Instruction manual
ModuleControl Closed Loop

Software Tool for Test and Parameterization of Closed Loop Motor Controller

commonplace robotics GmbH

Version 04.012
June 9, 2023

Contents

1 Introduction

1.1 Contact

Commonplace Robotics GmbH
Gewerbepark 9-11
Im Innovationsforum
D-49143 Bissendorf

Tel.: +49(0)5402 / 968929-0
Fax: +49(0)5402 / 968929-9
E-Mail: info@commonplacerobotics.de

Internet: https://cpr-robots.com

1.2 Intended Use

The intended use of the product is defined by the uses within the defined limits from the technical data. The permissible electrical parameters and the defined permissible ambient conditions must be observed in particular. These are specified in more detail later in this manual.
The intended use for this product can be found in the following section 3.

1.3 Target Group and Qualification

The product and this documentation are intended for technically trained professionals such as:

- development engineers
- plant designers
- assemblers/service personnel
- application engineers

Installation, commissioning, as well as operation is only allowed by qualified personnel. These are persons who meet all the following requirements.

- have appropriate training and experience in handling motors and their control.
- know and understand the contents of this technical manual.
- know the applicable regulations

1.4 Symbols Used

All notes in this document follow a consistent form and are structured according to the following classes.

The WARNING notice alerts the reader to possible dangerous situations.
Disregarding a warning can **possibly** result in moderate injury to the user.

- Within a warning, this describes ways to avoid hazards.

This note indicates possible incorrect operation of the product.
Failure to comply with this notice may **possibly** result in damage to this product or other products.

1.5 Product Safety

The following EU directives were observed:

- RoHS-Directive (2011/65/EU, 2015/863/EU)
- EMV-Directive (2014/30/EU)

1.6 Regulations

In addition to this technical manual, operation, commissioning is subject to the applicable local regulations, such as:

- Accident prevention regulations
- Local regulations for occupational safety

2 Operation with Module Control

The Module Control software provides various regulation and control methods. A selection is made via the start tab in Module Control, the desired procedure can be selected via the checkboxes to the right of the rotary control.

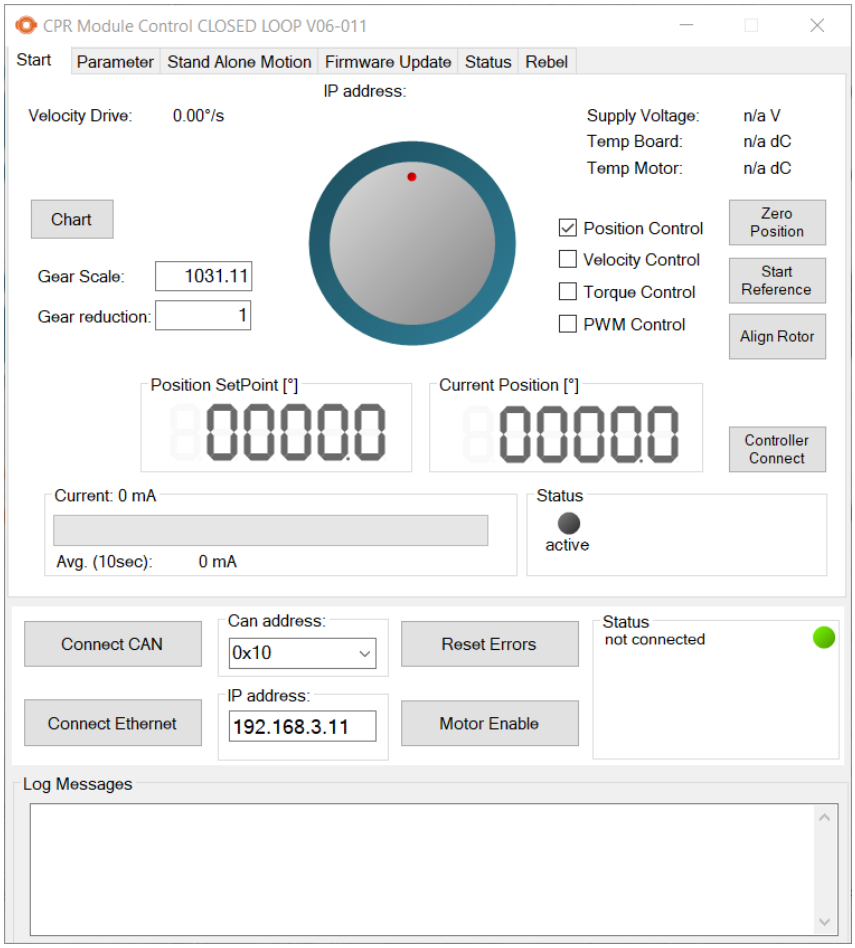

Figure 1: Start tab Module Control

2.1 Position Control

The mode "Position Control" sets the board in position control, a setpoint setting is made here via the rotary control from the PC or via the tab "Stand Alone Motion".

