RF SAFE AND ELECTRONIC SELECT FIRING

January 2009
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The **DYNA**energetics – **DYNAWELL**

**RF-Safe**

**Electronic Detonating System**
Summary

Chapters

1. Introduction
2. Operation of electronic detonator
3. Design of electronic detonator
4. Operating principle of the firing panel
5. Operating principle of the firing circuit tester
6. Safety criteria of the electronic detonator
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Annex

A) Design of electric and electronic detonators
B) Components of the electronic detonators
C) Operating flowchart for electronic detonators
D) Safety requirements for electronic detonators
E) Limitation for the impact of RF energies for standard detonators
F) Field strength as a function of distance for different powers
G) Impact sensitivity of detonating devices
1. INTRODUCTION

Conventional oil field firing techniques require high efficiencies in operation with a maximum safety against inadvertent premature firing caused by extraneous electricity. The requirements as regards the firing accuracy are clearly definable. The criteria as regards safety against extraneous currents are difficult to describe since the extent of the stray currents can rarely be accurately predicted. It would be most desirable if electric detonators were immune to any type of extraneous electricity. This is unfortunately not feasible with conventional electric detonators since stray currents which are higher than the no-fire current must inevitably cause premature firing if they reach the wires of the detonator. Nevertheless, DYNAENERGETICS have come very close to the objective of ensuring protection against all kinds of extraneous electricity with their newly developed OILTRONIC electronic detonator. In addition to the benefits of greater safety against extraneous electricity, this system also provides safety against firing by unauthorized personnel since the detonators can be fired only by a special firing panel.

The background to this development is explained in the following. First, the operating principle and design of the electronic detonator and the associated firing are described in detail. Finally the safety against extraneous electricity is discussed and compared with conventional detonators.

2. OPERATION OF THE ELECTRONIC DETONATOR

The characteristic technique of the electronic detonator differs fundamentally from the characteristic technique of conventional electric detonators.

The fuse head of a conventional electric detonator is fired directly by the input electric current of several amperes.

Unlike these conventional electric detonators, the electronic detonator uses a built-in capacitor to fire the fuse head.

This capacitor is charged by a small supply current of a few milliamperes. The charging and firing of the detonator is controlled via an electronic system integrated in the chip of each detonator. The capacitor for instance can only be charged by a current which delivers strictly defined information to the chip.

After activation of the firing panel the capacitor is charged to a low voltage of approximately 2 Volt, which is sufficient to reliably operate the electronics of the detonator, but which is not sufficient to initiate the fuse head. Only when the chip has analyzed specific voltage sequences can the capacitor be charged to the required firing voltage. After charging the capacitor a further specific voltage sequence must be delivered to the detonator to release an electronic switch which allows the capacitor to discharge and in turn initiate the fuse head. An current of approx. 1 - 2 mA is sufficient for charging the capacitor and programming the detonator.
3. DESIGN OF THE ELECTRONIC DETONATOR

Annex A shows the design of the electronic detonator compared to a conventional resistorized detonator. Both detonators have the same diameter and length. The safety against the mass explosion hazard is the same for both types of detonators. The electronic detonator can physically only be distinguished through a tag on the wires.

The chip circuit comprises three main function groups: the analogue element, the digital element and the firing stage. Annex B shows the basic operating principle of the chip circuit.

A voltage limiter in the analogue element ensures that the input voltage does not exceed approx. 20 Volt. This screens any excessive external voltages, such as those caused by extraneous electricity. Each polarity change at the signal coupling generates a pulse in the input pulse generator which is further processed in the digital element. Behind the signal coupling the energy store for the firing stage is a capacitor. It is charged via a rectifier. A digitally adjustable voltage regulator between the rectifier and energy store initially charges the capacitor to the low operating voltage, as explained above.

In the digital element the signals coming from the signal coupling are transferred to the input pulse generator. From this generator the pulses are transferred to the pulse decoder and switches I and II, which are initially in "open" mode. If the pulse decoder recognizes the correct pulse sequence, it activates the voltage regulator and closes switch I. Once the voltage regulator has been activated in this way, the capacitor is charged to the voltage present at the detonator entry within approximately 3 seconds. Once the capacitor has been charged, the pulses are transferred via switch I to the pulse counter. When 64 pulses have been recorded, the pulse counter issues a pulse to close switch II. The next pulse coming from the input pulse generator is transferred via switch II and closes switch III. The fuse head is fired by the capacitor when switch III is activated.

Although the pre-setting of 64 pulses is not basically necessary, it increases the safety of the system.

If the power supply is interrupted after activation but before the firing pulse is issued, the capacitor discharges in less than 2 minutes by means of the electronics without initiating the fuse head. In this case the detonator is fully reusable. Any wrong signal will be identified and the detonator will go to a safe position until the power supply is disconnected. Annex C shows the flowchart for the operation of the electronic detonator.

4. OPERATING PRINCIPLE OF THE FIRING PANEL

The complete operating sequence of the electronic detonator is controlled by the firing panel. The firing panel is powered by an integral accumulator. A lamp will illuminate if the voltage of the accumulator drops below the required operating voltage of the firing panel. On pressing two push-buttons, the detonator connected to the firing panel is armed and initiated. The firing panel can also be remote controlled by external pulses from a separate computer station. In this case the firing panel is only switched on manually.
The firing panel has the following dimensions of 121 mm wide, 256 mm deep and 42 mm high. It weighs approximately 800 g.

5. OPERATING PRINCIPLE OF THE FIRING CIRCUIT TESTER

The resistance characteristics of an electronic detonator differ fundamentally from those of an electric detonator. The resistance of the electronic detonator depends on the input voltage as the detonator input consists of a Zener diode. The conventional electric detonator, on the other hand, has a constant resistance owing to its bridge wire and possible resistors. With a voltage of 12 Volt, the electronic detonator has a resistance of approx. 12,700 Ohm. This means that it consumes a current of roughly 1 mA. If a voltage of 12 Volt is applied to the firing circuit a current of 1 mA will flow, which can be indicated by an analogue measuring device. This is the operating principle used by the firing circuit tester. Additional electronics compensate for the wireline and possible other electronic devices in the tool string.

6. SAFETY CRITERIA OF THE ELECTRONIC DETONATOR

One of the most striking features of the electronic detonator is its high safety against inadvertent ignitions caused by extraneous electricity (see test results in annex D).

The standard electric detonator already offers a high level of safety in this respect. The number of premature firings caused by extraneous electricity that have arisen even with the most sensitive detonators used in the oilfield is extremely low. In these extremely rare instances, in which electric detonators were fired by extraneous electricity, electronic detonators would merely have become unserviceable.

However, these events in particular - most of which stem from incorrect handling or even negligence - pose the greatest problems. To avoid such accidents, safety distances are laid down for power transmission lines, electrical railways or high-frequency transmitters which preclude premature firing even in the most unfavorable conditions. As outlined later, the majority of these safety distances need not be observed when using the electronic detonator described.

6.A SAFETY AGAINST STRAY CURRENTS AND STRAY VOLTAGES

The safety offered by the electronic detonators is far superior to that of the electric detonators as far as all stray currents and stray voltages are concerned. Electronic detonators have a high resistance at voltages below 15 Volt and therefore do not consume any significant current meaning they are not at risk from low-voltage sources such as those found in vehicle electronics and measuring instruments.

If the voltage exceeds 15 Volt, damage to the chip must be anticipated in the event of prolonged exposure to currents exceeding 50 mA. The detonator can be exposed to currents of 100 mA for approximately 5 seconds, to 180 mA for approximately 2 seconds and to 1 A for approximately 0.25 seconds without the chip being damaged. High voltages as well as high currents are required for this to occur. For instance it proved impossible to fire the electronic detonator with a voltage of 50 Volt and a current of 20 A. An infinite resistance
was merely created at the detonator input due to a damage of the electronics. Even when connected to the 220 V alternating current mains, several attempts to prompt electronic detonators to fire were unsuccessful.

For these reasons the observance of safety distances to electrical railways and power transmission lines can be reduced when electronic detonators are being used.

6.B SAFETY AGAINST STATIC ELECTRICITY

Energy pulses which are lower than 0.2 mJ/Ohm do not result in damage to the electronics. When a charge of 25 kV carried by a human body is discharged, this generates a firing pulse of approximately 0.05 mJ/Ohm. It can therefore be concluded that the operating reliability of electronic detonators is not impaired by the electrostatic charges in human bodies.

The electronic detonators could not be initiated by discharges from capacitors with a capacity of 2,500 pF with a charge of 30 kV.

6.C SAFETY AGAINST LIGHTNING

To operate explosives during lightning is always dangerous. All operations, as long as the explosives are on surface, have to be stopped during lightning. The energy output of a lightning strike is sufficient to initiate the detonating cord or the shaped charges directly. Nevertheless, the electronic detonator can not be initiated, as a result of stray currents during a lightning strike, when the Gun System is in the hole.

6.D SAFETY AGAINST HIGH FREQUENCY

Investigations conducted in a military engineering center of the German Federal Armed Forces showed that the electronic detonator has unparalleled safety against high-frequency irradiation. Conventional electric detonators with varying degrees of sensitivity and electronic detonators were exposed to high-frequency fields with frequencies varying between 100 KHz and 18 GHz and field strengths up to 200 V/m.

(See annex E, F, Test Report No.: EMV - 1 - 077-94 and VG Standard 95379 Part 12+20)

For the purpose of these tests, the detonator wires were formed as dipoles and shortened to an optimum length. The dipoles were positioned in front of the transmitting antenna in such a way that maximum energy absorption was ensured. Such unfavorable conditions are never found in reality.

Thus at a frequency of 110 MHz, for instance, Seismic U-type detonators were ignited at a field strength of 20 V/m, DW detonators at 28 V/m and HU detonators at 95 V/m. The electronic detonator remained fully operational after exposure to a field strength of 100 V/m. At field strengths of 150 and 200 V/m, it merely became unserviceable; no ignition occurred.

The emission of a transmitter with a power output of 1 kW has a field strength of 20 V/m at a distance of approximately 15 meters. In this instance the electronic detonator demonstrates a safety performance that is superior even to the HU detonator.

Beside the above mentioned tests conducted by the German Federal Armed Forces the UK based Thomson-Thorn Missile Electronics Ltd. has conducted an assessment of RF susceptibility of the DYNAenergetics electronic detonators. In the conclusions it is stated
that the detonator will either fail safe or remain safe and serviceable in the typical North Sea
environment, throughout the spectrum of rf transmitters considered.

6. E SAFETY AGAINST IMPACT

Annex G shows the necessary impact energy for initiation of different elements of a
detonator and detonating cord system. The most critical material for impact is the lead
azide, the primary explosive charges used in detonators. For lead azide the impact energy
needed for initiation is below 5 J. In the DYNAenergetics detonators the lead azide is
protected by a steel tube (see annex A). In the detonator the impact energy for initiation is
70 J. The necessary impact energy to initiate HMX is 10 J. Loaded into the detonating cord
the necessary impact energy for initiation is 20 J. This is still 3 times smaller than the
impact energy needed to initiate the detonator. We believe that the dangerous part is to place
the lead azide into the detonator and this is done in the DYNAenergetics production plant.
Once the detonator is assembled it is very safe against impact energies.
Annex

A) Design of electric and electronic detonators
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Annex A

DESIGN OF ELECTRIC AND ELECTRONIC DETONATORS

ELECTRIC DETONATOR

PLUG

INTEGRATED CIRCUIT

TANTALUM CAPACITOR

FUSE HEAD

PRIMARY CHARGE

SECONDARY CHARGE

80

56

\( \varnothing 7.4_{0.2} \)
START

↓

POWER ON LINE
7 V DC MIN

↓

CHARGE CONDENSER
2 V DC

↓

READY FOR DIGITAL CODE

↓

DIGITAL CODE OK?  ⇒  NO  ⇒  ERROR

↓

YES

↓

CHARGE CONDENSER
12 V DC

↓

READY FOR FIRE CODE

↓

FIRE CODE OK?  ⇒  NO  ⇒  POWER ON LINE
7 V DC MIN

↓

YES

↓

NO

↓

DETONATION

DISCHARGE CONDENSOR

↓

SAFE
Electric welding – open circuit voltages up to 80 VDC

Test condition:
500 V, 150 μF direct discharge to the detonator

Test result:
No initiation but damage to the electronics.

Active cathodic protection – up to 50 VDC

Test condition:
200 VDC, maximum DC current 20 A, 50 Hz rectified and 150 μF energy storage

Test result:
No initiation, but damage to electronics at currents above 100 mA

Transient and Electra-static discharge – up to 30 mJ

Test condition:
20 kV, 500 pF, discharge with 5 kΩ

Test result:
ESD tests simulating a human body or a machine caused no initiation or damage to the electronics

Radio and radar transmitter – up to 40 W of rf power available at the head of the perforating string (worst case frequency in the region of 1 MHz)

Test result:
No initiation or damage to the electronics

AC supplies – up to 300 VAC at 50 Hz, 60 Hz and 400 Hz

Test conditions:
300 VAC and 16 A fused

Test result:
No initiation or damage to the electronics
ANNEX E

IMPACT OF RF-ENERGIES ON DIFFERENT DETONATORS

DYNAenergetics

Page 13 of 15
Assumption: 1 kW-transmitter has a field strength of 3 V/m in a distance of 100 m
DYNAenergetics

IMPACT ENERGY FOR INITIATION

Annex G
IMPORTANT INFORMATION - PLEASE CONSIDER

Before mounting and/or starting up any device(s), carefully read the operating manual. In addition to the notes in the operating manual, the standard safety and accident prevention rules always apply.

