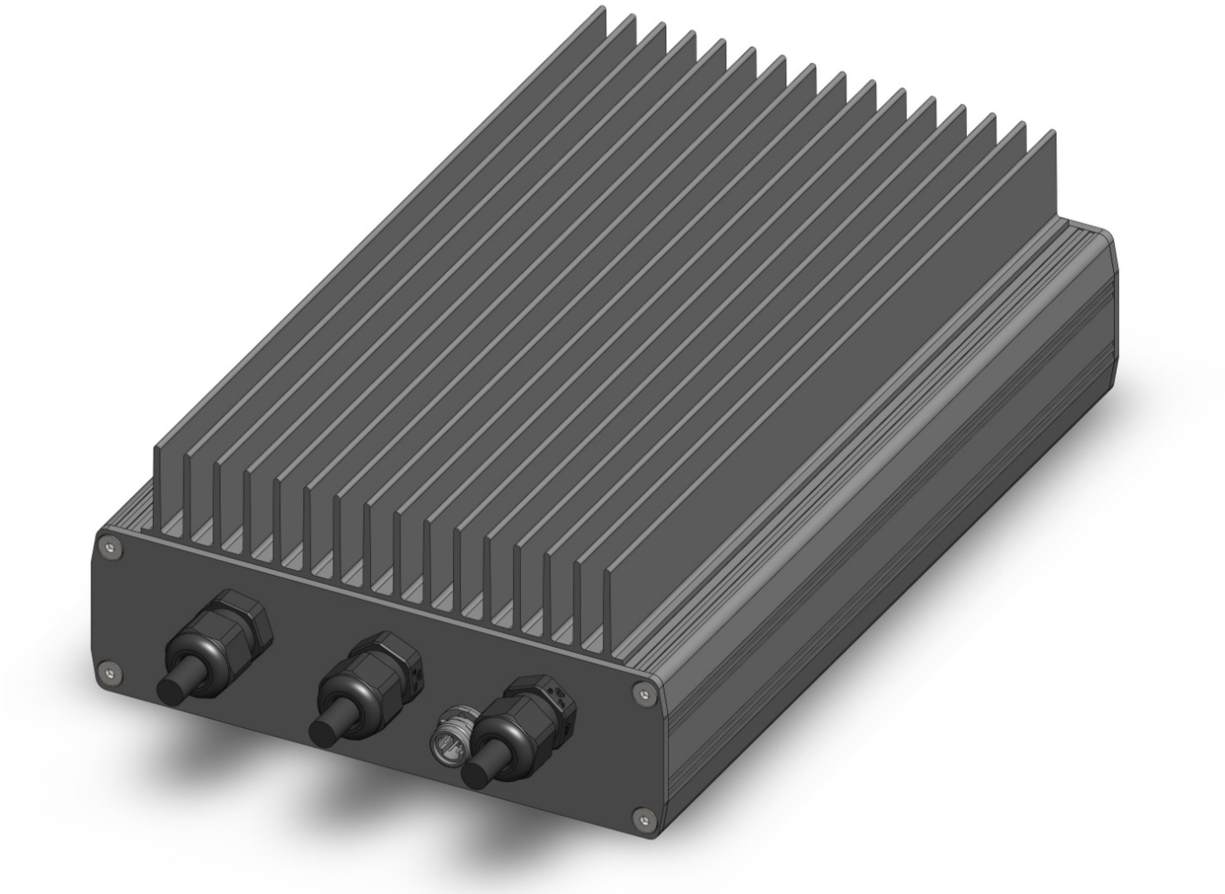
MST140-200



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1 Introduction :

This manual describes the features, installation and operation of Plettenberg motor control MST140-200.

Please read the instruction manual carefully and completely before using the controller. Disregarding the hints and instructions can be fatal and can cause lethal injuries! The limitation of the length of the battery input cables is mandatory(see chapter 4).

If you have questions please do not hesitate to contact us.

The engine control MST140-200 has been specially developed for the use with brushless Plettenberg electric motors with sensors. Brushless motors from other manufacturers can only be connected, if they are equipped with 3 Hall sensors in 120 ° electrical arrangement. We assume no guarantee for the proper functioning of the MST140-200 with motors from other manufacturers.

The MST140-200 can drive brushless motors electrically up to 240000 rpm. A 20-pole motor, for example, makes 10 electrical revolutions doing one shaft rotation. The maximum speed for such a 20-pole motor is calculated: 240000rpm / 10pole pairs = 24000rpm.