2.2 Velocity Control

The mode "Velocity Control" sets the board in velocity control, a setpoint setting is done via the rotary control from the PC. For a sensible setpoint setting, the gear ratio must be specified in the "Gear reduction" field. The setting is done in $\frac{degrees}{s}$, the speed refers to the output speed.

2.3 Torque Control

The mode "Torque Control" sets the board in torque control, a setpoint is set via the rotary control from the PC. The controlled torque represents the internal motor torque. When using the FOC, this

represents the requirement for the torque-forming component.

Attention to load fluctuations
In this mode, the motor generates a constant torque; in load-free operation, this leads to extreme speeds. These speeds can destroy the motor.

2.4 weitere Funktionen

Module Control provides the user with information beyond the functional scope of the robot controller, also various functions of the axes can be triggered.

2.4.1 Anzeige Umgebungsdaten

In the upper right corner of the start tab there are current measured values of the board. Here the focus is on the environmental data of the board. These data are the supply voltage, the temperature of the board and the motor. The display n/a shows the user that no measurement has been performed yet and that the motor controller does not have the corresponding sensor.

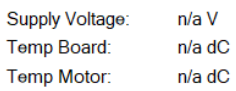

Figure 2: Starttab Environmental parameters

2.4.2 Special board functions

For the operation of the axes in a robot application, various steps are required to put the axis into an operational mode. These functions can also be triggered for test purposes.
A first disesr function is to set the position of the axis at the current position to 0. The Zero Position button is available for this purpose.
The referencing of the axis can be started with Start Reference.
In closed loop mode the motor controllers must know the exact rotor position in reference to the stator field. The measurement of the offset can be triggered by the Align Rotor button.

Figure 3: Starttab Special functions

3 Module Control Tabs

3.1 Parameter

The parameter tab is used to manage the individual parameters on the module. When Module Control is loaded, it generates a sample parameter set. In most cases this parameter set does not fit to the used board and motor type. Below the table bar there are five buttons in the software, the left three buttons cause interactions with the connected board. The right positioned areas allow the loading of stored configurations, as well as the saving of the current configuration from Module Control. With the button "Read from Board" it is possible to read the current configuration from the board. By means of "Save Changes" only changed parameters can be transferred. All parameters can be saved via the area "Save All".

Restart required
A restart of the motor controller is necessary to accept the parameters. This does not apply to the control parameters.