The ANTARES Datensysteme GmbH is only liable for defects as per its terms and conditions of sale. Further claims can not be recognized. Defective operation or fault on the part of the operator of this system or third parties excludes any liability. Installation, maintenance and repair work may only be practiced by professionally suitable and qualified personnel. Conversions or changes to this system or any parts of this system and accessories exclude any guarantee. If conversions or changes are necessary, we ask for consultation of the ANTARES Datensysteme GmbH.

Electric/electronic devices can affect and/or disturb other such devices through electrical lines or other metallic connections. In order to stop or to keep the mutual disturbances as small as possible the correct installation of this system is of utmost importance.

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DOCUMENTATION HISTORY

1958-7-00-01A - First Release.
(May 2005)
EQUIPMENT IDENTIFICATION

Manufacturer: ANTARES Datensysteme GmbH
Subject: DynaEnergetics Oiltronics II Firing Panel
Type: 1958
Serial No.: _______________
Year of Manufacture: 2006
Customer: _______________
Customer Registration No.: _______________
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6. INSTALLATION

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1. INTRODUCTION

1.1 Purpose of this document

This operating manual

- describes handling and operation of the 1958 Oiltronics Panel.
- gives important information about safe and efficient handling of the 1958 Oiltronics Panel.

1.2 Representation

Instructions and system reaction

A detailed description of operator's handlings is given as a list. Step order has to be kept. If system reaction of the prevailing handlings is given, it is marked with an arrow. For example:

- Operation Step 1
  → System reaction of this operation

Enumeration

Enumeration without urgent order is given as a list with some points. For example:

- Point 1
- Point 2

1.3 Warning signs

Safety signs are marked by icon and a signal word. A signal word describes seriousness of a danger.

<table>
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<tr>
<th>Signal Word</th>
<th>Description</th>
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<tr>
<td>Danger!</td>
<td>Direct danger for life and health of people (severe injury or death).</td>
</tr>
<tr>
<td>Warning!</td>
<td>Possible danger for life and health of people (severe injury or death).</td>
</tr>
<tr>
<td>Caution!</td>
<td>Possible dangerous situation (minor injury or property damage)</td>
</tr>
<tr>
<td>Information!</td>
<td>Tips for use and particularly useful information.</td>
</tr>
<tr>
<td>Important!</td>
<td>An obligation to be on particular behaviour or to perform particular tasks which are necessary for safe handling of logging equipment.</td>
</tr>
</tbody>
</table>
Warning signs for specific dangers

Danger – electrical energy

Danger of being drawn in

Danger – lifted loads

1.4 Proper use

The 1958 Oiltronics Panel is used to control DYNAWELL\textsuperscript{1} detonators in perforating guns in boreholes.

Reconstruction or modification

Safety behaviour of the panel can be disturbed by modifications or supplement. Because of this, modifications or supplements of electrical/electronic components without written authorisation of manufacturer are not permitted.

Consumables, spares and auxiliary materials

The use of spares and consumable parts of other manufacturers can cause dangerous situations. Because of this, only use original consumables or parts which are allowed by the manufacturer.

The manufacturer is not responsible for damages caused by using spares and consumable parts as well as auxiliary materials which are not allowed.

1.5 Dangerous areas while operating

Dangers and damages can be caused while operating the panel:

- for life and health of operator or other person,
- for the panel,
- for other objects.

Knowledge of safety requirements in this manual is the basis of safety and disturbance-proof operation.

Important!

Keep this operating manual in operative range with the perforating equipment. This manual has to be available for the operator and for the service personnel. In addition to this manual:

All common manuals and statutory regulation according accident and environmental protection have to be paid attention to.

---

\textsuperscript{1} See \textit{DYNAenergetics} documentation
1.6 Obligations of user

The user is obligated to let only the persons operate the equipment who

- are familiar with basic instructions of industrial safety and statutory regulation according accident protection
- are instructed to operate equipment
- have read and understood this operating manual.

The requirements of EU-Directive for using of equipment 89/655/EWG have to be observed.

1.7 Obligations of personnel

Before start of work, all persons who are authorised to operate the panel are obliged:

- to follow the basic instructions of industrial safety and statutory regulation according accident protection,
- to read and to pay attention to chapter about safety and warning signs in this operating manual.

Please, put all the questions about the equipment to the manufacturer, refer to Page 3.

1.8 Training of personnel

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<td>X</td>
<td>--</td>
<td>X</td>
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</table>

Key:  

- X allowed
- -- not allowed

1.9 Safety appliances

Not applicable.

Defective safety devices

Defective or disassembled safety devices can lead to dangerous situation. In this case

- System has to be immediately disconnected,
- System has to be protected against start.

1.10 Important safety information

CAUTION

TO REDUCE THE RISK OF ELECTRIC SHOCK DO NOT REMOVE THE COVER.
NO USER SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.
WARNING

TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK DO NOT EXPOSE THIS APPLIANCE TO WATER.
SHOCK HAZARD. DO NOT OPEN.

MAINS

This appliance is supplied with a non-rewireable battery charger. A replacement charger can be obtained from ANTARES Datensysteme GmbH. The cable connecting the charger to the panel should be kept in good condition. A cable with bared conductors is dangerous if engaged in a live socket.

1.11 Summary of safety instructions

1. Read instructions. Read the safety and operating instructions before operating the appliance. Please note that in addition to these notes, the standard safety and accident prevention rules always apply.
2. Retain instructions. Retain the safety and operating instructions for future reference.
3. Heed warnings. Observe all warnings on the appliance and in the operating instructions.
4. Follow instructions. Follow all operating and use instructions.
5. Water and moisture. Do not use the appliance near water.
6. Power cord protection. Route power cords so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, power sockets, and at the point where they exit from the appliance.
7. Damage requiring service. The product should be serviced by qualified personnel if:
   a) The power cord or charger has been damaged.
   b) Objects or liquid have fallen into the product.
   c) The product has been exposed to water.
   d) The product does not appear to operate normally or exhibits a marked change in operation.
   e) The product has been dropped or the enclosure damaged.
8. Servicing. Do not attempt to service the product beyond that described in the operating instructions.

All other servicing should be referred to qualified service personnel.

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Installation, maintenance and repair work may only be practiced by professionally suitable and qualified personnel. Conversions or changes to this product or any parts of the product and accessories exclude any guarantee. If conversions or changes are necessary, please call ANTARES Datensysteme GmbH.

1.12 General remarks

Electric/electronic devices can affect and/or disturb other devices. In order to stop or to keep the these disturbances as small as possible, the correct installation of this system is of utmost importance.

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2. GENERAL DESCRIPTION

2.1 Overview

The DYNAenergetics OILTRONIC II Firing Panel is designed to be a standalone product which can activate perforation guns in a well bore. Perforating guns can be controlled directly by the DYNAenergetics OILTRONIC II Panel as shown below.
2.2 The OILTRONIC II System

Using a small piece of electronics, it is possible to log data or to fire a perforating gun whilst utilizing the safety features of the DYNAWELL\(^2\) detonator.

The additional piece of electronics comes from the ANTARES Datensysteme GmbH and is a digitally addressable SPDT switch. The switch is mounted inside a logging tool (e.g. a Gamma Ray). Normally, the switch connects the line to the logging tool; if it is activated, it connects the line to the detonator.

If such an electronic switch has been addressed (activated) by sending a digital signal sequence 'A' from the OILTRONIC II panel, it remains in the new position permanently. If the electrical power is removed from the line and later applied again, the switch goes back into the start position.

![Diagram of Typical Configuration](image)

The activation of the electronic switch is performed by pressing the GR button on the DYNAMATRONICS OILTRONIC II panel. The timing of the signal sent (sequence 'A') is selected so that there is no interference with the programming of the detonator. An 8-bit wide signal decoder is used.

The programmability of the electronic detonator is an important part of the system. The time delay feature is not utilized. Within the OILTRONIC system, the sequence sent to the detonator for programming and firing is called sequence 'C'.

\(^2\) See DYNAMATRONICS documentation
3. TECHNICAL DESCRIPTION

3.1 General Information

The DYNAenergetics OILTRONIC II panel is built to work as a stand alone product. The panel is mounted inside a carrying case, together with an integrated battery charger.

3.2 DYNAenergetics OILTRONIC II Front Panel

3.2.1 ON Button

The ON button is used to apply battery power to the panel. Press for at least 2 seconds to activate. In case of a low battery the ON - Button starts flashing. After five minutes being idle, the panel does a self power off.

3.2.2 SAFE-OPERATE Switch

The SAFE-OPERATE switch shorts the line through a 100Ω resistor in the SAFE position and connects the line to the rest of the circuits in the OPERATE position. In the SAFE position, the panel circuits additionally are kept in the RESET state. The key of this key-switch can only be removed in the SAFE position.

3.2.3 FIRE Buttons with LED’s

The buttons FIRE #1 and FIRE #2 are used to initiate firing of the guns; for safety reasons, both buttons have to be pressed at the same time (within 0.5 s), for at least three seconds.
The LED's built into the fire buttons are turned on with the panel power. After initiating a fire sequence by pressing the two fire buttons, they start to blink. Four seconds before the actual firing, the blinking frequency is increased.

The LED's also act as error indicators. Should one of the buttons be pressed (e.g. by hardware failure) when applying power to the panel, then the respective LED starts to blink. If one of the two buttons is pressed for more than 10 s, the same thing happens: The LED starts to blink. If both buttons are pressed for more than 10 s, the two LED's blink alternately.

3.2.4 HIGH MODE Button
In normal digital signals sent by the DYNAenergetics OILTRONIC II panel have an amplitude of 15 Volts.

Sometimes (e.g. when using long cables) it may be necessary to send signals with a higher amplitude. By activating High Mode, signals are send with an amplitude of 30 Volts.

3.2.5 GR Button
If a logging tool and a perforating gun are connected in the same string an addressable electronic SPDT switch is used inside the logging tool. Pressing the GR button activates a sequence to switch from logging to perforation. This sequence (sequence A) is sent just before the firing signal (sequence C, fire buttons).

3.2.6 SIGNAL Indicator
The SIGNAL LED shows any signal on the line. Whenever there are digital signals sent, it flickers.

3.2.7 SHOT OK LED
Indicates that the tool current has changed by at least 5% after shooting.

3.3 DYNAenergetics OILTRONIC II Panel connectors

3.3.1 WIRELINE
Two banana jacks are provided to connect the wire line to the panel.

3.4 Battery Charger
The Battery Charger is used to charge the panel battery. It also can be used to power the panel, in case of low battery. The DC output of the battery charger does not actually use a connector but is hard wired to the OILTRONIC II panel.
4. FUNCTIONAL DESCRIPTION

The **Dyna**energetics OILTRONIC II Panel contains a power supply for supplying power to the Multitronic switch in the (optional) logging tool and to the Dynawell detonators. As described above, it also contains the elements for safety and firing control.

With the SAFE-OPERATE switch in SAFE, the logging line connected to the panel via the WIRELINE jacks is shorted through a small resistor (100Ω). The micro-controller is kept in the RESET state. In the OPERATE mode, the line is connected to the signal generating circuits.

![Warning](image)

*Note: For safety reasons, the two fire buttons must be pressed at the same time (within 0.5 s) for at least 3 seconds and released within 10s, before the fire circuit is activated.*

Three seconds after both fire buttons have been pressed, the digital signal sequence ‘C’ is sent to the detonator. To make sure that even on very long logging lines the signal is correctly understood by the detonator, the same sequence is sent several times, with different baud rates.

As soon as sequence C is initiated, the LED’s inside the fire buttons start to blink. Approximately 4 seconds before the actual firing, the LED’s start to blink faster. Four different fire sequences C are sent one after the other.

If a logging tool is run in combination with the perforating gun, then the switch inside the logging tool must be set to the position where the detonator is connected to the line. This is done by sending a sequence A down the logging line before the Fire buttons are pressed. Sequence A is sent by pressing the GR button on the panel.
5. OPERATION

5.1 Preparation of Perforating Guns

The detonator typically is located on the bottom of the perforating gun.

Normally, the detonator type DYNAWELL 0015 FDE is used. This type has the advantage of being fluid desensitised, i.e. it is disabled should any liquid leak into the gun body.

5.2 Lower Guns into the Well

Using standard safety procedures, lower gun into well to depth interval to be perforated. Safety procedures are not within the scope of this manual. Please refer to the appropriate documentation.

5.3 Fire Perforating Guns

As soon as the gun string is positioned at the depth required, simultaneously press the two red fire buttons on the front of the DYNAenergetics OILTRONIC II Panel.

If a logging tool is connected above the perforating guns, the GR button must be pressed first in order to connect the line to the detonator.

Note: For safety reasons, the two fire buttons must be pressed at the same time (within 0.5 s) for at least 3 seconds and released within 10s before the fire circuit is activated.

All four available sequences C are now sent to the detonator, one after the other. Between each sequence sent, there is a waiting time for resetting the detonator electronics. For this reason, the firing sequence takes more than one minute. This is true even if the detonator fired after the first sequence sent.

As soon as the first sequence is sent to the gun, the LED's in the buttons start to blink. About 4 seconds every time before a sequence is completed (just before the detonator potentially is fired), the LED's start to blink faster. The blinking frequency is then lowered again while the system is continuing with the next sequence.
6. INSTALLATION

Connect Line coming from the hoist collector to the wirline connector on the side of the panel. This completes the installation.
7. TECHNICAL DATA

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DYNAenergetics
Multitronic
Perforating Panel

June 2002
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TECHNICAL BULLETIN #08061201

MODIFICATION OF MULTITRONIC II FIRING PANEL

TO ENHANCE THE FUNCTIONALITY OF THE VOLTAGE CALIBRATION SEQUENCE OF THE MULTITRONIC II FIRING PANEL A HARDWARE MODIFICATION HAS BEEN MADE. THIS HARDWARE MODIFICATION CONSISTS OF A CHANGE OF ONE RESISTOR WHICH IS USED TO MEASURE THE CURRENT DRAW OF THE SYSTEM. TOGETHER WITH THIS HARDWARE MODIFICATION A NEW SOFTWARE VERSION HAS BEEN RELEASED. THE HARDWARE MODIFICATION IS EFFECTIVE FROM PANEL SERIAL NUMBER 1946-0021. THE MODIFIED PANELS HAVE TO BE RUN WITH A SOFTWARE VERSION 4.5 OR HIGHER.