The powerful 32-bit microprocessor allows a sensitive and fast motor control in conjunction with a very universal use. The measured values are displayed in real time on the RS232 interface in plain text so that they can be evaluated with a PC or other microprocessor control easy.

The firmware of the MST140-200 can be updated. However, it has to be sent to the factory for update.

2 Technical Data :

Weight: approx. 1300g without cable, approx. 1500g with 33cm battery cable and 27cm motor cable (8mm²)

Length: 204mm without connector and cable glands (AG12 22mmx17mm)
Width: 135mm
Height: 61mm with cooling fins

Protection class: IP53

Maximum Speed: 240000rpm electrical

Maximum continuous power 30kW

Maximum short term power 39kW

Battery voltage range 36V to 122V nominal
Permissible supply voltage 30 to 140V

Maximum current 280A / 220A continuous current (at 25 ° C ambient temperature)
At 50 ° C ambient temperature, the continuous current is 180A.
At 75 ° C ambient temperature, the continuous current is 125A.
The continuous current data refer to standard atmosphere (1013 mbar 25 ° C) and vertically aligned fins (eg control lies with the base plate horizontally with the ribs upwards on the table).

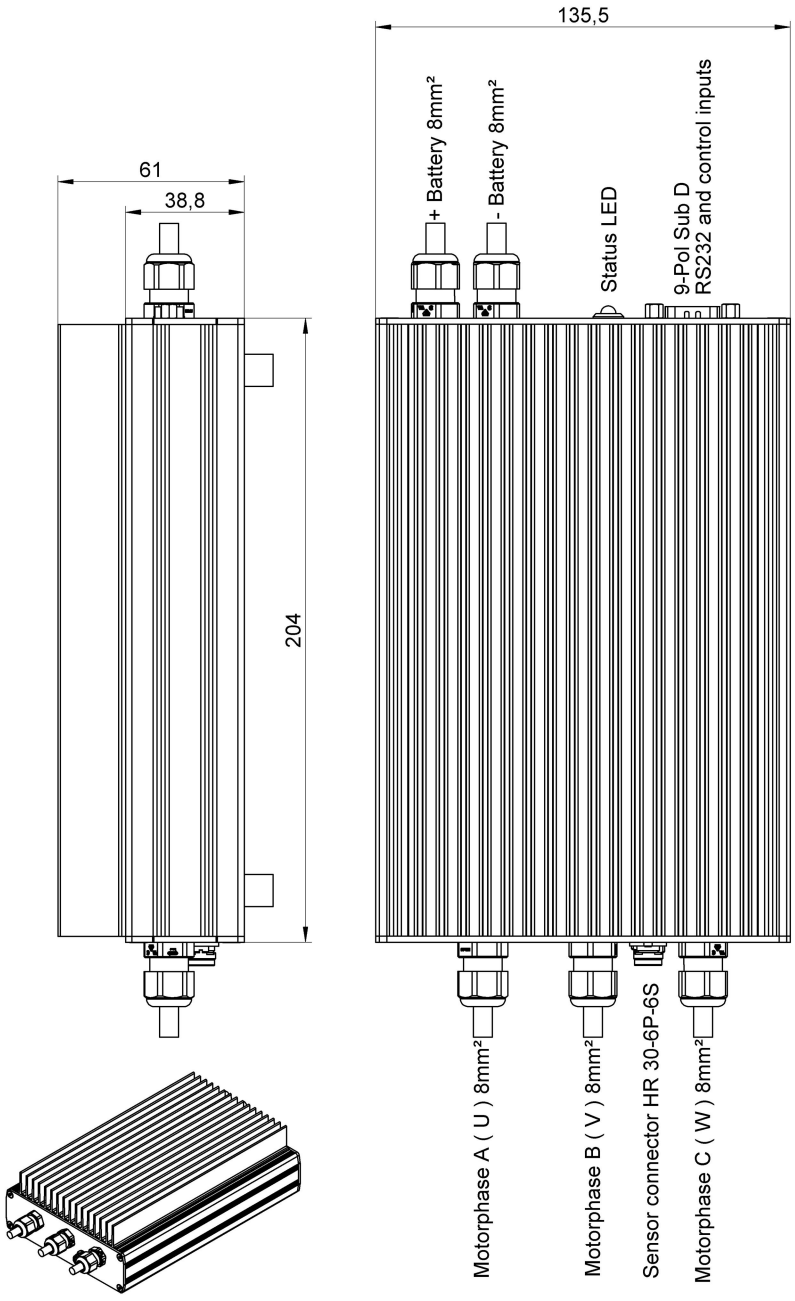
By forced cooling (forced ventilation with a fan or air flow), the allowable continuous current can be increased.

