PLETTENBERG
HIGH-END ELECTRIC DRIVE SOLUTIONS

Operating Manual

Starter-Generator Control Unit 1kW

OM_SGCU_1kW_EN | Version 1.0 | 2024.10.10

Table of contents

1. About this document

Legal provisions

The information contained in this document is the sole property of Plettenberg Elektromotoren GmbH & Co. KG ("Plettenberg"). Publication, in whole or in part, requires the express written consent of Plettenberg. 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 of the contract. Unlimited liability on our part exists for damages to the 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 unauthorized 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
34225 Baunatal, Germany
T: +49 (0) 56 01 97 96-0
www.plettenbergmotors.com
sales@plettenbergmotors.com

Scope of validity

This document applies for the following device types:

Device type
Starter-Generator Control Unit 1kW

Firmware version
Version 9 Starter

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 of 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.plettenbergmotors.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
Starter-Generator Control Unit	SGCU
Pulse Width Modulation	PWM

2. Safety

Intended use

The area of validity is defined as:

- Starter-Generator Control Unit

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

- Using the Starter-Generator Control Unit in manned vehicles
- Using the Starter-Generator Control Unit in public vehicles and transport
- Using the Starter-Generator Control Unit as a toy
- Using the Starter-Generator Control Unit 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).
- Before the first operation, the product must be checked against damage and the correct connection of all connections must be checked again.
- The Starter-Generator Control Unit must be protected against the motor phases being mixed up or short-circuited.
- Operation without a motor connection is forbidden.
- The interfaces (RS232, analog and digital) must be wired minimally (see Figure 6 page 23).
- The sensor supply (5V) must 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 operation.
- In order to prevent high-resistance connections, use only 6mm gold contact connectors from Plettenberg for battery cables and motor phases.
- Assembly and disassembly must be carried out only when in de-energized condition.
- Always ensure proper handling.
- The product must never be contaminated with foreign bodies / adhesives and/or paint during assembly.
- Always ensure that the Starter-Generator Control Unit is properly fastened.
- Always ensure that the Starter-Generator Control Unit is properly set up.
- The product must be sufficiently cooled.
- The cooling fins must be installed vertically. Additional air flow leads to lower temperatures therefore longer lifetime.

Danger

Danger from magnetic radiation
Malfunction / destruction of magnetically sensitive parts

- The Starter-Generator Control Unit must never be operated in the vicinity of magnetically sensitive parts such as pacemakers or data carriers.

Caution

Burns
Carelessly touching hot surfaces

- After the operation of the product, the surface 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 Starter-Generator Control Unit (air cooling).
- Maximum load on the Starter-Generator Control Unit is only permissible for short-term operation. The duration depends on the operating conditions and the cooling. The Starter-Generator Control Unit temperature must not exceed 100°C under any circumstances, otherwise the electronics will shut down.
- When using motor from other suppliers, it is essential that this is approved by Plettenberg.
- The battery for the drive must not be disconnected during starter operation.
- For operation with a mains adapter, note the instructions in chapter "Mains adapter operation" page 22.
- Multiple consecutive unsuccessful attempts to start the combustion engine may lead to overload, damage or failure of the SGCU

3. Product overview

Description

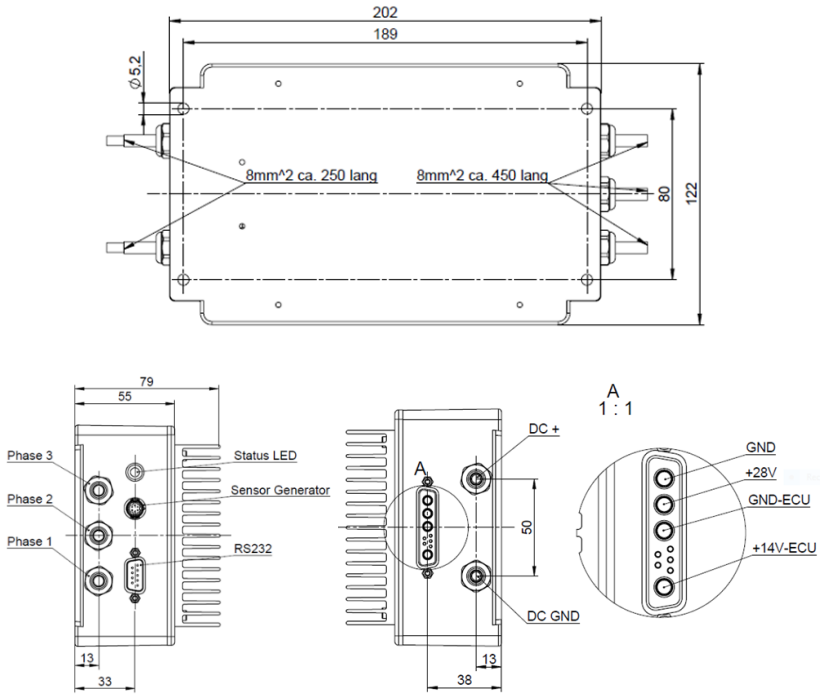
The Starter-Generator Control Unit 1 kW has been specially developed for the use of brushless Plettenberg electric motors. We assume no guarantee for the proper functioning of the Starter-Generator Control Unit 1kW with motors from other manufacturers.

