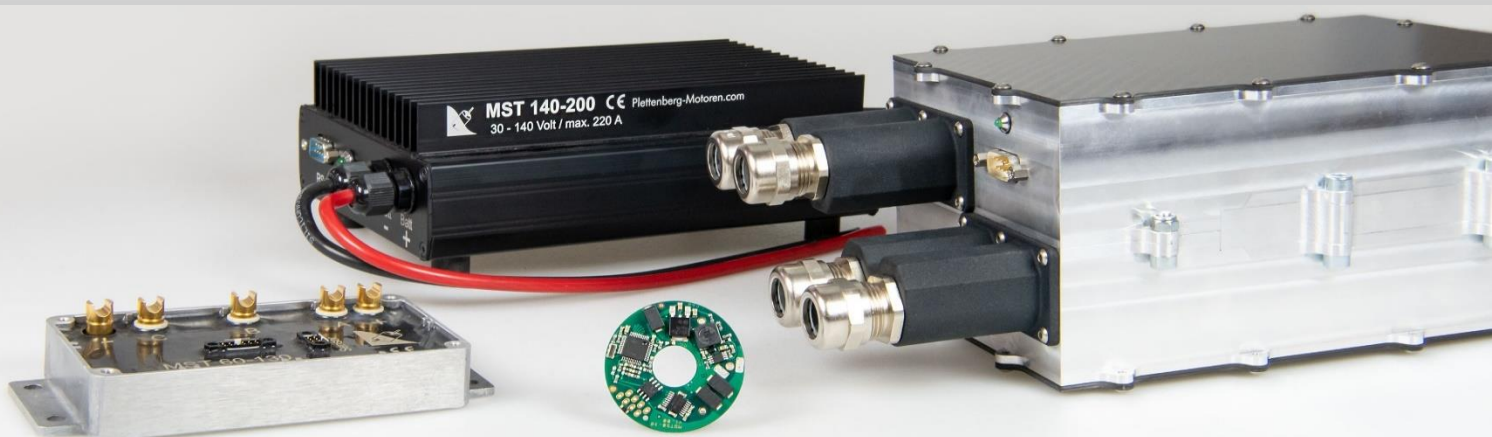


Operational Manual

MST 60-130 / MST 60-130 K



List of contents

List of contents	2
1. Notes regarding this document	3
Legal provisions	3
Liability	3
Scope of validity	4
Target group	5
Updated additional information	5
Symbols	5
Nomenclature	5
2. Safety	6
Intended use	6
Safety Information	6
3. Product overview	9
Type designation	9
Figure	9
Technical data	9
Environmental and climatic conditions	10
Interfaces	10
Block Diagram	11
4. Commissioning	12
Safety during commissioning	12
Connection and assembly	13
Protection	14
Reversing the direction of rotation	14
Connector	15
Pin allocation	16
Soldered connections	17
Power cable lengths	19
Commutation sequences	20
Mains adapter operation	21
RS-232 connection	22
CAN connection (only optional)	26
5. Configuration	27
Establishing the connection	27
Commands in Adjust mode	27
Expanded description	29
6. Check display	34
7. Protective functions	35
8. Repetitive handling	36
Care	36
9. Disposal	36
10. Service / Contact	36
11. EU Declaration of Conformity	37

1. Notes regarding this document

Legal provisions

The information contained in this document is the sole property of Plettenberg Elektromotoren GmbH & Co. KG. Publication, in whole or in part, requires the express written consent of Plettenberg Elektromotoren GmbH & Co. KG. An internal company duplication, which is intended for the evaluation of the product or for the appropriate assignment, is permitted and not subject to approval.

Liability

We shall not be liable for the slightly negligent breach of non-essential contractual obligations. In the case of slightly negligent breaches of essential contractual obligations, also if they have been committed by our legal representatives or our vicarious agents, our liability is limited to the foreseeable damage typical for the contract. Unlimited liability on our part exists for damages to body and health of the customer culpably caused by us, our legal representatives or our vicarious agents, as well as in the case of intent and gross negligence and for the absence of the guaranteed quality.

If damage caused by slight negligence on the part of the customer attributable to us is covered by an existing insurance policy of the customer, our liability in the event of damage to property and/or financial loss shall be limited to the disadvantages for the customer associated with the claim against the insurance company.

We shall not be liable for damage caused by improper handling of our products as well as improper influence of third parties on our products, improper assembly and/or installation, overstressing or overvoltage, unless these are due to our fault or a fault of our representatives or vicarious agents. The same applies in the event of unauthorised and improper repairs or interventions in the delivery item by the purchaser or third parties.

We shall not be liable for damage caused by incorrect information and communications from the customer, unless these are due to our fault or a fault of our representatives or vicarious agents.

We expressly point out that our motors, controls and other products have not been subjected to the safety and endurance tests prescribed for aircraft and aircraft equipment. We are therefore not liable for damage of any kind which occurs during and/or through the operation of our motors, controls and other

products in/on manned aircraft, in/on aeroplanes, microlight aircraft, model aircraft, drones, rockets, hang-gliders and gliders, parachutes, air traffic control systems and any other type of aircraft. We are also expressly not liable for damages due to aircraft being grounded.

We expressly point out that our motors, controls and other products are not approved for use in control systems of nuclear reactors.

We are not liable for any kind of damage caused during and/or by the operation of our motors, controls and other products in control systems of nuclear reactors or in/at nuclear reactors.

We are not liable for damages of any kind that arise from applications and use of our products that are subject to the German war weapons act.

Our liability under the product liability act remains unaffected.

Plettenberg Elektromotoren GmbH & Co. KG

Rostocker Straße 30
D-34225 Baunatal – Großenritte
Tel: +49 (0) 56 01 97 96-0
Fax: +49 (0) 56 01 97 96-11
Internet: www.Plettenberg-Motoren.com
Email: Info@Plettenberg-Motoren.com

© 2020 Plettenberg Elektromotoren GmbH & Co. KG. All rights reserved.

Scope of validity

This document applies for the following device types:

Device type
MST 60-130
MST 60-130K

Software version
Version 8

Target group






The activities described in this document may only be executed by qualified, skilled workers. The qualified, skilled workers must possess the following qualifications:

- Knowledge regarding the functional methods and operation for the product
- Knowledge and observation of these instructions with all safety notes
- Technical standards must be observed

Updated additional information

Links regarding updated additional information can be found under: www.Plettenberg-Motoren.com

Symbols

Symbol	Clarification
	Warning, the non-observance of which leads directly to death or serious injury
	Warning, the non-observance of which may result in serious injury
	Warning, the non-observance of which may result in minor or moderate injury
	Warning, non-observance of which may result in damage to property
	Information which is important for a specific subject or goal, but not relevant to safety.

