

200A DC brushed motor PWM speed controller

DATASHEET FOR: Motor PWM FR200200 v1.0 200V version

Revision:001

TECHNICAL SPECIFICATIONS:

| | |
|----------------------|---|
| Supply voltage: | 18-200V (180V recommended absolute maximum) |
| Output current: | 350A peak 200A continuous at 25°C additional heatsink may needed! |
| Minimal duty cycle: | 0% |
| Maximal duty cycle: | 100% |
| Protections: | Over current protection, Output short protection with minimal load inductance Over heating protection |
| Switching frequency: | 18kHz |
| Power connection: | M6 on 10x3mm copper rails |
| Dimensions: | 270 x 145 x 40 mm |

PIN DESCRIPTION:

Mode switch settings with red DIP switch:

These settings are only monitored when the controller is turning on. These settings can not be changed when the controller is already running.

10FF-20FF: Hall throttle or potentiometer mode.

Use 0-5V signal on the Speed input to change the output duty cycle. It can be a potentiometer, hall throttle or other analog 0-5V signal. Use the direction switch on Forward Reverse inputs to switch directions.

10FF-20N: Joystick mode.

Use potentiometer or 0-5V analoge signal on the Speed input and change both the output duty cycle and output directions. Center potentiometer generates zero ouput. Turn left or right to increase the output in forward or reverse.

10N-20FF: 0-100% PWM input mode

Use 3.3-10V PWM signal on PWM input to change the output duty cycle and use the Forward Reverse inputs to switch directions. If needed optocoupler isolators can be used between the motor controller board and the PWM signal source.

10N-20N: RC-receiver PWM mode

Use 3.3-10V PWM signal on PWM input to change both the output duty cycle and output directions. If needed optocoupler isolator can be used between the motor controller board and the PWM signal source.

30FF: Peak current turned off

Current limit settings works as normal reaching the level set by current limit potentiometer. Output current can not be higher than the current limit.

30N: Peak current on

Output current can be doubled for a short (5-20sec) period of time the controller allows typically +30-100% more output current depending on the temperature and the lenght of the peak load. This can allow higher extra acceleration in the motor.

40N: RS232, UART access with simple commands

(more infomation in the Simple Mode serial comunication sheet)

40FF: RS232, USART access with advanced commands

(more information in the Advanced Mode serial communication sheet)

50FF: Manual regeneration mode.

Manual regen (regen inputpin can accept voltagebeteen 0-5V. Voltage higher than 0.15V activates the output brake and regeneration. Mamimum brake force adjusted by P3 potentiometer.

50N: Automatic regeneration mode

Brake input pin must be connected to +5V pin. With Automatic regen mode regeneration activates automatically when motor speed becomes higher than the output voltage. The maximal regeneration current adjustable with P3 potentiometer.

60FF: Normal PWM mode.

Controller output behaves normally depending on the controll speed signal or PWM signal on PWM input.

60N: Supply compensation and speed regulation mode

Controller output will be regulated when supply voltage level changes. It keeps the output voltage and DC motor speed stable even if the supply voltage changes. P4 potentiometer (top speed) must be set. P4 potentiometer set the maximum relative output voltage what the controller can generate when maximum input controll voltage applied.

Motor+: *The motor negative connection.*
Motor-: *The motor positive connection.*
Suppy+: *The positive power supply connection*
Suppy-: *The negative supply connection.*

Speed GND: *Ground for the speed potentiometer*

Speed:

Speed potentiometer input. Possible to use 1-10 kOhm linear potentiometer or 5V throttle or 0-5V controll voltage. It behaves differently depending which operation mode is active.

- *Hall throttle mode: 0.8V or less = 0% output duty cycle
4.2V or higher = 100% output duty cycle*
- *Potentiometer mode: 0-5V = 0-100% output duty cycle*

**USART mode: Optional Analog input measuring external signal.*

+5V:

+5V reference voltage for the speed potentiometer and for small external circuits. Max load current 50mA.

DIR input: *Input for the direction signal. Use this to reverse the output voltage direction. Empty makes forward. Connecting to GND makes reverse the output. Only operates if throttle mode or 0-100% PWM mode is active.*

BRK/PWM input:

- *Hall throttle or potentiometer mode: It behaves as brake switch input. It brakes the output to 0V when Brake input connected to S-GND. It activates the current regeneration from the motor.*
- *0-100% PWM input mode: You can use your own PWM controll signal from your PLC or microprocessor. The minimum controll PWM frequency is 100Hz. The step resolution 1us. The acceptable voltage level: 3.3-10V. 0% PWM (low level) generates 100% output. 100% PWM (high level input) generates 0% output.*
- *RC-receiver PWM mode: PWM input for RC receiver or other PWM source
1.5msec-2.5msec pulse: 0-100% output duty*
- *Possible function to measure PWM, logical and pulse in USART mode*

Eenable input:

Enable input is open or high level: Controller output is disabled

Enable input connected to the Speed GND: Controller output is enabled.

RX/TX serial communication:

Serial communication is availale in all operation modes (potentiometet,joysick, PWM input and RC receiver mode). It is possible to read or set additional parameters in the controller while it is in any operation mode.Other possible option is to controll the the controller with only serial communication commands. The way of communicaton can be Simple mode or Advanced mode. (For information use theserial comunication sheets). The standard serial inputs are not isolated! It accepts 3.3V or 5V TTL level. If needed use the optional TTL or RS232 isolator.

Controll potentiometers:

P1: Current limit potentiometer 0-200A from CCW to CW.

P2: Acceleration limit potentiometer 0-41sec

P3: Regenerative current limit 0-200A from CCW to CW.

P4: Top speed level when controller in "Supply compensation and speed regulation" mode. 0-200V maximum output voltage from CCW to CC.

Example: 72V supply ;0-5V speed signal; P4:50%. In this case output will change between 0-36V when speed voltage changes. With 5V speed signal output remains stable 36V even if supply voltage changes between 36-200V.

LED light functions:

-2 blinks at starting up.

-At "potentiometer mode" operation when both Forward and Reverse inputs are open.

-Output current limitation is active. Output current reached the current limitation level.

-Over voltage protection. Input voltage higher than the allowed maximum level.

-Under voltage protection. Input voltage lower than the minimal input voltage

-Over temperature protection is active. The temperature sensor reaching 65 °C temperature.

-While UART communication. A short blink at every sent or received serial communication command.

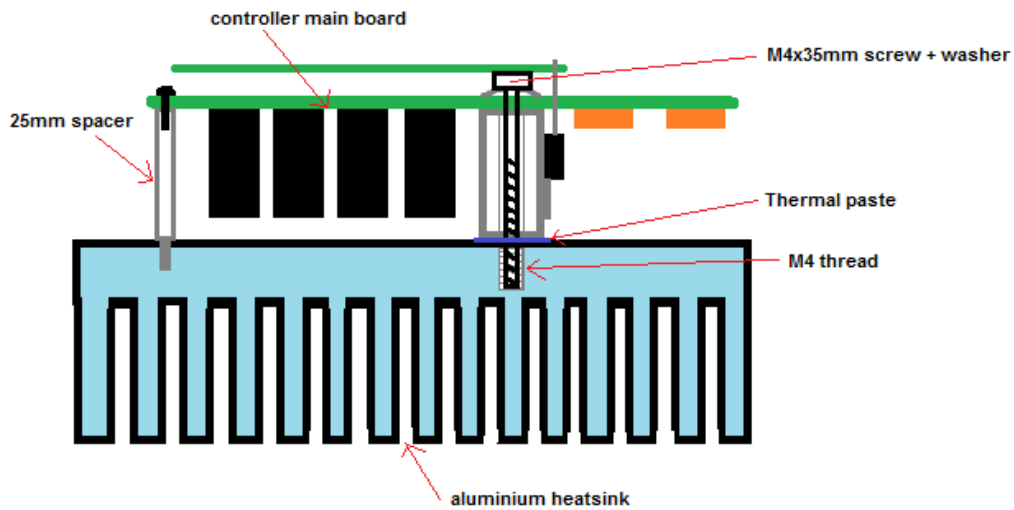
Instructions for the heatsink:

For the maximum power the controller needs an additional heatsink or aluminium case to cool the power transistors and the aluminium base. The dimensions of the heatsink can change depending on the supply voltage output load current the ambient temperature and air convection. Under 50A no additional heatsink is needed maybe a small fan. Up to 100A use the 200x 100 x 10mm heatsink touched to the aluminium base. Use the 25mm spacers to hold the heatsink on the bottom side of the board. With maximal load use 150x100x40mm heatsink or fan cooling.

