MICROTRAP™
VOD/DATA RECORDER

Operations Manual
Edition 4.4

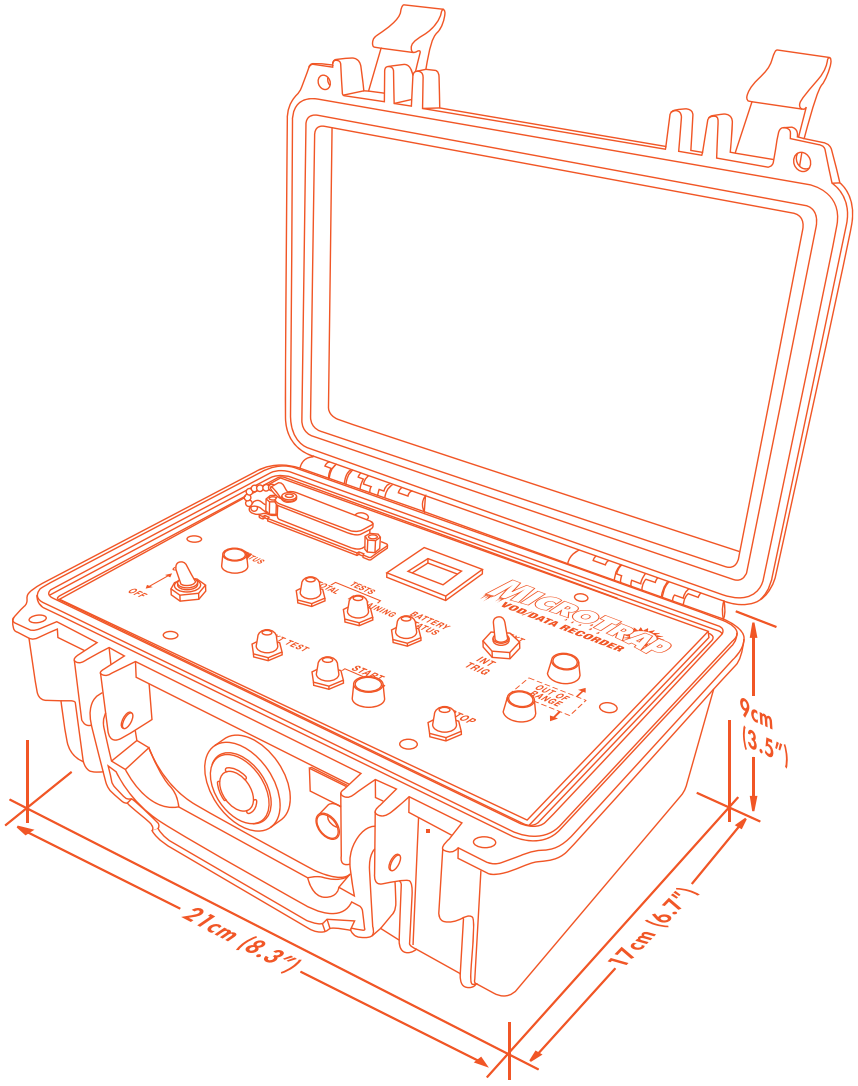

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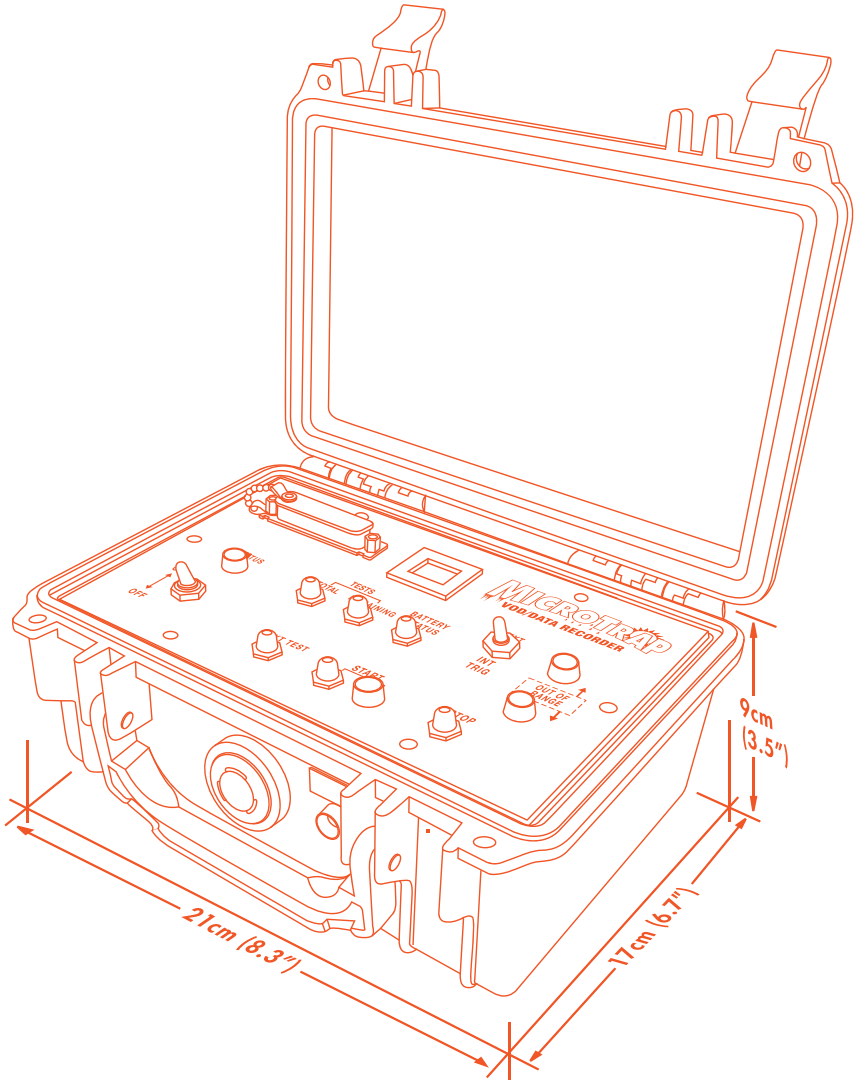
Table of Contents

Chapter 1
Getting Started



MREL GROUP OF COMPANIES

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 is installed and operational according to the DAS™ Data Acquisition Suite Software manual.**
3. **Ensure that the Operator's computer and MicroTrap™ are able to communicate with each other.**
4. **Program the MicroTrap's 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/Data Recorder**.
2. **MicroTrap™ Battery Charger** that is labeled 120 VAC or 220 VAC depending on your country's mains power.
3. **Communications Cable** - **USB cable**.
4. **BNC Adapters** x2.
5. **Carrying Case**.
6. **DAS™ Data Acquisition Suite Operations Software** on USB.
7. **MicroTrap™ Operations Manual**.
8. **DAS™ Data Acquisition Suite Manual.**
9. If Optional **Scope Upgrade** has been purchased, an additional **4x BNC Adapters** will be included.
10. **VOD** resistance probes: **VOD PROBERODs** and/or **VOD PROBECABLE** and/or **VOD PROBECABLE-LR**. (Optional)

1.2 Installing The DAS™ Data Acquisition Suite Software

Refer to the **DAS™ Data Acquisition Suite** 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 95%.

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%

Number of Tests is a number from 1 to 16 that the total memory of the unit is divided into. The lower the **Number of Tests**, the larger number of points will be recorded per test. The user needs to ensure that the amount of time is sufficient to capture the test which includes the amount of Pre-**Trigger Time** and the **Total Time**.

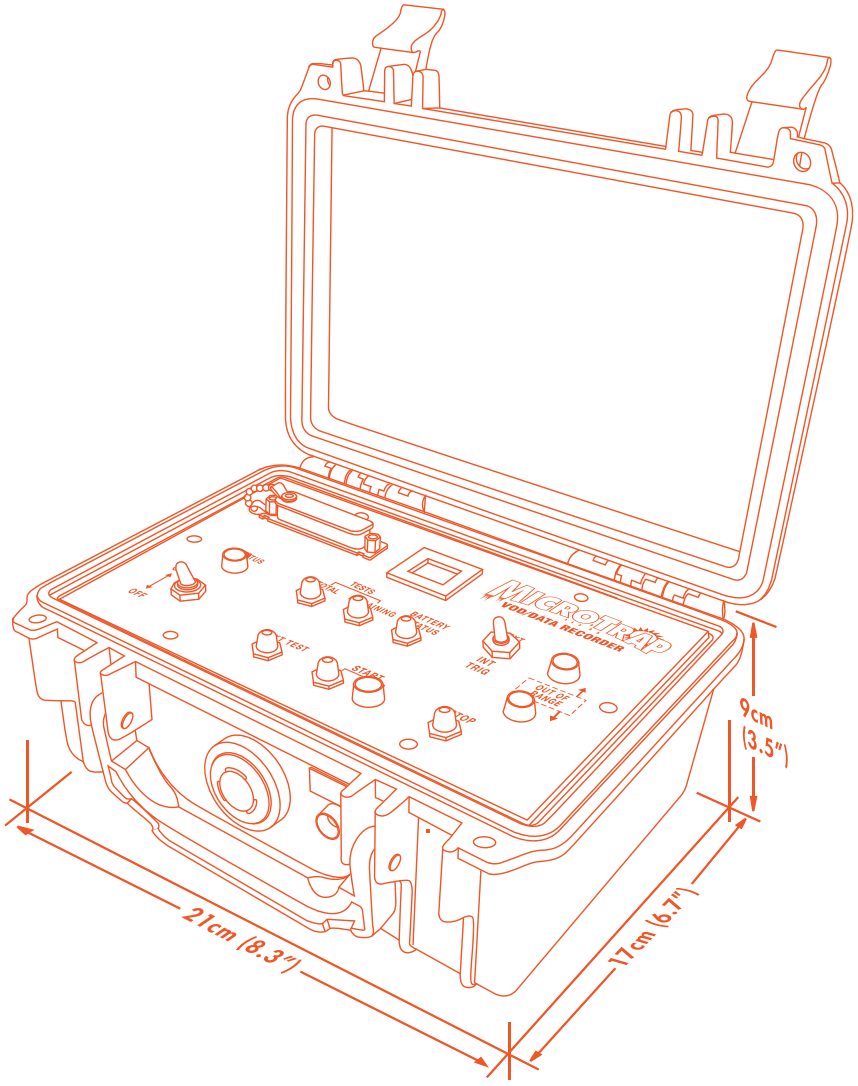
Recording Rate is the number of points captured per second. The faster the **Recording Rate**, the shorter the amount of time within each test. For **VOD**, the typical setting for **Recording Rate** is 1 MHz or or 2 MHz.
External Trigger is the setting that will allow the user to use an external source to have a valid trigger. There are two ways for the **MicroTrap™ VOD/Data 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 5.5**.

To use **External Trigger**, ensure that the switch on the panel has been set to **External** prior to pressing the **Start** button.

Chapter 2
Introduction



Overview

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

2.1 Background

The **MicroTrap™ VOD/Data Recorder** is a portable, 1 channel, high resolution, explosives continuous Velocity of Detonation (**VOD**) recorder. It can be upgraded easily to provide an additional 4 channels of DC voltage (VDC) recording (Scope) capability. The operator can use **DAS™ Data Acquisition Suite Software** to check if the unit has the **Scope Upgrade** installed during programming of the unit. Contact **MREL** for **MicroTrap™ VOD/Data Recorder Scope Upgrade** information. This provides the **MicroTrap™ VOD/Data Recorder** with the ability to record high resolution VODs of explosives and simultaneously record transient events such as blast vibrations, explosion pressures, air blast, etc. at high resolutions. It has proven its reliability under the extreme temperature, weather, dust and rugged conditions that characterize blasting environments around the world.

The **DAS™ Data Acquisition Suite** allows the User to analyze **VOD** traces and convert DC voltage signals recorded by the **MicroTrap™ VOD/Data Recorder** into the desired engineering units for analysis and presentation. The software is used to program the recording parameters of the **MicroTrap™ VOD/Data Recorder**, and to retrieve, display, analyze, print, and export **VOD** or other sensor data obtained through testing. The **DAS™ Data Acquisition Suite Software** runs under 32 or 64 bit **Microsoft Windows®**. 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 Software** for more information**.**

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

- One **VOD** channel capable of recording at up to 2 MHz (2 million data points/sec). 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, circular, digital memory (4 million data points) to store the recorded data. This allows the **MicroTrap™ VOD/Data Recorder** to record for relatively long periods (2.0 seconds) when recording at a rate of 2 MHz. The memory can be upgraded easily to provide a total memory of 8 million data points. Contact **MREL** for **MicroTrap™ Memory Upgrade** information.
- 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 up to 16 events before the data needs to be downloaded to a computer.
- Data is downloaded to the PC via the supplied **USB cable**.
- The **MicroTrap™ VOD/Data Recorder** can be upgraded easily to provide an additional 4 channels of DC voltage recording capabilities at a recording rate of 1 MHz. Contact **MREL** for **MicroTrap™ Scope Upgrade** information.
- The status of the **MicroTrap™ Memory** and **Scope Upgrade** for each **MicroTrap™ VOD/Data Recorder** can be found when the unit is connected to **DAS™ Data Acquisition Suite Software.** Please refer to the **DAS™ Data Acquisition Suite Manual** for the location of this information for each unit.

2.2 Safety Considerations

STOP

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

The **MicroTrap™ VOD/Data 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/Data 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/Data 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/Data Recorder**. This low excitation signal ensures that the **MicroTrap™** will not prematurely initiate explosives and/or detonators. With the optional **MicroTrap™ Scope Upgrade** installed, the **MicroTrap™'s Scope** channels do not output any excitation voltage or signal.

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/Data 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

When used as a **VOD** recorder, the main applications of the **MicroTrap™ VOD/Data 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

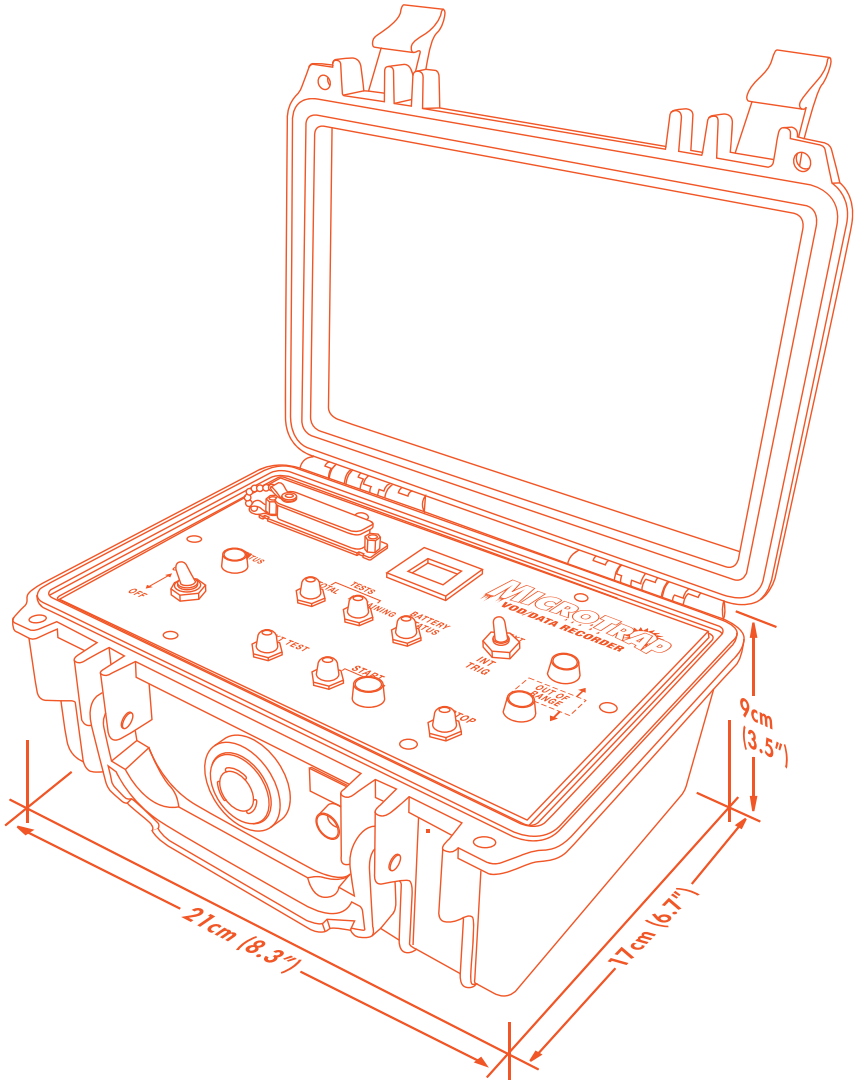
- Measure the continuous **VOD** in any hole diameter, wet or dry holes, and in any type of rock.
- Measure the continuous **VOD** in multiple holes per blast.
- Determine whether full detonation, low order detonation or failure occurred, and where in the explosive column it happened.
- Check **VODs** 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.