5V power supply (Max 50mA) for Hall sensors and electronic throttle and electronic brake pedal.

Two 0-5V analog inputs for throttle and brake function. One digital input for activating the reverse function.

An additional analog input for motor temperature monitoring.

A RS232 interface for outputting the current measured values and changing of the parameters of the controller. This can also be used for direct control without the analog inputs.



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High End Elektromotoren PLETTENBERG				(Zul. Abw.)		(Oberfl.)	Maßstab 1:2	Gewicht: ca. 1300g
							(Werkstoff, Halbzeug) (Rohteil-Nr) (Modell- oder Gesenk-Nr)	
					Datum	Name	Motorsteuerung 140-220	
				Bearb.	29.01.2013	Wüst		
				Gepr.				
				Norm				
				Plettenberg Elektromotoren Rostocker-Str.30 34225 Baunatal			10-002.000-001-01	Blatt A4
Zust.	Änderung	Datum	Name	(Urspr.)			(Ers. f.:)	(Ers. d.:)

4 Mounting and connection rules:

If the controller is mounted in a closed case, the warm air must be replaced accordingly or cooled. At 220A the dissipated heat is about 200W.

At the front plate 1 are 3 black 8mm² (AWG8) cables for the motor phases which feed through AG12 cable glands and the sensor connector.

The motor phase A(U) should be connected with the red motor phase at Plettenberg motors.

The motor phase B(V) should be connected with the white motor phase at Plettenberg motors.

The motor phase C(W) should be connected with the blue/black motor phase at Plettenberg motors.

At the front plate 2 are the two battery cables and the 9 pole Sub-D connector for communication and the green status LED.

Battery plus is the red 8 mm² (AWG8) cable, battery minus is the black 8 mm² (AWG8) cable, which is located right next to it. **Caution:** The permissible sum of all battery cables (plus and minus) is 1m. The connections between each cell must be added to the battery cable length. If multiple batteries are connected in series, the length of the connecting cables between the battery packs must be added to the battery cable length. The MST60-290 has 33cm battery cables as standard length. That means that 100cm – 2 x 33cm = 34cm total cable length remain for the internal connections in the battery pack.

Warning: Exceeding the permissible length of the battery wiring, the motor controller may be damaged. The motor controller is not protected against reverse polarity. If the battery is reversed, the motor controller may be damaged. Use an appropriate fuse (eg Bussmann FWA-300B Littelfuse L15S300, L25S300) between the battery pack and controller. **Caution:** When the operating voltage is connected without a corresponding power contactor to the motor controller, it creates a very strong connecting spark. We recommend a 220R 4W resistor to pre charge the capacitors in the motor control before making the connection. As a safety disconnect switch (emergency stop) we recommend Tyco Electronics AMP + EVC135 and KILOVAC EV200 series. A protective diode must be installed which, when the connection between the battery and the control unit is interrupted, draws the stored energy from the motor inductivity into the battery if current flows through the motor. The protective diode must be installed in parallel with the serial circuit fuse and safety disconnect switch. Anode to plus motor controller and cathode to battery plus. We recommend a DSEI2X121-02A dual diode, please connect both diodes in parallel to archive the best protection.

Warning: Never operate the controller with significant load on a power supply without permission from us. At partial throttle the input current of the controller could have high current spikes, which could cause overvoltage spikes, if using a power supply instead of a battery. These spikes can destroy the motor controller and/or the power supply. Never use

the brake function, if using a power supply. At braking the energy is feed back to the power supply, the resulting overvoltage may destroy the power supply and/or the controller.

Reversing the direction: If you want to reverse the main direction of rotation, swap the sensor cable A and B and the motor phases B with C. You can also use the digital reverse input for reversing the direction(recommended).

Please note that the possible cable length of the RS232 cable depends on the used line driver and the used cable. At cable length over 2m we recommend a shielded CAT5 cable for the RS232 connection.

