Impulse Generator IPG800 and Borehole Sources BIS-SH-DS & BIS-SV & SBS42 Operating and Maintenance Instructions

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Content

0. Precautions for Operating Seismic Sparker and other HV-Sources

Like other seismic sources such as explosives, air guns, or weight-dropping systems, operating an electrical spark or other high-voltage impulse sources requires several precautions. The most important precautions are:

1. **Do not connect or disconnect high-voltage connectors while the impulse generator is in operation or switched ON. Switch OFF the impulse generator before disconnecting cables or connectors.**
2. **No handling of surface cable, downhole source or borehole cable while the impulse generator is in operation.**
3. **Impulse generator operation only by authorised personnel.**
4. **Do not expose the impulse generator or connectors to water or dust.**
5. **Do not block air ventilation.**
6. **In case of any malfunction or emergency, switch OFF the impulse generator by pressing the red OFF button at the generator or the remote control.**
7. **Do not open the impulse generator or remote control. Maintenance has to be carried out by authorised personnel. The warranty will expire immediately on the un-authorized opening of the impulse generator.**

Moreover observe the following:

- Check cables for power supply, high-voltage surface and borehole cable, and all connectors concerning faultless conditions before and after every field survey.
- Please do not open the impulse generator while it is connected to mains or other power sources. Repair or maintenance should only be carried out by authorised personnel. The surface HV-connector (quick connector) should be **dry** to avoid a flashover inside the connector. Ensure that no water, e.g. rain, enters the connectors.
- If there is an electrical interruption between the impulse generator and borehole source, or if an impulse is released without a spark action, the cable can become charged with high-voltage like a small condenser. This charge has to be discharged by switching OFF the impulse generator. Check this by observing the HV-meter. Wait until the voltmeter at the impulse generator shows a voltage of 0 Volt!
- In case of a malfunction, the high-voltage charge will discharge slowly (in about 10 to 15 minutes) via a discharging resistor. Wait until the voltmeter at the impulse generator reads 0 volts!

1. Impulse Generator IPG800

The impulse generator IPG800 is used to supply the seismic probe with energy. The IPG800 is powered by 2 x 12V car batteries (not supplied). Figure 1 shows the impulse generator IPG800.

The IPG800 is supplied with the following accessories:

1. IPG800 in PELI box
2. Battery connecting cables and interconnecting cables
3. Manual

Figure 1: Impulse generator IPG800

The IPG800 supplies the energy of 1000J at 800V to the borehole source BIS-SH-DS using a short electrical pulse. This is done by an electromechanical switch that discharges condensers inside the IPG800. The electromechanical switch is made of Wolfram metal for long working life.

The impulses can be released by selecting three cycles (1, 5 or 10) using a turning knob on the front panel.

The connection between the borehole source and the IPG800 generator is accomplished by attaching two special HV connectors to the output contacts located on the right side of the IPG800 box.

The connection between the 12V batteries and the IPG800 generator is made by connecting the batteries to the input contacts located on the left side of the IPG800 box.

The generator should be operated at a certain distance from the seismic recorder to avoid electromagnetic interference.

The impulse generator must be protected from any wetness/moisture, e.g. rain and dust !

