6050X3K5B

OPERATING INSTRUCTIONS

6050X3K5B – MiniTrase Kit November 2012

6050X3K5B, MiniTrase Kit

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SOILMOISTURE

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1. THE 6050X3K5B MINI TRASE KIT

The MiniTrase (6050X3) uses Time Domain Reflectometry (TDR) to measure instantaneously the volumetric water content of soils and other moist media. A variety of connectors and waveguides for depth measurements ranging from 08 cm to 100 cm are available, and can be used in a portable manner or permanently installed for periodic moisture monitoring. The volumetric moisture content is displayed on the Android Tablet, and the graph of the TDR pulse can also be tagged for identification and stored for immediate viewing and analysis on the Android Tablet or later on the PC. All stored data can be transferred either by by downloading the data from the Android Tablet to your PC or via an RS-232 port connection from the MiniTrase to the PC. The MiniTrase unit is designed for rugged field use and is environmentally sealed to prevent damage to sensitive electronic components.

Unpacking

The MiniTrase Kit shipped to you was thoroughly tested before shipment. When packed, it was in perfect order. Unpack with care being sure to remove all packing material. Follow the instructions carefully in order to ensure long, trouble-free service.

Cautions and Warnings

Handle all components of the system with care to avoid any damage to delicate electronic components. Any damage found upon receipt should be reported immediately to the transport carrier for claim. It is important that you save the shipping container and all evidence to support your claim.

Be sure to read all operating instructions thoroughly before operating the unit. When in use, static discharge to waveguides or waveguide sockets may cause damage to sensitive electronic components.

Note

Operating the system when the "OPR" (operating) light is flickering on the MiniTrase can result in incorrect readings and can cause loss of stored data. MiniTrase involves proprietary electronic circuits and hardware. Repair of this precision instrument requires highly specialized equipment. For this reason, the unit should be returned to SEC for any major repair work. Tampering with the MiniTrase in any unauthorized manner prior to return will void warranty and make the user liable for costs of repair.

MiniTrase Warranty

Soilmoisture warrants all its products and related software to be free from defects for the period of one year.

Android Tablet Warranty

The Android Tablet is warranted through the manufacturer. Please refer to the Android Tablet's operating instructions for the warranty period. Any mechanical or Android Tablet operating system problems should be addressed directly with the manufacturer.

Not Liable for Improper Use

Soilmoisture Equipment Corp. is not responsible for any damage actual or inferred for misuse or improper handling of this equipment. MiniTrase is designed to be used solely as directed by a prudent individual under normal conditions in the applications intended for this instrument.

GENERAL SPECIFICATIONS - MODEL 6050X3K1B MINITRASE

Measuring Range	0-100% volumetric moisture content
Measuring Accuracy	±2% full scale or better with the standard waveguide connector
Operating Temperatures	0 to +45°C
Power Supply	One each NiCad battery, supplied. Total capacity: 1.7 amp hr. Recharge time, internal charges up to 12 hours, optional external charger 35-40 minutes. Auxiliary power input 18 volt DC, 2.2 Amp AC Power Adapter for independent operation. External battery input, 12 volts DC minimum, for independent operation.
Connecting Ports	BNC Port – For waveguide connection DB-9 Serial Port – For data transfer DB-15 Multiplexer Port - for multiplexing Power Port – 8-pin DIN
MiniTrase Memory	Standard 256 Kb memory with storage capacity greater than 180 graphs/5,610 readings. Optional 4 Mb memory board increases storage to greater than 3,900 graphs 122,880 readings. Automatic data tagging with time and date plus user definable Tag field.
MiniTrase Electronic Particulars	Measuring pulse amplitude 1.6 volt peak Sampling resolution, 10 picoseconds Hardware – 5-slot card cage: 3 system boards, 1 optional slot (for optional expanded memory), and multiplexing board

