

technical solutions to tactical problems

Layer  Services

ExploSim

Instruction Manual



www.layer3services.net.au

Disclaimer

Because the ExploSim® system uses radio frequency to indicate the effects of an explosion it is not an exact replication of those effects. The ExploSim system is not presented as a detailed blast modelling analysis tool. Rather, it is a system that provides an indication of injury and damage over distance, in a safe manner. It is stressed that ExploSim is not intended or designed to indicate minimum safe evacuation distances from potential explosive effects. It is important to note the calculated results are generic in nature. Layer 3 Services cannot be held responsible for any mishap or accident resulting from decisions drawn from use of this system. By continuing to use this equipment you understand and acknowledge the conditions of use.

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Note: This Instruction Manual will be updated. The latest versions of the Instruction Manual and Quick Start Guide are available from: services@layer3services.net.au/products/explosim

Layer 3 Services Pty Ltd
Canberra
Australian Capital Territory
www.layer3services.net.au
services@layer3services.net.au

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ExploSim Instruction Manual

Real-world, real-time emulation of explosive effects.

INTRODUCTION

Purpose

ExploSim®, developed by Layer 3 Services, uses electromagnetic, radio-frequency energy to provide a safe method of emulating explosive blast and fragmentation effects. The system demonstrates the distances at which injury and structural damage occurs without causing those effects. The indication of explosive effects in a 'real time' and 'real world' environment enhances training, operational planning, emergency procedures and practices, blast assessments and hence safety.

The radio frequency used offers similarities to blast in that it penetrates thin materials and is reflected from hard surfaces.

The system can be used wherever Wi-Fi devices are permitted.

The ExploSim system cannot be used as a firing system.

Important Information:

- Important information is highlighted in coloured text boxes.

Internal references within these Instructions:

- Text in *italics and underlined* are internal links within the electronic version of these instructions.

Overview

The system consists of a *The Transmitter Case* and a set of *The Receiver Case*. Using the transmitter unit's screen and keypad, users select:

- the system operating mode, either:
 - '*Bomb Technician Mode*' used to train bomb technicians, search and assault teams and which uses the external firing connectors; or
 - '*Blast Assessment Mode*' used to indicate blast effects by engineers, Security Managers, Emergency Managers, Safety Officers and others and which uses the built-in countdown timer.
- an explosive from a list of 25 commercial, military and home-made explosives;
- an amount of explosive between 0.1 and 20,000 kg (~ 2 to 44,000 pounds); or
- one of nine pre-defined IEDs.

The receiver units are issued to participants or placed around the site.

When the transmitter is triggered, the receivers indicate the type of damage expected via coloured LEDs

The process for using the ExploSim system is:

1. Plan the scenarios, see *Planning Scenarios*.
2. Position the transmitter at the location of the proposed 'explosion'.
3. Select the appropriate mode, see *Annex 1 Modes*.
4. Select the type and quantity of explosives, see *Selection of Explosives*.
5. Issue the receivers to participants or place them where required; receivers should be kept vertical for best reception.
6. Trigger the transmitter.
7. Note the results on the receivers.
8. Reset for next scenario, see *Receiver Reset*, or close down the system.

Indication of Explosive Damage

When the 'explosion' is triggered, using an external switch or the in-built timer, the transmitter unit sends the signal representing the type and quantity of explosive to the receivers. Each receiver determines if it is in the range that equates to: blast lethality, blast injury and severe structural damage, fragment injury or if the receiver was outside the expected damage range.

Positioning:

- For best results, the transmitter and receivers should be located at least one meter (3 feet) above the floor/ground.

The LEDs on the receivers indicate, for the distance from the selected type and quantity of explosive:

- Red LED: indicates lethal blast pressure being a minimum of 207 kPa (~30 psi) as the threshold damage level of lung damage;
- Orange LED: indicates injury from the blast being a minimum of 34 kPa (~5 psi) as the threshold damage for ear damage;
- Orange LED: indicates significant structural damage to the immediate area with a reflected pressure of greater than 70 kPa (>10 psi); any receiver with the Red or Orange LED illuminated indicates severe structural damage;
- Blue LED: indicates the probability of a fragmentation impact of greater than 79 Joules. The fragmentation indication can be turned on or off via the menu option at 5 Other Settings; and,
- Green LED: flashing approximately every 5 seconds, the receiver is operating and awaiting a signal from a transmitter or if solid green then a signal was received but the receiver is outside the expected damage range.



Figure 1 Indicative depiction of distances from the Transmitter

Structural Damage Indication:

- While the RF signal will pass through thin materials it will not pass through thick walls, floors or ceilings.
- For indication of structural damage, receivers should be placed on the side of the wall facing the transmitter in a vertical position. A Red or Orange LED indicates significant failure of the structure near the receiver.

The indications at the receiver show the effects at the actual distance from the transmitter as influenced by the real-world built and natural environments. The calculated distances are shown on the transmitter Home Page.

The information of each 'explosion' is stored in the transmitter for immediate viewing on the transmitter or later downloading and review by the exercise controller.

The basis of the calculations is provided in Annex 3 Explosive Calculations and Assumptions.

PLANNING SCENARIOS

ExploSim enables emulation of explosive effects for a range of scenarios. Prior planning gains the best results for the organisation. The *ExploSim Companion App*, available from the Apple APP Store, can be used to assist with planning, see *Annex 6 Companion App*.

Scenario planning may consider:

- The purpose of the scenario, for example:
 - to test the organisation’s emergency procedures in relation to ‘unidentified items’, bomb threats and related incidents;
 - to determine effects should a bomb explode at a particular location;
 - to test organisational search procedures;
 - to inform and validate protective security and safety designs;
 - to inform protective construction designs;
 - to instruct participants in the properties of energetic materials;
 - for government agencies:
 - to test the effectiveness of a particular bomb disposal technique;
 - to validate high-risk search procedures and practices;
 - to validate stand-off distances for breaching charges used by assault teams; and,
 - to evaluate safe distances for responding emergency service vehicles.
 - to validate safe distances for incident managers and commanders.
- Selection of the most appropriate ‘mode’ for the scenario.
- Selection of a feasible location(s) where an explosive device may be placed, i.e. where the transmitter will be placed.
- Selection of a feasible type and quantity of explosives that could be placed in the identified location.
- The means of triggering the transmitter which is related to the selected mode.
- The proximity of critical assets and functions.
- Participants for the scenario.
- The distribution of the receivers.
- How the results will be used to improve policies, procedures, practices or physical security.

Menu Selections:

Menu selections are made using the keypad. The four coloured keys (blue, yellow, red and green) are used to select menu options. Each screen indicates what function is actioned by the coloured keys.

MODES

ExploSim provides two Modes, see [Annex 1 Modes](#):

- The 'Bomb Technician' mode is used for training Improvised Explosive Device Disposal and Explosive Ordnance Disposal (IEDD and EOD) technicians, their commanders and support teams. When using the Bomb Technician mode, the transmitter can be wired to a training IED, training EO or the provided manual firing button. The transmitter has external connectors that can be connected to a 'voltage-free, normally-open' switch i.e. not powered and activate on being closed. If the switch within the training device closes due to mis-handling, timer rundown, incomplete render-safe technique or manual detonation, the transmitter will transmit the signal appropriate to the selected type and quantity of explosive.
- The 'Bomb Technician' mode is also used to train search and assault teams where multiple explosive devices/booby traps or breaching charges may be encountered. All receivers within range of a triggered transmitter will indicate. If a receiver receives a stronger signal from another transmitter, it will indicate the greater damage. For example: if having received a signal that requires the receiver to illuminate the Orange LED and the receiver then receives a signal requiring the Red LED to illuminate it will do so. A receiver will not downgrade the indication from Red to Orange.
- The 'Blast Assessment' mode is used to assist Security, Emergency and Safety managers, consultants, structural, façade and explosives engineers and others with a responsibility for protecting life and property from explosive incidents. This mode is also used by first responders and their commanders. The Blast Assessment mode can be used to practice bomb threat evaluation, site search, evacuation and other bomb incident response procedures and to validate protective security measures. This mode, uses the built-in countdown timer which may be set between zero seconds and 12 hours.

Number of Transmitters and Receivers:

- Any number of transmitters and receivers can be deployed within a training scenario.
- Any Receiver will respond to a signal from any transmitter.

SELECTION OF EXPLOSIVES

The 'Explosives' menu is selected by the yellow key from the Home page.

ExploSim offers a choice of 25 explosives with weight range from 100 grams to 20,000 kilograms (~0.2 to 44,000 pounds) and nine predefined IEDs. The explosives are divided into 'Common' and 'Military'. 'Common' does not necessarily relate to availability rather that they are commercial, industrial, laboratory or home-made explosives.

The explosives are:

Common	Military
TNT	C4 / PE4
ANFO	SEMTEX
PETN or Penthrite	RDX
Pentolite	HMX
Blasting AN/Water gel	PBX
Dynamite	Tritonal
Gelignite	Composition B
Ammonium Nitrate	Tetryl
Picric Acid	Octol
TATP	
HMTD	
Black Powder	
Nitrocellulose	
Guncotton	
AMATOL	
Nitro-glycerine	

Once the type of explosive is selected by pushing the related number key the user is required to enter the quantity. The '*' key can be used to enter a decimal place and the '#' key to clear the value.

When selecting the amount of an explosive, consider that for most people 5 kg (11 lb) can be carried in an out-stretched arm, 10 kg (22 lb) can be comfortably carried by the side of the body and 20 kg (44 lb) is a two-hand carry. Heavier than 20 kg is usually on wheels. For larger explosive weights such as those expected in vehicle bombs consideration should be given to what is a feasible quantity given the anticipated threat.

The nine predefined IEDs are:

Number	IED	Explosive Quantity (TNT)	
1	Pipe bomb	1.5 kg	3.3 pounds
2	Briefcase	5 kg	11 pounds
3	Medium bag	10 kg	22 pounds
4	Airline luggage	23 kg	50 pounds
5	Suicide vest	10 kg	22 pounds
6	Small car bomb	100 kg	220 pounds
7	Large car bomb	1,000 kg	2,205 pounds
8	Delivery van bomb	5,000 kg	11,023 pounds
9	Truck bomb	15,000 kg	33,070 pounds

The relative effects of the explosives are based on their 'TNT equivalency' which is drawn from a range of references. It is recognised that for 'home-made explosives' such as TATP and HMTD the equivalency factor will be a rough approximation.