Nomenclature

Full name	Name used in this document
Controller Area Network	CAN
Ground (earth)	GND
Motor controller	MST
Pulse Width Modulation	PWM

2. Safety

Intended use

The area of validity is defined as:

- Motor control

The following are considered improper use in the sense of a foreseeable misuse:

- Using the motor controller in manned vehicles
- Using the motor controller in public vehicles and transport
- Using the motor controller as a toy
- Using the motor controller in potentially explosive atmospheres
- Any use other than those provided for

Safety Information

This chapter contains safety instructions which must always be observed when working on and with the product. In order to prevent personal injury and property damage and to ensure continuous operation of the product, always read this chapter carefully and follow all safety instructions at all times.

Danger

Slight, moderate or severe injuries

Malfunctions can be caused by electromagnetic interference. Communication equipment and other devices in the surroundings must not be exposed to impermissible electromagnetic interference.

- The total length of all battery connection cables (positive and negative) must not exceed 1m (incl. cell connections).
- The product must be inspected and the contacts must be checked again before commissioning.
- The motor controller must be protected against the motor phases being mixed up or short-circuited.
- Operation without a motor connected is forbidden.
- The interfaces (RS232, analog and digital) must be wired minimally (see Figure 6 page 22).
- The sensor supply (5V) shall not be supplied with an external power source.
- The current limitation must be adapted to the motor used.
- Modifications to the product are not permitted.

Danger

- The interfaces are not galvanically isolated.
- The positive and negative lines must be laid straight together (no space).
- Connector contacts must be insulated to prevent short-circuits.

Warning

Electric shock, burns, fire
e.g., due to live parts

- The product as well as the contacts must be inspected for overheating, soiling, deformation, fire and moisture before commissioning.
- In order to prevent high-resistance connections, use only 6mm gold contact connectors from Plettenberg Elektromotoren for battery cables and the motor phases.
- Assembly and disassembly shall be carried out only when in de-energised condition.
- Always ensure proper handling.
- The product must never be contaminated with foreign bodies / adhesives and/or paint during assembly.
- Always ensure that the motor controller is properly fastened.
- Always ensure that the motor controller is properly set up.
- The product must be sufficiently cooled.
- Operation of the motor at idling speed without load is prohibited.

Warning

Danger from magnetic radiation

Malfunction / destruction of magnetically sensitive parts

- The motor controller must never be operated in the vicinity of magnetically sensitive parts such as pacemakers or data carriers.

Caution

Burns

Carelessly touching hot surfaces

- After operation of the product, the surfaces may still be hot. Always allow the product to cool down.

Notice

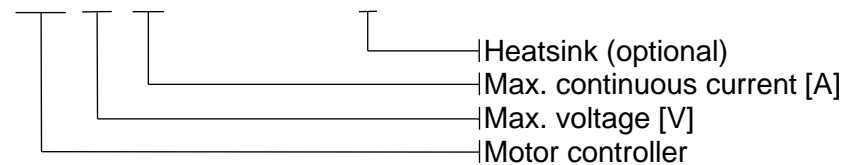
Destruction due to thermal overload/overvoltage/overcurrent

- Always ensure sufficient cooling for the motor controller (air or water cooling).
- Maximum load on the motor controller is only permissible for short-term operation. The duration is dependent on the operating conditions and the cooling. The motor controller temperature shall not exceed 110°C under any circumstances, otherwise the controller will shut down.
- When using motor from other suppliers, it is essential that this is approved by Plettberg Elektromotoren.
- If the battery for the drive is not able to accept braking energy, the motor controller will shut down.
- The battery for the drive shall not be disconnected during running operation.
- A short-circuit, on the 5V supply at the target control interface, will result in a failure of the power supply for the Hall sensors. If the motor is running this can lead to defects on the motor controller.
- For operation with a mains adapter, note the instructions in chapter "Mains adapter operation" page 21.

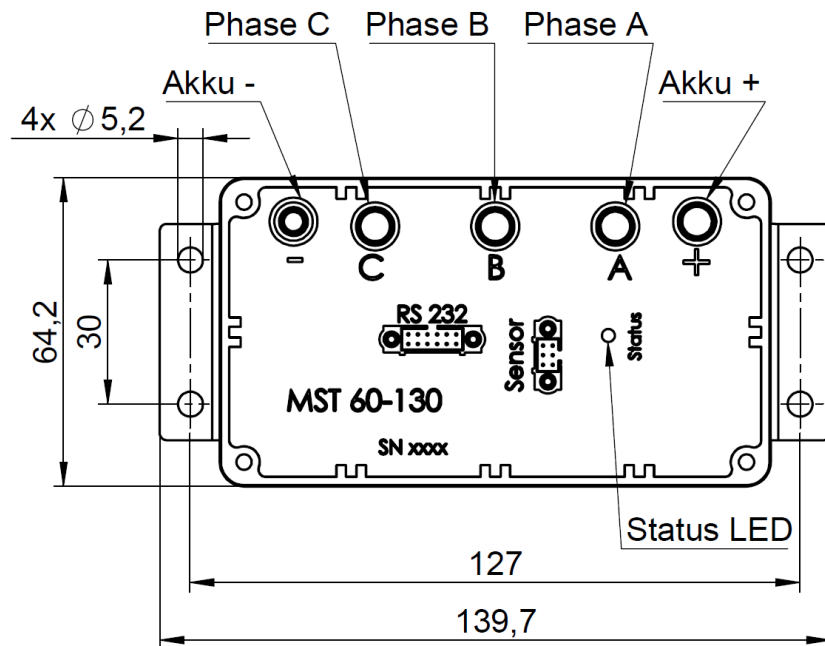
3. Product overview

Type designation

MST 60-130 / MST 60-130 K



Figure



Technical data

Weight	ca. 320g ca. 440g (with heatsink)
Length	139.7mm (with lugs) 115mm (without lugs)
Width	64.2mm
Height	21mm 36mm (with heatsink)
Max. rotational speed:	240,000rpm (electrical)
Max. continuous power ¹	7800W
Max. short-term power ¹	15600W
Rated voltage range of the battery	12 – 52V
Supply voltage	10 – 60V
Maximum current	260A
Continuous current ¹	130A (at 25°C ambient temperature) 105A (at 50°C ambient temperature) 74A (at 75°C ambient temperature)

¹ The power or continuous current specifications relate to motor controllers with heatsinks (3°C/W) in standard atmospheres (1013 mBar 25°C) and 100% PWM. The continuous current is also heavily influenced by the motor and motor timing, i.e. the continuous current could also be lower depending on the motor used. The continuous current can also be increased through forced cooling (forced cooling with a fan or air stream).