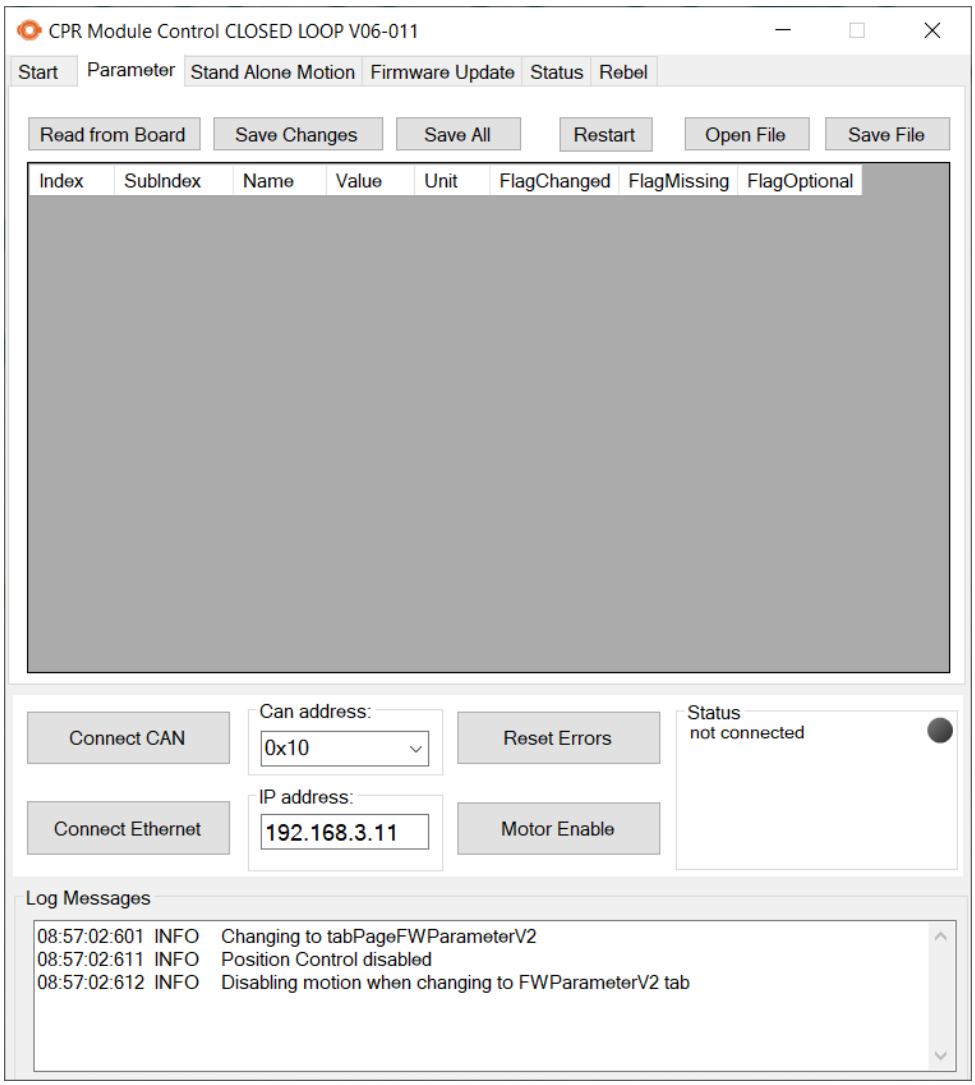

Figure 4: Module Control Parameter Tab

3.2 Parameters

This chapter describes the parameter interface for motor controllers from CPR.

Danger to life!
Changes to the parameter sets may only be carried out by trained personnel. Changing the parameters can override safety interrogations and lead to danger for persons and equipment! High currents can cause fires!.

The motor controllers use the CPR parameter interface in the 2nd version. The parameters are addressed via an index (8bit) [0-255] and a subindex (8bit) [0-255]. The index carries information about the assignment of the parameters to individual system modules. The index contains the following modules:

Index	Beschreibung
0	Board parameters
1	Motor parameters
2	Axis parameters
3	Control parameters
4	Communication parameters

Table 2: Parameter groups

Index 0 board parameters

Idx	SIdx	Name	Unit	Default value
0	**0**	**Serial no.**		
Description:		Serial number of the product. Used to identify the date of manufacture.		
0	**1**	**Firmwareversion**		
Description:		Firmware version number to identify the current software version.		
0	**2**	**Hardwareno.**		
Description:		Hardware version number to identify the hardware configuration used.		
0	**3**	**min. supply Voltage**	**V**	$V_{cc} - 2V$
Description:		Minimum permissible supply voltage. The minimum supply voltage should be approx. 2V below the nominal voltage. If the supply voltage falls below this limit, the board issues an error message.		
0	**4**	**max. Boardtemp.**	**m°C**	**70000**
Description:		Maximum permissible board temperature		

Table 3: Board parameters

Index 1 motor parameters

Idx	SIdx	Name	Unit	Default value
1	**0**	**Encoder Tics**	**1/Rev**	**4096**
Description:		Number of encoder pulses per revolution according to data sheet.		
1	**1**	**No. of Polepairs**		**7**
Description:		Number of pole pairs in the motor according to the data sheet.		
1	**4**	**max. RPM**	**RPM**	**0**
Description:		Maximum rotational speed of the motor. Setting is made according to the data sheet of the motor or on the basis of subsequent components. The value 0 cancels the limitation.		
1	**5**	**max. Motortemp.**	**m°C**	**0**
Description:		Maximum temperature in the motor. The measurement is performed via an optional sensor. The value 0 deactivates the query.		
1	**6**	**max. Current**	**mA**	**6000**
Description:		Maximum motor current according to data sheet.		
1	**7**	**StartUpMethod**		**1**
Description:		Method used to set up the motor when starting the controller. with the automatic start options, the motor starts IPO afterwards. 0. Openloop 1. Closedloop with rotor alignment 2. Closedloop with index search 3. Closedloop for DC Motor 4. Closedloop with rotor alignment and check for free rotation 10. Closedloop with rotor alignment and autostart		
1	**9**	**EncoderInverted**	**boolean**	**0**
Description:		Setting for the direction of rotation of the encoder. The direction of rotation of the signals at the input of the controller must be clockwise according to DIN EN 60034-8. After a change, the controller must be restarted. 0. Encoder not inverted 1. Encoder inverted		
1	**10**	**MotorInverted**	**boolean**	**0**