Type designation

Starter-Generator Control Unit 1 kW

Max. continuous output power

Figure



Starter-Specific Technical Specifications

Weight	Approx. 1,5 kg (with cables)
Length	202 mm (without cables)
Width	122 mm (with lugs)
Height	79 mm (inclusive heat sink)
Max. rotational speed:	240,000 rpm (electrical)
Max. continuous power [1]	17,5 kW
Max. short-term power [1]	23 kW
Nominal voltage range of the battery	12 – 24 V
Starting voltage input DC	15 – 30 V
Maximum current	600 A peak Phase (for 10 sec at 25° start temperature)
Start current for 1 minute [1]	290 A (at 25°C ambient temperature) 235 A (at 50°C ambient temperature) 170 A (at 75°C ambient temperature)
Analog inputs for accelerating and braking	0 – 5 V

[1] Considering an airflow of 3.5 m/s through the cooling fins.

Analog input for motor temperature	NTC 47 kOhm
Digital inputs (Direction switch and PWM)	
High level	1.5 – 28 V, recommended 5V
Low level	0 - 0.5 V
PWM (optional)	10 – 400 Hz
RS232 interface	115200 Baud / 8N1
CAN interface	CAN2.0 (optional)
Position input	3x Hall sensors (120° electrical)
Internal capacitor	12000 µF

Generator-Specific Technical Specifications

Nominal voltage range input generator	30 - 60V
Max. current output generator	40A
Max. continuous output power	1kW
Voltage output 1	28V (+- 0,5V)
Voltage output 2	14V (+- 0,5V) (max. 10A)
Total standby current consumption[1]	250mA at 12V 230mA at 24V

Environmental and Climatic Conditions

Ambient temperature	-20 °C up to +100 °C
Permissible humidity	Non-condensing
Protection class	IP54

Interfaces

Starter-Generator Control Unit

Motor phases (A, B and C)	4mm² silicone stranded wire
Battery positive pole Battery negative pole	4mm² silicone stranded wire
RS 232	Sub D 9-pole male
Starter-generator-electronic output	Sub-D 9W4
Motor sensor	Hirose 6-pole (HR30-6R-6P (71))

Cable side

RS 232	Sub D 9-pole female
Generator output	Sub-D 9W4
Motor sensor	Hirose 6-pole (HR30-6P-6S (31))

[1] Current Consumption of the Starter Generator with Sensors

Block Diagram

The block diagram (see Figure 1) serves to illustrate the functionality and the functional relationships of the Plettenberg Starter-Generator Control Unit.

