

# Café au CANopen

by Martin Schlenker and Roman Hofmann, IXXAT Automation

The new generation of high performance coffee machines by WMF for professional, public and congress use (Fig. 1) has nothing in common with the handy coffee-makers we use at home. It is a complex, but ordered mixture of boiler, valves, hoses, cables and grinders. Controlled by a pair of infineon 16bit microcontrollers, it takes no more than 20 seconds from the roasted coffee bean to a cup of creamy, steaming java.

Fig. 2 shows an overview of the process. After the bean is grinded, it falls into the boiler chamber where hot water is pressed in. Leaving the chamber, the coffee fluid is guided through a high pressure nozzle to the outflow chamber where additions such as milk, milk foam, hot or cold water and steam are mixed in. The remaining powder is pressed dry and caught in a drawer. For each station there is an average of 6 parameters accumulating to a total of 40 different parameters for each coffee product.

The communication structure follows a distributed I/O architecture. The so called ST5-Node attached to the front panel of the machine serves as main controller and controls the process and the user interface. The LST-Node located at the rear handles all the input signals from the different sensors and provides the output signals to the actuators like grind motor, water heater and valves. Each single actuators of the machine is represented in the Object Dictionary of the ST5 control unit with all its parameters allowing the complete configuration and tuning of the coffee machine using simple SDO communication. The ST5 control unit even knows, for example, the calibration parameters of the grinders and thus automatically corrects the exact amount of coffee

powder over time. This is where the experience of WMF in producing professional coffee machines for decades comes in, as well.

Although the Object Dictionary of the ST5 unit with its more than 300 main objects and about 2000 sub objects is one of the largest CANopen implementation IXXAT has ever realized, the process communication using PDOs is comparatively simple. For the communication between the ST5 and LST unit only few Process Data Objects (PDOs) are used: 2 Standard PDOs in each direction plus a Multiplexed PDO (MPDO) in each direction. Since bit-mapping is supported, all the digital inputs can be transmitted simultaneously in one PDO. With MPDOs (Fig. 3) it is possible to address each object dictionary entry by only one CAN-identifier. Therefore in a MPDO in the first bytes of its data field index and sub-index of the accessed object entry is specified.

The machine provides an external CAN connector allowing an easy extension of the network. The customer can choose from a wide range of external devices like cocoa, milk or sugar dispensers, hot-plated coffee in stock or coin boxes based also on CANopen and thus allowing plug-and-play operation. For the future, it is planned to connect to (still) proprietary waiter settlement systems as well. However, one of the most interesting uses of



Fig. 1: The new WMF coffee machine "combiNation S"