5 connectors and pin assignment:

Sensor connector: Hirose HR30-6P-6S (71) 32.3mmx12.6mm

Pin assignment hall sensor and motor temperature sensor:

Pin1: Sensor-C green
Pin2: +5V (20mA) red
Pin3: Sensor-B white
Pin4: GND black
Pin5: Sensor-A yellow or orange
Pin6: NTC (47k) blue

The sensor cable shield should be connected with sensor GND. Do not connect the sensor cable shield with the motor case and/or with the motor controller case.

Sub-D connector pin assignment:

Pin1: Brake input (aux), analog input 0-5V
Pin2: RxD
Pin3: TxD
Pin4: reverse switch (0V forward, 5V reverse)
Pin5: GND
Pin6: Throttle input, analog input 0-5V
Pin7: NC do not connect
Pin8: Impulse input, 5V Digital input
Pin9: +5V (30mA) Potentiometer supply

The shield of the RS232 cable should be connected with pin5 GND. Do not connect the shield with the motor case and/or with the motor controller case. Connect the shield only on one side of the cable.

For outdoor use, we recommend a Sub-D case with a gasket (eg RS720-3085).

6 Trouble free and safe operation:

The sum of all battery cable(plus and minus together) and the connections between the battery cells must not exceed 1m. Warning: Exceeding the length of the battery wiring, the motor controller may be damaged. The motor controller is not protected against reverse polarity. Warning: If the battery is connected in reverse, the motor controller will be damaged. Use the battery pack an appropriate fuse (eg Bussmann FWA-300B LittelfuseL15S300, L25S300).
The 5V power supply can deliver a maximum of 50mA. If the Hall sensors of the motor need in total of 20mA, 30mA are left for accelerator and brake pedals are available. Therefore check the power consumption of these components.

Warning: Even a short-term short-circuit on the 5V supply at the Sub-D connector leads to the failure of the power supply of the Hall sensors. This can cause a defect at the motor controller if the engine is running.

7 Safety functions :

Over voltage protection: At over 140V input voltage the MST controller switches off. If the input voltage rises over 150V the controller can be damaged, even if it is a short voltage spike.

Under voltage protection: Below 30V input voltage the MST controller switches of to protect the internal power supply voltages.

Motor temperature protection: If the motor temperature is exceed the motor temperature limit the MST controller switches off to protect the motor.

Controller temperature protection: If the controller temperature is exceed the controller temperature limit the MST controller switches off to protect the motor.

High pedal protection: To avoid that the controller went to full throttle in case the minus wire to the throttle potentiometer is broken, the MST controller switches off, if the voltage at the analog input exceed 4.95V for safety.

Start protection: To avoid that the motor starts unwanted at power on, the controller getting armed at power on after the throttle signal is at stop position.

Sensor error: If the positions sensors gives faulty signals the MST controller switches off to protect the motor and the controller.

8 Safety notes :

Over 60V battery voltage you leave the range of the Safety Extra Low Voltage! The wiring must be carried out at supply voltages above 60V only by qualified persons. It must be considered the relevant technical standards. Touching the motor terminals with the engine running with more than 60V battery voltage can cause injuries. Therefore, the wiring has to be made at battery voltages over 60V that no power contacts can be touched.

If you have questions please do not hesitate to contact us(technik@plettenberg-motoren.com).

Be careful with motors driving rotating parts.
If drive battery pack is connected, never stand in the hazard area of the rotating parts! Technical defects in electrical and mechanical systems can lead to an unexpected start of the motor and / or loose parts can greatly hurt you or persons located nearby! **Only use the controller when property and personal damages are excluded!** We are not responsible for the use in passenger-carrying equipment (see section 16 Legal Terms and Conditions)!

The controller is not protected against reverse polarity and confusion.
Never mix up with PLUS MINUS (reverse polarity)! This results in damage to the controller!
Never connect the drive battery on the motor connecting cable (confusion), this can lead to irreparable damage!

Never operate the controller with significant load on a power supply without permission from us. At partial throttle the input current of the controller could have high current spikes, which could cause overvoltage spikes, if using a power supply instead of a battery. These spikes can destroy the motor controller and/or the power supply. Never operate the controller with a power supply, when using the braking function. At braking the energy is feed back to the power supply, the resulting overvoltage may destroy the power supply and/or the controller.

Do not connect an external voltage source at the 5V sensor supply. Exceeding 5.5V on this connection may cause damage to the controller.

Never disconnect the drive battery with the engine running from the controller. This may damage the controller. If you have activated the safety disconnect switch (emergency stop) with the engine running, so a test run of the controller with a current-limited power supply without load is necessary. Only if it is ensured that the controller is without damage, the controller can be put into operation again.

