INDETSHOCK / SHOCKSTAR is a non-electric initiation system designed by Austin Detonator s.r.o., Czech Republic. This initiation system increases safety and ensures better blasting results. The system was introduced to the market in 1993 and since then has seen three major modifications to the surface connector which brought further reliability, precision, and safety to blasting in field. The last version of the Shockstar Surface connector brings a new optional function of securing connections by locking the tubes in the block in order to eliminate disconnections in some special applications, e.g. when the blasts need to be covered by heavy mats. The new block also further increases userfriendliness when making connections in temperatures exceeding -15°C.

Using of non-electric system for blasting brings a number of benefits including:

- Higher safety of blast work, as the system is immune to initiation by foreign sources of electric energy (radio frequency, stray currents).
- Higher variability of timing patterns enabling “tailor-made” blasts corresponding to the conditions in a given locality.
- More effective work from the point of view of logistics and storage (smaller product range necessary for achieving a given result).

All the mentioned benefits improve economy of blasting operations. Although the initial cost of using non-electric system may be higher, the overall economics of blasting and quarrying operations is more beneficial as opposed to traditional electric system.

The blasting results using non-electric system (fragmentation, vibration control) are much more positive. Before the non-electric system was introduced, the only way to perform a non-electric blast was using a detonating cord. The method is now almost abandoned as it has numerous undesired side effects. When initiating a blast using a detonating cord, the blast hole is opened from the top which creates excessive fly rock because the stemming is destroyed as the detonation passes through it. As a result, the energy created by detonation is used less effectively. In addition, when used to initiate relatively insensitive explosives such as ANFO and certain emulsion explosives, the detonating cord can cause dead-pressing of the explosive. Further disadvantages of using detonating cord for initiation include excessive noise. Using of non-electric system enables to initiate the blast hole from the bottom (see figure 0-1) which ensures better use of the blast energy.
1. COMPONENTS OF NON-ELECTRIC INITIATION SYSTEM AND THEIR FUNCTION

Austin Shock tube and all Austin Detonator products using Austin Shock tube can be initiated by regular electric or non-electric detonator, detonating cord, plain detonator, SHOCKSTAR BUNCH CONNECTOR, SHOCKSTAR SURFACE, and proper blasting machine (from an open end of the shock tube only).

1. SHOCKSTAR SURFACE

SHOCKSTAR SURFACE is a millisecond delay detonator enclosed in a color coded plastic block. This detonator has a smaller base charge designed for initiation of shock tube only.

2. INDETSHOCK MS 25/50 - INDETSHOCK TS

These are in-hole detonators with millisecond delay (steps 25 ms and 50 ms) and long period delay detonators used for initiation of explosive in a hole. INDETSHOCK MS 25/50 is used for surface applications, INDETSHOCK TS in underground applications. These detonators can be initiated by means mentioned at the top of this section. For initiation by detonating cord they can be fitted with a T-connector.

3. SHOCKSTAR BUNCH CONNECTOR

The base charge of these detonators is designed for initiation of a 5-6 g/m PETN detonating cord, which is attached to it. The detonator is enclosed in a plastic block and the detonating cord is inserted in the plastic block. The detonator is used for initiation of up to 20 shock tubes tied in a bunch, which is closely described later in this manual. The detonator is mostly used in underground applications.

4. SHOCKSTAR DUAL DELAY

SHOCKSTAR DUAL DELAY is composed of SHOCKSTAR SURFACE and an in-hole detonator INDETSHOCK MS 25/50. Dual Delay detonator is used in the same way as the two detonators of which it is composed. The benefits of Dual Delay detonators include faster handling, easier connections and decrease of excessive shock tube during connecting, thus making it easier to overview the connections on the blast site.
2. PRINCIPLE OF INITIATION OF A NON-ELECTRIC SYSTEM

The basic principle of initiation is transferring initiation from surface connector to a detonator in a hole and to another surface connector.

The figure 2-1 shows properly timed blasting pattern - the holes are initiated well before the rock starts moving.

