Bretschneider
Spezialelektronik by Elektrofischerei Eifel

OPERATING INSTRUCTIONS

EFGI 4000

Battery-powered electrofishing system for boat operation

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1 Safety instructions

Operators of electrofishing equipment are responsible for complying with all applicable laws and regulations. In addition, observe the following instructions.

Electrical safety

- Touching energised electrodes can be fatal.
- Stop operation immediately if the insulation of cables, connector housings, the control unit (including the current-indicator window), or battery packs is damaged, or if the dead-man switch does not operate correctly.
- Do not connect equipment or components from other manufacturers to the EFGI 4000, even where the connectors appear compatible.
- The three 24 V battery packs are connected in series when attached to the control unit. The resulting 72 V voltage is hazardous. Battery housings form part of the electrical insulation. Operate the EFGI 4000 only with the battery-box lids securely screwed down.
- People with heart disease or pacemakers, seizure disorders, balance problems, significant visual or hearing impairments, or those impaired by alcohol, drugs or psychotropic medication face increased risks and should not participate in electrofishing.

Handling batteries

- Always operate the battery packs upright, with their lids facing upwards.
- Faults in a battery or charger can cause explosive hydrogen/oxygen gas mixtures to form during charging. Charge outdoors or in well-ventilated rooms.
- Open battery-box lids only after disconnecting all plugs.
- Keep ignition sources, including cigarettes, away from batteries during maintenance.
- Battery acid is corrosive. Wear safety goggles whenever opening applicable lead-acid batteries or handling electrolyte.
- Never short-circuit batteries.
- Dispose of used batteries through an authorised recycling facility.

2 Technical specifications

Control unit

Input	72 V DC / maximum 60 A
Output voltage	65–520 V, DC or pulsed; six coarse ranges with continuous fine adjustment
Maximum output	4 kW DC / 8 kW pulsed (as stated in source; see appendix)
DC output	Smoothed; no residual ripple as specified
Pulse waveform	Fixed; rise time approx. 2 ms, exponential decay with time constant approx. 4 ms, 70 pulses/s
Dimensions (L × W × H)	400 × 360 × 150 mm
Weight	Approx. 14 kg
Features	Overload and short-circuit protection; reverse-polarity protection; battery voltage monitoring

Battery packs

Quantity	3 packs, 24 V each
Dimensions (L × W × H)	550 × 200 × 210 mm per pack
Ready-to-use weight	Approx. 35 kg per pack

The original documentation states that the system was manufactured to DIN VDE requirements. All equipment parts except the charger are described as protection class II (double insulation), with degree of protection IP54 (splash and rain resistance). Exact applicable standards and component ratings require confirmation before release.

3 System concept

The battery-powered EFGI 4000 was developed for boat electrofishing as an alternative to conventional combustion-engine-powered systems. Eliminating engine noise and exhaust emissions makes electrofishing possible in environmentally sensitive waters and improves working conditions even where combustion engines are permitted.

Easy handling

Dividing the battery system into three separate boxes makes loading and unloading the boat manageable, even for one person, despite the considerable overall weight. Space requirements are low.

High operational reliability

Several monitoring and safety functions protect the electronics against overload and improper operation.

Versatile operation

The wide 65–520 V output range allows use across a broad range of water conductivity, up to approximately 10 mS/cm (brackish water). The system supports both conventional hand-held anodes and large-area electrodes mounted alongside the boat.

Its pulse waveform produces galvanotaxis comparable to DC. Pulsed operation can provide considerably longer battery life; with hand-held anodes, the original document gives approximately 6–10 hours, depending on conditions.

Fish welfare

In DC mode, the output is fully smoothed to avoid the harmful effects of ripple. The gradual rise of the pulse waveform is intended to reduce tetanic muscle contractions while supporting galvanotaxis. Low output-voltage settings allow the operator to limit electrical exposure.

4 Controls and functions of the control unit

4.1 Main switch and start-up

The control unit becomes ready a few seconds after switching on. The green “Ready” indicator illuminates. Until then, pressing the dead-man switch (TMS) has no effect. When the unit is ready, operating the TMS illuminates the green “TMS” indicator.