2.4 Applications Of MicroTrap™ with Scope Upgrade Installed

As previously mentioned, with the **Scope Upgrade**, the **MicroTrap™ VOD/Data Recorder** has the ability to function as a digital oscilloscope recording device to record DC voltage signals from a wide variety of commercially available sensors. **DC voltage** and **VOD** can be recorded simultaneously. Typical applications of the **MicroTrap™ VOD/Data Recorder** when used as a data recorder include (external power sources may be required):

- Measurement of detonation pressure using calibrated PVDF (polyvinylidene fluoride) gauges.
- Measurement of air blast over-pressures using commercially available air blast pressure transducers.
- Measurement of cross-blasthole pressures using carbon composition resistors and/or commercially available tourmaline gauges.
- Measurement of blasting vibrations using geophones or accelerometer transducers.
- Measurement of temperature using thermocouples.
- Measurement of any phenomena that can be instrumented with gauges producing DC voltage signals in the range from -10 to +10 volts.

Chapter 3
Hardware



Overview

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

3.1 Hardware Components

The hardware components of the **MicroTrap™ VOD/Data Recorder System** include the **MicroTrap™ VOD/Data Recorder**, a **Carrying Case**, a **Battery Charger**, a **USB Communications Cable** and two (2) **BNC Adapters**. If the **MicroTrap™ VOD/Data Recorder Scope Upgrade** has been installed, there are four (4) additional **BNC Adapters** provided. Also included with the **MicroTrap™ VOD/Data Recorder System** is this **Operations Manual** and the **DAS™ Data Acquisition Suite Manual.** A brief description of each of the hardware components is in the following sections.

3.1.1 MicroTrap™ VOD/Data Recorder

The **MicroTrap™ VOD/Data 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/Data Recorders** front panel is shown on the following page.

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

MAIN CONTROL PANEL

Power:

The **ON/OFF** switch is used to provide power to the **MicroTrap™ VOD/Data Recorder**.

CAUTION

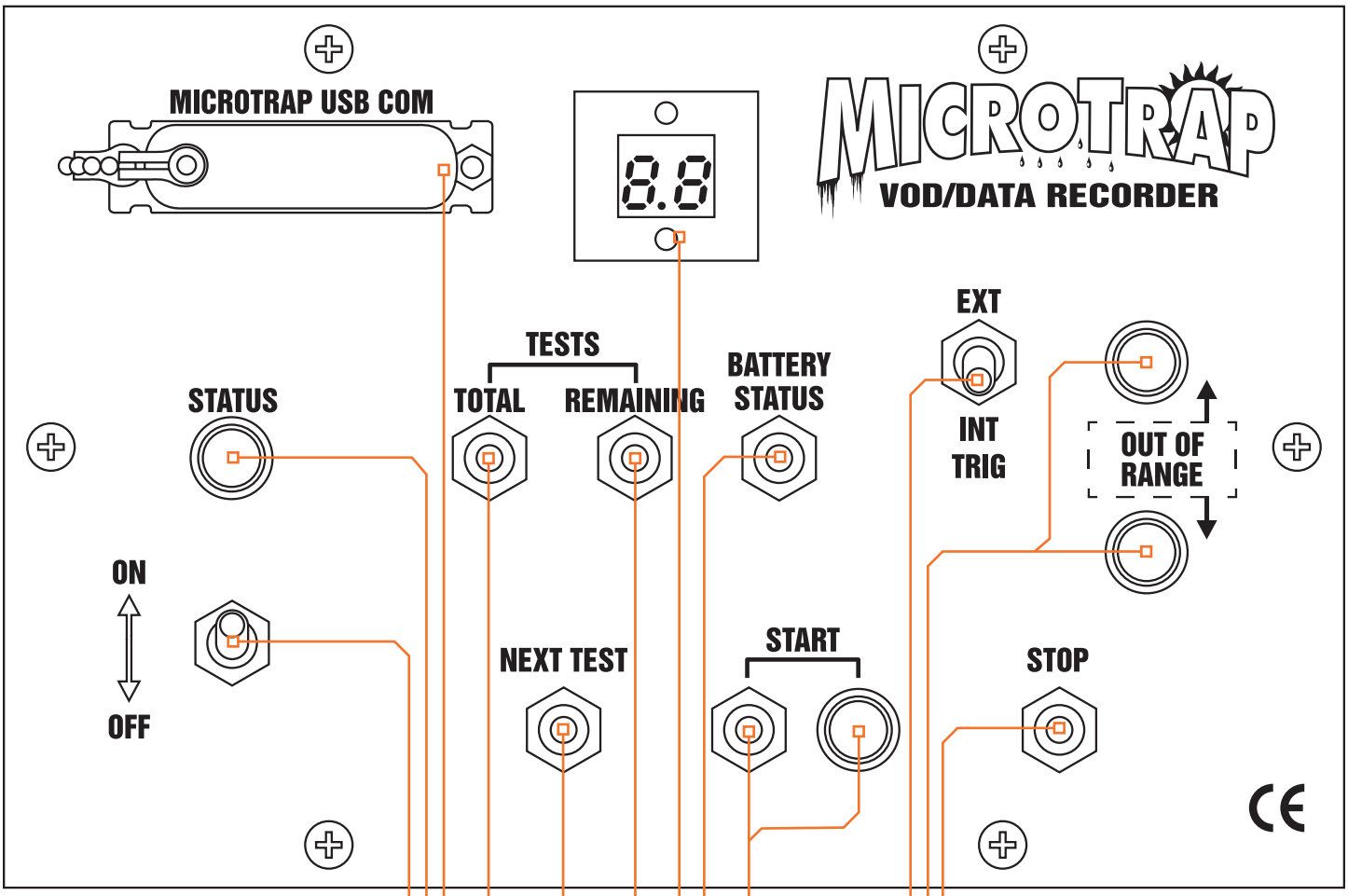
The Power switch must remain in its position for more than 5 seconds before it is changed back. Do not turn it on and off quickly to check the battery status. It must fully start. If this is not followed, an unrecoverable error can occur and the unit may be required to be sent in for service.

Status Light:

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

In **Active** mode, the light is illuminated, indicating that the **MicroTrap™ VOD/Data Recorder** is ready for the User to press the **START** button. When the **START** button is pressed it enters **Monitoring** mode, which starts recording in the circular memory. When the trigger criteria has been met, the **MicroTrap™ VOD/Data Recorder** will record the final loop of data, including the pre-set pre-trigger amount dictated by the User when programming the **MicroTrap™ VOD/Data Recorder.**

In **Stand-by** mode, the light flashes slowly, indicating that the **MicroTrap™ VOD/Data Recorder** has finished collecting and storing data. In Stand-by mode, the **MicroTrap™ VOD/Data 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. If the data will be downloaded the same day, the best practice is to leave the unit powered on.



ON/OFF Switch
STATUS Indicator
MICROTRAP USB COM
TOTAL TESTS Button
NEXT TEST Button
REMAINING TESTS Button
STOP Button
OUT OF RANGE Lights
TRIG EXT/INT Switch
START Button and Indicator
BATTERY STATUS Button
LED Screen

LED Display:

The **LED** screen is a two-digit display designed to report the status of the internal battery, the total number of tests programmed by the **DAS™ Data Acquisition Suite** , and the number of tests remaining to be filled. The **LED** screen also displays special characters when advanced operations are being performed.

Battery Level:

The **BATTERY STATUS** button is pressed to display the battery level on the **LED** screen. The **MicroTrap™ VOD/Data Recorders** battery level is displayed in integers from 0 to 10. Full battery is displayed as 10. A battery level of 8 would represent 80% charge remaining.

Total Tests:

The **TOTAL TESTS** button is pressed to display the total number of tests that the **MicroTrap™ VOD/Data Recorder** memory has been divided into. The total number of tests can be set using the **DAS™ Data Acquisition Suite Software**. Please refer to **DAS™ Data Acquisition Suite Software Manual** for instructions on programming the **MicroTrap™ VOD/Data Recorder**.

Remaining Tests:

The **REMAINING TESTS** button is pressed to display the number of programmed memory spaces that have yet to be filled with test data. This number represents the difference between the total number of tests, and the number of tests already conducted and stored in the **MicroTrap™ VOD/Data Recorder's** memory.

Deleting Test Data:

The **TOTAL TESTS** and **REMAINING TESTS** buttons also have an advanced function. They can be used by the Operator to erase the data recorded in the last test from the **MicroTrap™ VOD/Data Recorders** memory using hardware alone as opposed to using the **DAS™ Data Acquisition Suite**, as detailed in **DAS™ Data Acquisition Suite Software Manual**.

- Do not turn **OFF** the **MicroTrap™ VOD/Data Recorder** after the test, the **STATUS** light and **TRIG'D** lights should be flashing.
- To erase the data from the last test; simultaneously press the **TOTAL TESTS** and **REMAINING TESTS** buttons and hold them until this procedure is complete. The **LED** display will show **ct**. After about 2 seconds, the **ct** will begin blinking. After another 2 seconds, the **ct** will disappear. Release the buttons. The data from the last test has been deleted.
- Turn **OFF** the **MicroTrap™ VOD/Data Recorder**. Turn **ON** the **MicroTrap™** and press the **TOTAL TESTS** button and then the **REMAINING TESTS** button. This will confirm that the remaining tests have been increased by 1 and that the last test in the **MicroTrap™ VOD/Data Recorders** memory has been deleted.

CAUTION

MREL recommends the above procedure for times in which the **MicroTrap™ VOD/Data Recorder** triggers prematurely when the Operator is setting up the **MicroTrap™ VOD/Data Recorder** to record a VOD test. Premature triggering can be caused by situations such as: loose connections in the signal wires; excessive moving of or driving over the signal wires; or by the Operator inadvertently triggering the **MicroTrap™** when using an external trigger wire.

Trigger Selection:

The **TRIG EXT/INT** switch selects internal (**INT**) or external (**EXT**) triggering of the **MicroTrap™**. Using the **DAS™ Data Acquisition Suite Software**, the internal **Trigger Level** and **Pre-Trigger** memory allocation can be set. The **External Trigger** mode can be set using the software by selecting either "**BREAK circuit**" or "**MAKE circuit**" external triggers. The position of this switch is captured in the settings when the **START** button is pressed. After the **START** button is pressed, moving this switch will have no effect on the settings. Triggering is described in detail in **Chapter 4.8** and **Chapter 4.9**.

Next Test:

The **NEXT TEST** button is used to change the **MicroTrap™ VOD/Data Recorders** mode from **Stand-by** to **Active**. When in **Active** mode, the **MicroTrap™ VOD/Data Recorder** waits for the User to press the **START** button.

Start Button:

When **START** is pressed, the **MicroTrap™ VOD/Data Recorder** enters **Monitoring** mode, which starts recording in the circular memory. When the trigger criteria has been met, the **MicroTrap™ VOD/Data Recorder** will record the final loop of data, including the pre-set pre-trigger amount dictated by the User when programming the **MicroTrap™ VOD/Data Recorder**. When the **START** button is pressed, the **START** light illuminates. If the **TRIG EXT/INT** switch is set to **EXT** and the external trigger mode is set to "**BREAK circuit**" and nothing is

connected to the **EXT TRIG BNC**, the **MicroTrap™ VOD/Data Recorder** will trigger immediately when **START** is pressed. This is a common error for first time users. If the **OUT OF RANGE** Low or High lights are illuminated, the **START** button will not allow the test to start (and the **START** light to illuminate).

Stop Button:

The **STOP** button is particularly useful when the **MicroTrap™ VOD/Data Recorder** has been set at a very slow sampling rate using **DAS™ Data Acquisition Suite Software**. An example of this would be using a thermocouple sensor in a long-duration experiment with a **MicroTrap™ VOD/Data Recorder** that has had the **MicroTrap™ VOD/Data Recorder Scope Upgrade** installed. Given the large memory in the **MicroTrap™ VOD/Data Recorder**, if the lowest sampling rate (1 Hz) is selected, a total recording time of 4 million data points / 1 Hz = 4,000,000 seconds (46 days) will be available for recording. After the User is satisfied that the pertinent data has been recorded, pressing the **STOP** button marks the remaining data as unused, and the **MicroTrap™ VOD/Data Recorder** will then revert back to **Stand-by** mode. This saves the User from having to wait for the **MicroTrap™ VOD/Data Recorder** to finish the test automatically. If the **MicroTrap™ VOD/Data 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. When the file is opened, choose "Hide uninitialized memory" to not display the data that was not captured.

Erasing All Tests:

The **STOP** button also has an advanced function. It can be used as part of a sequence to manually erase all of the data in the **MicroTrap™ VOD/Data Recorders** memory in the absence of a PC. This can be performed in the following steps:

1. Turn **ON** the **MicroTrap™ VOD/Data Recorder**.
2. Press the **NEXT TEST** button to put the **MicroTrap™ VOD/Data Recorder** in Active mode. The **STATUS** light should be on.
3. Simultaneously press the **NEXT TEST** and **STOP** buttons and hold them down. The **LED** will display a blinking **dE**. Release the buttons.
4. Simultaneously press the **START** and **STOP** buttons and hold them down. The **LED** will display **dE** without blinking. Release the buttons. All of the data in the **MicroTrap™ VOD/Data Recorders** memory will be deleted.
5. Turn **OFF** the **MicroTrap™**. Wait 5 seconds. Turn **ON** the **MicroTrap™ VOD/Data Recorder** then press the **TOTAL TESTS** button and then the **REMAINING TESTS** button to confirm that these numbers are equal and that all of the test data in the **MicroTrap™ VOD/Data Recorders** memory has been deleted.

CAUTION

MREL recommends the above procedure for times in which the Operator is already in the field and has forgotten to **Clear All Tests** using the **MREL DAS™ Data Acquisition Suite**.

MICROTRAP USB COM:

The **MICROTRAP USB COM** port is used to connect the **Communications Cable** to the **MicroTrap™ VOD/Data Recorder**. The other end of the **Communications Cable** is connected to the **USB** Port of the computer, for programming the internal **Recording Parameters** of the **MicroTrap™ VOD/Data Recorder** and for retrieval of the recorded data (**Section 5.1**). See the **DAS™ Data Acquisition Suite Software Manual** for performing this task.