MULTITRONIC II FIRING PANELS THAT DO NOT HAVE THE MODIFICATION (SERIAL NUMBER 1946-0020 OR LOWER) CAN BE RUN WITH A SOFTWARE VERSION 4.5 OR HIGHER. IF THIS IS DONE THE CURRENT MEASUREMENTS MADE DURING THE VOLTAGE CALIBRATION, THE SWITCH TEST AND THE FIRING SEQUENCE WILL BE WRONG. THE VALUES SHOWN WILL READ DOUBLE THE ACTUAL VALUE.

MULTITRONIC II FIRING PANELS THAT DO NOT HAVE THE MODIFICATION (SERIAL NUMBER 1946-0020 OR LOWER) CAN BE UPGRADED. PLEASE CONTACT YOUR NEAREST DYNAenergetics REPRESENTATIVE FOR MORE INFORMATION.
IMPORTANT INFORMATION - PLEASE CONSIDER

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Electric/electronic devices can affect and/or disturb other such devices through electrical lines or other metallic connections. In order to stop or to keep the mutual disturbances as small as possible the correct installation of this system is of utmost importance.

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APPENDIX – SCHEMATICS
The descriptions in this document just provide essential information for working with the system. For supplementary questions as well as technical support please contact:

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A. INTRODUCTION

1. Overview

The DYNAenergetics Perforation Panel allows to perform well perforations. The panel is able to control the Multitronic perforating system. It can be made part of any standard surface system which uses a single conductor cable. If used in systems with multi-conductor cables, external routing switches or cables are required.

Logging data are sent through the logging cable to the DYNAenergetics Perforating panel and then on to the Standard Acquisition system. If perforating guns are connected, they can be controlled directly by the DYNAenergetics Perforating Panel.

2. The Multitronic System

Using a small piece of electronics, it is possible to fire perforating guns sequentially without giving up on any of the available safety features of the DYNAWELL\(^1\) detonator. Actually, by combining the two system parts, safety is even increased.

\(^1\) See DYNAenergetics documentation
The additional piece of electronics comes from the ANTARES Datensysteme GmbH and consists of two digitally addressable SPDT switches which, when selected, connect the line to the circuit below it or to the detonator right next to it. A switch assembly is mounted inside each gun body.

If such an electronic switch has been addressed, it remains in the new position permanently. If the electrical power is removed from the line and later applied again, the switches go back into the position where nothing is connected. The power to the downhole system must be removed before the next higher gun can be selected.

Typical Configuration

The activation of the electronic switch is performed using the DYNAnenergetics perforating panel. The timing of the signal is selected so that there is no interference with the programming of the detonator. An 8-bit wide signal decoder is used. The number of perforating intervals is limited by the unavoidable voltage drop caused by the switches in the circuit. A number easily achievable with the present design is 9 to 10 sequences.

The programmability of the electronic detonator is an important part of the system. The time delay feature is not utilized.
B. TECHNICAL DESCRIPTION

1. General Information
The *DYNAenergetics* panel is built in a way to be included directly in any acquisition system which works together with a single conductor cable.

2. *DYNAenergetics* Perforating Panel Front

![Front View of the Panel](image)

2.1 POWER Switch
The POWER switch is used to apply AC power to the panel.

2.2 SAFE-OPERATE Switch
The SAFE-OPERATE switch shorts the line through a resistor to ground in the **SAFE** position and connects the line to the rest of the circuits in the **OPERATE** position.

2.3 PERF-LOG Switch
The PERF-LOG switch selects the mode of operation. In **PERF**, the *DYNAenergetics* panel is used to control perforating guns, in **LOG**, the line is routed to the standard acquisition system.

2.4 FIRE Buttons
The buttons **FIRE #1** and **FIRE #2** are used to initiate firing of the guns; for safety reasons, both buttons have to be pressed at the same time.

2.5 RESET Button
After selected guns have been fired, the **RESET** button must be pressed before the next sequence of guns can be selected.

2.6 SIGNAL Indicator
The **SIGNAL** LED shows any signal on the line. Whenever there are communication signals sent, it flickers.
3. **DYNAenergetics Perforating Panel Back**

3.1 **Power Plug (117VAC or 230VAC - 50 Hz to 60 Hz)**
A fuse holder for the 1A (SB) panel protection fuse is integrated into the lower part of the power plug insert. The power plug is of the Euro-connector type.

3.2 **LINE IN**
This BNC-connector is provided to connect the line input, coming from the logging cable.

3.3 **LINE OUT**
This BNC-Connector is provided to connect the line output to the standard acquisition system – if desired.

3.4 **RS 232**
A 9-pole RS232 connector (female) is plugged into here, in order to connect the perforating panel to the controlling PC.

**Note:** All wires must be connected straight through (null modem cables can **not** be used!).

---

4. **Functional Description**

The **DYNAenergetics** Perforating Panel contains a power supply for supplying power to the Multitronic switches and the Dynawell detonators. It also contains a microprocessor which communicates with a standard PC. As described above, it also contains the elements for safety and firing control.

With the SAFE-OPERATE switch in SAFE, the logging line connected to the panel via LINE IN is shorted through a small resistor and connected to ground. In the OPERATE mode, the line is connected on to the PERF-LOG switch.

If the PERF-LOG switch is in the LOG position, the line is just routed through to the LINE OUT connector. If the PERF-LOG switch is in the PERF position, the logging line is connected to the output line of the perforating panel.

The perforating panel can produce three different types of digital sequences: Sequence A, B and C. Sequence A is used to switch the Multitronic switches in the perforating guns to pass-through. Sequence B is used to switch the Multitronic switches in the perforating guns to connect to the detonator. Finally, sequence C is sent to the detonator, which decodes it and fires - if decoding was successful.
Sequences A and B are initiated by the controlling program on the PC and sent by the micro controller in the panel, sequence C is sent by the micro controller as soon as the user presses the fire buttons.

There are different sequences C available: slow, medium and fast signals. The fast signals are the default. In some cases where the line length is extreme and the communications properties of the cable are bad, it might be necessary to select a slower sequence C. The selection is done via software on the PC.

It is also possible to use the panel in a 'Stand-Alone' mode, without a PC. In that case, a single digital detonator can be fired.
C. OPERATION WITH PC

1. Prepare Perforating Guns

The installation of the Multitronic switches is extremely simple. The electronics board is small and completely covered by a protecting medium, i.e. some kind of silicon rubber. Five wires hang out: Line in and out, detonator connections and ground. The wires are color coded for easy identification.

The wires can be connected to the outside world using a standard quick connection method, e.g. Scotch Lock.

<table>
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<th>Switch 1</th>
<th>Switch 2</th>
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<td>Ground</td>
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</tr>
</tbody>
</table>

The piece of electronics (selection switch) and the detonator are both typically located on the bottom of the perforating gun. The pressure feed through requirements between guns are minimal: Just one line.

The selection switches are all equal; one unit is used per gun.

Normally, the detonator type DYNAWELL 0015 FDE is used. This type has the advantage of being fluid desensitised, i.e. it is disabled should any liquid leak into the gun body.

2. Lower Guns into the Well

Using standard safety procedures, lower gun into well to depth interval to be perforated. Safety procedures are not within the scope of this manual. Please refer to the appropriate documentation.
3. Fire Perforating Guns

- Switch panel power on.
- Start Multitronic.exe on the PC. Several software functions are automatically called at start-up:
  - If the program is started for the first time after installation, the serial port selection dialog is displayed.
  - The dialog for entering the number of perforating guns pops up. Here, the number of available gun sections must be entered. The dialog also allows to check the checkbox **Logging with Gamma Ray**. This checkbox must be checked, if a (modified) Perforating Gamma Ray is in the string. The maximum number of guns which can be used in a string is nine.
    - If the number of guns entered is zero, a Current Measurement can be performed to test the cable (see below). If the number of guns is larger than zero, the next dialog to automatically pop-up is the Current Settings dialog.
  - The dialog for setting the differential current for the different possible sequences is displayed. It is used to enter the expected current increase when switching to the next switch position.
- The automatic determination of the supply voltage setting is performed. This dialog can be called at any time; it allows for manual supply voltage entries in case this is desired.

After pressing Start, 15 V are applied to the cable and the current is measured. Then the voltage is increased by 1 V and the current is measured again. This procedure is repeated until a non-linear increase is observed indicating saturation of the switches. The last ‘linear’ voltage is used for operations. The test can be performed manually by checking the respective check box (Manual). For manual checking, the voltage of course must be entered manually, too.

- After the above sequences have been worked through, the configuration dialog as shown below is displayed. Number is the Gun number, counting from top. The arrow in the Switch/Gun column can have three positions: down (sequence ‘A’ will be sent), right (sequence ‘B’ will be sent) and left (after a reset has been issued). The background color for the image in the Switch/Gun column changes depending on the operation status.

- Two operations are possible initially: Prepare Firing and Switch Test.

If the Prepare Firing button is pressed, the sequences as shown by the arrows are sent to the perforating gun string. The current before/after each sequence is measured and displayed in the Current column. The current must...
increase for each step, otherwise there is an error. The system automatically stops if the increase is outside the limits as given in the Current Settings dialog. If all goes right, the background of the images turns orange, indicating ‘Ready’.

If the Switch Test button is pressed, a test sequence is generated, testing the ability of switching into the ‘A’ position and into the ‘B’ position. The current is measured at each step and displayed in the Switch Test Table. The images in the Switch/Gun column change depending on the success as shown in the section about Possible switch positions.

- If the button Arm Panel is pressed now, the panel firing buttons are enabled and the user can initiate gun firing by pressing both fire buttons on the panel simultaneously. After successfully arming the panel, the image background turns yellow.

- The user can change his mind and issue a System Reset at any time. The condition ‘Armed Panel’ is additionally indicated by the Fire Status dialog, which also contains a button for terminating the program in the case that’s desired.

- After firing, the current is measured again. If it has changed compared to before firing, successful firing is indicated.

- Go to next interval to be perforated.

- Press the RESET button – software sequence re-starts and operation is as described above.

4. Adjusting Data Speed

As explained above, it is possible to vary the data frequency for the digital data of sequence C (detonator fire command). This feature is available through the Settings menu. Four different speeds are available. It is recommended to always start with the setting Very High and only reduce the speed in the case of problems due to super long cables.

5. Perform Current Measurement

If the number of guns as entered is zero, a special feature of the system is available: Current Measurement. A voltage between zero and 28 V can be set for the measurement. If the test button is pressed, a current measurement is performed and the result is displayed. This feature can be used to determine the logging cable condition.
6. Symbol Meanings

**Gamma Ray**
Symbol for Gamma Ray. Is always the first entry on top.

Switch in Position for sequence ‘A’

Switch in Position for sequence ‘B’

Switch in Position D after a ‘System Reset’

Switch destroyed (after firing)

Switch in Position A after successful ”Prepare” operation

Switch in Position B after successful ”Prepare” operation

Switch in Position A after non successful ”Prepare” operation

Switch in Position B after non successful ”Prepare” operation

Switch in Position A after ”Arm” operation

Switch in Position B after ”Arm” operation

Switch in Position A after non successful ”Switch test” operation

Switch in Position D after non successful ”Switch test” operation
D. STAND-ALONE OPERATION

1. Prepare Gun

No special equipment is required. Connect Dynawell detonator as usual.

Note: In the 'Stand-Alone' mode of the DYNAenergetics Perforation Panel, only one gun string can be fired during one run in the hole.

2. Lower Guns into the Well

Using standard safety procedures, lower gun into well to depth interval to be perforated. Safety procedures are not within the scope of this manual. Please refer to the appropriate documentation.

3. Fire Perforating Guns

As soon as the gun string is positioned at the depth required, simultaneously press the two red fire buttons on the front of the DYNAenergetics Perforation Panel. All four available sequences C are now sent to the detonator, one after the other. Between each sequence sent, there is a waiting time for resetting the detonator electronics. For this reason, the firing sequence takes about five minutes. This is true even if the detonator fired after the first sequence sent.
E. INSTALLATION

1. Hardware

- Connect AC Power to the AC power connector on the panel.
- Connect Line coming from the hoist collector to the LINE IN BNC connector on the rear of the panel.
- Connect LINE OUT BNC plug on the rear of the panel to the Line-in connector of the acquisition system.
- Connect PC serial connector on the rear of the panel to a serial input of the system PC.

**Note:** All wires must be connected straight through (null modem cables can not be used!).

2. Software

System requirements: PC with any 32 bit Windows operating system.