The first TMS actuation after start-up is intentionally ignored and the red “Overload” light illuminates. This is a safety check verifying that the TMS can interrupt operation. On the next actuation the unit operates normally, the “Overload” light goes out and a tone sounds.

If the unit has been switched off only briefly, the delay before the “Ready” indicator illuminates may be shorter.

4.2 Operating-mode selector

DC (GS)	Direct-current output
P	Pulsed-current output
DC/P (GS/P)	Either DC or pulsed output, selected via the TMS

In combined DC/pulse mode, a pause of more than 1 second between releasing and pressing the TMS selects DC. A pause shorter than 1 second selects pulsed current. The operating-mode selector can be changed while the TMS is pressed, as stated in the source.

4.3 Selecting output voltage

Output voltage is set using two controls: “Coarse output voltage” and “Fine output voltage”. The coarse selector has six positions. Its marked value is the actual output when the fine control is at 100%. Turning the fine control anticlockwise reduces output to the selected percentage. Together, the controls cover 65–520 V.

Changing the coarse selector with the TMS pressed would damage the switching contacts through arcing. The unit therefore interrupts output before switching. After each coarse-range change, briefly press and release the TMS once; the red “Overload” lamp illuminates. On the following actuation, normal operation resumes.

The fine voltage adjustment may be changed while the TMS is pressed.

4.4 Battery current indicator

The pointer indicates approximate output power and energy consumption. In DC mode, full scale (100) corresponds to approximately 4 kW; a reading of 60 therefore represents approximately 2.4 kW.

For pulsed operation, the original instructions apply a factor of five to the indication because of the configured pulse parameters: a reading of 20 corresponds to 20% of 4 kW (0.8 kW) multiplied by five, i.e. 4 kW. The maximum pulsed reading is stated as 40, corresponding to approximately 8 kW. These figures and the type of power being represented require technical verification (see appendix).

Lower pointer readings generally extend the time available before the batteries are depleted. Use the lowest power setting that still provides sufficient capture effectiveness.

4.5 Overload protection

This protective function prevents damage from overload or short circuits in the anode circuit. In DC mode, it trips if battery current exceeds 60 A (scale reading 100). The unit shuts off and the red “Overload” indicator illuminates. Releasing the TMS resets the protection and extinguishes the light. To identify the cause, observe the indicator before releasing the switch.

In pulse mode, shutdown occurs at approximately 40 on the indicator scale. If overload protection trips, reduce the output voltage. Reducing the fine-voltage setting also slightly lowers the trip threshold: at 70% fine adjustment, shutdown occurs at approximately 85 in DC mode. The trip threshold is further reduced in the two lowest coarse ranges (90 and 130 V) to prevent excessive anode current.

4.6 Undervoltage monitoring

This feature prevents excessive battery discharge by stopping operation below set voltage thresholds. Both battery voltage and the internal TMS control voltage are monitored at no load (TMS released) and under load (TMS pressed).

Below the no-load threshold, activation is inhibited. Below the slightly lower load threshold, the unit switches off shortly after activation (the tone sounds only briefly). In either case, the red “Undervoltage” lamp remains on while the TMS is pressed; check it before releasing the switch.

Reducing output voltage may permit brief further operation until undervoltage protection trips again. Repeated trips indicate depleted batteries.

4.7 Audible signal

A built-in sounder connected to the output circuit emits a tone to indicate that the unit is operating and that the electrodes are energised.

4.8 Automatic voltage ramp-up

Instead of applying full output voltage instantaneously, the EFGI 4000 increases it gradually from zero to the selected level over approximately one second. Ramp-up applies in both DC and pulse modes. In combined DC/pulse mode, ramp-up applies to DC; pulsed output begins immediately.

The ramp-up helps suppress the initial anodic reaction and associated avoidance behaviour in DC mode. In both modes, fish close to the anode have time to turn, which can lead to calmer responses and lower stress.

4.9 Connections

The anode, cathode and TMS sockets are labelled. The original instructions state that swapping these connections prevents operation without damaging the unit; this assertion requires verification before publication.

The three battery sockets are not individually labelled, and the battery packs can be connected to any of them. Their connectors cannot be confused with the other connectors, according to the source.