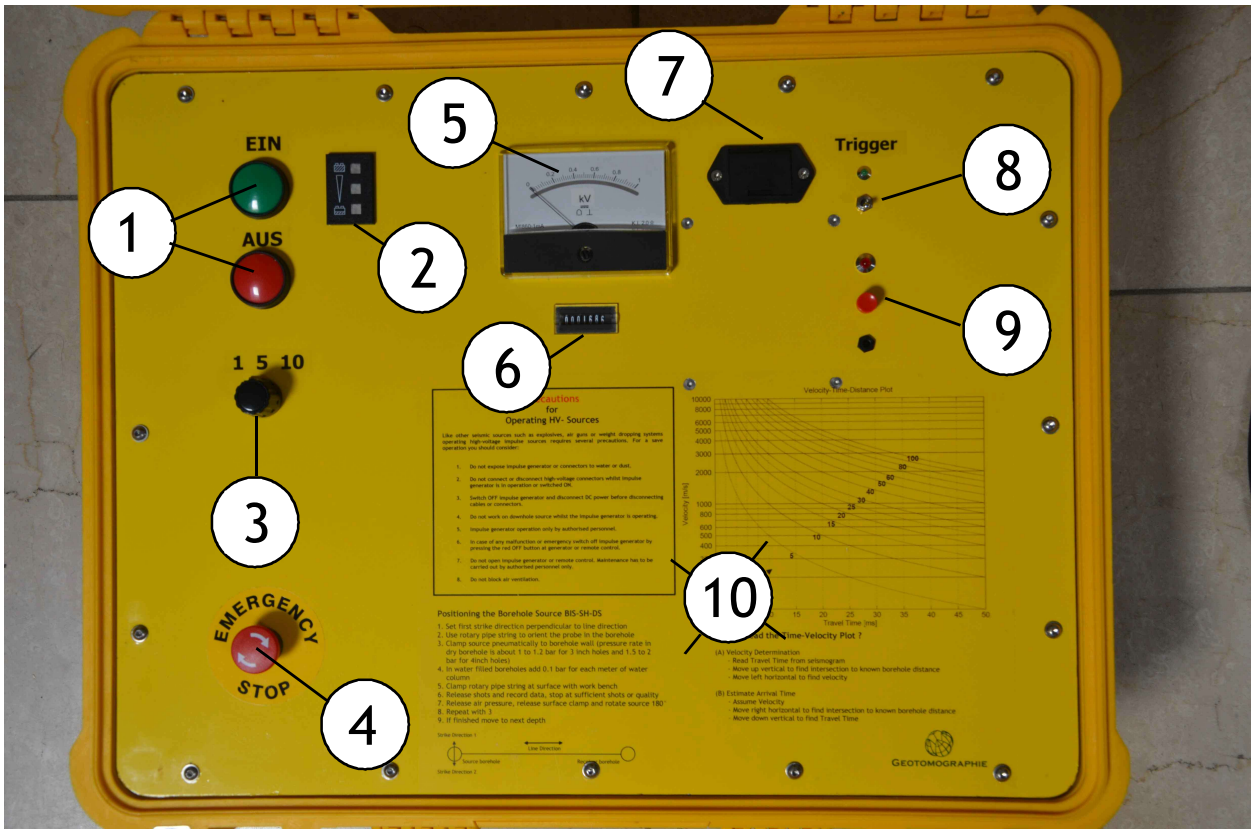


Figure 2: Front-side view

Function:

(1) : ON/OFF (on OFF = System shut down)
(2) : Battery Control (charge on yellow/red)
(3) : Shooting Timer (1 = Single Shot release, 5 = approx. five shooting cycles, 10 = approx. ten shooting cycles)
(4) : Emergency OFF Button (system shut down)
(5) : Voltage Charging Display
(6) : Impulse Counter
(7) : Battery Slot 9V for trigger circuit
(8) : Trigger ON/OFF (ON = green LED lights)
(9) : Trigger Test Button (on test red LED flashes)
(10) : General Instructions

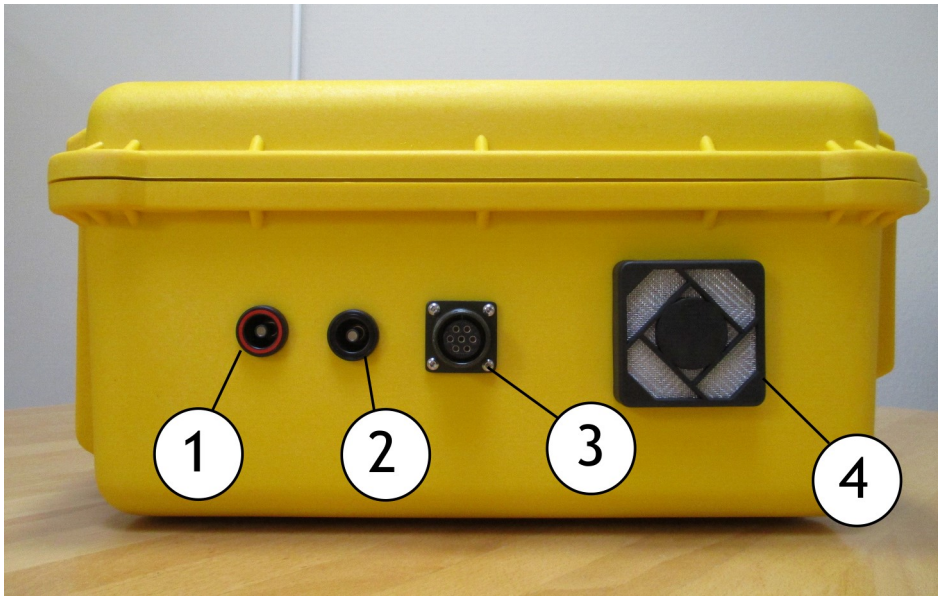


Figure 3: Left side view - Battery connecting side

Function:

(1) : MINUS Pole Battery 1 (**black**)
(2) : PLUS Pole Battery 2 (**red**)
(3) : Connector to Remote Unit
(4) : Air inlet (do not block)

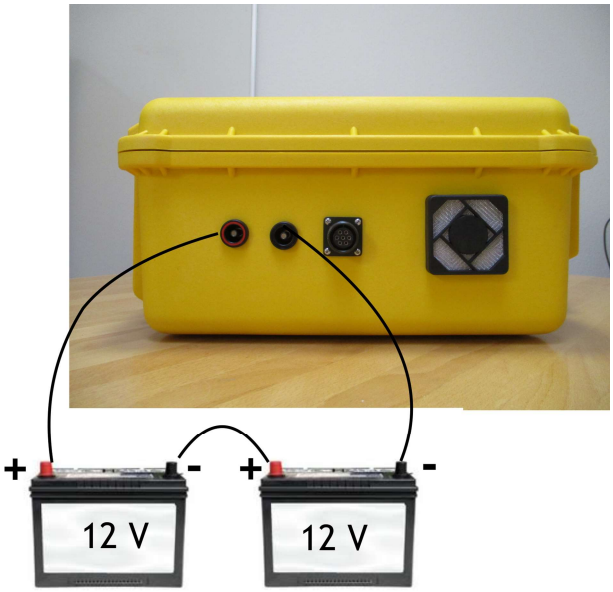


Figure 4: Battery Connection Scheme

Two 12V batteries need to be connected to the IPG800, as shown in the Figure 4 on the left. Please note that in earlier versions, the connection on the IPG800 could be reversed in position).