Included Items

1 - MiniTrase with Multiplexer Card
1 – Android Tablet - (6911ANT07B)
1 – Flash Drive with WinTrase and Android to PC Software (8009AN)
1 - WinTrase Software on CD (8001)
1 - Standard Waveguide Connector (6002F1)
1 - Set of 15 cm long Waveguides (6008L15)
1 - Internal Bluetooth Module (not separate)
1 - Connector Cable from MiniTrase to PC RS232 (MEZ036)
1 - Power Supply unit for MiniTrase (6051V100-240)
1 - MiniTrase Backpack (6031)
1 - Set MiniTrase Operating Instructions on Mini CD (0898-6050X3K1)
1 - Set of 3-Letter Code Instructions (0898-60503LC-1)

Optional:
1 - MiniTrase Battery Charger USA Style plug (6053V120)
1 - Bluetooth Transmitter/Receiver for Android (7006SF01); used with older MiniTrase Units that do not have internal Bluetooth capability.

ANDROID TABLET

The Current Android Tablet supplied with the MiniTrase Kit is a Samsung Galaxy 2; a product manufactured by Samsung. Any malfunctions in Android Tablet hardware and/or Android operating system software must be addressed with Samsung.

Please refer to the Android Tablet operating instructions provided with the tablet or manufacturer's website for more details.

TraseTerm Application and WinTrase Software

The TraseTerm application, used with the Android Tablet to operate your MiniTrase, is a product of Soilmoisture. WinTrase is also a product of Soilmoisture. All TraseTerm and WinTrase software issues should be directed to Soilmoisture's technical staff or your local Soilmoisture representative.

2. PRINCIPLES AND TECHNIQUES OF OPERATION

Theory

The speed with which an electromagnetic pulse of energy travels down a parallel transmission line depends on the dielectric constant, (Ka), of the material in contact with and surrounding the transmission line. The higher the dielectric constant the slower the speed.

Soil is composed, in general, of air, mineral and organic particles, and water. The dielectric constants, K, for these materials are:

Air 1
Mineral Particles 2-4
Water 80

Because of the great difference in the dielectric constant of water from the other constituents in the soil, the speed of travel of a microwave pulse of energy in a parallel transmission line buried in the soil is very dependent on the water content of the soil.

When a microwave pulse travels down a transmission line it behaves in many ways like a beam of light. Discontinuities in the transmission line and surrounding material cause some of the microwave energy to be reflected back through the line. When the pulse reaches the end of the transmission line, virtually all the remaining energy in the pulse is reflected back through the line; much the same as a beam of light traveling down a tube and being reflected back by a mirror at the end of the tube.

These characteristics make it possible, with sophisticated electronics, to measure the time required for a microwave pulse to travel down a known length of transmission line, referred to as waveguides, buried in the soil.

The apparent dielectric constant, Ka, of the air-soil-water complex can then be determined by the formula:

$$Ka = \left(\frac{tc}{L}\right)^2$$

Where "L" is the length of the waveguides in centimeters, "t" is the transit time in nanoseconds (billionths of a second), and "c" is the speed of light in centimeters per nanosecond. The transit time is defined as the time required for the pulse to travel in one direction from the start of the waveguide to the end of the waveguide.

If the soil is completely dry, Ka will be 2 to 4. If 25% of the volume of the soil is water, Ka will be approximately 11-12. For agricultural soils the value of Ka depends primarily on the volumetric water content of the soil and is largely independent of the type of soil.

The relationship of the Ka value to the volumetric water percentage has been established by careful measurements of Ka in test cells prepared with accurately known volumes of water in soil. This relationship is then used to automatically convert field measurements of Ka to the volumetric water content of the soil.