Idx	SIdx	Name	Unit	Default value
Description:		The direction of rotation of the motor must be clockwise according to DIN EN 60034-8. If the setting is incorrect, the motor does not rotate. Only the motor current increases. 0. Motor not inverted 1. Motor inverted		
1	**11**	**OpenLoopCurrent**	**mA**	**2000**
Description:		Setpoint current for the openloop control of the motor		
1	**12**	**OpenLoopCurrentStandstill**	**mA**	**1000**
Description:		Setpoint current for the openloop control at standstill.		
1	**13**	**Calibration Current**	**mA**	**1000**
Description:		Set current for rotor alignment.		
1	**14**	**Calibration Time**	**ms**	**10**
Description:		Duration for the alignment of the rotor		

Table 4: Motor parameters

Index 2 Axis parameters

Idx	SIdx	Name	Unit	Default value
2	**0**	**Reserved**		
Description:		Reserved for future use.		
2	**1**	**ReferencingType**		**1**
Description:		Selection for the referencing type. 0. no referencing current position = 0 1. Linear motion 2. Sinusoidal movement (Sinusoidal search for the sensor.) 3. Half disks (referencing method for axes equipped with a half disk, e.g. Robolink DP) 4. Gearencoder (only Rebel)		
2	**2**	**ReferencingOffset**	**Tics**	**0**
Description:		Offset for the axis position after referencing.		
2	**3**	**ReferencingSpeed**	**RPM**	**10**
Description:		Speed for approaching the sensor. If the axis is referenced in the wrong direction, this parameter can be set to negative.		
2	**4**	**ReferencingSpeedSlow**	**RPM**	**2**
Description:		Speed for fine positioning of the axis during homing. If the axis is referenced in the wrong direction, this parameter can be set to negative.		
2	**5**	**ReferencingSwitchType**		**0**
Description:		Type of the reference sensor. 0. n.C. 1. n.O.		
2	**6**	**max. Positionlag**	**Tics**	**10000**
Description:		Permissible position error of the axis. With fast movements, the axis runs after the position setpoint. If the limit value is exceeded, the axis stops and an error message appears. If the value is set to 0, there is no monitoring.		
2	**7**	**Break Type**	[0 – 2]	**0**

Idx	SIdx	Name	Unit	Default value
Description:		Parameter for activating a brake on the robot axis. If the robot has a holding brake, which should be controlled by the motor controller, this value must be set. The brakes are released when the axes are activated. 0. no brake 1. friction brake 2. blocking brake In the blocking brake mode, a free-positioning movement occurs. A blocking brake means a pin or similar, which blocks the rotor. A friction brake describes a disc brake.		
2	**8**	**Break PWM High**	**% V_{cc}**	**100**
Description:		If a brake is configured on the axis, this parameter specifies the PWM value for releasing the brake.		
2	**9**	**Break PWM Low**	**% V_{cc}**	**50**
Description:		Voltage to hold the brake after releasing the brake, the motor controller lowers the output voltage to the specified value.		
2	**10**	**IPO Position**	**Tics**	**200000**
Description:		Positive position value for the IPO. In standalone mode, the IPO moves this value symmetrically around the zero point. Thus from -IPO position to IPO position.		
2	**11**	**IPO Velocity**	**Tics/10ms**	**200**
Description:		Speed for IPO mode in standalone operation,		
2	**12**	**Axis inverted**	**boolean**	**0**
Description:		Changes the direction of the axis		
2	**13**	**Gear ratio**		**0**
Description:		Gear ratio of the gear unit. For i=1:50 correspondingly 50. Only integer values are possible.		