Red to +
Black to -

Do not connect in any other way.

It is recommended to use car batteries with at least 35Ah.

Note: The battery connectors on the IPG800 are of the push-pull type. To remove them, you have to put them in and then pull them out

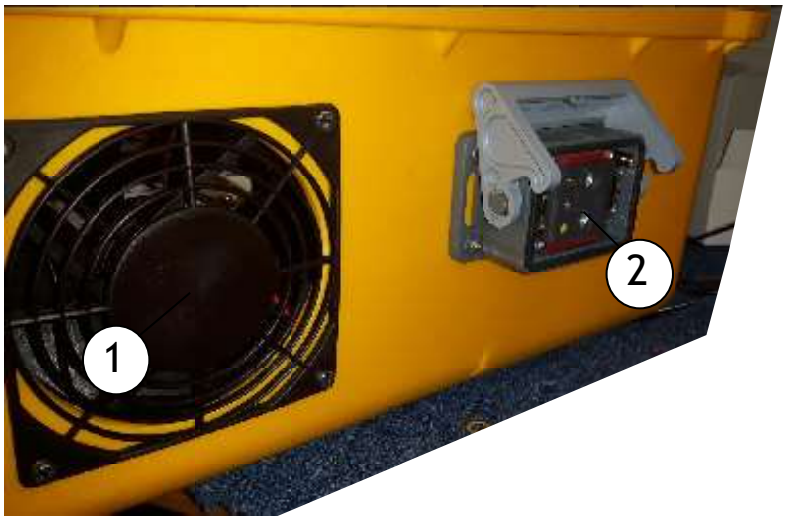


Figure 5: Right-side view (Source connecting side)

Function:

(1) : Air Outlet (do not block)
(2) : Source Connector

Figure 6: Rear side connector for 24V supply to the BIS-SV relay switch (2023+ IPG800 models)

Alternatively, users may use a battery cable to power supply the BIS-SV relay switch.

2. Remote Control Unit (RCU)

The remote control unit fulfils the following functions:

1. To convert the impulse reference signal into a trigger signal to start the seismic recorder.
2. Start/Stop of shot release
3. The immediate interruption of impulse operation by pressing the EMERGENCY OFF button

The following accessory is provided to operate the RCU:

1. Remote control with 20m cable on a drum

Figure 7: Remote Control Unit RCU

The Remote Control Unit is connected to the IPG800 by a single cable. The system can only be operated when the Remote Control Unit is connected to the IPG800 system.
The RCU provides two different triggers. One is a TTL trigger provided directly by the IPG800, and the other is the same but directed via an OPTO-Coupler. The second option is necessary if too much electrical noise and seismic traces get distorted. A 9V battery powers the OPTO-Coupler. Most seismographs do not require OPTO triggering. However, please make sample records to see which is the best option.

Attention: Rental units may only have the OPTO coupler option. In this case, no trigger will be released if the trigger on the RCU is not switched on (=LED lights).

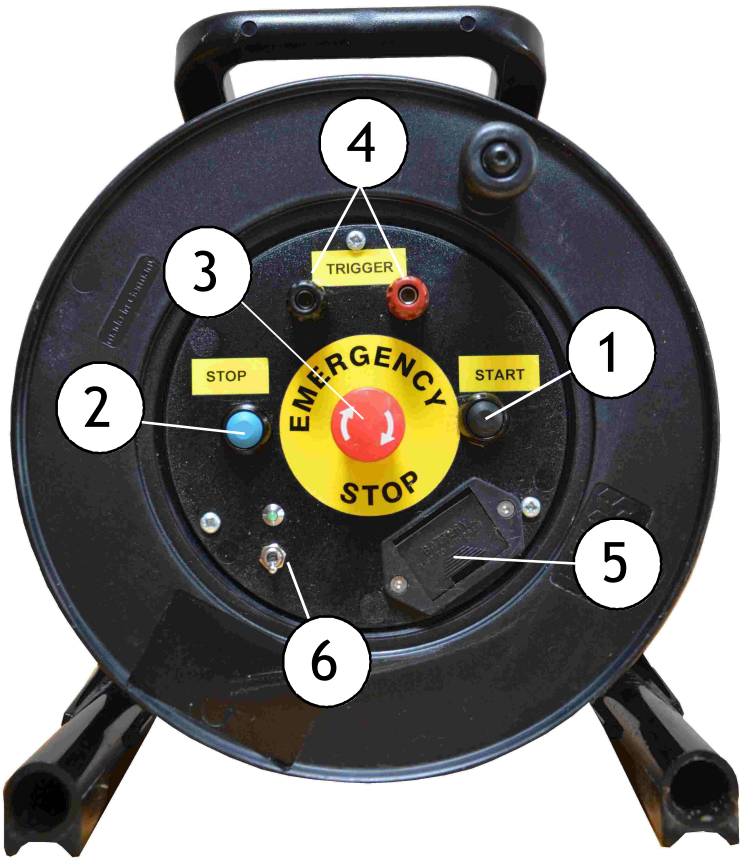


Figure 8: Front view

Function:

(1) : Start Shot release
(2) : Stop Shot release
(3) : Emergency OFF Button (system shut down)
(4) : Trigger output to seismograph (**red = +**, **black = -**)
(5) : Battery Slot 9V for OPTO-Coupling trigger circuit
(6) : Trigger Select (**Optocoupling = LED is green**, standard trigger = no LED)

The trigger signal is a raising edge TTL (positive pulse).