Keep clean the power transistors are around the legs any small metal , copper or aluminium sliver as a foreign material can cause short between the power transistor .

Follow the diagram how to attach the heatsink. Make four M4 threads on the heatsink for fixing. Apply thin layer of thermal paste between the heatsink and the controller's aluminium base. Use the additional screws+washers to fix the controller on the heatsink.

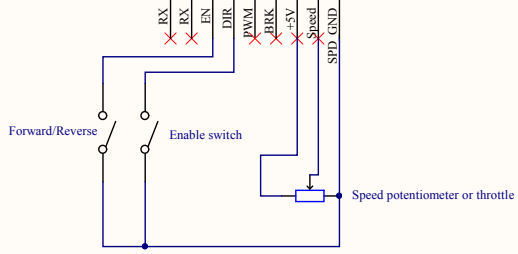
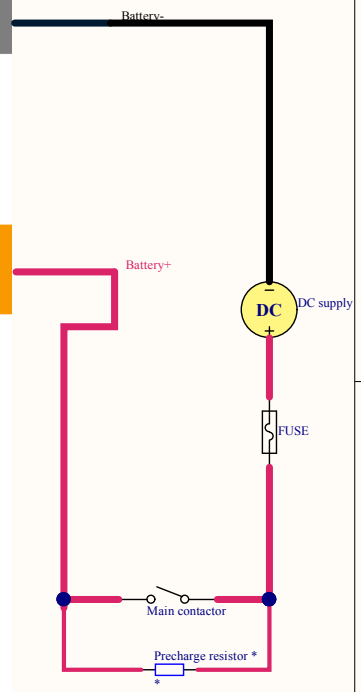
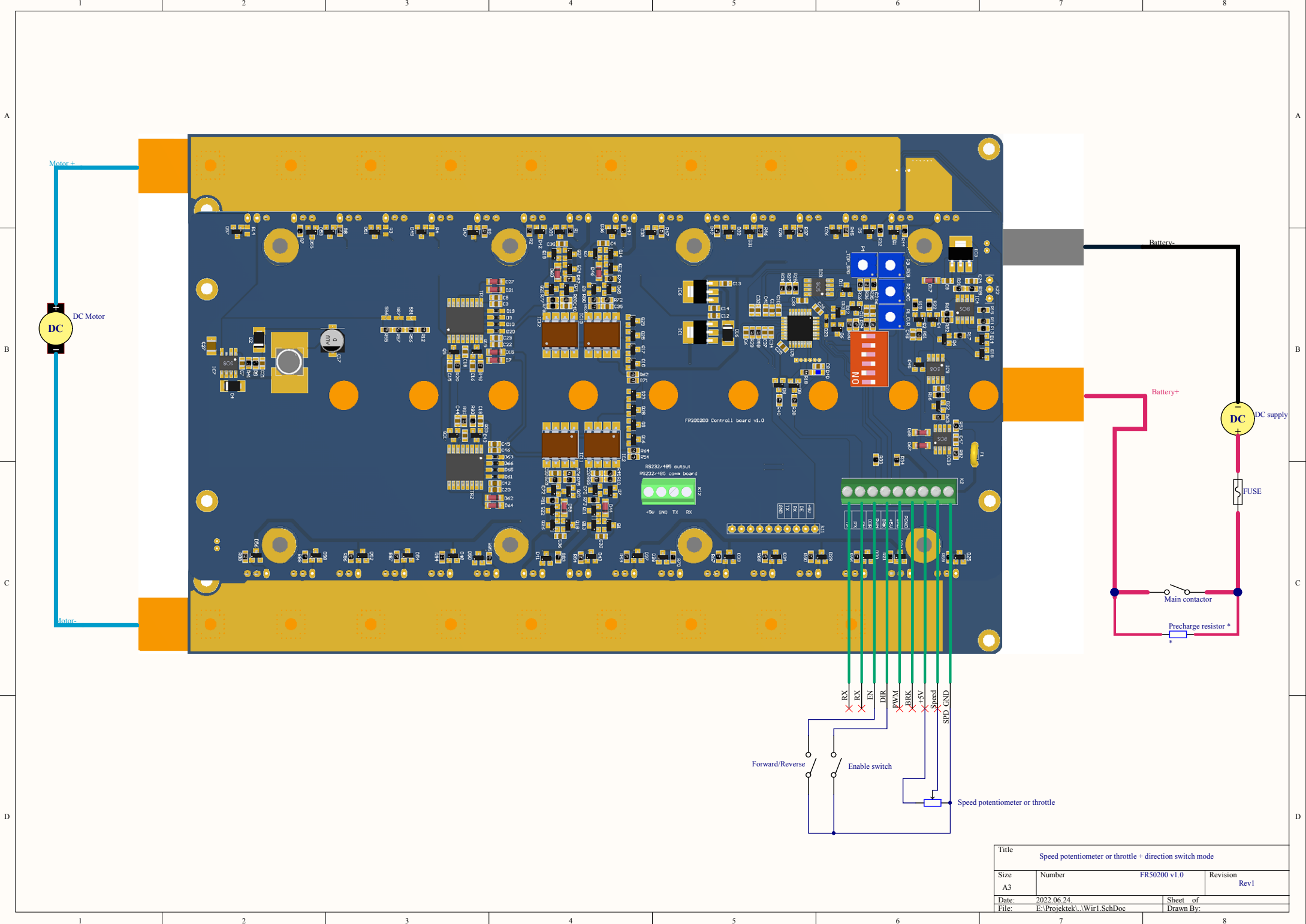
If you want to isolate the heatsink from the main GND you can do that using an isolator silicon between the heatsink and the aluminium base + pull heatshrink tubes on the M4 heatsink fixing screws to keep the screws and the aluminium base isolated inside the hole of the alu base.