Table 5: Axis parameters

Index 3 Control parameters

Idx	SIdx	Name	Unit	Default value
3	**0**	**Position P**		
Description:		P component for position control.		
3	**1**	**Position I**		**0**
Description:		I component for position control.		
3	**3**	**Position P scale**		
Description:		Scaling of the P component by 2^x		
3	**4**	**Position min.**	**RPM**	
Description:		minimum limitation for the output of the position control.		
3	**5**	**Position max.**	**RPM**	
Description:		maximum limitation for the output of the position control.		
3	**7**	**Velocity P**		
Description:		P component for speed control.		
3	**8**	**Velocity I**		
Description:		I portion for speed control.		
3	**10**	**Velocity P scale**		
Description:		Scaling of the P component in 2^x		
3	**11**	**Velocity min.**		**-1024**
Description:		minimum limitation for the output of the speed control.		
3	**12**	**Velocity max.**		**1024**
Description:		maximum limitation for the output of the speed control.		
3	**14**	**DQ-P**		
Description:		P component for DQ control		
3	**15**	**DQ-I**		
Description:		I component for DQ control		
3	**17**	**DQ back calc**		
Description:		Backcalculation factor for DQ controller		
3	**18**	**DQ-min.**		**-1024**
Description:		minimum limitation for the output of the DQ control		
3	**19**	**DQ-max.**		**1024**
Description:		maximum limitation for the output of the DQ control		
3	**20**	**Openloop P**	1/100	
Description:		P component for Openloop current control.		
3	**21**	**Openloop I**	1/100	
Description:		I component for Openloop current control.		
3	**22**	**Openloop D**	1/100	
Description:		D component for Openloop current control.		
3	**23**	**Openloop AntiWindUp**	1/100	

Idx	SIdx	Name	Unit	Default value
Description:		AntiWindUp for Openloop current control		
3	**24**	**Openloop min.**		
Description:		minimum limitation for the output of the Openloop current control.		
3	**25**	**Openloop max.**		
Description:		maximum limitation for the output of the Openloop current control.		

Table 6: Control parameters

Index 4 Communication parameters

Idx	SIdx	Name	Unit	Default value
4	**0**	**CAN max. missed Coms**		**100**
Description:		maximum number of failed communication attempts on the CAN bus. Exceeding the value leads to the motor controller being switched off.		
4	**1**	**CAN ID Source**		**1**
Description:		Source for the CAN ID: 1. hardware jumper 2. parameter set		
4	**2**	**CAN ID**		**16**
Description:		CAN ID for the controller		
4	**3**	**SPI Active**	**boolean**	**0**
Description:		Enable SPI communication		

Table 7: Communication parameters

3.3 Stand Alone Motion

In Stand Alone Motion mode, the board independently drives an oscillating motion between two defined points. The PC can be removed in this mode, so test stands can be easily set up. To use the Stand Alone Motion, all error messages must be acknowledged and the motor must be switched on. This state is indicated by the status "no error". Then it is possible to switch to the "Stand Alone Motion" tab. The definition of the positions is done in encoder tics, furthermore it is possible to specify the speed and a desired acceleration. The button "Start" starts the execution of the motion, "Stop" stops the current motion. The parameters are updated by pressing "Start" again. The Stand Alone mode allows the disconnection of the CAN connection.