Changing between Metric and US/Imperial units of measure:

- Change between Metric and US/Imperial measurements via *Settings/ 5 Other Settings/3. Measurement Unit*

THE EXPLOSIM SYSTEM COMPONENTS

The ExploSim system consists of a transmitter, six receivers and ancillary equipment. Additional sets of receivers can be obtained from Layer 3 Services.

The Transmitter Case

The transmitter case consists of the following elements:

- Hard outer case with automatic pressure equalisation.
- Removable antenna.
- Cover for antenna connection.
- Anderson connection.
- The transmitter module complete with display screen.

The transmitter case is 360 x 300 x 150 mm weight 7.5 kg (~14 x 12 x 6 inches 16.5 pounds).

The transmitter case contains a 12V 7.2Ah (86.4Wh) Sealed Lead Acid (SLA) battery, UN Dangerous Goods number 2800.

The elements of the transmitter module are shown in Figure 2 and described below.

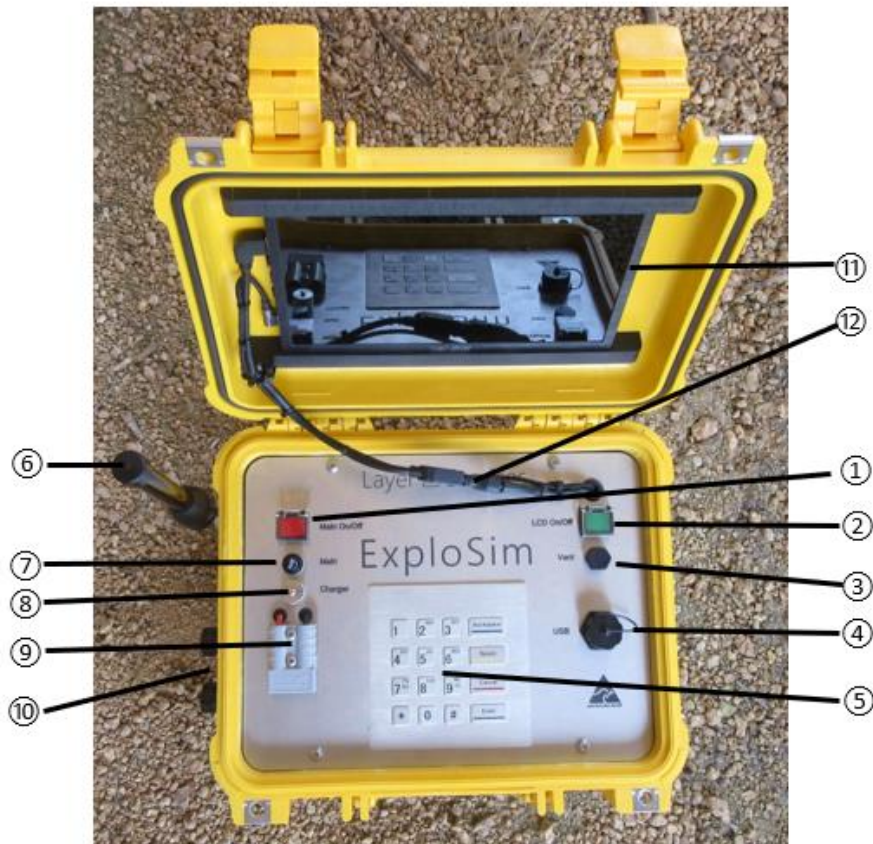


Figure 2 Transmitter Layout

1. Master On/Off switch (red) used to power up the system and to safely shut down the system. Push once to operate, the switch will illuminate. The Master switch will automatically turn the screen on.
2. Video (LCD) screen switch (green) used to turn the screen off if the lid is going to be closed during the scenario or to extend the battery life. An External Auxiliary Battery can be obtained from Layer 3 Services to approximately double the operating time of the transmitter.
3. An internal vent to equalise environmental pressure between the lower case and the upper (lid compartment) when the case is closed. No action required by the user.
4. USB port used to transfer incident history to a USB device for review by exercise controllers and others. The USB port is also used to update software provided by Layer 3 Services.
5. Keypad used to access options via colour coded buttons and for entering menu selections.
6. Antenna in mounted position. The connector cover can be stored on the fuse holder (8). The antenna is stored inside the case for transport.
7. Fuse for Master switch. Removing this fuse will initiate a hard shutdown. The fuse is rated at 7.5A fast-blow.
8. Fuse for Anderson connector (note metal cover for external antenna connector stored on fuse cover). The fuse is rated at 7.5A fast-blow.
9. Anderson connector used to charge the built-in battery and to attach an additional battery.
10. External firing input connectors. Used to connect the supplied firing button or a firing switch from the training improvised explosive device, explosive ordnance or booby trap. Any external device connected to this interface must be voltage-free with normally-open contacts.
11. Video screen, showing menu options and data.
12. Video connections. These HDMI connectors can be used to project the menus to external screens for training purposes.

Important note for external firing input connectors:

- The ExploSim internal relay is in the “Normally Open” position and activates when the external trigger closes.
- Connection to the ExploSim by an external trigger must be voltage-free and have normally-open contacts
- If a pyrotechnic, buzzer, squib or other indication of detonation is used, it must be wired separately to the ExploSim transmitter.

The Receiver Case

The receiver case consists of the following separate parts:

- Hard outer case.
- Six receivers.
- Inbuilt receiver battery charging circuitry.
- Anderson connection.
- Receiver battery charge indicators.
- Victron battery charger fitted with Anderson Plug.
- Manual firing button, for connection to external firing connectors on transmitter.
- A universal wall plug adaptor.
- A USB device with Instructions and other information.
- Quick start Guide.

The Receiver Charge Case is 420 x 340 x 180 mm Weight 6.75 kg (~16.5 x 13.4 x 7 inches 14.3 pounds).

The case contains six receivers each with a 3.7V 2.2Ah (8.14Wh) Lithium Polymer battery with a total of 48.84Wh (total <100 Wh), UN Dangerous Goods number 3481.

The elements of the receiver case are shown in Figure 3 and described below.

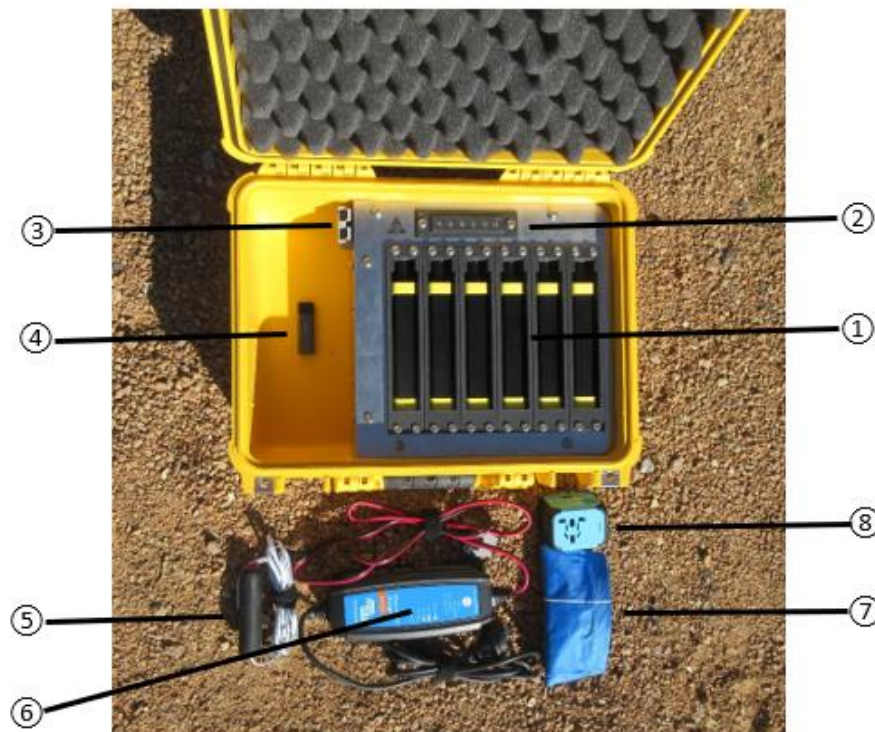


Figure 3 Transmitter Box Layout

1. Six receivers which are stored and transported in the re-charging cradles. Additional sets of receivers can be obtained from Layer 3 Services.
2. Receiver battery charging indicator lights.
3. Anderson connector used to connect battery charger to in-built charging system.
4. USB storage device with Instruction Manual and other information.
5. Manual firing button, for connection to the transmitter.
6. Battery charger for recharging transmitter and receiver batteries (110VAC or 220VAC version provided as specified by the purchaser).
7. Waterproof storage bag.
8. Universal wall plug adaptor.

The ExploSim Quick Start Guide is stored in the Receiver Charge Case.

Number of Transmitters and Receivers:

- Any number of transmitters and receivers can be deployed within a training scenario.
- A receiver will respond to a signal from any transmitter.

The ExploSim system is supplied with a Victron battery charger. See the battery charging instructions at [Battery Charging](#) and [Annex 5 VICTRON Battery Charger](#).

VictronConnect Application:

- The Victron system requires the 'VictronConnect' application available free of charge from the Apple Store and, for Android systems, from the Google Play store.

SETTING UP THE EXPLOSIM SYSTEM

Time Settings

When using ExploSim for the first time it is necessary to set the local time. This is done via the '[2 Time Settings](#)' menu. The time can be selected by choosing the continent and the closest listed city or through manual setting.

Metric or US/Imperial Units

The user can select Metric or US/Imperial units via the [5 Other Settings](#) menu.

Transmitter Preparation

To prepare the transmitter for use:

- Open the case.
- Attach the antenna to the connector on the side of the box. The metal protective cover can be placed over one of the fuse holders for safekeeping.
- If using 'Bomb Technician' mode, connect an external switch and or the provided manual firing button to the external connectors.