Power dissipation at 130 A	ca. 25W
Heatsink (optional)	4.5°C/W 3°C/W (at 1m/s air flow)
Analog inputs for accelerating and braking	0 – 5V
Analog input for motor temperature	NTC 47kOhm
Digital inputs (Direction switch and PWM)	
High level	1.5 - 28V, recommended 5V
Low level	0 - 0.5V
PWM (optional)	10 – 400Hz
Digital switch output	Max. 60V / 2A
RS232 interface	115,200Baud / 8N1
CAN interface (optional)	CAN2.0
Position input	3x Hall sensors (120° electrical)
Capacitor pre-charging	Internal (anti-flash)

Environmental and climatic conditions

Ambient temperature	-20°C up to +100°C
Permissible humidity	Non-condensing
Protection class	IP40

Interfaces

Motor controller

Motor phases (A, B and C)	Gold socket contact 6mm
Battery positive pole	Gold socket contact 6mm
Battery negative pole	Gold pin contact 6mm
RS 232 / analog / digital / CAN	Harwin 12-pole (M80-5101242)
Motor sensor	Harwin 6-pole (M80-5101242)

Cable side

Motor phases (A, B and C)	Gold pin contact 6mm
Battery positive pole	Gold pin contact 6mm
Battery negative pole	Gold socket contact 6mm
RS 232 / analog / digital / CAN	Harwin 12-pole (M80-4611242)
Motor sensor	Harwin 6-pole (M80-4610642)



The **MST 60-130** is delivered with analog interface as standard.

Block Diagram

The block diagram (see Figure 1) serves to illustrate the functionality and the functional relationships of the Plettenberg motor control.

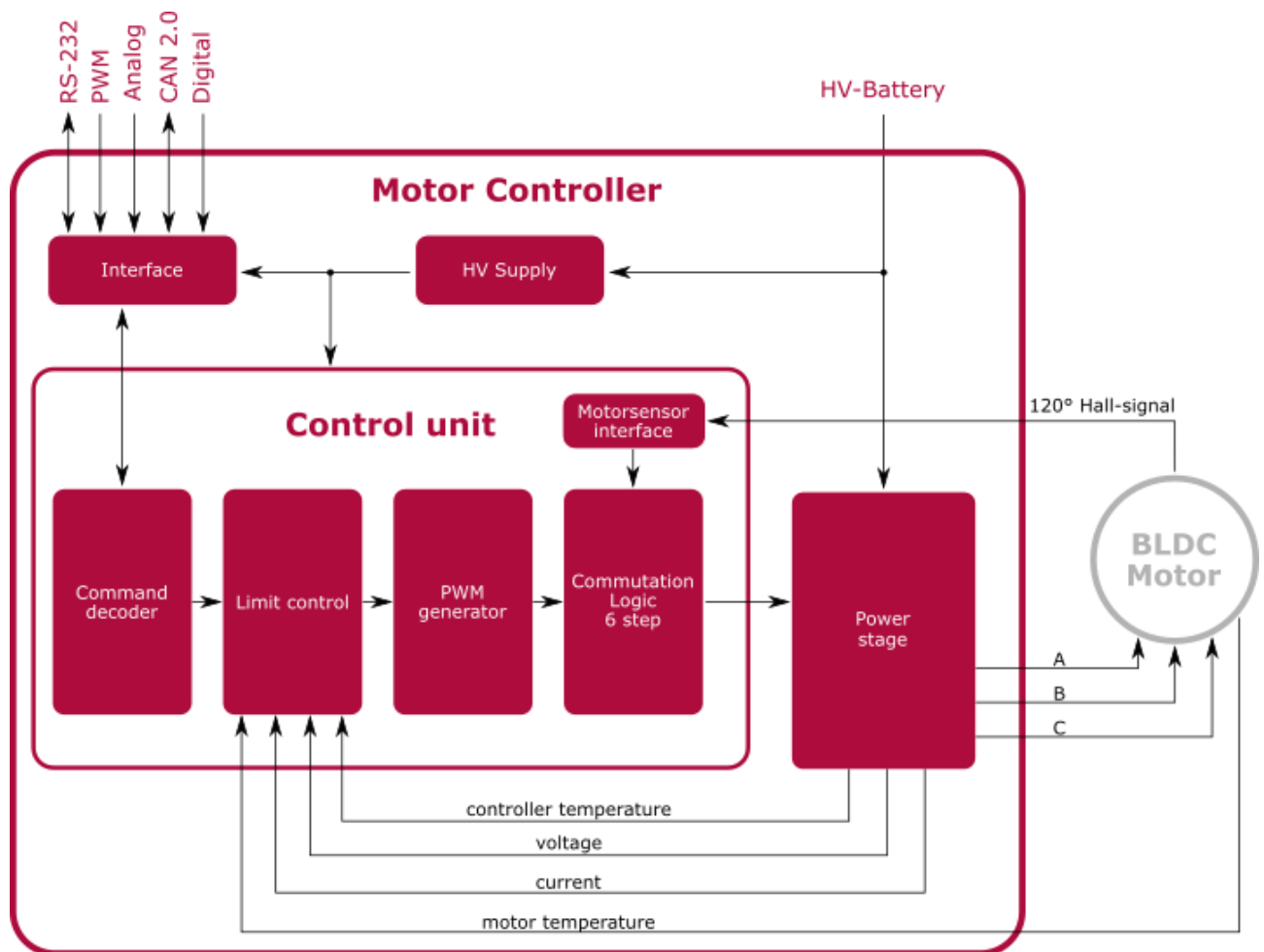


Figure 1: Block Diagram Plettenberg Motor Controller

4. Commissioning

Safety during commissioning

Danger

**Severe, moderate or minor injuries.
Destruction or damage to the product**

- Safety instructions from Chapter 2 must be complied with!
- The battery may only be connected to the motor controller immediately before use.
- During motor operation with airscrews, it is essential to ensure that no people are located to the side or in front of the rotation plane.

Caution

Burns

Carelessly touching hot surfaces

Destruction of / damage to the motor controller

- In closed housings, ensure there is adequate cooling.
- The total length of all battery connection cables (positive and negative together) must not exceed 1m.²
- The motor controller is not protected against reverse polarity connection.
- Use suitable fuses.³
- Use safety disconnectors.⁴
- The interfaces (RS232, analog and digital) must be wired minimally. (see Figure 6 page 22)
- Special conditions apply to operation with a mains adapter. (see page 21)
- Earth yourself before touching a component. (electrostatic discharge)
- Crimp contacts in accordance with the instructions of the contact manufacturer. These must be followed.

² If several batteries are connected in series, the connection lines between the battery packs must also be included in the calculation of the battery connection cable length. For example, if a 33 cm long battery connection cable is used with the MST 60-130, 34 cm of total cable length remains available for the battery pack. (100 cm – 2 x 33 cm = 34 cm)

³ e.g.: Littelfuse BF1 58V 200A 142.5631.6202, 142.7010.6202, MEGA-Fuse 58V 200A.

⁴ e.g.: Tyco Electronics KILOVAC EV100 series or KILOVAC EV200 series.

Connection and assembly

Notice

Destruction of / damage to the motor controller due to incorrect allocation of the motor phases or sensor allocation

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.

If motors from other manufacturers are used, the following points must be observed:

- The MST 60-130 motor controller has been developed specially for the use of brushless Plettenberg electric motors with sensors.

There are 6 options for connecting the motor phases:

Motor controller <i>MST 60-130</i>		
Phase A	Phase B	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

The motor sensor cable (6 pin Harwin) is connected to the motor controller (sensor). The battery positive terminal is the outermost socket, the battery negative terminal is the 6mm pin (see Figure 2).

