**A: "Normal“ torque mode.**

This is the „old“ torque control present in previous VLT types and the only mode first introduced for the VLT 5000 series. It is based on a measurement of the output current, and „extract“ the active current from this measurement. The torque is fairly good proportional with the active current (at least, when the magnetizing current is steady, this mean in the undersync. area; and in the oversync. area it is inverse proportional with the mag. current, which allow a calculation of the torque, in the oversync. range based on mag. current).

Therefore you can regulate a torque based on the active current as internal feedback parameter (when torque mode open loop is selected in P 100). The regulation characteristics of this active current feedback loop, can be influenced by the setting of the P and I part for the regulation (parameter P433 and P434).

The difficulties with this regulation is the feedback value of the active current at low RPM; especially at small inefficient motor size, where the active current „disappear“ in the motor as internal loss (remember the system is dependent on the active current as feedback to the VLT for the regulation). Besides, then the active current only have a „numerical“ value; therefore, in order for the system to know, whether it must regulate the RPM in one or the other direction, dependent on the motoric mode or generatoric mode, then the cos. phi must be determined. It is possible for the VLT to determine the cos. phi in the generatoric mode (negative torque reference) from max. frequency range down to about 20% of the nominal frequency, before the internal loss in the motor make a reliable cos. phi and active current measurement impossible.

Therefore going from motoric mode to generatoric mode through 0 RPM is not possible with this torque mode, necessary on application with winding/unwinding in the same workprocess. (but f. ex., in application with only winding, it would be possible to use above mode).

**B: TCSF mode:**

Based on above mentioned difficulties with regulation around 0 RPM, and a need to take care of winding/unwinding applications, then a new concept for torque was developed. This new concept is based on a torque regulation proportional to the slip for the motor. The slip is then used as the feedback regulation for this concept, and since the slip is measured via the „normal“ encoders used for speed regulation in closed loop, then the new concept was called: torque control speed feedback (TCSF).

Since the slip is the difference between the synchronous RPM and the actual RPM, then the actual RPM must be measured fairly accurately, and this mean a fairly high pulse rate per RPM for the encoder. (otherwise the feedback signal will be too course, and the regulation bad). F. ex. If a 4 pole motor has a nominal speed of 1440 RPM, then the slip is 1500 -1440 = 60 RPM, and this equal 100% torque (because the nominal speed is always at 100% load on the shaft). A reference setting of 10% torque, then correspond to 6 RPM; and it is obvious than an encoder with a low pulse rate per RPM will give a bad regulation. If you always regulate the output frequency to maintain this 6 RPM in difference to the actual measured RPM, then this system work no matter what the actual speed may be, and therefore also through 0 RPM.

The drawback with this system is the need for a fairly high pulse rate encoder (and still the slip is a small feedback value, especially on efficient motors with little slip); but as you know, then the slip change with temperature, and this will also change the actual torque compared to the reference torque setting. The only way to minimize this influence is to adjust the torque at working temperature (parameter P447). (100% torque reference at nominal speed , should give 100 % power output on the shaft at nominal speed; but remember the power display for the VLT is delivered power to the motor, you must multiply with the efficiency for the motor in order to correlate it to the motorshaft).

Since the encoder is working all the time in this mode, then the RPM and direction is measured. In one direction the motor is working as a motor and pull the material on the „drum"; in the other direction the material is being pulled off, and the motor must now provide a retarding torque (brake resistor might be needed). However, the slip is in the same direction and regulated automatic by the feedback loop. Friction is „overcome" by the motor in motoric mode (winding), but „overcome" by the material, when it is pulled off (unwinding). If you have the same torque both for winding as well as unwinding, then the torque on the material is lower in winding mode, because part of the torque is used to „overcome" the friction, and reversed for unwinding, where the material must „deal" with the torque setting but also the friction. Since winding and unwinding have a different direction, then it is possible to automatic compensate for the friction torque. Up to 50 % of the rated motor torque can automatic be compensated for as friction torque, this is set in parameter P449 (and add friction torque in motoric mode, but deduct friction torque for the retarding torque in generatoric mode).

If the encoder is not mounted on the motorshaft, but on the output shaft on a gear, then the RPM for the slip change and the gear ratio must be programmed in parameter P448.

Adjustment of parameter P447, P448 and P449 are basically the only adjustment for TCSF; but parameter P421 is the filter constant for the speed feedback signal, coming from the encoder and therefore also valid for TCSF mode. (See information about adjustment in the manual for this setting).