Application Note DK9222-1009-0006

Bus Terminal

Keywords
Speed control
Bus Terminals
Energy efficiency
Square characteristic
AC motors
KL2791

Speed control of single-phase AC motors

In order to reduce the power consumption of single-phase AC motors, their speed can be regulated as required. Depending on the process data, the speed can be reduced in the case of low load requirements in order to reduce noise emissions, increase energy efficiency and prolong the service life of the units.

Effects of the change in speed

Single-phase AC motors with square load characteristic curves are often used as additional units for fans or pumps, for example. As opposed to three-phase motors, no start-up optimisation is necessary as in the case of star-delta and adjustment to different load cases by means of a frequency converter is often not provided for. The additional units are usually switched in an interval orientated manner or simply activated during a certain phase of the control program. The following AC motors are in use, depending on the application: capacitor, universal and shaded-pole motors.

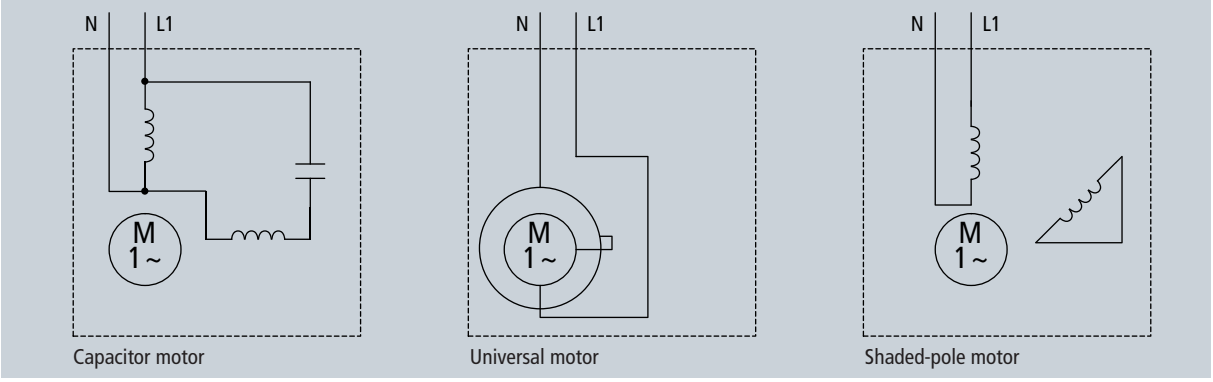

Fig. 1: Controllable AC motors on the KL2791

Application Note DK9222-1009-0006

Bus Terminal

When driving working machines whose production or conveying output can be influenced via the drive speed of the motor, energy can be saved by means of variable speed. This particularly applies if the change in the motor speed is also linked with large changes in the emitted mechanical output. Increase the speed – higher load, decrease – lower load. This procedure is particularly suitable for uncontrolled units with a square load characteristic, because regulating the speed just a little brings about a large change in energy consumption due to its square influence.

Practical example

Cooling lubricant pump in a milling machine

Two frequently occurring control scenarios are illustrated here, after which the optimisation is demonstrated. The pump is coupled in both cases to the tool drive in order to guarantee that sufficient cooling lubrication takes place when the blades cut into the workpiece.

Scenario 1

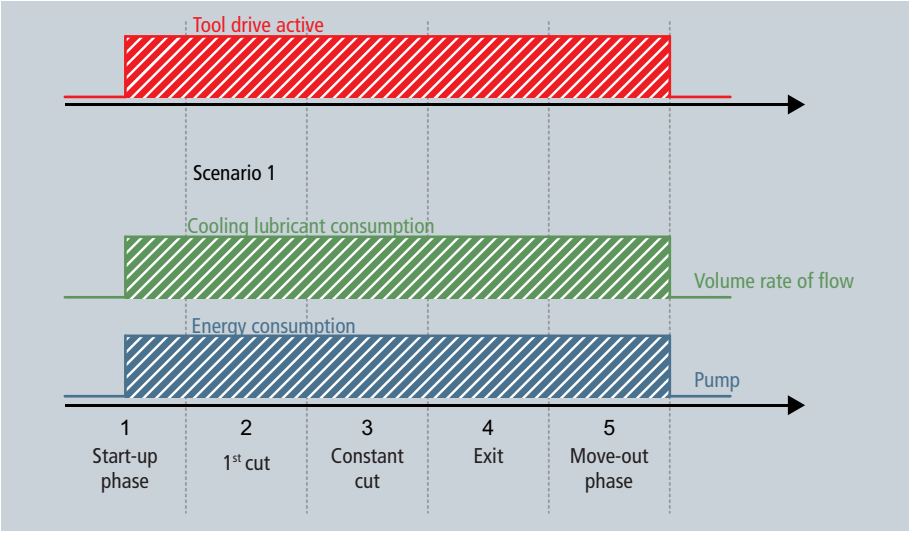

Fig. 2 Need for optimised control

Cooling lubrication is fundamentally required during the runtime of the miller (tool drive) in order to achieve appropriate surface qualities and to keep the thermal loading of the workpiece low. For this reason, the cooling lubricant circulation pump is linked to the tool drive in order to securely guarantee pumping. There are two operating cases for the pump: Pump on | pump off; therefore, no changes in the load take place. The pump always runs at full speed and with full power consumption, even during the phases where the tool is moving in and moving out (1 and 5), at which time the tool drive is active, but the tool itself is not cutting.