Note: Opto-coupling triggering is not required for most seismographs. It is only an option. First, try to see if your seismograph triggers without the opto-coupling switched ON. To do this, simply press the red Trigger Test Button at IPG800.

Figure 9: Complete assembly of IPG800 and Remote Control Unit

3. Borehole Source BIS-SH-DS

The borehole source BIS-SH-DS generates horizontally polarised S-waves in a borehole. Based on an outer diameter of approximately 65 mm, the BIS-SH probe can be used for SH-wave surveys in boreholes with a minimum diameter of 75 mm and up to 4 inches without extension.

Figure 10: Borehole source BIS-SH-DS

The borehole source consists of the following parts:

1. BIS-SH-DS source with borehole rotary string on the drum, standard length 50 m
2. Valve and pressure gauge adapter
3. Spooler device and air pump

The borehole rotary string ends in a white plastic cylinder which is usually directly mounted on the drum. This end terminator splits the HV cable and the air connection (to inflate the BIS-SH packer).

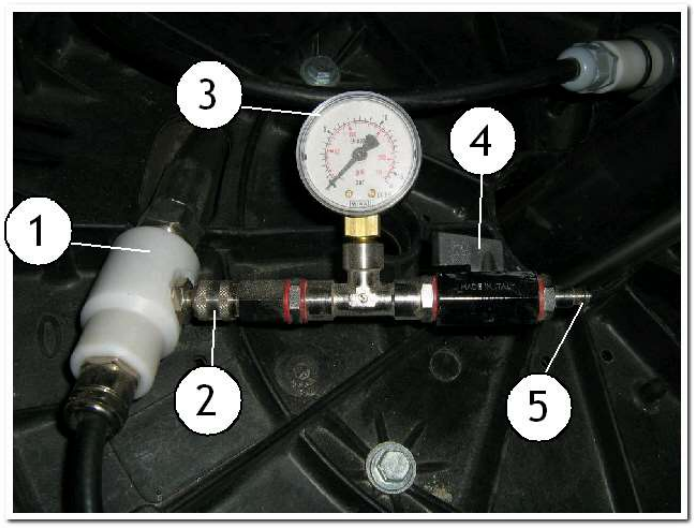
A special adapter with a gauge and valve can be connected to the air-in inlet. It's a push-pull connection on the gauge-valve adapter. An air pump is provided to inflate the packer to clamp the source to the borehole wall. Again, it's a push-pull connection.

Once air pressure is applied to inflate the packer, close the valve and disconnect the air pump. No air can be released without disconnection.

Always keep the push-pull connectors clean

The HV cable itself splits off after a few meters into two HV connectors (for connection to the IPG800).

Older BIS-SH-DS probes are connected to the IPG800 via the quick surface connector. The HV cable terminates in a surface connector.



Function:

(1) : Surface Connector
(2) : Push-Pull connection at (1) valve-gauge adapter
(3) : Pressure gauge
(4) : Valve
(5) : Connector to air pump

Figure 11: Surface end connector

The BIS probe consists of the probe head, two half sleeves, the rubber-protected and sealed active probe part, an air clamping device, and the probe end part (see Figure 12 below).

Figure 12: BIS-SH-DS probe

The probe head splits between the HV cable and the air supply. The probe head is also connected to the rotary pipe string. **Always ensure that the connection is very tight!**

Also, ensure that the active part of the probe (shooting direction) is aligned with the mark on the rotary string.

Figure 13: Rotary String Marking (points towards shooting direction)

The two half sleeves connect the probe head to the active probe part. One side can be opened to maintain the cable connection (cleaning) and connect/disconnect the air hose (Figure 14).

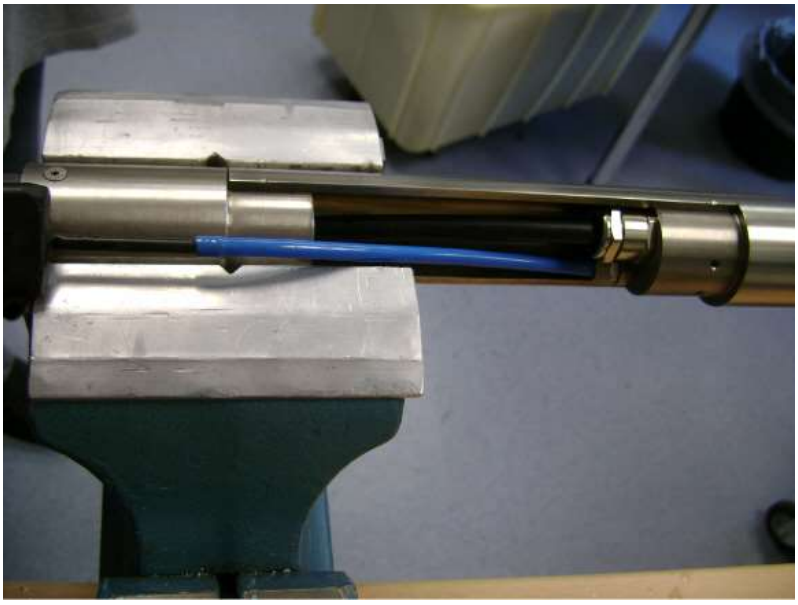


Figure 14: Half-Sleeves with HV cable and pressure hose connector

The air clamping part can be easily removed from the active part by unscrewing it to change the air bladder (Figure 15).