**NOTICE**
For a successful blast it is necessary that a hole is initiated well before the initiation network is destroyed by the blast itself. This is ensured by suitably designed blast pattern.
3. CONSTRUCTION AND TECHNICAL DESCRIPTION OF NONELECTRIC DETONATORS

SHOCKSTAR SURFACE
(with millisecond delay)

The new SHOCKSTAR SURFACE is a highly user-friendly product bringing substantial time-savings when connecting initiation network. The design of the connector virtually eliminates the shrapnel cut-off concerns, and makes easier the composition of initiation network. The connector has 9 delay stages. The initiation strength of SHOCKSTAR SURFACE detonators is 0,11 g PETN. The detonators are composed of an aluminum shell containing a base charge and a highly accurate delay composition system, anti-static rubber plug, shock-tube fitted with a stopper and a delay tag (see fig. 3-1). The stopper prevents the tube end from coming out of the connector block. The detonator is enclosed in a color coded plastic block. These units are specially designed for surface delay patterns and are used to initiate INDETSHOCK MS 25/50 and TS, and to relay the initiation impulse to the next SHOCKSTAR SURFACE connector(s) in sequence.

NOTICE

The SHOCKSTAR SURFACE is an assembly composed of two main parts: a plastic connector and a small detonator with a shock tube attached. The plastic connector houses the detonator. The entire unit is assembled by the manufacturer and makes a permanent assembly. The disassembly may result in damage to the unit. Surface detonators must not be used to initiate explosives and detonating cord!

**TECHNICAL DATA**

**Detonator Shell**
- Material: Aluminum
- Outside diameter: 7,65 mm max.
- Length: 62 mm
- Markings: nominal delay time

**Connector**
- Material: PE
- Body color: as per nominal delay
- Plug color: as per nominal delay

**Anti-static sealing plug**
- Material: conductive rubber
- Color: black

**Shock-tube**
- Material: Surlyn / PE
- Base length: 
  \[2,4 + x \times 0,6 \text{ m} \]
  \((x = 0, 1, 2, 3 ... 41)\)
- Color: yellow
- Detonation velocity: 2000 m/s
- Markings:
  - production series number
  - detonator type
  - nominal delay time
  - shock-tube length
  - traceability code

**NOMINAL DELAYS**

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</table>
**IN-HOLE DETONATORS**

**INDETSHOCK MS 25/50**
(with 25 or 50 ms delay interval)

**INDETSHOCK TS**
(with 50, 100, 200 and 500 ms delay interval)

These detonators have initiating strength No. 12 (0.72 g PETN). The detonators are made of aluminum shell containing the primary charge, delay composition system, shock-tube, antistatic sealing plug, stopper and delay tag.

The detonators can be fitted with a T-connector (see figure 3-3 and 3-4) for detonating cord compatibility, and they are used to initiate primers (boosters) or directly commercial explosives.

The T-connectors cannot be supplied separately for later application on the detonator shock tube. They can be applied only during production in the factory.

**TECHNICAL DATA**

**Detonator Shell**
- Material: Aluminum
- Outside diameter: 7.65 mm max.
- Length: 58 to 93 mm
- Marking:
  - nominal delay time
  - letter „V“ at the shell bottom

**Antistatic Sealing Plug**
- Material: conductive rubber
- Color: black

**Shock-Tube**
- Material: Surlyn / PE
- Base length: 
  \[2.4 + x \cdot 0.6 \text{ m} \quad (x = 0, 1, 2, 3 ... 41)\]
- Color: yellow
- Detonation velocity: 2000 m/s
- Marking:
  - production series number
  - detonator type
  - nominal delay time/delay number
  - shock-tube length
  - traceability code
## NONELECTRIC DETONATORS DELAY TIMES

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*tab. 2*
SHOCKSTAR BUNCH CONNECTOR

This detonator is fitted with a Bunch Connector with a 5 g/m PETN detonating cord. The detonator base charge of 0.16 g PETN is designed to initiate the attached detonating cord. SHOCKSTAR BUNCH CONNECTOR is available in the following delays: 0, 9, 17, 25, 33, 42, 67, 100, 200 ms.

