FIREX
ELECTRIC DETONATOR
Product information as of June 6, 2011
1. Electric detonator

Electric detonators function in the following manner: When an adequately high ignition current is led to the leading wires, the resistance wire heats up inside the fuse head, causing its pyrotechnical composition to deflagrate and ignite the delay element, which, in turn, ignites the explosive, initial charge, and base charge at the bottom of the detonator after a predefined time.

The pyrotechnical delay element delays the beginning of the explosion for a predefined time once the ignition impulse has reached the detonator. The delay times range from 25 ms (0.025 s) to 5000 ms (5s). To reduce the danger of unintended ignition caused by static electricity, the fuse head is covered by a protective sleeve.

FIREX detonators do not include a primary explosive. This has been replaced with penthrite compressed inside a steel reinforcement. With respect to penthrite encapsulated in this way, combustion quickly accelerates to detonation, which then ignites the base charge. In comparison to detonators that use very sensitive primary explosives, these types of detonators that do not include a primary explosive are not so sensitive to mechanical impact.

The base charge of Firex electric detonators manufactured by OY FORCIT AB is of hexogen, and the strength rating of the detonator is 8 (10 according to the Prior test). Therefore, it will reliably ignite detonator-sensitive explosives and boosters. A FIREX detonator includes, in total, 1 g of explosive.
2. Detonator types

On the basis of their electrical properties, the electric detonators manufactured by OY FORCIT AB are divided into two classes. In the new European standard (EN 13763-1), what was previously called a group is now referred to as a class.

<table>
<thead>
<tr>
<th>Finnish classification</th>
<th>Name in Finland</th>
<th>European classification</th>
<th>Name in Sweden and Norway</th>
<th>Finnish classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B</td>
<td>UR detonator</td>
<td>Class 2</td>
<td>Group 1a</td>
<td>Group B</td>
</tr>
<tr>
<td>Group C</td>
<td>VA detonator</td>
<td>Class 3</td>
<td>Group 2</td>
<td>Group C</td>
</tr>
</tbody>
</table>

Electrical properties of electric detonators:

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detonator's total resistance (Ω)</td>
<td>See table below</td>
<td>3.6 ± 0.3</td>
</tr>
<tr>
<td>Ignition current, minimum 0.01% (A)</td>
<td>≤0.45</td>
<td>≤1.2</td>
</tr>
<tr>
<td>Ignition current, maximum 99.99% (A)</td>
<td>1.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Ignition current in series (A)</td>
<td>&gt; 1.5</td>
<td>&gt; 3.5</td>
</tr>
<tr>
<td>Ignition energy (mJ/Ω)</td>
<td>8–16</td>
<td>80–140</td>
</tr>
</tbody>
</table>

Detonator’s total resistance, group B:

<table>
<thead>
<tr>
<th>Length of the cable (m)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>6</th>
<th>10</th>
<th>17</th>
<th>20</th>
<th>25</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (Ω)</td>
<td>0.99</td>
<td>1.16</td>
<td>1.33</td>
<td>1.66</td>
<td>2.34</td>
<td>3.52</td>
<td>4.03</td>
<td>4.88</td>
<td>5.72</td>
</tr>
<tr>
<td></td>
<td>±0.31</td>
<td>±0.32</td>
<td>±0.33</td>
<td>±0.36</td>
<td>±0.40</td>
<td>±0.49</td>
<td>±0.52</td>
<td>±0.58</td>
<td>±0.63</td>
</tr>
</tbody>
</table>

**ELECTRIC DETONATORS BELONGING TO DIFFERENT GROUPS/CLASSES MUST NOT BE USED IN THE SAME COUPLING!**

**IN ADDITION, DO NOT USE ELECTRIC DETONATORS FROM DIFFERENT MANUFACTURERS IN THE SAME COUPLING!**

Do not cut the cables of electric detonators in group C. If, for some reason, the cables have been cut, short-circuit the detonator by connecting the cables together and dispose of the detonator according to the instructions given further on in this document.
3. Electric detonator delay times

With respect to their delay time, FIREX detonators are manufactured in two series, millisecond detonators (MS) and tunnel-series detonators (T). In MS detonators, the delay times have been scaled in 25 ms steps. The MS-series detonators are used in blasting above ground. MS detonators are manufactured in classes B and C.

The tunnel series (T), intended for underground blasting, has been manufactured by combining MS-series detonators and detonators with a delay time interval extending all the way to 500 ms. In tunnel blasting, longer delay times are required, to give the rock time to detach and come out from the end of the tunnel. Using T-series detonators in above-ground blasting is forbidden, because the delay times are too long and can therefore cause unwanted throwing of rock material. The tunnel-series detonators are manufactured in class C only.