Never exceed the maximum length of the cables between the controller and battery (max. length 2x50 cm). All serial connections between the battery cells must be added to the battery cable length. If multiple batteries are connected in series, the length of the connecting cables between the battery packs must be added to the battery cable length. The MST140-200 has 33cm battery cables as standard length. That means that 100cm – 2 x 33cm = 34cm cable length remain for all the connections in the battery pack. Exceeding the maximum length of the cables can cause damages to the controller.

Always disconnect the drive battery from the controller, if you do not use this longer period or if you want to charge the battery.
The monitoring functions can't detect every possible abnormal operating condition. The current limit does not protect the controller against short circuit between the motor cables. In case of a short circuit immediately switch off the motor to avoid permanent damage to the motor controller!
Also a current limitation at stalled motor will protect the motor only if the maximum allowed current of the motor is higher than the current limitation value of the controller. For example, if a 20A rated motor operated at the MST140-200, the current monitoring in the case of blocking will not detect an excessive current and the motor may be destroyed.

9 Initial operation of the drive system:

For the first test of the wiring of the drive system, we recommend to use a current limited power supply. A power supply with an output voltage of 35V will do the job. Run the motor only without load. At the first time please use only low throttle, if the motor is running rough or only vibrates, put the throttle back to zero and disconnect the battery cables.

Please check in this case the connection between the controller and the motor. There exist only 6 combinations to connect the motor phases:

	Controller Phase A	Controller Phase B	Controller Phase C
	Motor Phase A	Motor Phase B	Motor Phase C
	Motor Phase B	Motor Phase A	Motor Phase C
	Motor Phase C	Motor Phase A	Motor Phase B
	Motor Phase A	Motor Phase C	Motor Phase B
	Motor Phase B	Motor Phase C	Motor Phase A
	Motor Phase C	Motor Phase B	Motor Phase A

After the MST controller is connected to the battery voltage the controller send on the RS232-Interface a small short instruction including the actual control parameters:

```
* Kommandoliste:
* 's' Serieller Sollwert
* 'p' Poti Sollwert
* 'i' Impuls  Sollwert
* 'f' Forward
* 'r' Reverse
* '0' Off
* 'b' Brake
* 'm' 100% PWM(max)
* '9'  90% PWM
* '8'  80% PWM
* '7'  70% PWM
* '6'  60% PWM
* '5'  50% PWM
* '4'  40% PWM
* '3'  30% PWM
* '2'  20% PWM
* '1'  10% PWM
* '+'  +1% PWM
* '-'  -1% PWM
* 'g'+0.1% PWM
* 'l'-0.1% PWM
* 'w'  write setup
* 'h' Help


 MST140-200
Input = Analog
```

```
AnalogStop/Start/Full/BrakeMax =  500mV/ 549mV/4499mV/4499mV
ImpulsStop/Start/Full = 1150µs/1200µs/1900µs
Throttle Expo For+Rev =    0%
For. Throttle Inc/Dec =  328  / 328
For. Throttle Max/Min =  100% /   3%
Rev. Throttle Inc/Dec =   66  / 328
Rev. Throttle Max/Min =  100% /   3%
Brake    Inc/Dec      =   66  / 328
Brake    Max/Min      =  100% /   5%
Voltage  Max/Min      = 140.0V/ 30.0V
Phase/BatteryAmp  Max = 220.0A/220.0A
Temp Max Motor/Power  = 100°C / 110°C
Motor RPM Limit       = 240000
Motor Polepairs       =   1
```

10 LED indicator functions and Error codes:

LED continuous light : No error
LED 1x Blinking : Error 0x0001 under voltage
LED 2x Blinking : Error 0x0002 over voltage
LED 3x Blinking : Error 0x0004 over current
LED 4x Blinking : Error 0x0008 over temperature controller
LED 5x Blinking : Error 0x0010 over temperature motor
LED 6x Blinking : Error 0x0020 Motor blocked
LED 7x Blinking : Error 0x0040 Sensor error
LED 9x Blinking : Error 0x0100 Error Analog input(voltage too high)
LED 10x Blinking : Error 0x0200 Error Impulse width

