

# 1 Motor De-Rating for Continuous Operation at Low Speed

## 1.1.1 Abstract

The cooling of the motor is depending on the speed of the rotor if no forced cooling is installed. The note describes how to handle cooling of the motor at continuously operation at low speed.

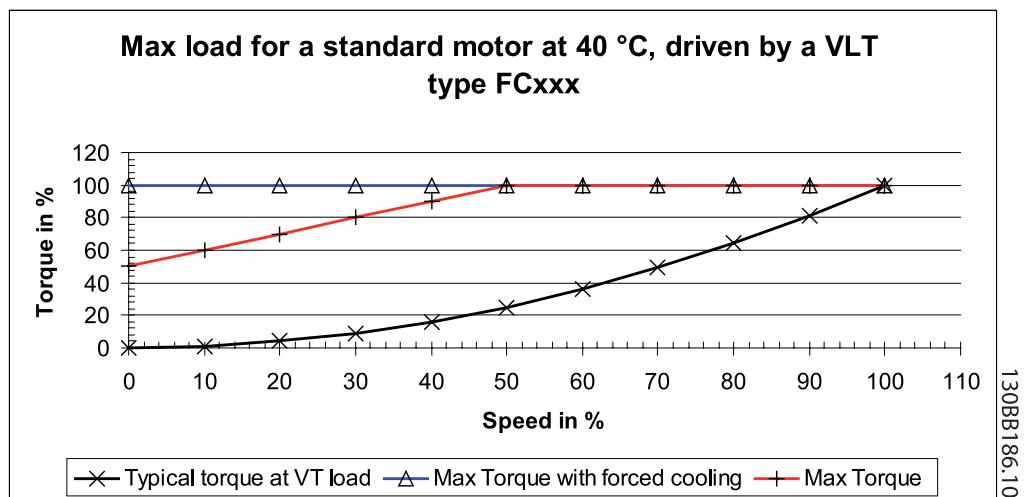
## 1.1.2 Constant Torque Applications (CT Mode)

In Constant torque applications a motor may over heat at low speeds due to less cooling air from the motor integral fan. The level of heating depends on the load on the motor, as well as the operating speed and time. If the motor fan is not able to provide the required airflow, then the solution is either to use external forced cooling of the motor or de-rate the motor size. De-rating or forced cooling is necessary below half the rated speed. See the graph below.

## 1.1.3 Variable (Quadratic) Torque Applications (VT)


In Variable (quadratic) torque applications, such as centrifugal pumps & fans, where the torque is proportional to the square of the speed and the power proportional to the cube of the speed, there is no need for additional cooling or de-rating of the motor.

In the graph shown below it is clear that the typical VT curve is below the Max torque with de-rating and Max torque with forced cooling at all speeds. (Check actual torque / speed characteristic).



**NB!**  
The VT curve is a typical curve for an IP54/55 motor.

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	<b>NB!</b> Over synchronous speed operation will result in the available motor torque decreasing inversely proportional with increase in speed. This must be taken into account during the design to avoid overloading the motor).
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### 1.1.4 Danfoss VLT® Features to Protect the Motor and the Application

To protect the application from running below a certain speed the VLT® AQUA Drive offers several dedicated features.

Min Speed Limit:	Limit the operating speed range to for instance between 30 and 50/60Hz.
Initial Ramp:	Ensure a fast as practical ramp from zero speed to min speed.
Final Ramp:	Ensure a fast as practical ramp from min. speed to zero speed.
Low flow detection:	In closed & open loop applications, on pumps with radial impeller, the drive can detect a low flow situation, where the drive will run at low speed and low power. The feature can provide an alarm or stop the drive
ETR (Electronic Thermal relay):	The VLT® ETR measures actual current, speed and time to calculate motor temperature and protect the motor from being overheated (Warning or trip). (An external thermistor input is also available).