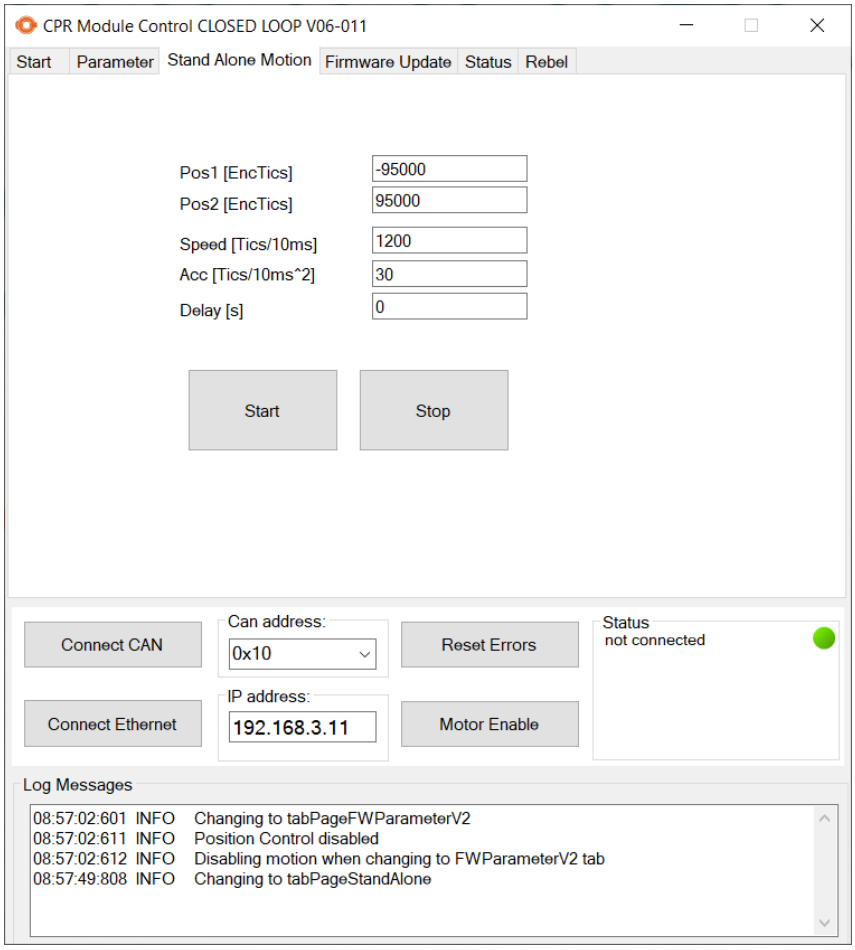

Figure 5: Stand-Alone-Motion Module Control

3.4 Firmware Update

Module Control allows an update of the firmware on the connected closed loop controller. This allows new features to be loaded or errors to be corrected. The firmware update tab is used for this purpose.

Parameter Backup Before starting the Firmware Update the parameter have to be backed up.

The motor controller has a short time window after startup in which a firmware update can be activated.
The controllers can be updated to a new version by the following procedure. The updater takes over all functions independently and carries out error handling independently if necessary.

- First read the instructions at the top of the page.
- In the "Firmware File" area, select the desired firmware file.
- In the "Parameter" area, select the desired handling of the axis parameters. You can backup the parameters by default. Below you can select whether the old parameters should be taken over or new parameters from a file should be used. If you decide to use a file, you must select it.
- The area "Write to Device" allows the selection of the CAN-IDs for the update. Thus it is possible to update the complete robot in one pass.
- A click on "Write to Modules" starts the process. The progress and status of the individual mod-

ules can be tracked in the status area.

