ENGINEERING TOMORROW

Case story | VLT® AutomationDrive FC 302 with IMC

Why a renowned wafer machine builder relies on **intelligent drives** with **integrated motion control**

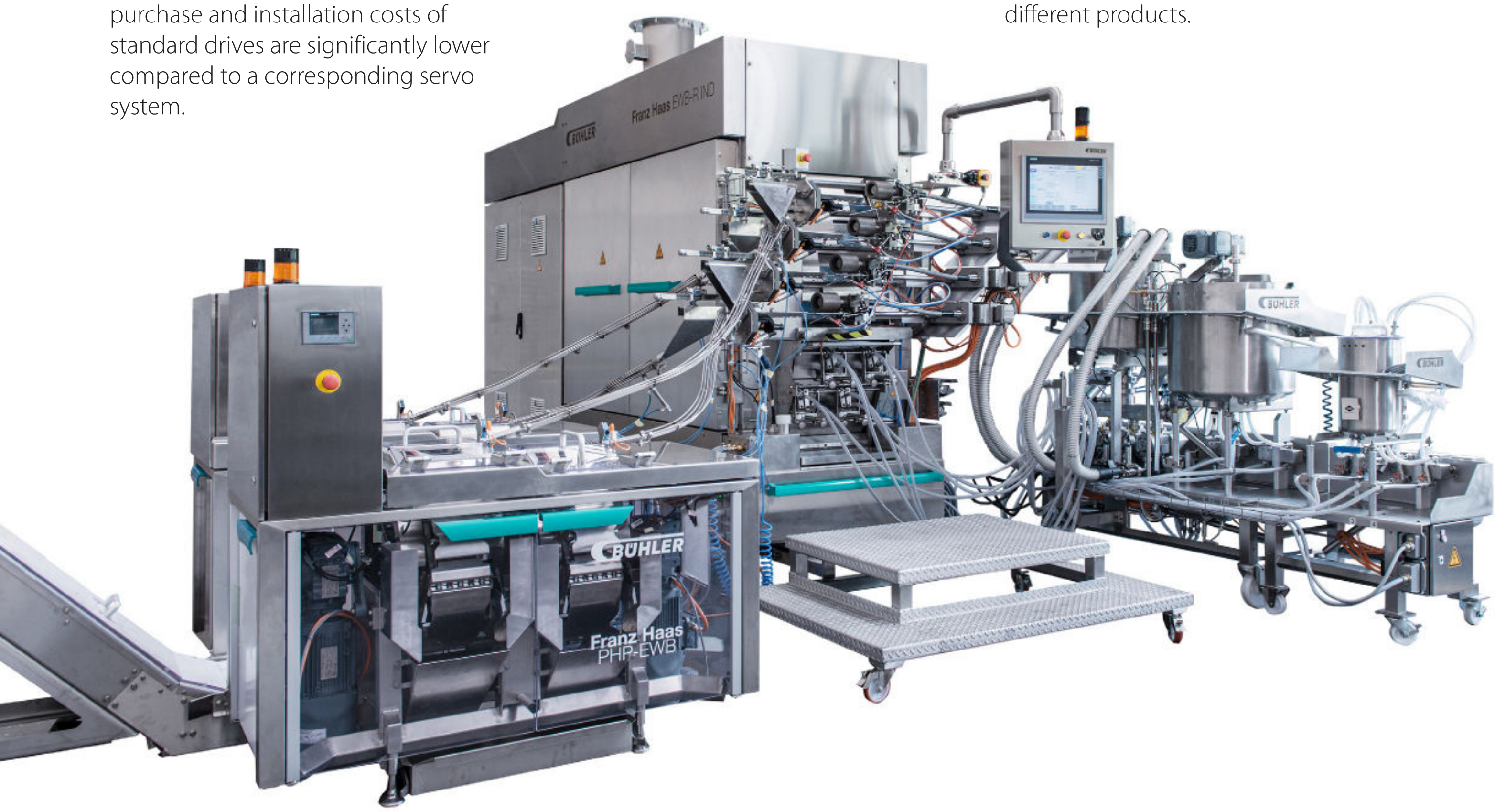
Motion control is traditionally synonymous with exact position, velocity, and acceleration control. Typically, such applications require complex servo solutions or an AC drive plus an additional motion control assembly and an encoder. With the Integrated Motion Controller (IMC) function, Danfoss offers an attractive alternative to servo motion control. Directly integrated into the VLT® AutomationDrive series, IMC very easily performs positioning and synchronization tasks with and without encoders. At the location of the former Haas Group (wafer machines) in Leobendorf, Lower Austria, which was acquired by the Swiss Bühler Group in 2018, the technicians already appreciate these advantages - in particular the resulting motor independence.