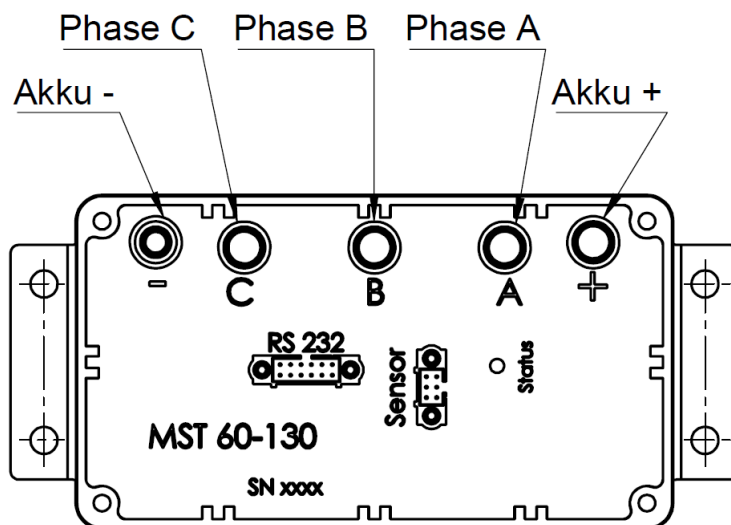


Figure 2: MST 60-130 schematic

Protection

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 (see Figure 3). Anode to plus motor controller and cathode to battery plus. We recommend a VS-100BGQ100 or a STPS80170CW diode.

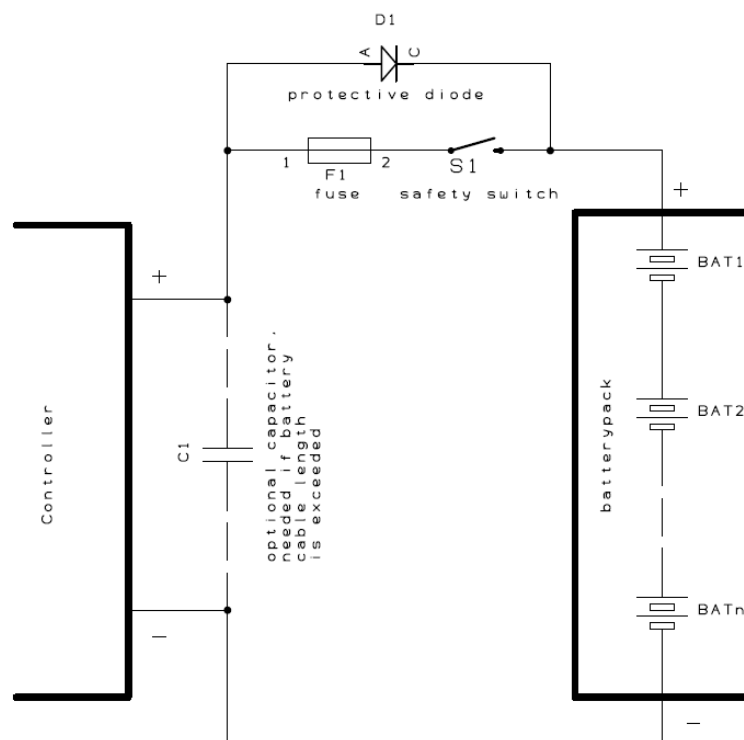


Figure 3: schematic drawing protection

Reversing the direction of rotation

i Pin 7 (control cable) is used as the reverse input switch for reversing the direction. The following levels indicate the selected rotational direction:

Forwards	0V
Backwards	5V

Note:

In the case of motors with a preferred direction of rotation, the motor timing changes.

Connector

Notice

Destruction of / damage to the motor controller due to poor-quality or high-resistance connections.

Crimping pliers can be ordered from Plettenberg Elektromotoren as an accessory. If the motor and the motor controller are ordered together, there is an option to have the cable fully finished.

Observe the installation instructions for Harwin Datamate J-Tek series.

Further information can be found at:

https://cdn.harwin.com/pdfs/C005XX_M80_and_M83_Datamate_Series_Connectors.pdf

The following crimping pliers are recommended:

Description	Crimping pliers / crimp tools
Manufacturer's part number	M22520/2-01
Manufacturer	Harwin, TE, DMC Tools, Astro Tool
Selector position	6
Positioner	T5747 (Harwin) K1419 (DMC Tools)

The shield of the sensor cable should be connected to pin 4 (GND).

The cable shield should **not** be connected to the motor housing or motor control housing.

The shield of the control cable should be connected to pin 9 (GND).

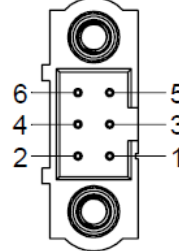
The cable shield should **not** be connected to the negative terminal of the battery or to the housing of the motor controller.

Pin allocation

Motor sensor

Pin	Designation	Colours
1	Motor sensor C	Green
2	+5V sensor supply (max. 20 mA)	Red
3	Motor sensor B	White
4	GND	Black
5	Motor sensor A	Yellow/orange
6	Temperature sensor input (NTC 47k)	Blue

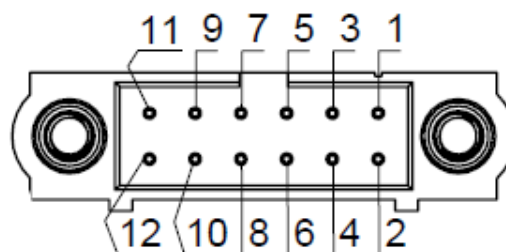
Sensor Motor



RS 232 / analog / digital

Pin	Designation	Description
1	Target value, brake (Aux)	Analog input 0-5V
2	Target value, throttle (Throttle)	Analog input 0-5V
3	RxD	RS232 receiver signal
4	NC	Not used
5	TxD	RS232 transmitter signal
6	Pulse input (optional)	Digital input ⁵
7	Reverse switch	0V forwards / 5V reverse
8	+5V (max. 30mA) ⁶	Potentiometer supply
9	GND	Signal Ground
10	CAN-H (optional)	CAN bus high
11	CAN-L (optional)	CAN bus low
12	I/O (optional)	Digital switch output (max. 60V / 2A) or control part supply

RS 232 / Analog / Digital



⁵ PWM signal high min. 1.5V, recommended 5V, max. 28V, low max. 0.5V

⁶ Supply for an electronic accelerator pedal and/or electronic brake pedal. The 5V power supply can deliver a maximum **total** of 50mA. If the Hall sensors of the motor require a total of 20mA, 30mA remain available for the accelerator pedal and brake pedal.

Soldered connections

Notice

Destruction of / damage to the motor controller due to poor-quality or high-resistance connections.

Caution

Burns

Caused by carelessly touching hot surfaces.