Important note for external firing input connectors:

- The ExploSim internal relay is in the "Normally Open" position and activates when the external trigger closes.
 - Connection to the ExploSim by an external trigger must be voltage-free and have normally-open contacts
 - If a pyrotechnic, buzzer, squib or other indication of detonation is used it must be wired separately to the ExploSim transmitter.
- If using the Blast Assessment mode, the internal countdown timer is used.
 - Push the Master switch (red light) to turn on ExploSim, this will automatically turn on the screen, this may take a few seconds as the system initialises. The transmitter will go through the boot-up process, this can take a few minutes. If required, turn the screen on by pushing the green light switch. The [Home Page](#) will appear.
 - Check battery life on the [Home Page](#), recharge if required.
 - Selection of mode, type and quantity of explosives and other variables using the menus, see [Annex 2 Menus](#).

Fit antenna:

- The antenna must always be fitted when a signal is being transmitted.

Delay between detonations:

- When a detonation is triggered using either the built-in timer or the external connectors another detonation cannot be triggered for 30 seconds. This is indicated by a green bar which appears at the top of the Home page.

Each transmitter has a unique Media Access Control (MAC) address which is used to identify the transmitter. Each transmitter's MAC address is accessible via Settings (blue key)/7. System /2. Software Versions/Serial Number.

The transmitter has an approximate battery life of 6 hours, or 12 hours if the video screen is turned off.

External Auxiliary Battery

A 12V 7.2Ah (86.4Wh) external auxiliary SLA battery in carry case (available from Layer 3 Services) can be used to extend the battery life of the transmitter to approximately double the operating time. If the external auxiliary battery is used, the additional 7.2Ah battery capacity is entered via the 4 Battery Management menu and the total battery capacity is displayed on the Battery Management page with the battery life updated on the Home page.

Transmitter Closedown

To close down the transmitter:

- Push the red light button to release it. This will initiate a safe 'soft' shut down of the system including turning off the screen, this may take some seconds. A hard shut down can be initiated by removing and replacing the 'Main' fuse.
- Remove any devices from the external connections.
- Remove the antenna and replace the protective cap. Place the antenna in the storage location.
- Clean, close and seal the case.

Receiver Preparation

To prepare the receiver units:

- Remove receivers from the Charging Case by pushing back and lifting up the receiver antenna.

Receiver removal and insertion:

- To avoid damage to charger pins care should be taken when removing and inserting the receivers from their charging slots.

- Turn on each receiver by pushing the rubber button on the bottom of the receiver, a red light will illuminate within the rubber button. The LEDs on the top of the receiver will illuminate in sequence as the receiver initiates its systems. The Green LED on top of the receiver will flash approximately every 5 seconds once the receiver is operating and waiting for a signal from a transmitter.
- Receivers are issued to people or placed around the site. When the transmitter sends the signal representing the explosion each receiver determines if it is in the range that equates to: blast lethality, injury, structural damage or fragment injury.
- The receivers should not be placed directly behind metal items which may disrupt or block the signal from the transmitter.
- The receivers should be kept vertical to improve reception as the transmitter's antenna has a vertical (vertical E-Field) orientation.

Each receiver has a unique Media Access Control (MAC) address which is shown on the receiver case. The MAC address can be used to record which participants were issued with which receiver.

Proximity of Receivers:

- Receivers should not be deployed closer than 500mm (~20 inches) to each other.
- Receivers closer than 500mm can influence each other thereby affecting the accuracy of both receivers.

Positioning:

- For best results, the transmitter and receivers should be located at least one meter (3 feet) above the floor/ground.

The receiver has an approximate battery life of 48 hours in the quiescent state.

Receiver Reset

After each scenario the receivers need to be reset so they are ready to receive the next signal from the transmitter.

The receiver can be reset:

- By turning the receiver off using the rubber button on the bottom of the receiver, the red light in the rubber button will turn off as will the green LED on the top of the receiver. Wait for five seconds and then turn the receiver back on.
- Via Settings/3 Clear Receiver LEDs menu option and confirming the reset.

- Once reset the receiver Green LED will return to flashing approximately every five seconds.

Receiver Closedown

To shut down the receiver, push the rubber button on the bottom of the receiver, the red light in the rubber button will turn off as will the green LED on the top of the receiver.

Place the receivers in the Charging Case. The receivers cannot be inserted incorrectly as the receiver antenna will only seat if correctly orientated.

Ensure the accessories are correctly stored in the Charging Case.

Clean, close and seal the Charging Case.



Figure 4 Receiver Top View

MENU SELECTIONS

ExploSim uses menus to guide the user through selection of required mode, type and quantity of explosives and other options. See: [Annex 2 Menus](#).

Menu selections are made using the keypad. The four coloured keys (blue, yellow, red and green) are used to select menu options. Each screen indicates what each coloured key will do, this varies depending on the page being viewed.

Menu Selection Notes:

- The colour codes on the key are be used to navigate through the menus rather than the words on the keys.
- The '#' key is used to advance a page where multiple pages are shown.
- The '*' key is used to return to a page where multiple pages are shown.
- The '*' key is used as the decimal point when quantities are being selected.
- The '#' key on selective pages is used to clear the entry.

Home Page

The [Home Page](#) shows:

- The selected mode: 'Bomb Technician' or 'Blast Assessment'.
- [2 Time](#) Settings and date.
- Remaining battery life in hours and minutes with the video screen turned on and with the screen turned off.
- The time countdown clock, used in the [Blast Assessment](#) mode.
- The type and amount of [Explosives](#) Menu selected.
- The calculated blast lethality distance for the selected type and amount of explosive.
- The calculated blast injury distance for the selected type and amount of explosive.
- Whether fragmentation injury indication is On or Off, the default is 'On'.

Menu selections from the home page are:

- In 'Blast Assessment' mode, the 'Detonate' (green key), activates the countdown timer. Once pushed, the 'Abort' (red key) becomes available. The 'Abort' key is used to stop the scenario before the countdown is completed.
- 'Explosives', used to select the type and amount of explosives (yellow key).
- 'Settings', (blue key).

PROJECTING TO AN EXTERNAL SCREEN

ExploSim provides the ability to project the transmitter screen to an external screen. This is useful when conducting training or explaining scenarios to a group.

To project to an external screen:

- Disconnect the HDMI connector from the cable to the LCD screen (Figure 5)
- Connect a suitable HDMI cable from the transmitter LCD cable to the projector, using HDMI male-to-male or HDMI/USB adaptors if necessary.
- Ensure the green (LCD) button is on and illuminated.
- Note: the transmitter LCD screen is not visible when an external projector is connected.



Figure 5 HDMI connector

RECORDING AND DOWNLOAD OF SCENARIO HISTORY

For each scenario the transmitter records the selected type and quantity of explosive and the date/time of the event. The results can be accessed via Settings (blue) key and then the History Menu (red) key.

The results can be downloaded in Microsoft Excel format to a USB storage device via the History Menu.

BATTERY CHARGING

ExploSim is fitted with an intelligent battery management system.

Battery charging is done via the supplied Victron 12V/5A charger unit and attached via the fitted Anderson connectors. The ExploSim system will be provided with a 120V AC or 240V AC charger as ordered by the user. The ExploSim system contains a universal wall plug adaptor.

Detailed instructions for the Victron battery charger are at [Annex 5 VICTRON Battery Charger](#).

The Victron battery charger is rated to environmental protection level IP65.

The downloadable 'VictronConnect' app (for IOS or Android) provides visibility of charging progress via Bluetooth link to a phone or portable device.

VictronConnect Application:

- The Victron system requires the 'VictronConnect' application available free of charge from the Apple Store and, for Android systems, from the Google Play store.



Figure 6 Battery Charger (240 v version shown)

Charging the Transmitter Battery

Connect the Anderson connector on the battery charger to the one in the transmitter case.

Plug the battery charger into a wall socket using the fitted plug or the provided universal wall plug adaptor.

When charging the transmitter the Victron charger must be in 'Charge' mode, selected via the 'VictronConnect' downloadable app, see [Annex 5 VICTRON Battery Charger](#).

Once the 'VictronConnect' app has identified the charger:

- Select the charger by clicking on it or pressing it on a touch screen.
- Select the 'Settings' via the cog symbol in the top right corner.
- Select the 'Charger' menu.
- Select "Charger" to charge the transmitter.

The charger will initiate the charging cycle.

When the transmitter is charged, disconnect and remove the charger. The charge status can be monitored via the 'VictronConnect' downloadable app or if the charger indicates it is in 'Float' status.

The charger can remain connected to provide a storage charge cycle.

An optional external 12V 7.2Ah sealed lead acid (SLA) battery can be fitted if additional battery life is required. If an external battery is fitted the additional capacity in amp hours should be entered via the [4 Battery](#) Management menu so the total expected battery life can be displayed on the [Home](#) Page.

Charging the Receiver Batteries

Ensure receivers are firmly seated in the in-built charging station in the receiver Charger Case.

Connect the Anderson connector on the battery charger to the one on the receiver Charger Case.

Plug the battery charger into a wall socket using the fitted plug or the provided universal wall plug adaptor.

When charging the receivers, the Victron charger must be in “Charge” mode, selected via the ‘VictronConnect’ downloadable app as described above.

In the Charger Case indicator blue lights (LEDs) above the receiver charging cradles indicate:

- Flashing blue light means Victron charger connected but no receiver connected or receiver not inserted correctly,
- Constant blue light means receiver battery is charging;
- Blue light off means receiver battery is charged or Victron charger not connected.

When all receivers are charged, indicated by all LEDs being off, disconnect and remove the charger.

TECHNICAL

See [Annex 7 RF Technical Information](#) for additional technical detail.

Range

The range of the ExploSim system has been limited to ~250 m (~820 feet). This is appropriate for training scenarios and enables the system to remain a low-power transmitter.

Changing the WiFi Channel

The ExploSim system uses the international WiFi frequency of 2.4GHz. The ExploSim default channel within the WiFi band is channel 8. If other users are using channel 8 it may interfere with the ExploSim system. In operation ExploSim uses a single channel and will work on channel 7, 8 or 9. The Wi-Fi channel setting may be changed via Settings/5 Other Settings. The ExploSim system only operates on channels 7, 8 or 9. The other channel settings (1 to 6 and 10 to 13) have been reserved for future use.

Batteries

The transmitter uses a 12V 7.2Ah (86.4Wh) Sealed Lead Acid (SLA) battery (UN ICAO number: UN2800).

The transmitter has an approximate battery life of 6 hours, or 12 hours if the video screen is turned off. A 12V 7.2Ah (86.4Wh) external ancillary SLA battery, available from Layer 3 Services, can be connected via the Anderson connector to extend the battery life, see [4 Battery Management](#).

