Motor control with DTC

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TECHNICAL NOTES

What is DTC?

Direct Torque Control - or DTC as it is called - is the very latest AC drive technology developed by ABB and is set to replace traditional PWM drives of the open- and closed-loop type in many applications.

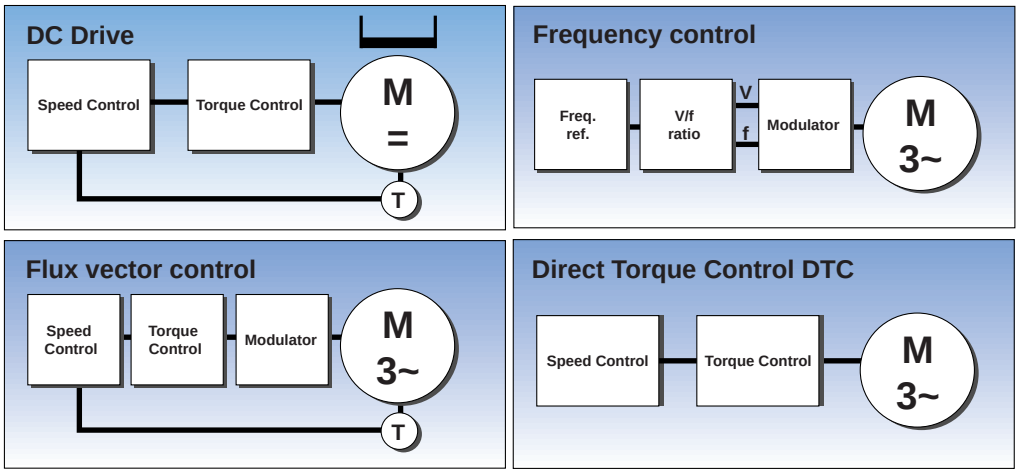
Why is it called Direct Torque Control?

Direct Torque Control describes the way in which the control of **torque** and **speed** are directly based on the electromagnetic state of the motor, similar to a DC motor, but contrary to the way in which traditional PWM drives use input frequency and voltage. DTC is the first technology to control the "real" motor control variables of torque and flux.

What other control methods exist?

Initially, DC drives were used for variable speed control because they could easily achieve a good torque and speed response with high accuracy. The method offers accurate and fast torque control, high dynamic speed response and is simple to control.

The evolution of AC variable speed drive technology has been partly driven by the desire to emulate the performance of the DC drive, such as fast torque response and speed accuracy, using the inexpensive and rugged standard AC motor.



DTC is the only AC drive technology to directly control torque - note the similarity with the DC control block.

AC drives with frequency control using PWM (Pulse Width Modulation) controls the motor in the form of a pulse train dictating both the voltage and frequency. However, this control method is too inaccurate for many demanding applications. In all PWM drives, a modulator is used, which slows down communication between the incoming voltage and frequency signal and the motor's response. Control is handled inside the electronic controller and not inside the motor.

AC drives with flux vector control were developed to emulate the magnetic operating conditions of a DC motor. To perform the field orientation process, the flux-vector drive uses the spatial angular position of the rotor flux inside the AC induction motor. But as a feedback device is required to achieve good torque response and speed accuracy, flux vector drives are complex and expensive.

DC and DTC both use motor parameters to directly control torque. But DTC has the added benefit of not requiring a feedback device; of using a rugged and inexpensive AC motor; and of not requiring external excitation.

DTC is the world's most advanced AC drive technology, based on the theory of field-oriented control of induction machines, published by German scientists Blaschke and Depenbrock in 1971 and 1985. Commercially launched by ABB in 1995, DTC is incorporated into the company's ACS 600 and ACS 1000 ranges of drives and is operational in hundreds of thousands of applications world-wide.

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How is DTC different?

With DTC, field orientation is achieved without feedback, using advanced motor theory to calculate the motor torque. DTC uses the fastest digital signal processing hardware available and a more advanced mathematical understanding of how a motor works.

The result is a drive with a torque response that is typically 10 times faster than any AC or DC drive.The dynamic speed accuracy of DTC drives will be 8 times better than any open loop AC drives and comparable to a DC drive that is using feedback.

What are the benefits of DTC?

DTC provides precise torque control without the need for a feedback device.This gives:

Fast torque response: - This significantly reduces the speed drop time during a load transient, bringing much improved process control and a more consistent product quality.

Torque control at low frequencies: - This is particularly beneficial to cranes or elevators, where the load needs to be started and stopped regularly without any jerking.Also with a winder, tension control can be achieved from zero through to maximum speed.

Torque linearity: - This is important in precision applications like winders, used in the paper industry, where an accurate and consistent level of winding is critical.

Dynamic speed accuracy: - After a sudden load change, the motor can recover to a stable state remarkably fast.

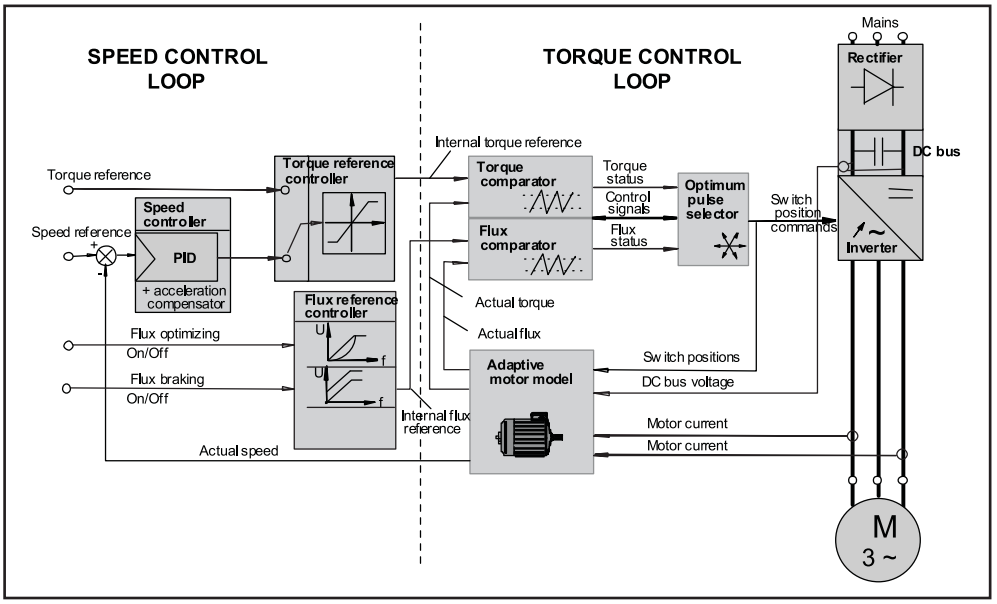
How does DTC work?

In normal operation, two motor phase currents and the DC bus voltage are simply measured, together with the inverter's switch positions.

The measured information from the motor is fed to the Adaptive Motor Model.

The configuration has immense processing speed such that every 25 microseconds the inverter's semiconductor switching devices are supplied with an optimum pulse for reaching, or maintaining, an accurate motor torque.

This high speed of switching is fundamental to the success of DTC.The main motor control parameters are updated 40,000 times a second.



The Motor Model is at the heart of DTC technology. Information about the motor is collected during an identification run, and used to calculate precise motor data

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