MICROTRAP+™
VOD RECORDER

Operations Manual
Edition 1.0

Copyright Information

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This version of the Manual

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Chapter 1
Getting Started

MREL
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Overview

All of the steps detailed in this Chapter should be completed before the Operator goes into the field to conduct a VOD test:

1. **Ensure that all MicroTrap +™ components have been received and are available.**

2. **Ensure that the DAS™ Data Acquisition Suite for MicroTrap +™ is installed and operational according to the DAS™ Data Acquisition Suite for MicroTrap +™ Software manual.**

3. **Ensure that the Operator's computer and MicroTrap +™ are able to communicate with each other.**

4. **Program the MicroTrap + internal recording parameters using the MicroTrap +™ Software.**

1.1 MicroTrap +™ Hardware Included

Photographs of these hardware components are contained in **Section 3.1**.

1. **MicroTrap +™ VOD Recorder**.
2. **MicroTrap +™ Battery Charger**.
3. **Communication and Charger Cable** - **USB cable**.
4. **BNC Adapters** x3.
5. **Carrying Case**.
6. **DAS™ Data Acquisition Suite Operations Software** on USB.
7. **MicroTrap +™ Operations Manual**.
8. **DAS™ Data Acquisition Suite for MicroTrap +™ Manual.**
9. **VOD** resistance probes: **VOD PROBERODs** and/or **VOD PROBECABLE** and/or **VOD PROBECABLE-LR**.

1.2 Installing The DAS™ Data Acquisition Suite for MicroTrap +™ Software

Refer to the **DAS™ Data Acquisition Suite for MicroTrap +™** Manual for installation procedure.

1.3 Definitions of VOD Settings

This section will discuss the meaning of each setting.

Trigger Level is the threshold that the signal will cross to indicate a valid trigger. For **VOD**, the typical setting for **Trigger Level** is 90% remaining of the remaining length of sensor.

Pre-Trigger Time is the amount of time of the **Total Time** available for each test that will be captured prior to the trigger point. For VOD, the typical setting for **Pre-Trigger Time** is 25%

Recording Rate is the number of points captured per second. The faster the **Recording Rate**, the shorter the amount of time within each test. For **VOD**, the typical setting for **Recording Rate** is 1 MHz or 2 MHz.

External Trigger is the setting that will allow the user to use an external source to have a valid trigger. There are two ways for the **MicroTrap +™ VOD Recorder** to receive an **External Trigger**.

- **Make Circuit** uses a loop of wire that is normally open circuit and triggers the **MicroTrap +™** when the circuit closes.
- **Break Circuit** uses a loop of wire that is normally closed circuit and triggers the **MicroTrap +™** when the circuit opens.

For more details on the **External Trigger** feature, refer to **Section 4.8**.

Chapter 2
Introduction
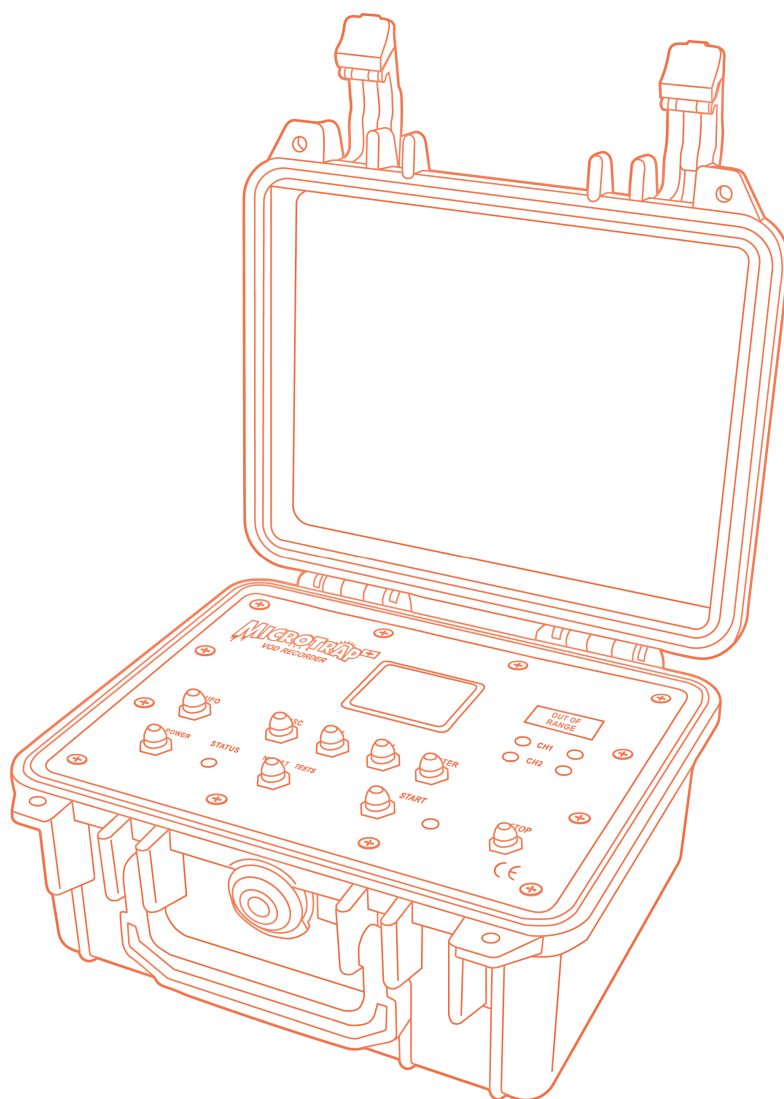
Overview

This Chapter provides an introduction to the MicroTrap +™ VOD Recorder.

2.1 Background

The **MicroTrap +™ VOD Recorder** is a portable, 2 channel, high resolution, explosives continuous Velocity of Detonation (**VOD**) recorder.

The **DAS™ Data Acquisition Suite for MicroTrap +™** allows the User to analyze **VOD** traces recorded by the **MicroTrap +™ VOD Recorder** into the desired engineering units for analysis and presentation. The software is used to program the recording parameters of the **MicroTrap +™ VOD Recorder**, and to retrieve, display, analyze, print, and export **VOD** results obtained through testing. The **DAS™ Data Acquisition Suite for MicroTrap +™ Software** runs under 64 bit **Microsoft Windows® 10** or newer. This facilitates extremely fast data handling, and the ability to copy and paste graphs into any word processors or spreadsheets running in the Windows® environment. Refer to the **DAS™ Data Acquisition Suite for MicroTrap +™ Software** for more information.

The main features of the **MicroTrap +™ VOD Recorder** for **VOD** recording are:

- Two **VOD** channels capable of recording at up to 2 MHz (2 million data points/sec per channel). This speed provides a time resolution of one data point for every 0.5 microseconds.
- Capability to record **VODs** and delay times using up to 900 m (2,950 ft.) of **MREL's PROBECABLE-LR VOD resistance cable**. This ensures that the **MicroTrap +™** can record the **VODs** and delay times in many blastholes per test.
- A large 48 MB digital memory to store the recorded data. This allows the **MicroTrap +™ VOD Recorder** to record for relatively long periods (5.2 seconds) when recording at a rate of 2 MHz.
- A high, 14 bit vertical (or distance) resolution (2^{14} or 1 part in 16,384). Use of shorter lengths of **PROBECABLE-LR** provides even more data points recorded along every meter.
- Large non-volatile memory for storing over 100 events before the data needs to be downloaded to a computer.
- Data is downloaded to the PC via the supplied **USB cable**.

2.2 Safety Considerations

STOP

Persons not trained and/or authorized to handle explosives should not attempt to utilize the **MicroTrap +™ VOD Recorder** for monitoring explosive properties.

The **MicroTrap +™ VOD Recorder** is an easy and safe instrument to operate. However, one should be aware of the inherent risk associated with explosives handling and familiar with working in blasting environments. For this reason, it is always recommended that only knowledgeable personnel, experienced in handling explosives and familiar with blasting procedures, operate the **MicroTrap +™ VOD Recorder** when testing explosives. The standard rules of safety used with explosives should apply when monitoring **VODs** or other explosive parameters.

When recording **VODs**, the **MicroTrap +™ VOD Recorder** outputs a low voltage (less than 8 V DC) and an extremely low current (less than 50 mA) to the probes within the explosives from the **VOD** connector on the **MicroTrap +™ VOD Recorder**. This low excitation signal ensures that the **MicroTrap +™** will not prematurely initiate explosives and/or detonators.

Standard (and common sense) rules apply when it comes to the presence of electrical storms near the testing area. Due to the inherent hazards associated with blasting during these storms, in addition to the possibility of electrical interference causing false trigger signals to the **MicroTrap +™ VOD Recorder**, it is recommended to immediately suspend all blasting activities and evacuate the area. This is standard policy at most blasting operations.

2.3 VOD Applications

The main applications of the **MicroTrap +™ VOD Recorder** include:

2.3.1 Testing of Explosive Samples

- Test the performance of explosives against the quality control standards stated by the manufacturer.
- Measure the continuous **VOD** in any charge diameter under confined or unconfined conditions.
- Determine the critical diameter and critical density of an explosive charge.
- Determine the gap sensitivity of explosives.
- Measure the timing accuracy of detonators.
- Measure the continuous **VOD** of primers/boosters.
- Determine the minimum booster size for any explosive by measuring run-up velocities.

2.3.2 Testing of Explosives in Blastholes

- Measure the continuous **VOD** in any hole diameter, wet or dry holes, and in any type of rock.
- Measure the continuous **VOD** in multiple holes per blast.
- Determine whether full detonation, low order detonation or failure occurred, and where in the explosive column it happened.
- Check **VODs** against manufacturers' specifications in full scale blasting environments.
- Determine the minimum booster size for any explosive by measuring run-up velocities in full scale blasting environments.
- Measure the timing accuracy of detonators in full scale blasting environments.
- Measure the effects of water, drill cuttings, and rocks, etc. trapped within the explosive mass.
- Determine the length of explosive column to use in decking operations to evaluate the effect of stemming and drill cutting dilution, water pick-up, etc. on the explosive run-up requirements.
- Determine the correct length and type of stemming material to be used between decks of explosives to prevent sympathetic detonation or explosive desensitization from occurring.
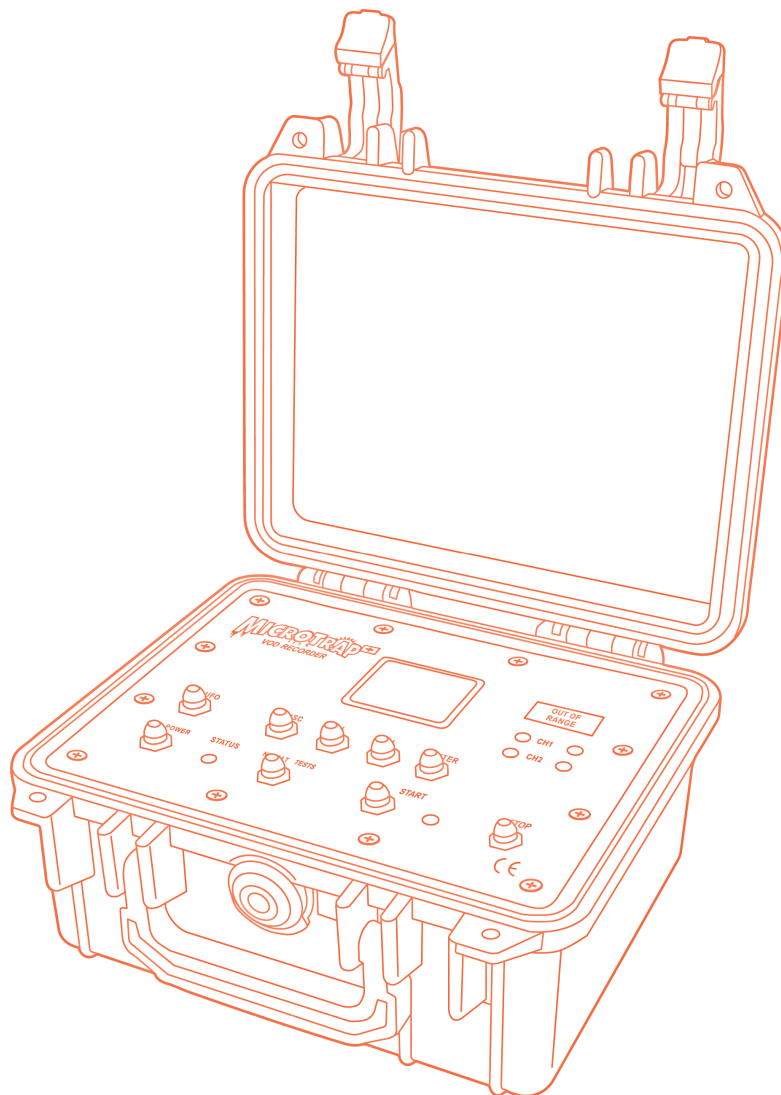
Overview

This Chapter describes all of the hardware components provided with the MicroTrap +™ VOD Recorder.