The Software consists of two files: Multitronic.exe and Multitronic.hlp. They come on a CD or floppy. The installation consists of just copying these files to any folder desired.
F. TECHNICAL DATA

1. General Data
Data transfer to/from PC: galvanically separated, RS232 with 9600 bits/sec, 8N1, Protocol: none
Logging LINE IN connector: BNC
Logging LINE OUT connector: BNC
Serial interface: DB9 connector (female)
Power-in-filter: for 230VAC, with integrated fuse holder and 500 mA SB fuse
Main power switch: with signal light
Supply to panel: 15 W, input voltage 117VAC or 230 VAC, 50-60 Hz
Supply to instruments: 10 V - 28 V

2. Connectors
AC Power 3-pole, male
PIN 1 AC power
PIN 2 AC power
PIN 3 Ground
Line in and Line out BNC
Center Pin Cable conductor
Housing Armor
Serial interface DB9, female
PIN 2 TXD
PIN 3 RXD
PIN 7 RTS
PIN 8 CTS
PIN 5 Signal ground
APPENDIX – SCHEMATICS
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The descriptions in this document just provide essential information for working with the system. For supplementary questions as well as technical support please contact:

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A. INTRODUCTION

1. Overview

The DYNAenergetics Multitronic Firing Panel is used for performing well perforations. The panel is able to control the Multitronic perforating system. It can be made part of any standard surface system which uses a single conductor cable. If used in systems with multi-conductor cables, external routing switches or cables are required.

Logging data are sent through the logging cable to the DYNAenergetics Multitronic panel and then on to the Standard Acquisition system. If perforating guns are connected, they can be controlled directly by the DYNAenergetics Multitronic Panel.

2. The Multitronic System

Using a small piece of electronics, it is possible to fire perforating guns sequentially without giving up on any of the available safety features of the DYNAWELL\(^1\) detonator. Actually, by combining the two system parts, safety is even increased.

The additional piece of electronics comes from the ANTARES Datensysteme GmbH and consists of two digitally addressable SPDT switches which, when selected, connect the line to the circuit below it or to the detonator right next to it. A switch assembly is mounted inside each gun body.

\(^1\) See DYNAenergetics documentation
If such an electronic switch has been addressed, it remains in the new position permanently. If the electrical power is removed from the line and later applied again, the switches go back into the position where nothing is connected. The power to the downhole system must be removed before the next higher gun can be selected.

**Typical Configuration**

The activation of the electronic switch is performed using the *DYNAenergetics* perforating panel. The timing of the signal is selected so that there is no interference with the programming of the detonator. An 8-bit wide signal decoder is used. The number of perforating intervals is limited by the unavoidable voltage drop caused by the switches in the circuit. The number achievable with the present design is 9 sequences.

The programmability of the electronic detonator is an important part of the system. The time delay feature is not utilized.
B. TECHNICAL DESCRIPTION

1. General Information

The DYNAenergetics Multitronic Firing Panel is built in a way to be included directly in any acquisition system which works together with a single conductor cable.

2. DYNAenergetics Multitronic Panel Front

2.1 POWER Switch

The POWER switch is used to apply AC power to the panel.

2.2 SAFE-OPERATE Switch

The SAFE-OPERATE switch shorts the line through a resistor to ground in the SAFE position and connects the line to the rest of the circuits in the OPERATE position. In the SAFE position, the panel circuits are kept in the RESET state. The key of this key-switch can only be removed in the SAFE position.

2.3 PERF-LOG Switch

The PERF-LOG switch selects the mode of operation. In PERF, the DYNAenergetics panel is used to control perforating guns. In LOG, the line is routed to the standard acquisition system.

2.4 FIRE Buttons with LED’s

The buttons FIRE #1 and FIRE #2 are used to initiate firing of the guns; for safety reasons, both buttons have to be pressed at the same time (within 0.5 s), for at least three seconds.

The LED’s built into the fire buttons are turned on with the panel power. After initiating a fire sequence by pressing the two fire buttons, they start to flash. Four seconds before the actual firing, the flashing frequency is increased.

The LED’s also act as error indicators. Should one of the buttons be pressed (e.g. by a hardware failure) when applying power to the panel, then the respective LED starts to flash. If one of the two buttons is pressed for more than 15 s, the same thing happens: The LED starts to flash. If both buttons are pressed for more than 15 s, the two LED’s flash alternatingly.

2.5 RESET Button

After selected guns have been fired, the RESET button must be pressed before the next sequence of guns can be selected.
2.6 SIGNAL Indicators
The line SIGNAL LED shows any signal on the line. Whenever there are signals sent to the switches or detonators, it flashes. The USB LED flashes whenever there are communication signals on the USB line between panel and PC.

3. DYNAenergetics Multitronic Panel Back

3.1 Power Plug (117VAC or 230VAC - 50 Hz to 60 Hz)
A fuse holder for the 1A (SB) panel protection fuse is integrated into the lower part of the power plug insert. The power plug is of the Euro-connector type.

3.2 WIRELINE
This BNC-connector is provided to connect the line input, coming from the logging cable.

3.3 LOGGING SYSTEM
This BNC-Connector is provided to connect the line output to the standard acquisition system – if desired.

3.4 PC USB
A USB connector is plugged into here, in order to connect the Multitronic panel to the controlling PC.

4. Functional Description

4.1 General
The DYNAenergetics Multitronic Panel contains a power supply for supplying power to the Multitronic switches and the Dynawell detonators. It also contains a microprocessor which communicates with a standard PC. As described above, it also contains the elements for safety and firing control.

With the SAFE-OPERATE switch in SAFE, the logging line connected to the panel via the WIRELINE connector is shorted through a 1 kOhm resistor and connected to ground. The micro-controller is kept in the RESET state. In the OPERATE mode, the line is connected on to the PERF-LOG switch.

If the PERF-LOG switch is in the LOG position, the line is just routed through to the LOGGING SYSTEM connector. If the PERF-LOG switch is in the PERF position, the logging line is connected just to the Multitronic panel.

4.2 Selective Perforating Mode (also see section C)
The Multitronic panel can produce four different types of digital sequences: Sequence A, B C and D. Sequence A is used to switch the Multitronic switches in the perforating guns to pass-through. Sequence B is used to switch the Multitronic switches in the perforating guns to connect to the detonator. Sequence C is sent to the detonator via the Multitronic switches, where it is decoded.
If decoding was successful, the detonator is fired. Sequence D is reserved for switches in Perforating Gamma Ray instruments. If a sequence D is sent, the GR switch is set to the pass-through mode.

**Note:** Previous versions of the Multitronic panel used sequence A for switching the Gamma Ray to pass-through. The Multitronic III panel utilizes sequence D for this purpose.

Sequences A, B and D are initiated by the controlling program on the PC and sent by the micro controller in the panel, sequence C is sent by the micro controller as soon as the user presses the fire buttons.

**Note:** For safety reasons, the two fire buttons must be pressed at the same time (within 0.5 s) for at least 3 seconds before the fire circuit is activated.

The signal sequence C is available at four speeds: very low, low, high and very high. The fast signals are the default (very high). In some cases, where the line length is extreme and the communications properties of the cable are bad, it might be necessary to select a slower sequence C. The selection is done via software on the PC.

As soon as sequence C is initiated, the LED's inside the fire buttons start to flash. Approximately four seconds before the actual firing, the LED's start to flash faster.

**4.3 Single Detonator Mode (also see section D)**

It is also possible to use the panel in a 'Stand-Alone' mode, without a PC. In that case, a single digital detonator can be fired. In this mode, after pressing the fire buttons, the four different fire sequences C are sent one after the other. After having been used together with a PC, the panel must be powered off for at least 2 s before the stand-alone mode is possible.
C. OPERATION WITH PC

1. Prepare Perforating Guns

The installation of the Multitronic switches is extremely simple. The electronics board is small and completely covered by a protecting medium, i.e. some kind of silicon rubber. Five wires hang out: Line in (orange) and out (blue), detonator connections (white and black) and ground (black). The wires are color coded for easy identification.

The wires can be connected to the outside world using a standard quick connection method, e.g. Scotch Lock.

![Diagram of perforating guns](image)

The piece of electronics (selection switch) and the detonator are both typically located on the bottom of the perforating gun. The pressure feed through requirements between guns are minimal: Just one line.

The selection switches are all equal; one unit is used per gun.

For perforating guns, normally the detonator type DYNAWELL 0015 FDE is used. This type has the advantage of being fluid desensitized, i.e. it is disabled should any liquid leak into the gun body.

For packer setting tools, the detonator type EIST should be used. Here it is necessary to identify the ground wire for the detonator (coming from the switch), because the EIST detonator only uses the 'hot' wire. It is recommended to cut off the black wire right next to the white wire.

2. Lower Guns into the Well

Using standard safety procedures, lower gun into well to depth interval to be perforated. Safety procedures are not within the scope of this manual. Please refer to the appropriate documentation.

3. Fire Perforating Guns

Switch panel power on.

Start Multitronic.exe on the PC. Several software functions are automatically called at start-up:

- The dialog for entering the number of perforating guns pops up.

Here, the number of gun sections to be used must be entered. The maximum number of gun sections which can be used in a string is nine.
The dialog also allows checking the checkbox **Logging with Gamma Ray**. This checkbox must be checked, if a modified Perforating Gamma Ray is in the string. A 'modified' Gamma Ray is one containing a high voltage Gamma Ray switch.

- If the number of guns entered is zero, then a Current Measurement can be performed to test the cable or to check if a single detonator (without switch) is connected to the line.

- If the number of guns is larger than zero, the next dialog to automatically pop-up is the Current Settings dialog. It is used to enter the expected current increase when switching to the next switch position. In some cases (e.g. if a well-tractor is in the string) it is desirable to bypass the current checking logic. This can be achieved by checking the check-box **Ignore safety cutout**. This check box becomes available after entering the key combination Ctrl-Alt-I.

**Note:** If the current checking logic is disabled, the software can not decide if switching and firing events had been successful. In this case, success is indicated regardless.

- Next, the automatic determination of the supply voltage setting is performed. This dialog can be called at any time; it allows for manual supply voltage entries in case this is desired. After pressing Start, 15 V are applied to the cable and the current is measured. Then the voltage is increased by 1 V and the current is measured again. This procedure is repeated until a non-linear increase is observed indicating saturation of the switches. The last 'linear' voltage is used for operations. The test can be performed manually by checking the respective check box (Manual). For manual checking, the voltage of course must be entered manually, too (via drop-down list).

- After the above sequences have been worked through, the configuration dialog as shown below is displayed. **Number** is the Gun number, counting from bottom. The arrow in the **Switch/Gun** column can have three positions: **down** (sequence 'A' will be sent), **right** (sequence 'B' will be sent) and **left** (after a reset has been issued). The background color for the image in the Switch/Gun column changes depending on the operation status.
Two operations are possible initially: **Prepare Firing** and **Switch Test**.

If the **Switch Test** button is pressed, a test sequence is generated, testing the ability of switching into the 'A' position and into the 'B' position. The current is measured at each step and displayed in the Switch Test Table. The images in the Switch/Gun column change depending on the success as shown in the section about possible switch positions.

If the **Prepare Firing** button is pressed, the sequences as shown by the arrows are sent to the perforating gun string. The current before/after each sequence is measured and displayed in the **Current** column. The current must increase for each step, otherwise there is an error. The system automatically stops if the increase is outside the limits as given in the Current Settings dialog. If all goes right, the background of the images turns orange, indicating 'Ready'.

If the button **Arm Panel** is pressed now, the panel firing buttons are enabled and the user can initiate gun firing by pressing both fire buttons on the panel simultaneously.

After successfully arming the panel, the image background turns yellow.

**Note:** For safety reasons, the two fire buttons must be pressed at the same time (within 0.5 s) for at least 3 seconds before the fire circuit is activated.

The user can change his mind and issue a **System Reset** at any time. The condition 'Armed Panel' is additionally indicated by the Fire Status dialog, which also contains a button for terminating the program in the case that's desired.

After firing, the current is measured again. If it has changed compared to before firing, successful firing is indicated. Otherwise, unsuccessful firing is indicated.

Go to next interval to be perforated.

Press the RESET button on the panel - software sequence re-starts and operation is as described above.
4. Adjusting Data Speed

As explained above, it is possible to vary the data frequency for the digital data of sequence C (detonator fire command). This feature is available through the **Settings** menu. Four different speeds are available. It is recommended to always start with the setting **Very High** and only reduce the speed in the case of problems due to super long cables.

5. Perform Current Measurement

If the number of guns as entered is zero, a special feature of the system is available: Current Measurement. A voltage between zero and 28 V can be set for the measurement. If the test button is pressed, a current measurement is performed and the result is displayed. This feature can be used to determine the logging cable condition or to find out if a single detonator (without switch) is connected to the line. In the case of a single detonator, this test can be repeated after firing, to get an indication of success (open circuit or short).

6. Symbol Meanings

**Gamma Ray**

Symbol for Gamma Ray. Is always the first entry on top.

Switch in Position for sequence ‘A’

Switch in Position for sequence ‘B’

Switch in Position D after a ‘System Reset’

Firing was not successful (no longer accessible)

Firing was not successful (active gun)

Switch destroyed (after firing)

Switch in Position A after successful “Prepare” operation
Switch in Position B after successful "Prepare" operation

Switch in Position A after non successful "Prepare" operation

Switch in Position B after non successful "Prepare" operation

Switch in Position A after "Arm" operation

Switch in Position B after "Arm" operation

Switch in Position A after non successful "Switch test" operation

Switch in Position D after non successful "Switch test" operation
D. STAND-ALONE OPERATION

1. Prepare Gun
No special equipment is required. Connect Dynawell detonator as usual.

Note: In the 'Stand-Alone' mode of the DYNAenergetics Multitronic Panel, only one gun string can be fired during one run in the hole.

2. Lower Guns into the Well
Using standard safety procedures, lower gun into well to the depth interval to be perforated. Safety procedures are not within the scope of this manual. Please refer to the appropriate documentation.

3. Fire Perforating Guns

Note: After having been used together with a PC, the panel must be powered off for at least 2 s before the stand-alone mode is possible.