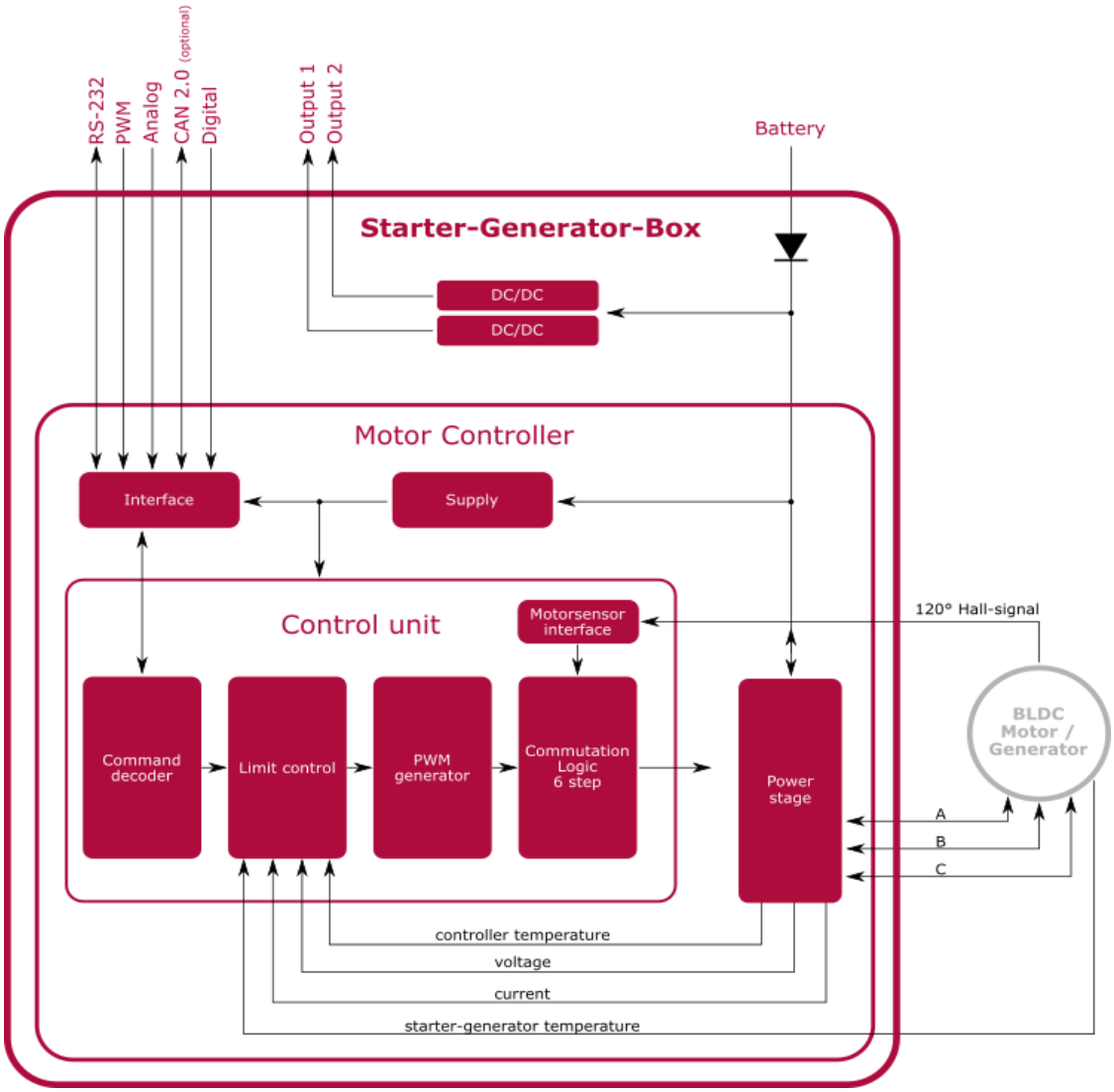


Figure 1: Block Diagram Plettenberg Starter-Generator Control Unit

4. Installation

Safety during installation

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 Starter-Generator Control Unit 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

Destruction of / damage to the Starter-Generator Control Unit

- In closed housings, ensure there is adequate cooling.
- The total length of all battery connection cables (positive and negative together) must not exceed 1m.[1]
- The Starter-Generator Control Unit is not protected against reverse polarity connection.
- Use suitable fuses.[2]
- Use safety disconnectors.[3]
- The interfaces (RS232, analog and digital) must be wired minimally. (see Figure 6 page 23)
- Special conditions apply to operation with a mains adapter. (see page 22)
- Earth yourself before touching a component. (electrostatic discharge)
- Crimp contacts in accordance with the instructions of the contact manufacturer. These must be followed.

[1] 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 Starter-Generator Control Unit 1kW, 34 cm of total cable length remains available for the battery pack. (100 cm – 2 x 33 cm = 34 cm)
[2] e.g.: Bussmann FWA-300B Littelfuse L15S300, L25S300.
[3] e.g.: Tyco Electronics AMP + EVC135 and KILOVAC EV200 series.