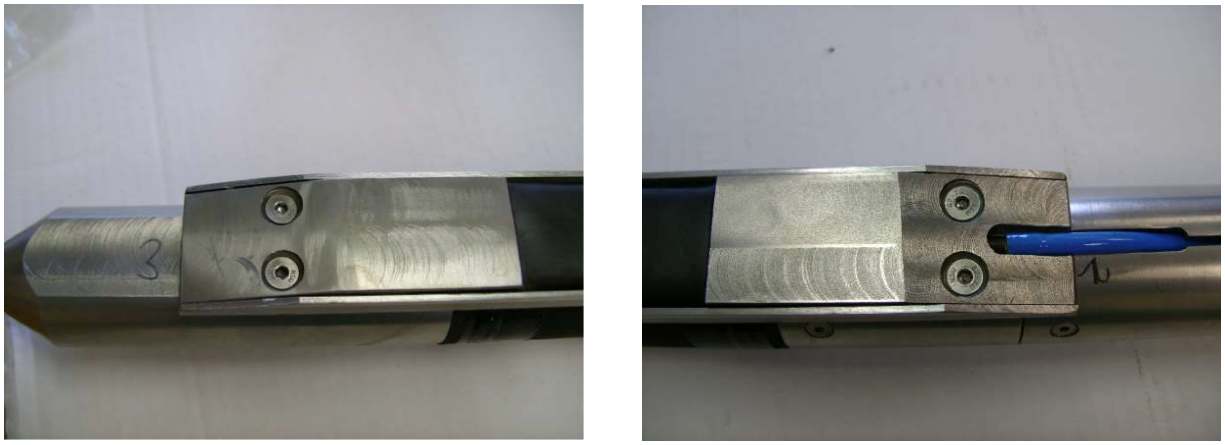


Figure 15: Unscrew to replace air bladder

The active part of the source contains a seismic source working after the eddy current principle. A high-duty rubber tube (3 mm wall thickness) protects the HV part from water and dust.

The probe can be run in a borehole on its own cable only.

The probe can work in water-filled and dry boreholes!

Due to the high voltage, the active probe part heats up. The temperature rises quickly up to 100°C. Ensure there is no overheating (for example: after 30 - 50 shots in continuous mode without stopping). This is mainly observed in dry boreholes where cooling is not as optimal as in water-filled boreholes.

4. Borehole Source BIS-SV

The BIS-SV borehole source generates vertically polarised S-waves in a borehole. Based on an outer diameter of approximately 65 mm, the BIS-SV can be used for SV-wave cross-hole surveys. It is coupled to the borehole wall by an inflatable air packer. It's the same packer and clamping mechanism used for the BIS-SH-DS source.

Figure 16: Borehole Source BIS-SV

The borehole source consists of the following parts:

1. BIS-SV with cable and marking on the drum, standard length 50 m
2. Valve and pressure gauge adapter
3. Spooler device and air pump
4. HV relay switch and remote switch box (Up/Down)

Figure 17: BIS-SV source

Functions:

(1) : BIS-SV probe with outer friction enhancer material
(2) : HV connector to IPG800
(3) : Air packer
(4) : Remote switch box for Up- or Down shots
(5) : HV relay switch box
(6) : Air connection

A high-voltage relay switch box is mounted on top of the cable drum. Inside is a relay that allows switching between the Up- or Down strike. The relay requires a 24V supply provided by a cable connection between the relay box and the IPG800 (connector socket at IPG800 rear side).