The world-renowned, domestic machine builder of production systems for wafers, biscuits and confectionery had already used VLT® drives from Danfoss under its former company name FHW Franz Haas Waffelmaschinen for many years - and remains true to this tradition even under the flag of the Bühler Group. Due to the increasing need to synchronize and position, the machine drives have recently been gradually converted to servo technology. When Danfoss launched the Integrated Motion Control (IMC) functionality in 2017, Haas - as it was known at that time - asked whether the new control technology would also be a practical alternative to servo controls for its machines. Advantages were particularly expected from the associated free choice of motor, the technology independence and the simple system optimization through automatic motor adaptation.

IMC offers three types of positioning
The IMC function can be used universally, since it can position absolutely, relatively and with sensor. In absolute position, the position reference refer to a defined machine zero point. This is determined at the start of the machine by the so-called homing run. If an optional feedback system with absolute position is used, this is not necessary because the zero point is set by the encoder. A typical application for this in Leobendorf is "downstream" of the cone oven with an absolute positioning of linear axes. The task here is to place paper in front of the continuously moving candy cones in order to be able to slide them into each other in the next step. The motors used are PM motors that are operated in open loop. The advantage of IMC: The rotary encoder can be omitted and thus the costs for the encoder as well as for cabling, evaluation and work time for installation and commissioning can be saved. The use of the VLT® AutomationDrive (with IMC) itself also brings savings, because the purchase and installation costs of standard drives are significantly lower compared to a corresponding servo system.

Relative (accurate) positioning
Another application relates to relative positioning. In contrast to absolute positioning, the position reference does not refer to a zero point of the machine, but to the current actual position of the drive. One example of such an application at Bühler are dosing pumps for dough. Here, the distance traveled by the motor corresponds to a certain amount of dough pumped. Once the positioning is complete (via the defined travel path) with the exactly correct amount of dough, the drive is moved minimally in the opposite direction of rotation, in order to generate a small vacuum. As a result, the dough in the line is pulled back slightly and does not drip. Both movements are relative positionings. The advantages for the user are the same as in the previous variant.

Touch probe at stop
Another application variant is the sensor or touch probe positioning. The drive starts and runs until an external sensor sends a signal to the drive – the desired target position is then calculated. Sensor positioning is used wherever an exact target position cannot be calculated without external specifications. Often, the sensor is also used to correct the target position, e.g. to compensate for the fault caused by the slip of an induction motor. This procedure is used for the so-called pillow stick crimper. Here, an induction motor with gearbox operated in open loop runs several revolutions in order to complete a full cycle of the mechanics. Then it stops at a certain position. Only in this position can new material be picked up again and the next cycle started. The advantage of touch probe positioning is an even more precise positioning than purely via start/stop on the VLT® AutomationDrive. The target position is also very easy to adjust because only one parameter needs to be changed. This also makes it extremely easy to adapt the machine to different products.



Touch probe in Speed Mode
As a variant of the touch probe, the Speed Mode is also available as a type of positioning. Here, the drive is started in normal velocity control and run continuously. The touch probe input monitoring is activated via a fieldbus signal. From this point on, the AC drive waits for the sensor signal and performs the positioning. The changeover from Speed Mode to positioning takes place without shocks while the motor is running. This is a function that can only be achieved so easily with an AC drive.

Synchronization made easy

Synchronization means creating an angle-synchronous synchronization of two or more axes. The gear ratio of the two axes to each other can be continuously adjusted. The reference signal for position and speed is either picked up by an external encoder, generated by a PLC as a pulse signal or specified via a virtual master signal. This virtual master signal is a pulse signal from which the direction of rotation, speed and position can be derived. The reference for the master drive is either carried out in the traditional way via an analog signal or via a setpoint on the fieldbus. This master drive then converts the signal into a virtual master signal, which serves as a reference value for the follower drives as well as for the master itself. The Leobendorf wafer machine specialists use synchronization with a master signal, for example in the follower drives of the cone oven. In the subsequent processes, up to eight axes each move at an angle synchronous to one another. A pulse signal from the PLC is used as the master signal. Before starting the drives, all are moved to a reference position (homing). The PM motors used in open loop with gearbox achieve angle-synchronous synchronization despite different gearboxes and different motors, via exact adjustment of the gear ratio. This removes the need for the complete encoder system for the eight axes and the servo controllers. In addition, the ovens can be started up much faster and the engineering has been simplified.