3.1 Hardware Components

The hardware components of the **MicroTrap +™ VOD Recorder System** include the **MicroTrap +™ VOD Recorder**, a **Carrying Case**, a **Battery Charger**, a **USB Communication and Charger Cable** and three (3) **BNC Adapters**. Also included with the **MicroTrap +™ VOD Recorder System** is this **Operations Manual** and the **DAS™ Data Acquisition Suite for MicroTrap +™ Manual.** A brief description of each of the hardware components is in the following sections.

3.1.1 MicroTrap +™ VOD Recorder

The **MicroTrap +™ VOD Recorder** contains electronic circuitry and an internal rechargeable battery within a protective plastic case measuring approximately 21 x 17 x 9 cm (8.3 x 6.7 x 3.5 in) and weighing 2 kg (4.4 lbs). The protective case prevents damage from water, sand, snow, dust and similar harsh weather conditions. As well, the case offers resistance to high temperatures, shocks and vibrations. The **MicroTrap +™ VOD Recorder's** front panel is shown on the following page.

Complete instructions for the field operation of the **MicroTrap +™ VOD Recorder** hardware are provided in **Chapter 4**. The main features of the control panel are outlined below:

MAIN CONTROL PANEL

Power:

The **POWER** button is used to turn the power on and off to the **MicroTrap +™ VOD Recorder**. To turn the unit on, press and hold for 5 seconds until the LED screen displays MicroTrap + and the date.

Status Light:

The **STATUS** indicator light has three working modes:

In **Stand-by** mode, the light flashes slowly, indicating that the **MicroTrap +™ VOD Recorder** is waiting after being powered on. In **Stand-by** mode, the **MicroTrap +™ VOD Recorder** is waiting for the User to either switch power **OFF**; press the **NEXT TEST** button (to go to **Active** mode); or download the data to a computer.

In **Active** mode, the light is illuminated solid, indicating that the **MicroTrap +™ VOD Recorder** is ready for the User to press the **START** button. To turn on **Active** mode, the user will press **NEXT TEST**. The **MicroTrap +™** will require up to 3 seconds to check the status of the 2 VOD BNC ports. This will be visible with the out of range high and low lights lit during the evaluation of the active channels.

When the **START** button is pressed it enters **Monitoring** mode, which starts recording in the circular memory. When the trigger criteria have been met, the **MicroTrap +™ VOD Recorder** will record the final loop of data, including the pre-set pre-trigger amount dictated by the User when programming the **MicroTrap +™ VOD Recorder**. If the test has finished and the **MicroTrap +™** has not triggered, press the **STOP** Button to store the test data, which will help us determine why the unit did not trigger. If **Auto-Advance** mode is active, the user will always need to press the **STOP** Button after the test.
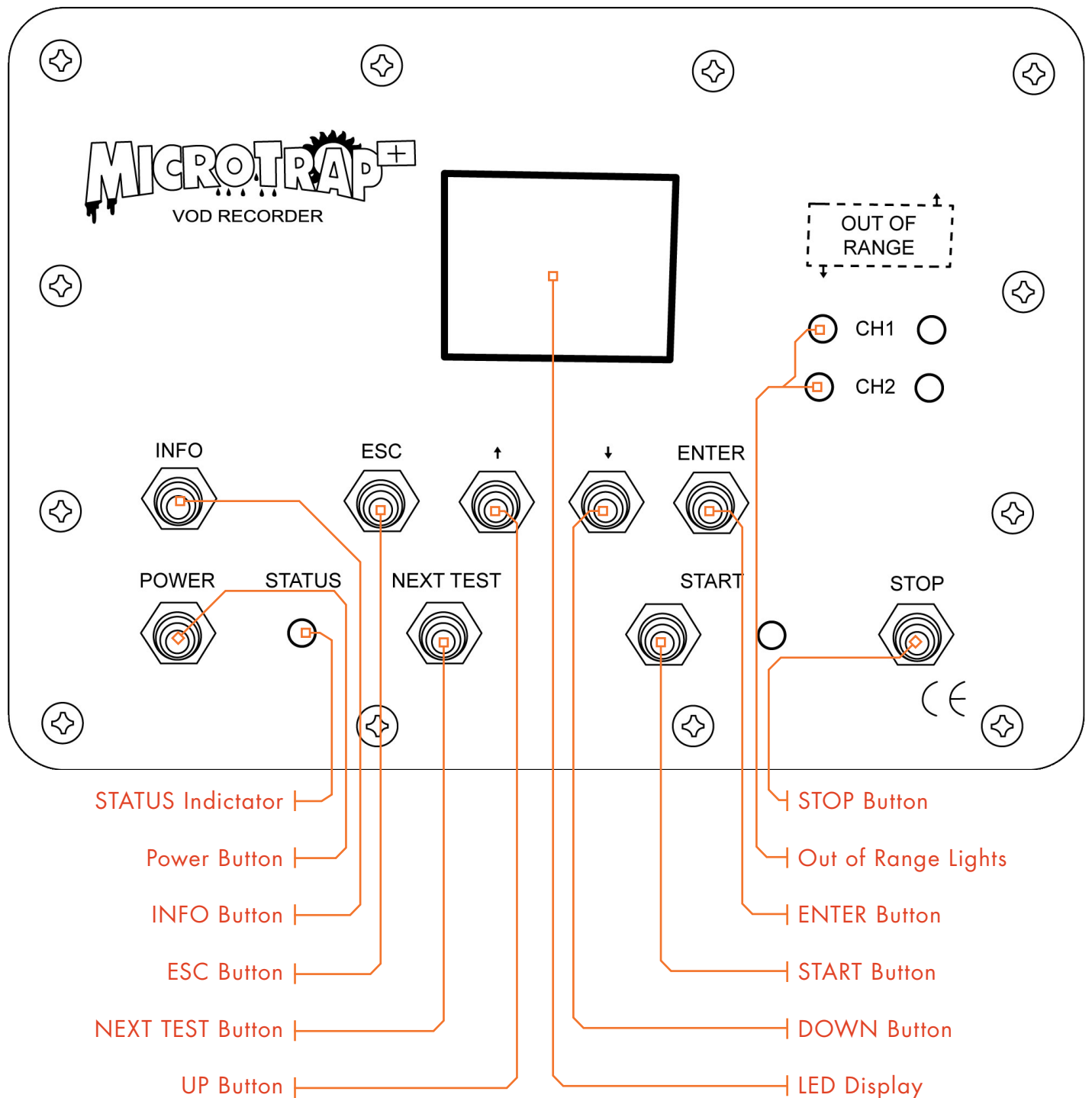
LED Display:

The **LED** screen is an OLED display designed to display all of the interactions with the operator. This screen will report the status of the internal battery, the setup of the recorder including which channels are active, the recording rate of the channels, the trigger level and type of trigger (internal or external).

INFO Button:

The **INFO** button is pressed to display the battery level on the **LED** screen. The **MicroTrap +™ VOD Recorder's** battery level is displayed in integers from 0 to 100%. Also displayed are the programmed date and time.

ESC Button:

The **ESC** button is pressed to display the Main Menu of the **MicroTrap +™ VOD Recorder**. The function of the **ESC** button will move backwards in the menu or a cancel button in the menu structure.

ENTER Button:

 The function of the **ENTER** button will move the forward in the menu or will be a confirmation button in the menu structure.

UP and DOWN Arrow Buttons:

The **Up** and **Down** buttons allow movement through the menu structure. The buttons will move the scroll bar up and down to the desired location to continue into the required menu (by pressing the **ENTER** button).

NEXT TEST Button:

The **NEXT TEST** button used to change the **MicroTrap +™ VOD Recorder's** mode from **Stand-by** to **Active**. When in **Active** mode, the **MicroTrap +™ VOD Recorder** waits for the User to press the **START** button. This will allow the user to confirm the status of Channel 1 and 2 with the Out of Range Lights. With the **NEXT TEST** button pressed, the **MicroTrap +™ VOD Recorder** will power the active VOD channels and confirm if the active channels are within the resistance range. Immediately after pressing **NEXT TEST**, the two **OUT OF RANGE** lights will illuminate for the active channels. After 2 seconds, the lights will extinguish. If the resistance of an active channel is below 50 ohms, the **OUT OF RANGE Low** light will be lit. If the resistance of an active channel is above 3000 ohms, the **OUT OF RANGE High** light will be lit. On the LED screen, the setup will be displayed. It will have the pre-trigger time in the bottom left with the post trigger time in the bottom right. The sampling rate will be in the top right with the active channels listed in the top left. Below the sample rate is the trigger setup and to the left is the trigger setup. Below the active channels will be the trigger setup on the unit. It will have the trigger numbers with the trigger level displayed in percentage or if set to external trigger will display **MAKE** for a circuit waiting to be shorted or **BREAK** for a circuit waiting to be broken.

START Button:

To be able to press the Start button, the **NEXT TEST** button must have been pressed. The **START** button can only be pressed if all of the **OUT OF RANGE** lights are out. When **START** is pressed, the **MicroTrap +™ VOD Recorder** enters **Monitoring** mode, which starts recording in the memory. When the trigger criteria has been met, the **MicroTrap +™ VOD Recorder** will record the final loop of data, including the pre-set pre-trigger time amount dictated by the User when programming the **MicroTrap +™ VOD Recorder**. When the **START** button is pressed, the **START** light illuminates.

STOP Button:

If the **MicroTrap +™ VOD Recorder** did not trigger, the User can press the **STOP** button to allow the diagnostic of the saved file for the possible reason that the unit did not trigger.   This button will create a data file that will allow the user to send the file to **MREL** for review and understanding of the settings and the potential reason for the unit not triggering. Under normal operating conditions, the **STOP** button will not be used.

When the user is using Advanced Mode for triggering, the unit will continue to record on any valid trigger that it is receiving. This means that it will normally continue to record after each new trigger event until the memory has been filled. If the user arrives to the unit after the event but before the memory has been filled, the STOP button can be pressed to stop the recording.

Out of Range Lights:

There are two **OUT OF RANGE** warning lights. They will flash when the probe resistance is out of range as discussed in **Chapter 4.7**.

BACK PANEL

The back of the **MicroTrap +™ VOD Recorder** has a variety of input and output ports that are described below:

VOD1 Connector

VOD2 Connector

COMM Connector
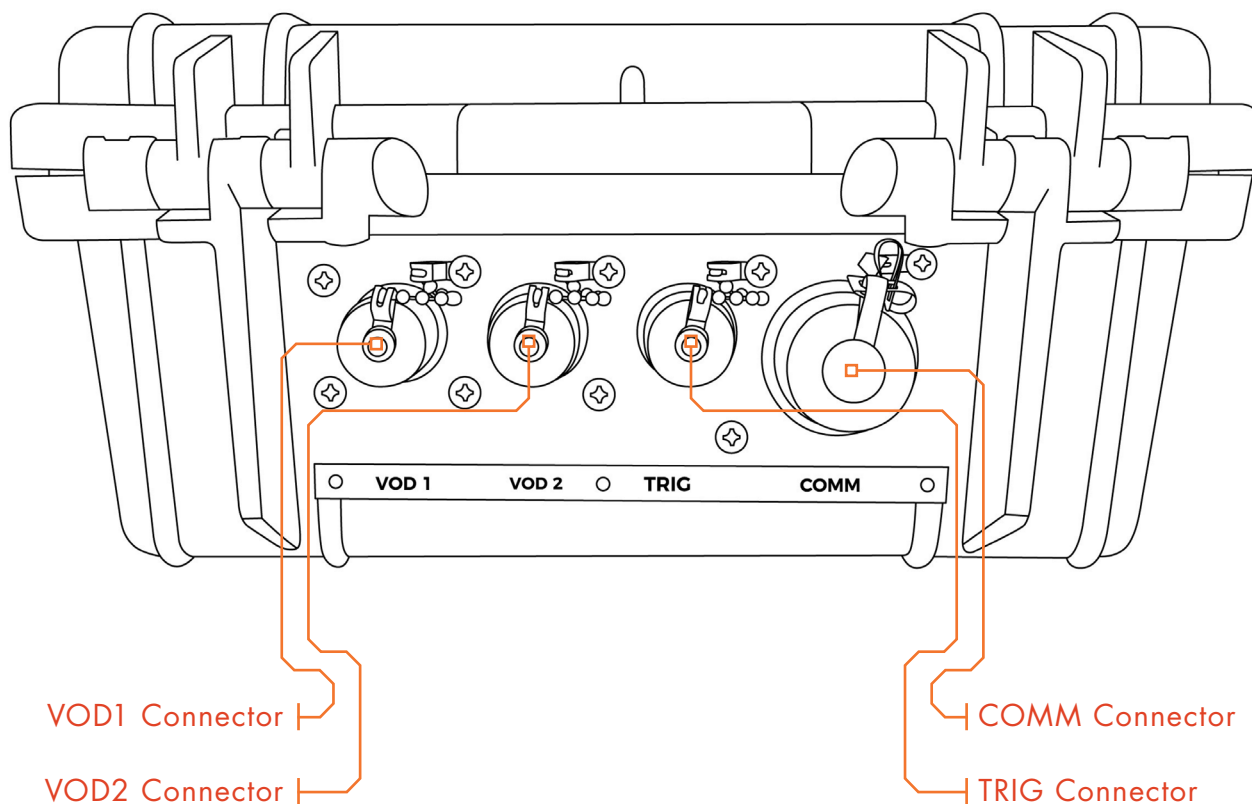
TRIG Connector

VOD1:

BNC connector for the VOD Resistance Sensor to be connected

VOD2:

BNC connector for the VOD Resistance Sensor to be connected

TRIG:

BNC connector for the trigger wire, if external triggering is used

COMM:

Used to connect the **MicroTrap +™ VOD Recorder** to the **Battery Charger** or the computer's USB Port to recharge the internal battery, or connect **DAS™ Data Acquisition Suite for MicroTrap +™ Software** to the unit.