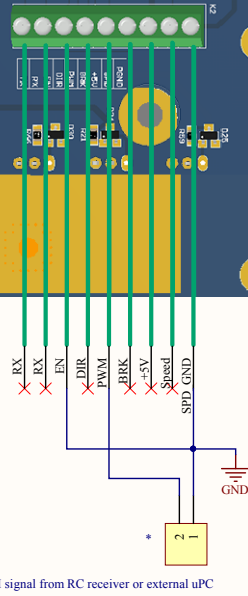
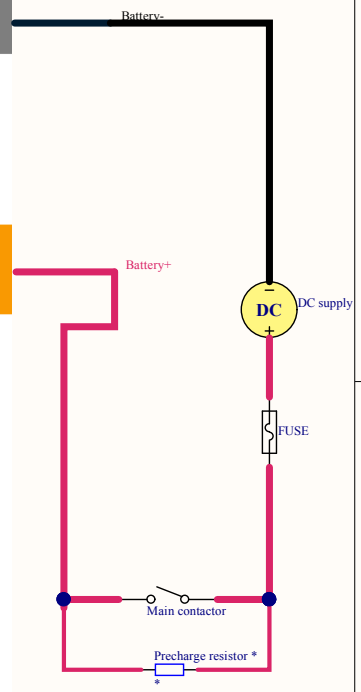
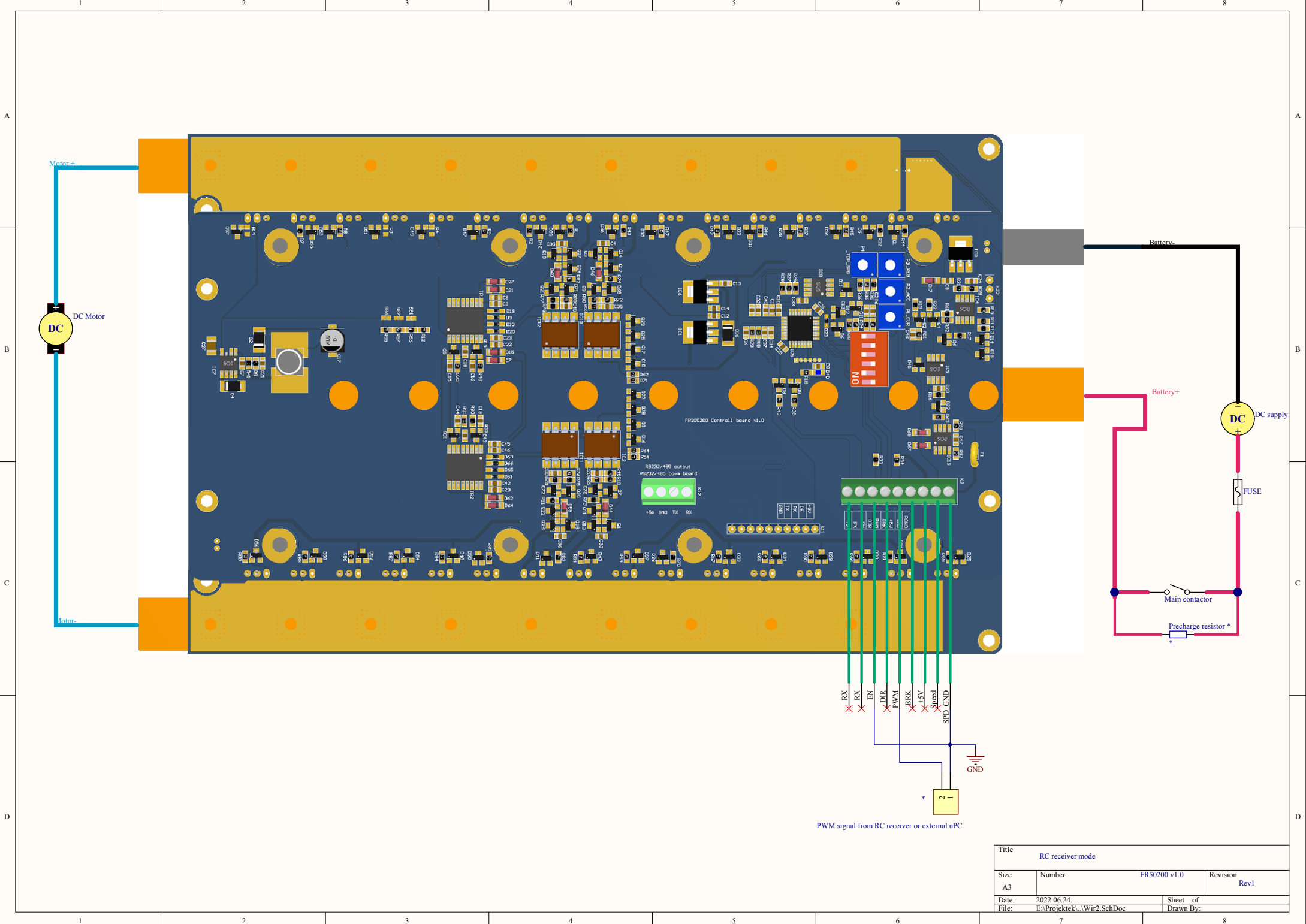
Precharge resistor:

At start limiting the turn up current avoiding any spark on the contactors use a precharge resistor. The value can change depending on the supply voltage:

| Supply voltage | Resistor Ohm | Resistor power |
|----------------|--------------|----------------|
| 24V | No need | - |
| 48V | 470 Ohm | 10W |
| 96V | 1k Ohm | 10W |
| 144V | 1.5k Ohm | 20W |



| | | | |
|---|---------------------------|--------------|----------|
| Title | | | |
| Speed potentiometer or throttle + direction switch mode | | | |
| Size | Number | FR50200 v1.0 | Revision |
| A3 | | | Rev1 |
| Date: | 2022.06.24. | Sheet of | |
| File: | E:\Projekte\k\Wir1.SchDoc | Drawn By: | |



| | | | |
|------------------|---------------------------|--------------|----------|
| Title | | | |
| RC receiver mode | | | |
| Size | Number | FR50200 v1.0 | Revision |
| A3 | | | Rev1 |
| Date: | 2022.06.24. | Sheet of | |
| File: | E:\Projekte\k\Wir2.SchDoc | Drawn By: | |

Controll register map for simple UART communication:

UART Data transmission:

revision: 1. *UART firmware v1.0*

Supported default baud rate: 9600 baud/sec

Supported bit rate: 1 start 8 data bit 1 stop and no parity bit.

Writing register you need to send first the comand byte than the second the data byte which contains the value of the writen register. Reading a register send the request command and wait for the data from the controller.

Sent bytes

| Command | Data | Write registers: | remark: |
|---------|---------|--------------------|---|
| 0x80 | 0x00-7F | speed motor 1 | |
| 0x82 | 0x00-7F | current limit | 1,95A/lsb |
| 0x83 | 0x00-7F | regen limit | 1,95A/lsb |
| 0x84 | 0x00-7F | accel limit | 0,32ms/lsb |
| 0x85 | 0x00-7F | decel limit | 0,32ms/lsb |
| 0x86 | 0x00-7F | turn off low | 2,14V/lsb |
| 0x87 | 0x00-7F | turn on low | 2,14V/lsb |
| 0x88 | 0x00-7F | turn on high | 2,14V/lsb |
| 0x89 | 0x00-7F | turn off high | 2,14V/lsb |
| 0x8A | 0x00-03 | motor deirection | 0x00: stop, 0x01 forward, 0x03 regen |
| 0xE0 | - | USART command mode | Autostop after 3 sec without speed update |
| 0xE1 | - | USART command mode | No Autostop |
| 0xE2 | - | cancel USART mode | Controll with onboard potentiometers |
| 0xA0 | 0x00-7F | saving_bits L | for saving use advanced mode |
| 0xA1 | 0x00-7F | saving_bits H | for saving use advanced mode |

| Command | Read registers: | | |
|---------|-----------------|--------------------|------------|
| 0xC0 | 00-7F | read motor 1 speed | |
| 0xC2 | 00-7F | read current limit | 1,95A/lsb |
| 0xC3 | 00-7F | read regen limit | 1,95A/lsb |
| 0xC4 | 00-7F | read accel limit | 0,32ms/lsb |
| 0xC5 | 00-7F | read decel limit | 0,32ms/lsb |
| 0xC6 | 00-7F | read turn off low | 2,14V/lsb |
| 0xC7 | 00-7F | read turn on low | 2,14V/lsb |
| 0xC8 | 00-7F | read turn on high | 2,14V/lsb |
| 0xC9 | 00-7F | read turn off high | 2,14V/lsb |
| 0xCA | 00-7F | motor 1 current | 3,9A/lsb |
| 0xCC | 00-7F | suppyl voltage | 2,14V/lsb |
| 0xCD | 00-7F | speed input | 37,7mV=lsb |
| 0xCE | | heatsink_temp | 1C |
| 0xCF | | mainboard_temp | 1C |
| 0xD0 | | status bits L | |

| | |
|------|-------------------------|
| 0xD1 | status bits H |
| 0xD2 | configurations_bits_1 L |
| 0xD3 | configurations_bits_1 H |
| 0xD4 | configurations_bits_2 L |
| 0xD5 | configurations_bits_2 H |
| 0xDE | software version |
| 0xDF | hardware version |

If you need more details about what the status register and configuration_bits are doing please check the advanced communication.

Examples:

1, Start the controller in uart control mode:

Send 0xE0 or 0xE1 (with E0 you need to send a new speed data in every 3 sec otherwise the controller will stop the motor)

2, Select direction forward:

Send 0x8A 0x01

3, Speed up the motor slowly:

Acceleration set: **Send 0x84 0x0F**

Speed set: **Send 0x80 0x1F**

4, Set lower 50% speed:

Send 0x80 0x3F

5, Read motor current:

Send 0xCA

6, Read supply voltage:

Send 0xCC

UART Data transmission:

revision: 1. UART firmware v1.0

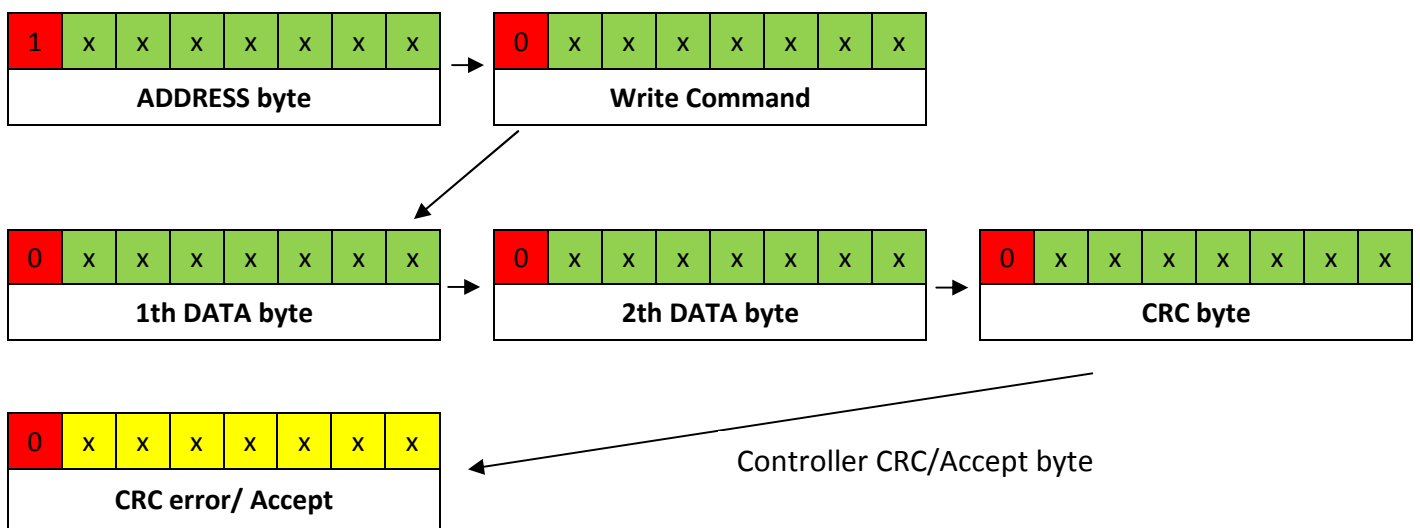
Supported default baud rate: 19200 baud/sec

Supported bit rate: 1 start 8 data bit 1 stop and no parity bit.

Sending data:

The controllers are working in SLAVE mode UART communication. It means that every commands are addressable and only the controller which has the same address will accept the command otherwise it goes into stanby mode. When an address match occurs the the controller wakes up and accept the data. As long as the controller does not get other address which is not its own address remains in active mode.

Sending data from master device must be 5 bytes:



Every ADDRESS byte MSB bit must be "1" any other which is not an ADDRESS byte must be "0".

For robust and errorless communication CRC byte can be used to check the data transmission errors.

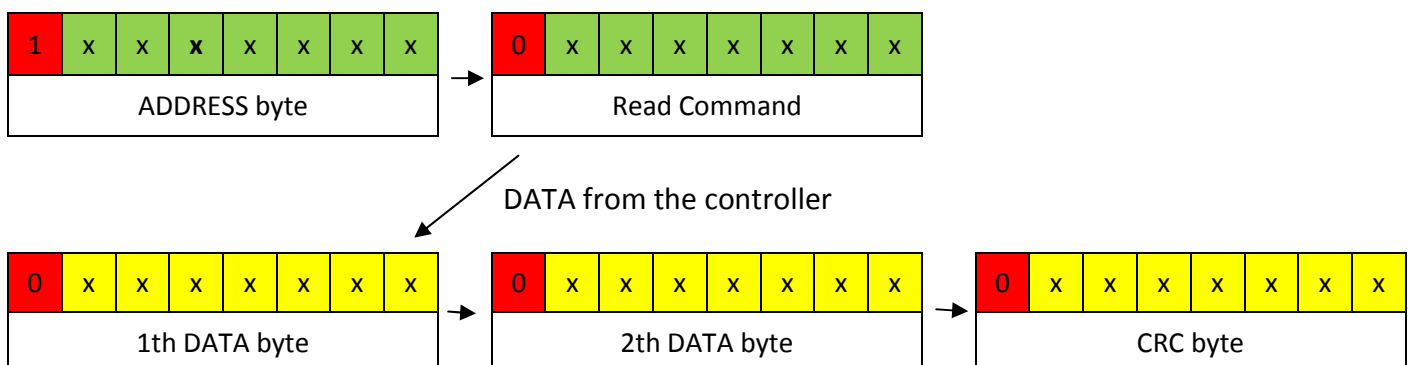
CRC ckeck byte calculated: ((Write command byte + 1th DATA byte + 2th DATA byte) & 0x7F)

Receiving successfully the write command and the DATA bytes the controller send a confirmation byte with his UART address (0x00 | address) or CRC error message with his address (0x80 | address).You can use this byte to know when to send the next data.

Reading data:

Requesting data from master device must be 2 bytes when the controller received the 2th byte it will send the answer 3 bytes (1th DATA byte ; 2th DATA byte ; CRC)

CRC ckeck byte calculated: ((Read command byte + 1th DATA byte + 2th DATA byte) & 0x7F)



Control register map for advanced USART communication:

Model: HL200200 v1.01

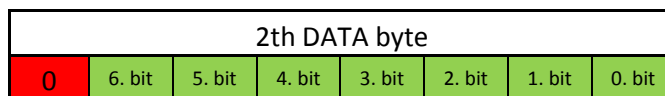
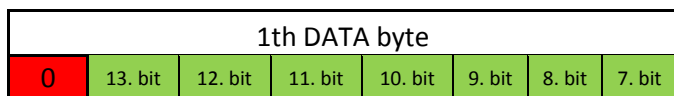
| Register name | Command | | Min Val. | Max val. | Value Range | Resolution | Remark |
|---------------------------------|---------|-------|----------|----------|-------------|------------|---|
| | Read | Write | | | | | |
| speed motor 1 | 0x00 | 0x40 | 0x0000 | 0x0FFF | 97% duty | | Other factors may change the output duty |
| current limit | 0x02 | 0x42 | 0x0000 | 0x0FFF | 250A | 61.0mA | This value is internally limited az 200A. |
| regen limit | 0x03 | 0x43 | 0x0000 | 0x0FFF | 250A | 61.0mA | This value is internally limited at 200A. |
| accel limit | 0x04 | 0x44 | 0x0000 | 0x0FFF | 41 sec | 10msec | |
| decel limit | 0x05 | 0x45 | 0x0000 | 0x0FFF | 41 sec | 10msec | |
| turn off low | 0x06 | 0x46 | 0x0000 | 0x0FFF | 273.8V | 66,88mV | Defaul value: 328 |
| turn on low | 0x07 | 0x47 | 0x0000 | 0x0FFF | 273.8V | 66,88mV | |
| turn on high | 0x08 | 0x48 | 0x0000 | 0x0FFF | 273.8V | 66,88mV | Defaul value: 2840 |
| turn off high | 0x09 | 0x49 | 0x0000 | 0x0FFF | 273.8V | 66,88mV | Internally limited on 2900 |
| Heatsink Temperature | 0x0A | | 0x000A | 0x0050 | 80°C | 1°C | Shut down at 75°C |
| Mainboard Temperature | 0x0B | | 0x000A | 0x0050 | 80°C | 1°C | |
| | 0x0F | | | | | | |
| Supply Voltage | 0x10 | | | | 273.8V | 66,88mV | |
| Speed ADC Input | 0x11 | | | | 4.85V | 1.18mV | |
| Load Current 1 | 0x12 | | | | 500A | 244.2mA | 0A=0x07FF |
| | | | | | | | |
| Input Frequency Period Register | 0x14 | | | | | | |
| Input Pulse Width | 0x15 | | | | | | |
| | 0x19 | | | | | | |
| I*R compensation gain | 0x20 | 0x60 | 0x0000 | 0x0FFF | | | |
| top speed | 0x21 | 0x61 | 0x0000 | 0x0FFF | 273.8V | 66,88mV | |
| potentiometer min | 0x22 | 0x62 | 0x0000 | 0x0FFF | 4.85V | 1.18mV | |
| potentiometer max | 0x23 | 0x63 | 0x0001 | 0x0FFF | 4.85V | 1.18mV | |
| | 0x24 | | | | | | |
| Status Register | 0x30 | | | | | | |
| Lock_level_2 Variables | 0x31 | 0x71 | | | | | |
| Save bites 1 | 0x32 | 0x72 | | | | | |
| save bites 2 | 0x33 | 0x73 | | | | | |
| Configuration bits 1 | 0x34 | 0x74 | | | | | |
| Configuration bits 2 | 0x35 | 0x75 | | | | | |
| | | | | | | | |
| UART Address | | 0x7C | 0x0000 | 0x007F | | | Default address 0x00 |
| Current measurement calibration | | 0x7D | 0x0000 | | | 244.2mA | |
| software version | 0x3E | | | | | | |
| hardware version | 0x3F | | | | | | |

Speed Register:

Type: Write / Read

Write command: 0x40

Read command: 0x00



Speed register gives the base value of the output voltage (duty cycle). The final value depending some other factors. The final duty cycle depending on several other factors (current limits, regen modes..)