The Measurement System

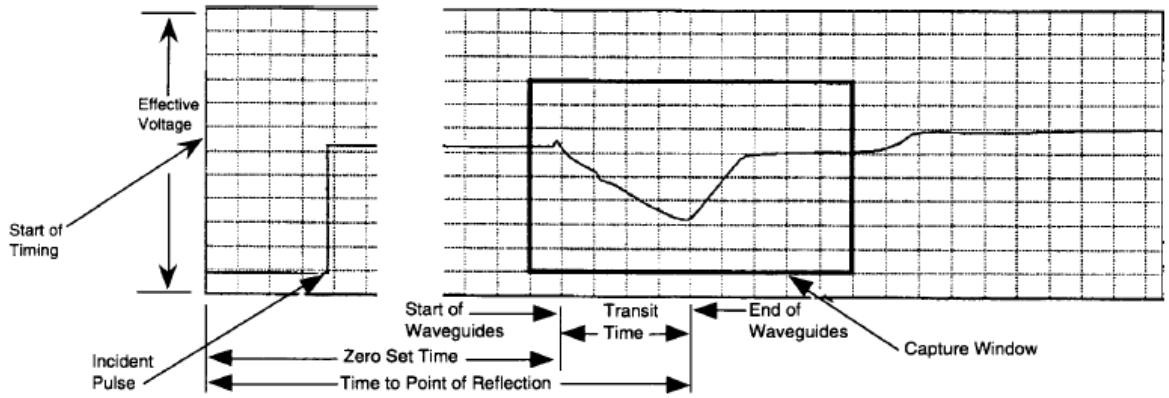


Fig. 2-1

The TDR processor incorporates a very accurate timing system capable of measuring time in picoseconds (a picosecond is one trillionth of a second). When making a measurement, a long series of timing cycles is initiated. Soon after the start of each timing cycle, a fast rise time pulse of electricity, referred to as the incident pulse, is generated and sent down the transmission line consisting of the coaxial cable and the waveguides buried in the soil.

After the start of a timing cycle, sophisticated electronic components and software measure the effective voltage of the transmission line at a precise moment. On the first cycle, for example, a measurement would be made 10 picoseconds after the start of timing. This value would be stored. On the next cycle, the measurement would be made 20 picoseconds after the start of timing. This value would be stored. For each successive cycle a measurement would be made 10 picoseconds later than the previous cycle. Each measurement is stored.

The process is repeated, timing cycle by timing cycle, until the stored values of the effective voltages cover the complete time range of interest. For example the 10 ns (nanosecond) capture window uses 1,200 each 10 ps (picosecond) readings, spanning 12 ns. This process is then repeated several times to determine the average value for each of the 1,200 reading points. Analysis, including tangent fitting is then made on this (1,200 point) TDR waveform, to determine start and end reflection. The developed transit time's information in turn provides the key in calculating the volumetric moisture content. When these processes have finished, the final 1,000 reading points can be viewed in our optional WinTrase PC software as the TDR graph. However, the full 1,200 points are retained in memory if the graph is saved.

The sampling time interval may be changed for different applications; the start of the sampling process is determined by the function being performed.

In Fig. 2-1, when you zero set the MiniTrase before making a series of readings, the zero set time is being determined as shown above. When you make a reading, the time to point of reflection is being determined. The difference between these two times is the transit time which is used to calculate the Ka value, as described above under "Theory".

MiniTrase's internal software then determines from a pre-programmed look up table the appropriate volumetric water percentage.

For moisture measuring purposes, it is only that portion of the pulse represented by its transit time on the buried waveguides which is of importance. For the user's convenience, MiniTrase software has been designed to capture and display in a window only this portion of the complete graph in the optional WinTrase PC software. The window starts before the zero set time is reached. The zero set time is the time at which the pulse starts down the waveguides.

The Capture Window

A choice of three window sizes is available: 10, 20, and 40 nanoseconds. The selection is made in the TraseTerm software on the Palm in the Trase Setup Screen. The 10 nanosecond length is set at the factory since this gives the greatest resolution when working with waveguides of 15 to 30 cm lengths.

When using long waveguides in very wet soils, the transit time may exceed the length of the window, as shown. A measurement can only be made if the entire transit time lies within the capture window.

