Wire it up with CANopen

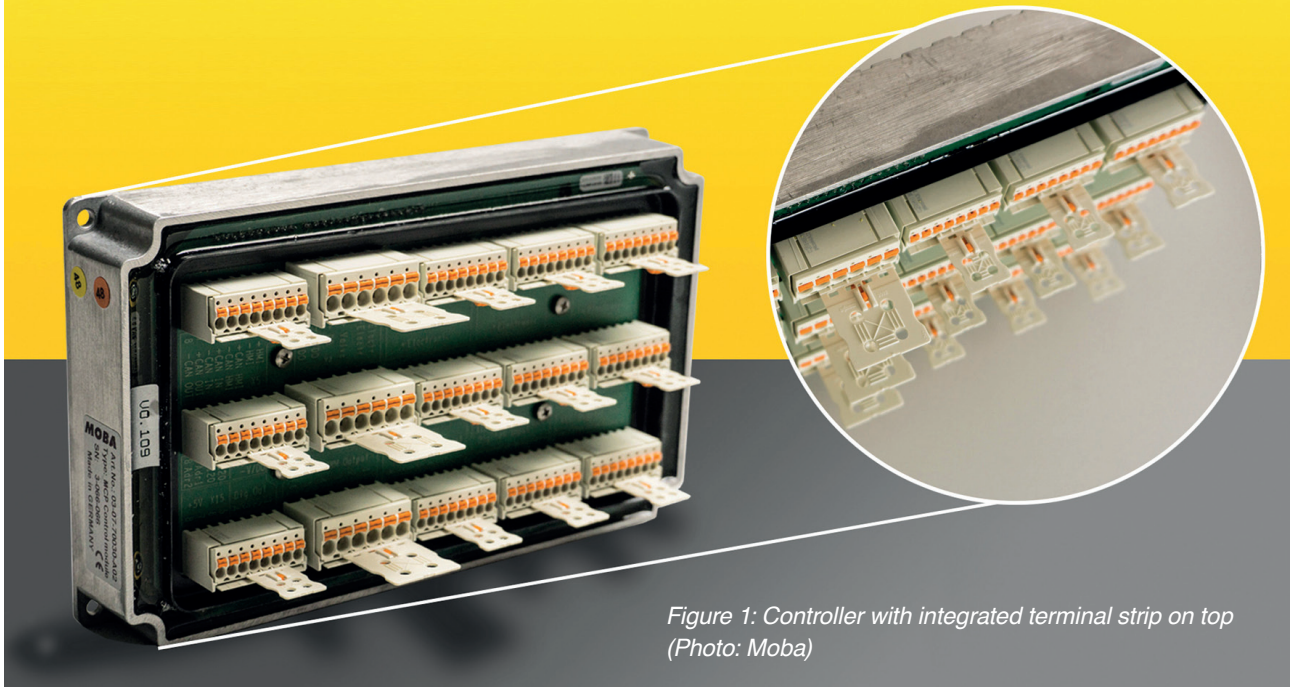

Figure 1: Controller with integrated terminal strip on top (Photo: Moba)

To reduce cabling effort, Moba developed a controller that contains an integrated terminal strip on top. OEMs are now able to wire their machines directly to the top of the controller.

There is one major challenge in installing a mobile controller into a cabinet: Usually, the controller and the terminal strip are placed right next to each other, wired via the controller's plug. This causes quite some cable work. However, for convenience reasons and most importantly for increased service-friendliness, there must be another solution. Moba thus has developed a controller that contains an integrated terminal strip on top (Figure 1). The necessary supplies are available at the inputs and outputs. OEMs are now able to wire their machines directly to the top of the controller. If a controller needs to be maintained or changed, one can simply disconnect the plugs and unwire the controller within minutes. This does not only save a significant amount of cable but also supports an easy exchange. Both, the machine manufacturer's service team and the customer thus save considerable time.