11 Standard Setup Values:

Input	= Analog
AnalogStop/Start/Full/BrakeMax	= 500mV/ 549mV/4499mV/4499mV
Impuls Stop/Start/Full	= 1150µs/1200µs/1900µs
Throttle Expo For+Rev	= 0%
For. Throttle Inc/Dec	= 328 / 328
For. Throttle Max/Min	= 100% / 3%
Rev. Throttle Inc/Dec	= 66 / 328
Rev. Throttle Max/Min	= 100% / 3%
Brake Inc/Dec	= 66 / 328
Brake Max/Min	= 100% / 5%
Voltage Max/Min	= 140.0V/ 30.0V
Phase/BatteryAmp Max	= 220.0A/220.0A
Temp Max Motor/Power	= 100°C / 110°C
Motor RPM Limit	= 240000
Motor Polepairs	= 1

12 RS232-Interface-Parameters :

115kbaud 8 Datenbits, no parity, 1 Stopbit.

13 RS232-Interface-Protocol-Description:

Data on the RS232 interface in analog mode:

```
T=3.649V,a=0.000V,PWM= 787,U= 34.9V,I=  3.7A,RPM=  1482,con= 28°C,mot= 26°C
T=4.964V,a=0.000V,PWM=1000,U= 35.0V,I=  4.0A,RPM=  1896,con= 28°C,mot= 26°C
```

„T“ means Throttle input, the big letter shows that it is active.
„a“ means Aux input (Brake), the small letter shows that the brake is inactive at the moment as the throttle input has priority over the brake input.
„U“ is the Input voltage
„I“ is the Phase current (no average function and no synchronization with the commutation)
„RPM“ is the motor speed in rpm
„con“ is the power stage temperature
„mot“ is the motor temperature

If the brake is active the “a“ change to “A“ and the “T“ changes to “t“:

```
t=0.000V,A=2.501V,PWM= 500,U= 35.0V,I=  0.0A,RPM=     0,con= 28°C,mot= 26°C
```

The Data on the RS232 interface in serial mode:

```
S=3.649V,a=0.000V,PWM= 787,U= 34.9V,I=  3.7A,RPM=  1482,con= 28°C,mot= 26°C
```

„S“ shows that the serial control mode is active.

14 RS232-Interface-Commands :

1 Byte Commands:

"s": switch to serial RS232 Input
"p": switch to analog input(Poti)
"i" : switch to impulse input(compatible with model radio control)
"f": forward
"r": reverse
"0": Motor off
"b": Brake
"m": 100% PWM(maximum)
"9": 90% PWM
"8": 80% PWM
"7": 70% PWM
"6": 60% PWM
"5": 50% PWM
"4": 40% PWM
"3": 30% PWM
"2": 20% PWM
"1": 10% PWM
"+": +1% PWM
"-": -1% PWM
"g": +0,1% PWM(V2 or higher)
"l": -0,1% PWM(V2 or higher)
"t" : activate 2s Timeout at the serial Interface(V2 or higher)
"h": help
"a": switch to adjust Mode
"e": exit adjust Mode

2 Byte Commands(only in Adjust Mode):

"sd": set default
"sp": show parameter
"wp": write parms
"se": show the last 8 errors

5 Byte Commands(only in Adjust Mode)

"rp": RPM limit[1000RPM] "rp100" = 100000U/min
"cl": current limit[A] "cl100" = 100A
"il": input current limit[A] "cl100" = 100A(V5 or higher)
"uv": under voltage [V] "uv020" = 20V
"ov": over voltage[V] "ov100" = 100V
"mt": motor temperature limit [°C] "mt100" = 100°C(V3 or higher)
"ct": controller temperature limit [°C] "ct110" = 110°C(V3 or higher)
"te": throttle expo curve in % "te000" = linear "te100" = 100% expo(V8 or higher)
"ti": throttle increase forward "ti001" = +1count/ms "ti010" = +10count/ms
"td": throttle decrease forward "td001" = -1count/ms "td010" = -10count/ms
"tl": throttle limit forward in % "tl100" = 100% "tl050" = 50%
"tm": throttle minimum forward in % "tm010" = 10% "tm050" = 50%
"ri": reverse throttle increase "ri001" = +1count/ms "ri010" = +10count/ms
"rd": reverse throttle decrease "rd001" = -1count/ms "rd010" = -10count/ms
"rl": reverse throttle limit in % "rl100" = 100% "rl050" = 50%
"rm": reverse throttle minimum in % "rm010" = 10% "rm050" = 50%
"bi": brake increase "bi001" = +1count/ms "bi010" = +10count/ms
"bd": brake decrease "bd001" = -1count/ms "bd010" = -10count/ms
"bl": brake limit [%] "bl100" = 100% "bl050" = 50%
"bm": brake minimum [%] "bm010" = 10% "bm050" = 50%
"af": analog input full throttle voltage "af450" = 4.50V
"ah": analog input halt motor voltage "ah050" = 0.50V
"as": analog input start motor voltage "as060" = 0.60V
"ab": analog input full brake voltage "ab500" = 5.00V(V5 or higher)
"if": impulse input full throttle "if200" = 2.0ms
"ih": impulse input halt motor "ih100" = 1.0ms
"is": impulse input start motor "is110" = 1.1ms
"pp": motor pole pairs count "pp001" = 2-Poles
"ot": output time RS232 [ms] "ot200" = 200ms (minimum 7ms) (V4 or higher)

