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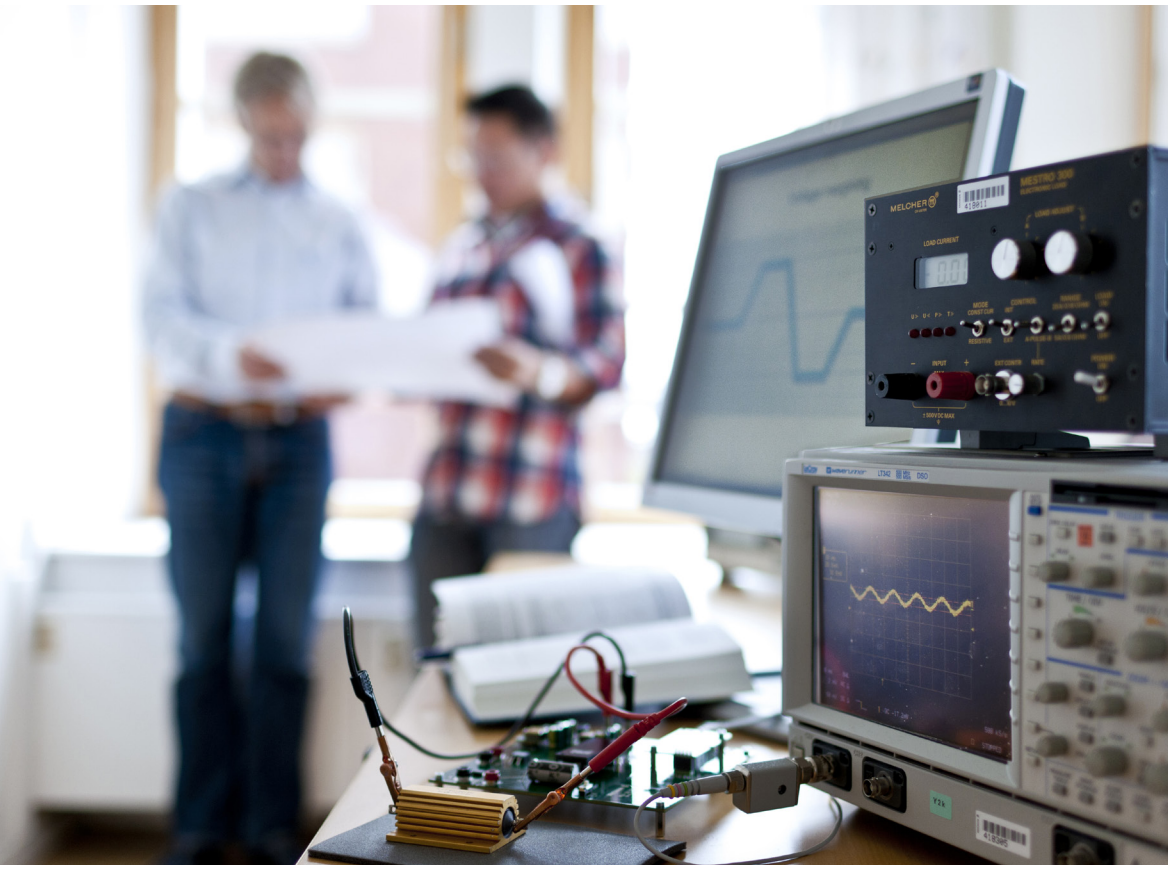
FORCED AIR COOLING OF DC/DC POWER MODULES AT HIGH ALTITUDE



DESIGN NOTE 025

Ericsson Power Modules

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Abstract

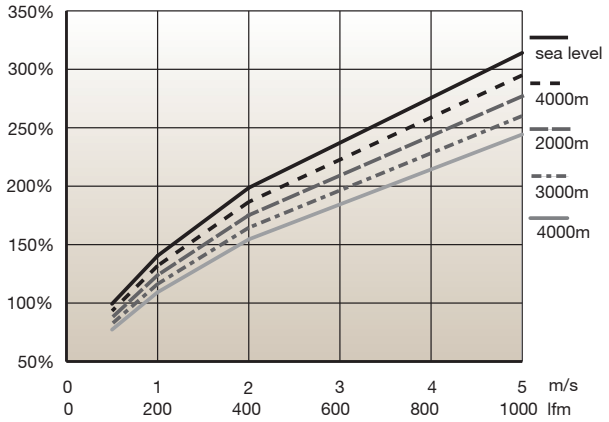
Due to lower air density at higher elevations, the convective heat transfer capabilities of air can vary depending on elevation. For uncontrolled environment this adverse effect is offset by a lower ambient temperature at higher elevations. For temperature controlled environment, the heat transfer will be slightly affected. This can be offset by a lower operating temperature or by higher fan air speeds. The air speed is not dependent on elevation.

This Design Note will focus on the relationship between air convective heat transfer and elevation. This should be considered within the context of cooling DC/DC converters and their associated thermal derating curves.

Forced air cooling

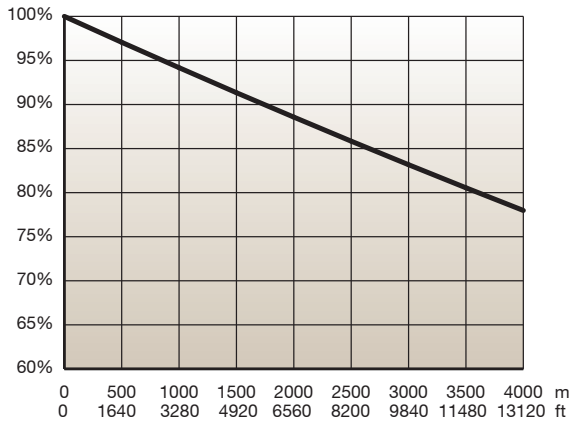
The graph below shows how air convective heat transfer varies with elevation and laminar air speed. We can see that for identical temperatures, an increase in air speed from e.g. 2 m/s to about 3.5 m/s is needed to obtain the same heat transfer ratio at 4000 meters compared to sea level.

Heat transfer
(in relation to sea level and 0,5 m/s airflow)



The diagram below shows how the cooling efficiency deteriorates with high altitude:

Cooling efficiency



Another way to put this is the following tabulated derating factors for the same temperature at different altitudes:

Altitude meter	Altitude feet	Derating factor
0	0	1.00
500	1640	0.97
100	3280	0.94
1500	4920	0.91
2000	6560	0.89
2500	8200	0.86
3000	9840	0.83
3500	11480	0.81
4000	13120	0.78

How temperature and pressure varies with altitude

From the table one can see that for outdoor applications, the temperature normally is considerably colder at 4000 m, 13120 ft, compared to sea level (about 25˚C) which for most applications compensates the loss in heat transfer.

Altitude meter	Temperature ˚C	Pressure kPa	Density kg/m3
-500	18	108	1.29
0	15	101	1.23
500	12	95	1.17
1000	9	90	1.11
1500	5	85	1.06
2000	2	80	1.01
2500	-1	75	0.96
3000	-4	70	0.91
3500	-8	66	0.86
4000	-11	62	0.82
4500	-14	58	0.78
5000	-17	54	0.74

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Formed in the late seventies, Ericsson Power Modules is a division of Ericsson AB that primarily designs and manufactures isolated DC/DC converters and non-isolated voltage regulators such as point-of-load units ranging in output power from 1 W to 700 W. The products are aimed at (but not limited to) the new generation of ICT (information and communication technology) equipment where systems' architects are designing boards for optimized control and reduced power consumption.

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