The time-saving benefit is only one aspect that convinced Ruthmann, manufacturer of truck-mounted working platforms, to use the Modular Control Panel MCP for their Steiger-series and models called 'Cockpit'. The integrated cabinet contains the mentioned controllers with a time-efficiently removable plug and clamp combination on top (Figure 2). The concept of structuring and optimizing the installation of the mobile controller is just another measure to guarantee an uncomplicated and time-efficient replacement. It complements the numerous additional developments within the scope of the modular concept that increase service-friendliness, such as a patented contactless joystick.

The MCP allows a variety of combinations of components, such as keypad, joystick and display modules. Furthermore, two gateway controllers are integrated to get a redundancy of the I/O's if needed. In the case of two controllers, the left controller is key element and operates as a gateway of the internal Moba bus to the external machine bus. Also, the left controller administers all Moba components through CANopen, CiA 301 Version 4.02. Both controllers are integrated into the machine bus and communicate via the CANopen protocol. This facilitates an easy integration of the control panel into the machine of any manufacturer. Figure 3 demonstrates the CAN communication of Ruthmann's 'Cockpit', an exemplary MCP with two controllers, two joystick modules, one keypad module, and one display module.

CANopen devices of the same bus must clearly be identifiable with their node number. Since there are MCP variants with two controllers, the controllers must somehow be addressable from the outside. For this reason, two analog pins were added to the hardware of the controller, to be able to influence the node number. The analog pins can have three states (open, high, and low), which enables $3^2 = 9$ different node numbers. All addressings of the controller are displayed in Table 1.

Furthermore, the Moba components obtain electricity through the connection board of the gateway controller. This connection can be operated via the software. By this means, an individual reset of the panel is possible without ▷

Table 1: All addressings of the controller in dependence of the analog pin (Photo: Moba)

Controller	Analog Pin 1	Analog Pin 2	Node number	Bitrate in kbit/s
Left controller	Open	Open	0x32	125
Right controller	Low	Open	0x3C	125
Left controller	Open	Low	0x33	125
Right controller	Low	Low	0x3D	125
Left controller	High	Open	0x32	250
Right controller	High	Low	0x3C	250
Left controller	Low	High	0x33	250
Right controller	High	High	0x3D	250

having to reset the whole machine. This is beneficial for e.g. an exchange of the joysticks. They can be exchanged without disassembling the whole panel. For a subsequent new initialization of the joysticks, a voltage reset is necessary, easily carried out by a controller reset. This works either with a key combination or the object directory. Another special feature is the joystick configuration. It is a well-known problem that each machine has another control, depending on the manufacturer. For operators it thus is a challenge to adapt to the control every time a new machine needs to be operated, especially when renting an aerial working platform. For this reason, the micro-controller has a setting that allows to change the logic of the joystick signals. These signals are correspondingly forwarded to the machine control.

This adjustment option is called 'joystick permutation'. It can be carried out with a key combination or via the CANopen object directory. In total, there are 384 different joystick permutations based on two joysticks. So far, there have been implemented 192 into the controller. The other 192, however, can be implemented anytime if necessary.

Controller features

Beside its function as the administrator of several Moba components, the controller can be used as a plain I/O device. It has 16 digital and 8 analog inputs. The switching level of the digital inputs is dependent on the present operating voltage and switches at 0,65 U_b to 0,75 U_b, while U_b is the operating voltage. The digital inputs can be configured as NPN or PNP input through transistors, which are connected to the micro-controller. For the user, it thus is possible to individually configure each digital input with the CANopen object directory. The evaluated digital inputs are subsequently sent via defined PDOs. Three of the digital inputs can optionally be used as a frequency input. The ▷