CAUTION

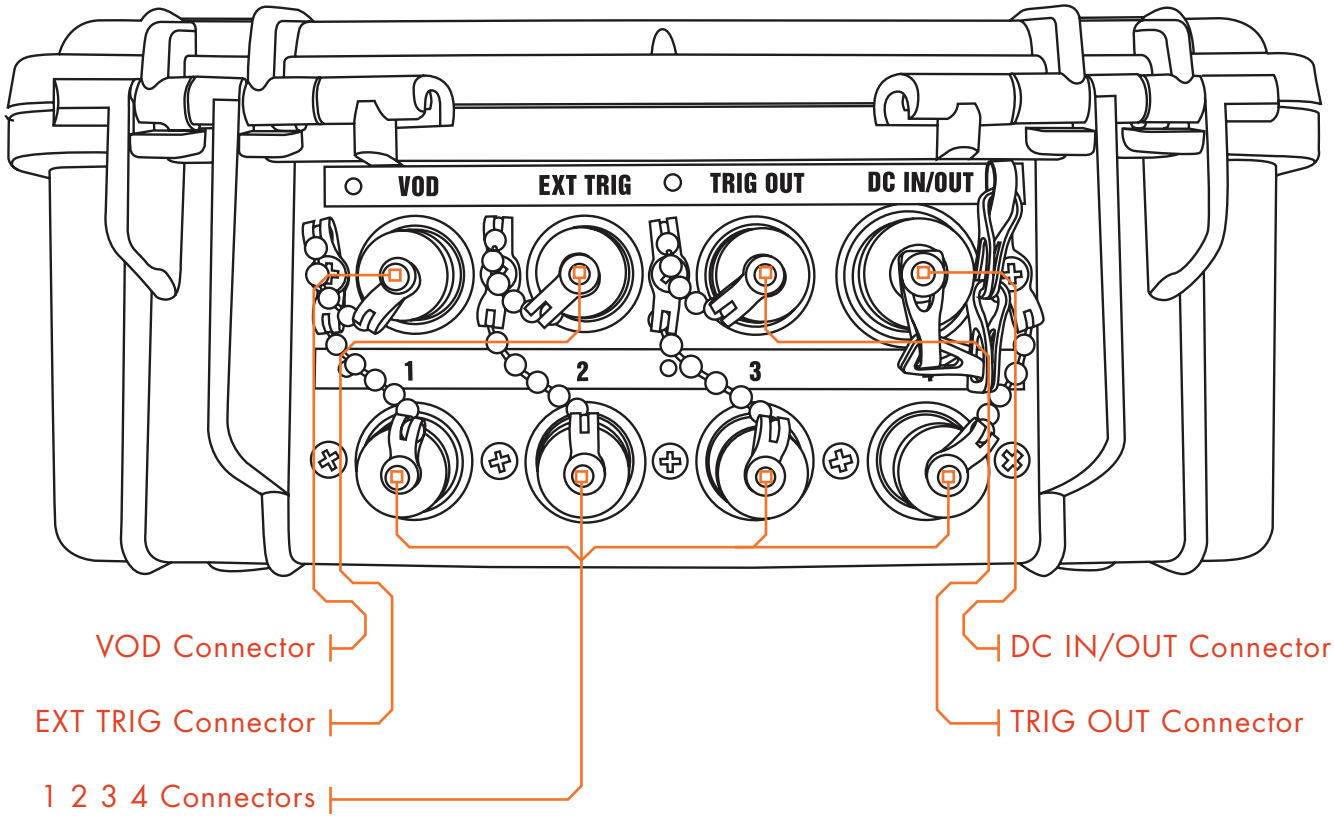
The unit must be powered on for at least 5 seconds prior to connecting the USB cable. If this is not followed, an unrecoverable error can occur and the unit may be required to be sent in for service.

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/Data Recorder** has a variety of input and output ports that are described below:



VOD:

BNC connector for the VOD resistance probe.

EXT TRIG:

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

TRIG OUT:

BNC connector that produces a voltage signal of 10 volts for 6 seconds when the **MicroTrap™ VOD/Data Recorder** is triggered. This signal is used to trigger other instrumentation.

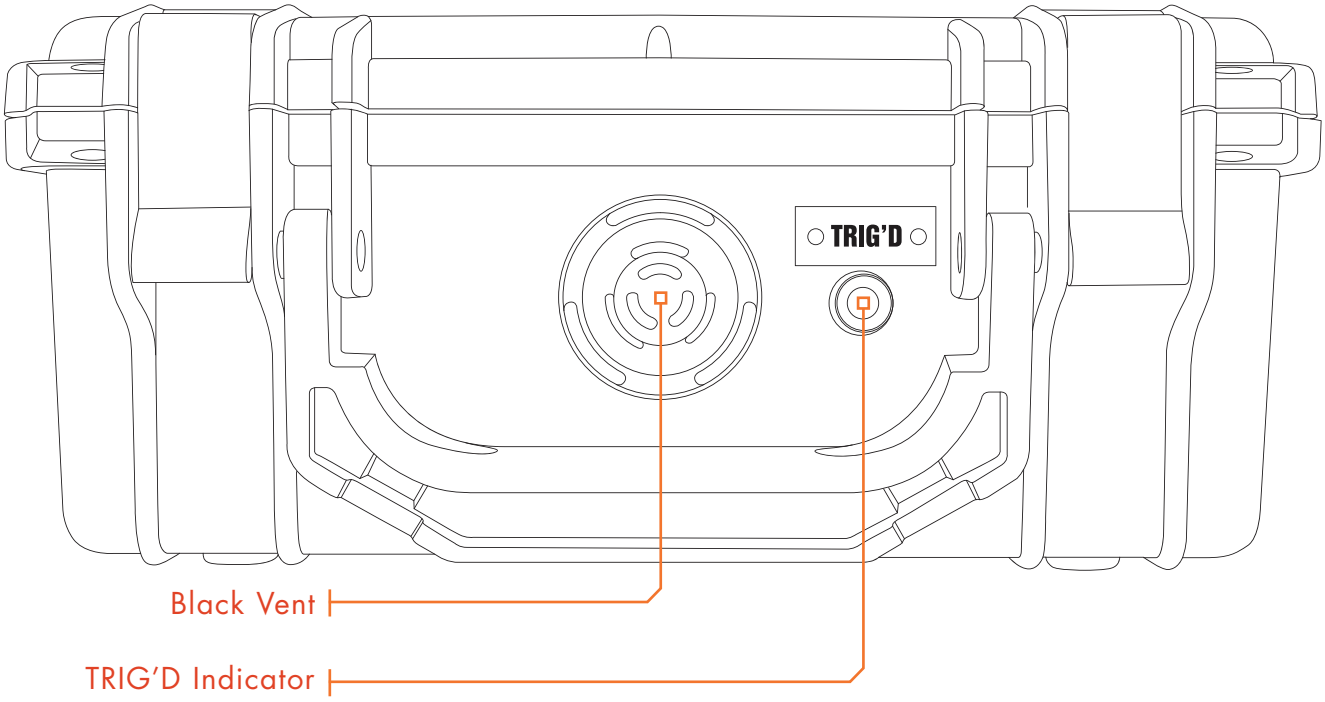
DC IN/OUT:

Used to connect the **MicroTrap™ VOD/Data Recorder** to the **Battery Charger** to recharge the internal battery, and to operate the **MicroTrap™ VOD/Data Recorder** from AC mains power. The **DC IN/OUT** port can also be used to power the **MicroTrap™ VOD/Data Recorder** from an external 12 VDC battery using the current limiting adapter that is supplied by **MREL**. It can also be used to supply 10 VDC as an excitation source for other types of gauges. All details and restrictions on use of the **DC IN/OUT** connector are contained in **Section 3.4** and **Section 3.5**.

1 2 3 4:

BNC connectors for **Channels 1, 2, 3** and **4** of the optional **MicroTrap™ VOD/Data Recorder Scope Upgrade**. These connectors have no function unless the **MicroTrap™ VOD/Data Recorder Scope Upgrade** has been installed.

FRONT PANEL



TRIG'D:

The **TRIG'D** indicator light on the front of the **MicroTrap™ VOD/Data Recorder** will illuminate when the trigger conditions are met. It will remain illuminated during collection of the data, which depends on the recording rate selected for the test. The **TRIG'D** light flashes rapidly while the data is being stored in the **MicroTrap™ VOD/Data Recorder's** non-volatile memory. The **TRIG'D** light flashes slowly after all data from the test has been stored in the **MicroTrap™ VOD/Data Recorder's** memory. Otherwise, the light will remain off.

BLACK VENT:

The **black knob** on the front of the **MicroTrap™ VOD/Data Recorder** is an automatic pressure relief valve. When transporting the **MicroTrap™ VOD/Data Recorder** by air, this valve allows pressure equalization upon landing. At high altitudes the internal pressure of the **MicroTrap™ VOD/Data 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/Data Recorder**, **Battery Charger**, **Communications 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/Data Recorder** from AC mains.

STOP

Contact **MREL** if the **Battery Charger** that has been supplied is incorrect for the mains voltage in your country.

3.1.4 USB Communications Cable

The **Communications Cable** is provided to connect the **MicroTrap™ VOD/Data Recorder** to a computer for programming the recording parameters of the **MicroTrap™ VOD/Data Recorder** and for downloading of the recorded data. The **Communications Cable** is connected between the **MICROTRAP USB COM** port on the front panel and a **USB** port of the computer. This is a specific cable that is required for the communication of the unit. Generic USB to parallel adapters will not work with the **MicroTrap™ VOD/Data Recorder**.

3.1.5 BNC Adapters

Two **BNC Adapters** are provided to facilitate easy connection between the VOD and EXT TRIG connectors on the **MicroTrap™ VOD/Data Recorder** to the coaxial cable (preferably RG-58 leading to the VOD probe, and the external trigger wire, respectively. If the **MicroTrap™ VOD/Data Recorder Scope Upgrade** has been installed, four additional BNC Adapters are provided, one for each Scope input channel.

3.2 Internal Rechargeable Battery

The **MicroTrap™ VOD/Data Recorder** has an internal Ni-Cad rechargeable battery. The **MicroTrap™ VOD/Data Recorder** is supplied with an approved 120 VAC or approved 220 VAC Battery Charger, depending on the country of use. When the internal battery is fully charged, the **MicroTrap™ VOD/Data Recorder** can operate for 12 hours (at maximum **MicroTrap™ VOD/Data Recorder** power consumption) before battery recharging is required. The **MicroTrap™ VOD/Data Recorder** is shipped from **MREL** fully charged. Since some time may elapse before the **MicroTrap™ VOD/Data Recorder** is actually put to use, the **MicroTrap™ VOD/Data Recorder** may not be charged fully the first time it is used. Full operating time will be obtained when the **MicroTrap™ VOD/Data Recorder** is recharged.

3.3 Checking the Power Status

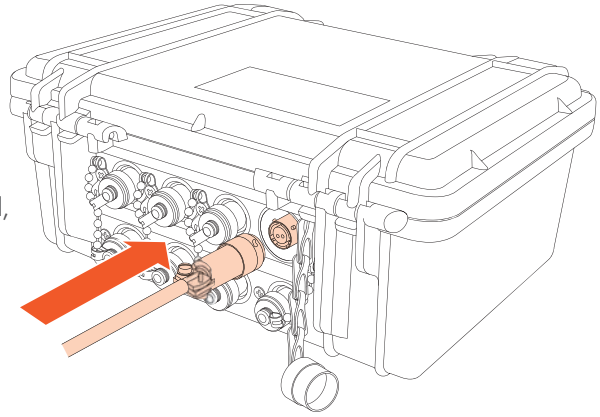
The procedure to check the power status of the **MicroTrap™ VOD/Data Recorder** is as follows:

1. Turn the **MicroTrap™ VOD/Data Recorder** switch to the **ON** position. Wait for 5 seconds until the **STATUS** light enters **Stand-by** mode and then, press the **BATTERY STATUS** button on the front panel. This button can be pressed at any time during operation of the **MicroTrap™ VOD/Data Recorder**.
2.

3. The **LED** will display the charge remaining in the battery as a percentage of the full charge. For example, if the display shows the number **8**, it means that 80% of the maximum charge remains in the battery. A display of **10** is shown when the **MicroTrap™ VOD/Data Recorder** is fully charged. A display of **0** is shown when the **MicroTrap™ VOD/Data Recorder** requires recharging.

3.4 Recharging

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



1. With the **MicroTrap™ VOD/Data Recorder** switched **OFF**, connect the **Battery Charger** between the **DC IN/OUT** port on the back of the **MicroTrap™ VOD/Data Recorder** and the wall outlet. The **LED** will display **Ch** indicating that charging is progressing.
2. Full recharging will take up to 10 hours. When charging has been completed, the **Ch** message on the **LED** will flash. Disconnect the **Battery Charger** at this point. 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/Data Recorder**. The **MicroTrap™ VOD/Data Recorder** battery status can be tested as detailed in **Chapter 3.3**.

CAUTION

Do not connect the **MicroTrap™ VOD/Data Recorder** directly to a 12 VDC source without any current-limiting circuit. Damage will occur to the unit and it will need to be returned for repair to an authorized facility.

CAUTION

The **MicroTrap™ VOD/Data Recorder** will operate appropriately at low power levels as indicated by 0 on the LED. The **MicroTrap™ VOD/Data Recorder** will emit a beeping sound continuously for up to 30 minutes before it shuts itself **OFF**. The **MicroTrap™ VOD/Data Recorder** shuts itself off to help prevent complete discharging of the internal battery. It is important to note that the **MicroTrap™ VOD/Data Recorder** has a non-volatile memory, allowing the data to be stored safely regardless of the power status of the internal battery.

3.5 Operating The MicroTrap™ from External Power Sources

The **MicroTrap™ VOD/Data Recorder** can be operated from AC voltage mains power using the **Battery Charger**. When operating from AC mains through the **Battery Charger**, the **LED** will display **P**.

The **MicroTrap™ VOD/Data Recorder** can be operated from a 12 VDC battery connected to the DC IN/OUT port on the back of the **MicroTrap™ VOD/Data Recorder**. Contact **MREL** to obtain the 12 VDC Battery Adapter required for connecting the battery to the DC IN/OUT port. When operating the **MicroTrap™ VOD/Data Recorder** from a 12 VDC battery, the **LED** will display **P**.

CAUTION

The **MicroTrap™ VOD/Data 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/Data Recorder** at temperatures from 10 to 30 °C (50 to 86 °F).

3.6 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/Data Recorder**. In the eventuality that the **MicroTrap™ VOD/Data Recorder** remains idle for long periods, it is recommended to recharge the **MicroTrap™ VOD/Data Recorder** once per month per the procedure in **Chapter 3.4**. This will maintain the conditioning of the internal battery.

3.7 VOD Resistance Probes

The following types of **VOD** resistance probes are available from **MREL** and are suitable for use with the **MicroTrap™ VOD/Data Recorder**:

3.7.1 VOD PROBEROD

The **VOD PROBEROD**, shown above, 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/Data Recorder**. Contact **MREL** for additional **PROBEROD** information and different lengths to suit your needs.

3.7.2 VOD PROBECABLE

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

VOD PROBECABLE "GREEN" and **VOD PROBECABLE-LR "BLUE"**. 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.