NOTE: Older style USB 2.0 ports are 5V and will not charge the **MicroTrap +™** but they will allow communication. USB-C ports on computers will both charge and communicate with **MicroTrap +™**.

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FRONT PANEL
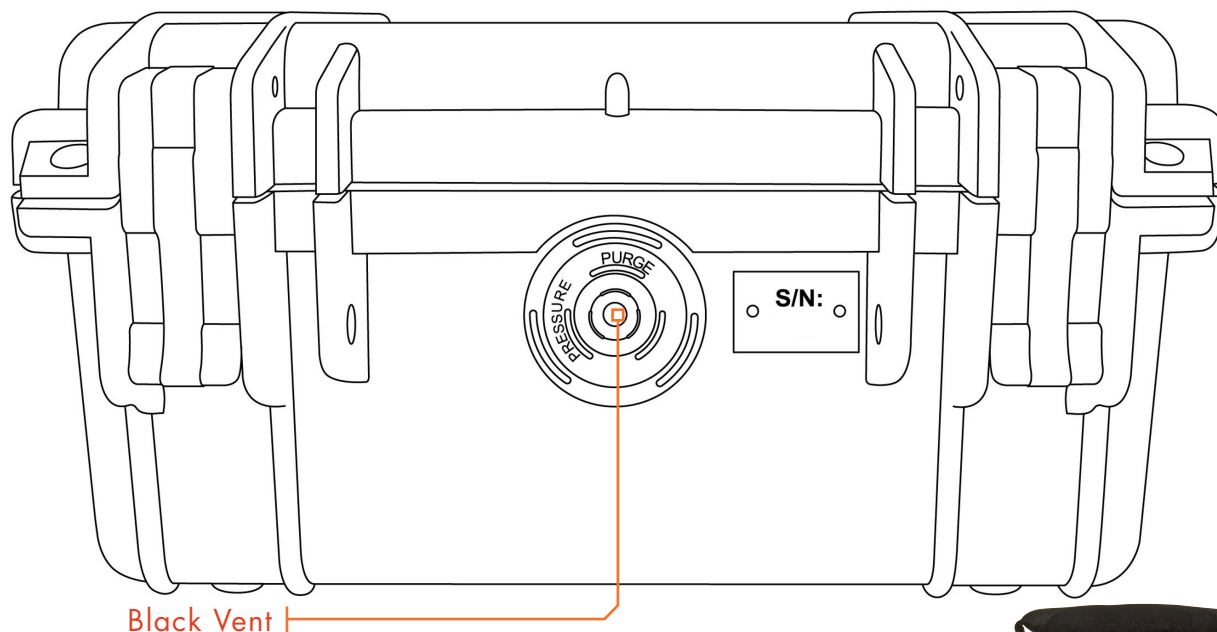
Black Vent

BLACK VENT:

The **black knob** on the front of the **MicroTrap +™ VOD Recorder** is an automatic pressure relief valve. When transporting the **MicroTrap +™ VOD Recorder** by air, this valve allows pressure equalization upon landing. At high altitudes the internal pressure of the **MicroTrap +™ VOD Recorder** may drop, causing a negative air pressure at ground elevation which makes the lid very difficult to open without this pressure equalization valve.

3.1.2 Carrying Case

The **Carrying Case** holds the **MicroTrap +™ VOD Recorder**, **Battery Charger**, **Communication and Charger Cable** and **BNC Adapters**.

3.1.3 Battery Charger

The **Battery Charger** has a specification printed on it, either 120 VAC or 220 VAC. It is used to charge the internal rechargeable battery, and it can be used to operate the **MicroTrap +™ VOD Recorder** from AC mains.

3.1.4 USB Communication and Charger Cable

The **Communication and Charger Cable** is provided to connect the **MicroTrap +™ VOD Recorder** to a computer for programming the recording parameters of the **MicroTrap +™ VOD Recorder** and for downloading of the recorded data. The **Communication and Charger Cable** is connected between the **COMM** port on the back of the unit and a **USB** port of the computer. This is a specific cable that is required for the communication of the unit.

3.1.5 BNC Adapters

Three **BNC Adapters** are provided to facilitate easy connection between the **VOD1**, **VOD2** and **TRIG** connectors on the **MicroTrap +™ VOD Recorder** to the coaxial cable. These cables are to be used to repair a BNC connector in the field with a field repair with the RG-58 cable. These are not designed to be long term solutions. It is important to minimize the connections between the recorder and the sensor.

3.2 Internal Rechargeable Battery

The **MicroTrap +™ VOD Recorder** has an internal NiMH rechargeable battery. The **MicroTrap +™ VOD Recorder** is charged using a USB-C power. When the internal battery is fully charged, the **MicroTrap +™ VOD Recorder** can operate for 6 hours (at maximum **MicroTrap +™ VOD Recorder** power consumption) before battery recharging is required. The **MicroTrap +™ VOD Recorder** is shipped from **MREL** fully charged. Since some time may elapse before the MicroTrap +™ VOD Recorder is actually put to use, the **MicroTrap +™ VOD Recorder** may not be charged fully the first time it is used. Full operating time will be obtained when the **MicroTrap +™ VOD Recorder** is recharged.

3.3 Checking the Power Status

The procedure to check the power status of the **MicroTrap +™ VOD Recorder** is as follows:

If the unit is currently powered off, press and hold the **INFO** button for 2 seconds. The power level will be displayed in percentage.

If the unit is currently powered on, press the **INFO** button. The power level will be displayed in percentage.

3.4 Recharging

The procedure to recharge the **MicroTrap +™ VOD Recorder** is as follows:

1. With the **MicroTrap +™ VOD Recorder** switched **OFF**, connect **Communication and Charger Cable** between the **COMM** port on the back of the **MicroTrap +™ VOD Recorder** and the **Battery Charger**.
2. Full recharging will take up to 10 hours. Do not leave the unit to continuously charge as damage will occur as the battery will generate heat and will decrease the total capacity over time.
3. Unplug the **Battery Charger** from the wall outlet and then from the **MicroTrap +™ VOD Recorder**. The **MicroTrap +™ VOD Recorder** battery status can be tested as detailed in **Chapter 3.3**.

3.5 Long Term Storage Considerations

No special procedures, other than those pertaining to the internal battery, should be taken for long term storage of the **MicroTrap +™ VOD Recorder**. In the eventuality that the **MicroTrap +™ VOD Recorder** remains idle for long periods, it is recommended to recharge the **MicroTrap +™ VOD Recorder** once per month per the procedure in **Chapter 3.4**. This will maintain the conditioning of the internal battery.

NOTE: If the batteries are not charged within 6 months, the battery may lose capacity permanently.

CAUTION

The **MicroTrap +™ VOD Recorder** internal battery should not be overcharged. According to the battery Manufacturer's specifications, full battery pack recharging will take up to 10 hours. The Manufacturer also recommends recharging the **MicroTrap +™ VOD Recorder** at temperatures from 10 to 30 °C (50 to 86 °F).

3.6 On-Screen Menu Structure

The on-screen menu will allow users to configure the **MicroTrap +™ VOD Recorder** without the use of the computer. This section will display the options of the menu and the meaning of each of the settings.

3.6.1 MAIN MENU
- SETTINGS – Allows the changing of the settings for recording VODs.
- CHANNELS ON – Allows for adjustment of which channels are active.
- MEMORY – Allows for deletion of tests.
- ADVANCED – Allows for the adjustment to the trigger level and trigger input.

3.6.1.1 SETTINGS
- ACTIVE MODE
- >The active mode< - possible options: PROBECABLE, PROBEROD, DELAY DET, CUSTOM
- VOD OPTIONS – Adjust the Active Mode to the presets of PROBECABLE, PROBEROD, DET. DELAY
- VIEW CONFIG – Shows the current settings of the recorder including sample rate, total recording time, pre-trigger time, trigger level and trigger type.

3.6.1.1.1 VOD OPTIONS
- PROBECABLE – Press ENTER to set to PROBECABLE or ESC to return to the previous menu.
- PROBEROD – Press ENTER to set to PROBEROD or ESC to return to the previous menu.
- DET. DELAY – Press ENTER to set to DET. DELAY or ESC to return to the previous menu.

Each of these options will configure the **MicroTrap +™ VOD Recorder** to the standard settings that are most commonly used for each of these sensors.

PROBECABLE will configure the unit to the following settings:
- Sample Rate: 2 MHz
- Total Recording Time: 5.2 seconds
- Pre-Trigger Time: 1.1 seconds
- Trigger Level: 90%
- Trigger Type: Internal – will trigger when 10% of the length of the sensor has been consumed.

PROBEROD will configure the unit to the following settings:
- Sample Rate: 2 MHz
- Total Recording Time: 145 ms
- Pre-Trigger Time: 33 ms
- Trigger Level: 90%
- Trigger Type: Internal – will trigger when 10% of the length of the sensor has been consumed.
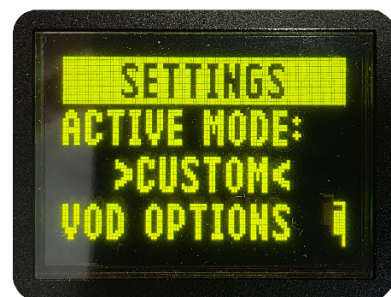
DET. DELAY will configure the unit to the following settings:

- Sample Rate: 100 kHz
- Total Recording Time: 62.9 seconds
- Pre-Trigger Time: 10.5 seconds
- Trigger Level: 90%
- Trigger Type: Internal – will trigger when 10% of the length of the sensor has been consumed.

DET. DELAY will use **PROBECABLE** to measure the actual timing of the detonators. This setting will sample at 100 kHz to allow for time accuracy of one sample every 10 microseconds with a recording time of over 60 seconds for the long delay detonators. Setup will include the use of the detonators (nonel, electric or electronic), **PROBECABLE** and short lengths of detonating cord. The detonators will be arraigned from the end of the **PROBECABLE** with the first ones to fire to the last ones to fire. The **MicroTrap +™ VOD Recorder** will record the time that each detonator functions.

3.6.1.2 CHANNELS ON

- CH1 – Will turn on Channel 1 only. Press ENTER to set or ESC to return to the previous menu.
- CH2 – Will turn on Channel 2 only. Press ENTER to set or ESC to return to the previous menu.
- CH1+CH2 – Will turn on Channels 1 and 2. Press ENTER to set or ESC to return to the previous menu.

3.6.1.3 MEMORY

- MEM. INFO
- DEL LAST TEST
- DEL ALL TESTS

3.6.1.3.1 MEM. INFO

- TESTS: - Displays the number of tests stored in memory
- FREE: - Displays the amount of available memory
- USED: - Displays the amount of memory currently in use

3.6.1.3.2 DEL LAST TEST

- Will be able to move from NO to YES. To back out of this menu, press ESC. To delete the last test, move the selected box to YES and press ENTER

3.6.1.3.3 DEL ALL TESTS

- Will be able to move from NO to YES. To back out of this menu, press ESC. To delete the last test, move the selected box to YES and press ENTER

3.6.1.4 ADVANCED

- TRG LEVEL – Allows adjustment of the internal trigger level
- ADVANCE MODE – Will turn **Auto-Advance** Mode on or off

3.6.1.4.1 TRG LEVEL

- 95% - Percentage of the length of the VOD sensor that will need to be consumed for the unit to trigger on internal trigger.
- 90% - Percentage of the length of the VOD sensor that will need to be consumed for the unit to trigger on internal trigger.
- 85% - Percentage of the length of the VOD sensor that will need to be consumed for the unit to trigger on internal trigger.