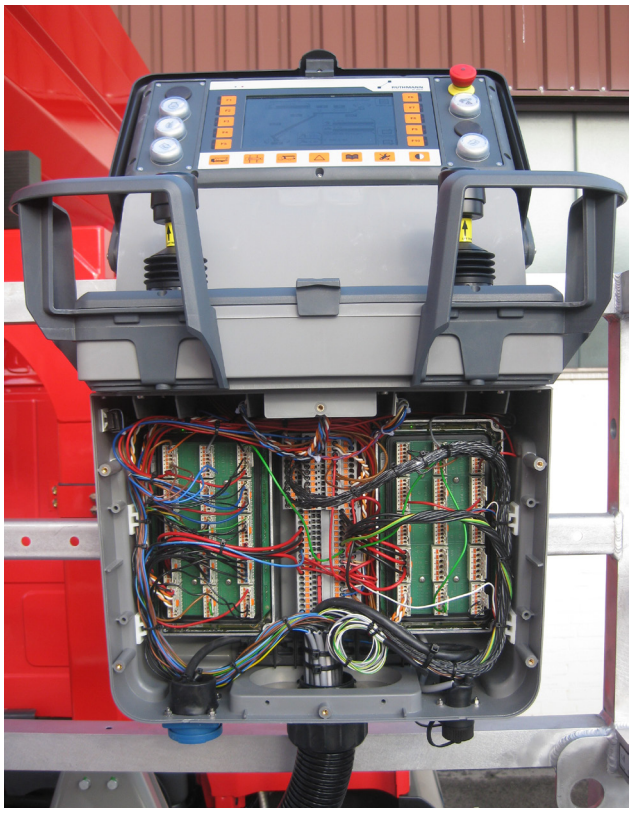

Figure 2: Wiring of the two controllers of Ruthmann's Cockpit (Photo: Moba)

user thus has the possibility to measure a frequency range of 0 kHz to 30 kHz with an accuracy of ±0,2 %. The analog inputs contain the operating modes 0 V to 5 V voltage input, 0 V to 10 V voltage input, 0 mA to 20 mA current input, or 4 mA to 20 mA current input.

Similar to the configuration of the digital inputs, each analog input can individually be configured via the CANopen object directory (index 2015_h). During the conversion from analog to digital, the micro-controller has a resolution of 12 bit. For the accuracy to be at least ±1 % FS (Full-scale), each analog input is calibrated by the in-house test system. The calibrated values are subsequently saved into the EEPROM, which is situated at the controller. The controller has four digital outputs, which are checked through a feedback to the controller, and additional six PWM outputs. For safety reasons, all outputs are connected via an AND gate. The AND gate does only connect through if the voltage supply of the controller is stable and the controller is in faultless operation. If a fault is detected by the software, the micro-controller switches off the AND gate through a control line. Each PWM output contains a control circuit (Figure 4), which enables the current control of the PWM outputs. Via the CANopen object directory it is also possible to deactivate the current control in order to directly adjust the pulse-pause ratio. Also, it is possible to individually adjust the PWM frequency (200 Hz to 1000 Hz).

The controller sends the following PDOs: the evaluated analog inputs with 12-bit resolution, digital input level or frequency, the keys of the HMI keypad and the current position of the joysticks, and a PDO that forwards data from the display. It receives the following PDOs: the current set point for every PWM output, the condition of the digital outputs, the LED actuation of the HMI keypad and the joysticks, and a PDO to forward data to the display.

With the CANopen object directory, the following configurations are possible:

- Individually configuring digital inputs as NPN or PNP inputs,
- Individually configuring analog inputs for four operating modes,
- Saving the complete object directory in EEPROM - this special feature has retrospectively been implemented to avoid an adjustment of the complete object directory when restarting,
- Flexibly adjusting the PWM frequency,
- PWM outputs with current control or via the direct adjustment of the pulse-pause ratio,
- Button-pressed-time to get into special operator interaction,
- Reading the software version of the Moba components.