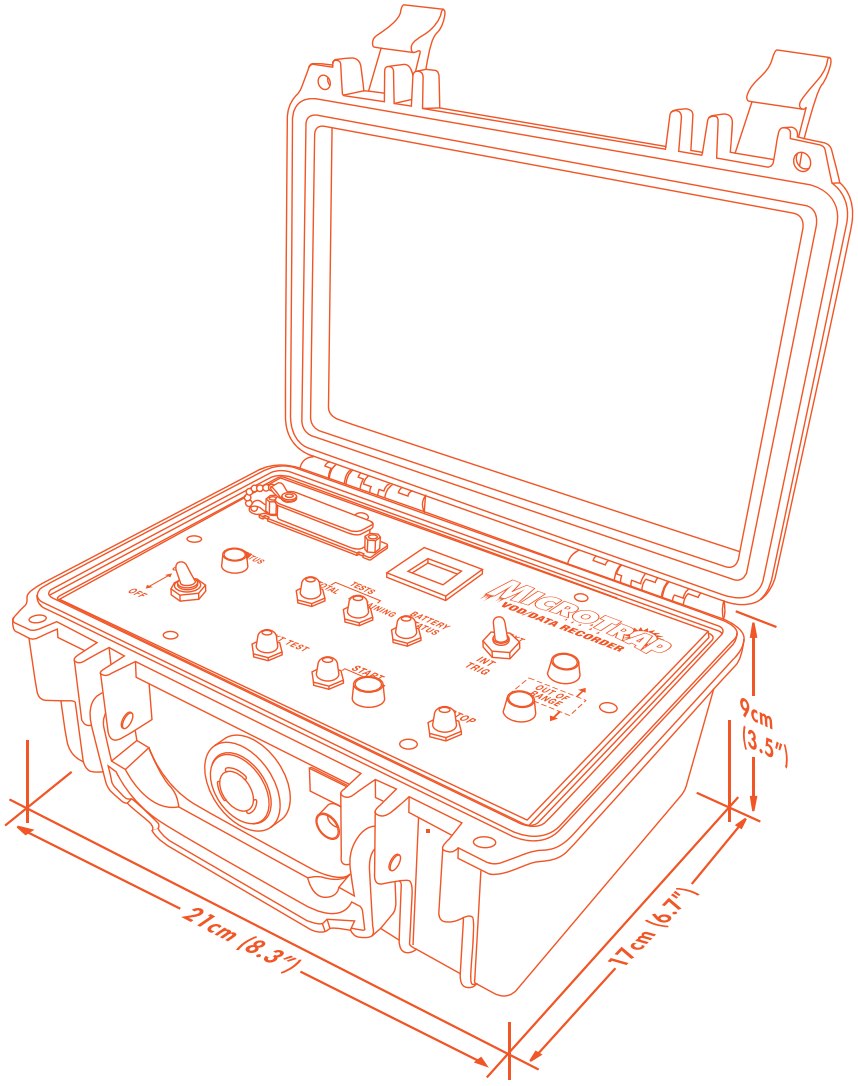
PROBECABLE and **PROBECABLE-LR** are used for measuring **VODs** of explosives in blastholes as well as the delay times between holes and decks. The selection of either **PROBECABLE** or **PROBECABLE-LR** is based on the total resistance of the circuit, which in turn depends on the number of holes being monitored. The only difference between these two cables relates to their nominal resistance, or resistance per unit length. **PROBECABLE (GREEN)** has a unit resistance of 10.8 ohm/m (3.29 ohm/ft) while **PROBECABLE-LR (BLUE)** (LR stands for Low-Resistance) has a unit resistance of 3.38 ohm/m (1.03 ohm/ft). The latter allows VOD recording for lengths up to approximately 900 m (2,950 ft.) per test with the **MicroTrap™ VOD/Data Recorder**. Each box has a specific **Quality Control Sticker** that will display the correct value to select in the **DAS™ Data Acquisition Suite Software** during downloading.

Both types of **PROBECABLE** are available directly from **MREL** in a unique "reel-in-a-box" packaging with 1,000 m per box. The reel-in-a-box allows free spooling of the **PROBECABLE** into the blasthole by one operator without the need for a cable reel stand or another person to hold the reel of cable. The reel-in-a-box assembly is also conveniently wrapped in waterproof plastic to prevent degradation of the box in wet conditions. Please contact **MREL** for additional **PROBECABLE** information.

3.8 Technical Specifications

Number of Channels	1 channel for VOD. Upgradeable to provide an additional 4 channels for DC voltage recording of other types of gauges.
Vertical Resolution	14 bits, 1 part in 16,384.
Recording Rate	User selectable by Software from 1 Hz to 2 MHz (VOD Only), 1 Hz to 1 MHz (Scope Channel active).
Total Recording Time @ 2 MHz Recording Rate	2.0 seconds (4 million data points). Reducing the Recording Rate increases the Total Recording Time. Upgradeable to provide twice the amount of memory (8 million data points).
Pre-Trigger Time	User selectable by Software from 0-100% of the Total Recording Time.
Trigger Modes	User selectable by switch: Internal or External. External Mode: user selectable by Software "**wire make**" or "**wire break**". Internal Trigger Level: user selectable by Software from 2.4 to 98% of signal level.
Power	Internal rechargeable Ni-Cad battery pack providing up to 12 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. The **Battery Charger** is provided in 120 or 220 VAC configurations. Recharging takes up to 10 hours. Operational from AC mains power through **Battery Charger** and from external DC power.
Multiple Event Storage	User selectable by Software: up to 16 tests stored in permanent memory.
Components Provided	**MicroTrap™ VOD/Data Recorder**, Battery Charger, Communications Cables, BNC Adapters, Padded Carrying Case, Operations Manual and **DAS™ Data Acquisition Suite Software** (32 or 64 bit) for **Windows®**.
Size and Weight	**MicroTrap™ VOD/Data 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 -40 to +60 °C (-40 to +140 °F). Snow, rain, dust and sand proof. Drop proof from a height of at least 1 m (3 ft.).
PC Connection	After conducting the test(s), the **MicroTrap™ VOD/Data Recorder** is connected to a computer's **USB port** using the **Communications Cable** to allow fast downloading of the data to the computer. The connection between the **MicroTrap™ VOD/Data Recorder** and the computer also allows the operator to confirm and/or change the recording parameters.
Software	The **DAS™ Data Acquisition Suite Software** operates under **Windows®**. 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/Data 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/Data 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/Data Recorder** with no requirements for additional instrumentation. For safety considerations, the **MicroTrap™ VOD/Data 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/Data 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



MREL GROUP OF COMPANIES

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/Data 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/Data 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/Data 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/Data Recorder** provides a regulated constant excitation signal to the probe and monitors the drop in voltage across it.

The **MicroTrap™ VOD/Data 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/Data Recorder** records the resulting decrease in voltage across the probe versus time.

The **DAS™ Data Acquisition Suite 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 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 Software Manual** for more information.

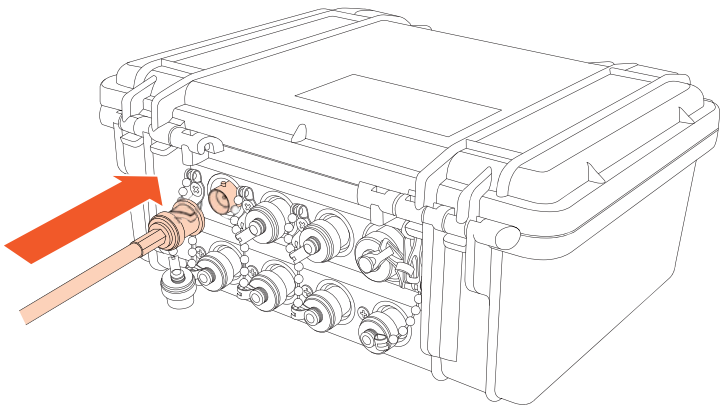
4.3 Using ProbeRods for Testing Samples Of Explosives

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

- The **MicroTrap™ VOD/Data 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/Data 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/Data 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/Data 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/Data 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/Data 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 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/Data 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/Data 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.
(continued on page 25.)

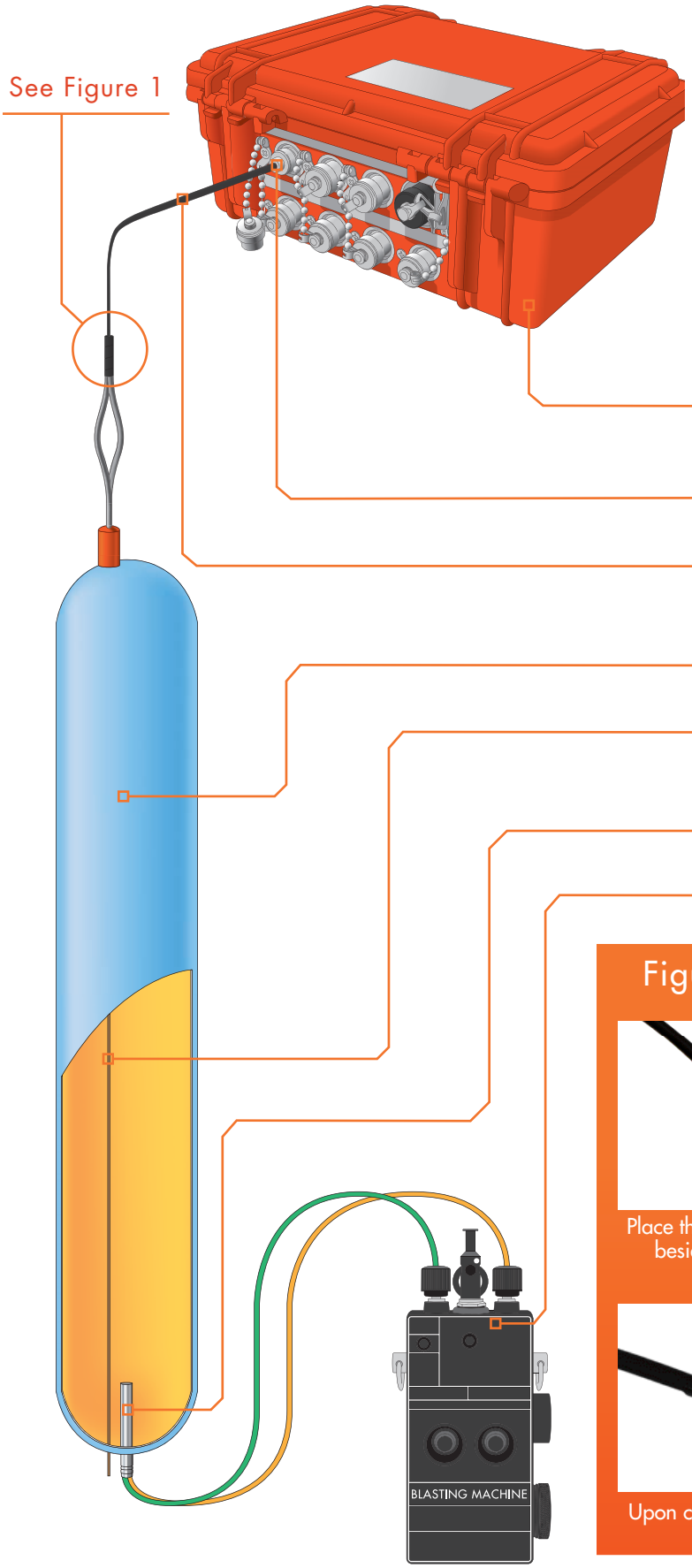
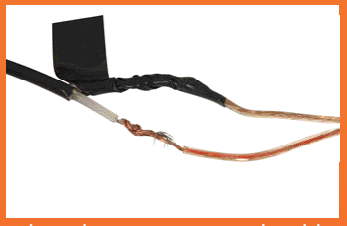


Figure 1

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/Data Recorder**, as shown to the right.
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/Data Recorder** is now ready to be prepared to record the test as detailed in **Chapter 4.6**.

4.4 Using ProbeCable for Testing Explosives In Blastholes

The equipment and supplies that are required to conduct **VOD** tests on samples of explosives in blastholes are:

- The **MicroTrap™ VOD/Data 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/Data 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 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/Data 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/Data 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/Data 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/Data 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/Data Recorder**. If your reel of RG-58 coaxial cable is not equipped with a BNC male connector, a convenient

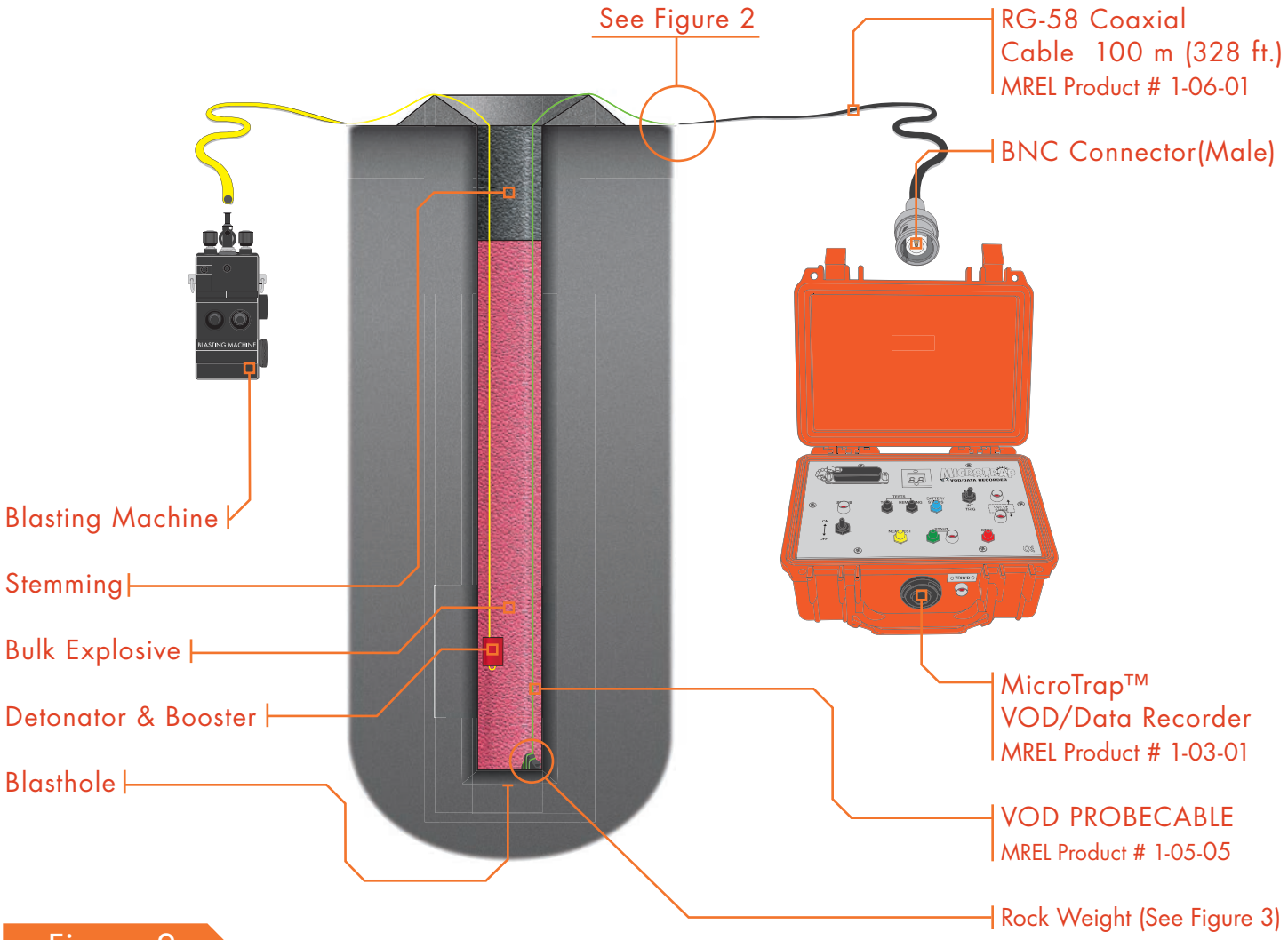
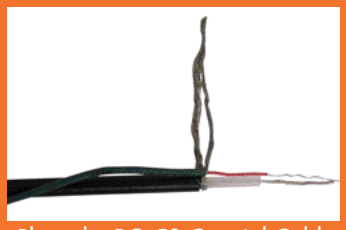
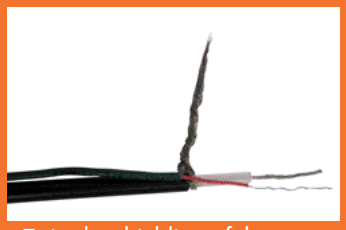


Figure 2



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.