Fig. 3-5

TECHNICAL DATA

Detonator Shell
- Material: Aluminum
- Outside diameter: 7.65 mm max.
- Length: 54 mm
- Marking: nominal delay time

Connector
- Material: PE
- Body color: as per nominal delay
- Plug color: as per nominal delay

Anti-static sealing plug
- Material: conductive rubber
- Color: black

Shock-tube
- Material: Surlyn / PE
- Base length: 2.4 m min.
- Color: red
- Detonation velocity: 2000 m/s
- Marking: delay tag

SHOCKSTAR DUAL DELAY DETONATOR

SHOCKSTAR DUAL DELAY detonator is a combination of SHOCKSTAR SURFACE (nominal delays 0, 17, 25, 42, 67, 100, 200 ms) and INDETSHOCK MS 25/50 or INDETSHOCK TS (nominal delays 350, 475, 500, 800, 9000 ms). DUAL DELAY detonators are used in surface bench blasts and underground blasts. Like all nonelectric detonators, they cannot be used in gassy coalmines underground. Their use results in smaller number of detonators needed for one blast. Use of SHOCKSTAR DUAL DELAY detonators brings the following advantage:
- reduced handling and storage requirements
- faster Composition of initiation network
- reduced number of connections between units
- easier and more reliable visual inspection of connection

Fig. 3-6 Non-electric detonators SHOCKSTAR Dual Delay

Fig. 3-5 Non-electric detonators SHOCKSTAR Dual Delay

TECHNICAL DATA

Shock-tube
- Material: Surlyn / PE
- Base Length: 
  - 2.4 + x . 0.6 m
  - (x = 0, 1, 2, 3 ... 41)
- Color: yellow
- Detonation velocity: 2000 m/s
- Marking: delay tag

NOMINAL DELAYS

<table>
<thead>
<tr>
<th>NOMINAL DELAYS</th>
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Tab. 3
Bench blast design using SHOCKSTAR DUAL DELAY, SHOCKSTAR SURFACE and INDETSHOCK MS 25/50

Shock-tube color
- SHOCKSTAR SURFACE
- SHOCKSTAR DUAL DELAY
- INDETSHOCK MS 25/50

4. PRACTICAL USE OF NONELECTRIC DETONATORS AND THE BENEFITS OF USE

SHOCKSTAR/INDETSHOCK detonators are used for initiation of commercial explosives used for blasting both above and underground.

WARNING
Non-electric detonators SHOCKSTAR/INDETSHOCK must not be used in worksites with coal dust and methane atmosphere.

Conditions of use:
- temperatures ranging from -30 °C to +60 °C
- in water pressure of max 0.3 MPa / 7 days

Advantages:
- fit for use in wet conditions and under water
- high variability of timing
- highly safe product
- reduction of vibration during blast

Instruction for use of SHOCKSTAR SURFACE

CONNECTING
Prepare a loop as shown in the picture. When connecting the tube in the connector, always pull the tube in the direction towards the middle of the connector block cavity for tubes. This method puts the least demand on strength needed for making a connection.

Fig. 3-7
DISCONNECTING
Hold the loop as when connecting and pull the tube out from the connector block.

CAUTION
During connection make sure that the tubes are properly inserted into the connector block and that they are not crossed inside the connector block. Each side of the connector block can hold up to 4 tubes, the total capacity of the block is 8 tubes.

If needed, it is possible to lock the tubes in to secure the connection. The connector is however fully functional in both locked and unlocked position provided the tubes are inserted properly.

CAUTION
Do not use any version of „double hooking“ as a safety precaution against preventing the shock tube from slipping out of the Shockstar connector. For this purpose, every shock tube is fitted with a plastic sleeve at its end. Double hooking is a nonstandard connection not compliant with the design of the Shockstar product, and it may result in improper function.

Application INDETSHOCK MS 25/50 detonators in open pit blasting operations

The explosive in the drill hole is initiated by two in-hole detonators INDETSHOCK MS 25/50. One detonator is located at the bottom (lower) part of the drill hole. The other detonator is positioned at the top (upper) part of the drill hole, under the stemming. Normally, a 475 ms detonator is used at the bottom and a 500 ms detonator at the top of the drill hole. With drill holes longer than 30 m, a 450 ms detonator is recommended for use at the bottom of the hole.