3.7 VOD Resistance Sensors

Many different types of VOD resistance sensors are available from MREL and are suitable for use with the **MicroTrap +™ VOD** Recorder:

3.7.1 The VOD PROBEROD

The **VOD PROBEROD** is a rigid probe consisting of a high resistance insulated wire placed within a small diameter metal tube, which acts as the return lead of the circuit. **PROBERODs** are specifically designed to measure **VODs** of explosive cartridges and/or of short sample tubes of explosives, under confined or unconfined conditions. They are available from **MREL** in a standard length of 0.9 m (3 ft.) and are supplied with two leads, ready to be connected to the inner and outer leads of the **RG-58 coaxial cable**. The other end of the **RG-58 Coaxial cable** is fitted with a BNC connector for attachment to the **VOD connector** on the **MicroTrap +™ VOD Recorder**. Contact **MREL** for additional **PROBEROD** information and different lengths to suit your needs.

3.7.1.1 VOD PROBEROD

VOD PROBEROD is our standard VOD sensor. It is a calibrated rigid resistance probe for use in high energy explosives samples to monitor the continuous explosives VOD.

3.7.1.2 VOD PROBEROD-HS

VOD PROBEROD-HS is a VOD sensor that is easily crushed. It is a calibrated rigid resistance probe for use in low energy explosives samples and most emulsions to monitor the continuous explosives VOD.

3.7.1.3 VOD PROBEROD-HR

VOD PROBEROD-HR is a short VOD sensor used with short samples. It is a calibrated high-resistance rigid resistance probe for use in short explosives samples to monitor the continuous explosives VOD.

3.7.1.4 VOD PROBEROD-HR/HS

VOD PROBEROD-HR/HS is a short VOD sensor that is easily crushed. It is a calibrated rigid resistance probe for use in low energy explosives samples and most emulsions to monitor the continuous explosives VOD.

3.7.1.5 VOD PROBEROD-OS

VOD PROBEROD-OS is a VOD sensor that is used for low energy explosives samples to monitor the continuous explosives VOD. May also be suitable for use in recording the burning rate of some propellants.

3.7.1.6 VOD PROBEROD-XT

VOD PROBEROD-XT is a VOD sensor that is can be placed in high temperature applications like melt pour explosive samples.

3.7.1.7 VOD PROBEROD-2E

VOD PROBEROD-2E is a VOD sensor that can be used in line with other 2 ended PROBEROD-2E sensors.

3.7.2 The VOD PROBECABLE

Three types of flexible resistance wire are available from **MREL**:

VOD PROBECABLE "GREEN", VOD PROBECABLE "BLUE" and **VOD PROBECABLE-K "KEVLAR"**.

These cables have been specially developed and refined by **MREL** with extensive feedback and assistance from **MREL's** Blasting Instrumentation Customers since 1987. They are ideally suited to all explosive types loaded into all blasthole conditions, including wet holes. They have the classical configuration of a standard RG-type coaxial cable, where the high resistance wire is the central conductor and the braided shield acts as the return lead. A dielectric material placed between the resistance wire and the return lead provides both electrical insulation and a physical barrier between them. This reduces the possibility of short circuits during handling of the **PROBECABLE**. A PVC outer layer protects the **PROBECABLE** from tearing and damage during loading of the blasthole.

3.7.2.1 PROBECABLE "GREEN"

PROBECABLE "GREEN" is the standard cable that is used in the mines and quarries to measure VOD in boreholes. It is packaged 1000m reel-in-a-box for easy deployment in the field. With the **MicroTrap +™ VOD Recorder**, the minimum length is approximately 5m (15 ft.) and a maximum length of approximately 270m (890 ft.).

3.7.2.2 PROBECABLE-LR "BLUE"

PROBECABLE-LR "BLUE" is a low resistance cable that is used when longer lengths are required in the setup. It is packaged 1000m reel-in-a-box for easy deployment in the field. With the **MicroTrap +™ VOD Recorder**, the minimum length is approximately 15m (50 ft.) and a maximum length of approximately 900m (2970 ft.).

3.7.2.3 PROBECABLE-K "KEVLAR"

PROBECABLE-K "KEVLAR" is a high tensile strength cable that is used when large ground movement occurs typically found in iron mines. It is packaged 1000m reel-in-a-box for easy deployment in the field. With the **MicroTrap +™ VOD Recorder**, the minimum length is approximately 5m (15 ft.) and a maximum length of approximately 270m (890 ft.).

3.7.2.4 PROBECABLE-HT

PROBECABLE-HT is a pre-packaged cable that comes 30m (100 ft.) to a spool. The end that is placed at the bottom of the hole has been pre-manufactured to be shorted so the cable is ready to be installed. It is packaged with 12 spools to a box.

3.8 Technical Specifications

Number of Channels	2 channels for VOD.
Vertical Resolution	14 bits, 1 part in 16,384.
Recording Rate	User selectable: 100, kHz, 1 MHz, 2 MHz
Total Recording Time @ 2 MHz Recording Rate	5.2 seconds Reducing the Recording Rate increases the Total Recording Time.
Pre-Trigger Time	User selectable by Software from 25, 50 or 75% of the Total Recording Time.
Trigger Modes	Internal Trigger Level: user selectable by Software from 70 to 95% of signal level. External Mode: user selectable by Software "wire make" or "wire break".
Power	Internal rechargeable Ni-MH battery pack providing up to 6 hours of active operation when fully charged. The non-volatile memory allows the data to be stored securely regardless of the status of the internal battery pack. Recharging takes up to 10 hours.
Multiple Event Storage	Unit can store more than 100 tests before the memory will need to be downloaded.
Components Provided	**MicroTrap +™ VOD Recorder**, Battery Charger, Communications Cables, BNC Adapters, Padded Carrying Case, Operations Manual and **DAS™ Data Acquisition Suite for MicroTrap +™ Software** (64 bit) for **Windows®**.
Size and Weight	**MicroTrap +™ VOD Recorder**: 21 x 17 x 9 cm (8.3 x 6.7 x 3.5 in.); 2 kg (4.4 lbs.). System in Carrying Case: 23 x 16.5 x 21.5 cm (9 x 6.5 x 8.5 in); 3 kg (6.6 lbs.).
Environmental	Fully operational at -20 to +60 °C (-4 to +140 °F). Snow, rain, dust and sand proof. Drop proof from a height of at least 1 m (3 ft.). IP 68 rated.
PC Connection	After conducting the test(s), the **MicroTrap +™ VOD Recorder** is connected to a computer's **USB port** using the **Communication and Charger Cable** to allow fast downloading of the data to the computer. The connection between the **MicroTrap +™ VOD Recorder** and the computer also allows the operator to confirm and/or change the recording parameters.
Software	The **DAS™ Data Acquisition Suite for MicroTrap +™ Software** operates under **Windows® 10** or newer. It provides an easy-to-use and familiar graphical-user-interface that allows the operator to easily set the recording parameters of the **MicroTrap +™ VOD Recorder**, download the data to the computer and analyze the data. **VOD** data are automatically displayed as graphs of distance versus time. All Software operations are "**point and click**". The **Software** allows unlimited graphical zoom on graphs, creation of annotated sub-graphs and **VOD** and hole/deck delay time analyses of any parts of the **VOD** graph. Annotating, printing, saving and export of graphs and data to other **Windows®** software are all easily accomplished. The operator can select Metric (m/s) or Imperial (ft/sec.) units.
VOD Excitation/Safety	The **MicroTrap +™ VOD Recorder** automatically adjusts its excitation voltage for the maximum 14-bit resolution across the VOD probe. All **VOD** operating parameters are recorded by the **MicroTrap +™ VOD Recorder** with no requirements for additional instrumentation. For safety considerations, the **MicroTrap +™ VOD Recorder** is physically unable to output as much as 50 mA of current to a **VOD probe**.
VOD Resistance Probes	A complete line of **VOD** probes is available from **MREL** to record the **VOD** of explosive samples and multiple holes in large surface mine blasts. The **MicroTrap +™ VOD Recorder** can record VODs across **PROBECABLE-LR** (resistance cable) lengths of up to 900 m (2,950 ft.) per test.

Chapter 4
Recording VOD and
Hole/Deck Delay Times
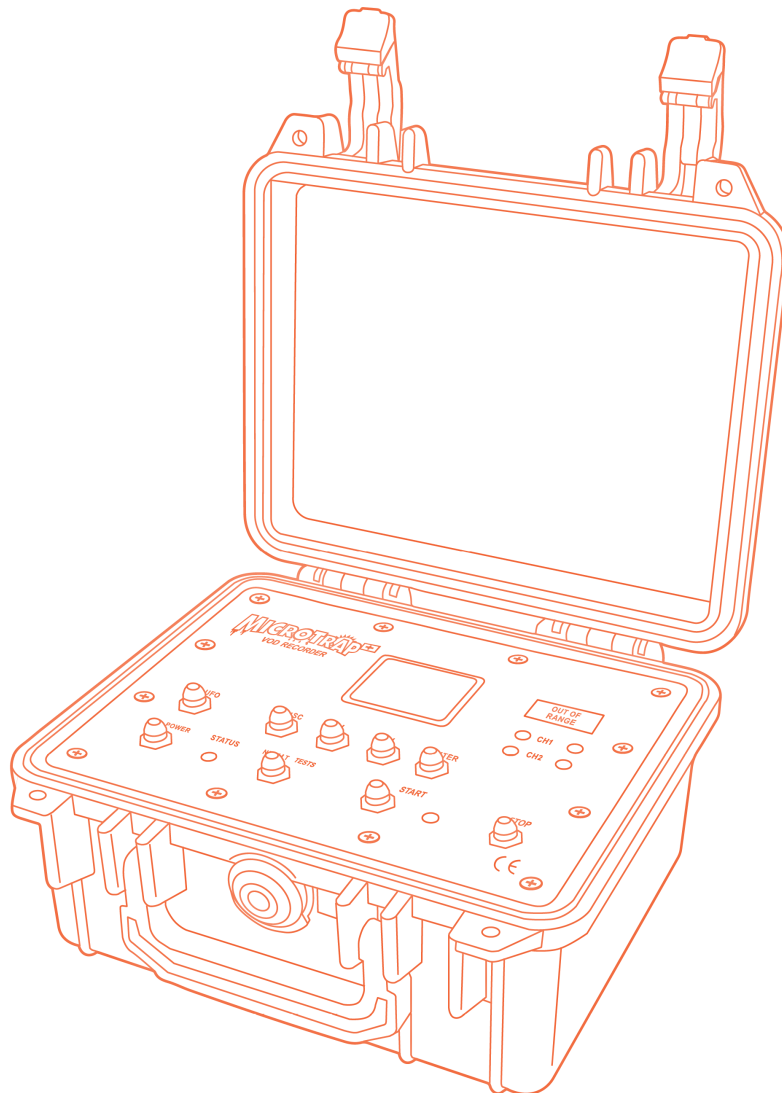
Overview

This Chapter provides detailed instructions on selecting a suitable site for testing explosive samples, loading VOD PROBEROD and VOD PROBECABLE and connecting the MicroTrap +™ VOD Recorder to record VODs and deck delay times.

4.1 Safety Considerations for Selecting an Explosive Testing Site

STOP

Contact **MREL** for site specific recommendations for testing samples of explosives.

Care must be taken to select a good site for detonation and recording **VOD** of explosive samples. If possible, a permanent test site may be constructed. A pit surrounded by an earth wall is typically sufficient for smaller detonations. Additionally, a protected shelter for the **MicroTrap +™ VOD Recorder** and personnel can be constructed at an appropriate distance from the explosive. The distance will depend on the amount of explosive being detonated at one time, and how the explosives are confined (be aware of steel shrapnel from confined shots). Ensure that the area is well demarcated with the appropriate signage and that access is restricted.

If samples of explosives are to be detonated at an unprepared site, then the Operator must be careful when deciding upon what type of ground the charges are to be placed. Avoid placement on ground with stones, rubble or anything that is likely to turn into a projectile. The best surfaces are fines, sand or tailings.

It is always good practice to have maximum control over the time of firing of the test, therefore safety fuse initiation is not recommended. Electronic, electric or shock tube initiation is best with the detonator either initiating the sample of explosives or the primer/booster in the explosive sample.

4.2 The Resistance Wire Technique for Measuring VOD

The **MicroTrap +™ VOD Recorder** is capable of monitoring the continuous VOD profile of an explosive column. It can measure the VOD of relatively short explosive samples such as cast boosters or explosive cartridges. It can also measure the VOD of explosives loaded in multiple surface or underground blastholes. The **MicroTrap +™ VOD Recorder** provides a regulated constant excitation signal to the probe and monitors the drop in voltage across it.

The **MicroTrap +™ VOD Recorder** uses the proven continuous resistance wire technique for monitoring **VODs**. An MREL-qualified probe of known linear resistance (i.e. ohm/m or ohm/ft) is placed axially in the explosive sample or explosive column. As the detonation front of the explosive consumes the probe, the resistance of the circuit will decrease in proportion to the reduction in length of the probe. The **MicroTrap +™ VOD Recorder** records the resulting decrease in voltage across the probe versus time.