Each receiver uses a 3.7V 2.2Ah (8.14Wh) Lithium Polymer (LiPo) battery (UN ICAO number: UN3481).

The receiver has an approximate battery life of 48 hours in its quiescent state.

The total watt hours in each of the transmitter and receiver Case is less than 100Wh. Being less than 100Wh, the cases are suitable for carriage on aircraft under ICAO and IATA rules. Users should check with the individual carrier.

Dangerous Goods

The batteries are designed and fitted so they do not require Dangerous Goods Declarations for transport. Confirm with the carrier.

For the Transmitter, External and EAVI battery: "UN2800 Batteries, Wet, Non-spillable SP A67 applies. NOT-RESTRICTED. 1 @ 2.4 kg 12V 7.2Ah (86.4Wh)".

For the Receiver batteries: "UN 3481 Lithium Ion batteries. 6 @ 0.080 kg (total of 0.480 kg), 3.7V 2.2Ah 8.14Wh (total of 48.84Wh <100 Wh) in compliance with PI 967 Section II".

Additional information can be obtained from Layer 3 Services.

Safety

Safety is a critical element of the ExploSim design:

- ExploSim transmits at low power (~100 milliwatts) on the globally available Wi-Fi frequency of 2.4 GHz.
- The ExploSim system cannot be used as a firing system.
- The installed Sealed Lead Acid (SLA) and Lithium Polymer (LiPo) batteries are of a type approved for carriage on aircraft; UN2800 and UN3481 respectively. Users should confirm local requirements.
- The system can be used wherever Wi-Fi devices are permitted.
- The ExploSim Wi-Fi network(s) will co-exist with other Wi-Fi networks.
- The ExploSim external connectors are NOT designed to receive an electrical current. External trigger switches *must* be voltage-free and normally-open contacts.
- If a pyrotechnic, buzzer, squib or other indication of detonation is used it must be wired separately to the ExploSim transmitter.

Standards

The ExploSim system has been designed to meet the following standards:

- Transmitter Case Intrusion Protection (IP) 65. (Note: the LCD display and its connections are not IP rated).
- Receivers Intrusion Protection (IP) 65.
- Electromagnetic Interference (EMI),
- Electromagnetic Compatibility (EMC),
- Conformité Européenne (CE).
- Shock and vibration protection to 'ruggedized commercial'.

MAINTENANCE AND SUPPORT

See [Annex 4 Maintenance and Support](#) for details of maintenance, support, warranty and repairs.

EXPLOSIM COMPANION APP

ExploSim is supported by the '[Annex 6 Companion App](#)' which is a mobile application available for IOS (Apple) devices. The Companion App provides an additional planning tool, it is not required to operate the ExploSim system.

The Companion App provides an indication, based on the ExploSim methodology, of expected distances for blast lethality, blast injury and fragmentation injury for selected explosive types and amounts. This information can be used for scenario planning, for monitoring scenarios and during post-activity evaluations. The ExploSim system enables identification of the difference between the calculated results and the real-world results.

For simulated explosive ordnance disposal (EOD) scenarios, the companion application includes the ability for the operator to calculate demolition danger areas based on UN IATG 01.80 guidelines.

Details are at [Annex 6 Companion App](#)

ANNEX 1 MODES

Bomb Technician Mode

For Bomb Technicians i.e. IED Disposal (IEDD) and EO Disposal (EOD) operators, ExploSim is used to indicate the effects of the IED or Explosive Ordnance (EO) should it detonate. The distances and which blast and fragmentation injuries will be experienced can be used by the operators, incident commanders and support services to develop and validate policies, practices and procedures.

When using the 'Bomb Tech' mode the transmitter can be wired to a training IED or training EO. The transmitter has external connectors that operate as a 'normally open' switch. If the switch within the training device closes due to timer run down, handling, incomplete render-safe technique or user detonation, the transmitter will transmit the signal appropriate to the selected type and quantity of explosive.

The provided manual firing button can be connected to provide command 'detonation' by exercise staff.

Important Note:

- The ExploSim external input is expecting a "Normally Open" quiescent state and activates when the external trigger contacts become short-circuit (or closed).
- Connection to the ExploSim by an external trigger must be voltage-free and have normally-open contacts
- If a pyrotechnic, buzzer, squib or other indication of detonation is used it must be wired separately to the ExploSim transmitter.

Due to the transmitter's battery life of approximately 6 hours, the transmitter can be positioned well ahead of the exercise, 12 hours can be achieved if the transmitter screen is turned off. An external ancillary battery, available from Layer 3 Services, can be connected via the Anderson connector to extend the battery life.

If the render-safe procedure is successful the switch will not complete the firing circuit and the transmitter will not send the signal to the receivers.

The transmitter can be located a short distance from the training IED/EO so that it is not damaged during the render-safe procedure but close enough that the blast emulation is consistent with the location of the training device. The transmitter can be concealed to disguise the location of the training device as long as the antenna is not shielded.

Receivers can be issued to the IEDD and EOD operators, the support crews, incident commanders, expected media sites. Receivers can also be placed on critical equipment and assets, at the forward operating site and at the command site.

The results of each scenario, including which receivers recorded what level of injury, are recorded in the transmitter for later review.



Figure 1.1 ExploSim Transmitter connected to training IED

Effect of Bomb Suits or Other Protective Equipment.

When bomb suits or other protective equipment is worn, the readings will need to be adjusted. Depending on the type and effectiveness of the protective equipment, for the Orange LED representing (>34 kPa ~5 psi) it may be considered that blast injury has not occurred. If the Red LED indicates (>207 kPa ~30 psi) while the operator may not have suffered lethal injury, they would certainly be damaged, not least by being projected by the blast.

Search Teams and Assault Teams

The 'Bomb Technician' mode is used to train search and assault teams where multiple explosive devices/booby traps or breaching charges may be encountered. All receivers within range of a triggered transmitter will indicate. If a receiver receives a stronger signal from another transmitter it will indicate the greater damage. For example: if having received a signal that requires the receiver to illuminate the Orange LED and the receiver then receives a signal requiring the Red LED to illuminate it will do so. Note: a receiver will not downgrade the indication from Red to Orange.

Number of Transmitter and Receiver:

- Any number of transmitters and receivers can be deployed within a training scenario.
- Any Receiver will respond to a signal from any transmitter.

Blast Assessment Mode

The 'Blast Assessment' mode is designed to assist managers, consultants and engineers who offer advice in relation to blast and protection from Improvised explosive devices (IEDs), by providing the ability to 'see' the effects of different explosive attacks in a real-world, real-time environment.

This mode, using the built-in countdown timer, can be used to practice bomb threat evaluation, site search, un-attended item reporting and response and other bomb incident procedures and to validate protective measures.

The transmitter is positioned where an explosive device could be placed. The appropriate explosive type and charge weight are entered.

The receivers are issued to participants and positioned at critical points or areas of concern.

The transmitter may be triggered using the built-in countdown timer. The timer can be set from zero seconds to 12 hours.

For the manual triggering, the timer can be set to zero seconds and will activate when the Detonate key is pressed.

For example: the transmitter can be placed in an area where an IED could reasonably be positioned, a suitable explosive type and quantity entered and the timer set for (say two hours). A training bomb threat (clearly identified as a training exercise) is delivered and the ability for the organisation to assess the threat, conduct a search if considered necessary, evacuate staff before the timer counts down can be tested. This scenario assists organisations in determining their minimum decision-making times.

The receivers will indicate if the pressures required for injury or significant structural damage have been received. See: *Annex 3 Explosive Calculations and Assumptions*.

The ExploSim frequency will pass through thin walls and materials indicating damage to areas that are visually separated from the transmitter. The frequency will also reflect off hard surfaces and provide some indication of blast reflected around corners.

The 'Fragmentation' (Blue) LED, if the Fragmentation indication is turned on, will indicate where fragments can be expected to strike assets.

It is noted that ExploSim can only provide an indication of injury and physical damage.

ANNEX 2 MENUS

Home Page

The Home page consists of:

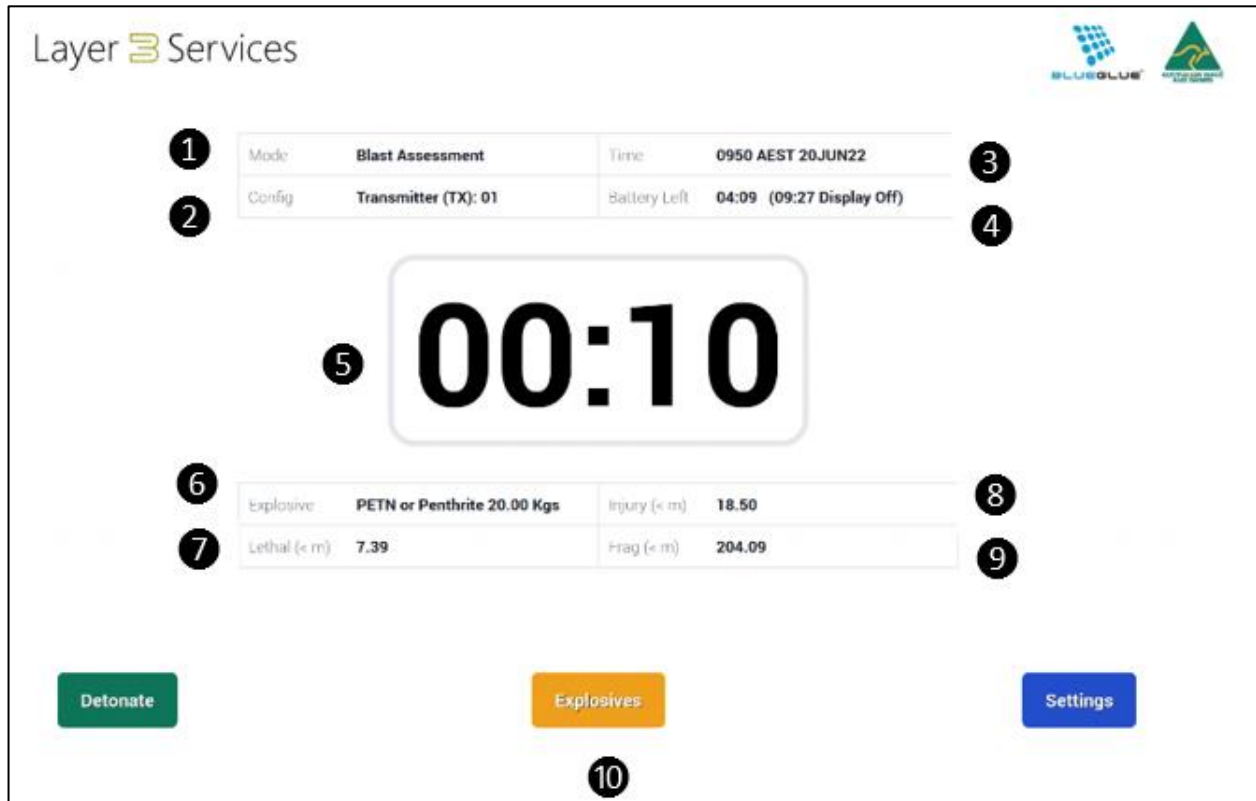


Figure 2.1 Home Page

1. Shows which 1 Modes Selection is active: Bomb Technician (external switch) or Blast Simulation (internal timer).
2. The allocated identification number for this transmitter see [Settings/5 Other Settings](#).
3. Local [2 Time Settings](#).
4. Remaining transmitter battery life and battery life with the display turned off, see [4 Battery Management](#).
5. Countdown timer, used in Blast Simulation mode, will start when 'Detonate' green button is pressed.
6. Type and quantity of [Explosives Menu](#) selected.
7. Calculated lethal blast distance for the selected type and quantity of explosive.
8. Calculated blast injury distance for the selected type and quantity of explosive.
9. Calculated fragmentation injury distance for the selected type and quantity of explosive.
10. Menu navigation bar '[Explosives Menu](#)' to choose an explosive, access to the 'Settings' menu, and 'Detonate' to begin the countdown in Blast Assessment mode.

Settings Menu

The menu options at the top of the page are: Home Page (blue key), Explosives Menu (yellow key) and History Menu (red key).

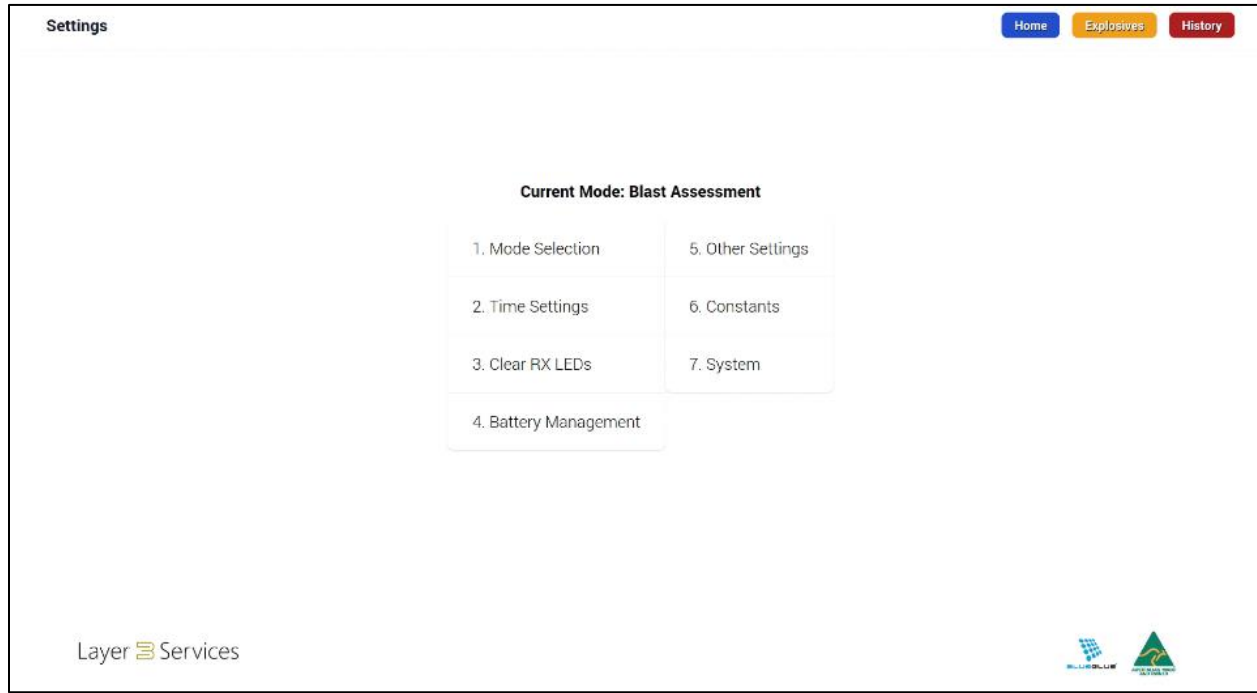


Figure 2.2 Settings Menu

Settings selections are:

1 Modes Selection

1. Bomb Technician (utilises the external firing connectors); or,
2. Blast Assessment (utilises the built-in countdown timer from zero seconds to 12 hours).

2 Time Settings

1. 'Closest City'. Select time by choosing the country and closest city by selecting the number next to the entry, use '#' to move to next page and '*' key to go back a page.
2. 'Set System Time'. Manually input local time and date using the keypad.

3 Clear Receiver LEDs

1. Resets all receivers in range. Successful reset indicated by the receiver's Green LED flashing.

4 Battery Management

1. 'External Battery capacity (Ah)'. If the external auxiliary battery (available from Layer 3 Services) is used to extend battery life, the battery's capacity in amp hours is entered here and the figure is added to the total battery capacity which is displayed on this page and the updated remaining battery life on the Home page.

2. 'Internal battery capacity (Ah)' shows the remaining battery capacity of the installed transmitter battery.
3. 'Total Battery Capacity (Ah)' shows the total of the internal and any external battery.
4. 'Battery remaining with display (hh:mm)' shows calculated time remaining for the transmitter. This figure is shown on the Home page.
5. 'Battery remaining without display (hh:mm)' shows calculated time remaining for the transmitter if the display is turned off via the green lit button. This figure is shown on the Home page.
6. 'Battery preservation shutoff (volts)' shows the voltage at which the transmitter will automatically shut down.

5 Other Settings

1. 'Include Fragmentation calculations'. Turn on or off fragmentation calculations depending on construction of training IED or EO. The default is 'On'.
2. 'WiFi channel (1-13)' shows which channel within the 2.4 GHz frequency is being used. If necessary the channel can be altered to 7, 8 or 9.
3. 'Transmitter ID (1-99)', used to allocate a unique identification number to the transmitter. Used where multiple transmitters are deployed, each transmitter must have a unique ID number between 1 and 99.
4. 'Weight Measurement Unit'. Select between Metric and US/Imperial, kilograms/pounds.
5. 'Distance Measurement Unit'. Select between Metric and US/Imperial, meters/feet.

6 Constants

Lists the constants used in the blast calculations.

7 System

1. 'Restart' restarts the system
2. 'Software Versions' shows the current versions of the software installed on the ExploSim system. Also shows the unique MAC address for the transmitter.

Explosives Menu

1. 'Common' a list of 16 common explosives including TNT, commercial and home-made explosives.
2. 'Military' a list of nine military explosives.
3. 'IEDs' a selection of nine predefined IEDs.

The explosive is selected by entering the number in the right-hand column. Use '#' to move to next page and '*' key to go back a page.

Once the explosive type is selected the user inputs a quantity. The '*' button is used as the decimal point and the '#' key to clear the entry. The metric or US/Imperial units can be selected in the 5 Other Settings menu.

If using 'Blast Assessment' mode a delay between zero seconds and 12 hours is entered. On the Home page the timer is shown and the countdown will begin once the 'Detonate' (green) key is pushed.

The type and quantity of explosive are shown on the Home Page along with the calculated lethal and injury distances.

EXPLOSIVE	TNT SCALE	
TNT	1.00	1
ANFO	0.74	2
PETN or Penthrite	1.66	3
Pentolite	1.33	4
Blasting AN/water gel	0.80	5
Dynamite	1.25	6
Gelignite	1.60	7
Ammonium Nitrate	0.32	8
Picric Acid	1.17	9

1 of 2 # Next

Layer 3 Services

Figure 2.4 Example of Explosives menu page

History Menu

Accessed via Settings (blue) key and then History (red) key.

All ExploSim events are recorded in the transmitter and are available for download by exercise controllers.

1. 'Detonations'. A list of all events programmed into the transmitter. Individual events can be accessed by selecting the indicated number on the keypad. The 'Result' column shows if the event resulted in a detonation, was aborted or there was no result meaning the render safe procedure was successful.
2. 'Export Detonations'. Once a USB memory device is inserted in the USB port on the transmitter the historical record can be downloaded, this may take some seconds.
3. 'Clear All History'. Allows the history file on the transmitter to be cleared.