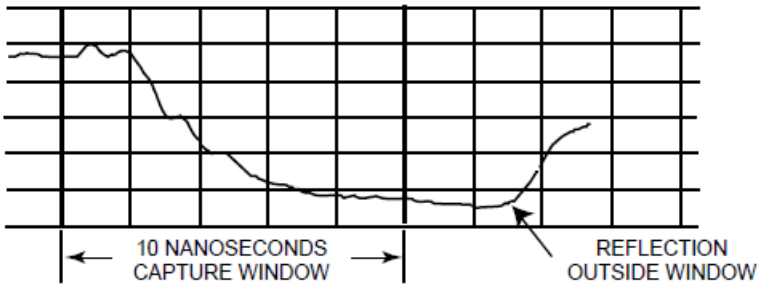


Fig. 2-2

In this case, the transit time cannot be measured and it is necessary to change to a longer time window, as shown.

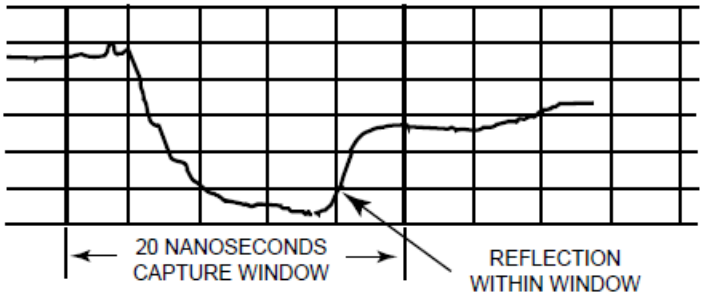


Fig. 2-3

The transit time while in the waveguides can now be displayed and measured.

The 40 nanosecond capture window provides for greater waveguide lengths or unusual conditions that may be found in some applications.

Connector Graph Features

When the pulse of electricity travels down the waveguides its speed is influenced substantially by the surrounding soil or other media. The resultant graph of the pulse reveals much about the surrounding soil or media.

Waveguide Connector only, no Waveguides

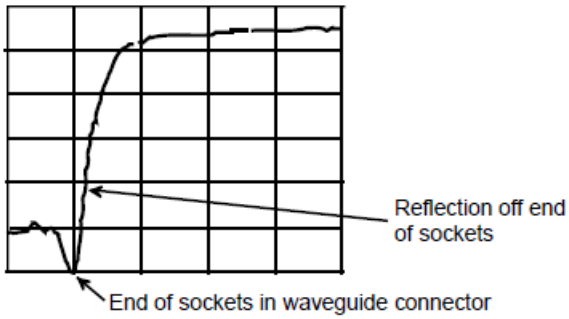


Fig. 2-4

Above is a typical graph of the waveguide connector without waveguides mounted. The bottom of the depression corresponds to the end of the waveguide sockets in the connector. In this case this is the end of the transmission line and the pulse energy is reflected back through the line at this point.

Connector Waveguides in Dry Soil

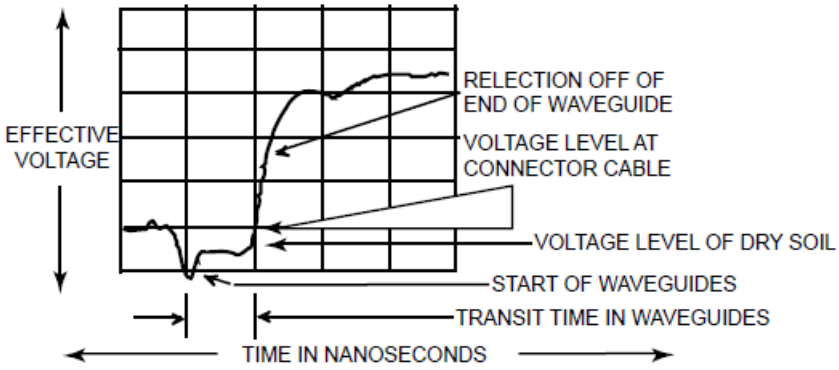


Fig. 2-5

In dry soil there is practically no attenuation (loss) of the pulse energy as it travels along the waveguides. This is indicated by the small difference in height between the pulse in the connecting cable and the pulse while in the waveguides (Fig. 2-5).