5 Commissioning and operation

5.1 Commissioning

- Bring the equipment into the boat and place the three battery packs next to one another on a level, load-bearing surface.

- Place the control unit on top of the packs with the supplied rubber mat between them.
- With the main switch in the OFF position, connect all plugs.
- Deploy the cathode and secure its strain relief to a suitable fixed point.
- Switch on the unit. Start with a low output voltage and increase it only until fish respond as required. Higher power shortens operating time; lower power extends it.

5.2 Electrofishing with direct current (DC)

DC offers the strongest galvanotaxis, aided by the completely smoothed output of the EFGI 4000. Its avoidance effect is generally lower than that of pulsed current, but energy consumption is higher and the effective range shorter.

Prefer DC when:

- the water is shallow and only modest power is needed;
- targeting fish species that are difficult to capture;
- minimal avoidance behaviour is important;
- long operating time is not essential;
- conductivity is relatively low (up to about 1 mS/cm).

As a starting point, the original instructions recommend approximately 2 kW (current-indicator reading near 50), providing about 2–3 hours of operation under typical conditions. In shallow water the power may be reduced further. Higher power may be useful briefly in difficult locations, but sustained full-load operation reduces battery runtime and service life.

5.3 Electrofishing with pulsed current

Compared with DC, pulsed current generally consumes much less energy and allows longer operation. With the specified waveform, galvanotaxis is only slightly weaker, but avoidance behaviour is stronger and extends farther from the anode.

Avoidance behaviour matters less where fish can shelter among many structures, but may interfere with capture in open waters, particularly for species that are less dependent on cover.

When electrofishing for eels, the source notes that an eel sensing current initially tends to burrow more deeply into cover, often producing visible bubbles. Here, “avoidance” refers to the effect outside the effective galvanotaxis/capture zone. Fish that have left cover under electrical stimulation may attempt to flee while still able to move; this also applies to eels.

Prefer pulse mode when:

- operation is required throughout the day;
- water conductivity is high (above approximately 1 mS/cm) and DC becomes less effective;
- large-area plate anodes are used.

The source suggests adjusting voltage to obtain a current-indicator reading of approximately 10–20, corresponding to around 6–10 hours of operating time under the described conditions. Reduce power in shallow water; greater conductivity (e.g. brackish water) may require higher output.

FISH WELFARE More power is not necessarily better. Excessive pulsed power can immobilise fish before they reach the anode, making them difficult to see and recover, especially in poor visibility.

5.4 Combined DC/pulse mode (GS/P)

This mode was designed primarily for catching eels. At relatively low DC power, eels may remain highly mobile and difficult to net. Select the middle position of the mode switch. Wait at least one second after releasing the TMS before pressing it again to select DC.

When an eel approaches the netting area, release the TMS briefly and press it again within one second for a few seconds. The unit then switches to pulsed output, temporarily immobilising the eel to assist netting. A subsequent pause of at least one second selects DC again. The source also mentions using this feature for escaping fish, provided the operator reacts quickly.

APPROVAL REQUIRED The combined-mode procedure, temporary immobilisation and its legal and animal-welfare suitability must be reviewed for the intended country of use.

6 Electrodes

6.1 Anode and cathode

Electrode shape and area substantially influence electrofishing performance. Independently of output power, current type and water conductivity:

- A larger anode distributes current over a greater surface area, reducing current density close to the electrode. This can improve effective range for the same power while reducing fish exposure.
- Some of the power delivered by the unit is dissipated at the cathode and does not contribute to fish capture. To minimise losses, cathode size must be adequate for the anode; larger anodes require correspondingly larger cathodes. The supplied electrodes are matched. Do not alter them without consulting the manufacturer.

6.2 Hand-held anodes

Hand-held ring anodes used for point-by-point fishing are usually circular, up to approximately 50 cm in diameter. The resulting electrical conditions involve high local current density, so only comparatively low power can be used without injuring fish.

They require physical effort but are highly manoeuvrable in complex habitats. Use hand-held anodes when plate anodes are unsuitable, such as irregular shorelines, rapidly changing water depths, driftwood, branches or broad, loosely structured reed margins. Prefer the largest practicable anode diameter.