As soon as the gun string is positioned at the depth required, simultaneously press the two red fire buttons on the front of the DYNAenergetics Perforation Panel.

Note: For safety reasons, the two fire buttons must be pressed at the same time (within 0.5 s) for at least 3 seconds before the fire circuit is activated.

All four available sequences C are now sent to the detonator, one after the other. Between each sequence sent, there is a waiting time for resetting the detonator electronics. For this reason, the firing sequence takes more than one minute. This is true even if the detonator fired after the first sequence sent.

As soon as the first sequence is sent to the gun, the LED's in the buttons start to flash. About 4 seconds every time before a sequence is completed (just before the detonator potentially is fired), the LED’s start to flash faster. The flashing frequency is then lowered again while the system is continuing with the next sequence.
E. INSTALLATION

1. Hardware

- Connect AC Power to the AC power connector on the panel.
- Connect Line coming from the hoist collector to the LINE IN BNC connector on the rear of the panel.
- Connect LINE OUT BNC plug on the rear of the panel to the Line-in connector of the acquisition system.
- Connect USB cable between the connector on the rear of the panel to a USB connector on the system PC.

2. Software

System requirements: PC with Windows XP or Windows Vista (32 bit or 64 bit) operating system.

- Place Installation CD into the CD Drive.
- If auto-start is disabled on your computer, go to the CD folder using the explorer and double click the program **Autorun.exe**.
- After a CD auto-start or auto-run, a short menu is displayed: Install MultitronicIII, Explore CD, Exit
- Select **Install Multitronic III**.
- The rest of the installation is performed as usual; just follow the orders in the text/on the buttons.
F. TECHNICAL DATA

1. General Data
Data transfer to/from PC: galvanically separated USB connection
Logging LINE IN connector: BNC
Logging LINE OUT connector: BNC
Serial interface: USB connector
Power-in-filter: for 230 VAC, with integrated fuse holder and 250 mA SB fuse
Main power switch: with signal light
Supply to panel: 15 W, input voltage 117VAC or 230 VAC, 50-60 Hz
Supply to switches: 10 V - 30 V

Maximum line current in Operate Mode: 500 mA
Maximum line voltage in Operate Mode: 250 VAC or 170 VDC

2. Connectors

AC Power
3-pole, male
PIN 1  AC power
PIN 2  AC power
PIN 3  Ground

Line in and Line out
BNC
Center Pin  Cable conductor
Housing  Armor

Serial interface
USB Series B-Plug Receptacle
PIN 1  V-Bus
PIN 2  D-
PIN 3  D+
PIN 4  GND

Diagram:

+  D-

1  2

4  3

-  D+
G. EC DECLARATION

EC DECLARATION OF CONFORMITY

We,  ANTARES Datensysteme GmbH
     Rudolf-Diesel-Strasse 6-8
     28816 Stuhr
     Germany

Declare that the product:

Product name:  Multitronic III Firing Panel
Model number:  1963

Is in accordance with the following Directives:

89/336/EEC  (Electromagnetic Compatibility Directive)

It has been designed and manufactured based upon the following specifications
(Harmonized Standards):

EN 61000-4-2, EN 61000-4-3, EN 61000-4-4 and EN 61000-4-5
EN 61000-4-6, EN 61000-4-11, EN 61326-1

As tested and certified by:

EMV-Services GmbH & Co. KG, Harburger Schloss-Str. 6-12, 21079 Hamburg;
Report No.: 08/8120-2 dated September 5, 2008

The CE marking affixed on the product and this declaration mean that the
manufacturer can provide the technical files to authorities, if required.

Place of Issue:  ANTARES Datensysteme GmbH
     Rudolf-Diesel-Strasse 6-8
     28816 Stuhr
     Germany

Date of Issue:  September 9, 2008

Signed:  

Helmut Lechen
QC & QA Director
ANTARES Datensysteme GmbH
Selective Perforating Switch Selectronic

Various wireline service companies have come up with methods for sequential perforations. Practically all of these solutions have their shortcomings. A new method for monoconductor wirelines has been developed, which takes advantage of the safety features of the DYNAWELL RF-Safe Electronic Detonator and allows the sequential perforation of multiple Zones, using a small, additional piece of electronics.

This additional piece of electronics comes from the ANTARES Datensysteme GmbH and consists of the small addressable Selectronic Switch. This switch is mounted inside each gun body together with the DYNAWELL RF-Safe Electronic Detonator. Each Detonator – Switch combination can be individually addressed using the Selectronic software on a standard PC in conjunction with the DYNAWELL Selectronic Firing Panel.

- Use on monoconductor wireline
- Perforate up to 10 Zones in one run
- Work with an RF-Safe detonator
- Easy to use one type only switch
- Small dimensions of 60x30x10 mm

Warning: Unprofessional use of Explosives by untrained or inexperienced people may kill or injure.
1. Introduction

The cemented steel casings in oil or gas wells are typically perforated opposite oil or gas bearing zones using especially designed explosives; shaped charges in the majority of the cases. A common problem is the necessity to perforate several intervals during one run, where the various intervals differ in length and location.

A solution for the problem is to separate the perforating gun into sections with the appropriate lengths and then perforate the different intervals sequentially.

Various wireline service companies have come up with methods for sequential perforations. Practically all of these solutions have their shortcomings. A new method is described below, which takes advantage of the safety features of the DYNAenergetics programmable Detonator Dynawell.
2. The Electronic Detonator DYNAWELL

The DYNAenergetics has designed an electronic detonator which must receive an electronic signal, i.e. a digital ‘message’ in order to be activated. This design provides a maximum amount of safety in respect to radio frequency, AC and DC stray currents, human error etc. If this detonator is connected to an AC or DC voltage, nothing happens - certain digital signals are required before a detonation occurs.

Three types of DYNAWELL detonators are available:

- DYNAWELL 0015FDE Fluid desensitised, 150°C
- DYNAWELL 0026FDE Fluid desensitised, 260°C
- DYNAWELL 1015E High pressure (100 MPa), 150°C

The temperature and pressure ratings of this detonator makes it an excellent choice for borehole perforations.

The special firing panel OILTRONIC is required and also available from DYNAenergetics. It provides the necessary digital signal; additional safety is added by a required two-hand operation for triggering the detonation.

The digital signal in principle consists of two sequences: an unlock-sequence which is composed of pulses with different, distinct frequencies and another sequence which then actually provides the firing information. The second sequence can e.g. contain the information about a delay between the end of the digital signal and the actual detonation. The delay feature is not normally used when perforating in boreholes.

If any digital signal is applied to the detonator which does not exactly meet the specifications, the detonator can not be fired any more. It is still intact, though; after a period of about 20 seconds, with no electrical power applied to the detonator, its electronics is reset, a new firing attempt can be made.
3. Sequential Perforations

Using a small, additional piece of electronics, it is possible to fire perforating guns sequentially without giving up on any of the available safety features of the Dynawell detonator. Actually, by combining the two system parts, safety is even increased.

The additional piece of electronics comes from the ANTARES Datensysteme GmbH and consists of two addressable SPDT switches which, when selected, connect the line to the circuit below it or to the detonator right next to it. A switch assembly is mounted inside each gun body.

If such an electronic switch has been addressed, it remains in the new position permanently. If the electrical power is removed from the line and later applied again, the switches go back into the position where nothing is connected. The power to the downhole system must be removed before the next higher gun can be selected.

The activation of the electronic switch is performed using the DYNAenergetics perforating panel OILTRONIC. The timing of the signal is selected so that there is no interference with the programming of the detonator. An 8-bit wide signal decoder is used. The number of perforating intervals is limited by the unavoidable voltage drop caused by the switches in the circuit. A number easily achievable with the present design is 9 to 10 sequences.

The programmability of the electronic detonator is an important part of the system. The time delay feature is not utilised.

4. Detailed System Description

There are three different sequences which can be generated by the Oiltronic panel; they can be called sequence A, B and C. Each of the switch assemblies in the guns contains two switches; one switch is actuated by sequence A, the other one by sequence B. If a sequence A is received, switch A connects the input line to the output line; at the same time switch B of this unit is locked in the open position. If a sequence B is received, switch B connects the input
line to the detonator. A following sequence C is hence is fed through to the detonator selected by sequence B and causes the detonator to go off.

Here an example of the sequence of events when perforating three intervals (gun sections) at different depths:

- Move perforating gun to the lowest perforating interval.
- Turn on Oiltronic panel.
- Program the Oiltronic panel for sending two sequences A and one sequence B. This programming is performed by simply selecting the third gun via PC software.
- Press the fire buttons.
- The Oiltronic panel now sends two sequences A and one sequence B. The lowest detonator is connected.
- The Oiltronic panel then sends sequence C. The selected detonator goes off and fires the charges in the lowest gun.
- Turn off Oiltronic panel.
- Move to the next higher perforating interval.
- Turn on Oiltronic panel.
- Program the panel for sending one sequence A and one sequence B.
- Press the fire buttons.
- The Oiltronic panel now sends one sequence A and one sequence B. The next higher detonator is connected (second gun from bottom).
- The Oiltronic panel then sends sequence C. The detonator goes off and fires the charges in the second gun.
- Turn off Oiltronic panel.
- Move to the next higher perforating interval.
- Turn on Oiltronic panel.
- Program the panel for sending one sequence B.
- Press the fire buttons.
- The Oiltronic panel now sends just one sequence B. The next higher detonator is connected (third gun from bottom).
- The Oiltronic panel then sends sequence C. The detonator goes off and fires the charges in the third gun.
- Ready!

After positioning the gun opposite the respective perforating interval, the user enters the gun number to be fired (via PC keyboard and PC program) and then just has to press the fire buttons (two-hand operation). Sending of the correct sequences is now performed automatically by the OILTRONIC perforating panel.
The described system is also flexible in respect to technical problems with perforating guns and in the case of a decision change while the perforating gun is already in the borehole:

It is possible to address any detonator anywhere in the string at any time.

Of course, it is not possible to address a switch below the lowest active (unused) gun.

5. Software Control

The perforating operation is controlled via the PC program SEQ.EXE and the OILTRONIC panel.

The gun to be fired is selected via software. A graphical display on screen allows to visualise what’s happening. Inside a sketch of the complete gun string, the section (gun) to be fired next is flashing when selected and turns red after it has been fired.

Whenever a switch or a detonator is connected to the cable, the required supply current changes. This current change is sensed inside the OILTRONIC panel and so provides a means for constant monitoring of the operations sequences. Each time anything happens to the current, the measured value is sent back to the controlling program on the PC. The program evaluates the change and verifies the sequence of events. If anything happens out of order, the firing sequence is interrupted automatically.

The communication between the PC and the OILTRONICS panel is performed via RS232 connection.

6. Installation of the System in the Perforating Gun

The installation is extremely simple. The electronics board is small and completely covered by a protecting medium, e.g. some kind of silicon rubber. Five wires hang out: Line in and out, detonator connections and ground. The wires are colour coded for easy identification.

The wires can be connected to the outside world using a standard quick connection method, e.g. Scotch Lock.
The piece of electronics (selection switch) and the detonator are both typically located on the bottom of the perforating gun. The pressure feed through requirements between guns are minimal: Just one line.

The selection switches are all equal; one unit is used per gun.

Normally, the detonator type DYNAWELL 0015 FDE is used. This type has the advantage of being fluid desensitised, i.e. it is disabled should any liquid leak into the gun body.

7. System Cost

Sequence decoding is done using standard high temperature logic IC’s which are available at low cost. The detonator uses a specially designed IC which is used in a large number of assemblies, i.e. cost is low there, too.

8. Technical Data

8.1 DYNAWELL 0015 FDE Detonator

- Temperature rating 150°C (1 hr)
- Safe for radio and microwave frequencies
- Safe for AC and DC stray currents
- Human error is minimised by electronic locking system
- Primary explosive (PbN₆) protected by heavy wall steel tube
- Secondary explosive RDX
- Fluid desensitised

8.2 Selection Switch

- Temperature rating 150°C (1 hr)
- Supply voltage +15-20 VDC
- Latching operation - remains in the position last switched to as long as power is applied
- Up to 10 perforating gun sections can be prepared per run (this number will increase in the near future)

8.3 PC-Program

- Available for DOS, Windows 3.1, Windows 95 and Windows NT*
- Runs on any PC
- Requires less than 1 MB installation space on the hard disk

* Windows 3.1, Windows 95 and Windows NT are registered trademarks of the Microsoft Corporation
9. Summary

The DYNAenergetics and the ANTARES Datensysteme GmbH have jointly designed a new system for sequential perforations in boreholes. The reliability and especially the safety of this new system is unmatched by any other solution. The design is simple and cheap. The system is available in quantities on short notice.

For further information or special support please contact DYNAenergetics – Dynawell under numbers given on page 1.
IMPORTANT INFORMATION - PLEASE CONSIDER

Before mounting and/or starting up any device(s), carefully read the operating manual. In addition to the notes in the operating manual, the standard safety and accident prevention rules always apply.

The ANTARES Datensysteme GmbH is only liable for defects as per its terms and conditions of sale. Further claims can not be recognized. Defective operation or fault on the part of the operator of this system or third parties excludes any liability. Installation, maintenance and repair work may only be practiced by professionally suitable and qualified personnel. Conversions or changes to this system or any parts of this system and accessories exclude any guarantee. If conversions or changes are necessary, we ask for consultation of the ANTARES Datensysteme GmbH.

Electric/electronic devices can affect and/or disturb other such devices through electrical lines or other metallic connections. In order to stop or to keep the mutual disturbances as small as possible the correct installation of this system is of utmost importance.