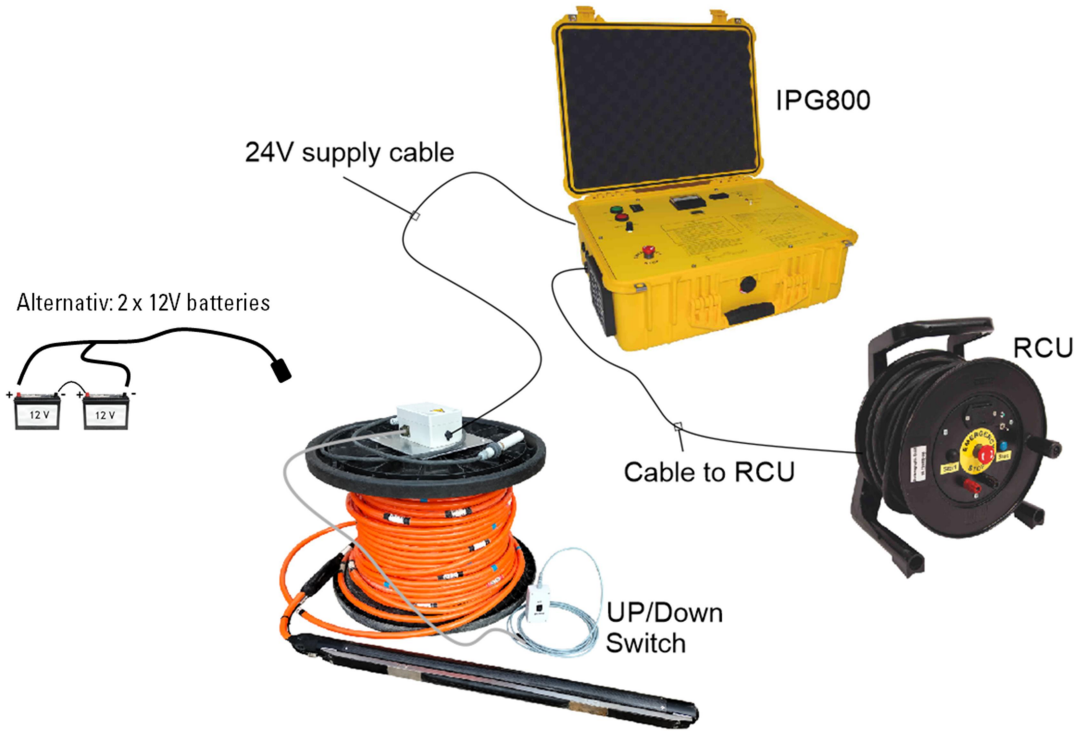


Figure 18: Schematic connection diagram

The HV relay box (see figure 17, function 5) is mounted on top of the cable drum. It has three connections, i.e. the 24V power in, the connector socket to the UP/Down switch box and the air in supply (see below).

Figure 19: UP/Down remote switch box with connections

A remote switch box allows up/down switching (see Figure 19). The box needs to be connected to the HV relay box on top of the cable drum.

Under no circumstances - do not switch while a shot is being released.

For example, you can do five shots in Up direction, then stop, switch to Down and continue with five shots in the Down direction. If the data quality is poor, you can set a higher gain factor on your seismograph.

There is a friction-enhancing material glued to the outer housing (see Figure 20). The purpose of this is to increase friction and reduce the sliding of the source along the borehole wall during shooting.

Figure 20: Friction-enhancing material covers the outer probe housing

The active part of the source contains a seismic source working after the eddy current principle. A high-duty rubber tube (3 mm wall thickness) protects the HV part from water and dust.

The probe works in water-filled or dry boreholes!

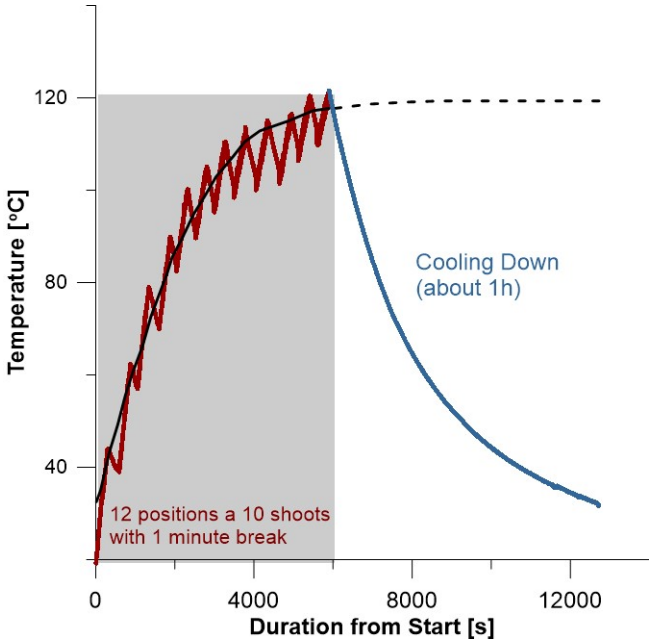


Figure 21: Temperature behaviour

Due to the high energy, the active probe part heats up quickly. The temperature rises quickly up to 120°C. **Take care not to overheat.**
A maximum of 5 shots in one direction is recommended. This is mainly observed in dry boreholes where cooling is not optimal compared to water-filled boreholes.

5. Borehole Source SBS42 (P-sparker)

The borehole sparker probe SBS42 consists of the probe head, an exchangeable spark electrode, and the housing (see Figure 22).

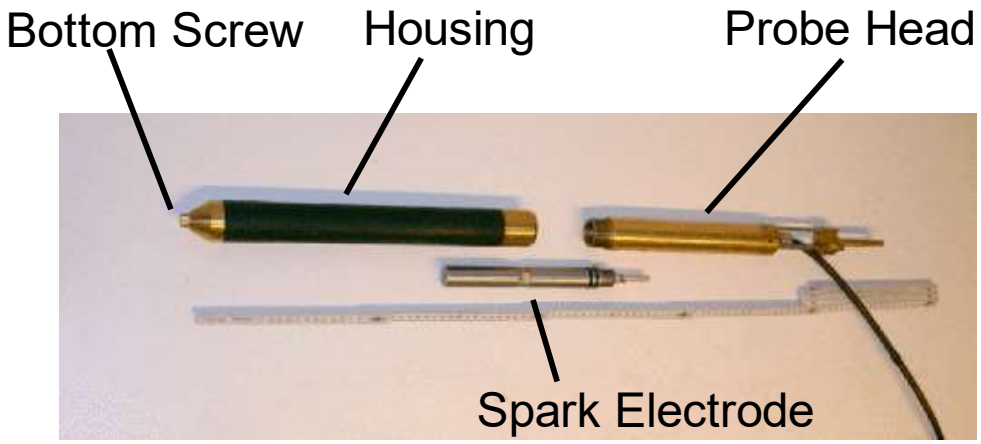


Figure 22: SBS42 borehole source

The probe head electrically connects the probe with the coaxial HV cable. The replaceable electrode is a high-performance long-life spark electrode made of stainless steel and a tungsten-copper alloy inner electrode. The housing consists of a plastic tube with rubber protection around the circumference. Openings made in the plastic tube allow an omnidirectional pressure release into the rock formation. A bottom screw seals the lower end.