Additionally required tools/materials (not included)

- No-Clean lead-free solder
- Heat shrink tubing
- Cable
- Soldering iron rated at least 100W
- Hot air gun

The following cable types are available from Plettenberg Elektromotoren:

<i>Silicone stranded wire, 4sq.mm, "EG" red</i>	Art. no.: kabel-00020
<i>Silicone stranded wire, 4sq.mm, "EG" black</i>	Art. no.: kabel-00019
<i>Silicone stranded wire, 4sq.mm, "EG" yellow</i>	Art. no.: kabel-00021
<i>Silicone stranded wire, 6sq.mm, "EG" red</i>	Art. no.: kabel-00044
<i>Silicone stranded wire, 6sq.mm, "EG" black</i>	Art. no.: kabel-00043
<i>Silicone stranded wire, 6sq.mm, "EG" yellow</i>	Art. no.: kabel-00045
<i>Silicone stranded wire, 8sq.mm, "NEG" red</i>	Art. no.: kabel-00016
<i>Silicone stranded wire, 8sq.mm, "NEG" black</i>	Art. no.: kabel-00015



Figure 4: 6.0mm gold pin system from Plettenberg with internal fins

The high-quality 6mm gold pin system (see Figure 4) developed in-house is available exclusively from Plettenberg Elektromotoren. The feature of this system is that the fins are located inside the socket. The plug-in connection is insensitive to sparks arising through connection to the battery. Even after many uses, the spring force is maintained. It is not permitted to machine the plug-in connectors.

Loose plug connections are often the cause of faults and problems. Interruption of electrical contact during operation can be almost completely ruled out with these connectors.

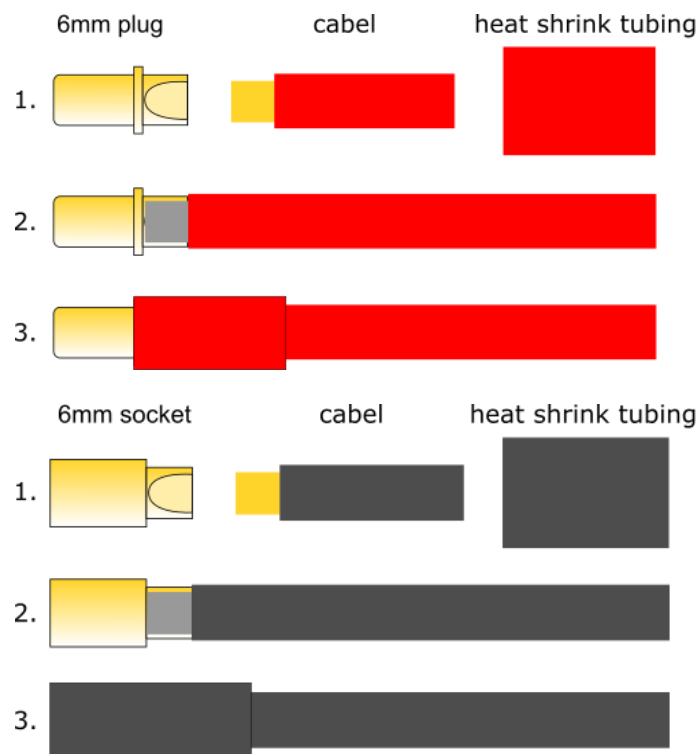


Figure 5: Assembling the 6 mm gold contact system

The assembly of the 6mm gold contact system is carried out in the sequence shown above (see Figure 5):

1. Strip ca. 8mm of insulation from the end of the cable and trim the heat shrink tubing to size (socket contact 30mm, pin contact 20mm).
2. Tin the stripped cable end and check that the tinning is complete. Then insert the tinned end into the recess in the gold pin/socket and solder it in place.
3. Check the soldered joint to ensure that the cable and the recess are both fully soldered.
4. After the soldering process, check the contact surfaces for contamination (flux) and clean with a suitable cleaning product if necessary.
5. Slide the trimmed heat shrink tubing over the contact and shrink with a heat gun.

Power cable lengths

Notice

Destruction of / damage to the motor controller due to the connection cable between the motor controller and the battery being too long.



Caution

Burns

Carelessly touching hot surfaces

The maximum cable length from the motor controller to the battery is dependent on the maximum phase current required. The phase current can be higher than the input current of the motor controller by a factor.

The total cable length includes the positive and negative lines as also the cable lengths in the battery, if applicable.

Phase current	Max. total cable length
260A	50cm
130A	100cm
65A	200cm
40A	Irrelevant

Important:

The phase current is not the input current (other than at 100% PWM). The phase current reflects the required torque of the motor. The accelerator setting (PWM) is the switch-on time for the motor. Only during this time is the phase current the same as the battery current. Driven by the motor inductance, the phase current continues to flow for the rest of the time.

If the power cable is to be extended, additional capacitors at the input are absolutely essential.

The length of the phase cable is not critical with regard to the phase current.

Commutation sequences

Notice

Destruction of / damage to the motor controller due to short-circuits or incorrect wiring.

Block commutation with sensors

The feedback of the rotor position is implemented through three sensors integrated into the motor. The sensors are electrically offset by 120° and deliver six different switch positions per revolution. The three partial windings are driven by the motor controller in accordance with the sensor information.

Forwards switch positions:

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Fault 1	Fault 2
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

Reverse switch positions:

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Fault 1	Fault 2
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

Index	Description
Z	High-resistance
+	Plus
-	Minus
1	> 3V
0	< 2V

Mains adapter operation

Caution

Burns

Caused by carelessly touching hot surfaces.

Destruction of / damage to the motor controller

Note the following points:

- Drive the motor controller only when a motor is connected.
- No coupling on the motor shaft.
- Only approved for checking cabling and control.
- Max. voltage **no** more than 2V over the minimum voltage of the connected *MST*.
- Set current limiting of the power supply to a quarter of the rated current of the *MST*.
- The brake function **must** be deactivated.

Explanation:

In partial load operation, depending on the motor used, a high current ripple is generated on the supply side of the controller. This can lead to overvoltage peaks that damage the power supply unit and/or the controller.

The braking function generates energy feedback during braking. In some circumstances, the resulting overvoltage may destroy the power supply unit and/or the controller.

RS-232 connection

Notice

Additional required material (not included):

- USB serial adapter (USB to RS232)
MST programming adapter
Art. no.: Elektronik-00198
- Serial cable, if required (not null modem cable)

Figure 6 is the schematic (cabling) for the minimal wiring of the MST in conjunction with a PC.

Figure 7 describes the wiring with analog throttle, analog braking and reverse switch of the MST in conjunction with a PC.