Application Note DK9222-1009-0006

Bus Terminal

Scenario 2

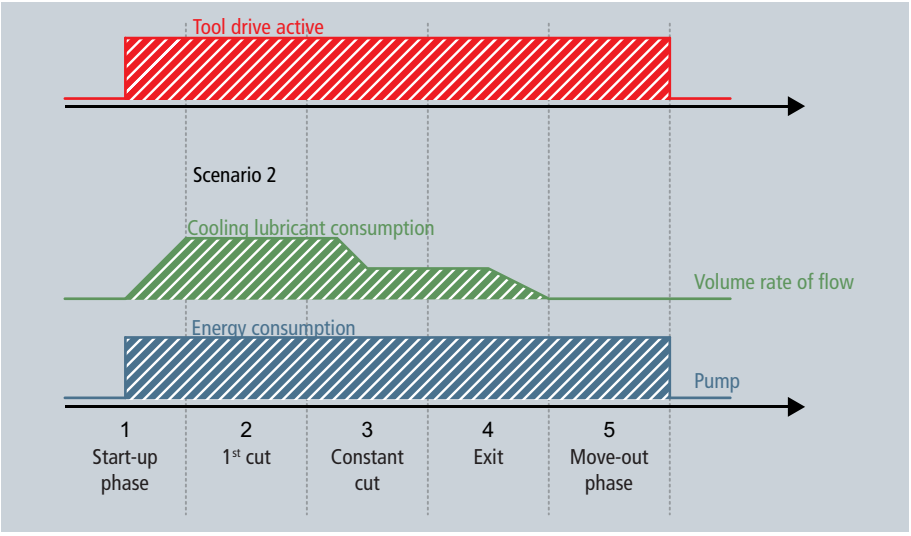

Fig. 3 Fractional optimised control

Similar to the example above, the pump is linked logically to the tool drive. However, additionally, there is a valve to regulate the flow rate for different load cases and to prevent pumping when the tool is driving in. Although the cooling lubricant consumption is thus optimised, the pump is still running at 100 % utilisation, even though the flow rate is only minimal. Furthermore, a dynamic pressure builds up at the valve due to the constantly running pump, so that when the valve is opened the cooling lubricant shoots out before the normal pumping pressure has been established.

Application Note DK9222-1009-0006

Bus Terminal

Optimisation – speed control using the KL2791

In neither case the power consumption of the pump is affected; therefore, the use of the single-phase AC motor terminal makes sense in order to achieve a reduction in the consumed power.

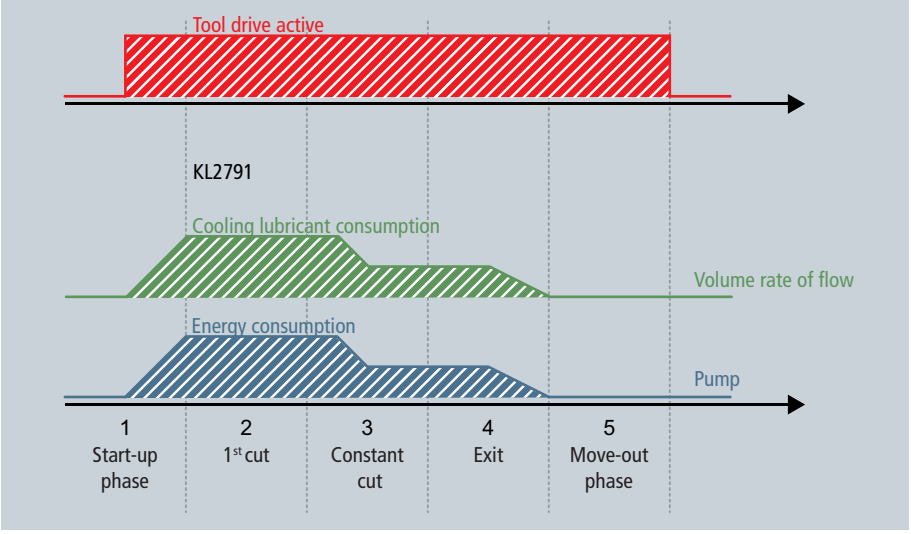

Fig. 4 Optimised control with the KL2791

Using the KL2791 single-phase AC motor terminal, a single-phase AC motor with a maximum power consumption of 0.1 kW can be operated with speed control depending on the process data. L1 and N of the motor are wired directly to the terminal; this is in turn integrated in the control environment via a Bus Coupler or connected directly to an embedded device.
The controller specifies the set value for the motor speed in the form of a 16-bit word; the speed is regulated internally in the terminal: the motor is switched on and off with a practice-proven mains-synchronous pattern, so that the motor consumes less power and the speed falls significantly. This method is well suited to motors with fixed loads, such as pumps and fans, in order to achieve a control range for the flow rate from 10 % to 100 %.

– 1-channel AC motor speed controller, 230 V AC, 100 VA **www.beckhoff.com/KL2791**
– The modular fieldbus system for automation **www.beckhoff.com/Busterminal**