The housing must be filled with salt water through the bottom screw thread.
After filling, close the bottom screw.

Simply remove the screw and fill it with water. You can add some salt to the water to increase electrical conductivity (1/2 tablespoon to 500 ml water). Close the bottom screw. A small amount of gas produced by the electrolysis effect of the current impulses passes Through narrow channels and can escape from the probe through openings in the probe head. The higher electrical conductivity results in a sharper and more defined spark breakthrough and increases trigger stability, i.e., improves the trigger accuracy.

The spark electrode is designed for long-time operation and has a total service/working life of several thousand shots. It is recommended that the front surface of the electrode be fallteded with a mechanical file tool after approximately 1000 to 2000 shots l.

When replacing the electrode, ensure that the system is switched OFF. When replacing the electrode, fold it downwards to prevent water from entering the probe head. Apply grease to O-rings only.

Grease only the O-rings on the spark electrode.. Do not grease the spark electrode thread.

Do not shoot into free air if the sparker probe is filled with water. If there is insufficient static counter pressure, the rubber hosemay be overstretched. For this reason, the minimum operating depth should not be less than approximately one meter below the water table.

The rubber tube section can be dismantled for repair or maintenance, e.g., the spark electrode.

A sparker electrode needs to be screwed into the SBS42 probe. The system power has to be OFF, and the system must be completely discharged.

The sparker electrodes start with a new and flat surface. The recommended sparker electrode gap is **3 mm** between the inner and outer ring electrodes.

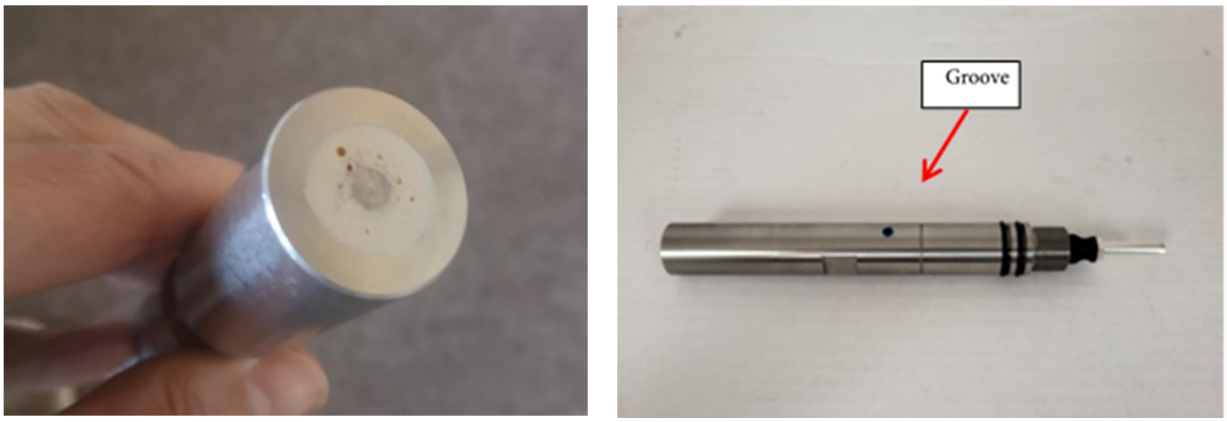


Figure 23: Sparker electrode (with groove)

Figure 24: Sparker electrode screwed in completely

Screw in the electrode until the groove on the electrode aligns with the sparker chamber's outer thread.

The sparker electrode undergoes abrasion on continuous use. It will still work, but it will show further wear if the electrode is not flattened at the end of the day. **Use a file or a saw to flatten the electrode**. Remove any burrs from the electrode. Electrodes that show heavy abrasion break down sooner or later, resulting in unstable signal quality and unstable triggering.

Figure 25: (left): new and flat surface of the sparker electrode (right): sparker electrode after approximately 2000 shots.

6. Operation and Maintenance Instructions

6.1 Connecting batteries to the IPG800

Two 12V batteries must be connected to the IPG800, as shown in the Figure 26 below. It is recommended to use car batteries with at least 35Ah each.