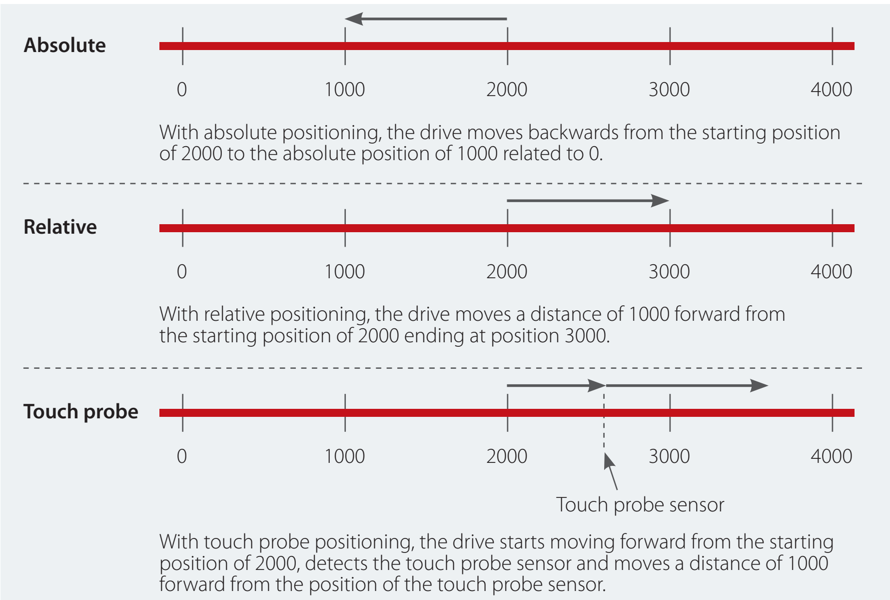
Start from a defined position

Homing of the drive is necessary in order to define a machine home position when using incremental encoders or in open loop operation and to bring the drive to a defined starting position. There are different ways to define the home position. The VLT® AutomationDrive with IMC supports the following possible actions:

- The current position can be defined as a home position.
- An external home sensor defines the home position; this sensor is approached at the set homing speed.
- An analog input defines the home position.
- The zero pulse of an incremental encoder defines the home position.
- A combination of the external sensor and the zero pulse defines the home position.
- Mechanical blockage based on a set torque level defines the home position.

The home synchronizing function sets actual position (that is, home position) at each passing of the home sensor while positioning or synchronizing without interrupting the movement. This can be used to avoid position drifting over time especially for sensorless control of induction motors.

The value of the home position is set by parameter and can be any value within the defined position range. For example in a machine with position range from 0 to 4000 and the home sensor placed in the middle, the home position would be set to 2000.



With absolute positioning, the drive moves backwards from the starting position of 2000 to the absolute position of 1000 related to 0.

With relative positioning, the drive moves a distance of 1000 forward from the starting position of 2000 ending at position 3000.

With touch probe positioning, the drive starts moving forward from the starting position of 2000, detects the touch probe sensor and moves a distance of 1000 forward from the position of the touch probe sensor.

Conclusion

In addition to simple parameterization, IMC offers high reliability thanks to proven AC drive technology and easy troubleshooting in the event of a fault. Recommissioning can usually be done by the operator and requires specially trained personnel. The Integrated Motion Controller reduces costs for OEMs and users through simple engineering with fewer components as well as reduced downtime.

About the author: Michael Hitter is Business Development Manager at Danfoss Drives in Austria.

Danfoss VLT® Automation Drive FC 302 series with Integrated Motion Controller (IMC) is available with outputs from 0.37 kW to 1.2 MW.

What IMC offers:

- Motor independence, enabling free choice of motor and motor technology (PM, induction)
- Easy adaptation to each motor thanks to Automatic Motor Adaptation
- Operation with encoder (incremental, absolute) or also possible without encoder
- Fieldbus independence
- Own IMC motion profile for fieldbus operation with customizable control word
- Supports linear and rotating systems
- Handling of limit switches integrated
- No extra software or programming by specialists required – all parameter settings are made via the LCP control panel or optionally via the MCT 10 set-up software
- Easy exchange in the event of service, parameter copy via LCP or MCT 10
- Manual operation via LCP possible
- Commissioning and all parameter settings are carried out via the graphic display of the LCP or optionally via the MCT 10 setup software