CAUTION
Do not use any version of “double hooking” as a safety precaution against preventing the shock tube from slipping out of the Shockstar connector. For this purpose, every shock tube is fitted with a plastic sleeve at its end. Double hooking is a nonstandard connection not compliant with the design of the Shockstar product, and it may result in improper function.
Detonators should be positioned such that the detonator bottom is directed towards the longer part of the explosive column. The lower detonator should point upwards and the upper detonator should point downwards. The in-hole detonators are initiated by SHOCKSTAR SURFACE. The initiation of explosive in this fashion brings the most effective consumption of energy released during explosion.

The detonation velocity of the shock-tube impulse is 2000 m/s. The shock-tube then presents a delay of 0.5 ms/m of tube. The delay caused by shock-tube therefore needs to be taken into consideration when designing the blasting patterns. Where detonators of identical nominal delay time in drill hole are used, the explosive in the drill hole is initiated from the top causing less effective consumption of energy released during explosion.

**PRECAUTIONS**

- The detonator bottom must be directed towards the longer part of explosive charge column.
- All in-hole priming assemblies (detonator + primer) should have identical orientation.
- When designing a blast pattern, a shock tube added delay time of 1 ms / 2 meters must be taken into consideration.
- With drill holes longer than 10 m, two priming assemblies should always be used. If the drill hole is shorter than 10 m, only one priming assembly may be used provided the drill hole walls are smooth and the risk of interruption of explosive column during charging is eliminated.
- The minimal length of the shock tube coming out of priming assembly and out of the drill hole is 0.6 m.
- Make sure that connector-to-connector distances are identical in all connections.
- Do not cut short the shock tube. Water or humidity may make the shock tube non-functional. Only cut the shock tube immediately prior the blast for testing the blasting machine and for the blast itself.
Notes on designing blasting patterns

Gradual initiation of blastholes

Very frequently, the blast pattern is designed such that rows are initiated from one side as shown in figure 4-9. This method brings time savings during connecting the blast pattern. The method has disadvantage however. If initiation is stopped in a row, the entire initiation process is not stopped but continues. Problem which result from an undetonated row in an otherwise finished blast could be costly.

Austin Detonator, on the other hand, recommends to design the blasting pattern in such a way, that if in one element, the initiation is stopped, entire initiation process is stopped and only properly initiated holes blast. This method is shown in figure 4-10 and is considered by blasters as an important preventive measure which could be taken to avoid problems with removing misfires.

Coupled initiation blasting pattern

Another means of ensuring a successful blast is a blasting pattern is using initiation of a blast hole from two sources of initiation (two connectors). This blasting pattern can be used when two detonators are used in a hole. The initiation impulse is brought to the hole from two sources, bringing extra ensuring feature to blasting operations.

The bench blasting examples

Three-row one-side-initiated bench blast

Fig. 4-10 - the initiation point is marked as START. All drill holes are charged with detonators of identical nominal delay time. SHOCKSTAR SURFACE provide individual drill hole timing. The diagram shows a pattern with delay times of 25 ms between holes in the first row and last two holes in the second and third row. The delay time between rows is 42 ms. The numbers inside the circles show the firing time of the SHOCKSTAR SURFACE in a given drill hole. The value is a sum of SHOCKSTAR SURFACE nominal delay and delays preceding the given point of initiation. The explosive charge in the drill hole is initiated 475 ms after the arrival of initiation impulse. Arrows indicate the direction of detonator connections and the detonation wave travel direction. The diagram also shows the direction of rock movement.
PRECAUTION

- Detonator connections should be made only in one direction, i.e., either from the first or the last delay in sequence.
- The connector is designed to reliably initiate up to 8 shock tubes.
- It is highly recommended that the shock-tubes between drill holes are not subject to mechanical stress (tension).
- A minimum of 0.6 m of additional shock-tube per detonator should be included when considering the required length of shock tube.
- After all drill holes are connected, a careful visual inspection of all connections must be made. After the inspection, no one should be allowed to enter the blast area.

The system can be initiated by special blasting machines SUREFIRE and MICKO 1 (fig. 4-18 and 4-19). It is also possible to use an electric detonator or fuse cap fastened to shock tube by a tape. The bottom of the initiating detonator must point in the direction of the blast pattern initiation.