6.3 Plate anodes

Plate anodes (also called strip anodes) consist of several parallel metal strips, typically arranged over an area of approximately 1 × 1 m or larger and mounted alongside the boat. As they move with the boat, the operator can concentrate on netting fish and controlling the equipment.

Their larger area improves the electrical field distribution and can energise a larger volume of water than a hand-held anode at the same power. The original instructions describe continuous coverage of a 2–3 m wide strip in water up to approximately 1 m deep. In deeper water, the anode may be lowered to about 0.5–1 m above the bottom, provided visibility is adequate and obstacles are absent.

Particularly useful locations include:

- shallow areas with aquatic vegetation, including water lilies, provided the crossbar is kept just above the surface and the hanging strips skim over vegetation;
- fairly straight banks, such as riprap along rivers and canals;

- narrow, sharply defined reed margins.

The source describes using plate anodes during continuous movement of the boat, with the TMS held on. This arrangement must be checked against applicable dead-man-switch safety requirements before it is approved. In open waters where fish flee readily, short activation intervals may improve capture by reducing the avoidance response.

The boat may be poled or moved with an engine, provided the engine can be throttled sufficiently and manoeuvrability is maintained. The source recommends DC with plate anodes mainly in shallow water up to about 0.5 m; operation time is relatively short because power is applied continuously. In deeper water or for multi-hour operation, pulse mode is described as necessary.

7 Fish welfare

7.1 Possible injuries

When carried out correctly, electrofishing can be a comparatively gentle capture method. Improper application, however, may cause injury or mortality.

- spinal damage (compression, displacement or fractures of vertebrae);
- internal bleeding caused by vascular damage, often around the spine;
- detachment of ribs or other bones from the spine.

The original manual attributes these injuries to tetanic muscle contraction caused by excessive electrical exposure, particularly with poorly smoothed DC or unsuitable pulse waveforms. Trout and pike are described as particularly vulnerable. The assertion that many injuries heal must not be treated as proof that the exposure is harmless.

Mortality may result from:

- extreme electrical exposure causing immediate death;
- prolonged exposure to weak pulsed current, especially when fish are held in an unshielded livewell near plate anodes;
- prolonged immobilisation with delayed return of respiration (perch are particularly vulnerable);
- stress and oxygen depletion during holding and transport.

7.2 Preventive measures

- Use sufficiently large anodes to distribute current over a wider area and reduce current density near the electrode.
- Use the lowest effective voltage and power. DC must not be assumed harmless: shallow water and small anodes can still create hazardous exposure.
- Pulsed mode has substantial available power. Do not routinely use the maximum output; particularly strong conductivity and large plate anodes change electrical loading.
- Keep energisation periods as short as practicable, especially in pulse mode. Switch off the anode before netting or lifting fish.

When using plate anodes continuously, exposure time can be prolonged. Avoid unnecessarily slow boat movement. If fish remain immobilised for too long, reduce the voltage.

The fish holding container (known in German as a “Schweff” or livewell) should be electrically shielded when using pulsed current; the source specifically requires this when plate anodes are used. The described shielding uses bare, electrically bonded metal mesh or perforated sheet along the inner walls, or a basket-like insert of the same material.

CHECK Fish held in the livewell must show no reaction when the TMS is operated. Ensure adequate oxygen supply during holding and transport.

Actual fish welfare depends strongly on voltage and delivered power. Values suggested in sections 5.2 and 5.3 are only starting points and must be adjusted to conditions. Begin low and stop increasing power as soon as the required capture response is achieved.

Assess the response:

- Low exposure: fish follow the moving anode and swim away immediately when current is switched off, or recover after only a few seconds.
- Do not increase power: most fish remain immobilised for up to roughly one minute (large cyprinids possibly longer) but all recover. Monitor perch especially closely.
- Reduce power immediately: fish remain immobilised for several minutes, any fish fails to recover, or perch exhibit severe distress. Fish may be immobilised so far from the anode that they never reach it.

8 Charging the battery packs

The source specifies the following connection sequence: connect the charging adapter to the switched-off charger first; then attach all three battery packs to the adapter sockets. On disconnecting, remove the battery connections first, then disconnect the adapter from the charger. This sequence is intended to prevent shorts at exposed adapter cable ends.