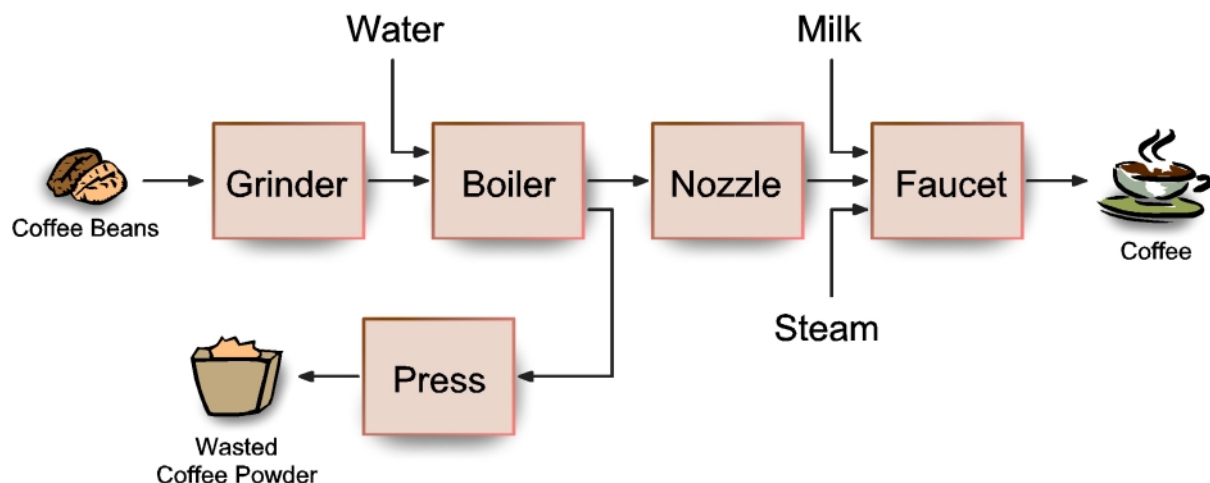


Fig. 2: The Process of professional coffee making

CANopen in a coffee maker is the standardized configuration, servicing and assembly operations it provides. Using the external CAN connector, a service engineer can read the customer's recipes, the product counters, error memory and so on. A development engineer may insert standard CANopen devices to the machine's bus for test or simulation purposes. In the final assembly, the firmware is written to the nodes using the "download SDO segment" protocol to a domain Object Dictionary entry. Using the same method, the service worker can update the machine's firmware in a few minutes from his laptop while being on site. For easier migration, it is also possible to "tunnel" SDO messages via a serial RS232 connection protocol.

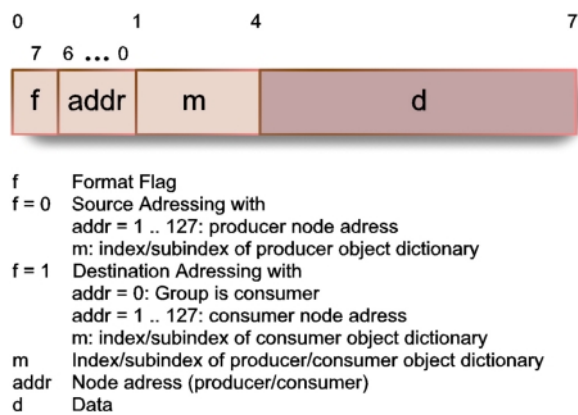


Fig. 3: Structure of a multiplexed PDO

IXXAT developed a full set of software tools based on its CANopen Configuration Studio that covers the complete range of servicing, assembly and testing of the new generation of coffee machines. This Win32 tools suite consists of an application for product configuration, an application for setting of the machine equipment, loading of the firmware and finally a framework for testing. The product configuration program presents the recipes of different coffee specialties in a lucid way making it very easy to adjust the numerous parameters and allowing to assign these recipes to the product buttons on the front panel (Fig. 4). With the machine outfit program the worker declares each individual machine's parts and stores them together with the serial number in a protected part of the Object Dictionary. Last

but not least there's the test application that provides an open framework for development, experiment and long-term testing. Since the framework exposes COM-Interfaces for SDO access and logging, a single test can be implemented as a standalone executable in C++, Visual Basic, Delphi, Java, and even as a Windows Script. The user writes a test sequence in the framework with a simple point-and-click interface by selecting single tests and grouping them together. He can repeat a single test and loop groups. When he starts the test sequence, the framework calls the external single tests one after the other, logs their output messages and results and stores everything in a comma separated ASCII test protocol. With this set of tools integration of the product into the manufacturer's IT infrastructure is made easy. For the future, this allows remote servicing, diagnosis and tracking of each machine.

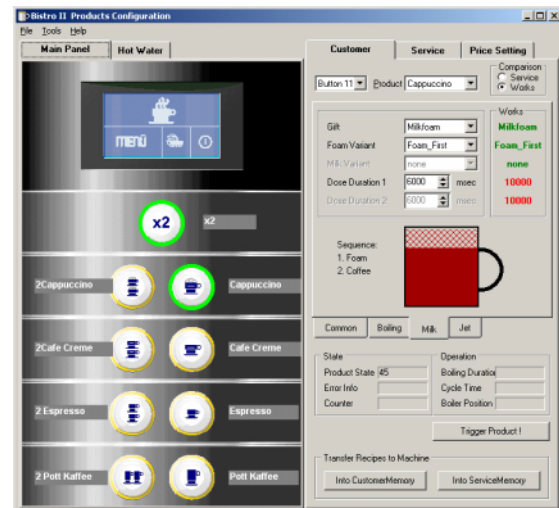


Fig. 4: Screenshot of the Product Configuration program

You wouldn't have believed that the coffee specialty you used to order at your favorite café and that you always enjoy with great relish is made possible not least due to CANopen, would you? So watch out next time, it's not so unlikely that your "Latte macchiato" pours from this high-tech coffee machine with completely integrated CANopen functionality.