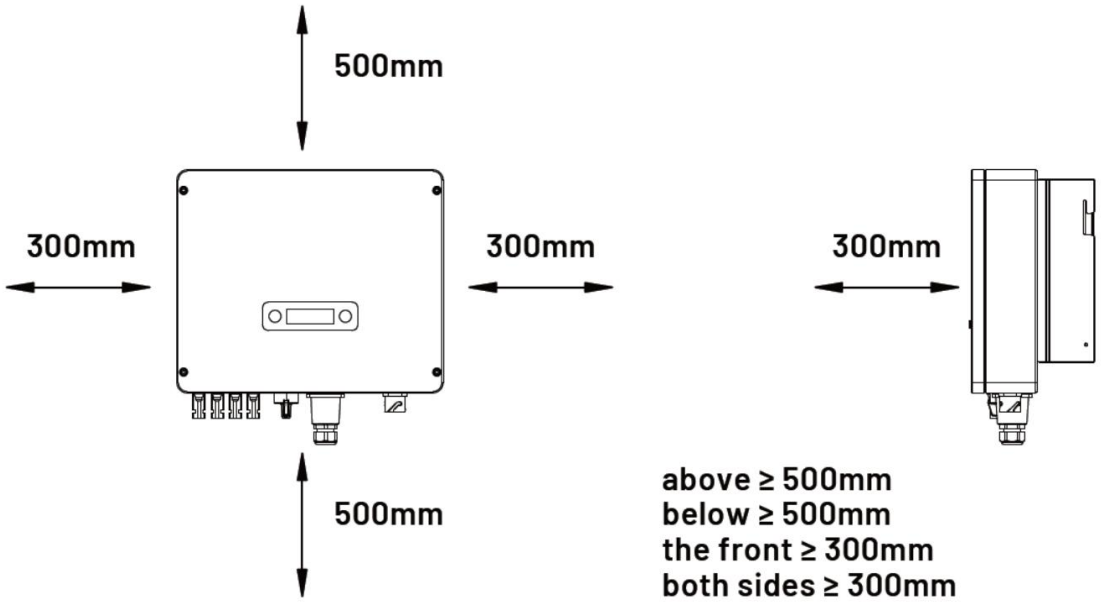
You can avoid temperature derating by installing inverters in such a way that the heat is adequately dissipated:

- Install inverters in cool locations (e.g. basements instead of attics), the ambient temperature and relative humidity must meet the following requirements.

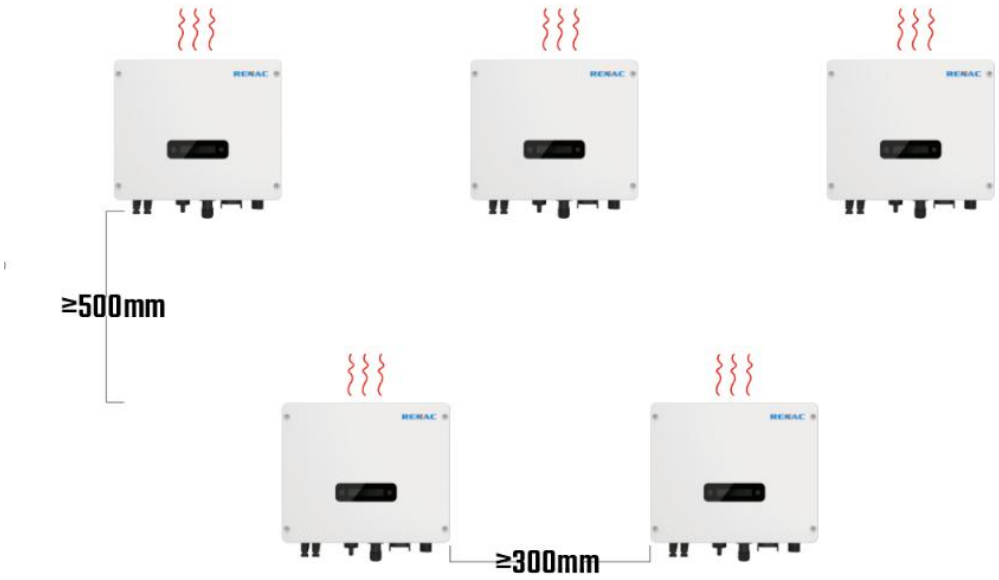
- Do not install the inverter in a cabinet, closet, or other small enclosed area, sufficient air circulation must be provided in order to dissipate the heat generated by the unit.
- Do not expose the inverter to direct solar irradiation. If you install an inverter outdoors, position it in the shade or install a roof overhead.

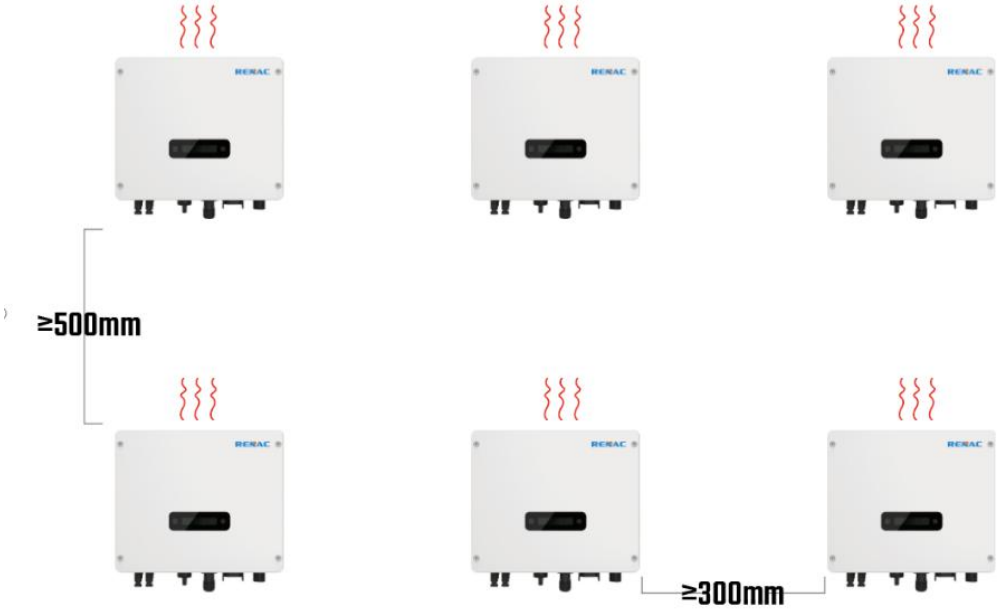


- Maintain the minimum clearances from adjacent inverters or other objects, as specified in the installation manual. Increase the clearances if high temperatures are likely to occur at the installation site.



- When installing several inverters, reserve enough clearance around the inverters to ensure sufficient space for heat dissipation.





5. Conclusion

Renac inverters have cooling systems tailored to their power and design, temperature derating has no negative effects on the inverter, but you can avoid temperature derating by installing inverters in a correct way.