With default settings the speed register equal to the controller speed input ADC value modified by the acceleration/deceleration settings. Writing into this register this will be the new base value of the output voltage as long as the Speed input ADC has the same value as it was before the overwrite. When the Speed input voltage changes (turning up/down the speed potentiometer) the controller going to overwrite the register with the value of the potentiometer.

It is possible to lock the register value (speed potentiometer can't overwrite the speed register) for this feature use the **Lock Variable Register**.

The register set and cleared by UART write or Speed potentiometer input and loses it's value after restarting the controller. Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **SPEED [11:0]**: Speed register value

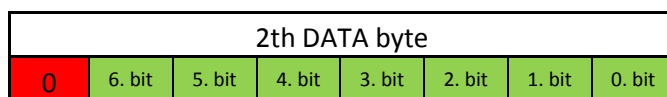
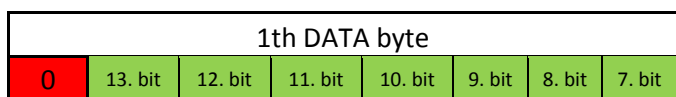
Max value is 4095 it is the 97% duty cycle.

Min value is 0 it is the 0% duty cycle.

Note: final duty cycle may change depending on other factors.

Current Limit Register:

Type: Write / Read
 Write command: 0x42
 Read command: 0x02



Current Limit Register sets the value of the current limitation. With default settings the current limit register is equal to the controller's current limit potentiometer setting. Writing into this register overwrites the value of the potentiometer and holds the value as long as the potentiometer has the same value as it was before the overwrite. When the potentiometer changes (turning up/down the potentiometer) the controller going to overwrite the register with the value of the potentiometer.

It is possible to lock the register value (potentiometer can't overwrite the register) for this feature use the **Lock Variable Register**.

The register set and cleared by UART write or the current limit potentiometer and loses it's value after restarting the controller. Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **CURRENT_LIMIT [11:0]**: Current limit register value
Max value is 4095
Min value is 0

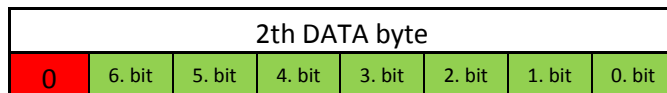
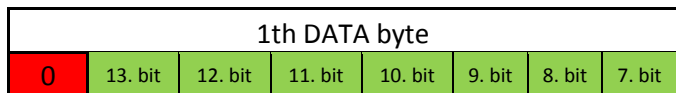
*Note: for the corresponding current value check the **Register Value Range** table.*

Regenerative Current Limit Register:

Type: Write / Read

Write command: 0x43

Read command: 0x03



Regenerative Current Limit Register sets the value of the current limitation. With default settings the current limit register is equal to the controller's potentiometer setting. Writing into this register overwrites the value of the potentiometer and holds the value as long as the potentiometer has the same value as it was before the overwrite. When the potentiometer changes (turning up/down the potentiometer) the controller going to overwrite the register with the value of the potentiometer.

It is possible to lock the register value (potentiometer can't overwrite the register) for this feature use the **Lock Variable Register**.

The register set and cleared by UART write or the potentiometer and loses it's value after restarting the controller. Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **CURRENT_LIMIT [11:0]**: Regenerative current limit register value

Max value is 4095

Min value is 0

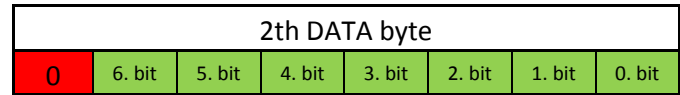
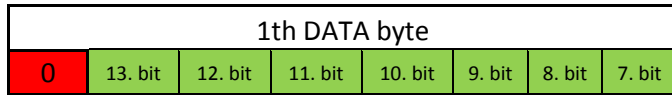
*Note: for the corresponding curret value check the **Register Value Range** table.*

Acceleration Limit Register:

Type: Write / Read

Write command: 0x44

Read command: 0x04



Acceleration Limit Register sets the time how fast the output follows the speed register's value under raising condition. With default settings it is equal to the controller's acceleration (RAMP) potentiometer's setting. Writing into this register overwrites the value of the potentiometer and holds the value as long as the potentiometer has the same value as it was before the overwrite. When the potentiometer changes (turning up/down the potentiometer) the controller going to overwrite the register with the value of the potentiometer.

It is possible to lock the register value (potentiometer can't overwrite the register) for this feature use the **Lock Variable Register**.

The register set and cleared by UART write or the potentiometer and loses it's value after restarting the controller. Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **CURRENT_LIMIT [11:0]**: Acceleration limit register value

Max value is 4095

Min value is 0

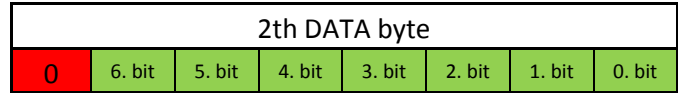
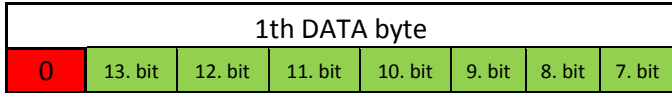
*Note: for the corresponding time value check the **Register Value Range** table.*

Deceleration limit register:

Type: Write / Read

Write command: 0x45

Read command: 0x05



Deceleration Limit Register sets the time how fast the output follows the speed register's value under falling condition. With default settings it is disabled in the controller.

Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **DECELERATION_LIMIT [11:0]**: Deceleration limit register value

Max value is 4095

Min value is 0

*Note: for the corresponding time value check the **Register Value Range** table. The minimum value is 1.*

Turning off minimum voltage register:

Type: Write / Read

Write command: 0x46

Read command: 0x06

| 1th DATA byte | | | | | | | |
|---------------|---------|---------|---------|---------|--------|--------|--------|
| 0 | 13. bit | 12. bit | 11. bit | 10. bit | 9. bit | 8. bit | 7. bit |

| 2th DATA byte | | | | | | | |
|---------------|--------|--------|--------|--------|--------|--------|--------|
| 0 | 6. bit | 5. bit | 4. bit | 3. bit | 2. bit | 1. bit | 0. bit |

Turning Off Minimum voltage register sets the voltage level where the controller will shut down if the supply voltage is lower than the register value. With default settings it is disabled in the controller. Writing and locking this register activates the function. When the controller shutting down because of the low supply voltage level the corresponding status register gets an update about the low supply voltage.

Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **TURN_OFF_MIN [11:0]:**

Max value is 4095

Min value is 0

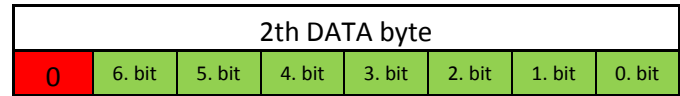
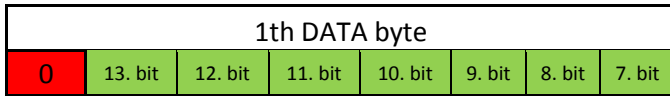
*Note: for the corresponding voltage level check the **Register Value Range** table.*

Turning on minimum voltage register:

Type: Write / Read

Write command: 0x47

Read command: 0x07



Turning On Minimum voltage register sets the voltage level where the controller will turn back from low supply status if the supply voltage is higher than the register value. With default settings it is disabled in the controller. Writing and locking this register activates the function.

Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **TURN_ON_MIN [11:0]:**

Max value is 4095

Min value is 0

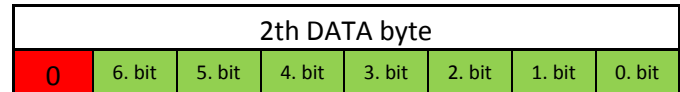
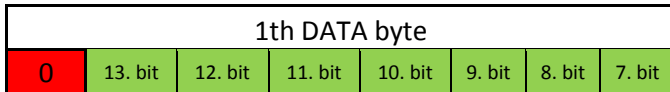
*Note: for the corresponding voltage level check the **Register Value Range** table.*

Turning on maximum voltage register:

Type: Write / Read

Write command: 0x48

Read command: 0x08



Turning On maximum voltage register sets the voltage level where the controller will turn back from high supply voltage status if the supply voltage is lower than the register value. With default settings it is disabled in the controller. Writing and locking this register activates the function.

Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **TURN_ON_MAX [11:0]:**

Max value is 4095

Min value is 0

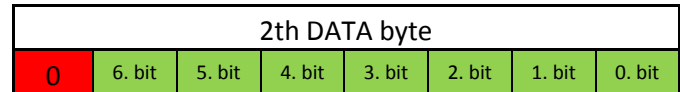
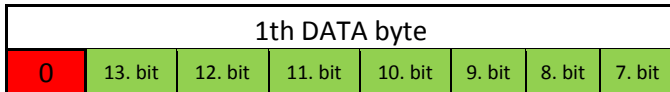
*Note: for the corresponding voltage level check the **Register Value Range** table.*

Turning off maximum voltage register:

Type: Write / Read

Write command: 0x49

Read command: 0x09



Turning Off Maximum voltage register sets the voltage level where the controller will shut down if the supply voltage is higher than the register value. With default settings it is disabled in the controller. The internal maximum voltage settings may rewrite this register. Writing and locking this register activates the function. When the controller shutting down because of the high supply voltage level the corresponding status register gets an update about the high supply voltage.

Saving the value into the FLASH use the **Save Register**.

Bit 11:0 **TURN_OFF_MAX [11:0]:**

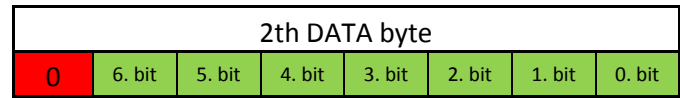
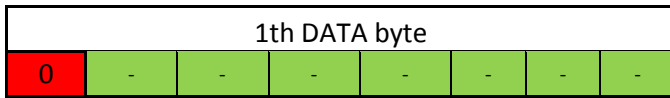
Max value is 4095

Min value is 0

*Note: for the corresponding voltage level check the **Register Value Range** table.*

Heatsink Temperature Register:

Type: Read
Read Command: 0x0A



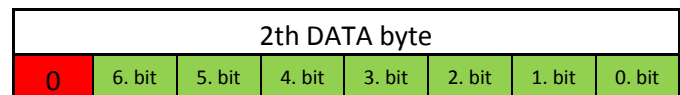
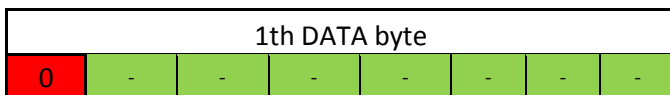
This register holds the actual heatsink temperature value in °C.

Bit 11:0 **HEATSINK TEMPERATURE [11:0]:**
Max value is 80
Min value is 10

*Note: for the corresponding temperature value check the **Register Value Range** table.*

Mainboard Temperature Register:

Type: Read
Read Command: 0x0B



This register holds the actual mainboard temperature value in °C.

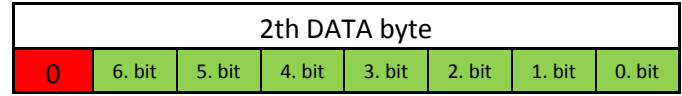
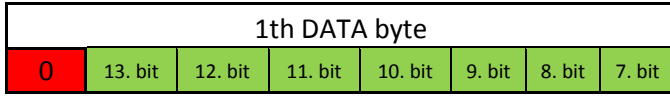
Bit 11:0 **MAINBOARD TEMPERATURE [11:0]:**
Max value is 4095
Min value is 0

*Note: for the corresponding temperature value check the **Register Value Range** table.*

Supply Voltage Register:

Type: Read

Read Command: 0x10



This register holds the actual supply voltage value.

Bit 11:0 **SUPPLY VOLTAGE [11:0]:**

Max value is 4095

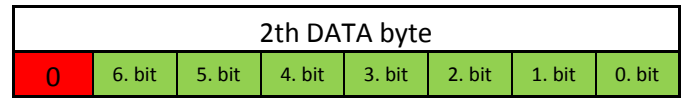
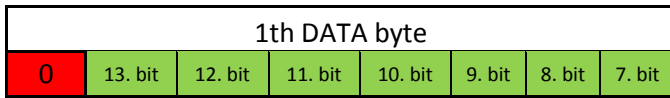
Min value is 0

*Note: for the corresponding voltage value check the **Register Value Range** table.*

Speed ADC Input Register:

Type: Read

Read Command: 0x11



Controlling and locking the controller with UART Speed commands the Speed ADC input can serve other task like measuring a sensor or anything else.

Using the Speed ADC input for other task and not for the speed control function the Speed Register Lock bit must be enabled.

Bit 11:0 **SPEED ADC INPUT [11:0]:**

Max value is 4095

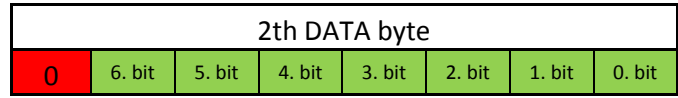
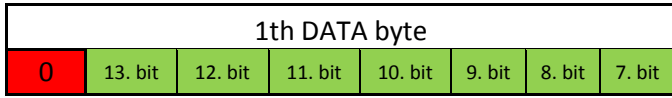
Min value is 0

*Note: for the corresponding voltage value check the **Register Value Range** table.*

Load Current Register:

Type: Read

Read Command: 0x12



This register holds the actual output load current.

Bit 11:0 **LOAD CURRENT [11:0]:**

Max value is 4095

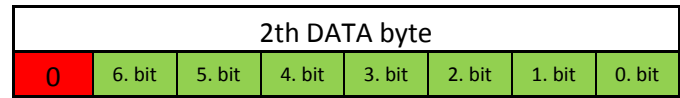
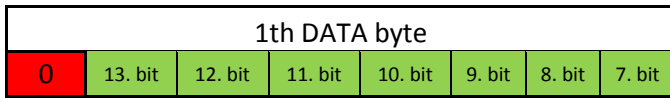
Min value is 0

*Note: for the corresponding current value check the **Register Value Range** table.*

Input Frequency Period Register:

Type: Read

Read Command: 0x14



The controller PWM/brake input can be used for measuring pulses and other purposes. Like hall sensors encoders etc. Input Frequency Register holds the period's of the measured signal.

Bit 13:0 **INPUT FREQUENCY PERIOD REGISTER [13:0]:**

Max value is 16383

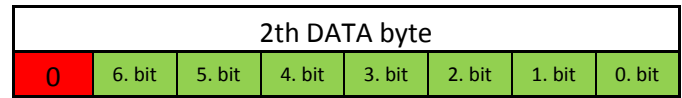
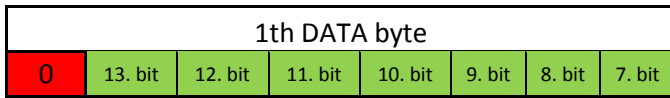
Min value is 0

*Note: for the corresponding value check the **Register Value Range** table.*

Input Pulse Width Register:

Type: Read

Read Command: 0x15



The controller PWM/brake input can be used for measuring pulses and other purposes. Like hall sensors encoders etc. Input Pulse Width Register holds the width of the captured pulse of the measured signal.

Bit 13:0 **INPUT PULSE WIDTH REGISTER [13:0]:**

Max value is 16383

Min value is 0

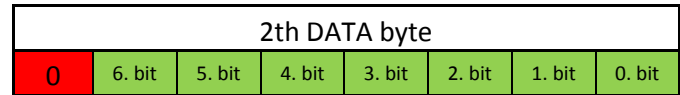
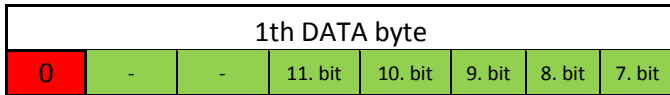
*Note: for the corresponding time value check the **Register Value Range** table.*

I x R compensation register:

Type: Write / Read

Write Command: 0x60

Read Command: 0x20



I x R compensation value can be used for gain the output voltage when the motor internal resistance causing voltage drop and RPM drop. This value will be multiplied with the load current and added to the output voltage.

Using the I X R compensation constant from the Register Value Range table you can calculate the needed value.

The [%/A] tell how much compensation is needed for running the motor at the same RPM under load.