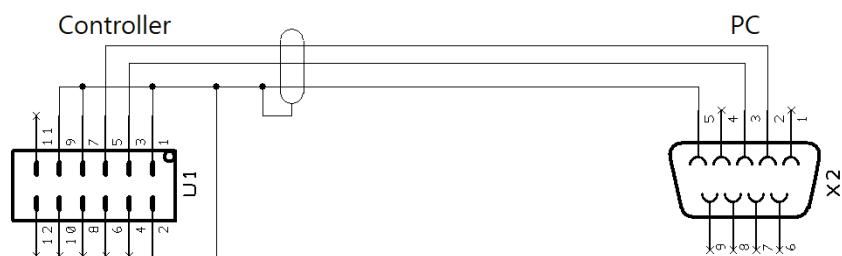


Figure 6: RS232 Connection without analog control

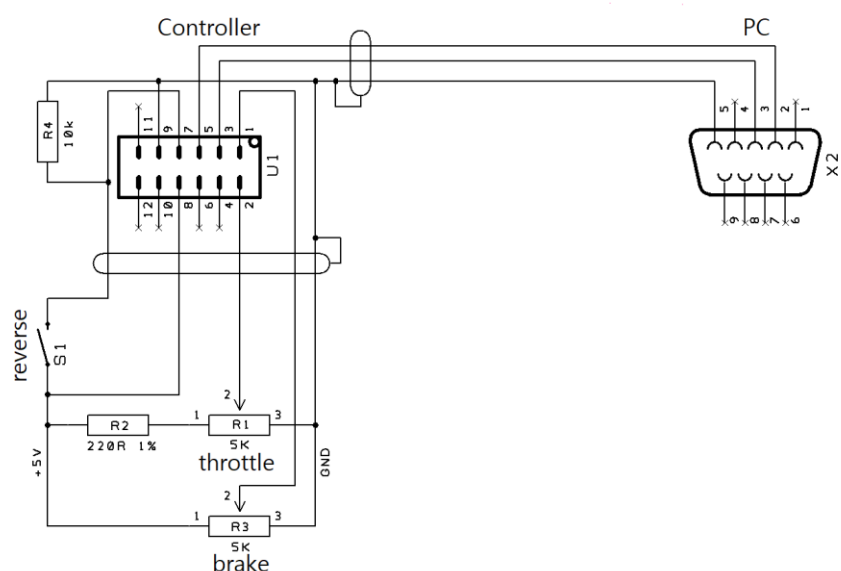


Figure 7: analog throttle control and analog braking control and reverse switch and RS232 connection

Cable requirements:

The cable length and cable quality have an effect on the signal quality. Observe the following cable requirements! With line lengths over 2m, screened CAT5 cable must be used.

The following cable types are available from Plettenberg Elektromotoren and can be ordered by the metre:

Alpha Wire 3306 SL005 sensor cable, 6 x AWG28
 Art. no.: kabel-00032

Alpha Wire 3308 SL005 sensor cable, 8 x AWG28
 Art. no.: kabel-00067

Alpha Wire 3310 SL005 sensor cable, 10 x AWG28
 Art. no.: kabel-00135

All cables fulfil the MIL-W 16878 type B specification.

Procedure:

Connect the serial RS-232 interface with your computer or laptop.

The RS-232 interface is parametrised as follows:

Baud rate	115200 baud
Data bits	8
Parity	No
Stop bit	1

After connecting the controller to the operating voltage, it outputs a short instruction manual, including the control parameters currently set, on the RS232 interface:

```
* 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
MST60-130
Input = Analog
AnalogStop/Start/Full/BrakeMax = 500mV/
549mV/4499mV/4499mV
ImpulsStop/Start/Full = 1150µs/1200µs/1900µs
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 = 60.0V/ 10.0V
Phase/BatteryAmp Max = 300.0A/300.0A
Temp Max Motor/Power = 100°C / 110°C
Motor RPM Limit = 240000
Motor Polepairs = 1
  
```

RS232 interface protocol

Output on the RS232 interface with control via analog input:

```

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
  
```

Index	Description	Unit
T	Throttle input	Volt
a	Aux input / Brake is inactive	Volt
PWM	Pulse width modulation	%%
U	Input voltage	Volt
I	Phase current	Ampere
RPM	Rotational speed	rpm
con	Motor controller temperature	°C
mot	Motor temperature	°C

i If the brake is activated, the "a" changes to "A" and the "T" to "t":

```

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

i Output on the RS232 interface with control via RS232:

```

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

The designator "S" stands for serial input.



The following 1 byte commands are possible in serial operation:

Command	Description
<i>s</i>	Changeover to serial RS232 input
<i>p</i>	Changeover to analog input(Potentiometer)
<i>i</i>	Changeover to pulse input
<i>f</i>	Forward
<i>r</i>	Reverse
<i>0</i>	Stop
<i>b</i>	Brake
<i>m</i>	100% PWM (max.)
<i>9</i>	90% PWM
<i>8</i>	80% PWM
<i>7</i>	70% PWM
<i>6</i>	60% PWM
<i>5</i>	50% PWM
<i>4</i>	40% PWM
<i>3</i>	30% PWM
<i>2</i>	20% PWM
<i>1</i>	10% PWM
<i>+</i>	+1% PWM
<i>-</i>	-1% PWM
<i>g</i>	+0.1% PWM (from version V2)
<i>l</i>	-0.1% PWM (from version V2)
<i>t</i>	activating timeout for the serial interface (from version V2)
<i>h</i>	Help
<i>a</i>	Change to Adjust mode
<i>e</i>	Exit Adjust mode

Examples:

- run the motor forward with 10% throttle PWM send *1f*
- increase the throttle PWM to 33% send *3+++*
- increase to maximum throttle send *m*
- switch off the motor current send *a 0*
- brake with 10% brake PWM send *1b*
- increase the brake PWM to 33% send *3+++*
- run the motor with 8% throttle PWM send *1--r*

CAN connection

(only optional)

Notice

Basic knowledge of CAN is assumed!
 The CAN2.0 protocol is supported.

i

Default CAN specification of the motor controller:

1Mbit 11bit Identifier 100ms frame rate
 All telegrams have 8 data bits

CAN_ID_TX 0x100 // DLC8 target values for *MST*

Byte	Description
1	Rotational speed limitation low byte value range 0 to 65535 rpm
2	Rotational speed limitation high byte
3	Pole pair value range 1 to 255
4	PWM low byte value range 0 to 65535
5	High byte
6	Current limitation low byte value range 0.0 to 6553.5A (max. 130% of rated current)
7	Current limitation high byte
8	bit0-bit6 = 0 (reserved for future modes) bit7 = 1 Reverse bit7 = 0 Forward

CAN_ID_RX 0x101 // DLC8 current values from the *MST*

Status message every 100 ms

Byte	Description
1	bit0-bit3 Message counter value range 0-15 bit4-bit7 Input voltage high byte
2	Input voltage low byte value range 0 to 409.5 Volt, resolution 0.1 V
3	Temperature controller value range -100°C to +155°C, resolution 1°C
4	Temperature motor value range -100°C to +155°C, resolution 1°C
5	Speed low byte value range 0 to 65,535rpm
6	Speed high byte
7	PWM value range 0-255 0-100%
8	Current value up to rated current 200A range 0-255A, above 0-511A

5. Configuration

After you have put the motor control unit into operation, you may have to make various settings via the RS-232 connection. This chapter describes the configuration procedure and provides an overview of the steps to be carried out and the specified order.

Establishing the connection

Connect the motor control unit as described in chapter 04, RS-232 connection.