The **DAS™ Data Acquisition Suite for MicroTrap +™ Software** automatically converts the recorded data into a graph of distance versus time. The slope of this graph at any position is the **VOD** of the explosive at that particular position. The **DAS™ Data Acquisition Suite for MicroTrap +™ Software** includes functions that will automatically calculate and display the **VOD** of an explosive at any selected location in the graph. Other functions allow the Operator to calculate and display the delay time between selected blastholes or between selected explosive decks within a blasthole. Refer to the **DAS™ Data Acquisition Suite for MicroTrap +™ Software Manual** for more information.
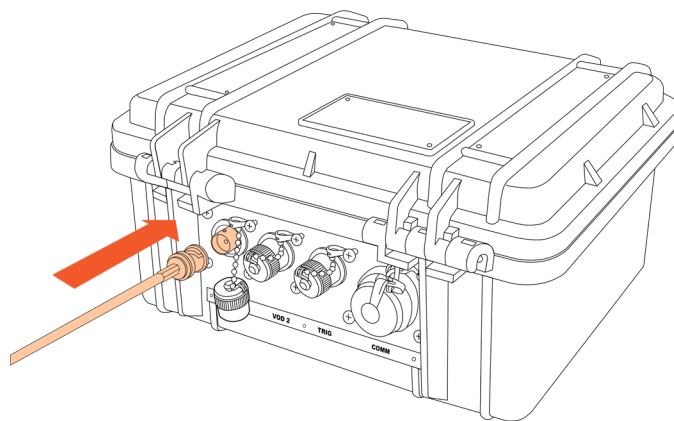
MICROTRAP+™
VOD RECORDER

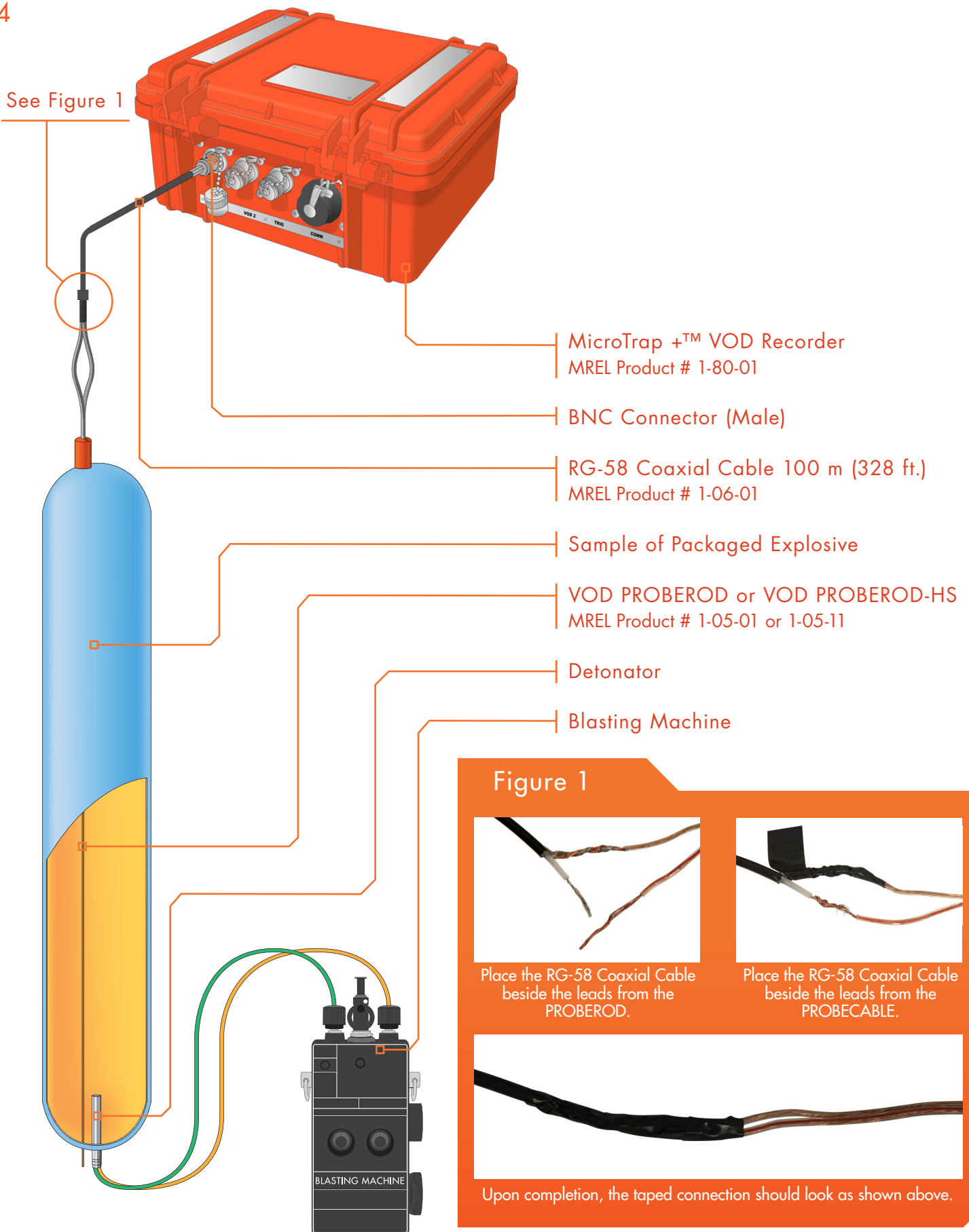# 4.3 Using ProbeRods for Testing Samples Of Explosives

The equipment and supplies that are required to conduct **VOD** tests on samples of explosives or on explosive cartridges are:

- The **MicroTrap +™ VOD Recorder** System.
- **VOD PROBEROD** (available from **MREL**) - one (1) per explosive sample.
- Coaxial cable (type **RG-58** is recommended) - sufficient length to run between the **MicroTrap +™ VOD Recorder** location and the explosives.
- Wire cutters and electrical tape.
- Explosives, detonators and shot exploder.

The procedure for preparing a **VOD** test is as follows:

1. Demarcate the charge detonation area.
2. Place the **MicroTrap +™ VOD Recorder** in a protective shelter and/or a safe distance away from the detonation area. This distance may be closer than what is considered safe for the User. Once the setup is completed, the **MicroTrap +™ VOD Recorder** does not require the User to collect the data; it does so automatically without assistance.
3. Run a length of coaxial cable from the **MicroTrap +™ VOD Recorder** to the detonation area with enough excess length to compensate for cable movement produced by the products of detonation. A male BNC connector should be attached to the end of the coaxial cable that is to be attached to the **VOD** input at the back of the **MicroTrap +™ VOD Recorder**. If your reel of **RG-58 coaxial cable** is not equipped with a BNC male connector. A BNC Adapter has been supplied with the **MicroTrap +™** for the purpose of connecting to the **VOD** input. The **BNC Adaptor** can be connected to the coaxial cable using wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center". Ensure that the center conductor and the shielding conductor do not touch each other across the connection.
4. Note the **Unit Resistance** of the probe by reading the value in ohm/m or ohm/ft from the **MREL** factory label on the **PROBEROD**. Note the ohm/m value if the **VOD** is to be reported in m/s. Note the ohm/ft value if the **VOD** is to be reported in ft/sec. The **Unit Resistance** information will be requested later by the **DAS™ Data Acquisition Suite for MicroTrap +™ Software**.
5. Insert a **PROBEROD** axially in the sample of explosives. Start at the opposite end from where the detonator will be placed as shown. If bulk explosives are being tested in a tube that has been sealed at both ends, make a small hole in the centre of each end to allow the

PROBEROD to pass through. The **PROBEROD** should be inserted all the way to the orange junction where the **PROBEROD** meets the two lead wires. This will ensure that the **MicroTrap +™ VOD Recorder** triggers most dependably. If a measurement of run-up to detonation is required, ensure that the **PROBEROD** is pushed well into the explosives so that it reaches the position of the detonator or booster. If the **PROBEROD** reaches the booster or protrudes past it, the effect of the booster will be recorded by the **MicroTrap +™ VOD Recorder**. The same holds true for cartridges of explosives. To test the VOD of detonation cord, tape the detonation cord along the entire length of the **PROBEROD**.

6. Connect the **PROBEROD** to the coaxial cable using the wire cutters and electrical tape. The polarity of the connection is not important. For the cleanest possible data, there are some items that can help. Connect the shielding wire of the coax to the copper tube wire. This can be found easily by using a galvanometer to measure the resistance between the lead wire and the copper tube. The lead wire with the resistance that is near zero will connected to the shielding of the coax. Also, align the explosive sample with the coax to allow a straight line back to the recorder.

MREL
GROUP OF COMPANIES

See Figure 1

MicroTrap +™ VOD Recorder
MREL Product # 1-80-01

BNC Connector (Male)

RG-58 Coaxial Cable 100 m (328 ft.)
MREL Product # 1-06-01

Sample of Packaged Explosive

VOD PROBEROD or VOD PROBEROD-HS
MREL Product # 1-05-01 or 1-05-11

Detonator

Blasting Machine

BLASTING MACHINE

Figure 1

Place the RG-58 Coaxial Cable beside the leads from the PROBEROD.

Place the RG-58 Coaxial Cable beside the leads from the PROBECABLE.

Upon completion, the taped connection should look as shown above.

7. Connect the coaxial cable to the **VOD** connector located on the back of the **MicroTrap +™ VOD Recorder**.
8. The **PROBEROD** installation aspects of the test are complete. The User can now place the detonator and connect it to the shot exploder as per standard procedures. The **MicroTrap +™ VOD Recorder** is now ready to be prepared to record the test as detailed in **Chapter 4.6**.
9. If testing 2 samples, repeat for the 2nd sample.

4.4 Using ProbeCable for Testing Explosives In Blastholes

The equipment and supplies that are required to conduct **VOD** tests in blastholes are:

- The **MicroTrap +™ VOD Recorder** System.
- **VOD PROBECABLE "GREEN"** or **VOD PROBECABLE-LR "BLUE"** (available from **MREL**).
- Coaxial cable (type **RG-58** is recommended) - sufficient length to run between the **MicroTrap +™ VOD Recorder** location and the last blasthole in the blast to be recorded.
- Wire cutters and electrical tape.
- Explosives, detonators and shot exploder.

4.4.1 Preparation of ProbeCable for Single Blasthole Recording

1. Prepare the end of the **PROBECABLE** by using the wire cutters to remove the insulation from the end. Then short the **PROBECABLE** by connecting the shielding wire to the center conductor wire and twist them together. Protect the connection well with electrical tape.
2. Using tape or wire, attach the short circuit end of the **PROBECABLE** to the primer/booster or to a rock and lower the **PROBECABLE** into the hole as shown in the diagram on the following page. Detonation cord downlines may damage the **PROBECABLE** or cause side initiation of the bulk explosive. When initiating with detonation cord, attach the **PROBECABLE** to a rock and lower it on the side of the hole opposite to the detonation cord downline.
3. The **PROBECABLE** can then be cut at the top of the hole.
4. Note the Unit Resistance of the probe by reading the value in ohm/m or ohm/ft from the **MREL** factory label on the spool of **PROBECABLE**. Note the ohm/m value if the **VOD** is to be reported in m/s. Note the ohm/ft value if the **VOD** is to be reported in ft/sec. The Unit Resistance information will be requested later by the **DAS™ Data Acquisition Suite for MicroTrap +™ Software**. When measured with a blaster's galvanometer, the Probe Resistance should compare closely with the calculated resistance of the **PROBECABLE** (Unit Resistance multiplied by length). If this is not the case then remove the length of **PROBECABLE** and reload another length into the hole.
5. The hole can now be loaded with explosives and stemming per usual procedure. Hold the **PROBECABLE** taut during the loading of the explosive to avoid slack in the hole. If you will not be present during loading, tie the **PROBECABLE** taut around a hole marker stake, or around a rock at the top of the borehole. After loading, you may wish to check the total resistance of the **PROBECABLE** to ensure that no damage has occurred. Damage is unlikely, as the **PROBECABLE** is well protected with PVC coating.
6. Connect the **PROBECABLE** to the coaxial cable using the wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center". Ensure that the center conductor and the shielding connections do not touch each other.
7. Place the **MicroTrap +™ VOD Recorder** in a protective shelter (a short piece of steel pipe is a good shelter) and/or a safe distance away from the blast area as dictated by flyrock. This distance may be closer than what is considered safe for the User. When set, the **MicroTrap +™ VOD Recorder** does not require a User to collect the data; it will record the data automatically.
8. Run the coaxial cable from the **PROBECABLE** to the **MicroTrap +™ VOD Recorder**. Shorter lengths of coaxial cable may be connected together using the wire cutters and electrical tape. Somewhere along the length of the coaxial cable, loop the coaxial cable around a large rock. When the blast is fired, and the ground moves, looping the coaxial cable around a large rock will stop the blast from pulling the coaxial cable, and the **MicroTrap +™ VOD Recorder**, with the blast. Alternatively, leave sufficient slack in the coaxial cable to allow for ground movement.
9. A male BNC connector should be attached to the end of the coaxial cable that is to be attached to the **VOD** input on the **MicroTrap +™ VOD Recorder**. If your reel of RG-58 coaxial cable is not equipped with a BNC male connector, a convenient