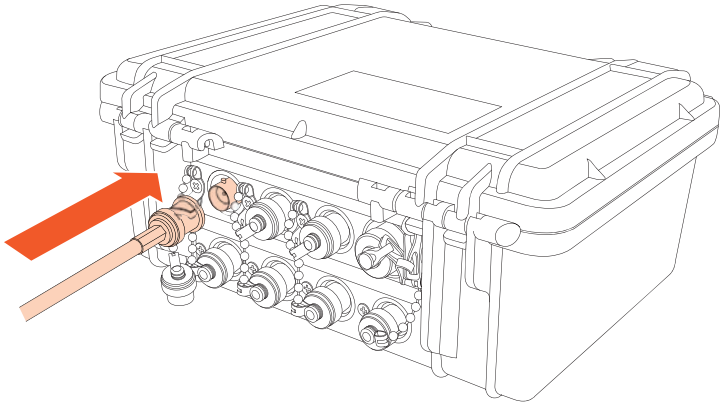
Pull the shielding wires back along the cables and start taping from the cable to the end.

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/ Data 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/Data 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/Data Recorder** is now ready to be prepared to record the test as detailed in **Chapter 4.6**.

Figure 3

4.4.2 Preparation of ProbeCable for Multiple 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. 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 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.

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

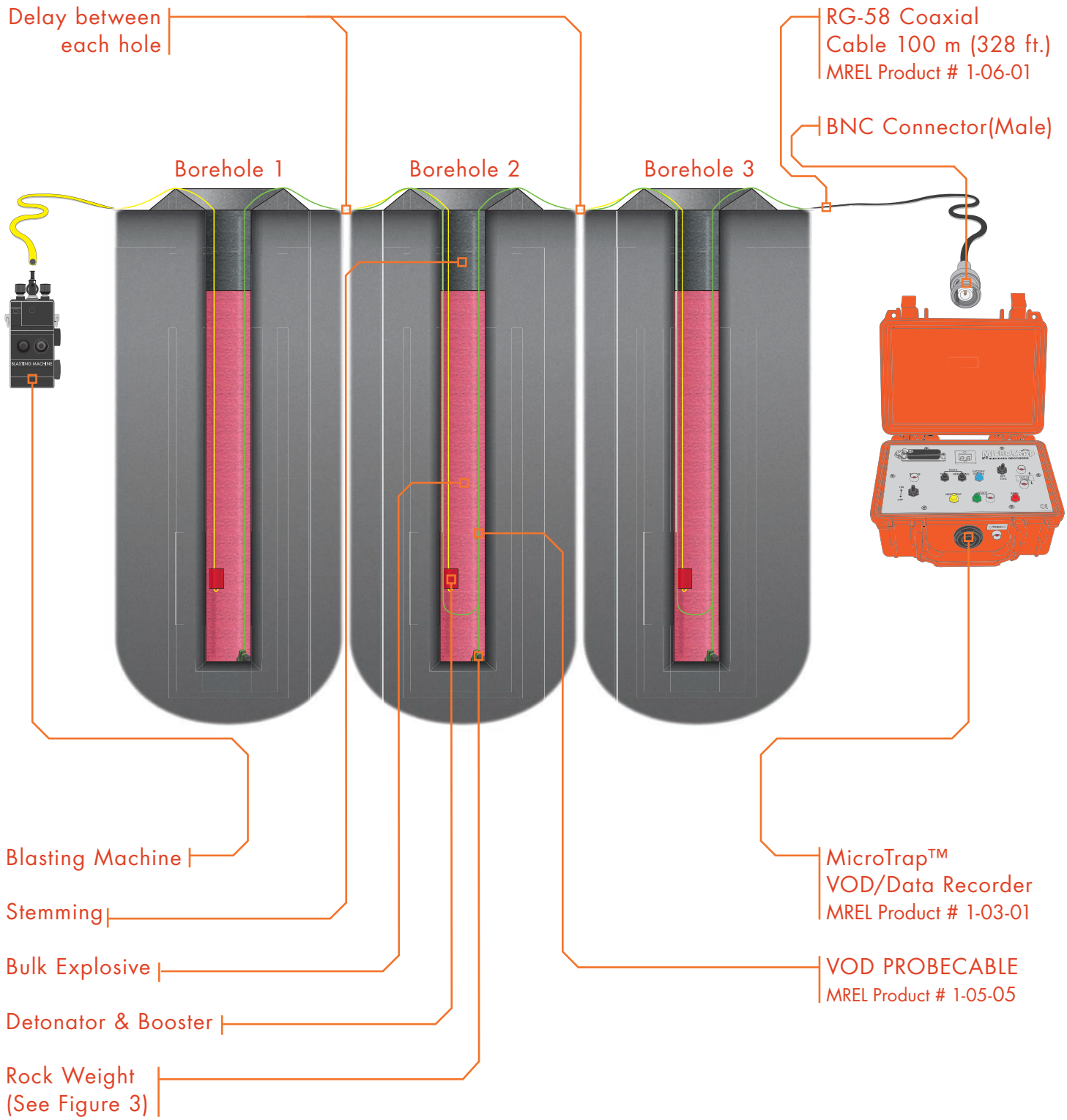
4.5 ProbeCable And Coaxial Cable Protection

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/Data Recorders** recording parameters have been pre-set to settings appropriate for most blasthole **VOD** recording situations. Recording Rate = 2 MHz. Total Recording Time = 2 seconds, with standard memory and 4 seconds with the **MicroTrap™ VOD/Data Recorders Memory Upgrade** installed. Memory Allocation = 1 test fills the **MicroTrap™ VOD/Data Recorders** internal memory. Pre-trigger Time = 25% of Total Recording Time = 0.5 seconds. Trigger Level = 95%. These settings recommendations are based on **MREL's** extensive worldwide experience in **VOD** recording.


Delay between each hole
RG-58 Coaxial Cable 100 m (328 ft.)
MREL Product # 1-06-01
BNC Connector(Male)
Borehole 1
Borehole 2
Borehole 3
Blasting Machine
Stemming
Bulk Explosive
Detonator & Booster
Rock Weight (See Figure 3)
MicroTrap™ VOD/Data Recorder
MREL Product # 1-03-01
VOD PROBECABLE
MREL Product # 1-05-05

IMPORTANT

MREL recommends a **Trigger Level** of about 95% and a **Pre-Trigger Time** of about 25% for **VOD** recording of explosives samples and explosives in blastholes.

MREL recommends setting the Number of Tests = 1 for **VOD** recording of blastholes using **PROBECABLE**. The Operator will normally be able to download the data from the **MicroTrap™ VOD/Data Recorder** to a computer before conducting the next **VOD** test.

MREL recommends setting the Number of Tests = 16 for **VOD** 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/Data Recorder** with standard memory will record for a total of 131 ms per test if the Number of Tests = 16. 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/Data 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/Data Recorder** signal input connector labeled **VOD**.
2. Turn the **MicroTrap™ VOD/Data Recorder ON**. The **STATUS** light will illuminate and begin to flash quickly for approximately 2 seconds while the recorder conducts some internal verification testing. If the recorder passes the internal verification tests, the **STATUS** light will begin to flash slowly (**Stand-by mode**). The User can go on to **Step 3**. **CAUTION:** Do not turn **OFF** the **MicroTrap™ VOD/Data Recorder** until after the internal verification testing has been complete or an unrecoverable error can occur and the unit may be required to be sent in for service. If the **MicroTrap™** fails to pass the internal verification tests, the **STATUS** light will flash three times in succession and **EE** will appear on the **LED**. If this happens, switch the **MicroTrap™ OFF**, wait 10 seconds, and switch it on again. If the **MicroTrap™** continues to fail the internal verification tests, then contact **MREL** as the **MicroTrap™ VOD/Data Recorder** requires service.

IMPORTANT

If the you do not wish to keep the existing data in memory, then you can either clear the **MicroTrap™ VOD/Data Recorders** internal memory using the **DAS™ Data Acquisition Suite Software** or by following this procedure:

a. Turn **ON** the **MicroTrap™ VOD/Data Recorder**.
b. Press the **NEXT TEST** button to put the **MicroTrap™** in **Active mode**. The **STATUS** light should be on.
c. Simultaneously press the **NEXT TEST** and **STOP** buttons and hold them down. The **LED** will display a blinking **dE**. Release the buttons.
d. Simultaneously press the **START** and **STOP** buttons and hold them down. The **LED** will display **dE** without blinking. Release the buttons. All of the data in the **MicroTrap™'s** memory will be deleted.
e. Turn **OFF** the **MicroTrap™ VOD/Data Recorders**. Turn **ON** the **MicroTrap™ VOD/Data Recorder** and pressing the **TOTAL TESTS** button and then the **REMAINING TESTS** button will confirm that these numbers are equal and that all of the test data in the **MicroTrap™ VOD/Data Recorders** memory has been deleted.

3. Press the **NEXT TEST** button; the **STATUS** light will stop flashing and will remain illuminated (Active mode).
4. Press the **TOTAL TESTS** button to see the number of tests that the **MicroTrap™ VOD/Data Recorders** memory has been divided into, using the **DAS™ Data Acquisition Suite Software**.
5. Press the **REMAINING TESTS** button to see the number of memory slots that remain to be filled in the **MicroTrap™ VOD/Data Recorders** non-volatile memory. If this number does not equal the number of **TOTAL TESTS**, then there are one or more tests already stored in the **MicroTrap™ VOD/Data Recorders** internal memory. If the value shown on the display is 0, the memory is full and will need to be cleared prior to conducting further tests.
6. Look for the **OUT OF RANGE** warning light indicators (↓ and ↑). If there is a warning light, there is a problem with the resistance probe, the coaxial cable, or the BNC Adapter. If this is the case, the User is referred to **Chapter 4.7** for possible solutions.The **START** button will be blocked and the **MicroTrap™ VOD/Data Recorder** will be unable to record **VODs** when an **OUT OF RANGE** condition exists. If neither of the **OUT OF RANGE** lights are illuminated, the User may proceed with the next step.
7. If you intend to use the **MicroTrap™ VOD/Data Recorders** internal trigger, ensure the **EXT/INT TRIG** switch is set to the **INT**ernal position. The use of **EXT**ernal triggering is discussed in **Chapter 4.8**.
8. Press the **START** button. The **START** light will illuminate steadily. The **MicroTrap™ VOD/Data Recorder** then starts monitoring the blast, waiting for the trigger signal to start collecting voltage data. Personnel may now vacate the **MicroTrap™ VOD/Data Recorder** location if necessary.
9. When the **MicroTrap™ VOD/Data Recorders** internal triggering criteria is met (i.e. a sufficient length of **PROBEROD** or **PROBECABLE** has been consumed by the detonation), the **MicroTrap™ VOD/Data Recorder** will begin recording **VOD** information. Upon triggering, the **TRIG'D** light will illuminate and remain on during the collection of data (this time depends on the recording rate and number of tests programmed into the **MicroTrap™ VOD/Data Recorder**). During this time, both the **START** and **STATUS** lights will also be illuminated.

NOTE: When the internal triggering criteria are met, the **MicroTrap™ VOD/Data Recorder** will send a 10 VDC signal to the **TRIG OUT** port on the back of the unit. This pulse is 6 seconds in duration, and has a rise time of 2 microseconds. Some Users may wish to trigger other instrumentation from the **MicroTrap™ VOD/Data Recorders TRIG OUT** port.

10. Once data collection ends, the **TRIG'D** and **START** lights flash rapidly and the **MicroTrap™ VOD/Data Recorder** begins storing data into its non-volatile memory. During this short time, the **STATUS** light is illuminated to indicate that writing is taking place. Do not switch the **MicroTrap™ VOD/Data Recorder OFF** during this time. This can take up to 45 seconds to download into memory.
11. When the **MicroTrap™ VOD/Data Recorder** finishes storing the data, the **START** light will go dark and the **STATUS** and **TRIG'D** lights will begin to flash slowly. The **MicroTrap™ VOD/Data Recorder** has now returned to **Stand-by** mode.

IMPORTANT

If the **MicroTrap™ VOD/Data Recorder** has triggered prematurely, or the data that you have collected is not of use to you, then you may erase only the last test by performing the following sequence:

a. Do not turn **OFF** the **MicroTrap™ VOD/Data Recorder** after the test, the **STATUS** light and **TRIG'D** lights should be flashing.
b. To erase the data from the last test; simultaneously press the **TOTAL TESTS** and **REMAINING TESTS** buttons and hold them until this procedure is complete. The **LED** display will show **ct**.
c. After about 2 seconds, the **ct** will begin blinking. After another 2 seconds, the **ct** will disappear. Release the buttons. The data from the last test has been deleted.
d. Turn **OFF** the **MicroTrap™ VOD/Data Recorder**, wait several seconds and then turn the **MicroTrap™ VOD/Data Recorder ON** again. Pressing the **TOTAL TESTS** button and then the **REMAINING TESTS** button will confirm that the remaining tests have been increased by 1 and that the last test in the **MicroTrap™ VOD/Data Recorder's** memory has been deleted.

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 Software**. If data transfer is to be conducted later, then the **MicroTrap™ VOD/Data Recorder** can be switched **OFF** and the data will remain in the **MicroTrap™ VOD/Data Recorders** non-volatile memory.

4.7 Probe Resistance Out Of Range Lights

There are two **OUT OF RANGE** warning lights on the **MicroTrap™ VOD/Data Recorder**. One is labeled ↑, which illuminates when the total resistance (resistance VOD sensor plus coaxial cable) is greater than 3,000 ohms. The other is labeled ↓, which illuminates when the total resistance is less than 50 ohms. The **MicroTrap™ VOD/Data 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 and solved by remaking the connections or replacing faulty **BNC Connectors**. Item 2 is addressed by replacing the damaged **PROBEROD**. If 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**.

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.

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 and 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 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/Data Recorder** begin to record exactly when a specific external event occurs. For the specific event to trigger the **MicroTrap™ VOD/Data Recorder**, and subsequently correspond to time zero on the **VOD** graph, the **EXT TRIG** port is used.

The **EXT TRIG** function operates on the simple concept of **MAKE** or **BREAK** circuits. Both types of trigger capitalize on the fact that the **EXT 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 **EXT 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/Data 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/Data Recorder**. Beware that even a momentary break in the trigger circuit will cause the **MicroTrap™ VOD/Data Recorder** to trigger. Avoid disturbing a **BREAK** trigger once the **START** button has been pressed.

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

4.9 Additional Information on Memory and Triggering

4.9.1 Memory

The **MicroTrap™ VOD/Data Recorder** has a large circular memory containing 4,194,000 data points (doubled with optional memory upgrade) that are allocated across each of the tests into which the **MicroTrap™ VOD/Data Recorders** memory has been divided. The total number of tests and selected recording rate dictate the total record time available for each test. Selection of the number of tests to be recorded and the **Recording Rate** is done using the **DAS™ Data Acquisition Suite Software**.

The **DAS™ Data Acquisition Suite 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:

A general equation to calculate the **Total Recording Time** (**Pre-Trigger Time** + **Post-Trigger Time**) is:

Total Recording Time (seconds) = 4,194,000 points / ((# of tests) x (recording rate))

If the number of tests selected is one, the available recording time will be maximized for a given **Recording Rate**.

For example, at the maximum **Recording Rate** 2 MHz, the **Total Recording Time** will be:

4,194,000 points / ((1 test) x (2,000,000 points/sec)) = 2.097 seconds

At a slower Recording Rate of 1 MHz (for example), the **Total Recording Time** will become 4.194 seconds. If the **MicroTrap™ VOD/Data Recorders** internal memory is divided into 4 tests, the **MicroTrap™ VOD/Data Recorder** will partition the memory allocating 4,194,000 points/4 tests = 1,048,500 points per test.