	A	B	C	D	E	F	G	H	I	J
1	time	name	quantity	scale	tnt_scale	delay	lethal	injury	frag	result
2	02:12:54 UTC 10JUN22	TNT	5.00	kilograms	1.00	0	3.9295326	9.8402119	108.58347	detonated
3	02:13:28 UTC 10JUN22	TNT	5.00	kilograms	1.00	0	3.9295326	9.8402119	108.58347	detonated
4	07:18:07 AEST 14JUN22	TNT	5.00	kilograms	1.00	0	3.9295326	9.8402119	108.58347	detonated
5	16:17:54 AEST 28SEP22	Pipe bomb	5.00	kilograms	1.00	3	3.9295326	9.8402119	108.58347	detonated
6	16:19:39 AEST 28SEP22	Pipe bomb	5.00	kilograms	1.00	3	3.9295326	9.8402119	108.58347	detonated
7	16:20:30 AEST 28SEP22	Suicide vest	5.00	kilograms	1.00	2	3.9295326	9.8402119	108.58347	detonated
8	16:23:29 AEST 28SEP22	Small car bomb	5.00	kilograms	1.00	3	3.9295326	9.8402119	108.58347	detonated
9	16:28:11 AEST 28SEP22	Airline luggage	23.00	kilograms	1.00	0	6.5352195	16.365290	180.58555	detonated
10	16:51:13 AEST 28SEP22	Large car bomb	1000.00	kilograms	1.00	5	22.980046	57.545908	635	detonated
11	16:52:36 AEST 28SEP22	Pipe bomb	1.50	kilograms	1.00	3	2.6305586	6.5873621	72.689354	detonated
12	16:53:22 AEST 28SEP22	Large car bomb	1000.00	kilograms	1.00	0	22.980046	57.545908	635	detonated
13	16:54:03 AEST 28SEP22	ANFO	3.00	kilograms	0.74	0	2.9977947	7.5069831	82.837067	detonated
14	16:56:06 AEST 28SEP22	SEMTEX	8.00	kilograms	1.35	0	5.0795529	12.720056	140.36160	detonated
15	17:06:01 AEST 28SEP22	Medium bag	10.00	kilograms	1.00	0	4.9509009	12.397890	136.80660	aborted
16	17:53:41 AEST 28SEP22	Suicide vest	10.00	kilograms	1.00	0	4.9509009	12.397890	136.80660	detonated
17	10:33:06 AEST 29SEP22	TNT	5.00	kilograms	1.00	3	3.9295326	9.8402119	108.58347	detonated
18	12:50:45 AEST 29SEP22	TNT	35.00	kilograms	1.00	3	7.5169255	18.823648	207.71271	detonated
19	12:54:55 AEST 29SEP22	TNT	5.00	kilograms	1.00	3	3.9295326	9.8402119	108.58347	detonated
20	12:56:14 AEST 29SEP22	TNT	35.00	kilograms	1.00	3	7.5169255	18.823648	207.71271	detonated
21	09:36:16 AEDT 04JAN23	TNT	10.00	kilograms	1.00	2	4.9509009	12.397890	136.80660	detonated
22	09:47:51 AEDT 04JAN23	TNT	10.00	kilograms	1.00	2	4.9509009	12.397890	136.80660	detonated
23	09:50:36 AEDT 04JAN23	TNT	50.00	kilograms	1.00	2	8.4659215	21.200094	233.93600	detonated
24	10:11:16 AEDT 04JAN23	TNT	5.00	kilograms	1.00	2	3.9295326	9.8402119	108.58347	detonated
25	10:30:37 AEDT 10JAN23	TNT	5.00	kilograms	1.00	2	3.9295326	9.8402119	108.58347	detonated

Figure 2.4 Example of History download

ANNEX 3 EXPLOSIVE CALCULATIONS AND ASSUMPTIONS

This Annex outlines the basis behind the ExploSim indication of blast lethality and injury, fragmentation injury and building damage.

Blast Calculations

The basis for ExploSim are calculations on the blast distance relationship. These are based on the normal cube root scaling for a hemispherical (ground based) explosion; where the blast scaling factor $k = R / W^{0.33}$. Where R = range, W = explosive charge weight.

ExploSim calculations assume a 'confined' explosive. For the ExploSim calculations all Improvised Explosive Devices (IEDs) and items of Explosive Ordnance (EO) are considered to be contained within some form of thick-skinned container. From a practical point of view in the use of ExploSim the difference between confined and unconfined is considered minimal.

Blast calculations assume perfectly mixed, primed and detonated explosives and utilise ideal gasses and flat, usually infinite surfaces. Variations between the predicted distances and ExploSim indication of effects is due partially to the variance between radio frequency (electromagnetic energy) and the hydro-dynamic effects of explosives but mainly due to variations in the actual environment which will affect both RF and blast.

Calculation for 64 different charge weights using TNT were conducted to determine modelling curves.

Calculations were based on work by Kingery and Bulmash¹ and use in the CONWEP² model. CONWEP is a dated but recognised reference, well validated in field trials. The calculations were cross referenced against other Level one blast software such as the ExpSAFE Blast Calculator³

Blast Injury and Lethality

There are numerous references for blast damage to humans.

The pressures selected for ExploSim are taken from US Federal Emergency Management Agency FEMA 426 "*Reference Manual to Mitigate Potential Terrorist Attacks Against Buildings*" Table 3.1 quoting US Department of Defence 3-340-02, "*Structures to Resist the Effects of Accidental Explosions*" (2008b).

¹ Kingery, C.N. and Bulmash, G. (1984), Airblast Parameters From TNT Spherical Air Burst and Hemispherical Surface Burst, Technical Report ARBRL-TR-02555, US Army Armament Research and Development Centre, Ballistic Research Laboratory, Aberdeen Proving Ground, United States

² US Army TM5-855, (1992) Conventional Weapon Effects (CONWEP), US Army Waterways Experiment Station, US Department of the Army.

³ Gibbs Software, see ExpSAFE applications for IOS.

The figure of 5 psi for threshold of eardrum rupture is converted to 34 kPa and 30 psi for threshold of lung damage is converted to 207 kPa.

Fragmentation Injury

Fragmentation calculations rely on a range of assumptions as to the size, shape and ballistic stability of the fragment. ExploSim does not indicate the nature or severity of the injury only the likelihood of the receiver being in range of fragmentation strike.

The ExploSim formula for lethal fragments distances, while based on published data, is generic and applicable to low angle, high velocity metal fragments from the casing of the IED or EO.

The user should consider the expected packaging and containment of the proposed explosive device. In addition, any intervening barriers should be considered with light structures not considered to offer effective protection. In some scenarios, fragmentation will not be a consideration and the fragmentation indicator (the Blue LED) is not used.

The formulas for estimating fragmentation vary from detailed calculations that require knowledge of the type and design of specific munition to generic conservative estimations.

Even the comprehensive equations that take into consideration design fragment weight, initial velocity based on Gurney methods, and Mott distribution estimations assume ideal situations and evenly-distribution fragment patterns. Variations in explosive fill and case manufacture process can impact the outcomes. Add considerations to the alignment of the munition; surrounding conditions at the explosion site; the actual point of detonation of the munition and multiple other variables, the science of predicting fragment distance becomes near impossible and ends up being a best guess.

ExploSim fragmentation scaling is based on published algorithms for the computation of primary fragmentation distances described in the publicly released paper by M. Swisdak and M. Crull of 1999. While the paper might be considered dated, the methodology is still sound. A simple scaling formula was developed based on cube root rule. The equation is simply Hazard Fragment Distance = $63.5 \times (\text{NEQ})^{1/3}$. The resultant deviation is a minor; worst case 35% for 5KG with the average deviation over explosive magnitudes of 5%. This is not a perfect curve fit but given the unknowns and variables the calculations provide the basis for indicating fragmentation strike based on charge weight and distance.

While it is acknowledged that the approach taken in ExploSim to simulate lethal fragment distances may appear simplistic, in reality any attempt to accurately predict fragment density and the probability of lethal fragment strike would require design specification of the IED, such as case to explosives ratio, nominal fragment mass and initial fragment velocity. Not to mention placement of the IED, position of the detonator within device, departure angle of fragments and any intervening environmental factors that could impact ballistic characteristics of fragments.

During the design phase consideration to using methods such as V50 formulas to try to improve the fragment lethality estimations but as previously alluded too, IED design specifications would need to be known by the operator. It was deemed this would not be feasible. By means of example, no manufactured pipe bomb based on the same design would react the same in terms of breakup and fragment throw. For this reason, and because of the unknown other related variables, the decision was taken to use scaled root equation in ExploSim that generally aligns with other similar mathematic estimations based on fragment lethality of 79 Joule⁴ with subjective probability of strike.

Structural Damage

ExploSim can be used to indicate damage to structures from an explosion.

If the structure does not fail immediately when it is struck by the initial peak incident pressure (Pi) the pressure will continue to build until either the structure fails or the reflected pressure (Pr) is reached at which time the pressure will reflect off the structure. Table 3.1 shows indicative pressures for structural damage⁵.

Type of damage	Pressures
Threshold of serious damage to Steel framed building (4 psi)	Pr 27.6 kPa (Pi 13 kPa)
Threshold of severe damage to reinforced concrete building (7 psi)	Pr 48.2 kPa (Pi 22 kPa)
Threshold of probable total destruction of most buildings (10 psi) NOTE: roughly equates to ExploSim Injury (orange) LED	Pr 69 kPa (Pi 31 kPa)

Table 3.1 Structural damage pressures

The ExploSim injury (Orange) LED indicates at ~ 35 kPa Pi which roughly equates, depending on a range of variables, to a Pr of >70 kPa which exceeds the point at which structural failure will occur.

The area around any receiver where the Red or Orange LEDs are illuminated can be expected to have suffered severe structural damage.

Some consideration of the scenario is required to determine the probable effects of an explosion at the nominated site. A small charge may cause significant damage to surrounding fixtures and damage nearby walls and facades but is unlikely to cause the destruction of an entire building. A large explosive device, if it impacts enough structural elements or, if protection from progressive collapse was not a design criterion, may cause demolition of the

⁴ 79 Joule is an accepted injury threshold for projectiles, see Henderson J Lethality Criteria for Debris Generated from Accidental Explosions

⁵ FEMA 426 (2003 version)

building. Additional engineering and blast modelling will be required to determine the exact failure modes.

The degree of structural failure will require interpretation based on the size and location of the donor charge. This can be supported by Computational Fluid Design (CFD) and Finite Element Analysis (FEA) modelling.

Structural Damage Indication:

- While the RF signal will pass through thin walls it will not pass-through thick walls, floors or ceilings.
- For indication of structural damage, receivers should be placed on the side of the wall nearest the transmitter. A Red or Orange LED indicates significant failure of the structure in the immediate vicinity of the receiver.

ANNEX 4 MAINTENANCE AND SUPPORT

Maintenance and Cleaning

All equipment should be kept clean. The outside and inside of the ExploSim cases and the ancillary equipment can be cleaned with soft, dry cloths. Avoid the use of abrasive cleaning brushes and agents.

The transmitter's LCD screen should be cleaned with suitable materials such as a microfibre cloth.

Keep water, moisture, ice, dirt and dust from inside the cases.

Once the mode and settings have been entered the transmitter can operate with the case closed to prevent moisture and dust ingress.

The receiver Charger Case should be kept closed when not in use.

Updates and Support

Software updates and support will be provided. Check the www.layer3services.net.au website for information on updates.

Warranty and Repair

Check the www.layer3services.net.au website for warranty and repair information or contact support@layer3services.net.au .

ANNEX 5 VICTRON BATTERY CHARGER

ExploSim is supplied with a Victron charger which is a 12V DC 5A suitable for the Sealed Lead Acid battery in the transmitter and Lithium Polymer batteries in the receivers.