Bit 13:0 I x R COMPENSATION REGISTER [13:0]:

Max value is 16383

Min value is 0

*Note: for the corresponding value check the **Register Value Range** table.*

Top Speed register:

Type: Write / Read
 Write Command: 0x61
 Read Command: 0x21



Top Speed value can be used for making a reference voltage for the speed input or speed register. This can make a supply compensation when the supply voltage is changes or you can limit the maximum output output voltage / motor RPM and does not matter if the speed potentiometer would set higher output voltage the Top Speed will overwrite this value.

For the calculation use the given top speed constant from the **Register Value Range** table.

Giving and example: If the constant for the given controller is 18,51mV than if you need a maximum output voltage of 20V than calculate like this: $Top\ Speed = 20V / 0.01805V = 1080$.

So writing the 1080 in the top speed register you can set maximum 20V output voltage with the potentiometer. If your supply voltag changes between higher ranges for example 25-50V your output voltage remains the same 20V or less depending on your speed potentiometer's setting.

With TOP Speed settings you can have supply compensation fixing the speed variation with different supply voltages.

Turning on the supply compesation you need to turn on the **Top Speed /Supply compensation** bit in the **Configuration_bits_2** register.

Giving 0 or near 0 value of this register can cause 0V output voltage.

Bit 13:0 **TOP SPEED REGISTER [11:0]:**

Max value is 4095

Min value is 0

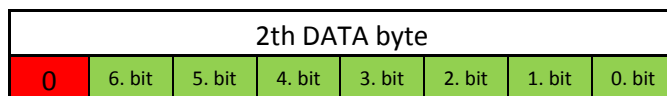
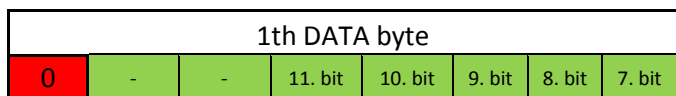
*Note: for the corresponding value check the **Register Value Range** table.*

Potentiometer min. register:

Type: Write / Read

Write Command: 0x62

Read Command: 0x22



With Potentiometer min and max you can define your voltage levels on the speed input what you need for the given 0% output voltage and the given 100% output voltage.

For the calculation use the given potentiometermin/max constant from the **Register Value Range** table.

Giving and example: If the constant for the given controller is 1,184mV than if you need the 0% output starting form the speed input=1V

$$\text{Potentiometer min register} = 1V/1,184mV = \underline{844}$$

Using this function you need to save the potentiometer min/max registers in the flash memory using the **Save register** and restart the controller with SW mode setting: 1:OFF 2:OFF.

Bit 13:0 **Potentiometer Min register [11:0]:**

Max value is 4095

Min value is 0

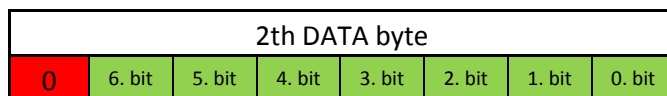
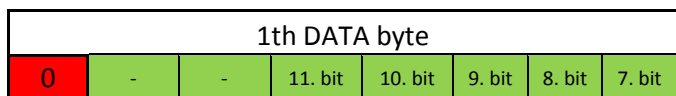
*Note: for the corresponding value check the **Register Value Range** table.*

Potentiometer max. register:

Type: Write / Read

Write Command: 0x63

Read Command: 0x23



With Potentiometer min and max you can define your voltage levels on the speed input what you need for the given 0% output voltage and the given 100% output voltage.

For the calculation use the given potentiometermin/max constant from the **Register Value Range** table.

Giving and example: If the constant for the given controller is 1,184mV than if you need the 100% output ending at the speed input=3,5V

$$\text{Potentiometer maxregister} = 3,5V / 1,184mV = \underline{2956}$$

Using this function you need to save the potentiometer min/max registers in the flash memory using the **Save register** and restart the controller with SW mode setting: 1:OFF 2:OFF.

Bit 13:0 Potentiometer Max register [11:0]:

Max value is 4095

Min value is 0

*Note: for the corresponding value check the **Register Value Range** table.*

Status Register:

Type: Read
Read Command: 0x30

| 1th DATA byte | | | | | | | |
|---------------|---|---|---|---|----|---|---|
| 0 | - | - | - | - | FM | - | - |

| 2th DATA byte | | | | | | | |
|---------------|--------|---|----|---|----|----|----|
| 0 | BR pin | - | DT | - | OT | OV | UV |

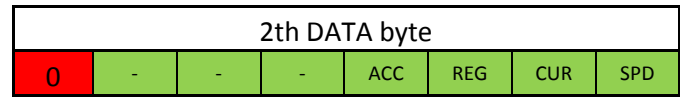
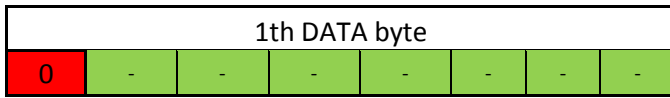
- Bit 9 **FM:** Forward mode:
0: Stop
1: Controller in forward mode.
- Bit 6 **BR Pin:** Brake input pin state bit.
0: Brake pin is "Low"
1: Brake pin is "High"
Note: reading this you need to be not in PWM mode.
- Bit 4 **DT:** Drive status bit:
0: Drive mode
1: Brake mode
- Bit 2 **OT:** Over temperature status bit.
0:
1: Supply voltage is lower than the Turn on minimum register value.
- Bit 1 **OV:** Over voltage status bit.
0:
1: Supply voltage is higher than the Turn off maximum register value.
- Bit 0 **UV:** Under voltage status bit.
0:
1: Supply voltage is lower than the Turn on minimum register value.

Lock Variables Register:

Type: Write / Read

Write Command: 0x71

Read Command: 0x31



Locking any register means only USART update can overwrite it's value. The on board potentiometers will be disabled as long as the associated bit is "1".

This is good if you want to deny the possibility to change the value of the registers on board. Other advantage if you want to use the Speed input for other purposes than you need to lock the SPD register otherwise the value of the speed input will be used for setting the output voltage.

- Bit 3 **ACC:** Writing "1" locks the Speed Register.
- Bit 2 **REG** Writing "1" locks the Current Limit Register.
- Bit 1 **CUR:** Writing "1" locks the Regeneration Limit Register.
- Bit 0 **SPD:** Writing "1" locks the Acceleration Limit Register.

Note: This register going to lose it's content after restarting the controller.

Save bits 1 register:

Type: Write / Read
 Write Command: 0x72
 Read Command: 0x32



These bits are set all the registers you want to save into the flash memory. Writing into this register only designates the register to be saved. The actual saving command will be done only with writing the Save_bits_2 register. When a memory saving occurs the data will be reloaded from the memory after every restart. Saving a register data automatically locks the particular register and only USART update can rewrite it.

- Bit 13 **CONF2:** Configuration 2 Register.
 0: no saving
 1: Save the given register into flash memory.

- Bit 12 **CONF1:** Configuration 1 Register.
 Refer to the Bit 13 CONF2 description.

- Bit 11 **ADDR:** Configuration 2 Register.
 Refer to the Bit 13 CONF2 description.

- Bit 9 **OFF_H:** Save turning off maximum value.
 Refer to the Bit 13 CONF2 description.

- Bit 8 **ON_H:** Save turning on maximum value.
 Refer to the Bit 13 CONF2 description.

- Bit 7 **ON_L:** Save turning off minimum value.
 Refer to the Bit 13 CONF2 description.

- Bit 6 **OFF_L:** Save turning off low value.
 Refer to the Bit 13 CONF2 description.

- Bit 5 **DEC:** Save deceleration value.
 Refer to the Bit 13 CONF2 description.

- Bit 4 **ACC:** Save acceleration value.
 Refer to the Bit 13 CONF2 description.

- Bit 3 **REG:** Save regenerative current limit value.
 Refer to the Bit 13 CONF2 description.

- Bit 2 **CUR:** Save current limit value.
 Refer to the Bit 13 CONF2 description.

- Bit 0 **SPD:** Save speed value.
 Refer to the Bit 13 CONF2 description.

Save bits 2 register:

Type: Write / Read

Write Command: 0x72

Read Command: 0x33



These bits are set all the registers you want to save into the flash memory. Writing into this register designates the register to be saved and initiates the saving command. When a memory saving occurs the data will be reloaded from the memory after every restart. Saving a register data automatically locks the particular register and only USART update can rewrite it.