Commands in Adjust mode

The commands do not require a <CR>/<LF> at the end. After connecting the supply voltage, the *MST 60-130* controller is always preset to the analog input. For configuration in adjust mode, an *s* and an *a* must be sent via RS-232 after the initialisation phase. The following commands are then accepted:

2 Byte commands

Command	Description
<i>sd</i>	Set default values
<i>sp</i>	Show parameters
<i>wp</i>	Write parameters
<i>se</i>	Shows the last 8 errors

5 Byte commands

Comm	Description	Value range	Default	Unit
<u>rp</u>	RPM limit	001 to 240	240	[1000 rpm]
<u>cl</u>	Current limit	010 to 300	300	[A]
<u>il</u>	Input current limit	010 to 300	300	[A]
<u>uv</u>	Undervoltage	010 to 050	010	[V]
<u>ov</u>	Overvoltage	014 to 063	060	[V]
<u>mt</u>	Motor temperature limit	070 to 100	100	[°C]
<u>ct</u>	Controller temperature limit	070 to 110	110	[°C]
<u>te</u>	Throttle exponential curve	000 to 100	000	[%]
<u>ti</u>	Throttle increase (forward)	001 to 653	131	[count/ms]
<u>td</u>	Throttle decrease (forward)	001 to 999	328	[count/ms]
<u>tl</u>	Throttle limit (forward)	005 to 100	100	[%]
<u>tm</u>	throttle minimum (forward)	001 to 100	002	[%]
<u>ri</u>	Reverse throttle increase	001 to 653	066	[count/ms]
<u>rd</u>	Reverse throttle decrease	001 to 999	328	[count/ms]
<u>rl</u>	Reverse throttle limit	005 to 100	100	[%]
<u>rm</u>	Reverse throttle minimum	001 to 100	002	[%]
<u>bi</u>	Brake increase	001 to 653	131	[count/ms]
<u>bd</u>	Brake decrease	001 to 653	328	[count/ms]
<u>bl</u>	Brake limit	001 to 100	100	[%]
<u>bm</u>	Brake minimum	000 to 100	005	[%]
<u>ab</u>	Full braking analog input	006 to 498	450	[1/100 V]
<u>af</u>	Full throttle analog input	122 to 498	450	[1/100 V]
<u>ah</u>	Stop analog input	012 to 366	050	[V]
<u>as</u>	Start analog input	018 to 379	055	[V]
<u>if</u>	impulse input full throttle	120 to 220	190	[1/100 ms]
<u>ih</u>	impulse input halt	080 to 170	115	[1/100 ms]
<u>is</u>	impulse input start	085 to 175	120	[1/100 ms]
<u>pp</u>	Number of motor pole pairs	001 to 100	001	[-]
<u>ot</u>	RS232 output repeat time	007 to 999	200	[ms]

To save, send a *wp*

To exit Adjust mode without saving, send a *e*

Acceleration/deceleration values for throttle and brake

653 = 0.1s	093 = 0.7s
326 = 0.2s	065 = 1.0s
218 = 0.3s	044 = 1.5s
163 = 0.4s	033 = 2.0s
131 = 0.5s	001 = 65.3s

Expanded description



RPM limit

rp revolutions per minute

The rotational speed limitation restricts the shaft speed by the controller throttling back. This is primarily intended to protect the motors and airscrews so that the highest permissible rotational speed of the motor or the airscrew will not be exceeded.

Attention!

First set the number of pole pairs and then the rotational speed limiting.

The number of pole pairs set has an influence on the real rotational speed limiting.

Phase current limit

c/ current limit

The phase current limiting restricts the current in the motor phases and this limits the maximum torque of the drive.

For example, *c/200* represents a phase current limit of 200 A. In the case of a motor with a torque constant of $k_M = 12 \text{ Ncm/A}$ and an idle current of $I_0 = 10 \text{ A}$, with a phase current limit of 200 A this approximates to a maximum torque of $(200 \text{ A} - 10 \text{ A}) * 12 \text{ Ncm/A} = 2280 \text{ Ncm} = 22.8 \text{ Nm}$.

Input current limit

i/ intput limit

The input current limit restricts the input current, which in turn limits the maximum power of the drive. This is required to protect the battery from overloading. For example, *i/100* represents an input current limit 100 A. If the input voltage is 50 V, the input power is limited to $50 \text{ V} * 100 \text{ A} = 5000 \text{ W}$. The average input current approximates to the phase current multiplied by the PWM value / 1000. With a PWM value of 50% and a phase current of 200 A, we have an input current of approx. 100 A.

Undervoltage limit

UV under voltage limit

The undervoltage protective function prevents the input voltage dropping below the chosen limit. This causes the controller to autonomously reduce the throttle in order to protect the battery.

Overvoltage limit

OV over voltage limit

The overvoltage limit function prevents the input voltage exceeding the chosen limit voltage. This causes the controller to autonomously reduce the braking in order to protect the battery.

Motor temperature limit

mt motor temperature limit

The temperature limit of the motor can be set between 70°C and 100°C.

Controller temperature limit

ct controller temperature limit

The temperature limit of the motor controller can be set between 70°C and 110°C.

Throttle exponential curve

te throttle expo

The exponential throttle curve serves to adjust the relationship between the input signal (e.g. grip position) and the actual PWM output signal. The enables a greater range with less reaction right from the start. *te000* sets the exponential factor to 0%, i.e. linear throttle curve. *te100* sets the exponential factor to 100%, so that the throttle curve is very bend. With half-pedal or half-grip throttle, the PWM output signal then represents 25% rather than 50%.

Throttle increase forward

ti throttle increase

The throttle increase determines how quickly the controller follows an increase in throttle. The higher the value, the faster the controller reacts to the throttle increase.

Throttle decrease forward

td throttle decrease

The throttle decrease determines how quickly the controller follows a decrease in throttle. The higher the value, the faster the controller reacts to the throttle decrease.

Throttle restriction forward

tl throttle limit

The throttle limit restricts the maximum throttle position.

Minimum throttle forward

tm throttle minimum

Minimum throttle forwards describes the starting throttle, at which the drive starts.

Reverse throttle increase

ri reverse increase

The reverse throttle increase determines how quickly the controller follows an increase in throttle during active reverse travel. The higher the value, the faster the controller reacts to the throttle increase.

Reverse throttle decrease

rd reverse decrease

The reverse throttle decrease determines how quickly the controller follows a decrease in throttle during active reverse travel. The higher the value, the faster the controller reacts to the throttle decrease.

Reverse throttle limit

rl reverse limit

The reverse throttle limit restricts the maximum throttle position during active reverse travel.

Reverse throttle minimum

rm reverse minimum

The reverse throttle minimum describes the PWM value at which the drive starts in reverse operation.

Brake acceleration

bi brake increase

The brake increase determines how quickly the controller follows an increase in braking. The higher the value, the faster the controller reacts to the braking decrease.

Brake deceleration

bd brake decrease

The brake decrease determines how quickly the controller follows a decrease in braking. The higher the value, the faster the controller reacts to the braking decrease.

Brake limit

bl brake limit

The brake limit restricts the maximum brake position. At 100% brake, the motor is fully short-circuited so that none of the braking energy is fed back to the battery. In conjunction with a mechanical brake, the brake should therefore be limited to max. 90%.