Battery charging is done via the supplied Victron 12V/5A charger unit and attached via the fitted Anderson connectors.

The ExploSim system will be provided with a 120V AC or 240V AC charger as ordered by the user. The ExploSim system contains a universal wall plug adaptor.

Instructions for the Victron charger are available from www.victronenergy.com/chargers/blue-smart-ip65-charger#downloads.

The Victron battery charger is rated to environmental protection level IP65.

The downloadable 'VictronConnect' app (for IOS or Android) provides visibility of charging progress via Bluetooth link to a phone or portable device.

VictronConnect Application:

- The Victron system requires the 'VictronConnect' application available free of charge from the Apple Store and, for Android systems, from the Google Play store.

The downloadable 'VictronConnect' app (for IOS or Android) provides visibility of charging progress via Bluetooth link to a phone or portable device. Instructions are at www.victronenergy.com/media/pg/VictronConnect_Manual/en/index-en.html.

To connect the charger:

- Connect the Victron charger to the wall socket. Ensure the charger is the appropriate 120 V or 240 V version for the country's power supply.
- Using the 'Mode' button on the charger ensure the 'normal' mode is selected (see Figure 6).
- Open the VictronConnect app on a suitable device. Choose 'Local', the app will identify the charger (see Figure 7).
- Select the charger by clicking on it or pressing it on a touch screen.
- Select the 'Settings' via the cog symbol in the top right corner (see Figure 7).
- Select the 'Charger' menu (Figure 8).
- Select "Charger" (Figure 8).

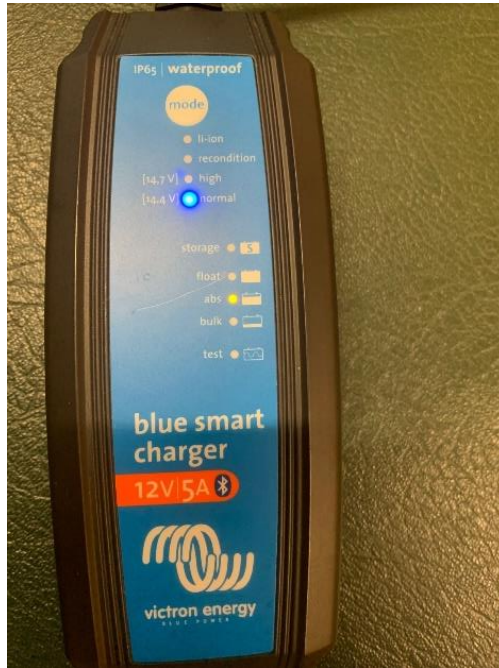


Figure 7 Charger in 'normal' mode.

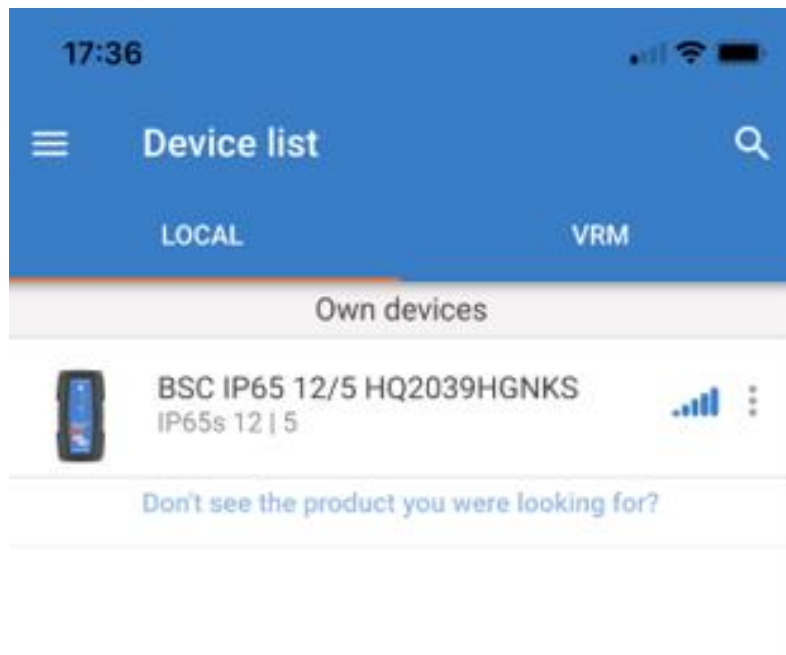


Figure 8 Identification of charger

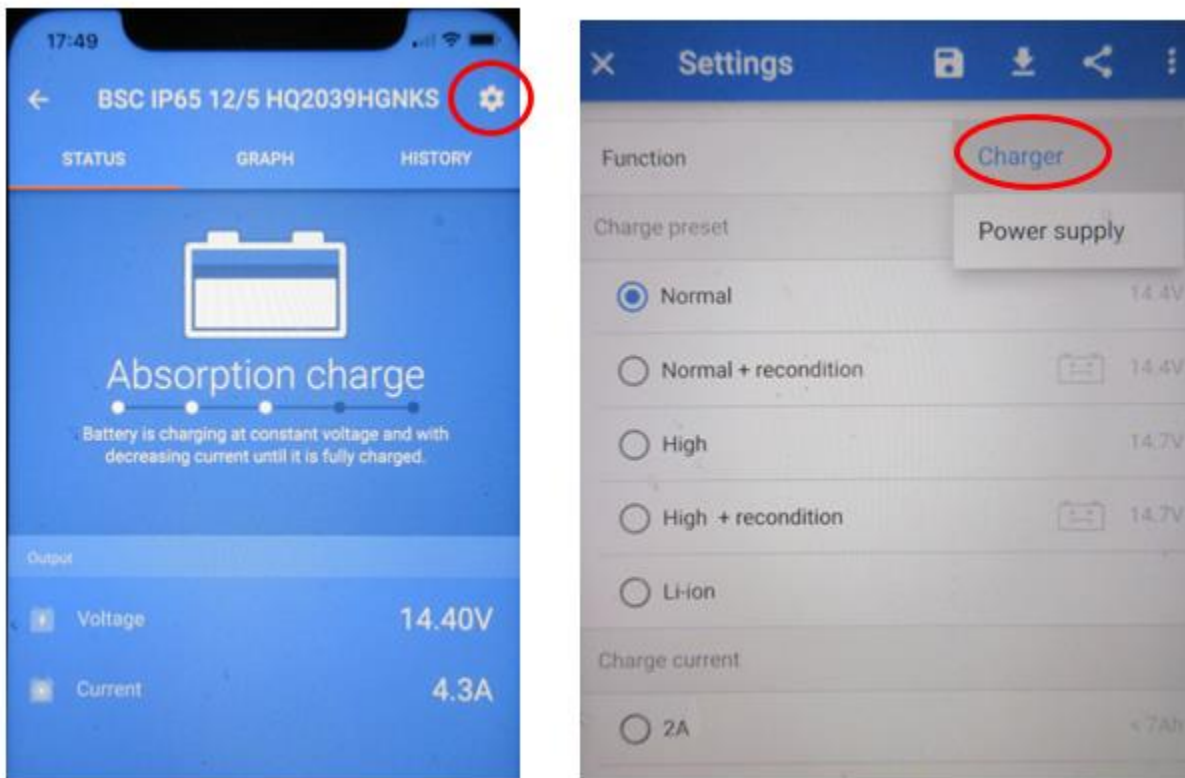


Figure 9 Selection of charger status

When charging is complete carefully clean and pack away the charger ensuring the connecting leads are properly stored.

ANNEX 6 COMPANION APP

The ExploSim Companion Application, available for IOS devices, is provided as a supplementary tool to support the use of ExploSim. The Companion App is not essential to the setup, employment and operation of the ExploSim system. It a supplemental software tool that can be used to:

Plan Scenarios

The Companion App enables exercise planners to determine estimated safe and hazardous zones or pre-plan designated areas to achieve a desired outcome. In this way the app can be used to estimate the distances for death, injury and fragmentation (if applicable) based on the placement of ExploSim transmitter and selected explosives yield.

Assess Scenarios

The Companion App can be used by assessors to valid a student's response plan, such as placement of Command Posts, cordons, support personnel and safety distances.

For simulated explosive ordnance disposal (EOD) scenarios, the application includes the ability for the operator to calculate demolition danger areas based on UN IATG 01.80 guidelines.

Evaluate Scenarios

The Companion App enables activity assessors to evaluate if assets or other supporting personnel (not wearing a receiver unit) would have been within the designated threshold distances associated with ExploSim LED indicators.

The difference between the calculated hazardous distances and those experienced in the real-world scenarios as indicted by the ExploSim receiver provide a valuable learning tool for all involved.

The key functional objectives of the companion app are:

- The application is aligned with the design specifications of the ExploSim system. In that, outputs distances associated with blast and fragmentation estimations based on user selected effective yield of the explosives are to match as designated by the three LED indicators built-in to the ExploSim Receiver Units.
- The application enables operators to toggle between metric and imperial units.



- Based on the effective explosive yield, the application presents operators the ability to show threshold distances for a selection of blast injury and damage criteria that are commonly promulgated in reference sources.

ANNEX 7 RF TECHNICAL INFORMATION

The ExploSim system uses the international WiFi frequency of 2.4GHz. The ExploSim default channel within the WiFi band is channel 8. If other users are using channel 8 it may interfere with the ExploSim system. In operation ExploSim uses a single channel and will work on channel 7, 8 or 9. The Wi-Fi channel setting may be changed via Settings/5 Other Settings. The ExploSim system only operates on channels 7, 8 or 9. The other channel settings (1 to 6 and 10 to 13) have been reserved for future use.

The ExploSim Wi-Fi network(s) will co-exist with other Wi-Fi networks due to the design of WLAN 802.11 standards.