Delay element delay times:

<table>
<thead>
<tr>
<th>Order number</th>
<th>Delay time ms</th>
<th>Order number</th>
<th>Delay time ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25</td>
<td>11</td>
<td>275</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>12</td>
<td>300</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>13</td>
<td>325</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>14</td>
<td>350</td>
</tr>
<tr>
<td>5</td>
<td>125</td>
<td>15</td>
<td>375</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>16</td>
<td>400</td>
</tr>
<tr>
<td>7</td>
<td>175</td>
<td>17</td>
<td>425</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>18</td>
<td>450</td>
</tr>
<tr>
<td>9</td>
<td>225</td>
<td>19</td>
<td>475</td>
</tr>
<tr>
<td>10</td>
<td>250</td>
<td>20</td>
<td>500</td>
</tr>
</tbody>
</table>
4. Storage life and weather-resistance

The recommended operating temperature for FIREX electric detonators is from -25°C to +40°C. In colder temperatures than this, the insulator in the electric detonator cables may crack. In addition, attention should be paid to the fact that some explosives require a stronger ignition method than a detonator in below-zero temperatures. We recommend that storage and transport be performed in a cool environment or at normal room temperature.

The storage life is at least 1.5 years from the date of manufacture, provided that the products are stored in conditions recommended by the manufacturer. Storage must comply with the legislation in force.

The detonators have excellent water-resistance. Detonators that have a continuous cable – in other words, the cable insulator underwater is intact all the way – can take water pressure of at least 3 bar, which corresponds to a depth of 30 m underwater. The detonator has a tensile strength of at least 4 kg for 2 min, when pulled from both cables.
## 5. Electric detonator packages and labeling

Cable lengths, series, and package sizes

<table>
<thead>
<tr>
<th>Name</th>
<th>Cable length (m)</th>
<th>Numbers (series)</th>
<th>Pcs. / inner package</th>
<th>Pcs. / transport package</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firex-UR MS-3.0</td>
<td>3.0</td>
<td>1-10, 11-20 *</td>
<td>50</td>
<td>400</td>
</tr>
<tr>
<td>Firex-UR MS-4.0</td>
<td>4.0</td>
<td>1-10, 11-20 *</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Firex-UR MS-6.0</td>
<td>6.0</td>
<td>1-10, 11-20 *</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>Firex-UR MS-10.0</td>
<td>10.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-UR MS-17.0</td>
<td>17.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-UR MS-20.0</td>
<td>20.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-UR MS-25.0</td>
<td>25.0</td>
<td>1-10, 11-20 **</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Firex-UR MS-30.0</td>
<td>30.0</td>
<td>1-10, 11-20 **</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Firex-VA MS-3.0</td>
<td>3.0</td>
<td>1-10, 11-20 *</td>
<td>50</td>
<td>400</td>
</tr>
<tr>
<td>Firex-VA MS-4.0</td>
<td>4.0</td>
<td>1-10, 11-20 *</td>
<td>50</td>
<td>300</td>
</tr>
<tr>
<td>Firex-VA MS-6.0</td>
<td>6.0</td>
<td>1-10, 11-20 *</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>Firex-VA MS-10.0</td>
<td>10.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-VA MS-17.0</td>
<td>17.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-VA MS-20.0</td>
<td>20.0</td>
<td>1-10, 11-20 **</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>Firex-VA MS-25.0</td>
<td>25.0</td>
<td>1-10, 11-20 **</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Firex-VA MS-30.0</td>
<td>30.0</td>
<td>1-10, 11-20 **</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Firex-VA T-7,0</td>
<td>7.0</td>
<td>1-20 ***</td>
<td>10</td>
<td>200</td>
</tr>
</tbody>
</table>

* Series package.
** Number package.
*** Box package.
External package

The Firex electric detonator boxes have been marked with adhesive labels that include the details of:

- The detonator variety
- Detonator type
- Cable length
- Delay numbers
- Number of detonators
- Manufacture date
- Total amount of explosive in the detonators, in grams
- Manufacturer and CE mark

![Label Content]

Inner package

The plastic bag operating as the inner package includes the following details on a piece of paper:

- Detonator type
- Delay number(s)
- Cable length
- Number of detonators included in the inner package
- The electrical properties of the detonator: resistance, ignition current in series, ignition current, and ignition impulse
The paper band for a bundle
The cable bundles of the detonators manufactured by OY FORCIT AB have a paper band for each bundle that includes the following details:

- Manufacturer
- CE mark

Labeling in the detonator’s connector shell
The detonator connector shell has a label that includes the following details:

- Detonator type and delay number
- Group
- Manufacture date (dd.mm.yy)

Labeling on the detonator shell
OY FORCIT AB’s detonator shells feature the following text: "DETONATOR xxMS," "DANGER G," and "EXPLOSIVE." xx = delay element delay time. In this way, the detonator’s order number can be recognized even if the cable’s number label has disappeared during charging. For example, if the detonator includes a label indicating 500 ms and the cables are green and yellow, this is a VA-MS detonator, number 20.
Electric detonators' color codes
In Finland, the electric detonators are color-coded. In group B, one cable is blue and in group C, it is green. The other cable is either yellow (MS) or red (T), depending on the scaling of the delay times. Other countries may abide by different kinds of color codes.