See Figure 2

RG-58 Coaxial
Cable 100 m (328 ft.)
MREL Product # 1-06-01

BNC Connector(Male)

Blasting Machine

Stemming

Bulk Explosive

Detonator & Booster

Blasthole

MicroTrap +™
VOD Recorder
MREL Product # 1-80-01

VOD PROBECABLE
MREL Product # 1-05-05

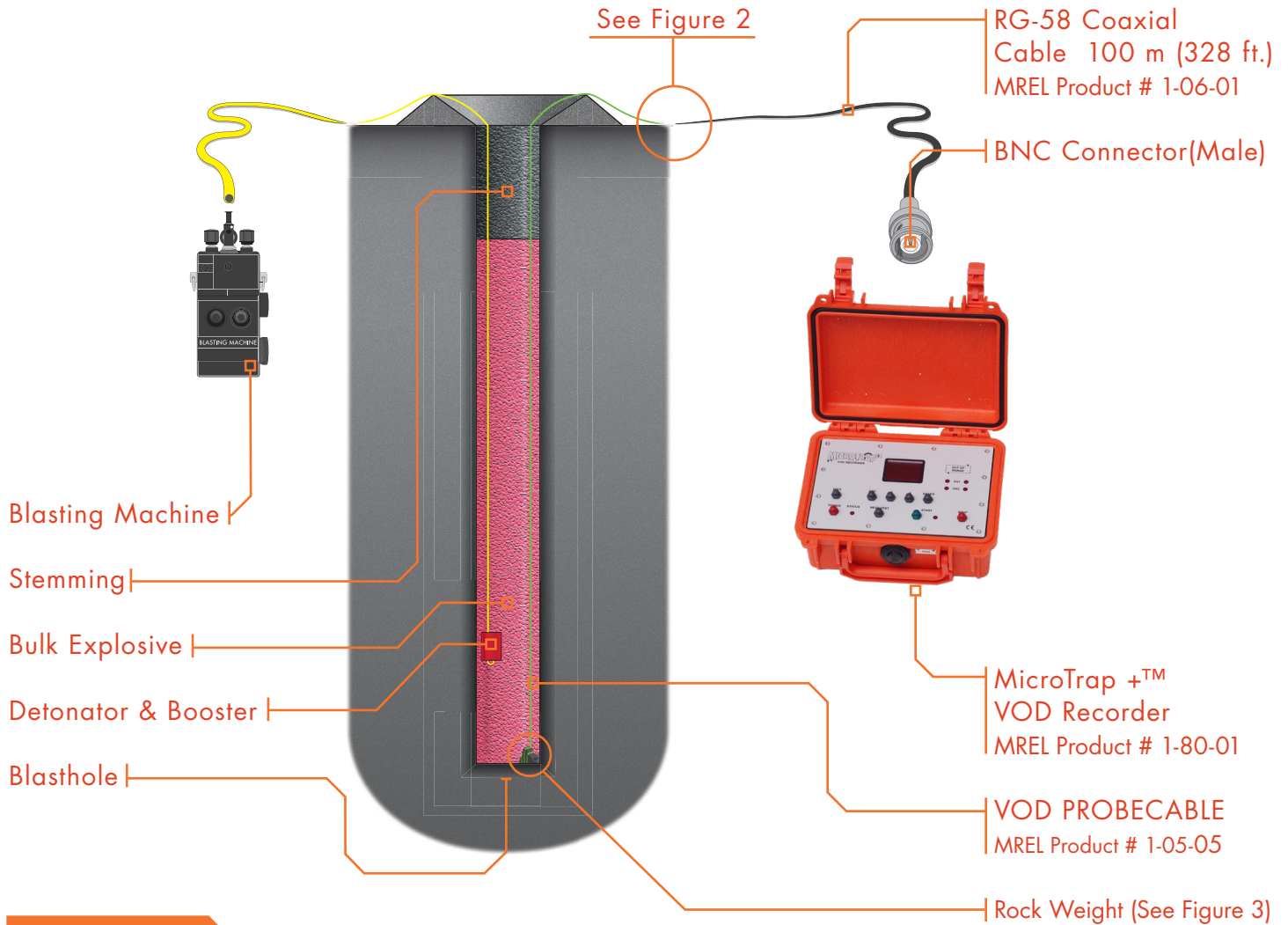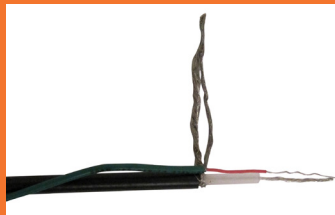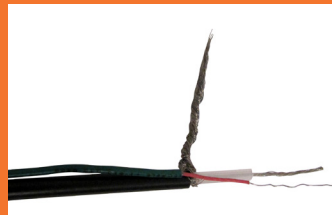Rock Weight (See Figure 3)

Figure 2

Place the RG-58 Coaxial Cable beside the leads from the PROBECABLE.

Twist the shielding of the coax and the PROBECABLE together.

Twist the center conductors together.

Pull the shielding wires back along the cables and start taping from the cable to the end.

Making sure that there is no loose wires from the shielding touching the center conductors, continue to tape past the end.

Upon completion, the taped connection should look as shown above.

For strain relief, tie a loose knot down the cables from the connection as shown above.

BNC Adapter has been supplied with the **MicroTrap +™ VOD Recorder** for the purpose of connecting to the **MicroTrap +™ VOD** input. The BNC Adapter is a short length of coaxial cable with a male BNC connector attached to one end, and two bare leads on the other. The BNC Adaptor can be connected to the coaxial cable using wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center". Ensure that the center conductor and the shielding conductor do not touch each other across the connection. It is a good practice to check the total resistance of the **PROBECABLE** and coaxial cable. Ensure that the total resistance is between 50 and 3000 ohms.

10. Connect the coaxial cable to the **VOD** input located on the back of the **MicroTrap +™ VOD Recorder**.
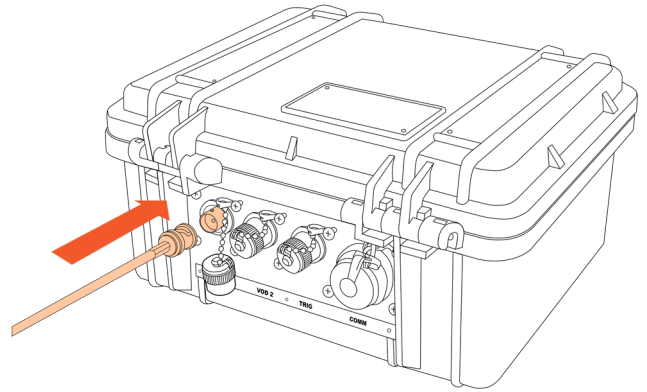
NOTE: If the out-of-range Low light is on, there is probably a short or less than 4 m of **PROBECABLE**. If the out-of-range High light is on, there is probably an open circuit somewhere.

11. The **PROBECABLE** installation is complete. The **MicroTrap +™ VOD Recorder** is now ready to be prepared to record the test as detailed in **Chapter 4.6**.

12. If testing 2 boreholes, repeat for the 2nd borehole.

4.4.2 Preparation of ProbeCable for Multiple Blasthole Recording

Figure 3

This tape marks 1m (39 in.) from the end of the PROBECABLE.

1. Prepare the end of the **PROBECABLE** by using the wire cutters to remove the insulation from the end. Then short the **PROBECABLE** by connecting the shielding wire to the center conductor wire and twist them together. Protect the connection well with electrical tape.

2. Start at the first blasthole in the sequence, attach the short circuit end of the **PROBECABLE** to the booster or to a rock using tape or wire, and lower the **PROBECABLE** into the hole. Detonation cord downlines may damage the **PROBECABLE** or cause side initiation of the bulk explosive, therefore when using detonation cord you should attach the **PROBECABLE** to a rock and lower it on the opposite side of the blasthole from the detonation cord downline.

3. Run the **PROBECABLE** between the first hole and the second hole leaving sufficient slack between the holes to allow for ground movement between the delayed holes. Coil the slack cable near the collar of the second hole.

4. Each blasthole following the first hole will require a doubled length of **PROBECABLE** in order to form a continuous circuit throughout the blast. There are two common methods of lowering a doubled length of **PROBECABLE** in these holes. The first and simplest method is to run the **PROBECABLE** through a wire loop that has been tied or taped around a rock or booster. This allows the rock to slide along the **PROBECABLE** as the **PROBECABLE** is lowered into the hole, until the rock reaches the bottom of the hole. The second method is to measure out the midpoint of the length of **PROBECABLE** that is to be lowered into the hole, and attach the rock or booster so that it reaches the exactly the bottom of the hole when inserted.

5. After the last hole to be recorded has been loaded with **PROBECABLE**, the **PROBECABLE** can then be cut a short distance from top of that hole.

6. Note the Unit Resistance of the probe by reading the value in ohm/m or ohm/ft from the **MREL** factory label on the box of **PROBECABLE**. Note the ohm/m value if the **VOD** is to be reported in m/s. Note the ohm/ft value if the **VOD** is to be reported in ft/sec. The **Unit Resistance** information will be requested later by the **DAS™ Data Acquisition Suite for MicroTrap +™ Software**. When measured with a **Blaster's galvanometer**, the **Probe Resistance** should compare closely with the calculated resistance of the **PROBECABLE** (**Unit Resistance** multiplied by its length). If this is not the case then remove the length of **PROBECABLE** and reload another length into the hole.

MREL GROUP OF COMPANIES
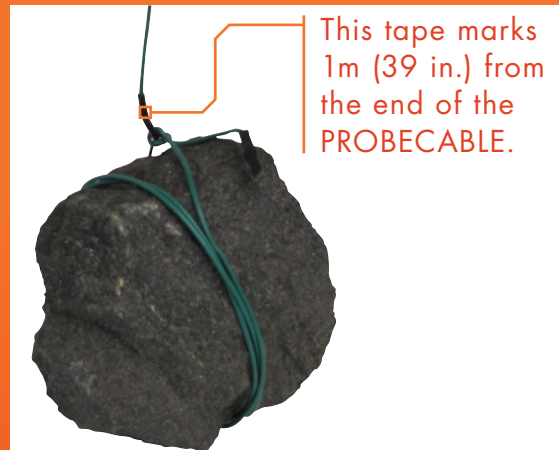
7. The hole can now be loaded with explosives and stemming per usual procedure. Hold the **PROBECABLE** taut during the loading of the explosive to avoid slack in the hole. If you will not be present during loading, tie the **PROBECABLE** taut around a hole marker stake, or around a rock at the top of the borehole. After loading, you may wish to check the Probe Resistance with a digital **Blaster's Galvanometer** to ensure that no damage has occurred to the **PROBECABLE**. Damage is unlikely, as the **PROBECABLE** is well protected with PVC coating.

8. At the top of the last hole, connect the **PROBECABLE** to the coaxial cable using the wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center". Ensure that the center conductor and the shielding conductor do not touch each other across the connection.

9. Place the **MicroTrap +™ VOD Recorder** in a protective shelter and/or a safe distance away from the blast area as dictated by flyrock. This distance may be closer than what is considered safe for the User. When set, the **MicroTrap +™ VOD Recorder** does not require a User to collect the data; it records the data automatically.

10. Run the coaxial cable from the **PROBECABLE** to the **MicroTrap +™ VOD Recorder**. If necessary, shorter lengths of coaxial cable may be connected together using the wire cutters and electrical tape to make a longer length of coaxial cable. Somewhere along the length of the coaxial cable, loop the coaxial cable around a large rock. When the blast is fired, and the ground moves, looping the coaxial cable around a large rock will stop the blast from pulling the coaxial cable and the **MicroTrap +™** with the blast. Alternatively, leave sufficient slack in the coaxial cable to allow for ground movement.

11. A male **BNC connector** should be attached to the end of the coaxial cable that connects to the VOD input on the back of the **MicroTrap +™ VOD Recorder**. If your reel of RG-58 coaxial cable is not equipped with a BNC male connector, a convenient **BNC Adapter** has been supplied with the **MicroTrap +™ VOD Recorder** for the purpose of connecting to the **MicroTrap +™ VOD Recorder VOD** input. A **BNC Adapter** is a short length of coaxial cable with a male BNC connector attached to one end, and two bare leads on the other. The **BNC Adaptor** can be connected to the coaxial cable using wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center". Ensure that the center conductor and the shielding conductor do not touch each other across the connection.

12. Connect the coaxial cable to the **VOD** input on the back of the **MicroTrap +™ VOD Recorder**.

13. The **PROBECABLE** installation aspects of the test are now complete. The **MicroTrap +™ VOD Recorder** is now ready to be prepared to record the test as detailed in **Chapter 4.6**.