Software within the transmitter determines, based on the selected explosive and quantity, the outer ranges (threshold distances in metres) at which the indicated effects will be experienced under ideal conditions. These effects being:

- 207 kPa (~30 psi) as the threshold damage level of lung damage, considered to be the outer distance for blast lethality and represented by the Red LED on the receiver;
- 34 kPa (~5 psi) as the threshold damage for ear damage, considered to be the outer distance for blast injury represented by the Orange LED on the receiver;
- >70 kPa (>10 psi) reflected pressure indicating severe structural damage, also represented by the Orange LED on the receiver;
- The probability of a fragmentation impact of greater than 79 Joules represented by the Blue LED on the receiver. The fragmentation indication can be turned on or off by a setting if not required for the scenario.
- The Green LED changes from a flashing 'ready' signal to a constant illumination if the receiver calculates it was not impacted by blast or fragmentation.
- The indications at the receiver show the effects at the actual distance the receiver is located at as influenced by the real-world and real-time built and natural environments as opposed to the idealised calculations which are shown on the Home page.
- When the simulated explosion event occurs, the threshold distances for the selected explosive (and magnitude) are dynamically encoded into a specific broadcast to indicate the simulation of an explosion.
- The simulated explosion broadcast is received by the receiver. The receiver decodes the broadcast to determine threshold distances. The receiver then uses internal logic (software) to determine its effective distance from the transmitter. The receiver then compares its effective distance to the received threshold values to determine an appropriate LED indication (Red or Orange and/or Blue or Green).
- If a second simulated explosion event occurs the receiver will repeat the analysis and determine if the LED indication needs to be escalated (i.e. changing from Orange to Red). Similarly, if the first simulated explosion has fragmentation OFF then the receiver

Blue LED will be off then if a second simulated explosion event occurs and fragmentation is ON then the Blue LED will turn on. This logic allows for the escalation of potential injuries for the same Receiver in the scenario. For the purpose of clarity, the Receiver will not de-escalate LED indications.

As a result of many factors the RF signal strength received by the receiver is not constant at any distance as it includes random magnitude variations. To reduce the impact of these variations and to deliver increased range accuracy an adaptive Kalman Filter is used in each receiver's software. The Kalman filter is used to determine the most reliable signal strength magnitude at that receiver's distance from the transmitter. Adaptive Kalman filtering is also used to determine transmitter and receiver factory calibration settings.

ANNEX 8 EXPLOSIM AUDIO VISUAL INDICATOR (EAVI)

The ExploSim Audio Visual Indicator (EAVI) is an additionally purchased item which provides an audio and visual indication that the ExploSim transmitter has been triggered

Purpose

The EAVI system provides an audio and visual indication to advise participants not issued with ExploSim receivers that the ExploSim transmitter has been activated.

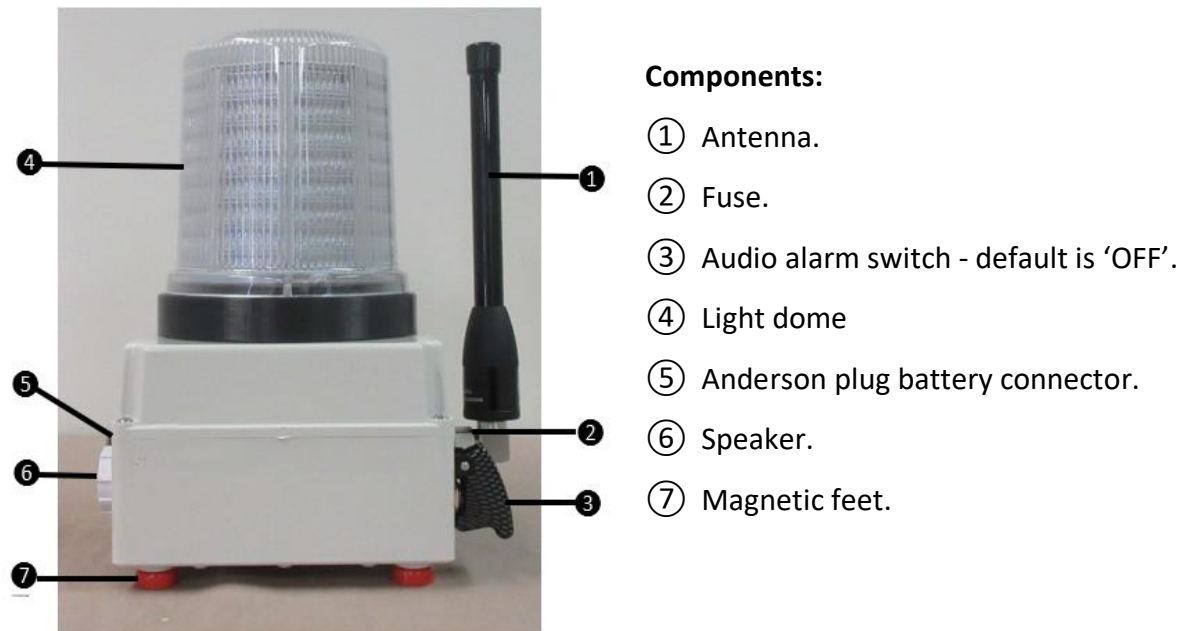


Figure 8.1 ExploSim Audio Visual Indicator

Use of the EAVI unit.

1. Remove EAVI from the case.
2. Place it near the ExploSim transmitter where it can be seen or heard by participants.
3. Connect the battery pack to EAVI using the supplied 2 m cable. EAVI will flash approximately every 30 seconds to indicate it is ready to receive a signal.
4. Prepare ExploSim as per Instruction Manual.
5. When ExploSim is triggered, EAVI will flash alternating colours indicating a signal is being received. EAVI will then flash Red until reset.
6. If Audio is turned ON (default setting is OFF) a siren will sound at 80 decibels for six seconds. Audio may be turned OFF using the switch ③.
7. Reset the EAVI along with the ExploSim receivers via ExploSim keypad, 'Settings' (blue button) then '3. Clear RX LEDs' and confirm by pressing the green key.
8. Reset the transmitter by setting up a new scenario.

9. When finished, disconnect the battery and antenna, clean, inspect and pack away all equipment.

The EAVI system is fitted with an accessible fuse.

Components

The elements of the EAVI system are shown in Figure 8.2 and described below.

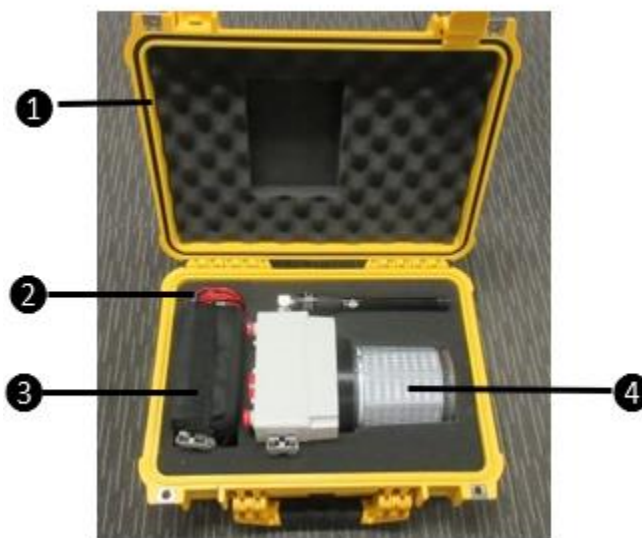


Figure 8.2 EAVI case and contents

1. Hard outer case.
2. Connecting cable.
3. 12V 7.2Ah (86.4Wh) Sealed Lead Acid (SLA) battery, UN Dangerous Goods number 2800 in carry case and fitted with Anderson connection.
4. EAVI light and sound unit fitted with Anderson connector.

The case is rated to IP55.

Battery

The battery is 12V 7.2Ah (86.4Wh) Sealed Lead Acid (SLA) battery, UN Dangerous Goods number 2800.

The battery can be recharged using the Victron charger provided with ExploSim.

The total watt hours in the EAVI case is less than 100Wh. Being less than 100Wh, the case is suitable for carriage on aircraft under ICAO and IATA rules. Users should check with the individual carrier.

ANNEX 9 'SURVEY' MODE

Purpose

'Survey Mode' an additional capability for ExploSim which enables the type and quantity to be constantly transmitted and the LED indications of the receivers to vary as they are moved around.

Survey mode provides an indication of the ranges for a specified explosive type and quantity, within the built and natural environments, at which the pressures of 207 kPa peak incident (Red LED) and 34 kPa peak Incident (Orange LED) may be expected.

Accessing Survey Mode

If Survey Mode has been purchased it will be accessible via: Settings/Mode Selection/Survey.

Use of the Survey Mode

Survey Mode is used to provide an indication of the two pressure data points at distance. The data points being ~207 kPa peak incident pressure (Red LED) and ~34 kPa peak incident pressure (Orange LED).

- In Survey Mode a type and quantity of explosive, or one of the nine pre-defined IEDS, is selected on the transmitter as per normal procedure, see *Selection of Explosives*.
- The Home page now indicates "Start" using the Green keyboard key. Once the Green key is pressed the transmitter will constantly transmit the selected type and quantity of explosive.
- The receivers' Red and Orange LEDs will illuminate and turn off as the receivers are moved towards and away from the transmitter.
- The receiver should be kept stationary at the required location for 30 seconds before relocating to ensure receipt and analysis of the transmitter signal.
- To stop the transmission, press the Red keyboard key.

Survey Mode caveat

It is stressed that Survey Mode provides an approximate indication of pressures. There are numerous variables related to radio frequency energy and blast effects that prevent exact measurement.

ANNEX 10 'CUSTOM EXPLOSIVE' MODE

Purpose

'Custom explosive mode' an additional capability for ExploSim which enables users to enter details of explosives to the on-board library. Access is restricted to Law Enforcement and related organisations.

Accessing Custom Mode

If Custom Mode has been purchased it will be accessible via: Explosive/Custom. If Custom explosive mode has not been purchased this option will not be available.

Use of the Custom Mode

The user can enter explosives into the data base.

- The new explosives are entered via Settings (Blue key)/8. Custom Explosives. If Custom explosive mode has not been purchased this option will not be available.
- The number corresponding to the next available Custom Explosive is selected.
- A dialogue box requests the 'TNT Scale' which is the equivalency based on the free-air weight of the new explosive required to produce a selected shock wave parameter (suggested as 34 kPa/5 psi peak incident pressure) compared to the weight of TNT to produce the same effect. The equivalency is given as a figure compared to TNT having a value of 1. The '*' key is used as the decimal place.
- The user can not alter the Titles on the Custom Explosives page so will need to maintain a record of which explosive is represented by which number on the Custom Explosive page.
- Once the new explosive is entered it can be accessed via the Explosive/Custom menu and be used for ExploSim scenarios as per other explosives in the library.