Connector Waveguides in Moist Soil

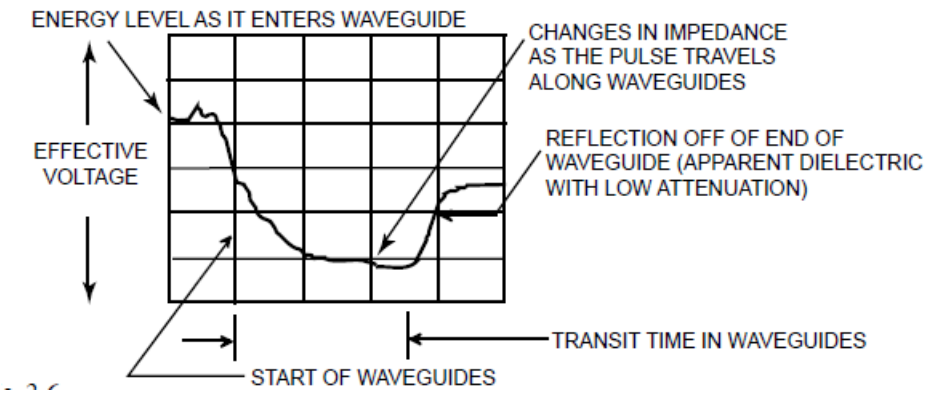


Figure 2-6

In moist soil there is considerable attenuation (loss) of the pulse energy as it travels along the waveguides. This is indicated (Fig. 2-6) by the large difference in height between incoming pulse energy as it enters the waveguides and the energy level at the reflection off of the ends of the waveguides.

Connector Waveguides in Saline Soil

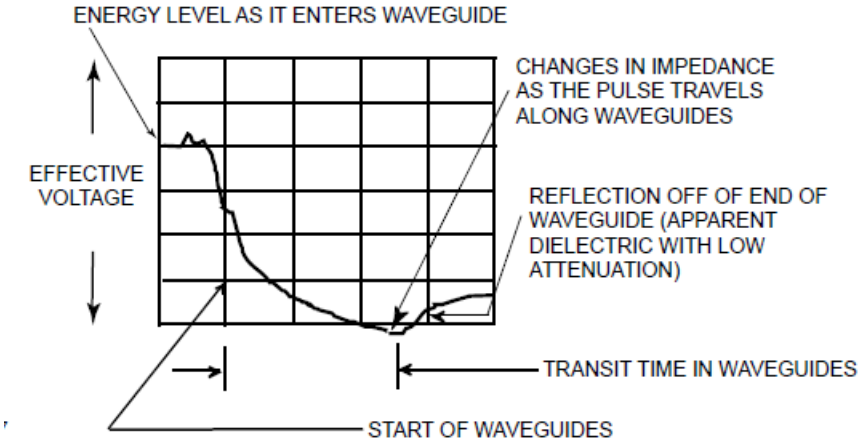


Fig. 2-7

In a saline soil (high bulk electrical conductivity/high attenuation), with the same moisture content as a nonsaline soil, the attenuation (loss) of pulse energy is much greater as it travels along the waveguides. This is indicated (Fig. 2-7) by a much smaller, and less energetic pulse being reflected off of the ends of the waveguides. The reflected pulse shows the loss of energy by the smaller height of the reflected pulse.

NOTE: In highly attenuated environments (high bulk electrical conductivity (EC), unusual clays of high water content) TDR waveform analysis may be hindered by the lack of a recognizable end refection. This frequently can occur in areas where strong fertilizers are applied or where EC values are elevated as a by-product, such as rock salt

applications in the winter time. If you have encountered this type of situation or will be monitoring in high EC environments, we suggest the use of our Model 6005CL2 coated buriable waveguide or our Model 6008CL15 (15 cm) or 6008CL30 (30 cm) coated waveguides. Both provide reliable end reflections in 50.0 ds EC conditions.