Three-row one-side-initiated bench blast including snake holes

Fig. 4-12 - A situation similar to Fig. 4-10 but with snake holes connected using SHOCKSTAR SURFACE 42 ms, 34m shock tube length. The delay between holes in the first row is 17 ms, the delay between rows is 25 ms. The snake holes are initiated by
Instruction for removal of misfires

The procedure for removal of misfires is the same as with other types of initiations. The difference using INDETSHOCK/SHOCKSTAR non-electric initiation system is that it is possible to easily identify whether an initiation impulse passed through the misfired detonator. Simply cut off 20-30 cm of the shock-tube. Place the shock-tube vertically against a pad and blow through the shock tube. If there was no initiation impulse passing through the shock tube, you will see a white powdery explosive charge coming out of the shock tube onto the pad. When cutting off the shock-tube, use only knife. Never cut the shock-tube by scissors!

Three-row center-initiated bench blast including snake holes

Fig. 4-13 - The picture shows the same blasting pattern as in figure 4-12 except that the initiation start is in the center of the first row and the delays between holes in the first row are a combination of 17 and 42 ms. The delays between snake holes are a combination of 9, 17, 25 and 42 ms. Rock movement is to the center of the field.

Central-initiated pull shot

Fig. 4-14 - This pattern is one of many which are possible for this type of blasting operation. The system is initiated gradually from the center of the pattern. The precautions and instruction valid for blasts in Figures 4-6 and 4-10 should be applied also for this blast. The initiation pattern should be connected from the center of the field - nominal delay 0 ms. The rock movement in this case is limited only to pile up and raise.

Using SHOCKSTAR detonators in underground blasting applications

The advantage brought by non-electric initiation system INDETSHOCK/SHOCKSTAR can be conveniently used for tunneling and underground blasting as well. For these applications INDETSHOCK TS has been especially designed. Normally, the detonator is inserted into a booster or an explosive charge to form a primer for the hole.

The detonator bottom should always point towards the longer part of the explosive charge column to ensure efficient initiation. The tubes coming out of the holes are bound together in bunches. A bunch can be made of maximum of 20 tubes. Each bunch should be securely taped with electrical tape at two points 30 cm apart (see fig. 4-7). Each bunch of tubes, the section enclosed by electrical tapes, is then fed through a BUNCH CONNECTOR. In this way, all the tubes are connected.
shock-tubes in a blast are assembled into bunches and connected to BUNCH CONNECTORS. The number of BUNCH CONNECTORS is determined by the number of holes to be fired. The shock-tubes coming out of the detonators in holes are connected to SHOCKSTAR SURFACE, 0 ms (start-line) or BUNCH CONNECTOR, depending on the number of shock-tubes. As shown in figure 4-15, there are 65 charged drillholes. Shock-tubes coming out of the detonators inside the holes, are fed into 4 BUNCH CONNECTOR units. The tubes coming out of the 4 BUNCH CONNECTOR units are connected into a SHOCKSTAR SURFACE (start-line) of required shock-tube length.

Application of INDETSHOCK/SHOCKSTAR detonators for demolition operations

The advantage brought by non-electric initiation system INDETSHOCK / SHOCKSTAR can be conveniently used for demolition operations, especially in environments where foreign sources of electricity (stray currents, radio frequency, or electrostatic energy) may be present and use of electric detonators would present a hazard.

A very advantageous solution is a combination of detonating cord and non-electric detonator fitted with a T-connector. T-connector (”J” hook) provides a quick and reliable connection to detonating cord for initiation of detonators. The detonating cord itself is then initiated by a regular electric detonator. One of the advantages of using detonating cord/T-connector combination is easy and fast connecting resulting in increased safety of the whole blast work.

Initiation of non-electric system

The shock-tube of nonelectric detonators can be initiated by means of a regular electric detonator attached to the tube by a tape, or by means of a spark blasting machine SUREFIRE, or by means of blasting machine MICKO 1.