During charging, the three packs are connected in parallel, giving a nominal voltage of 24 V. Do not interpret this as proof that touching live conductors is safe: short-circuit and other hazards remain. Connection order and electrical safety require validation for the actual charger configuration.

Connect the charger to the power supply in accordance with its approved instructions. The source describes an initial constant-current charge phase that may last up to approximately 20 hours, depending on battery capacity and discharge level. The indicator is red during charging, green when fully charged, and unlit if charging does not occur.

If the charge indicator remains off, stop and contact the manufacturer. Once green, disconnect the mains supply and the battery connection.

Charging precautions

- Connect the charger only to a suitable earthed mains outlet.
- Provide unrestricted cooling airflow. The charger is not waterproof; protect it from rain without blocking ventilation.
- Partial charging may permit further operation but reduces available runtime.
- The original documentation states that the approved charger may remain connected after charging because its electronics reduce current to zero. Verify that this applies to the actual charger and battery chemistry.
- Check the charge indicator periodically. If it has not turned green within approximately 10–20 hours, stop charging and have the batteries or charger checked.
- The source suggests periodic topping-up every three months for lead-acid batteries or six months for lithium batteries. Confirm suitable storage-charge intervals with the battery manufacturer and the actual chemistry.

IMPORTANT The original manual instructs users to recharge depleted batteries promptly and to recharge even after partial discharge. Apply battery-chemistry-specific recommendations rather than assuming lead-acid and lithium systems behave identically.

9 Care and maintenance

- Protect the control unit against shock and impact.
- Prevent dirt and water from entering electrical connectors.

- The source describes battery packs as splash- and rain-resistant and says they can stand in bilge water during operation. This claim requires component-specific verification before it can be relied on.
- The TMS is described as splash-resistant, but must not be left in bilge water.
- With connectors or protective caps properly secured, the control unit is described as resistant to rain and splashing from above or at an angle.

Cooling openings protected by ducts are located beneath the housing, together with a fan and inlet dust filter. Never place the control unit in water. Protect it against strong, low-angle spray, such as during fast boat travel in waves. Store the equipment in a dry, temperature-controlled environment.

Battery maintenance

Service battery packs in accordance with their actual chemistry and the manufacturer's instructions, with all connectors disconnected. For serviceable flooded lead-acid cells only, the source describes annual electrolyte-level inspection, topping up with distilled water as necessary to keep the plates covered, and cleaning and protecting corroded terminals. Never open sealed lithium or $LiFePO_4$ batteries to inspect electrolyte.

Battery replacement

Prevent short circuits and observe polarity. Battery posts and terminals are identified, and positive and negative posts may have different diameters. The source states that the control and charging units have reverse-polarity protection; nevertheless, incorrect polarity when connecting packs through the charge adapter can cause a short circuit.

10 Troubleshooting

First check that the anode, cathode and TMS connectors have not been interchanged. Wear and repeated bending can cause intermittent cable breaks, particularly near connector strain points. Such faults may initially occur only occasionally and become more frequent.

Any continuity test, bending or manipulation of cables must be carried out with the equipment fully switched off, disconnected from all power sources and confirmed safe. Suspected broken cables should be examined by qualified personnel.

If the audible tone sounds but electrofishing performance is absent, the source suggests investigating anode and cathode cables. If there is no tone and the "TMS" indicator does not illuminate when pressed, the TMS or its cable may be faulty.

If the problem persists, record:

- How do the indicator lights respond to the main switch and the TMS?
- What does the battery current indicator show?
- Does the audible tone sound when the TMS is operated?

DANGER Contact the manufacturer with these observations. Do not open or attempt repairs inside the control unit.

11 External wiring / connector pin assignments

25 A connectors — battery circuit only

Pins 1 and 2	Positive (+), in parallel
Pins 3 and 4	Negative (−), in parallel

16 A connectors — anode, cathode and TMS

Pins 1 and 2	Dead-man switch (TMS)
Pin 1	Cathode
Pin 3	Anode

Unused contacts are removed as a general rule, according to the source.