Soil dry at top of and moist at bottom of connector waveguides

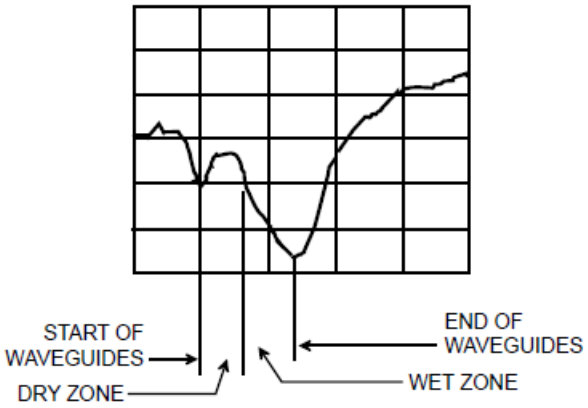


Fig. 2-8

Soil moist at top and dry at bottom of connector waveguides

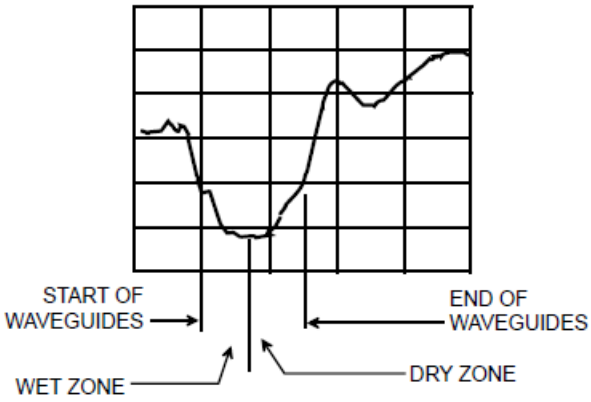


Fig. 2-9

Graphs Produced by Buriable Waveguide

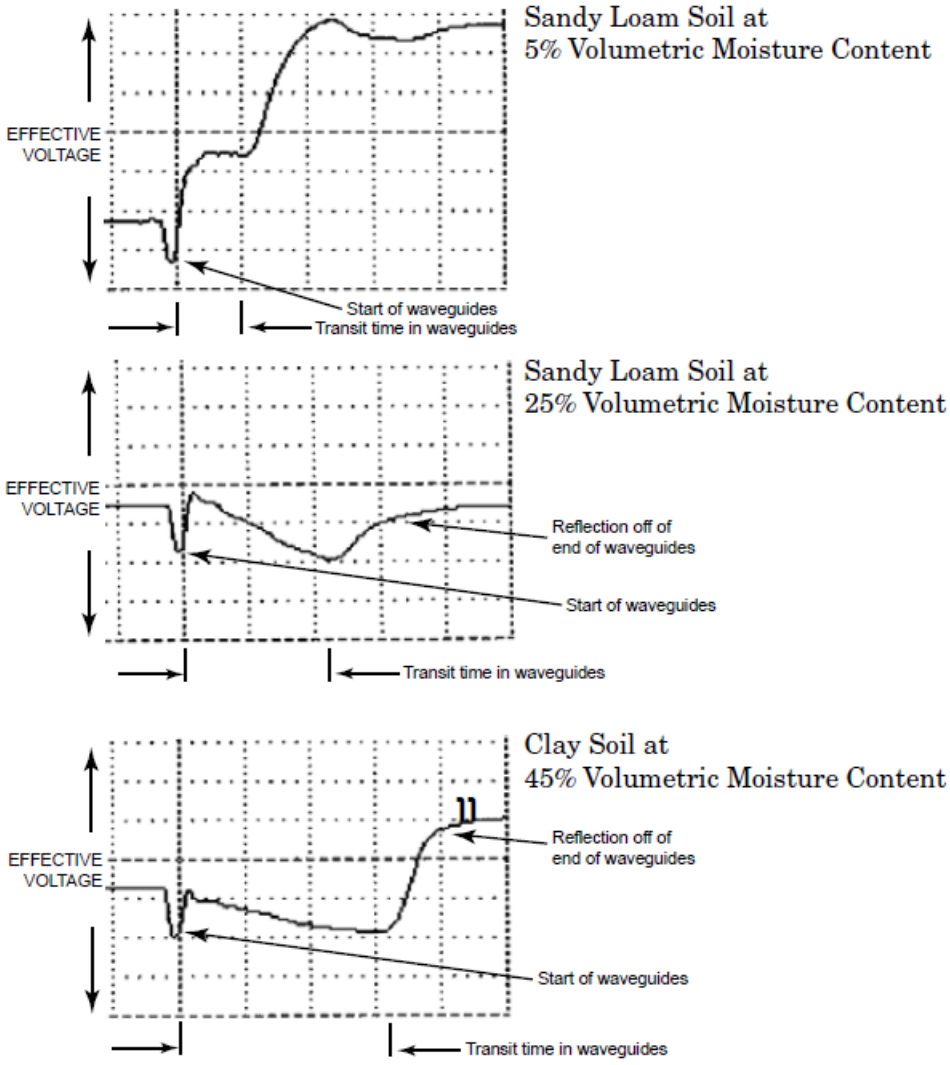


Fig. 2-10

Determine Ka

To determine Ka, the apparent dielectric constant of the soil, it is necessary to have an accurate measure of the travel time of the pulse along the waveguides. Measuring the transit time accurately depends on knowing exactly when the pulse is reflected off of the ends of the waveguides. Because of the nature of the pulse of electricity, the point of reflection is not sharp and steps have to be taken to further define this point. The graph below illustrates the manner in which the point of reflection is determined.

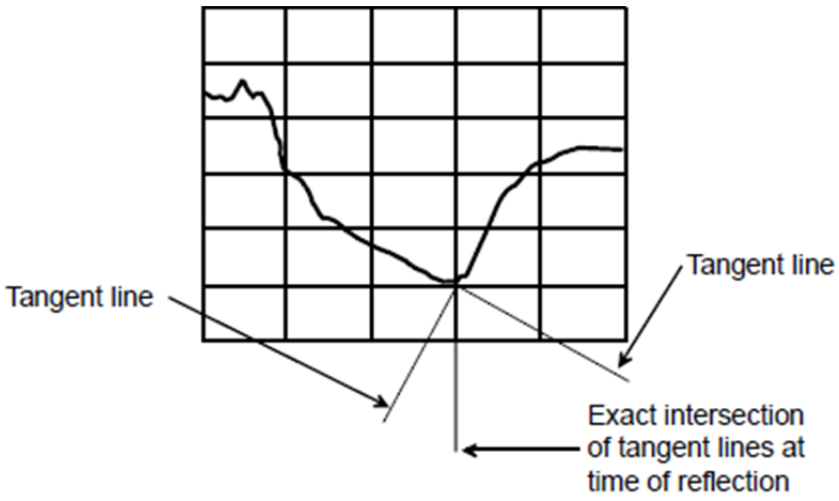


Fig. 2-11

Tangents are constructed to the graph of the incoming pulse and to the graph of the reflected pulse, as shown. The intersection of the two tangent lines is the specific point of reflection. The Trase software automatically constructs these tangent lines and determines the intersection point in the process of calculating the transit time of the pulse in the waveguides and the subsequent determination of Ka.

The Graph Screen and the associated time bars allow you to make independent measurement of the transit time in the waveguides using the "intersecting tangent" method. Ka is then calculated using the formula given under *"Theory"*. See the section on "Using the Graph Screen" for time measurement details.

Relationship of Ka to Moisture Percentage

The following two pages show the relationship of the Ka value to the volumetric moisture percentage in soil.

The heavy line indicates the moisture percentage displayed by Trase for the corresponding Ka value calculated from the moisture measurement sequence.