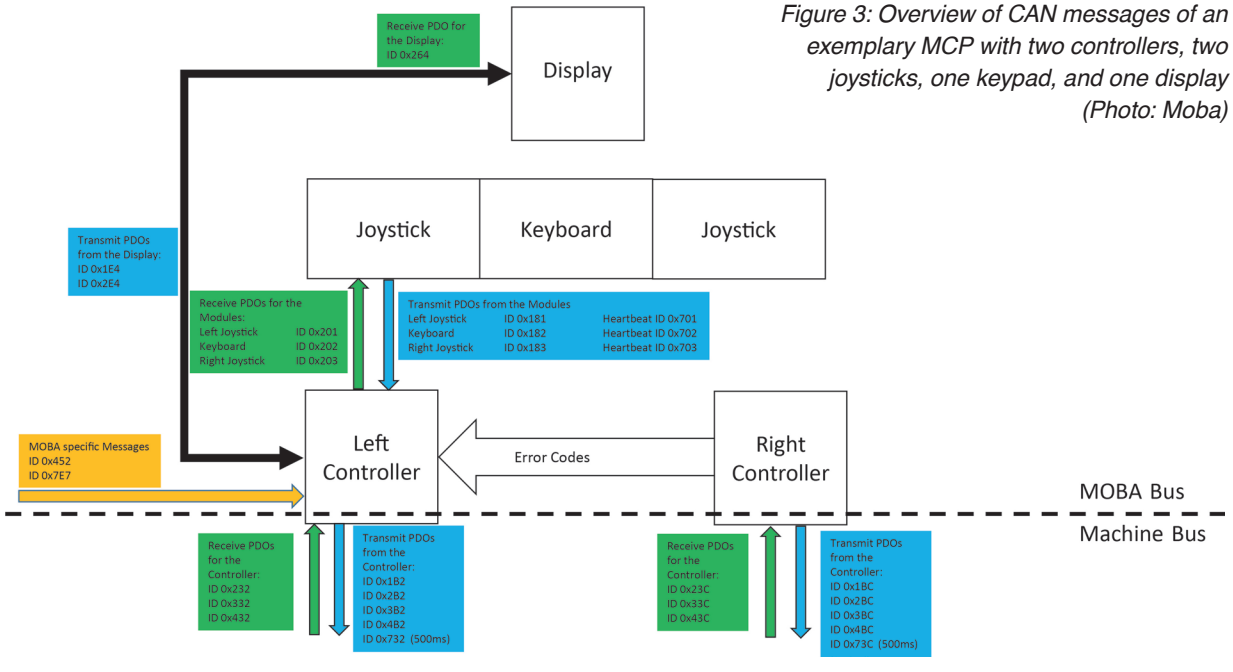

Figure 3: Overview of CAN messages of an exemplary MCP with two controllers, two joysticks, one keypad, and one display (Photo: Moba)

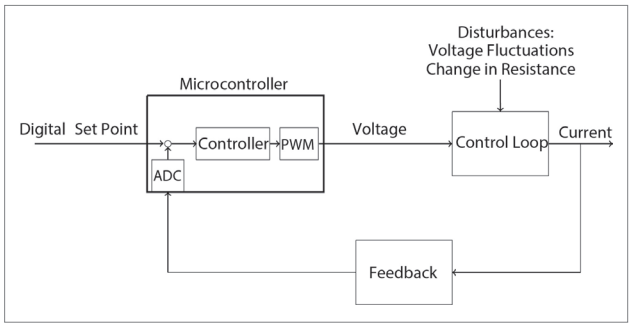

Figure 4: Design of the control structure in the controller (Photo: Moba)

Conclusion

All things considered, the described controller is the right choice for a space-optimized cabinet, which does not allow too much cable work and thus requires special terminal strips. Furthermore, by saving considerable amounts of clamps and cables, the associated wiring work is omitted, thereby reducing wiring faults to a minimum. The possibility of a time-efficient exchange is an extra advantage for the machine manufacturer's service team, saving considerable resources.

Author

Sebastian Schneider
Moba Mobile Automation
sschneider@moba.de
www.moba.de

CAN in Automation

The non-profit CiA organization promotes CAN and CAN FD, develops CAN FD recommendations and CANopen specifications, and supports other CAN-based higher-layer protocols.

Join the community!

- Initiate and influence CiA specifications
- Receive information on new CAN technology and market trends
- Have access to all CiA technical documents also in work draft status
- Participate in joint marketing activities
- Exchange knowledge and experience with other CiA members
- Get the CANopen vendor-ID free-of-charge
- Get credits on CANopen product certifications
- Get credits on CiA training and education events
- Benefit from social networking with other CiA members
- Get credits on advertisements in CiA publications

For more details please contact CiA office at headquarters@can-cia.org

www.can-cia.org