14. If testing with 2 channels, repeat for the 2nd channel.

4.5 ProbeCable And Coaxial Cable Protection

It is important to protect the **PROBECABLE** and the coaxial cable from damage caused by personnel and machinery operating on the blast. It is also important to protect the **PROBECABLE** from damage caused by detonation of other holes and/or surface accessories such as detonating cord, detonating relays, and shock tube bunch blocks.

The cables may be protected in many ways. Experience has shown that it is best to lead the **PROBECABLE** and coaxial cable under the detonating cord and leave a barrier of sand or drill cuttings between the cables and the detonating cord. A danger point is the collar area of the holes as the detonating cord or shock tube bunch blocks that initiate the downlines may cross directly over the **PROBECABLE** or coaxial cable. A good procedure is to protect the area where there is a cross over for about 1.5 m (5 ft) along the length of cable. Experience has shown that a sand or stemming barrier thickness of 15-30 cm (0.5-1 ft) is sufficient to protect the cables.

IMPORTANT

When shipped from **MREL**, the **MicroTrap +™ VOD Recorders** recording parameters have been pre-set to settings appropriate for most blasthole **VOD** recording situations. Recording Rate = 2 MHz. Total Recording Time = 5.2 seconds. Pre-trigger Time = 25% of Total Recording Time = 1.2 seconds. Trigger Level = 90%. These settings recommendations are based on **MREL's** extensive worldwide experience in **VOD** recording.
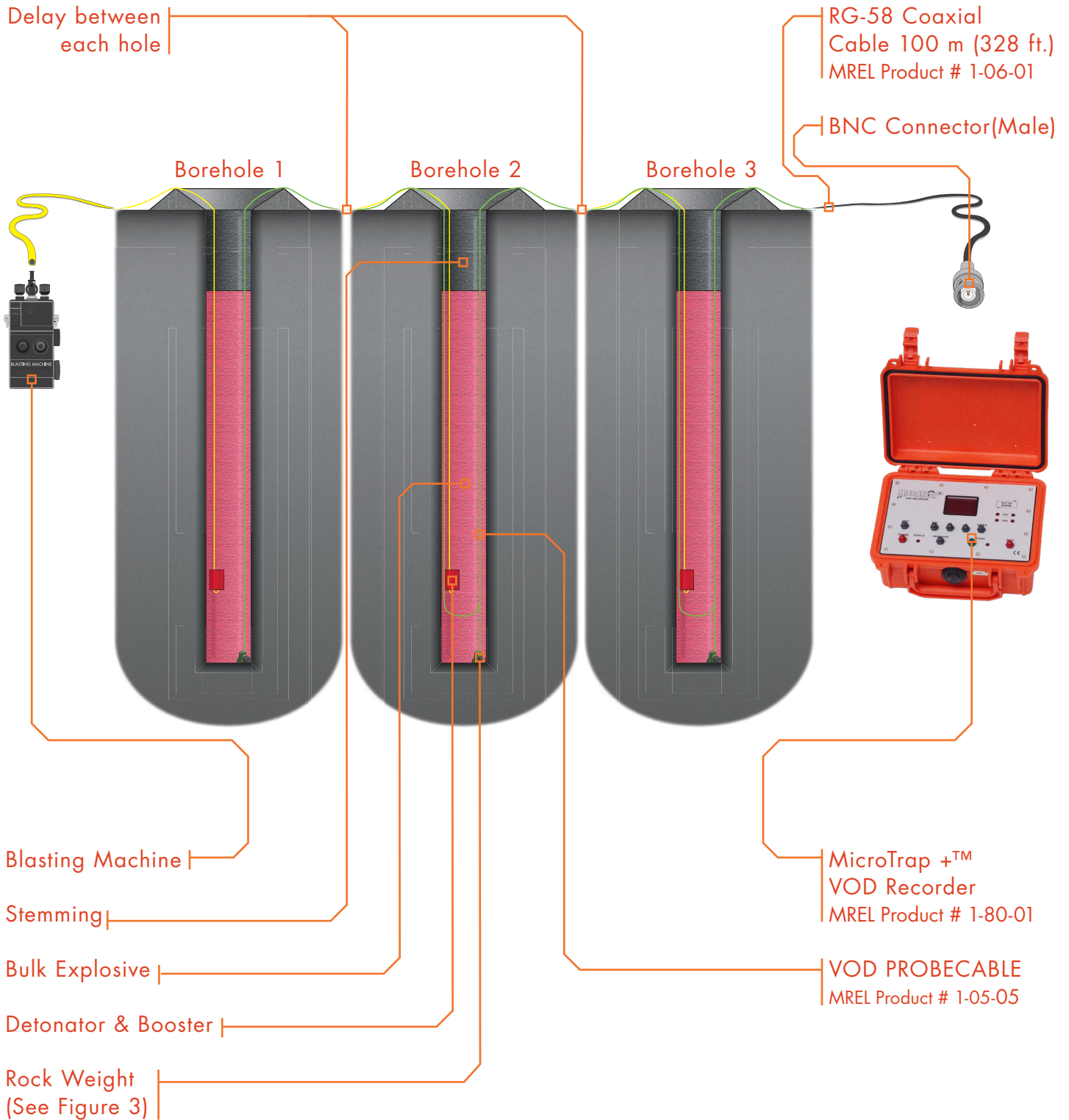
IMPORTANT

MREL recommends a **Trigger Level** of 90% and a **Pre-Trigger Time** of 25% for **VOD** recording of explosives samples and explosives in blastholes.

MREL recommends setting of **PROBECABLE** for recording of blastholes using **PROBECABLE**. The Operator will normally be able to download the data from the **MicroTrap +™ VOD Recorder** to a computer before conducting the next **VOD** test.

MREL recommends setting of **PROBEROD** for recording of samples of explosives using a **PROBEROD**. This reduces the quantity of data collected per test and conserves the computer's disk space. At a 2 MHz recording rate, a **MicroTrap +™ VOD Recorder** will record for a total of 145 ms per test. This is more than sufficient recording time for a sample of explosives

4.6 MicroTrap +™ Setup Procedure For VOD Measurements

Once the **VOD** probe has been placed in the explosive and connected to the **RG-58** coaxial cable running to the **VOD** input on back of the **MicroTrap +™ VOD Recorder**, the User may now prepare it for recording. The procedure to record a new **VOD** test consists of the following steps:

1. Ensure that the coaxial cable coming from the **PROBEROD** or **PROBECABLE** is connected to the **MicroTrap +™ VOD Recorder** signal input connector labeled VOD1 or VOD2. This unit can accept two different VOD sensors to make measurements.
2. Turn the **MicroTrap +™ VOD Recorder ON**. The **STATUS** light will illuminate.
3. Ensure that the unit is configured for the testing that is about to be performed. Press **UP Arrow** to see the menu. Select **SETTINGS** to view the current **ACTIVE MODE**. To change the active mode, press **ENTER** to select VOD OPTIONS. In this menu, three different options can be selected: **PROBECABLE**, **PROBEROD** or **DET. DELAY**. Select the correct option for the work that will be conducted. This selection will overwrite any selections that have been made using **DAS™ Data Acquisition Suite for MicroTrap +™ Software**.
4. Confirm the required channels are active for the measurement. Press **ENTER** to see the menu. Press the **Down Arrow** to select **CHANNELS ON**. Press **ENTER**. Select the correct channels to be active (**CH1**, **CH2** or **CH1 + CH2**). Press **ENTER** to confirm.
5. Confirm the **VOD** settings are correct for the test setup. Select **SETTINGS** in the **MAIN MENU**. Confirm the settings are correct. Press the **DOWN ARROW** to see **VIEW CONFIG**. Press **ENTER**. This will show the settings of the unit. If correct, press ESC until at the **MAIN MENU**.
6. Press **NEXT TEST**.
7. The **MicroTrap +™ VOD Recorder** will have the **STATUS** light solid. The Active channels will have both the out of range lights on for 2 seconds to show that the channels are active. After 2 seconds, the out of range lights will go out and then will show if the sensor attached is within the required range of 50 to 3000 ohms.
   If the **OUT OF RANGE**↑ (high) light is on, this will mean that the resistance is greater than 3000 ohms attached to the channel. Some of the more common issues for this problem can be the connection between the coax and VOD sensor is not made properly and there is an open circuit. Another common issue can be with the BNC connection if there is a loose connection.
   If the **OUT OF RANGE**↓ (low) light is on, this will mean that the resistance is less than 50 ohms attached to the channel. Some of the more common issues for this problem can be the connection between the coax and VOD sensor is not made properly and there is a short circuit. Another common issue can be with the BNC connection if there is a loose connection.
8. With the **OUT OF RANGE** lights off, press the **START** button.
9. The **MicroTrap +™ VOD Recorder** is now recording the data on the active channels waiting for a valid trigger.
10. When the **MicroTrap +™ VOD Recorder** triggers, the data will be recorded into the unit and will take a moment after the event to write the information to non-volatile memory.

11. When the **MicroTrap +™ VOD Recorder** finishes storing the data, the **MicroTrap +™** will power off.

.

If no more experiments are to be conducted and the data storing process has been finished (**Step 11** above), then the data are ready to be transferred to a computer using the **DAS™ Data Acquisition Suite for MicroTrap +™ Software**.

4.7 Probe Resistance Out Of Range Lights

There are four **OUT OF RANGE** warning lights on the **MicroTrap +™ VOD Recorder**. The lights labeled ↑ , which illuminate when the total resistance (resistance VOD sensor plus coaxial cable) is greater than 3,000 ohms. The others are labeled ↓ , which illuminates when the total resistance is less than 50 ohms. The **MicroTrap +™ VOD Recorder** is designed to only perform **VOD** tests using this range of initial resistance values (50 – 3,000 ohms).

There are three reasons for the initial total resistance to be LOW:

1. A short circuit somewhere in the coaxial cable and probe assembly, including any BNC connector(s) or **BNC Adapter**;
2. A damaged **PROBEROD**;
3. An insufficient length of **PROBECABLE**.

Item 1 can be tested using a **Blaster's Galvanometer** to test the resistance/continuity of the coaxial cable and probe assembly. It can be solved by remaking the connections or replacing faulty **BNC Connectors**. Item 2 is addressed by replacing the damaged **PROBEROD**. Item 3 can be addressed by attaching some additional length of **PROBECABLE** to the probe circuit. This will not affect the VOD results. If **PROBECABLE-LR** is being used in the test, then consider using **PROBECABLE** for such tests in the future. The unit resistance of **PROBECABLE** is approximately 3 times that of **PROBECABLE-LR**.

There are three reasons for the total resistance to be HIGH:

1. An open circuit somewhere in the coaxial cable and probe assembly, including any BNC connector(s) or **BNC Adapter**;
2. A damaged **PROBEROD**;
3. Too long a length of **PROBECABLE**.

Item 1 can be tested using a blaster's galvanometer to test the resistance/continuity of the coaxial cable and probe assembly. It can be solved by remaking the connections or replacing faulty **BNC Connectors**. Item 2 is addressed by replacing the damaged **PROBEROD**. If Item 3 is the cause, then reduce the length of the **PROBECABLE** used in the test by cutting out excess **PROBECABLE** between holes and extending the coaxial cable from the recorder and remaking the connections using the wire cutters and electrical tape. Alternatively, this can be achieved by reducing the number of holes being recorded by cutting the **PROBECABLE** and remaking the appropriate connection with the wire cutters and electrical tape. If **PROBECABLE** is being used in the test, then considering using **PROBECABLE-LR** for such tests in the future. The unit resistance of **PROBECABLE-LR** is approximately 1/3 that of **PROBECABLE**.

4.8 Utilizing the External Trigger

In some **VOD** and data recording applications, it may be desirable to have the **MicroTrap +™ VOD Recorder** begin to record exactly when a specific external event occurs. For the specific event to trigger the **MicroTrap +™ VOD Recorder**, and subsequently correspond to time zero on the **VOD** graph, the **TRIG** port is used.

The trigger type is set to Internal and external mode of **MAKE** or **BREAK**, function operates on the simple concept of **MAKE** or **BREAK** circuits. Both types of triggers capitalize on the fact that the **TRIG** port outputs a constant voltage after the **START** button is pressed. The traditional **MAKE** circuit is triggered when the open circuit is closed by the event of interest, even if only momentarily. The traditional **BREAK** circuit is triggered when the complete circuit is broken, even if only momentarily.

To create a **MAKE** or **BREAK** trigger using the **TRIG** port, connect a **BNC Adaptor** to the port and subsequently connect a "**duplex**" (two wired) cable to the adaptor. A good example of a duplex wire that is fit for duty as a trigger line is the lead line used for initiating electric detonators in the field.

An example of a **MAKE** trigger would be to twist the duplex wire with itself, leaving the insulation on each wire, and then run it over the tip of a detonator or around a section of detonating cord, so that upon detonation of the explosive, the insulation is stripped and the two wires are forced into contact with each other under pressure from the explosive. This momentary contact will complete the **MAKE** circuit and thus trigger the **MicroTrap +™ VOD Recorder**. The **MAKE** trigger is especially dependable because the explosive itself generates an electrically conductive plasma in the vicinity of the detonation front, that will assist in arcing the current from one wire to the other.