IMPORTANT: Writing into this register as a repeated operation is not recommended. **The FLASH memory rewritable life cycle is limited about 10.000 saving operation! Under the save operation the PWM controller stops and no other operation can be used!**

- Bit 4 **P_MAX:** Potentiometer Maximum
0: no saving
1: Save the given register into flash memory.

- Bit 3 **P_MIN:** Potentiometer Minimum
Refer to the Bit 8 OFH description.

- Bit 2 **TOP_S:** Top Speed/Supply compensation
Refer to the Bit 8 OFH description.

- Bit 1 **IR_COM:** I x R compensation
Refer to the Bit 8 OFH description.

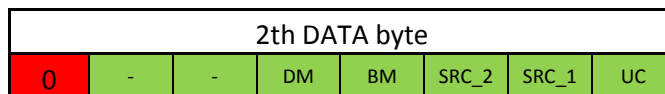
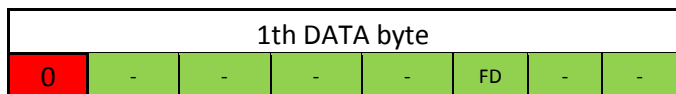
- Bit 0 **C_CAL:** Current calibration
Refer to the Bit 8 OFH description.

Configuration bits 1 register:

Type: Write / Read

Write Command: 0x74

Read Command: 0x34



Bit 9 **FD:** Forward Direrection:

0: Stop

1: Set forward direction.

Bit 4 **DM:** Selecting operation mode

This bit set and cleared by UART write and cleared by hardware after restart.

0: Drive mode.

1: Brake mode or free running mode depending on **BM** bit.

Bit 3 **BM:** Braking mode

This bit set and cleared by UART write and cleared by hardware after restart.

0: Manual brake (free running mode)

1: Auto brake (automatic regeneration)

Note: Manual brake let the motor spinning free after turning down the speed or sending 0 speed command. Auto brake start automatic current regeneration into the supply when the motor internal voltage is higher than the speed.

Bit 2:1 **SRC[1:0]:** Speed reset controll

This bit set and cleared by UART write and cleared by hardware after restart.

00: No speed reset after no UART speed update.

01: Speed reset after 50msec without new UART speed update.

10: Speed reset after 500msec without new UART speed update.

11: Speed reset after 2800msec without new UART speed update.

Bit 0 **UC:** UART controll bit

This bit set and cleared by UART write and cleared by hardware after restart.

0: Disable the configuration bits

1: Enable the configuration bits

Configuration bits 2 register:

Type: Write / Read
 Write Command: 0x75
 Read Command: 0x35



Note: writing 1 clears the given bit writing 0 makes no changes.

- Bit 8 **TOP_S:** Top Speed/Supply compensation enable bit.
 0: Disable
 1: Enable

- Bit 7 **P_OFF:** Pin terminals OFF .
This bit is used to disable the Brake function of the PWM/Brake input and using as a logical input.
 0: Enable
 1: Disable

- Bit 6 **BMC:** Pulse Measurement resolution
Resolution on the PWM/brake input
 0:
 1:

- Bit 2:1 **USP [1:0]:** USART communication speed.
 Default speed is 19200 Baud/sec
These bits set the UART baud/sec rate.
 00: 19200 Baud/sec
 01:
 10:
 11:

USART Address Register:

Type: Write
Write command: 0x7C



USART Address bits is a unique 7bit address which marks the given controller. It allows to connect several controllers or even other USART devices to connect to the same RX TX channel. The default USART address is 0x00. If you want to control two or more controllers through the USART you have to change the address first one by one. After this it is possible to connect more devices to the same USART channel. USART Address will be saved into the FLASH memory and reloaded from the memory after every restart.

The controllers send out their unique USART address right after the system start. This helps to recover and recognize a forgotten address.

Bit 6:0 **USART ADDRESS [6:0]:**
Max value is 0x7F
Default value: 0x00

Current measurement calibration register:

Type: Write
Write command: 0x7D



Motor controller boards may have current measurement error 1-15% depending on the model. Calibrating and saving the current measurement register solve the error problem and will use the value for the measurement correction.

For the calibration you need follow the steps:

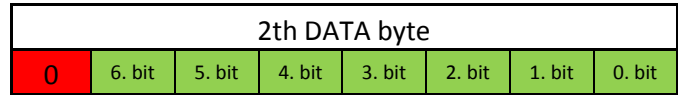
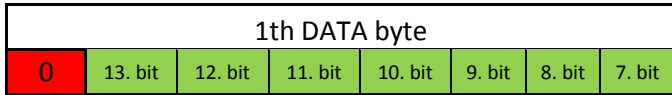
1. Set maximum speed potentiometer input
2. Turn down the current limit
3. Place a pure inductive load to the output. You can use large inductors or a stalled DC- motor.
4. Place a current meter or digital clamp meter measuring the motor current.
5. Turn on the supply
6. Slowly turn up the current limit potentiometer
7. Regarding the controller and your load current capabilities turn up the current to a high enough level. For example with a 100A motor controller 30A is enough.
8. When you read the exact current on your own current meter you need to send the equivalent value into the **Current Measurement Calibration** register. Calculating the value use the constant in the **Register Value Range** table.
9. Save the register with the **Saving bits** register.

Note: If the deviation between the sent value and the internal current measurement is larger than +/-20% than the controller will ignore the command.

Exaple: If you Set 30A load current and your constant is 0,244A tah the register value will be: $30A/0,244A = \underline{123}$

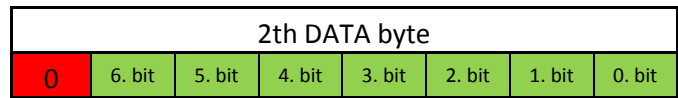
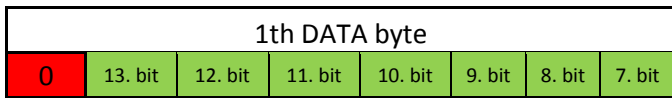
Software version register:

Type: Read
Read command: 0x3E



Hardware version register:

Type: Read
Read command: 0x3F



Examples:

Example 1: Calling 0x00 address device and writing DATA_to send: 0x05C5 value into the Speed register:

Sent bytes:

| | | | | |
|------|------|------|------|------|
| 0x80 | 0x40 | 0x0B | 0x45 | 0x10 |
|------|------|------|------|------|

C conversion code before sending out the bytes:

```
ADDRESS=UNIT_ADDRESS | 0x80;
COMMAND= for this check the write commands in the register table
DATA_1th= (DATA_to_send>>7) & 0x7F;
DATA_2th=DATA_to_send & 0x7F;
CRC=( COMMAND + DATA_1th + DATA_2th) & 0x7F;
```

Example 2: Calling 0x02 address device and locking Speed variable:

Sent bytes:

| | | | | |
|------|------|------|------|------|
| 0x82 | 0x71 | 0x00 | 0x01 | 0x72 |
|------|------|------|------|------|

C conversion code before sending out the bytes:

Refer to the Example 1.

Example 3: Calling 0x02 address device to change the regenerative braking mode to "auto regen" from "free running mode" and initiating regenerative braking with 0x062C current:

For this you need to execute 2 write commands. The first set the regenerative current limit.

Sent bytes:

| | | | | |
|------|------|------|------|------|
| 0x82 | 0x43 | 0x0C | 0x2C | 0x7B |
|------|------|------|------|------|

C conversion code before sending out the bytes:

Refer to the Example 1.

Second to set the Configuration bit:

Sent bytes:

| | | | | |
|------|------|------|------|------|
| 0x82 | 0x74 | 0x00 | 0x19 | 0x0D |
|------|------|------|------|------|

C conversion code before sending out the bytes:

Refer to the Example 1. and **Set Configuration bits register**.

Example 4: Calling 0x00 address device to read the load_current_register:

Sent bytes:

| | |
|------|------|
| 0x80 | 0x12 |
|------|------|

 (read command)

Received bytes from the controller:

| | | |
|------|------|------|
| 0x13 | 0x36 | 0x0D |
|------|------|------|

C conversion code for the received bytes:

CRC check:

```
if(((received_byte_1th + received_byte_2th + Read_command) & 0x7F) == received_byte_3th)
{
    load_current_register = (received_byte_1th << 7) | (received_byte_2th & 0x7F);
}
```