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DOCUMENTATION HISTORY

1959-7-01A - First Release.
   (May 2005)
EQUIPMENT IDENTIFICATION

Manufacturer:            ANTARES Datensysteme GmbH
Subject:                DYNAenergetics Detonator Test Panel
Type:                   1959
Serial No.:             
Year of Manufacture:    2006
Customer:               
Customer Registration No.:  


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<tr>
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<td>15</td>
</tr>
</tbody>
</table>
1. INTRODUCTION

1.1 Purpose of this document
This operating manual
- describes handling and operation of the 1959 Detonator Test Panel.
- gives important information about safe and efficient handling of the 1959 Detonator Test Panel.

1.2 Representation

Instructions and system reaction
A detailed description of operator's handlings is given as a list. Step order has to be kept. If system reaction of the prevailing handlings is given, it is marked with an arrow. For example:
- Operation Step 1
  → System reaction of this operation

Enumeration
Enumeration without urgent order is given as a list with some points. For example:
- Point 1
- Point 2

1.3 Warning signs
Safety signs are marked by icon and a signal word. A signal word describes seriousness of a danger.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Danger!</td>
<td>Direct danger for life and health of people (severe injury or death).</td>
</tr>
<tr>
<td>Warning!</td>
<td>Possible danger for life and health of people (severe injury or death).</td>
</tr>
<tr>
<td>Caution!</td>
<td>Possible dangerous situation (minor injury or property damage)</td>
</tr>
<tr>
<td>!</td>
<td>Information! Tips for use and particularly useful information.</td>
</tr>
<tr>
<td>!</td>
<td>Important! An obligation to be on particular behaviour or to perform particular tasks which are necessary for safe handling of logging equipment.</td>
</tr>
</tbody>
</table>
Warning signs for specific dangers

<table>
<thead>
<tr>
<th>Icon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Electricity Symbol]</td>
<td>Danger þ electrical energy</td>
</tr>
<tr>
<td>![Person Symbol]</td>
<td>Danger of being drawn in</td>
</tr>
<tr>
<td>![Lifted Loads Symbol]</td>
<td>Danger þ lifted loads</td>
</tr>
</tbody>
</table>

1.4 Proper use

The 1959 Detonator Test Panel is used to test DYNAWELL\(^1\) detonators outside and in perforating guns.

Reconstruction or modification

Safety behaviour of the panel can be disturbed by modifications or supplement.

Because of this, modifications or supplements of electrical/electronic components without written authorisation of manufacturer are not permitted.

Consumables, spares and auxiliary materials

The use of spares and consumable parts of other manufacturers can cause dangerous situations. Because of this, only use original consumables or parts which are allowed by the manufacturer.

The manufacturer is not responsible for damages caused by using spares and consumable parts as well as auxiliary materials which are not allowed.

1.5 Dangerous areas while operating

Dangers and damages can be caused while operating the panel:

- for the panel,
- for other objects.

Knowledge of safety requirements in this manual is the basis of safety and disturbance-proof operation.

Important!

Keep this operating manual in operative range with the perforating equipment. This manual has to be available for the operator and for the service personnel. In addition to this manual:

All common manuals and statutory regulation according accident and environmental protection have to be paid attention to.

---

\(^1\) See DYNAenergetics documentation
1.6 **Obligations of user**

The user is obligated to let only the persons operate the equipment who

- are familiar with basic instructions of industrial safety and statutory regulation according accident protection
- are instructed to operate equipment
- have read and understood this operating manual.

The requirements of EU-Directive for using of equipment 89/655/EWG have to be observed.

1.7 **Obligations of personnel**

Before start of work, all persons who are authorised to operate the panel are obliged:

- to follow the basic instructions of industrial safety and statutory regulation according accident protection,
- to read and to pay attention to chapter about safety and warning signs in this operating manual.

Please, put all the questions about the equipment to the manufacturer, refer to Page 3.

1.8 **Training of personnel**

<table>
<thead>
<tr>
<th>Field of activity</th>
<th>Persons trained personnel (Manufacturer)</th>
<th>Instructed operators (User)</th>
<th>Persons with professional education (Mechanics/Electrical engineering)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commissioning</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Trouble shooting</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Operation</td>
<td>X</td>
<td>X</td>
<td>--</td>
</tr>
<tr>
<td>Routine maintenance</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
<tr>
<td>Periodic maintenance</td>
<td>X</td>
<td>--</td>
<td>X</td>
</tr>
</tbody>
</table>

Key: X allowed -- not allowed

1.9 **Safety appliances**

Not applicable.

**Defective safety devices**

Defective or disassembled safety devices can lead to dangerous situation. In this case

- System has to be immediately disconnected,
- System has to be protected against start.

1.10 **Important safety information**

**CAUTION**

**TO REDUCE THE RISK OF ELECTRIC SHOCK DO NOT OPEN THE PLUG-IN POWER MODULE (BATTERY CHARGER).
NO USER SERVICEABLE PARTS INSIDE.
REFER SERVICING TO QUALIFIED SERVICE PERSONNEL.**
WARNING

TO REDUCE THE RISK OF FIRE OR ELECTRIC SHOCK DO NOT EXPOSE THE PLUG-IN POWER SUPPLY TO WATER.
SHOCK HAZARD. DO NOT OPEN.

MAINS

This appliance is supplied with a non-rewireable battery charger. A replacement charger can be obtained from ANTARES Datensysteme GmbH. The cable connecting the charger to the panel should be kept in good condition. A cable with bared conductors is dangerous if engaged in a live socket.

1.11 Summary of safety instructions

1. Read instructions. Read the safety and operating instructions before operating the appliance. Please note that in addition to these notes, the standard safety and accident prevention rules always apply.
2. Retain instructions. Retain the safety and operating instructions for future reference.
3. Heed warnings. Observe all warnings on the appliance and in the operating instructions.
4. Follow instructions. Follow all operating and use instructions.
5. Water and moisture. Do not use the appliance near water.
6. Power cord protection. Route power cords so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords at plugs, power sockets, and at the point where they exit from the appliance.
7. Damage requiring service. The product should be serviced by qualified personnel if:
   a) The power cord or charger has been damaged.
   b) Objects or liquid have fallen into the product.
   c) The product has been exposed to water.
   d) The product does not appear to operate normally or exhibits a marked change in operation.
   e) The product has been dropped or the enclosure damaged.
8. Servicing. Do not attempt to service the product beyond that described in the operating instructions.

All other servicing should be referred to qualified service personnel.

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Installation, maintenance and repair work may only be practiced by professionally suitable and qualified personnel. Conversions or changes to this product or any parts of the product and accessories exclude any guarantee. If conversions or changes are necessary, please call ANTARES Datensysteme GmbH.

1.12 General remarks

Electric/electronic devices can affect and/or disturb other devices. In order to stop or to keep these disturbances as small as possible, the correct installation of this system is of utmost importance.

The specifications contained in this document can be modified without previous announcement. No part of this document may be duplicated or transmitted without explicit written permission of the ANTARES Datensysteme GmbH.
2. GENERAL DESCRIPTION

2.1 Overview

The DYNAenergetics Detonator Test Panel is designed to be a standalone product which can be used to test the RF-safe DYNAWELL\textsuperscript{2} electronic Detonators. For the test, a DC voltage is applied to the detonator and a series of LED's\textsuperscript{3} is provided to indicate the condition of the detonator. The test includes missing continuity to the detonator or a short circuit somewhere between panel and detonator. The panel operates off a re-chargeable battery. A battery charger is provided to charge the batteries once the panel is not in use.

\textsuperscript{2} See DYNAenergetics documentation

\textsuperscript{3} LED=Light Emitting Diode
2. TECHNICAL DESCRIPTION

2.1 General Information

The DYNAenergetics Detonator Test Panel is built to work as a stand alone product. The panel is mounted inside a carrying case, together with a battery charger.

2.2 Front Panel

2.2.1 TEST Button
The TEST button is used to apply battery power to the panel and to perform the measurement on the detonator.

2.2.2 Indicator LED’s
Two green and three red LED’s are provided to display the test result. There are the green OK and ON LED’s and the red LINE OPEN, NOT IN SPEC and LINE SHORT LED’s.

2.2.3 IGNITER
Two banana jacks are provided for the connection of a perforating gun with a detonator or for the connection of just a detonator.
2.3 Battery Charger

The Battery Charger is used to charge the panel battery. It also can be used to power the panel, in case of low battery. The DC output of the battery charger does not actually use a connector but is hard wired to the Detonator Test Panel.
3. OPERATION

3.1 Connection to Detonator

The Electronic Detonator Tester can be used to test a detonator which is directly connected to the IGNITER jacks. The electronic DYNAWELL detonators are working with either polarity; it does not matter which way around they are connected to the tester panel jacks.

Within assembled perforating guns, detonators typically are located inside a gun body. In this case, the two connector jacks must be connected to the cable head connector on the top sub of the perforating gun to be tested. Again, polarity does not matter.

3.2 Testing

After the connection to the detonator (direct or through gun wiring) has been established, the TEST button is pressed. After a short flash of all LED's, the result of the test is shown. The ON LED must always be ON; it indicates that the panel power is okay. If the OK LED is on, too, then the detonator resistance is within specifications. If, instead, one of the red LED's is ON together with the ON LED, an error condition has been detected. The LINE OPEN indicates a resistance far above the expected one; the NOT IN SPECS indicates a resistance higher or lower than normal and the LINE SHORT indicates a resistance close to zero Ohms (below about 25 Ohm).

If the ON LED flashes after pushing the TEST button, then the battery voltage is below the required level for testing and it has to be recharged before the Tester Panel can be used.
4. INSTALLATION

Connect the detonator or the perforating gun to the IGNITER connector jacks on the panel. This completes the installation.
## 5. TECHNICAL DATA

<table>
<thead>
<tr>
<th>Description</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Test connector (IGNITER)</td>
<td>Banana Sockets</td>
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<tr>
<td>Supply to panel:</td>
<td>1.5 W, Input Voltage 7.2 VDC</td>
</tr>
<tr>
<td>Charger</td>
<td>100VAC ± 230VAC, 50 ± 60 Hz</td>
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</table>
## Technical Data Sheet

Refer to technical data sheets for more information and transport details.

<table>
<thead>
<tr>
<th>Issue: AA-2004/12</th>
<th>Temperature Resistant and Fluid Disabled RF-Safe Electronic Detonators</th>
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<td></td>
<td>0015FDE RDX</td>
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| Explosive | RDX | HNS |

<table>
<thead>
<tr>
<th>Temperature Resistance</th>
<th>150C/1h - 302F/1h</th>
<th>260C/1h - 500F/1h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(with flask)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Data Sheet</th>
<th>1.4 S</th>
<th>1.4 B</th>
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<tr>
<td></td>
<td>SS08025AC</td>
<td>SS08027AC</td>
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<tr>
<td></td>
<td>SS08026AC</td>
<td>SS08028AC</td>
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</tbody>
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Click technical data sheet revision number to open PDF file.
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---

**Electronic Detonator DYNAWELL 0026 FDE HNS 1.4S**

<table>
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<th>Classification</th>
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<th>UN No.</th>
<th>D.O.T.</th>
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<td>0456</td>
<td>EX-9911039</td>
</tr>
</tbody>
</table>

**Technical Information**

**APPLICATION:**
RF-SAFE, FLUID DISABLED, TEMPERATURE RESISTANT DETONATOR FOR OILFIELD USE

**TEMPERATURE RESISTANCE:**
- 150 °C / 1 h
- 260 °C / 1 h
- 302 °F / 1 h WITH HEAT INSULATED SPECIAL VACCUM FLASK (Ø 40 x 300 mm)

**ELECTRICAL PARAMETERS:**
- RESISTANCE: 12.7 kΩ ± 3.2 kΩ (MEASURING VOLTAGE 12 V)
- DIGITAL LOCKED
- OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
- SAFE AGAINST STATIC ELECTRICITY (2.500 PF 30 KV)
- SAFE AGAINST HIGH FREQUENCY (200 MHZ, 200 V/M)
- SAFETY TESTED AT 50 V AND 20 A

**FLUID DESENSITIZATION:**
AFTER 2 MINUTES IN WATER

**EXPLOSIVES:**
- PRIMARY CHARGE: 80mg PbN₆ 1.23 grains
- BASE CHARGE: 675mg HNS 10.42 grains

**SHELF LIFE:**
5 YEARS AT STORAGE CONDITION:
- + 5 °C TO + 30 °C
- + 41 °F TO + 86 °F
- max. 65% RELATIVE HUMIDITY
- GOOD VENTILATION WHEN SEALED IN VACUUM BAG

**DISPOSAL:**
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHORISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

**Technical Drawing**
(all dimensions in mm)

1. CRIMP EXTENSION
2. SHUNT
3. ALUMINIUM-SHELL
4. HOLES
5. LEG WIRE

**Packing Information**

<table>
<thead>
<tr>
<th>Quantity per box</th>
<th>50 pcs</th>
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</thead>
<tbody>
<tr>
<td>Gross weight per box</td>
<td>21.8 kg</td>
</tr>
<tr>
<td>Net weight per box</td>
<td>0.65 kg</td>
</tr>
<tr>
<td>NEC per box</td>
<td>0.04 kg</td>
</tr>
<tr>
<td>Dimensions of box</td>
<td>33 x 32 x 23 cm</td>
</tr>
<tr>
<td>Product weight</td>
<td>13 g</td>
</tr>
</tbody>
</table>

Package Type: Steel Case + Vacuum Bag

www.dynaenergetics.com dynawell@dynaenergetics.com Tel.: +49 (0)5102 6757 0
DYNAenergetics GmbH & Co. KG warrants only title to the equipment, products, materials and supplies and that the same are free from defects in workmanship and materials. There are no warranties, expressed or implied, of merchantability fitness or otherwise, which extend beyond those stated in the immediately preceding sentence. DYNAenergetics liability and Customer’s remedy in any case of action arising out of the sale or use of any equipment, products, materials and supplies is expressly limited to the replacement of such equipment, products, materials and supplies on their return to DYNAenergetics or, at DYNAenergetics option, to the allowance to the Customer of credit for the cost of such items. In no event shall DYNAenergetics be liable for special, incidental, punitive or consequential damages.