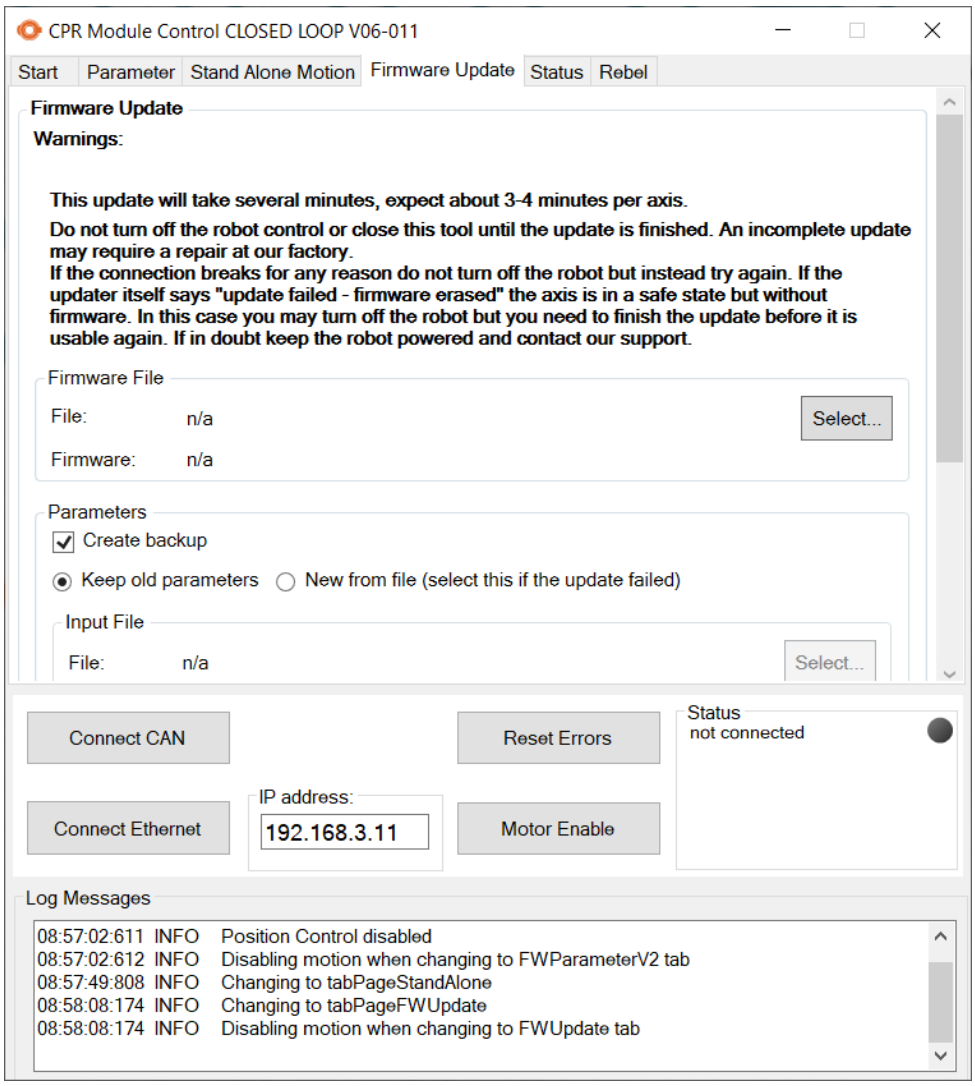

Figure 6: Module Control Firmware Update Tab

3.5 Status

The status tab provides further information about the axis. In this tab, the errors can be viewed individually, the inputs and outputs of the axis, and internal states can be evaluated. Furthermore, the firmware version can be read and outputs on the board can also be set.

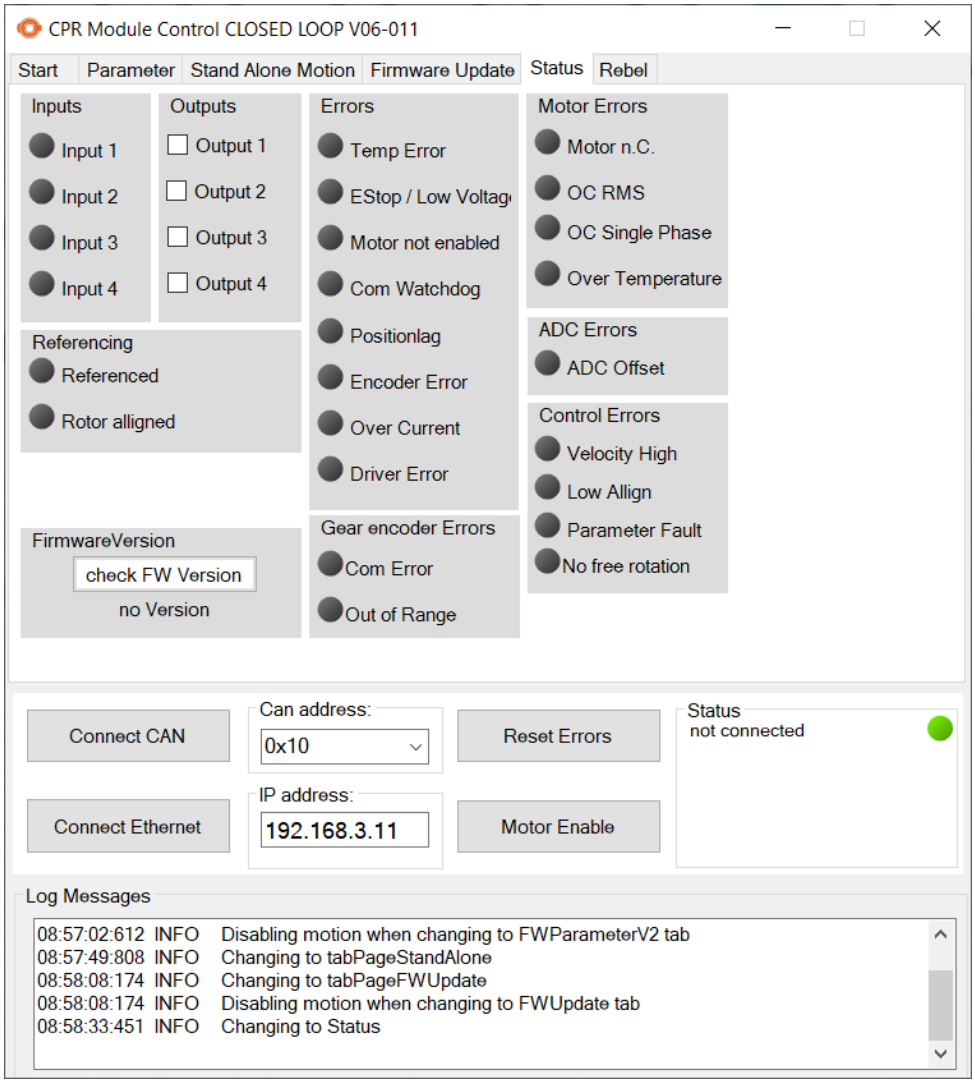

Figure 7: Module Control Status Tab

3.6 Absolute Encoder of the igus Rebel

For integrated closedloop controllers in the igus Rebel robot arm, a separate page is available in ModuleControl for all special functions of these motor controllers. The special functions include parameterizing the output encoders, calibrating them and checking the calibration data. The display for the encoder position is updated once per second. For this the board must be parameterized accordingly before.