An example of a **BREAK** trigger would be to wrap a duplex wire around an object that is expected to deform or expand during the event of interest, and then twist the bare ends of the wires together so as to complete the circuit. When this object deforms or expands, the wires will disconnect and cause the circuit to open - triggering the **MicroTrap +™ VOD Recorder**. Beware that even a momentary break in the trigger circuit will cause the **MicroTrap +™ VOD Recorder** to trigger. Avoid disturbing a **BREAK** trigger once the **START** button has been pressed.

CAUTION

The continuity mode of commercial multimeters may apply a higher current than is allowed at a blasting site. Any tests with continuity mode of a multimeter should be done with cables which are in a non-blasting field location. If the VOD sensor is in the vicinity of energetics, it is recommended to use a **Blaster's Galvanometer** to measure the resistance values.

The procedure for using the **DAS™ Data Acquisition Suite for MicroTrap +™ Software** to program the **MicroTrap +™ VOD Recorder** for **MAKE** or **BREAK** external triggering is detailed in the **DAS™ Data Acquisition Suite for MicroTrap +™ Software Manual**.

4.9 Additional Information on Memory and Triggering

4.9.1 Memory

The **MicroTrap +™ VOD Recorder** has a large circular memory containing 5.2 seconds that are allocated for each test.

The operator can adjust the sample rate from the default 2 MHz to a slower value of 1 MHz to extend the recording time for each test.

4.9.2 Triggering

When the **MicroTrap +™ VOD Recorder** is set to trigger from external trigger (**BREAK CIRCUIT** or **MAKE CIRCUIT**) it will receive the trigger signal from the Trigger Wire as detailed in **Section 4.8**. This corresponds to time = 0 on the resulting VOD graph.

When **Internal** trigger is chosen, the **MicroTrap +™ VOD Recorder** is triggered by the signal received from the probe placed in the explosives. This trigger signal occurs according to the following principle: when the explosive detonates, the probe is consumed and the probe length is reduced. This in turn reduces the resistance and thus the voltage across the probe decreases from the initial voltage that is set automatically by the **MicroTrap +™ VOD Recorder.** When the voltage across the probe reaches the value corresponding to the Trigger Level selected by **DAS™ Data Acquisition Suite for MicroTrap +™ Software**, the **MicroTrap +™ VOD Recorder** is triggered. This represents time = 0 on the resulting **VOD** graph. For example, with a **Trigger Level** setting of 90%, the **MicroTrap +™ VOD Recorder** will be triggered when the total length of cable drops to 90% of the initial value that was captured when the **START** button was pressed.

Once the **MicroTrap +™ VOD Recorder** receives the trigger signal, it stores the **VOD** information received immediately prior to the trigger signal into the pre-trigger memory; the **VOD** information received after the trigger signal is stored into the post-trigger memory. The recording time for each memory allocation (pre and post-trigger) will depend on the setting selected, using the **DAS™ Data Acquisition Suite for MicroTrap +™ Software**, for **Pre-Trigger** %. The **DAS™ Data Acquisition Suite for MicroTrap +™ Software** automatically calculates and displays the **Total Recording Time** per Test and the **Pre-Trigger Time**. For those Operators with additional interest in recording times:

<div align="center">

Pre-Trigger Time = (Total Recording Time) x Pre-Trigger %
Post-Trigger Time = (Total Recording Time) - (Pre-Trigger Time)

</div>

For the **PROBECABLE**, **PROBECABLE-K** or **PROBECABLE-LR** length loaded in the blastholes, and the recommended **TRG LEVEL** setting of 90%, The trigger point will be when 90% of the initial length remains (when 10% of the cable is consumed). **PROBECABLE-LR** should be used for tests involving several holes where if **PROBECABLE** was used it would result in the Total Resistance exceeding the maximum resistance accepted by the **MicroTrap +™ VOD Recorder** (3,000 ohms).

For example, at a 90% **Trigger Level** and with 250 metres of **PROBECABLE** loaded into blastholes, then 25 metres of **PROBECABLE** must be consumed to trigger the **MicroTrap +™ VOD Recorder**. If the first hole does not consume a sufficient length of **PROBECABLE** to trigger the **MicroTrap +™ VOD Recorder**, then all of the **VOD** data for the first hole will be before time = 0.

The Operator should ensure that there is sufficient **Pre-Trigger** time to record the time it takes for the trigger length of **PROBECABLE** to be consumed in the blast. This is particularly important if several delayed holes must be detonated in order for sufficient **PROBECABLE** to be consumed. The **MicroTrap +™ VOD Recorder** has a very large memory and a very long Total Recording Time. At a Pre-Trigger % setting of 25%, the **MicroTrap +™ VOD Recorder** has a long **Pre-Trigger Time**. It is likely that there will always be sufficient **Pre-Trigger Time** to record the time it takes for the trigger length of **PROBECABLE** to be consumed in the blast.

If there is insufficient **Pre-Trigger** time, the best procedure is for the Operator to re-program the **MicroTrap +™ VOD Recorder** using the **DAS™ Data Acquisition Suite for MicroTrap +™ Software** and increase the **Pre-Trigger** % to increase the amount of **Pre-Trigger Time** to suit the test. Alternatively, the Operator can reduce the **Recording Rate** to increase the amount of both **Pre** and **Post-Trigger Time**. It should be noted that the minimum sample rate recommended for **VOD** measurements is 1 MHz.

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Chapter 5
MicroTrap +™ VOD Recorder Software
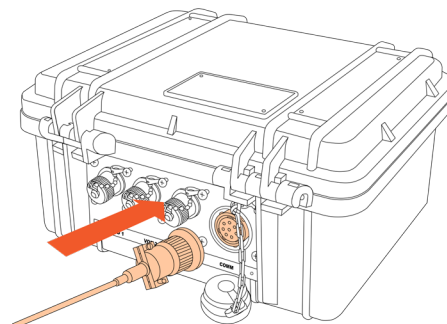
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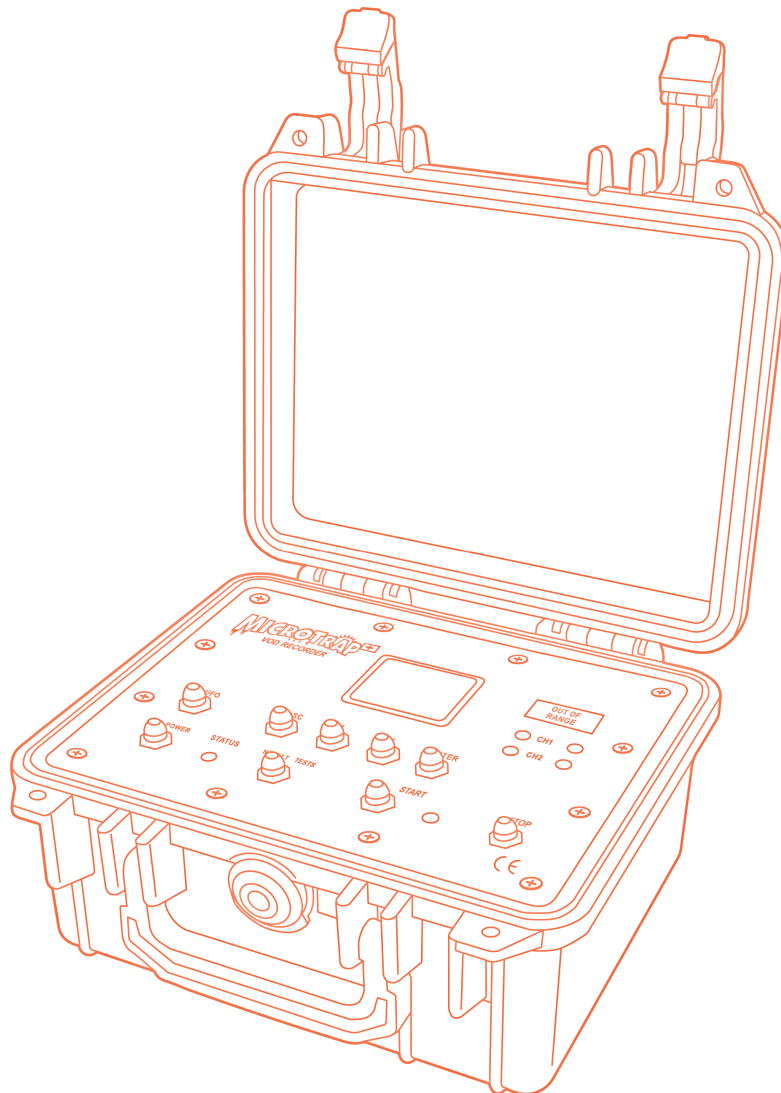
Overview

This Chapter provides an overview on how to retrieve data from the MicroTrap +™ VOD Recorder and how to analyze the data obtained.

5.1 Retreiving Data From The MicroTrap +™ VOD Recorder

The procedure to retrieve data from the **MicroTrap +™ VOD Recorder** to a computer is as follows:

1. Connect the **Communication and Charger Cable** between the **USB Port** on the computer and the **COMM** port on the back panel.
2. Turn the **MicroTrap +™ VOD Recorder** power **ON**.
3. The display will show **USB CONNECTED**.
4. Start the **DAS™ Data Acquisition Suite for MicroTrap +™ Software** by clicking on **Start-Programs-MREL-Data Acquisition Suite for MicroTrap +™** for MicroTrap +™ Software Manual
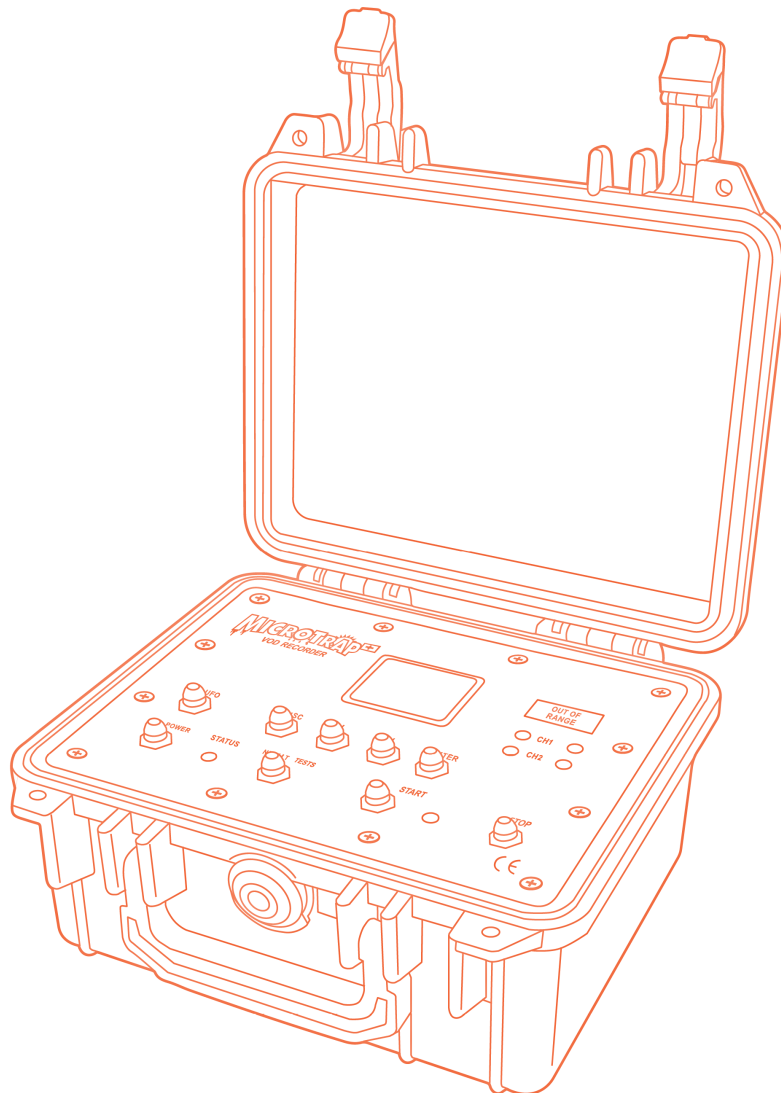
5.2 Selecting Data Files for Analysis

Refer to the **DAS™ Data Acquisition Suite for MicroTrap +™ Software Manual** for the procedure for selecting a data file for analysis.

Chapter 6
Contacting MREL for
Technical Support

6.1 Contacting MREL

MREL Group of Companies Limited

Blasting Instrumentation Team

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Kingston, Ontario K7L 1H3
Canada

Toll Free +1-877-544-MREL (Canada/USA)
Tel: +1-613-545-0466

Email: support@mrel.com

Support: www.mrel.com/contact.html

MREL looks forward to providing you with assistance.