Electronic Detonator DYNAWELL 0015 FDE RDX 1.4B

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Classification</th>
<th>CE No.</th>
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<th>D.O.T.</th>
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<td>0255</td>
<td>EX-9409082</td>
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Technical Drawing
(all dimensions in mm)

Technical Information

APPLICATION:
RF-SAFE, FLUID DISABLED, TEMPERATURE RESISTANT DETONATOR FOR OILFIELD USE

TEMPERATURE RESISTANCE:
150 °C / 1 h 302 °F / 1 h

ELECTRICAL PARAMETERS:
RESISTANCE: 12.7 kΩ ± 3.2 kΩ
(MEASURING VOLTAGE 12 V)
DIGITAL LOCKED
OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
SAFE AGAINST STATIC ELECTRICITY (2,500 PF 30 KV)
SAFE AGAINST HIGH FREQUENCY (200 MHZ, 200 V/M)
SAFE AGAINST STATIC ELECTRICITY (2,500 PF 30 KV)

FLUID DESENSITIZATION:
AFTER 2 MINUTES IN WATER

EXPLOSIVES:
PRIMARY CHARGE: 80mg PbN₆ 1.23 grains
BASE CHARGE: 600mg RDX 9.26 grains

SHELF LIFE:
5 YEARS AT STORAGE CONDITION:
+ 5 °C TO + 30 °C + 41 °F TO + 86 °F
max. 65% RELATIVE HUMIDITY
GOOD VENTILATION WHEN SEALED IN VACUUM BAG

DISPOSAL:
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHOURISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

Packing Information

<table>
<thead>
<tr>
<th>Quantity per box</th>
<th>150 pcs</th>
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<td>Gross weight per box</td>
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<tr>
<td>Net weight per box</td>
<td>2.0 kg</td>
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<tr>
<td>NEC per box</td>
<td>0.11 kg</td>
</tr>
<tr>
<td>Dimensions of box</td>
<td>44 x 30 x 31 cm</td>
</tr>
<tr>
<td>Product weight</td>
<td>13.3 g</td>
</tr>
</tbody>
</table>

Package Type
Carton + Vacuum Bag

www.dynaenergetics.com dynawell@dynaenergetics.com Tel.: +49 (0)5102 6757 0

DYNAenergetics GmbH & Co. KG warrants only title to the equipment, products, materials and supplies and that the same are free from defects in workmanship and materials. There are no warranties, expressed or implied, of merchantability fitness or otherwise, which extend beyond those stated in the immediately preceding sentence. DYNAenergetics liability and Customer’s remedy in any case of action arising out of the sale or use of any equipment, products, materials and supplies is expressly limited to the replacement of such equipment, products, materials and supplies on their return to DYNAenergetics or, at DYNAenergetics option, to the allowance to the Customer of credit for the cost of such items. In no event shall DYNAenergetics be liable for special, incidental, punitive or consequential damages.
DYNAenergetics GmbH & Co. KG warrants only title to the equipment, products, materials and supplies and that the same are free from defects in workmanship and materials. There are no warranties, expressed or implied, of merchantability fitness or otherwise, which extend beyond those stated in the immediately preceding sentence. DYNAenergetics liability and Customer's remedy in any case of action arising out of the sale or use of any equipment, products, materials and supplies is expressly limited to the replacement of such equipment, products, materials and supplies on their return to DYNAenergetics or, at DYNAenergetics option, to the allowance to the Customer of credit for the cost of such items. In no event shall DYNAenergetics be liable for special, incidental, punitive or consequential damages.

Electronic Detonator DYNAWELL 0015 FDE RDX 1.4S

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Classification</th>
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Technical Drawing
(all dimensions in mm)

1. CRIMP EXTENSION
2. SHUNT
3. ALUMINIUM-SHELL
4. HOLES
5. LEG WIRE

Technical Information

APPLICATION:
RF-SAFE, FLUID DISABLED, TEMPERATURE RESISTANT DETONATOR FOR OILFIELD USE

TEMPERATURE RESISTANCE:
150 °C / 1 h 302 °F / 1 h

ELECTRICAL PARAMETERS:
RESISTANCE: 12.7 kΩ ± 3.2 kΩ
(MEASURING VOLTAGE 12 V)
DIGITAL LOCKED
OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
SAFE AGAINST STATIC ELECTRICITY
(2,500 PF 30 KV)
SAFE AGAINST HIGH FREQUENCY
(200 MHZ, 200 V/M)
SAFETY TESTED AT 50 V AND 20 A

FLUID DESENSITIZATION:
AFTER 2 MINUTES IN WATER

EXPLOSIVES:
PRIMARY CHARGE: 80mg PbN₀.6 1.23 grains
BASE CHARGE: 600mg RDX 9.26 grains

SHELF LIFE:
5 YEARS AT STORAGE CONDITION:
+ 5 °C TO + 30 °C
+ 41 °F TO + 86 °F
max. 65% RELATIVE HUMIDITY
GOOD VENTILATION
WHEN SEALED IN VACUUM BAG

DISPOSAL:
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHORISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

Packing Information

<table>
<thead>
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</thead>
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<tr>
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<td>Product weight</td>
<td>13 g</td>
</tr>
<tr>
<td>Package Type</td>
<td>Steel Case + Vacuum Bag</td>
</tr>
</tbody>
</table>

www.dynaenergetics.com dynawell@dynaenergetics.com Tel.: +49 (0)5102 6757 0
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### Electronic Detonator DYNAWELL 0026 FDE HNS 1.4B

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Classification</th>
<th>CE No.</th>
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#### Technical Drawing
(all dimensions in mm)

1. CRIMP EXTENSION
2. SHUNT
3. ALUMINIUM-SHELL
4. HOLES
5. LEG WIRE

#### Technical Information

**APPLICATION:**
RF-SAFE, FLUID DISABLED, TEMPERATURE RESISTANT DETONATOR FOR OILFIELD USE

**TEMPERATURE RESISTANCE:**
- 150 °C / 1 h
- 260 °C / 1 h
- 302 °F / 1 h
- 500 °F / 1 h WITH HEAT INSULATED SPECIAL VACUUM FLASK (Ø 40 x 3001)

**ELECTRICAL PARAMETERS:**
- RESISTANCE: 12.7 kΩ ± 3.2 kΩ
- (MEASURING VOLTAGE 12 V)
- DIGITAL LOCKED
- OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
- SAFE AGAINST STATIC ELECTRICITY (2,500 PF 30 KV)
- SAFE AGAINST HIGH FREQUENCY (200 MHZ, 200 V/M)
- SAFETY TESTED AT 50 V AND 20 A

**FLUID DESENSITIZATION:**
AFTER 2 MINUTES IN WATER

**EXPLOSIVES:**
- PRIMARY CHARGE: 80mg PbN₆ 1.23 grains
- BASE CHARGE: 675mg HNS 10.42 grains

**SHELF LIFE:**
5 YEARS AT STORAGE CONDITION:
- + 5 °C TO + 30 °C
- + 41 °F TO + 86 °F
- max. 65% RELATIVE HUMIDITY
- GOOD VENTILATION WHEN SEALED IN VACUUM BAG

**DISPOSAL:**
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHORISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

#### Packing Information

<table>
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<tr>
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<td>Dimensions of box</td>
<td>44 x 30 x 31</td>
<td>cm</td>
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<tr>
<td>Product weight</td>
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<td>g</td>
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**Package Type**
Carton + Vacuum Bag

**Revision:**
SS08028AC

**Package Type Code:**
TD Z 983
## Technical Data Sheet

Refer to technical data sheets for more information and transport details.

<table>
<thead>
<tr>
<th>Issue: AA-2004/12</th>
<th>Temperature and Pressure Resistant RF-Safe Electronic Detonators</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1015 E HMX</td>
</tr>
<tr>
<td>Explosive</td>
<td>HMX</td>
</tr>
<tr>
<td>TemperatureResistance</td>
<td>150°C/1h - 302°F/1h</td>
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<tr>
<td>TemperatureAndPressureResistance</td>
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<td></td>
<td>302°F/14,400 psi/1h</td>
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<table>
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<tr>
<th>Technical Data Sheet</th>
<th>1.4 S</th>
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<td>SS08030AD</td>
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Click technical data sheet revision number to open PDF file.
DYNA® energetics

DYNA® WELLE®

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Electronic Detonator DYNAWELL 1015 E HMX 1.4S

<table>
<thead>
<tr>
<th>Part No.</th>
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<th>CE No.</th>
<th>UN No.</th>
<th>D.O.T.</th>
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Technical Drawing
(all dimensions in mm)

Technical Information

APPLICATION:
RF-SAFE, TEMPERATURE AND PRESSURE RESISTANT DETONATOR FOR OILFIELD USE

PRESSURE / TEMPERATURE RESISTANCE:
150 °C / 1,000 bar / 1 h 302 °F / 14,500 psi / 1 h

ELECTRICAL PARAMETERS:
RESISTANCE: 12.7 kΩ ± 3.2 kΩ
(MEASURING VOLTAGE 12 V)
DIGITAL LOCKED
OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
SAFE AGAINST STATIC ELECTRICITY (2,500 PF 30 KV)
SAFE AGAINST HIGH FREQUENCY (200 MHZ, 200 V/M)
SAFETY TESTED AT 50 V AND 20 A

EXPLOSIVES:
PRIMARY CHARGE: 250mg PbN₆ 3.86 grains
700mg HMX 10.80 grains
BASE CHARGE: 1300mg HMX 20.06 grains

RECOMMENDED WIRE STRIPPER:
IDEAL-STRIPMASTER-SPEZIAL 45-171 WITH BLADE L-5211

SHELF LIFE:
5 YEARS AT STORAGE CONDITION:
+ 5 °C TO + 30 °C + 41 °F TO + 86 °F
max. 65% RELATIVE HUMIDITY
GOOD VENTILATION

DISPOSAL:
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHORISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

Packing Information

<table>
<thead>
<tr>
<th>Quantity per box</th>
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Package Type
Steel Case

TD Z 1139
Revision: SS08029AD

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### Technical Information

**APPLICATION:**
RF-SAFE, TEMPERATURE AND PRESSURE RESISTANT DETONATOR FOR OILFIELD USE

**PRESSURE / TEMPERATURE RESISTANCE:**
- $150 \, ^\circ C / 1,000 \, \text{bar} / 1 \, \text{h}$
- $302 \, ^\circ F / 14,500 \, \text{psi} / 1 \, \text{h}$

**ELECTRICAL PARAMETERS:**
- RESISTANCE: $12.7 \, k\Omega \pm 3.2 \, k\Omega$
- (MEASURING VOLTAGE 12 V)
- DIGITAL LOCKED
- OPERATION ONLY POSSIBLE WITH THE SUITABLE DYNAWELL DIGITAL FIRING PANEL
- SAFE AGAINST STATIC ELECTRICITY (2,500 PF 30 kV)
- SAFE AGAINST HIGH FREQUENCY (200 MHz, 200 V/M)
- SAFETY TESTED AT 50 V AND 20 A

**EXPLOSIVES:**
- PRIMARY CHARGE: 250mg PbN$_6$ 3.86 grains
- 700mg HMX 10.80 grains
- BASE CHARGE: 1300mg HMX 20.06 grains

**RECOMMENDED WIRE STRIPPER:**
IDEAL-STRIPMASTER-SPEZIAL 45-171 WITH BLADE L-5211

**SHELF LIFE:**
5 YEARS AT STORAGE CONDITION:
- $+5 \, ^\circ C \text{ TO } +30 \, ^\circ C$
- $+41 \, ^\circ F \text{ TO } +86 \, ^\circ F$
max. 65% RELATIVE HUMIDITY
GOOD VENTILATION

**DISPOSAL:**
DETONATORS SHOULD BE DESTROYED ONLY BY AUTHORISED PERSONS (ACCORDING TO NATIONAL LAW AND REGULATION).

---

### Packing Information

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</tr>
<tr>
<td>Product weight</td>
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</tr>
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**Package Type:** Carton

---

Electronic Detonator DYNAWELL 1015 E HMX 1.4B

<table>
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<th>Part No.</th>
<th>Classification</th>
<th>CE No.</th>
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Technical Drawing (all dimensions in mm)
Assembly of the RF Safe System

This section deals with assembly of an RF safe detonation system for a gun string, using the LRI Universal Isolation Sub; it is intended for use by gun loaders and operators who have been trained by LRI or DynaEnergetics in the use of DynaEnergetics’ RF safe and select fire procedures. A separate comprehensive manual on this topic, is available from your LRI representative.

Prepare for the job and load the guns to be used, by following the procedures detailed in the complementary manual “Gun Loading Procedures”\(^1\).

Requirements:

- Guns, charges, cord, top and bottom subs, selectronic switches and RF safe detonators as determined by the job requirements.
- Shooting wire to run the length of each gun in the string.
- A 3-piece LRI Universal Isolation Sub for each gun in the string. The centre body of this sub is used with top and bottom pieces of this sub interchangeable for different gun sizes. Ensure the top and bottom sections are of the size required and that threads and sealing surfaces are clean and in good shape.
- A DynaEnergetics style booster assembly, c/w brass conductor pin, for every gun in the string.
- A pressure bulkhead for every gun in the string.
- Standard gun assembly tools.