Fig. 4-16 Demolition of concrete beds

Fig. 4-17 Initiation by means of an electric detonator. Ensure that the detonator bottom is pointing in the direction opposite to the Startline signal propagation and opposite to the initiation network area.

Fig. 4-18 MICKO - 1, blasting machine for initiation of electric and nonelectric detonators

Fig. 4-19: Blasting machine SUREFIRE
Removal of nonelectric initiation system remains after use

Non-active (fired) remains of shock-tubes are collected in a designated area and handed over to companies licensed for removal of industrial waste, catalogue No. 15 01 02, category O (plastic packages). Metal parts of detonators (shrapnels) are collected in a designated area and handed over to companies licensed for use of industrial waste, catalogue No. 17 04 07, category O (various metals).

5. PACKAGE, STORAGE AND ORDERING

Packaging

Assembled non-electric detonators are packed into fibreboard cartons. Inside the cartons the detonators are packed in vacuum-sealed plastic bags. The quantity per carton is determined by the shock-tube length (see packaging in Austin Detonator Product Literature CD). The cartons are tested and certified and are in strict conformity with the International Agreement of Road, Train, Sea and Air Transport (ADR, RID, IMDG, IATA). The cartons and are marked with the appropriate ® code.
Shelf life and storage conditions

a) For nonelectric detonators packed in original unopened aluminum foil bags, the shelf life is 2 years, if stored in temperatures between -30 and +40°C. After opening the foil bag, the detonators must be used within 3 months.

b) For nonelectric detonators packed in original unopened plastic bags, the shelf life is 2 years if stored in temperatures between -30 and +40°C and relative humidity not exceeding 65%. After opening the plastic bag, the detonators must be used within 3 months.

c) For nonelectric detonators packed in paper boxes without aluminum foil bags, the shelf life is 3 months.

The storage place should be clean, well ventilated, dry, protected from fire, and securely locked when not in use.

Storage and transportation classification

The detonators are classified for transport as follows:

**Standard packaging**

**1.1B, UN 0360**

INDETSHOCK MS 25/50, INDETSHOCK TS, SHOCKSTAR DUAL DELAY, SHOCKSTAR BUNCH CONNECTOR (with detonating cord)

**1.4S, UN 0500**

SHOCKSTAR SURFACE, SHOCKSTAR BUNCH CONNECTOR (without detonating cord)

**Special packaging** (at special request)

**1.4S UN 0500; 1.4B, UN 0361**

Available for all products except SHOCKSTAR SURFACE and SHOCKSTAR BUNCH CONNECTOR (without detonating cord)

This classification also relates to transportation regulations as per RID, ADR, ADN and IATA DGR.

The detonators should not be subject to temperatures higher than 50°C and should be protected from direct sunlight.

**AVAILABLE SHOCK TUBE LENGTHS**

### Loop configuration

All detonators except DUAL DELAY:

- 3 - 10,2 m - step of 0,6 m
- 12 m and more - step of 3 m
- DUAL DELAY:
  - 6 m and more - step of 3 m

### Spool configuration

- 30 m and more - step of 3 m

Placing orders

An example of an order:

<table>
<thead>
<tr>
<th>Type/nominal delay time</th>
<th>Shock-tube length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDETSHOCK MS 25/50</td>
<td>3,6 m</td>
</tr>
<tr>
<td>DUAL DELAY</td>
<td>18 m</td>
</tr>
<tr>
<td>INDETSHOCK TS TS 300</td>
<td>4,8 m</td>
</tr>
<tr>
<td>SHOCKSTAR SURFACE</td>
<td>4,8 m</td>
</tr>
<tr>
<td>SHOCKSTAR BUNCH CONNECTOR</td>
<td>4,8 m</td>
</tr>
<tr>
<td>SHOCKSTAR DUAL DELAY</td>
<td>17-475 ms/18 m</td>
</tr>
</tbody>
</table>

**AVALIABLE SHOCK TUBE LENGTHS**

### Loop configuration

All detonators except DUAL DELAY:

- 3 - 10,2 m - step of 0,6 m
- 12 m and more - step of 3 m
- DUAL DELAY:
  - 6 m and more - step of 3 m

### Spool configuration

- 30 m and more - step of 3 m
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