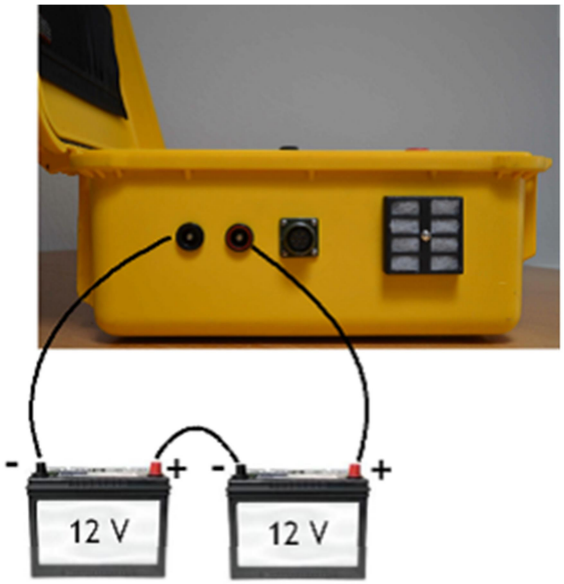


Figure 26: Battery Connection Scheme

Do not connect in any other way!

In earlier versions, the connection to the IPG800 could be reversed.

Red to + Plus
Black to - Minus

6.2 Connecting the Remote Control Unit to the IPG800

Connect the Remote Control to the 7-pin connector on the left side of the IPG (please refer to Figure …).

Figure 27: Connection RCU to IPG800

Make sure the emergency button is up.

If the emergency button is down (=pressed), the system will not work.

6.3 Connect the probe to the IPG800

Un-spool borehole source to the desired working depth. Figure 28 shows the HV socket on the IPG800 and the connector on the borehole source.

Figure 28: Connectors at the IPG800 for connecting the source

Figure 29: Connection established to the IPG800

6.4 Placing the borehole source into the borehole

To determine the correct clamping air pressure, place the source at the top of the borehole (0,5m) and carefully begin to apply pressure. The air volume of the cable will cause the pressure to rise slowly at first but then rapidly!

- Visually check that the air bladder reaches the borehole wall (AP1-Air pressure 1).
- Determine AP1
- Apply 1.2 .. max 1.5 bar overpressure to AP1 to obtain sufficient clamping pressure.

If the rubber hose is damaged, stop all work immediately. The rubber hose must be exchanged. A separate instruction is given for the maintenance of this part.

Warning: During continuous or extensive SINGLE mode operation, the temperature of the active part of the probe might rise to a temperature level that can damage the source or cause burns if touched without gloves. Wear gloves when operating the source. Avoid overheating.

The rotary pipe string does not need any special maintenance. Check the cable mantle regularly for mechanical damages as cuts.

6.5 Setting the IPG800 in operation

Please read the instructions carefully to start working with the cross-hole system.

1. Connect the batteries to IPG800 as described in 6.1
   Check that the batteries are fully charged using the "Battery Control" located to the right of the ON switch on the IPG800 front panel

2. Connect the Remote Control as described in 6.2
   Check that the "Emergency OFF" button is in the UP position (=not pressed)
   Connect trigger to the seismograph

3. Connect the borehole source to the IPG800 as described in 6.3 and 6.4

4. On the IPG800, check that the "Emergency OFF" button is in the UP position (=not pressed) Switch ON the trigger on the IP800

5. Press "ON" on the IPG800 (the system should start charging until 800V is reached).

6. Set "Shooting Timer" to the desired position (1/5/10). The IPG800 is now ready to start cycling and can only be controlled by the Remote Control Unit.

7. Make sure that everything is well-connected and secure. The operator is responsible for the handling of the system and its safety. When the source is in the desired position and clamped, you can start your survey by pressing the "START" button on the RCU (remote control unit). The source will start working.

   The shooting is finished when the "Shooting Timer" has reached the end or by pressing the "STOP" button on the RCU. Press "Start" again if you want to start a new cycle.

8. Any operation can be stopped at any time by pressing the "Emergency OFF" buttons on the IPG800 or on the RCU.

6.6 Finish operating the IPG800

- To end the survey, press the "OFF" button on the IPG800 or one of the two "Emergency buttons".
- Next, disconnect the batteries, followed by disconnecting the RCU.
- Finally, disconnect the trigger cable and the source from the IPG800.

6.7 FAQs

(1) How to adjust the source?

Please refer to the "General Instructions" on the front panel of the IPG800 for instructions.

(2) Can I check if the trigger works?

You can test if your seismograph accepts a trigger by pressing the "Trigger Test" button on the IPG800. The LED will flash red when the trigger is released. This is the same as when a real trigger is released. Pay attention to the reaction of your seismograph.

(3) The seismograph does not trigger.

Please check if the trigger on the IPG800 is ON.

If yes, check that the LED flashes red when a shot is released. If it flashes red, the IPG and source are working correctly. If it does not flash check the 9V battery on the IPG800 and test again.

If you are triggering via OPTO coupling, please check the 9V battery.

If you are not using an OPTO-coupling trigger, please check the sensitivity of your seismograph and the selected trigger slope (positive/negative).

Also, check that the wires connecting RCU and seismograph are OK.

Last but not least, check the RCU cable that connects the RCU and the IPG800 to make sure that all wires have continuity. To do this, open the RCU (shut down the IPG800 first).

(4) Traveltimes are far too short (approx. 10ms).

It looks as if the shot is already released before the seismograph starts triggering. Please check the selected trigger slope (positive/negative) of your seismograph. The slope must be positive.

(5) Everything is connected correctly, but the system does not start charging up to 800V.

Please check that both "Emergency OFF" buttons are released (UP position).