Assembly Instructions

1. Check packaging to ensure all necessary components are present for each system.

2. Starting with the lowermost gun assembly, insert brass pin into holder assembly with threaded end protruding from the small end of the holder and the cupped portion protruding out the larger end of the holder and slide over provided spring.

\(^1\) 1. This system requires that the perforating gun be assembled with a thru wire, as all guns will be fired from the bottom of each assembly. For purposes of this procedure we will be using only a 2 gun system.

2. When assembling guns that have an isolation sub below, allow enough extra cord to protrude the gun, to facilitate crimping to the detonator in the sub’s window.
3. Attach thru wire of perforating gun to bottom of brass pin assembly using the provided screw. Insert fully assembled pin retainer system into the provided end plate, give ¼ twist and release so as spring holds assembly firmly in place.

4. Insert loaded tube into carrier.

5. Lubricate the o-ring sealing surface of the Pressure bulkhead (provided) and utilizing a long socket or piece of pipe carefully tap the bulk head into the lower portion of the 3 piece Isolation Sub until it bottoms out in the sub. Tighten in the retainer nut.

6. Re-attach the bottom portion of the 3 piece Isolation Sub into which you just inserted the pressure bulk head, to the main body of the isolation sub assembly.
Attach the isolation sub assembly to the lower gun assembly ensuring that the pin of the pressure bulk head in the sub makes contact with the brass pin assembly on the gun. Tighten all pieces together with pipe wrenches and meter gun to confirm connections.

7. Attach the top portion of the 3 piece sub to the main sub body and carefully insert the detonation cord and thru wire of the upper gun assembly in to the sub and tighten the gun firmly on to the entire assembly. If the 2 guns are properly assembled you will have 2 wires and 1 piece of detonating cord showing in the window of the sub body.

8. Using the wire color coding system that is on the Selectronic switch, proceed as follows.

9. Attach the orange wire from the switch to the thru wire of the upper gun. Attach one
of the black wires to the sub body. Attach the blue wire to the wire leading to the lower gun. (The remaining steps must be done out in the field)

10. Test detonator according to procedures outlined in “RF Safe and Select Fire Perforating” document provided at your RF Safe training session.

11. After testing detonator, insert the detonator into a capping chamber and connect the remaining black wire to one of the detonator leads and the white wire to the other detonator lead. Carefully remove detonator and attach to the detonating cord protruding from the window.

12. Carefully place the switch, detonator, and all wiring into the void in the isolation sub and slide the sleeve over the opening and tighten down to ensure a tight seal, taking care to only use wrenches on knurled portions of the sub and sleeve. The assembly should be ready for deployment in the well bore.
**OT** stands for Oiltronic  
**MT** stands for Multitronic

<table>
<thead>
<tr>
<th>Applicable for</th>
<th>Problem</th>
<th>Cause / Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>OT II</td>
<td>If the two detonator wires are shorted during the firing sequence the Switch can be damaged.</td>
<td>The software will give an error message indication that the current increase is higher than expected. If this message is not acknowledged with OK after several seconds the Switch can be damaged as the panel only turns off the voltage after the acknowledgement.</td>
</tr>
<tr>
<td>MT II</td>
<td>If the two detonator wires are shorted during the Switch test the Switch can be damaged.</td>
<td>Current leak on line. Possibly due to CCL with low resistance (under 2kOhm, which are recommended as minimum).</td>
</tr>
<tr>
<td>MT III</td>
<td>Problems with initiation (although a MT Switch test was successful).</td>
<td>Current leak on line. Possibly due to CCL with low resistance (under 2kOhm, which are recommended as minimum).</td>
</tr>
<tr>
<td>MT II</td>
<td>At low temperatures the Switch test shows problems after the first gun has been addressed.</td>
<td>Due to low temperature the capacitors in the Switches can not bleed off so Switches do not go into an idle state which is necessary for a second test. Avoid Switch test at low temperatures or allow system time between tests.</td>
</tr>
<tr>
<td>MT II</td>
<td>At low temperatures guns can not be fired directly after Switch test.</td>
<td>Due to low temperature the capacitors in the Switches can not bleed off so Switches do not go into an idle state which is necessary for firing. Avoid Switch test at low temperatures or allow system time before firing.</td>
</tr>
<tr>
<td>MT III</td>
<td>All problems which you want analysed.</td>
<td>The MT software will generate a dump file each time you open the software. This dump file contains a log of the job taking place. These files are serialised &quot;Message.txt&quot; files which are generally stored in a Multitronic folder under Programs/Antares. The files contain valuable information to analyse problems experienced during jobs. The appropriate dump file (see date and time of generation) should be transmitted to your DYNAenergetics representative or agent together with the panel serial number and software version used.</td>
</tr>
<tr>
<td>x</td>
<td>Hardware change. All panels with serial numbers of 1958-0025 and above have an increased current range and a more accurate shot indication (variance increased from 7% to 20%)</td>
<td>Shot indication is more reliable.</td>
</tr>
<tr>
<td>x</td>
<td>Hardware and software change. All panels with serial numbers of 1956-0021 (software version of 4.7) and above have a changed current measurement.</td>
<td>A mismatch of panels and software will result in wrong current readings. The function of the system will not be effected. Old panels used with new software will show values which are double as high as real values. New panels with old software will show values which are half as high as real values.</td>
</tr>
<tr>
<td>x</td>
<td>Current increase is higher than allowed by software.</td>
<td>Current increase might be higher than allowed by software due to leaks in the line or attached components (i.e. Well Tractor electronics). To be able to bypass failure messages press &quot;CTRL-ALT-1&quot; while the Current Settings window is open and tick the &quot;Ignore safety cutout&quot; box.</td>
</tr>
<tr>
<td>x</td>
<td>Guns can not be fired while working off barges or on offshore.</td>
<td>Possibly the installation is in motion which will result in down hole CCL movements. The induced CCL signals can distort the firing signal resulting in the detonator staying in a safe state. Mark cable and remove CCL or repeat firing while motion is reduced.</td>
</tr>
<tr>
<td>Issue</td>
<td>Description</td>
<td>Possible Cause</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>----------------</td>
</tr>
<tr>
<td>System shows gun has not been fired although gun has been fired.</td>
<td>The indication if a gun has been fired results from a current measurement directly before and after initiation. If the values vary by more than 20% the software assumes the detonator has been shot, as we assume an open or a short after firing. If the electronic board in the detonator is not damaged or destroyed during the initiation (i.e. shooting in a dry gas environment) the variation of the current measurement is smaller than 20%, resulting in a wrong assumption of the gun not having been fired. To avoid this scenario tape one detonator wire to the base charge of the detonator. The initiation will damage the wire and result in a correct reading.</td>
<td></td>
</tr>
<tr>
<td>No shot ok indication while testing with dummy LED detonators.</td>
<td>The indication if a gun has been fired results from a current measurement directly before and after initiation. If the values vary by more than 20% the software assumes the detonator has been shot, as we assume an open or a short after firing. If the electronic board in the detonator is not damaged or destroyed during the initiation (i.e. using a dummy LED detonator) the variation of the current measurement is smaller than 20%, resulting in a wrong assumption of the gun not having been fired. To avoid this scenario while testing you will have to disconnect one of the detonator wires after observing the LED flash. This will result in a correct reading.</td>
<td></td>
</tr>
<tr>
<td>Detonator can not be initiated while running a high voltage GR-Switch.</td>
<td>GR-button has not been pressed on the OT panel / GR has not been selected in the MT software.</td>
<td></td>
</tr>
<tr>
<td>Detonator can not be initiated while running a high voltage GR-Switch although the GR-button has been pressed on the OT panel / the GR has been selected in the MT software.</td>
<td>Wrong GR-Switch is being used. There are two different GR-Switches available. One is for use with the OT and MT II panel, the other is for use with the MT III panel.</td>
<td></td>
</tr>
<tr>
<td>Gun can not be fired.</td>
<td>To high stray current leaks or to high resistances in the system (bad connections, bad insulation, etc.). As the system is working with a low voltage of between 15 and 35 VAV and a current of under 100 mA it is imperative to have good connections and good insulation with no leaks.</td>
<td></td>
</tr>
<tr>
<td>Initiators do not work on an other frequency than very low.</td>
<td>The software of the MT allows the alteration of the data rate in the settings window. This change in data rate was initially integrated to compensate for extreme temperatures, cable lengths and cable properties. In 2007 the electronic section of the initiators was redesigned. The redesign compensated for the adverse conditions and it was decided that the new electronic will only be able to be initiated with the very low data rate. If you have initiators with manufacturing dates after the following you will only be able to use the very low data rate for initiation: 0015 FDE – March 2007 1015 E – June 2007 Electronic Igniter EIST – November 2007</td>
<td></td>
</tr>
<tr>
<td>Output voltage after calibration via Voltage Setting screen is too high.</td>
<td>The identification of the optimum voltage for a given setup is done through a calibration via the Voltage Setting screen. This calibration should only be done while the system is on surface or relatively shallow in the hole, with a temperature that is not too high. The calibration utilised the Zener Diodes that are integral part of the Switches. The Zener Diodes change their properties when exposed to increased temperatures. This though does not have any effect on the function of the Switch, it does though have an effect on the calibration via the Voltage Setting screen, which can result in a damage of the top Switch. If the system has to be</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>rebooted between two initiations the voltage should not be adjusted through a calibration via the Voltage Setting screen, but should be entered manually in the Voltage Setting screen.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>x</td>
<td></td>
<td>Panel has been damaged as it is still connected to the system while a standard shooting panel is being used.</td>
</tr>
<tr>
<td>x</td>
<td></td>
<td>The OT panel does not have a protection for high voltage being fed into the “Wireline” port.</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>Panel has been damaged as a standard firing panel has been used and was routed through the MT panel.</td>
</tr>
<tr>
<td></td>
<td>x</td>
<td>Shooting a standard firing panel through a MT panel will damage the MT electronics even though the MT panel is in Log mode. A standard firing panel always has to be placed behind the MT panel.</td>
</tr>
</tbody>
</table>

- include all technical letters
TECHNICAL BULLETIN #08061203

CHANGE OF RESET TIME

THE USE OF THE MULTITRONIC RF-SAFE SELECTIVE PERFORATING SYSTEM AT LOW TEMPERATURES (-10°C / 14°F) HAS BROUGHT TO OUR ATTENTION THAT THE RESET TIME OF THE SOFTWARE IS NOT LONG ENOUGH WHEN THE SYSTEM IS EXPOSED TO THESE CONDITIONS.

THE COMPONENTS OF THE MULTITRONIC RF-SAFE SELECTIVE PERFORATING SYSTEM (SELECTRONIC SWITCH AND INITIATORS) HAVE CAPACITORS AS INTEGRAL PARTS OF THEIR ELECTRONICS. TO ALLOW THESE CAPACITORS TO DISCHARGE AND TO ALLOW THE COMPONENTS TO DROP INTO AN IDLE STATUS THE SOFTWARE ALLOWS FOR A RESET TIME AFTER EVERY COMMUNICATION. AT LOW TEMPERATURES THIS PRE-PROGRAMMED RESET TIME IS NOT SUFFICIENT TO ALLOW FOR THE CAPACITORS TO DISCHARGE. THIS WILL BE NOTICED BY THE USER BY WAY OF AN “UNEXPECTED CURRENT INCREASE” ERROR MESSAGE WHEN THE FIRST SWITCH IS ADDRESSED A SECOND TIME TO TEST THE SECOND GUN IN THE STRING.

THE SOFTWARE HAS BEEN MODIFIED IN SUCH A WAY THAT THE USER CAN EXTEND THIS RESET TIME. TEMPERATURE TESTS HAVE SHOWN THAT THE NECESSARY RESET TIME AT -10°C / 14°F IS 120 SECONDS.

TO CHANGE THE RESET TIME PLEASE START “REGEDIT” (START – EXECUTE) AND LOOK FOR THE FOLLOWING KEY:

HKEY_CURRENT_USER \ Software \ ANTARES Datensysteme GmbH \ Multitronic \ Settings \ ResetTime

HERE YOU CAN DEFINE THE RESET TIME IN HEXDECIMAL OR DECIMAL CODE. PLEASE USE DECIMAL. THE VALUE IS ENTERED IN SECONDS.

WE DO NOT RECOMMEND TO CHANGE THE RESET TIME UNLESS THIS IS ABSOLUTELY NECESSARY.

PLEASE CONTACT YOUR NEAREST DYNAenergetics REPRESENTATIVE FOR MORE INFORMATION OR IF YOU HAVE ANY QUESTIONS.
Use of USB to RS232 Adapter with Multitronic Panel

During the installation of the USB to RS232 Adapter, the Windows system is set to a communications port for this (virtual) RS232 port which can not be selected by the user. The actual port chosen can be viewed via the Windows Device Manager (the examples are shown for a German system - but the meaning is recognizable). How to call the device manager is different for different versions of Windows; use Start-Help if you don't know how to. Typically, right click on the systems icon.

The Multitronic panel only allows for the selection of COM port 1, 2 or 3. It is easily possible, to move the USB adapter to one of these numbers - if (at least) one of them is free. In the example above, the port COM1 is free, so the USB Adapter can be moved there:

Double click on the line USB-SERIAL. In the Dialog select Port Settings (I'm not sure if this is the correct translation). Then select Extended.

Select a free COM port within the first three entries. Click OK/OK and you are done.

In the case that there are no free entries within the first three COM port entries, you have to move one of the devices out first and then move the USB Adapter in as a second step.
The only action remaining now is to select the just prepared COM port for use with the Multitronic panel (in the Settings Menu).

Please note that the new settings appear in the Device Manager only after it has been closed and re-opened.