Group B
UR-MS detonators, blue/yellow

Group C
VA-MS detonators, green/yellow

Group C
VA-T detonators, green/red

6. Use of the connector shell

Firex electric detonators are equipped with a connector shell that facilitates connecting the cables to each other and provides additional protection for the connection. The connector shell is used as follows: Take a loose cable from inside the connector shell, connect it to the connector shell of the next detonator being coupled, and twist the shell for 5–6 turns. Ensure the coupling is successful by pulling gently on the cables.
For particularly wet conditions, we have separate, grease-filled connector shells available to be used instead of the open connector shell. In use of a grease-filled connector shell, the original connector shell is disconnected from the cable and the coupling is performed similar to that for detonators that have no connector shell. The coupling is threaded in the grease-filled connector shell, and the shell is bent to prevent the cables from sliding out of the shell.

7. Checking the circuit of the round before firing

When you are using group B detonators, the verifying measurements must be performed outside the danger zone – from the intended firing location, for example. In addition, if detonators are connected into parallel series, measurement for each series must be performed from outside the danger zone.

If heavy blasting mats are used, it is important to measure the resistance of the round after the placement of each mat, so that you can immediately detect a possible break in the circuit or a change in the total resistance of the round.

Connection in series
Checking of a round that has been connected in series is performed by multiplying the nominal resistance of one detonator by the number of detonators. After this, the resistance of the round is measured by a resistance meter approved for this purpose. The resulting figure must be the same as the calculated resistance value. The resistance may vary slightly if an extension is used during measuring or in the connection.

An example of calculating the resistance of a round connected in series before the measurement:
The circuit has 60 UR detonators (group B) connected in series, and the resistance marked on the detonator packages is 1.66 ohms (Ω). In total, 100 m of extension (red and yellow in the picture) has been coupled together. The resistance of the extension is 6.0 Ω / cable / 100 m. The resistance measured for the main is 3.8 Ω.

Resistance of the detonators: $60 \times 1.66 \, \Omega = 99.6 \, \Omega$

Resistance of the extension: $1 \times 6.0 \, \Omega = 6.0 \, \Omega$

Resistance of the main: 3.8 Ω.

Total resistance of the circuit = $99.6 \, \Omega + 6.0 \, \Omega + 3.8 \, \Omega = 109.4 \, \Omega$

**Series–parallel coupling (connection to parallel series)**

First, check that the resistances of the series are equal to each other. The greatest deviation in resistance allowed between series is 5%. After this, the series are connected in parallel and the resistance of the entire round is measured. An excellent starting point for a successful parallel coupling is that each series has the same quantity of detonators.
An example of calculating the resistance of a series-parallel-coupled round:

The circuit has 80 VA detonators (group C) that have been coupled in two series, each of which has 40 detonators. The resistance of the detonators is 3.6 Ω. Each series includes 80 m of extension (long red and yellow). The resistance of the extension is 6.0 Ω/cable/100 m. The resistance of the main is 3.8 Ω.

\[
\text{The resistance of each series's detonators} = 40 \times 3.6 \, \Omega = 144 \, \Omega
\]

\[
\text{The resistance of each series's extensions} = \frac{80}{100} \times 6 \, \Omega = 4.8 \, \Omega
\]

\[
\text{The total resistance of each series} = 144 \, \Omega + 4.8 \, \Omega = 148.8 \, \Omega
\]

\[
\text{The resistance of two series coupled in parallel} = \frac{148.8 \, \Omega}{2} = 74.4 \, \Omega
\]

\[
\text{The total resistance of the circuit} = 74.4 \, \Omega + 3.8 \, \Omega = 78.2 \, \Omega
\]

**Troubleshooting**

Before firing, the resistance of the coupling is checked once more. In most cases of error, the resistance is too low (detonators have not been connected) or infinite, ∞ (circuit broken). For
locating the fault, the circuit is divided into two parts. Both parts are measured, and the faulty section is divided again. This is continued until the fault is localized.

**Earth leakage**

Earth leakage is a leakage current that is conducted to the ground and causes a section of the circuit to remain without ignition current. If an uninsulated part of the detonator cables touches, for example, the ground, water, or the wires in a blasting mat, earth leakage may occur. The cable cover may become damaged during charging, or uninsulated cable connections may touch the surface of a conductive rock or be submerged in water.