Following the previous example, the **Total Recording Time** per test can be calculated as follows:

4,194,000 points / ((4 tests)x(2,000,000 points/sec)) = 0.524 seconds per Test

If the Recording Rate is reduced to 1 MHz, the **Total Recording Time** will become 1.048 seconds per test. If these recording times are insufficient for your testing applications, then contact **MREL** and ask about the **MicroTrap™ VOD/Data Recorder Memory Upgrade**, which doubles the **MicroTrap™'s** internal memory and thus doubles the Total Recording Time.

4.9.2 Triggering

When the **EXT/INT** switch is set to the **EXT** position, the trigger signal that the **MicroTrap™ VOD/Data Recorder** receives is from the **Trigger Wire** as detailed in **Section 4.8**. This corresponds to time = 0 on the resulting **VOD** graph.

When the **EXT/INT** switch is set to the **INT** position, then the **MicroTrap™ VOD/Data 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 5.0 VDC (approximately) set automatically by the **MicroTrap™ VOD/Data Recorder**. When the voltage across the probe reaches the value corresponding to the **Trigger Level** selected by **DAS™ Data Acquisition Suite Software**, the **MicroTrap™ VOD/Data Recorder** is triggered. This represents time = 0 on the resulting **VOD** graph. For example, with a **Trigger Level** setting of 95%, the **MicroTrap™ VOD/Data Recorder** will be triggered when the voltage signal coming from the probe crosses the 95% level (4.75 VDC of the full-scale voltage, which is approximately 5.0 VDC).

Once the **MicroTrap™ VOD/Data 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 Software**, for **Pre-Trigger** %. The **DAS™ Data Acquisition Suite 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:

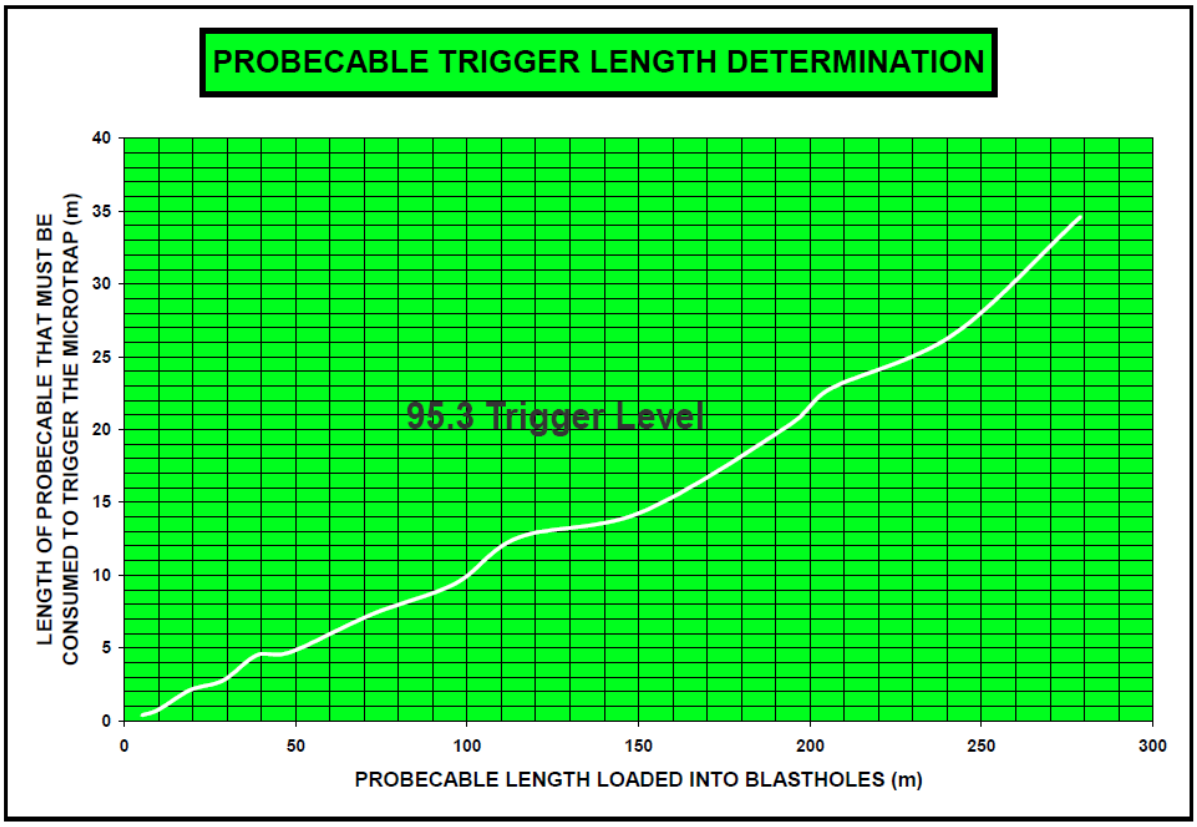
Pre-Trigger Time = (Total Recording Time) x Pre-Trigger %
Post-Trigger Time = (Total Recording Time) - (Pre-Trigger Time)

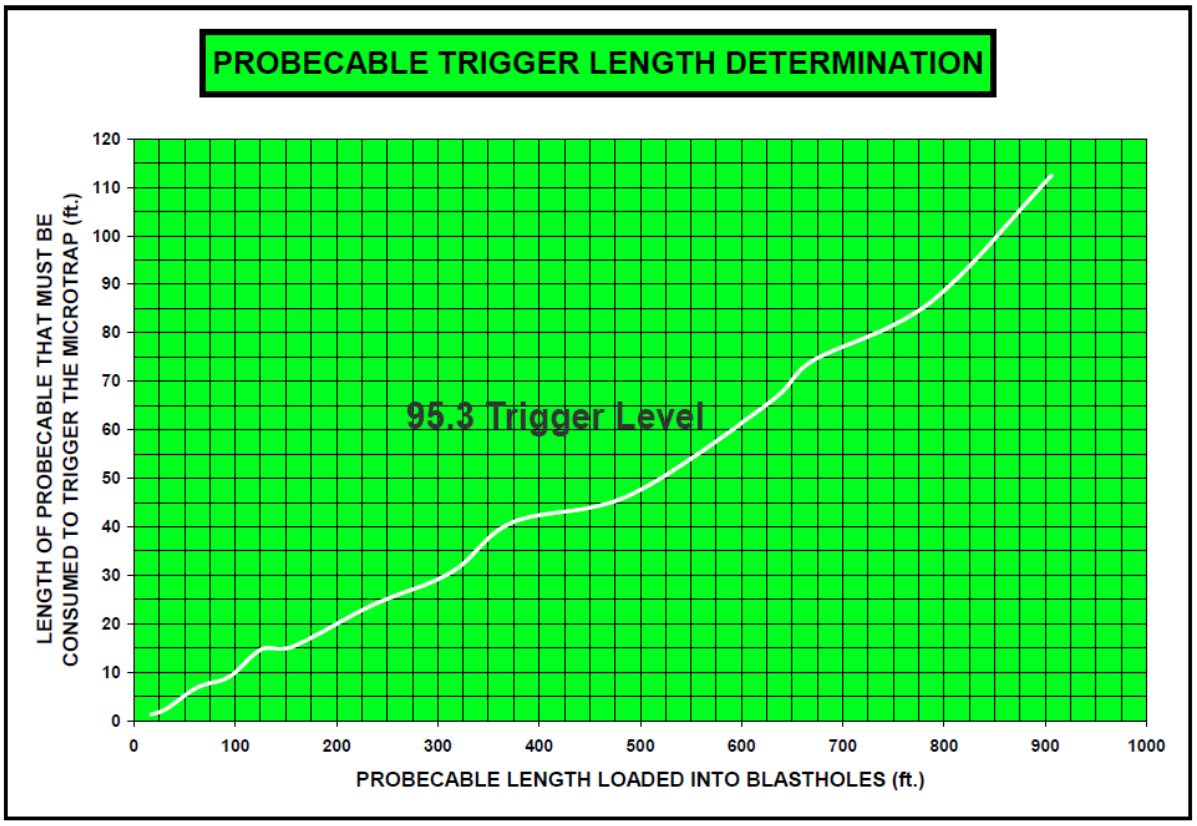
For the **PROBECABLE** or **PROBECABLE-LR** length loaded in the blastholes, and the recommended **TRIG%** setting of 95.3%, the graphs on the following pages show the lengths of **PROBECABLE** and **PROBECABLE-LR** that must be consumed for the **MicroTrap™ VOD/Data Recorder** to receive the **INT**ernal trigger signal. **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/Data Recorder** (3,000 ohms).

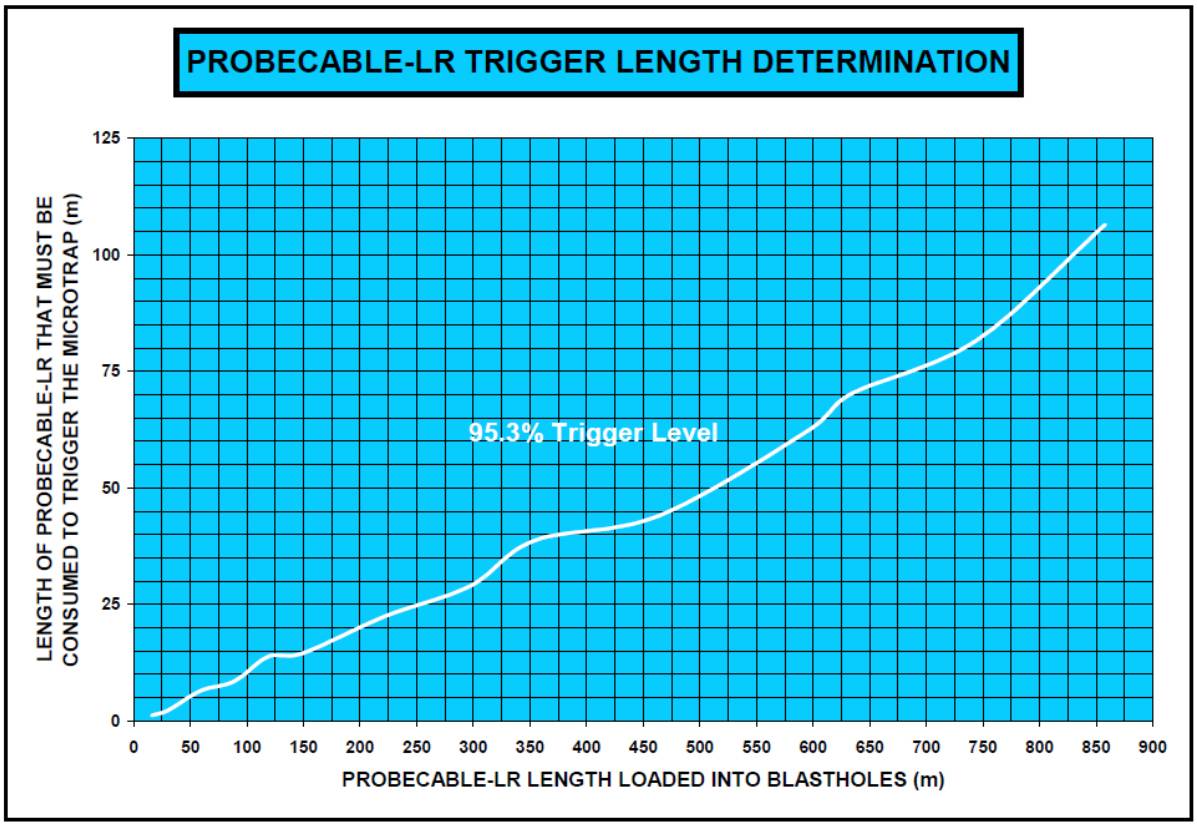
For example, at a 95.3% **Trigger Level** and with 250 metres of **PROBECABLE** loaded into blastholes, then 28 metres of **PROBECABLE** must be consumed to trigger the **MicroTrap™ VOD/Data Recorder**. If the first hole does not consume a sufficient length of **PROBECABLE** to trigger the **MicroTrap™ VOD/Data Recorder**, then all of the **VOD** data for the first hole will be before time = 0.

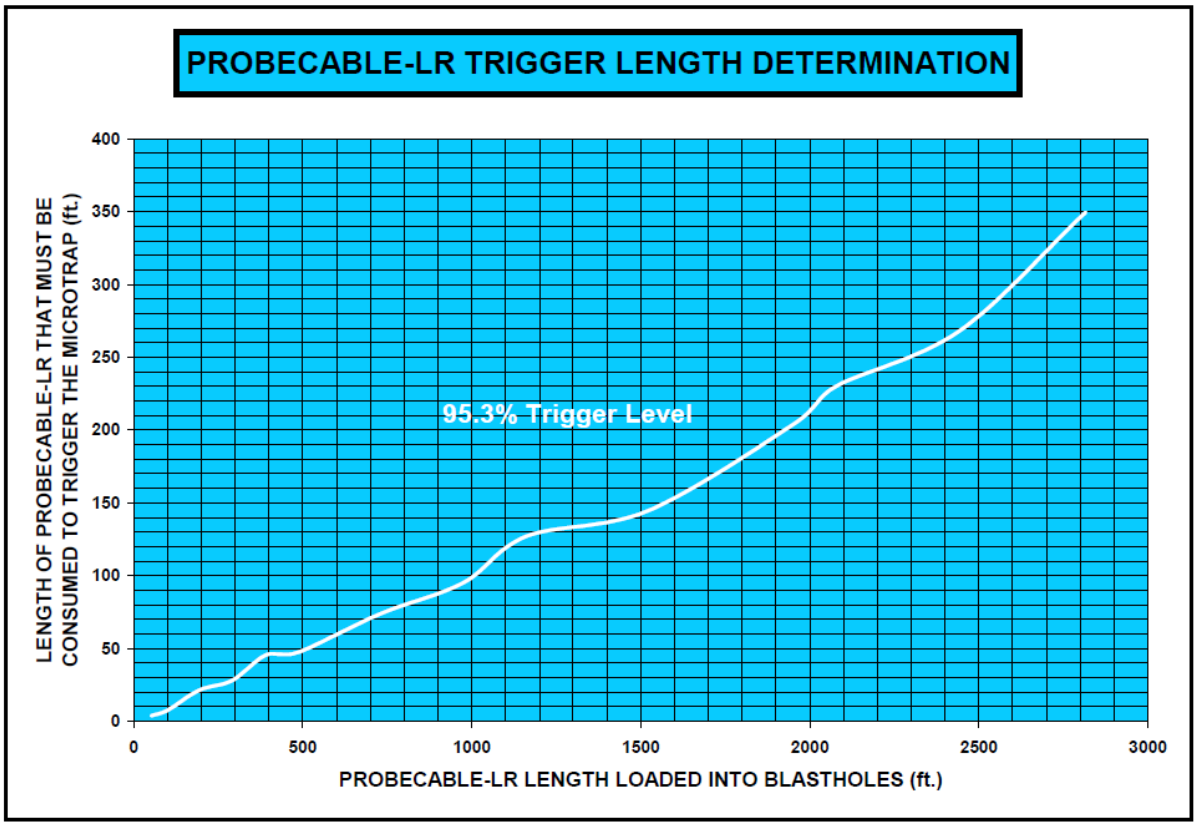
The Operator should ensure that there is sufficient **Pre-Trigger** time to record the time it takes for the trigger length of **PROBECABLE** to be consumed in the blast. This is particularly important if several delayed holes must be detonated in order for sufficient **PROBECABLE** to be consumed. The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