Connection and assembly

Notice

Destruction of / damage to the Starter-Generator Control Unit due to incorrect allocation of the motor phases or sensor allocation

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

The starter-generator phase B(V) should be connected with the white/yellow motor phase at Plettenberg motors.

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

- The Starter-Generator Control Unit has been developed specially for the use of brushless Plettenberg electric motors with sensors.

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

There are 6 options for connecting the motor phases:

Starter-Generator Control Unit		
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-generator sensor cable (Hirose 6-pole) is connected to the Starter-Generator Control Unit (sensor). The battery cable to DC plus and DC minus (see Figure 2).

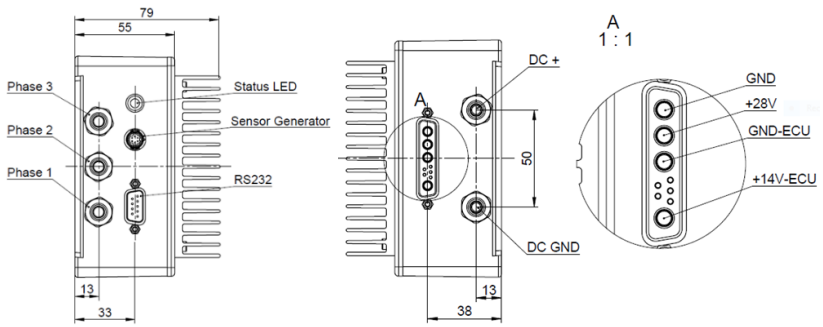


Figure 2: Starter-Generator Control Unit 1kW drawing

Protection

As a safety disconnect switch (emergency stop) we recommend Tyco Electronics AMP + EVC135 and KILOVAC EV200 series.

A suitable precharging circuit is necessary.

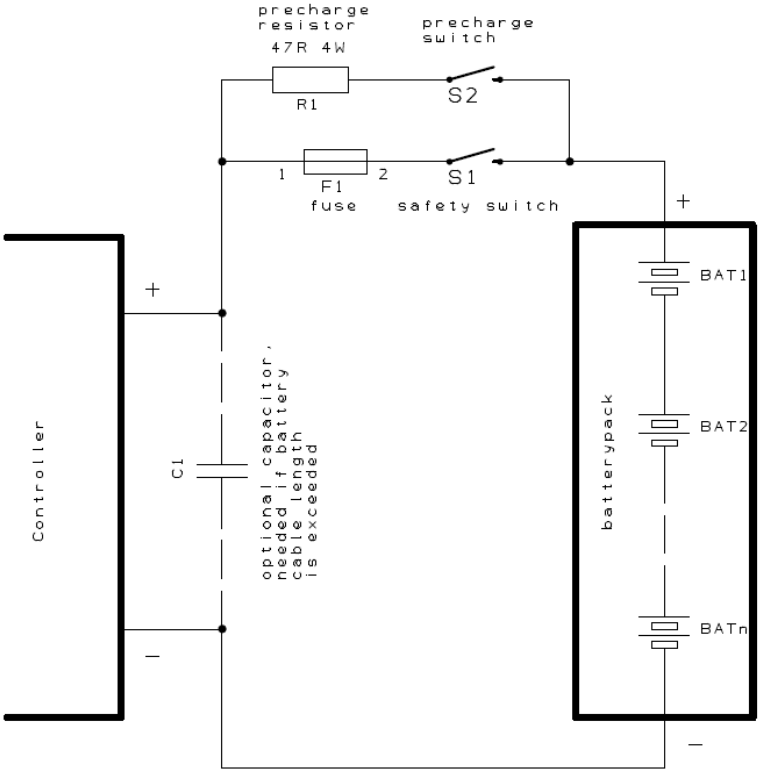


Figure 3: schematic drawing protection

Connector

Notice

Destruction of / damage to the Starter-Generator Control Unit due to poor-quality or high-resistance connections.

If the motor-generator and the Starter-Generator Control Unit are ordered together, there is an option to have the cable fully finished.

Observe the installation instructions Hirose, CONEC and Plettenberg Elektromotoren GmbH & Co. KG.

Cable shield

Notice

Destruction of / damage to the Starter-Generator Control Unit due to wrong shield connections.