When heavy-duty blasting mats are used, earth leakage must be checked with a special earth leakage detector after each mat is set in place.

In underwater blasting or other blasting that involves the risk of earth leakage, control measurements must be conducted with an earth leakage detector. If a leak is detected in the round, the fault is localized similar to a resistance measurement.

**8. Firing the round**

Igniting of electric detonators may only be performed with a blasting machine approved by the authorities for this specific use in Finland. Correspondingly, a blasting machine may be used in other countries as long as it complies with each of these countries’ requirements.

Check the blasting machine's type plate to verify that the number of detonators in the round or the total resistance does not exceed the values specified for the machine.

Follow the instructions for use that are given on the blasting machine type plate.

Procedures for firing of the round:

- Clear the blast site
- Connect the main to the terminal screws, and set the generator crank handle in place
- Sound the necessary warning signal
- Press the CHARGING button
- Turn the crank handle to reach the necessary firing level
- Fire the round by pressing the IGNITION button
- Disconnect the generator crank handle and main
Handling of misfires

If the round includes missed holes after the blast, adhere to the following pattern.
9. Disposal of detonators

Detonators that are suspected to be faulty or are past their best-before date must not be used. They must be disposed of. Disposal may only be performed by a person qualified as a blaster, or a person who is qualified for this specific task and appointed by the head of the police precinct and approved by Tukes, the Safety Technology Authority.

Individual defective, suspected as defective, or outdated detonators may be disposed of by blasting them in a drill hole along with explosive.

In addition, detonators may be disposed of by taping them to an explosive cartridge that is then fired. If the explosive cartridge is fired in an open space, attention must be paid to the air pressure and fragmentation effect.

If larger numbers of detonators need to be disposed of, please contact OY FORCIT AB’s technical service staff or your explosive dealer.

10. Danger of unintended electric ignition

Static electricity
Static electricity is predominantly created by the friction of non-conductive items, for example, during compressed air charging of ANFO or placement of covers in dry conditions or in a snowstorm.
or sandstorm. The static electricity creates a charge on these items and may discharge into the detonator fuse head through the cables or the detonator shell and ignite it. The theoretical capacitance of humans is 34 mJ, which is enough to ignite a UR detonator.

**Lightning**

No "thunderstorm-safe" electric detonators exist, although detonators in group C are somewhat safer than detonators in group B. Charging must always be interrupted if a thunderstorm is closing in.

High-tension cables and radio, TV, and radar transmitters are risk factors during the use of electric detonators. With respect to these risks, the legislation and regulations in each specific country shall apply. In Finland, the safety distances have been set by the Ministry of Labour in decision 495/93:

**High-tension cables**

Voltage of a high-tension cable (kV) / minimum horizontal distance (m) from the closest high-tension cable

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>3</th>
<th>6</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>45</th>
<th>110</th>
<th>220</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B (UR)</td>
<td>10</td>
<td>10</td>
<td>30</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Group C (VA)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

**Radio and TV transmitters**

Power of a radio or TV transmitter (kW) / minimum horizontal distance from an antenna (m)

<table>
<thead>
<tr>
<th>Power (kW)</th>
<th>0.025</th>
<th>0.05</th>
<th>0.1</th>
<th>1</th>
<th>4</th>
<th>10</th>
<th>40</th>
<th>100</th>
<th>200</th>
<th>400</th>
<th>2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B (UR)</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>80</td>
<td>160</td>
<td>250</td>
<td>500</td>
<td>800</td>
<td>1200</td>
<td>1600</td>
<td>3600</td>
</tr>
<tr>
<td>Group C (VA)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>30</td>
<td>60</td>
<td>100</td>
<td>200</td>
<td>300</td>
<td>450</td>
<td>600</td>
<td>1400</td>
</tr>
</tbody>
</table>
Radar transmitters
Minimum horizontal distance (m) from a radar transmitter’s antenna

<table>
<thead>
<tr>
<th>Group</th>
<th>Distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group C (VA)</td>
<td>50</td>
</tr>
<tr>
<td>Group B (UR)</td>
<td>300</td>
</tr>
</tbody>
</table>

Electrical appliances used on the site
When handling electric detonators, bear in mind that electrical machines and equipment may cause leakage currents and increase the risk of unintended ignition.

11. Restrictions on use

In addition to the aforementioned restrictions, the following must be observed:

FIREX electric detonators are not intended for use in circumstances that include a danger of gas or dust explosions, such as use in a coal mine.

FIREX electric detonators cause a danger of fragmentation if they are used outside the drill hole. FIREX electric detonators may be used outside a drill hole to ignite non-electric detonators, detonating fuses, and surface boosters. In such a case, situation-specific protection must be observed. Any use contrary to instructions is forbidden.