RS232 Command examples:

1. CR/LF is not necessary
2. After connecting the supply voltage to the MST140-200 controller the analog input is active by default. If you want to use the serial control input, you have to send „s“ after the initialization of the controller.

Examples:
If you want to run the motor forward with 10% throttle PWM you send „1f“.
If you want to increase the throttle PWM to 33% you send „3+++“.
If you want to increase to maximum throttle you send „m“.
If you want to switch off the motor current you send a „0“.
If you want to brake with 10% brake PWM you send a „1b“.
If you want to increase the brake PWM to 33% you send „3+++“.
If you want to run the motor with 8% throttle PWM you send „1--r“.
If you want to change a parameter you have to switch the MST into the adjust mode by sending an „a“. That is only possible if the motor does not run.
For example if you want to change the pole pair count to 10 pole pairs(20 pole motor) that the MST sending the shaft speed instead of the electrical speed on the RS232 interface send an „a“ for adjust mode, after that you send „pp010“ for 10 pole pairs and „e“ for exit adjust mode. If you want to store the changed parameter, you have to leave the adjust mode by sending a “wp” instead of the “e”.

15 Sensor Phase Mapping :

Commutation Sequence Forward

	Step1	Step2	Step3	Step4	Step5	Step6	Error1	Error2
Phase A(U)	+	Z	-	-	Z	+	Z	Z
Phase B(V)	Z	+	+	Z	-	-	Z	Z
Phase C(W)	-	-	Z	+	+	Z	Z	Z
Sensor A	1	1	0	0	0	1	0	1
Sensor B	0	1	1	1	0	0	0	1
Sensor C	0	0	0	1	1	1	0	1

Commutation Sequence Reverse

	Step1	Step2	Step3	Step4	Step5	Step6	Error1	Error2
Phase A(U)	-	-	Z	+	+	Z	Z	Z
Phase B(V)	Z	+	+	Z	-	-	Z	Z
Phase C(W)	+	Z	-	-	Z	+	Z	Z
Sensor A	1	1	0	0	0	1	0	1
Sensor B	0	0	0	1	1	1	0	1
Sensor C	0	1	1	1	0	0	0	1

Z: high impedance, +:plus, -:minus, 1:>3V, 0:<2V

16 Rechtliches:

Es wird keine Haftung übernommen für Sach- und Vermögensschäden, sowie Sach- und Vermögensfolgeschäden:

- **durch unsachgemäße Handhabung.**
- **an sämtlichen Fluggeräten wie Ultraleichtflugzeugen, Drachen, Fallschirmen, Flugmodellen, Raketen, Drohnen, Hängegleitern und Gleitseglern oder deren Teilen, sowie Schäden durch Grounding von o.g. Fluggeräten .**
- **an fremden Luftfahrzeugen oder Luftfahrzeugteilen**
- **durch Anwendungen aller Art, die dem deutschen Kriegswaffengesetz unterliegen.**

Generell ausgeschlossen sind Vermögens- und Vermögensfolgeschäden.

Die Steuerung wurde nicht den für Flugzeugen vorgeschriebenen Sicherheits- und Dauertests unterzogen. Es wird keinerlei Haftung übernommen für Personen- bzw. Sachschäden, Sachfolge- und Vermögensschäden, sowie Vermögensfolgeschäden beim und durch den Betrieb in manntragenden Fluggeräten!

Im Zweifel holen Sie bitte eine schriftliche Zustimmung für den Betrieb in Ihrer speziellen Anwendung ein.

Grundsätzlich gelten unsere Allgemeinen Geschäftsbedingungen.