Beyond Performance

MAXAM Deutschland GmbH
Zünderwerke Ernst Brün

ZEB Blaster OP

User Manual – Antenna Appendix

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Introduction

The ZEB Blaster OP is a high voltage Shock Tube Initiation System. The battery powered device charges a high voltage capacitor and discharges it by command into an electrode to generate a powerful spark to initiate shock tubes.

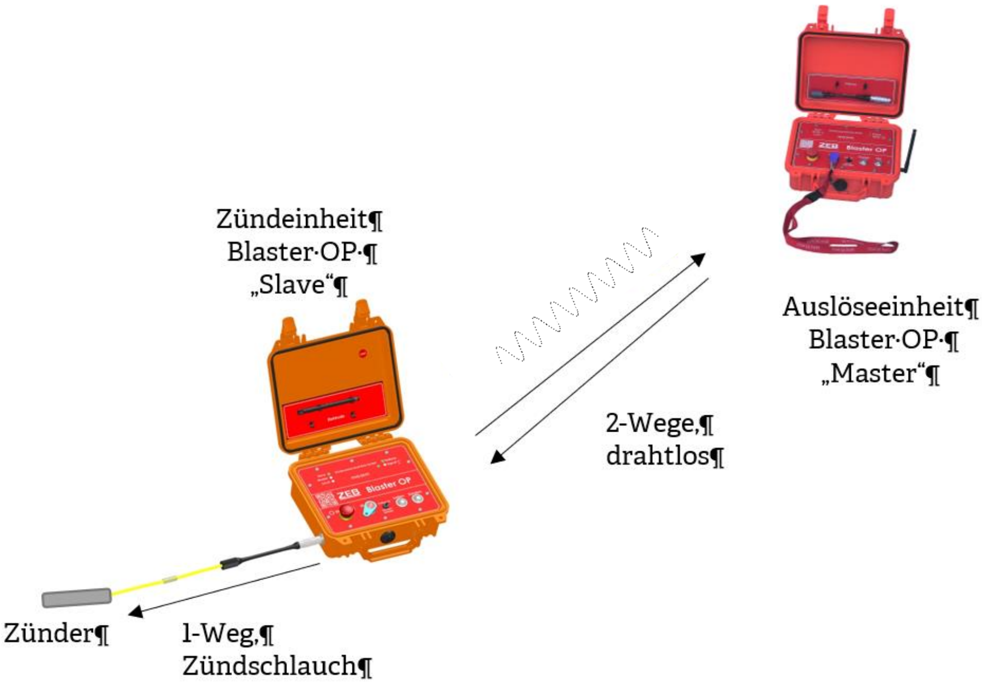
ZEB Blaster OP (Left: Slave Mode, Right: Master Mode)

The following document will give an overview on radio remote operation of the ZEB Blaster OP.

ZEB Blaster OP (Master Mode preparation)

Technical realization

The ZEB Blaster OP is used as an example to describe the realization of detonations triggered by radio signals. This is a blast ignition machine, which operates at 868MHz in the ISM band. This frequency range can be used for industrial, scientific and medical applications in Europe and beyond (International Region 1). The devices at the blasting site and the blaster communicate via a bi-directional radio link.



This means that the units mutually exchange their status queries and releases. This ensures that an ignition is only triggered by the ignition unit when all the required releases of the triggering unit have been made.

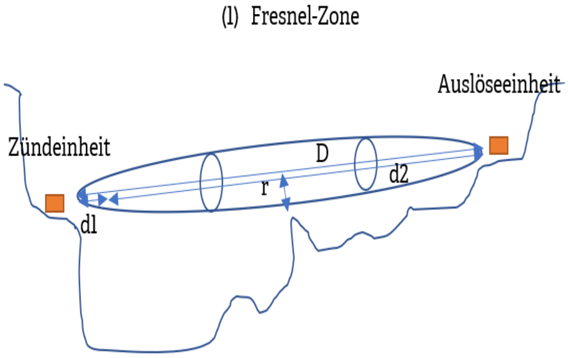
In addition, the individual enable levels of the release unit can only be reached if the ignition unit has confirmed defined states (e.g. ignition readiness with sufficient ignition voltage).

Radio Transmission physics

Generally applicable requirements apply to the radio link. A direct line-of-sight connection is advantageous, but not absolutely necessary. Non-penetrable surfaces cause interfering reflections (metal), penetrable materials cause absorption of the signal (concrete).

This also applies to small areas if they are in the Fresnel zone. With soft materials such as trees, a slight absorption per object occurs, which reduces the signal strength.

For an optimal radio connection, the 1st Fresnel zone must be kept free from interference. There should be no sources of interference within this ellipsoidal zone between the transmitter and receiver.



Various online calculators can be found on the Internet. The calculations take place according to the simplified basic formular (A. J. Fresnel):

$$r = \frac{\sqrt{\lambda * D}}{2}$$

Here, the largest extension between transmitter and receiver is calculated as radius r. λ corresponds to the wavelength of the radio signal and D to the distance between transmitter and receiver. If one wants to determine the extension at a certain point, D can be divided into d1 (distance from the transmitter) and d2 (remaining distance to the receiver). The formula for the first zone expands to:

$$r = \sqrt{\frac{\lambda * d1 * d2}{D}}$$

Using the ZEB Blaster OP as an example, the calculation is performed for a radio ignition at a distance of 300m. For this, the wavelength λ is calculated from the radio frequency and the speed of light c.

$$\lambda = \frac{c}{f} = \frac{299\,792\,458 * m * s}{868000000 * s} = 0{,}3454m$$

The maximum extension of the rotational ellipsoid is calculated.

$$r = \frac{\sqrt{\lambda * D}}{2} = \frac{\sqrt{0{,}3454m * 300m}}{2} = 5{,}1m$$

For example, if the ignition unit is located at the blast site with the antenna on the ground, the Fresnel zone can be determined at a distance of 10cm from the transmitter.

$$r = \sqrt{\frac{\lambda * d1 * d2}{D}} = \sqrt{\frac{0{,}3454m * 0{,}1m * 299{,}9m}{300m}} = 0{,}19m$$

The Fresnel zone is disturbed by the ground directly at the device. There is a strong absorption of the radio signal, which limits the range.

Quarry example

Elevated approx. 1m above the ground, the radius of the Fresnel zone is approx. 60cm. Since in a quarry it can be assumed that the person authorized to blast is on a higher position, a significant improvement of the radio signal can be achieved by increasing the distance of the receiving trigger unit from the ground by approx. 100cm.

With the ZEB Blaster OP it is possible to connect a wired antenna to prevent interference and to protect the unit from possible flying rocks.

Good practice

- Never place a unit, that should communicate via radio link, on the ground, except that the operator is at a much higher position
- Set the antennas up vertical, except that the operator is at a much higher position, then tilt the antenna to avoid loss due to the 1st Fresnel zone.
- Don’t set the equipment directly in front of a rock face. The reflections of the vertical wall reduce the transmission signal quality.
- Use external cable extended antennas to protect the Blaster OP from flying rocks.
- To get more transmission power by raising the antenna to an elevated position of the ground. 2m above ground would be perfect.
- Always keep a distance of >5m between each ZEB Blaster OP