Motor-generator sensor connector (Hirose 6-pole)
The sensor cable shield must be connected with sensor GND. Do not connect the sensor cable shield with the motor case and/or with the Starter-Generator Control Unit case. Connect the shield only on one side of the cable.

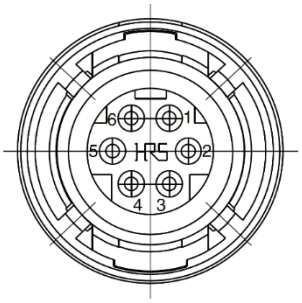
Sub-D9 connector
The shield of the RS232 cable must be connected with pin 5 GND. Do not connect the shield with the motor case and/or with the Starter-Generator Control Unit case. Connect the shield only on one side of the cable.

Pin allocation

Motor-Generator sensor
Hirose 6-pol connector HR30-6P-6S (31)

Manufacturer Part Number: **HR30-6P-6S (31)**

Pin	Designation	Colors
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



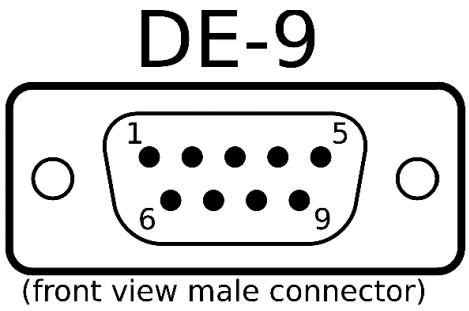
Further information about the Connectors can be found at:
Component Specification Catalog – Hirose HR30

Plettenberg uses the following 6 pol connector from Hirose on Starter-Generator Control Unit side:
Hirose 6-pol connector HR30-6R-6P (71)

Manufacturer Part Number: **HR30-6R-6P (71)**

RS 232 / analog / digital

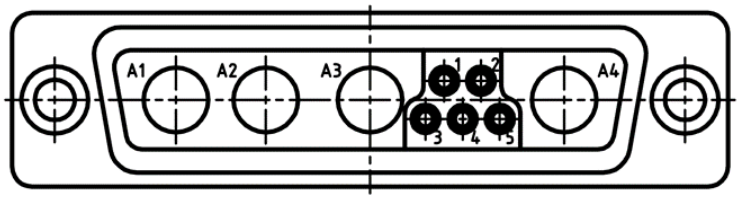
Pin	Designation	Description
1	Brake input (Aux)	Analog input 0-5V
2	RxD	RS232 receiver signal
3	TxD	RS232 transmitter signal
4	Reverse switch	0V forwards / 5V reverse
5	GND	Signal Ground
6	Throttle input	Analog input 0-5V
7	DNC	do not connect
8	Impulse input	5V Digital input
9	+5V (max. 30mA)[1]	Potentiometer supply



[1] 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.

Sub-D 9W4 connector

Pin	Designation	Description
A1	GND 40A	DC/DC Output 1
A2	+28V 40A	DC/DC Output 1
A3	GND 10A	DC/DC Output 2
1	NC	not connected
2	NC	not connected
3	NC	not connected
4	NC	not connected
5	NC	not connected
A4	+14,4V 10A	DC/DC Output 2



Further information about the Connectors can be found at:
Component Specification Catalog – CONEC 9W4

The following crimping pliers are recommended for the Sub-D 9W4 connector:

Description	Crimping pliers / crimp tools
Manufacturer's part number	KNIPEX 975265DG, CONEC 360X10409X
Manufacturer	KNIPEX, CONEC
Selector position	1.0 mm, pos. 5
Positioner Depth	Male: 20.0 mm
Spare Cable Crimp Contact (Manufacturer's part number)	131C11029X

Soldered connections

Notice

Destruction of / damage to the Starter-Generator Control Unit 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 shrinks tubing
- Cable
- Soldering iron rated at least 100W
- Hot air gun

A wide portfolio of flexible high temperature cables of different cross-sections, colors and requirements is available from Plettenberg.

For more information, please contact our sales team.

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. 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.