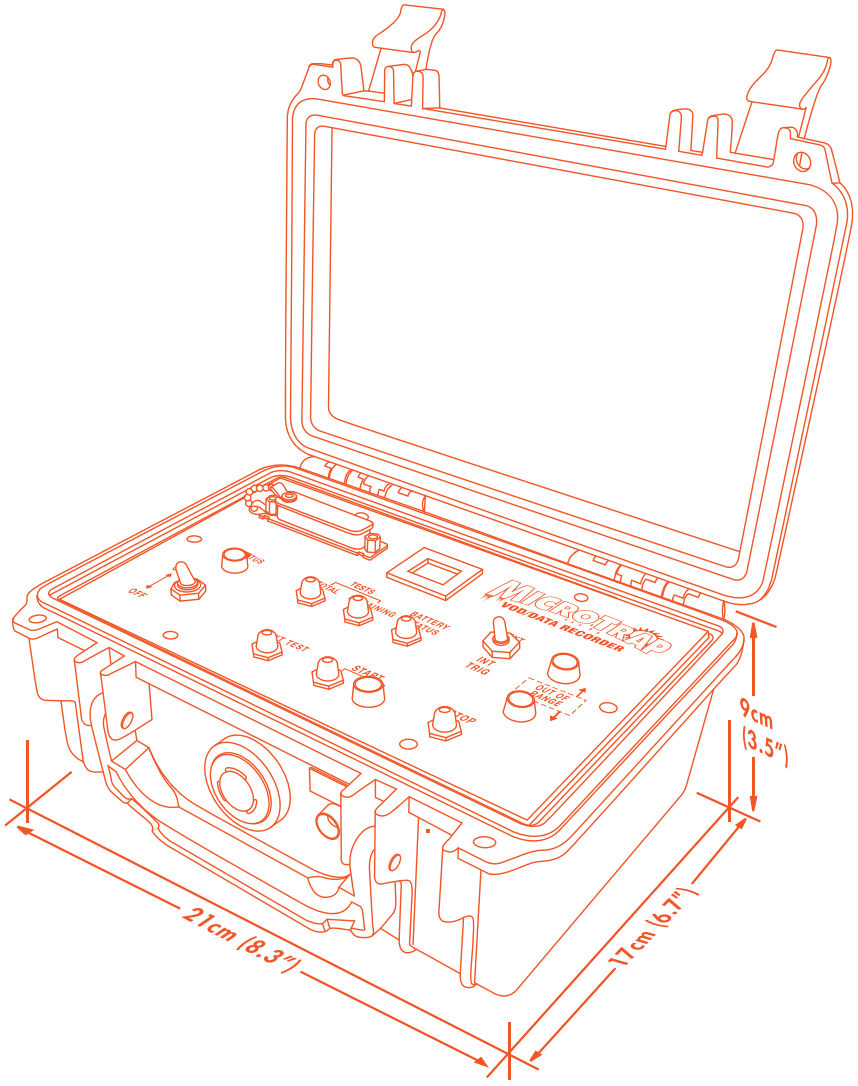

PROBECABLE TRIGGER LENGTH DETERMINATION
LENGTH OF PROBECABLE THAT MUST BE CONSUMED TO TRIGGER THE MICROTRAP (m)
95.3 Trigger Level
0
5
10
15
20
25
30
35
40
0
50
100
150
200
250
300
PROBECABLE LENGTH LOADED INTO BLASTHOLES (m)


PROBECABLE TRIGGER LENGTH DETERMINATION
LENGTH OF PROBECABLE THAT MUST BE CONSUMED TO TRIGGER THE MICROTRAP (ft.)
95.3 Trigger Level
0
10
20
30
40
50
60
70
80
90
100
110
120
0
100
200
300
400
500
600
700
800
900
1000
PROBECABLE LENGTH LOADED INTO BLASTHOLES (ft.)


PROBECABLE-LR TRIGGER LENGTH DETERMINATION
LENGTH OF PROBECABLE-LR THAT MUST BE CONSUMED TO TRIGGER THE MICROTRAP (m)
125
100
75
50
25
0
95.3% Trigger Level
0 50 100 150 200 250 300 350 400 450 500 550 600 650 700 750 800 850 900
PROBECABLE-LR LENGTH LOADED INTO BLASTHOLES (m)


PROBECABLE-LR TRIGGER LENGTH DETERMINATION
LENGTH OF PROBECABLE-LR THAT MUST BE CONSUMED TO TRIGGER THE MICROTRAP (ft.)
400
350
300
250
200
150
100
50
0
95.3% Trigger Level
0 500 1000 1500 2000 2500 3000
PROBECABLE-LR LENGTH LOADED INTO BLASTHOLES (ft.)

Chapter 5
Recording Voltage Signals From Gauges



Overview

This Chapter provides the Operator with detailed instructions on connecting the gauges to the MicroTrap™ VOD/Data Recorder and setting the MicroTrap™ VOD/Data Recorder hardware to record the voltage signals produced by the gauges.

5.1 Introduction to Recording DC Voltage Signals

The **MicroTrap™ VOD/Data Recorder** with optional **Scope Upgrade** is capable of recording DC voltage signals on up to 4 channels. Additionally, the **VOD** channel can be used to record **VOD** data simultaneously with the recording of voltage signals. When simultaneously recording voltage and **VOD** data the triggering of the MicroTrap, when set on **INT**ernal triggering, is controlled by the **VOD** channel.

The **MicroTrap™ VOD/Data Recorder** is specifically designed to be used with gauges, power supplies and signal conditioning equipment producing DC voltage signals in the range of -10 to +10 VDC. Each of the **Scope** channels can be individually programmed to accept a variety of uni-polar or bi-polar voltage ranges. The 0-2.5, 0-5 and 0-10 volt ranges refer to the uni-polar setting commonly used to measure slowly changing events such as temperature recordings. The -2.5 to 2.5, -5 to 5 and -10 to 10 volt input ranges refer to the bipolar mode which is frequently used to record faster events such as explosion & detonation pressures, blast vibrations, over-pressures, air blast, strains, etc.

The **MREL MicroTrap™ VOD/Data Recorder** is commonly used to record voltage signal inputs from commercially available sensors such as include (external power sources may be required):

- Tri-axial Geophones and Uni-axial Velocimeters for recording vibration data.
- Tourmaline gauges for recording high pressures associated with shock, such as underwater blasts.
- Carbon Resistors for recording very high pressure signals in harsh environments, such as cross-borehole propagation.
- PVDF transducers to measure detonation pressures.
- Thermocouples to measure temperatures.
- Various PCB sensors to measure blast overpressures or accelerations.

Some types of sensors require an excitation signal to operate. In this case, the appropriate amplifier or signal conditioner must be used in conjunction with the sensor.

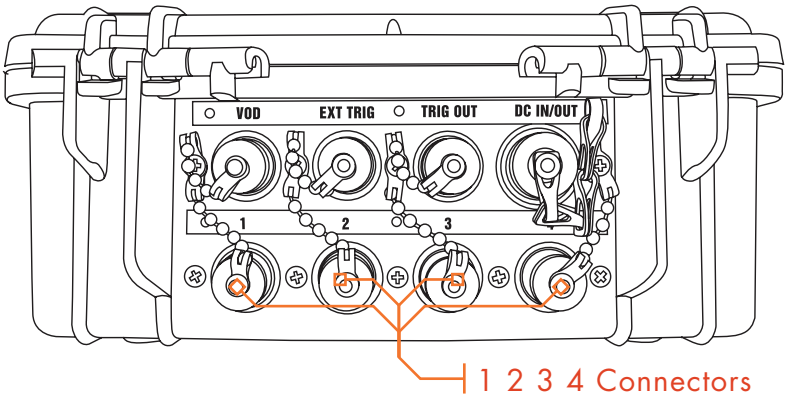
The **DAS™ Data Acquisition Suite Software** automatically displays the recorded data in graphs of voltage versus time. The **DAS™ Data Acquisition Suite Software** includes menu functions that allow the User to apply equations to the voltage data in order to convert it into a graph of proper engineering units (versus time). The User has the freedom to choose any engineering unit that corresponds to the sensor data. Also, if desired, the data can be exported to be used in other software programs that the User has access to. The user can purchase an upgrade to the **Advanced Edition** of the **DAS™ Data Acquisition Suite Software** to enable the application of filters for the data. Refer to the **Advanced Edition** section in the **DAS™ Data Acquisition Suite Software Manual** for more information.

5.2 Connecting Gauges to the MicroTrap™ VOD/Data Recorder

The equipment and supplies that are required to record voltage signals from gauges are:

1. The **MREL MicroTrap™ VOD/Data Recorder**.
2. Up to 4 Sensors and 1 **VOD Probe** (optional).
3. **Coaxial Cable** (type RG-58 is recommended) of sufficient length to run between the **MicroTrap™ VOD/Data Recorder** and the sensors.
4. Wire Cutters and Electrical Tape.

The procedure for connecting sensors to the **MicroTrap™ VOD/Data Recorder** is as follows:



1. Place the **MicroTrap™ VOD/Data 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/Data Recorder** does not require the User to collect the data; it does so automatically without assistance.
2. For each sensor you intend to use, run a length of coaxial cable from the **MicroTrap™ VOD/Data Recorder** to that sensor with enough excess length to compensate for cable shortening or cable damage from each test (if applicable). Shorter lengths of coaxial cable may be connected together using the wire cutters and electrical tape. A male BNC connector should be attached to the end of the coaxial cable that is to be attached to the Scope inputs (labeled **1 2 3 4**) on the back of the **MicroTrap™ VOD/Data Recorder**. Convenient **BNC Adapters** have been supplied with the **MicroTrap™ VOD/Data Recorder** for this purpose. The **Adapters** can be connected to the coaxial cable using the wire cutters and electrical tape. The connection should be "shielding to shielding" and "center to center" conductor. Ensure that the center conductor and the shielding do not touch each other.
3. Make note of the conversion formulas of the sensors being used. If using multiple sensors of the same type are to be used, make note of the serial number and conversion formula of each sensor. These conversion formulas are generally used in equations that relate voltage to engineering units. You will need to enter these conversion formulas into the **DAS™ Data Acquisition Suite Software** to convert the graphs of voltage versus time, to graphs of the appropriate engineering units versus time.
4. Install your sensors in their final positions.
5. Connect the coaxial cable to your sensors using the appropriate connectors, or your wire cutters and electrical tape. Note that the polarity of the connection is typically important to indicate positive or negative readings from the sensors. The centre conductor of the coaxial cable is termed "**active**" and the shielding is "**common**". Remember to connect and adjust the settings on your amplifier or signal conditioner(s) as required.
6. Connect the coaxial cables to the Scope inputs (labeled **1 2 3 4**) on the back of the **MicroTrap™ VOD/Data Recorder**.
7. The **MicroTrap™ VOD/Data Recorder** is now ready to begin the recording sequence, as detailed in **Section 5.4** below.

5.3 Signal Cable Protection

It is important to protect the gauge signal cable from damage caused by personnel and machinery operating at the test area. If testing explosives, it is also important to protect the cable from damage caused by detonation of other holes and/or surface accessories such as detonating cord, detonating relays, and shock tube bunch blocks.

5.3.1 Detonation Cord

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.

5.4 MicroTrap™ Setup Procedure for Recording Voltage Signals

Now that your sensor(s) are placed and connected to the **MicroTrap™ VOD/Data Recorder**, it is time to being the recording sequence. Remember that the **MicroTrap™ VOD/Data Recorder** should already be programmed with the appropriate number of tests, number of channels per test, record rates, trigger level, and pre-trigger memory allocation. Refer to the **DAS™ Data Acquisition Suite Software Manual** if required.

IMPORTANT

MREL recommends setting the Number of Tests = 16 for when recording short duration events. This reduces the quantity of data collected per test and conserves the computer's disk space. At a 1 MHz recording rate, a **MicroTrap™ VOD/Data Recorder** with standard memory will record for a total of 65 ms per test if the Number of Tests = 16 and the Number of Channels = 4. This is sufficient recording time for many short duration events. See **Section 4.6** for more information on memory.

The procedure to record a new test consists of the following steps:

1. Ensure that the coaxial cable coming from the gauge(s) is connected to the Scope input connectors (labeled **1 2 3 4**) on the **MicroTrap™ VOD/Data Recorder**.
2. Turn the **MicroTrap™ VOD/Data Recorder ON**. The **STATUS** light will illuminate and begin to flash quickly for approximately 2 seconds while the **MicroTrap™ VOD/Data Recorder** conducts some internal verification testing. If the **MicroTrap™ VOD/Data Recorder** passes the internal verification tests, the **STATUS** light will begin to flash slowly (**Stand-by mode**). The User can go on to Step 3. **CAUTION:** Do not turn **OFF** the **MicroTrap™ VOD/Data Recorder** until after the internal verification testing has been complete or an unrecoverable error can occur and the unit may be required to be sent in for service. If the **MicroTrap™ VOD/Data Recorder** fails to pass the internal verification tests, the **STATUS** light will flash three times in succession and **EE** will appear on the **LED**. If this happens, switch the **MicroTrap™ VOD/Data Recorder OFF** , wait several seconds, and turn the **MicroTrap™ VOD/Data Recorder ON** again. If the **MicroTrap™ VOD/Data Recorder** continues to fail the internal verification tests, then contact **MREL** as the **MicroTrap™ VOD/Data Recorder** requires service.
3. Press the **NEXT TEST** button; the **STATUS** light will stop flashing and will remain illuminated (**Active** mode).
4. Press the **TOTAL TESTS** button to see the number of tests that the **MicroTrap™ VOD/Data Recorders** memory has been divided into, using the **DAS™ Data Acquisition Suite Software**.

IMPORTANT

If you do not wish to keep the existing data in memory, then you can either clear the **MicroTrap™ VOD/Data Recorders** internal memory using the **DAS™ Data Acquisition Suite Software** or by following this procedure:

a. Turn **ON** the **MicroTrap™ VOD/Data Recorder**.
b. Press the **NEXT TEST** button to put the **MicroTrap™ VOD/Data Recorder** in **Active** mode. The **STATUS** light should be on.
c. Simultaneously press the **NEXT TEST** and **STOP** buttons and hold them down. The LED will display a blinking **dE**. Release the buttons.
d. Simultaneously press the **START** and **STOP** buttons and hold them down. The **LED** will display **dE** without blinking. Release the buttons. All of the data in the **MicroTrap™ VOD/Data Recorders** memory will be deleted.
e. Turn **OFF** the **MicroTrap™ VOD/Data Recorder**. Turn **ON** the **MicroTrap™ VOD/Data Recorder** and pressing the **TOTAL TESTS** button and then the **REMAINING TESTS** button will confirm that these numbers are equal and that all of the test data in the **MicroTrap™ VOD/Data Recorders** memory has been deleted.

5. Press the **REMAINING TESTS** button to see the number of memory slots that remain to be filled in the **MicroTrap™ VOD/Data Recorders** non-volatile memory. If this number does not equal the number of **TOTAL TESTS**, then there are one or more tests already stored in the **MicroTrap™ VOD/Data Recorders** internal memory. If the value shown on the display is 0, the memory is full and will need to be cleared prior to conducting further tests.
6. If you intend to use the **MicroTrap™ VOD/Data Recorders** internal trigger, ensure the **EXT/INT TRIG** switch is set to the **INT**ernal position. The use of external **EXT**ernal triggering is discussed in **Chapter 4.8**.

NOTE: When simultaneously recording voltage and VOD data the triggering of the **MicroTrap™ VOD/Data Recorder**, when set on **INT**ernal triggering, is controlled by the VOD channel. Details on the procedure for recording VOD data are provided in the **Chapter 4.**

7. Look for the **OUT OF RANGE** warning light indicators (↓and↑). If there is a warning light, then the voltage being produced by one of the sensors is out of the voltage range set by the **DAS™ Data Acquisition Suite Software**. If this is the case, then disconnect the signal wires from the **MicroTrap™ VOD/Data Recorder** one at a time, until the warning light goes off. When the warning light goes off, the unplugged sensor is identified as the fault. The User should test the cable connections to the sensor, as well as the power supply and/or signal conditioner. A voltmeter should be used to verify the baseline voltage output of the sensor. If the **OUT OF RANGE** lights are not illuminated the User can proceed to Step 8.