Brake minimum

bm brake minimum

Brake minimum means the minimum value with which braking will be implemented. Thus, there is a possibility to achieve an almost linear triggering of the braking torque.

Full braking throttle/aux input

ab analog brake

If the value for full braking is greater than the value from the stop analog input, the controller uses both analog inputs: Throttle for acceleration and Aux for braking.

If the value for full braking is less than the value from the stop analog input, the controller uses only the throttle input for accelerating and braking. This configuration can be used with a throttle level with neutral centre position.

Full throttle analog input

af analog full

This parameter defines the voltage value at the analog input for full throttle. **Attention!** If this value is set too high, a throttle grip with a hall sensor may not reach full throttle because some of these have a maximum output voltage of only 4.1V.

Stop analog input

ah analog halt

This parameter defines the voltage value at the analog input for 0% throttle. **Attention!** If this value is set too low, a throttle grip with a Hall sensor may cause the control unit not to detect a stop after switching on the supply voltage and not release it. Some Hall sensors have a minimum output voltage of only 1.2V.

Start analog input

as analog start

This parameter defines the voltage value at the analog input for the motor starting. **Attention!** This value must be higher than the analog halt value. We recommend setting the analog start value around 0.02 to 0.1V higher than the analog halt value. This prevents the motor continuously switching on and off in the event of minor fluctuations in the analog signal at low throttle.

Number of motor pole pairs

pp pole pairs

This parameter is used for converting the electric rotational speed to shaft rotational speed.

Output repeat time


ot output time

The output time is the repeat time in milliseconds, with which the [RS232 protocol](#) outputs are updated on the RS232 interface during active drive.

Examples of the repeat time

200 = 5Hz
100 = 10Hz
050 = 20Hz
025 = 40Hz
020 = 50Hz
010 = 100Hz
008 = 125Hz

6. Check display

 The motor controller has a status LED. This is located on the connection side.

LED behaviour	Explanation	Error message
LED illuminates steadily	No fault	
LED flashes 1x	Undervoltage	0x0001
LED flashes 2x	Overvoltage	0x0002
LED flashes 3x	Overcurrent	0x0004
LED flashes 4x	Controller overtemperature	0x0008
LED flashes 5x	Motor overtemperature	0x0010
LED flashes 6x	Motor jammed	0x0020
LED flashes 7x	Sensor fault	0x0040
LED flashes 9x	Analog input fault (Wire break)	0x0100
LED flashes 10x	Pulse width fault	0x0200

Notice

Multiple faults can arise at the same time.

For example: Error 0x0240 = Pulse width fault and sensor fault

7. Protective functions

Notice

Overvoltage protection

With input voltage over 63V, the controller shuts down due to overvoltage. If the voltage exceeds 66V, the controller could be damaged.

Undervoltage protection

If the input voltage is below 10V, the controller shuts down in order to guarantee the stability of the internal power supply voltages.

Motor temperature protection

At motor temperatures above 100°C, the controller shuts down in order to protect the motor.

Controller temperature protection

At internal temperatures above 110°C, the controller shuts down in order to protect itself.

Wire break detection

To ensure that the motor does not autonomously switch to full throttle in the event of the negative wire to the throttle potentiometer being broken, the controller shuts the motor down for safety reasons as soon as the control voltage exceeds 4.95V.

Start-up protection

To ensure that the motor does not start up unbidden when the operating voltage is switched on, the controller only becomes active once the control signal is set to stop, for safety reasons.

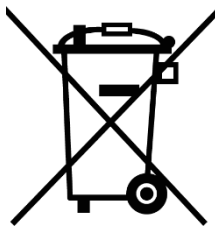
Sensor fault

If the position sensors deliver invalid values, the controller shuts down in order to protect the motor and the controller from defects.

8. Repetitive handling

Care The housing surfaces can be cleaned with compressed air and a dry, lint-free cloth.

9. Disposal



A motor controller that has reached the end of its service life is electrical scrap.

Electrical scrap consists on the one hand of valuable materials which can be recovered as secondary raw materials and, on the other hand, it contains environmentally hazardous substances.

Information regarding optimum material recycling is available from commercial waste disposal companies.

10. Service / Contact

Should, despite proper handling and sufficient care, problems should still occur or the motor will be damaged, then please send the motor back to our address stating the problem, defect or damage.

Plettenberg Elektromotoren GmbH & Co. KG

Rostocker Straße 30

34225 Baunatal – Großenritte

Tel: +49 (0) 56 01 97 96-0

Fax: +49 (0) 56 01 97 96-11

Internet: www.Plettenberg-Motoren.com

Email: Info@Plettenberg-Motoren.com

11. EU Declaration of Conformity

In the sense of the EU Directives

- **EMC Directive 2014/30/EU Appendix IV**
- **Low Voltage Directive 2014/35/EU Appendix IV**
- **RoHS Directive 2011/65/EU Appendix I**



Plettenberg Elektromotoren GmbH & Co. KG

Rostocker Straße 30

34225 Baunatal – Großenritte

hereby declares, as the manufacturer, that the articles and objects described below comply with the provisions of the relevant community harmonisation legislation referred to above.

Device type
MST 60/130 MST 60/130 K

Emitted interference	EMC Directive Article 6 Appendix I.1.a
DIN EN 61000-6-3:2011-09	Electromagnetic Compatibility (EMC)- Part 6-3: Generic standards - Interference emission for residential areas, business and commercial areas as well as small businesses (IEC 61000-6-3:2006 + A1:2010); German Edition EN 61000-6-3:2007 + A1:2011

Immunity to interference	EMC Directive Article 6 Appendix I.1.b
DIN EN 61000-6-1:2007-10	Electromagnetic Compatibility (EMC)- Part 6-1: Generic standards - Immunity for residential environments, business and commercial areas as well as small businesses (IEC 61000-6-1:2005);

Device safety	
DIN EN 60335-1:2012-10	Safety Household and similar electrical appliances - Part 1: General requirements (IEC 603351:2010, modified);
DIN EN ISO 12100:2010	Safety of machinery - General principles for design - Risk assessment and risk mitigation ISO 12100:2010 (): German Edition EN ISO 12100

Maximum permissible concentrations in homogeneous materials in % by weight	RoHS Directive Appendix II
Lead	0.1%
Cadmium	0.01%
Polybrominated biphenyl (PBB)	0.1%
Polybrominated diphenyl ether (PBDE)	0.1%
Mercury	0.1%
Hexavalent chromium	0.1%

Note:

The sole responsibility for drawing up this declaration of conformity lies with the manufacturer. This declaration of conformity will lose its validity when the product is converted, extended or altered in any other manner without the express consent of Plettenberg Elektromotoren GmbH & Co. KG and when components, not belonging to Plettenberg Elektromotoren GmbH & Co. KG, or accessories are installed in the product as well as in the event of improper connection or improper use of the product.



Baunatal, 01. 04. 2016

.....

(Uwe Plettenberg, Managing Director)