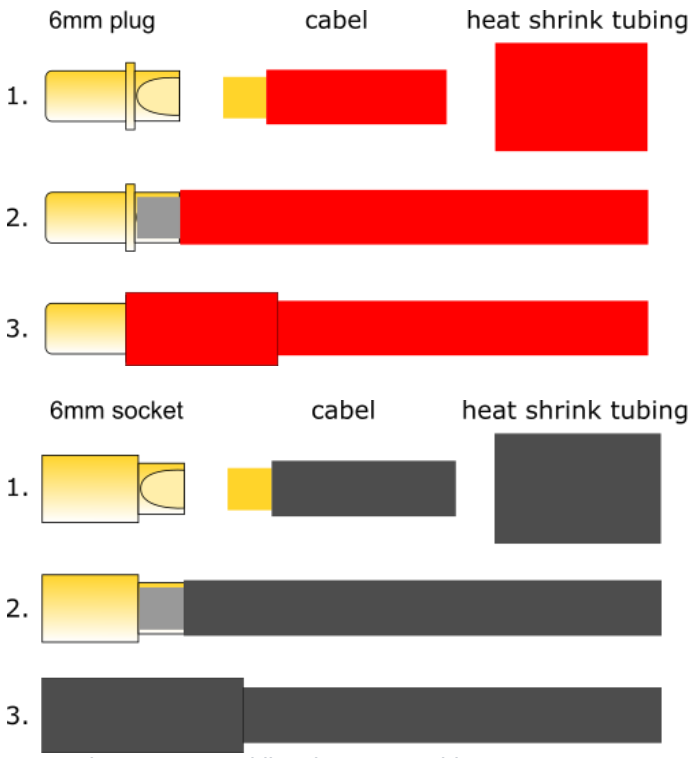


Figure 5: Assembling the 6 mm gold contact system

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 Starter-Generator Control Unit due to the connection cable between the Starter-Generator Control Unit and the battery being too long.

⚠ Caution

Burns
Carelessly touching hot surfaces

The maximum cable length from the Starter-Generator Control Unit to the battery is dependent on the maximum phase current required. The phase current can be higher than the input current of Starter-Generator Control Unit 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
600 A	50 cm
300 A	100 cm
150 A	200 cm

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 cables between additional capacitors and the controller must be short as possible!

The length of the phase cable is not critical regarding the phase current.

Commutation sequences

Notice

Destruction of / damage to the Starter-Generator Control Unit 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 Starter-Generator Control Unit 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 Starter-Generator Control Unit

Note the following points:

- Drive the Starter-Generator Control Unit 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 Starter-Generator Control Unit.
- Set current limiting of the power supply to a quarter of the rated current of the Starter-Generator Control Unit.
- 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/SGCU programming adapter (Order optional)
- Serial cable, if required (not null modem cable)

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

Figure 6: RS232 Connection without analog control

Starter button

Notice

Multiple consecutive unsuccessful attempts to start the combustion engine may lead to overload, damage or failure of the SGCU

Figure 7 illustrates the wiring schematic for the Starter button connected to the Starter-Generator Control Unit via the Sub-D9 connector.

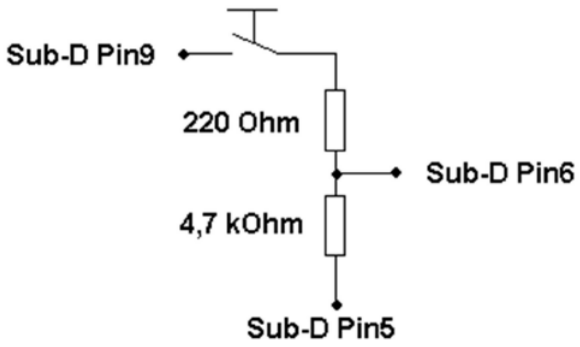


Figure 7: Connection for the Starter button

Cable requirements:

The cable length and cable quality influence 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 and can be ordered by the meter:

Alpha Wire 3306 SL005 sensor cable, 6 x AWG28

Alpha Wire 3308 SL005 sensor cable, 8 x AWG28

Alpha Wire 3310 SL005 sensor cable, 10 x AWG28

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 parameterized 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
```

```
MST60-290 Starter V6
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% /   2%
Rev. Throttle Inc/Dec =  328  / 328
Rev. Throttle Max/Min =  100% /   2%
Brake    Inc/Dec      =   66  / 328
Brake    Max/Min      =  100% /  10%
Voltage  Max/Min      =  63.0V/  9.0V
Amp  Max              = 600.0A
Temp Max Motor/Power  =  100°C / 110°C
Motor RPM Limit       = 240000
Motor Polepairs       =   1
Output Time RS232     = 200ms
Offset AMP PhaseA: 1, PhaseB: 1, PhaseC: 1,
Temp: 23
ID =974064728
```

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	SGCU temperature	°C
mot	Motor temperature	°C

If the brake is activated, the "a" change 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
```