The calibration of the rebel axes is fully automated, the process can be started via the "Start Calibration" button. The axis first moves to -180 degrees and then learns 35 points in 10 degree steps. For calibration, the axis must be load-free and rotatable through 360 degrees.

Module Control also checks the calibration automatically. Module Control displays the data in the window next to the calibration buttons. If a data set is faulty, the window turns red. For the simple recognition of the errors Module Control writes the error message under the line with the faulty data.

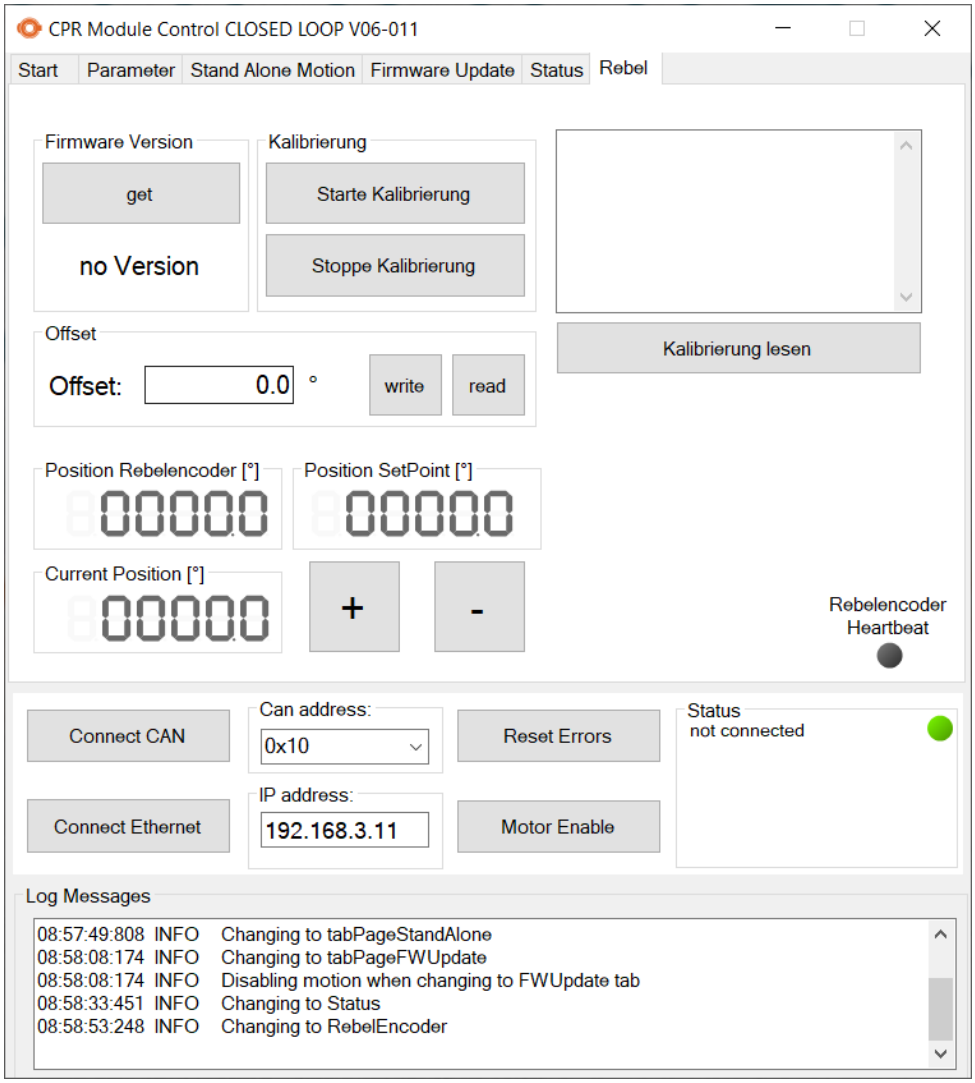

Figure 8: Module Control Rebel Tab