NOTE: If a scope channel is in UniPolar mode, a negative voltage will cause an out-of-range error. This may be due to incorrect polarity. Also, some sensors produce a slightly negative voltage when zero is expected, so they require a bipolar range.

8. Press the **START** button. The **START** light will illuminate steadily. The **MicroTrap™ VOD/Data Recorder** then starts monitoring the blast, waiting for the trigger signal to record the voltage data. Personnel may now vacate the **MicroTrap™ VOD/Data Recorder** location if necessary.
9. When the **MicroTrap™ VOD/Data Recorders** internal triggering criteria is met (i.e. the voltage signal on one of the channels has crossed the trigger level set in the **DAS™ Data Acquisition Suite Software**), the **MicroTrap™ VOD/Data Recorder** will begin recording voltage iinformation. Note that **Scope** trigger is "absolute value above". For example, if in bipolar mode and 60% trigger level is selected with the range set to +/- 10 volts, it triggers above 6 volts or below -6 volts. Upon triggering, the **TRIG'D** light will illuminate and remain on during the collection of data (this time depends on the recording rate and number of tests programmed into the **MicroTrap™ VOD/Data Recorder**). During this time, both the **START** and **STATUS** lights will also be illuminated.

IMPORTANT

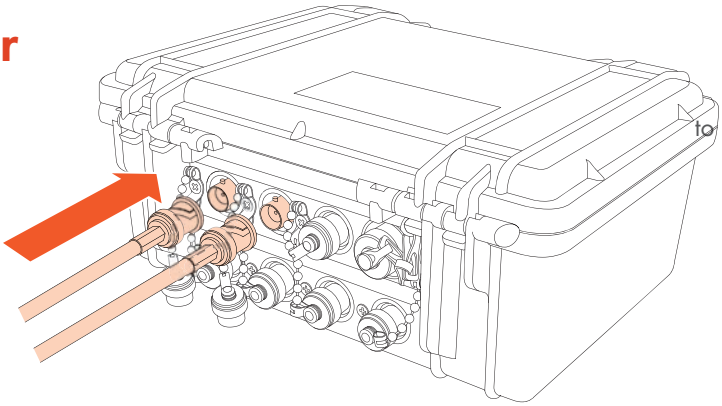
If the **MicroTrap™ VOD/Data Recorder** has triggered prematurely, or the data that you have collected is not of use to you, then you may erase only the last test by performing the following sequence:

a. Do not turn **OFF** the **MicroTrap™ VOD/Data Recorder** after the test, the **STATUS** light and **TRIG'D** lights should be flashing.
b. To erase the data from the last test; simultaneously press the **TOTAL TESTS** and **REMAINING TESTS** buttons and hold them until this procedure is complete. The **LED** display will show **ct**.
c. After about 2 seconds, the **ct** will begin blinking. After another 2 seconds, the **ct** will disappear. Release the buttons. The data from the last test has been deleted.
d. Turn **OFF** the **MicroTrap™ VOD/Data Recorder**, wait several seconds and then turn the **MicroTrap™ VOD/Data Recorder ON** again. Pressing the **TOTAL TESTS** button and then the **REMAINING TESTS** button will confirm that the remaining tests have been increased by 1 and that the last test in the **MicroTrap™ VOD/Data Recorders** memory has been deleted.

NOTE: When the internal triggering criteria are met, the **MicroTrap™ VOD/Data Recorder** will send a 10 VDC signal to the **TRIG OUT** port on the back of the unit. This pulse is 6 seconds in duration, and has a rise time of 2 microseconds. Some Users may wish to trigger other instrumentation from the **MicroTrap™ VOD/Data Recorders TRIG OUT** port.

10. Once data collection ends, the **TRIG'D** and **START** lights flash rapidly and the **MicroTrap™ VOD/Data Recorder** begins storing data into its non-volatile memory. During this short time, the **STATUS** light is illuminated to indicate that writing is taking place. Do not switch the **MicroTrap™ VOD/Data Recorder OFF** during this time.
11. When the **MicroTrap™ VOD/Data Recorder** finishes storing the data, the **START** light will go dark and the **STATUS** and **TRIG'D** lights will begin to flash slowly. The **MicroTrap™ VOD/Data Recorder** has now returned to **Stand-by** mode.
12. 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 Software** as detailed in **Section 6.1**. If data transfer is to be conducted later, then the **MicroTrap™ VOD/Data Recorder** can be switched **OFF** and the data will remain in the **MicroTrap™ VOD/Data Recorder** non-volatile memory.

5.5 Utilizing the External Trigger



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

The **EXT TRIG** function operates on the simple concept of **MAKE** or **BREAK** circuits. Both types of trigger capitalize on the fact that the **EXT 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 momentary. 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 **EXT 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/Data 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. Ensure that the resistance of the external trigger wires have a total resistance below 100 ohms in order to detect the change in status to trigger the unit. It is always best to test the external trigger if possible.

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/Data Recorder**. Beware that even a momentary break in the trigger circuit will cause the **MicroTrap™ VOD/Data Recorder** to trigger. Avoid disturbing a **BREAK** trigger once the **START** button has been pressed. Ensure that the resistance of the external trigger wires have a total resistance below 100 ohms in order to detect the change in status to trigger the unit. It is always best to test the external trigger if possible.

5.6 Additional Information on Memory

The **MicroTrap™ VOD/Data Recorder** has a large circular memory containing 4,194,000 data points (doubled with optional memory upgrade) that are allocated across each of the tests into which the **MicroTrap™ VOD/Data Recorders** memory has been divided. The total number of tests and selected recording rate dictate the total record time available for each test. Selection of the number of tests to be recorded and the Recording Rate is done using the **DAS™ Data Acquisition Suite Software**.

The **DAS™ Data Acquisition Suite Software** automatically calculates and displays the **Total Recording Time per Test** and the **Pre-Trigger Time**. Notice that the graphic shown is for a **MicroTrap™ VOD/Data Recorder** with the optional **MicroTrap™ VOD/Data Recorder Memory Upgrade** installed.

For those Operators with additional interest in recording times:

A general equation to calculate the **Total Recording Time** (**Pre-Trigger Time** + **Post-Trigger Time**) is:

Total Recording Time (seconds) = 4,194,000 points / ((# of tests) x (# of channels) x (recording rate))

If the number of tests selected is one, and only one channel is being recorded, the available recording time will be maximized for a given **Recording Rate**. For example, at the maximum Recording Rate 1 MHz, the Total Recording Time will be:

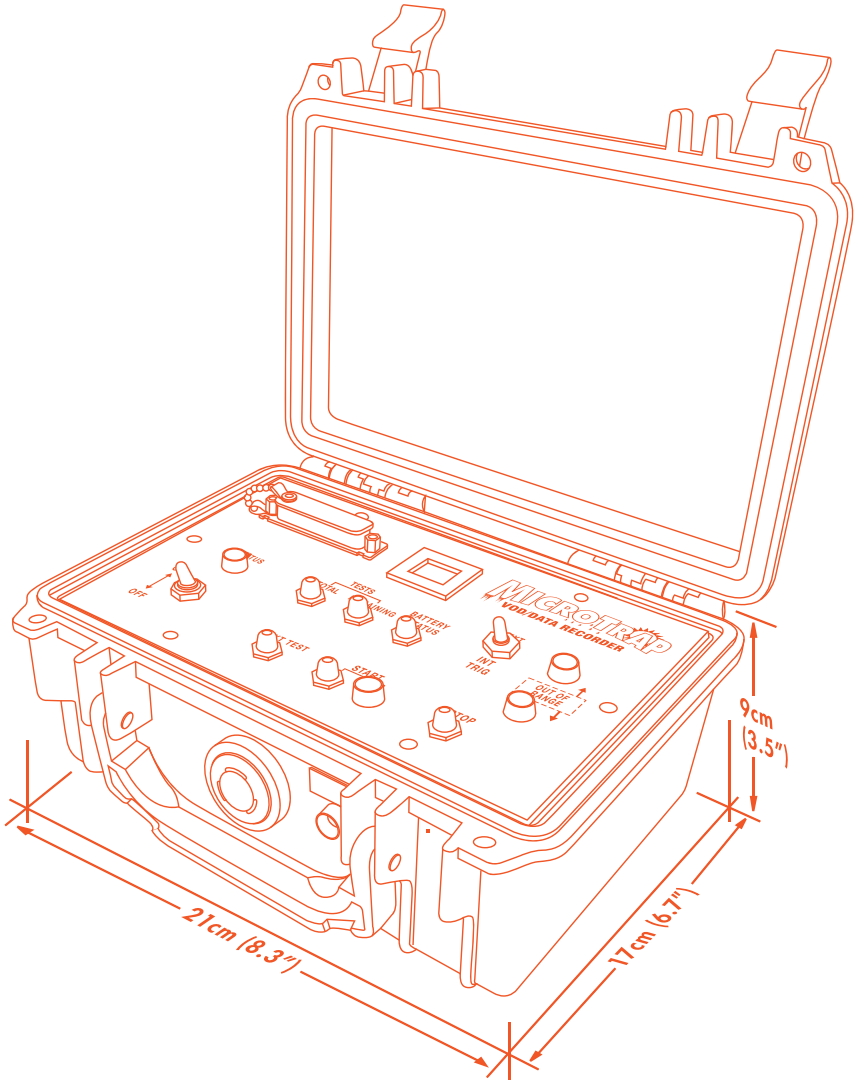
4,194,000 points / ((1 test) x (1 channel) x (1,000,000 points/sec)) = 4.194 seconds

At a slower **Recording Rate** of 500 kHz (for example), the **Total Recording Time** will become 8.390 seconds. If the **MicroTrap™ VOD/Data Recorders** internal memory is divided into 4 tests and there are 4 Scope channels on and VOD is also being recorded, the **MicroTrap™ VOD/Data Recorder** will partition the memory allocating 4,194,000 points/((4 tests)x(5 channels)) = 209,700 points per test per channel. Following the previous example, the Total Recording Time per test can be calculated as follows:

4,194,000 points / ((4 tests) x (5 channels) x (1,000,000 points/sec)) = 0.210 seconds per test

If the Recording Rate is reduced to 500 kHz, the **Total Recording Time** will become 0.42 seconds per test per channel. If these recording times are insufficient for your testing applications, then contact **MREL** and ask about the **MicroTrap™ VOD/Data Recorder Memory Upgrade**, which doubles the **MicroTrap™ VOD/Data Recorders** internal memory and thus doubles the **Total Recording Time**. For slower phenomena such as temperature, much lower recording rates can be used to allow the **MicroTrap™ VOD/Data Recorder** to record for hours.

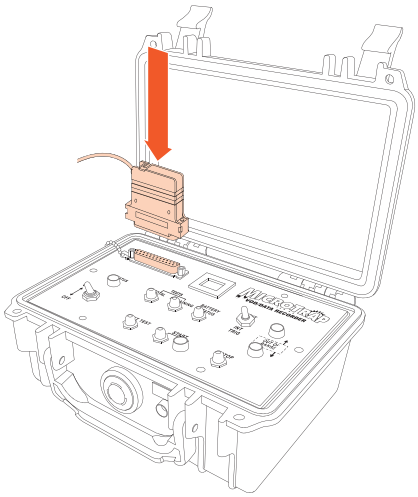
Chapter 6
MicroTrap™ VOD/Data Recorder Software



Overview

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

6.1 Retreiving Data From The MicroTrap™ VOD/Data Recorder



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

1. Turn off the **MicroTrap™ VOD/Data Recorder**.
2. Connect the **Communication Cable** to the computer. Wait for the **Green** light to show the cable is operating properly.
3. Connect the **Communications Cable** between the **USB Port** on the computer and the **MICROTRAP USB COM** port on the front panel.
4. Turn the **MicroTrap™ VOD/Data Recorder** power **ON**.

NOTE: If the **USB cable** has not been connected prior to turning **ON** the unit, the User MUST wait approximately 5 seconds before connecting the **USB cable** or an unrecoverable error can occur and the unit may be required to be sent in for service.

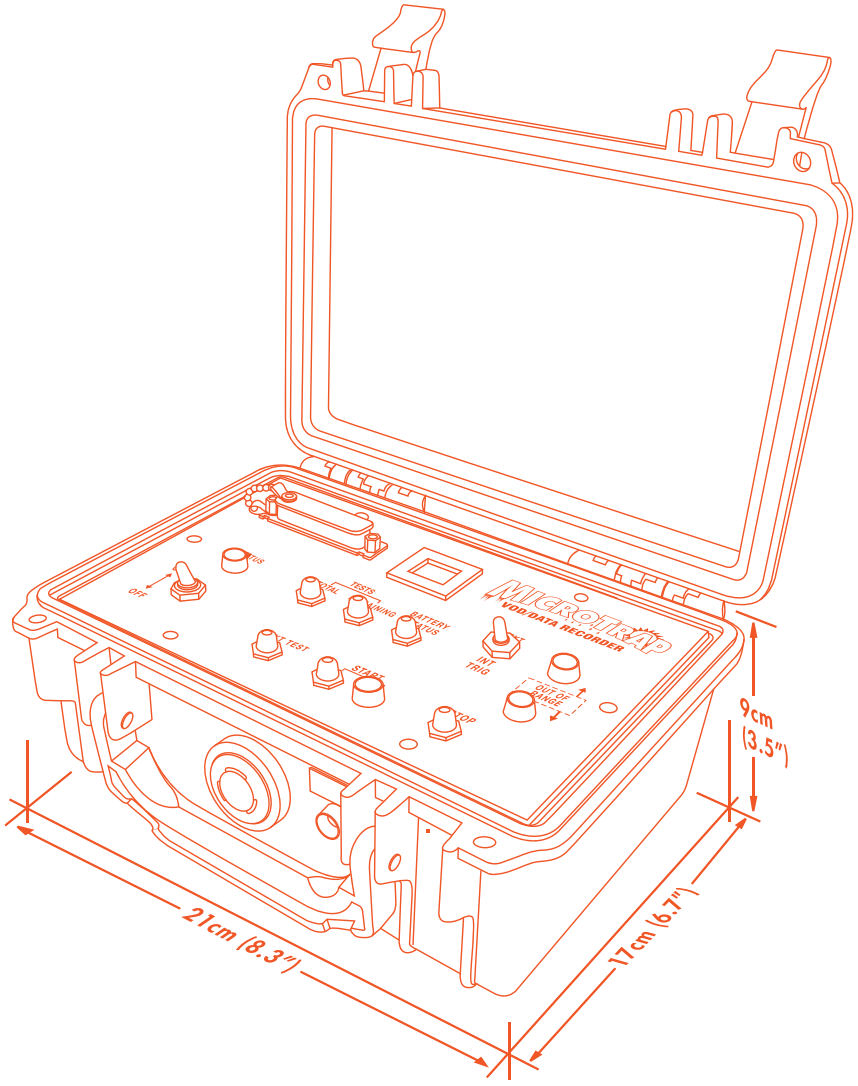
5. Start the **MicroTrap™ VOD/Data Recorder Software** by clicking on **Start-Programs-MREL-Data-Acquisition-Suite**.

To continue the download, refer to the **DAS™ Data Acquisition Suite Software Manual.**

6.2 Selecting Data Files for Analysis

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

Chapter 7
Contacting MREL for Technical Support



7.1 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.

MREL is committed to product innovation; accordingly product may undergo specification improvements without notice.

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