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
s	Changeover to serial RS232 input
p	Changeover to analog input (Potentiometer)
i	Changeover to pulse input
f	Forward
r	Reverse
0	Stop
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 (from version V2)
l	-0.1% PWM (from version V2)
t	activating timeout for the serial interface (from version V2)
h	Help
a	Change to Adjust mode
e	Exit Adjust mode

RS232 Command examples:
1. CR/LF is not necessary
2. After connecting the supply voltage to the Starter-Generator Control Unit controller with the standard firmware, please note that the analog input is active by default. If you wish to switch to the serial control input, you need to send the command "s" after the controller's initialization

If the Starter-Generator Control Unit is delivered with CAN2.0 firmware the CAN bus interface is active after connecting the power supply to the Starter-Generator Control Unit. If CAN message commands are sent to the Starter-Generator Control Unit a switch over to the serial control input is blocked.

Examples of RS232 control:

- 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.

Default CAN specification of the Starter-Generator Control Unit:

1Mbit 11bit Identifier 100ms frame rate (CAN timeout is 2500ms)
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-bit5 = 0 (reserved for future modes) bit6=1: Brake, bit6=0: Throttle 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 Starter-Generator Control Unit into operation, it may be necessary to perform several parameter adjustments via the RS-232 connection. If you have a Starter-Generator Control Unit with CAN interface, this is only possible if no CAN communication is present. 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 Starter-Generator Control Unit as described in chapter 4, RS-232 connection.

Commands in Adjust mode

The commands do not require a <CR>/<LF> at the end. After connecting the supply voltage, the Starter-Generator Control Units are always preset to the analog input. To configure in adjust mode, an "**s**" and an "**a**" must be sent via RS-232 after the initialization phase. The following commands are then accepted:

2 Byte commands

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

5 Byte commands

Comm	Description	Value range	Default	Unit
rp	RPM limit	*001 to 240*	*240*	[1000 rpm]
cl	Current limit	*010 to 300*	*280*	[A]
uv	Undervoltage	*010 to 050*	*010*	[V]
ov	Overvoltage	*014 to 063*	*063*	[V]
mt	Motor temperature limit	*070 to 100*	*100*	[°C]
ct	Controller temperature limit	*070 to 110*	*110*	[°C]
te	Throttle exponential curve	*000 to 100*	*000*	[%]
ti	Throttle increase (forward)	*001 to 653*	*131*	[count/ms]
td	Throttle decrease (forward)	*001 to 999*	*328*	[count/ms]
tl	Throttle limit (forward)	*005 to 100*	*100*	[%]
tm	throttle minimum (forward)	*001 to 100*	*002*	[%]
ri	Reverse throttle increase	*001 to 653*	*066*	[count/ms]
rd	Reverse throttle decrease	*001 to 999*	*328*	[count/ms]
rl	Reverse throttle limit	*005 to 100*	*100*	[%]
rm	Reverse throttle minimum	*001 to 100*	*002*	[%]
bi	Brake increase	*001 to 653*	*131*	[count/ms]
bd	Brake decrease	*001 to 653*	*328*	[count/ms]
bl	Brake limit	*001 to 100*	*100*	[%]
bm	Brake minimum	*000 to 100*	*010*	[%]
ab	Full braking analog input	*006 to 498*	*450*	[1/100 V]
af	Full throttle analog input	*122 to 498*	*450*	[1/100 V]
ah	Stop analog input	*012 to 366*	*050*	[1/100 V]
as	Start analog input	*018 to 379*	*055*	[1/100 V]
if	impulse input full throttle	*120 to 220*	*190*	[1/100 ms]
ih	impulse input halt	*080 to 170*	*115*	[1/100 ms]
is	impulse input start	*085 to 175*	*120*	[1/100 ms]
id	CAN bus ID	*000 to 999*	*256*	[-]
pp	Number of motor pole pairs	*001 to 100*	*001*	[-]
ot	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

i

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

Example of the procedure for a finer speed limit.
Speed limit of approx. 2500 RPM at a Motor with 30 poles (P30)

1. set the number of motor pole pairs to 1 with *pp001*.
2. Calculate the electrical RPM by multiplying the number of pole pairs with the limit of the shaft speed: 15pp x 2500RPM = 37500eRPM
3. Limit the electrical revolutions with *rp038.*
4. set the number of motor pole pairs to 15 with *pp015*. (15 pole pairs = 30 motor poles)
5. check the speed limit with *sp*, the speed limit should now be 2533rpm (38000rpm / 15pp)
6. save settings with command *wp*.

Phase current limit

cl current limit

The phase current limiting restricts the current in the motor phases, and this limits the maximum torque of the drive.
For example, *cl200* represents a phase current limit of 200 A. In the case of a motor with a torque constant of kM = 12 Ncm/A and an idle current of Io = 10 A, with a phase current limit of 200 A this approximates to a maximum torque of (200 A - 10 A) * 12 Ncm/A = 2280 Ncm = 22.8 Nm.

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 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 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 Starter-Generator Control Unit 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 bent. 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 describe 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 the 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 brake energy is fed back to the battery. In conjunction with a mechanical brake, the brake limit should therefore be set to max. 90%.

Brake minimum

bm **brake minimum**

The brake minimum parameter specifies the minimum value with which the brake is applied. This makes it possible to achieve an approximately linear response 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 center 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.

CAN bus id

id CAN bus id

This parameter defines the CAN bus ID, it defines the CAN bus base address. The new CAN Bus ID will be used after the next power up. The CAN Base Address is changed in two increments each increment.
CAN_ID_TX = ID * 2
CAN_ID_RX = ID * 2 + 1
“id000” address: CAN_ID_TX 0d = 0x000 and CAN_ID_RX 1d = 0x001
“id100” address: CAN_ID_TX 200d = 0x0C8 and CAN_ID_RX 201d = 0x0C9
“id128” address: CAN_ID_TX 256d = 0x100 and CAN_ID_RX 257d = 0x101
“id999” address: CAN_ID_TX 1998d = 0x7CE and CAN_ID_RX 1999d = 0x7CF

Full throttle impulse input

if impulse full

This parameter defines the impulse ton value[10µs] at the impulse input for full throttle. Attention! If this value is set too high, the radio control receiver may not reach its full throttle. Default at most radio control receiver is 1.9ms equals a value of 190.

Stop throttle impulse input

ih impulse halt

This parameter defines the impulse ton value[10µs] at the impulse input for 0% throttle. Attention! If this value is set too low, the 0% throttle signal of radio control receiver may cause the control unit not to detect a stop after switching on the supply voltage and not release it. Default at most radio control receiver is 1.1ms equals a value of 110. To have some margin for a jitter we recommend a value of 115 equals 1.15ms

Start impulse input

is impulse start

This parameter defines the impulse ton value[10µs] at the impulse input for the motor starting. Attention! This value must be higher than the impulse halt value. We recommend setting the impulse start value around 5 equals 50µs higher than the impulse halt value. This prevents the motor continuously switching on and off in the event of minor fluctuations in the impulse 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 Starter-Generator Control Unit has a status LED. This is located on the connection side.

LED behavior	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 63 V, the controller shuts down due to overvoltage. If the voltage exceeds 63 V, the controller could be damaged.

Undervoltage protection
If the input voltage is below 10 V, 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 start function 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 4.95 V.

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.

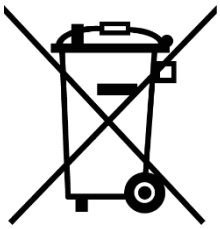
Sensor fault
If the position sensors deliver invalid values, the controller shuts down in order to protect the motor and the controller from defects.

8. Repetitive handling

Care

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

9. Disposal



A Starter-Generator Control Unit that has reached the end of its service life is electrical scrap.

Electrical scrap consists of 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, Germany
T: +49 (0) 56 01 97 96-0
www.plettenbergmotors.com
sales@plettenbergmotors.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**

CE

Plettenberg Elektromotoren GmbH & Co. KG

Rostocker Straße 30
34225 Baunatal, Germany

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

Device type
Starter-Generator Control Unit 1kW

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, 10.10.2024 .....

(Bastian Greiner, Managing Director)

12. Document Changelog

Version	Date	Author	Revised Sections	Justification
V1.00	10.10.2024	MW	All Sections	Initial Release