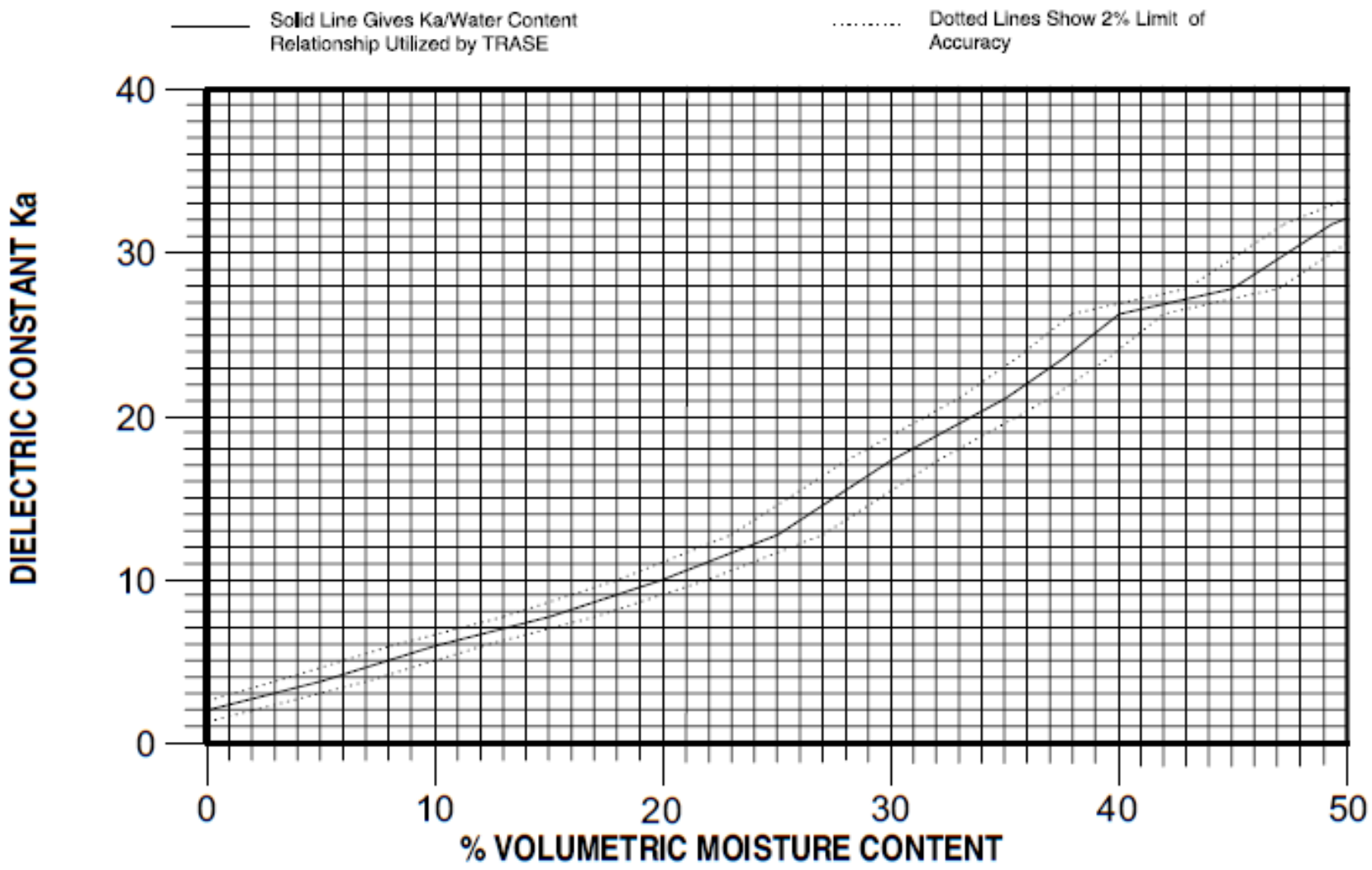
These graphs can be used to develop moisture percentages from Ka values determined independently by time measurements made on graphs of the TDR pulse using the Graph Screen.

The graph of the relationship of Ka to volumetric moisture content was developed using test cells carefully prepared to accurately known volumetric moisture contents. The Ka

value for a given volumetric moisture content is not exactly the same for all types of soils. The graphs indicate the differences encountered for 3 types of soils. These differences appear to be due to differences in bonding of water molecules to differing minerals in the soil as well as other physical characteristics that are not fully understood at this time. The differences shown, however, only result in a minor difference in the evaluation of the moisture content.

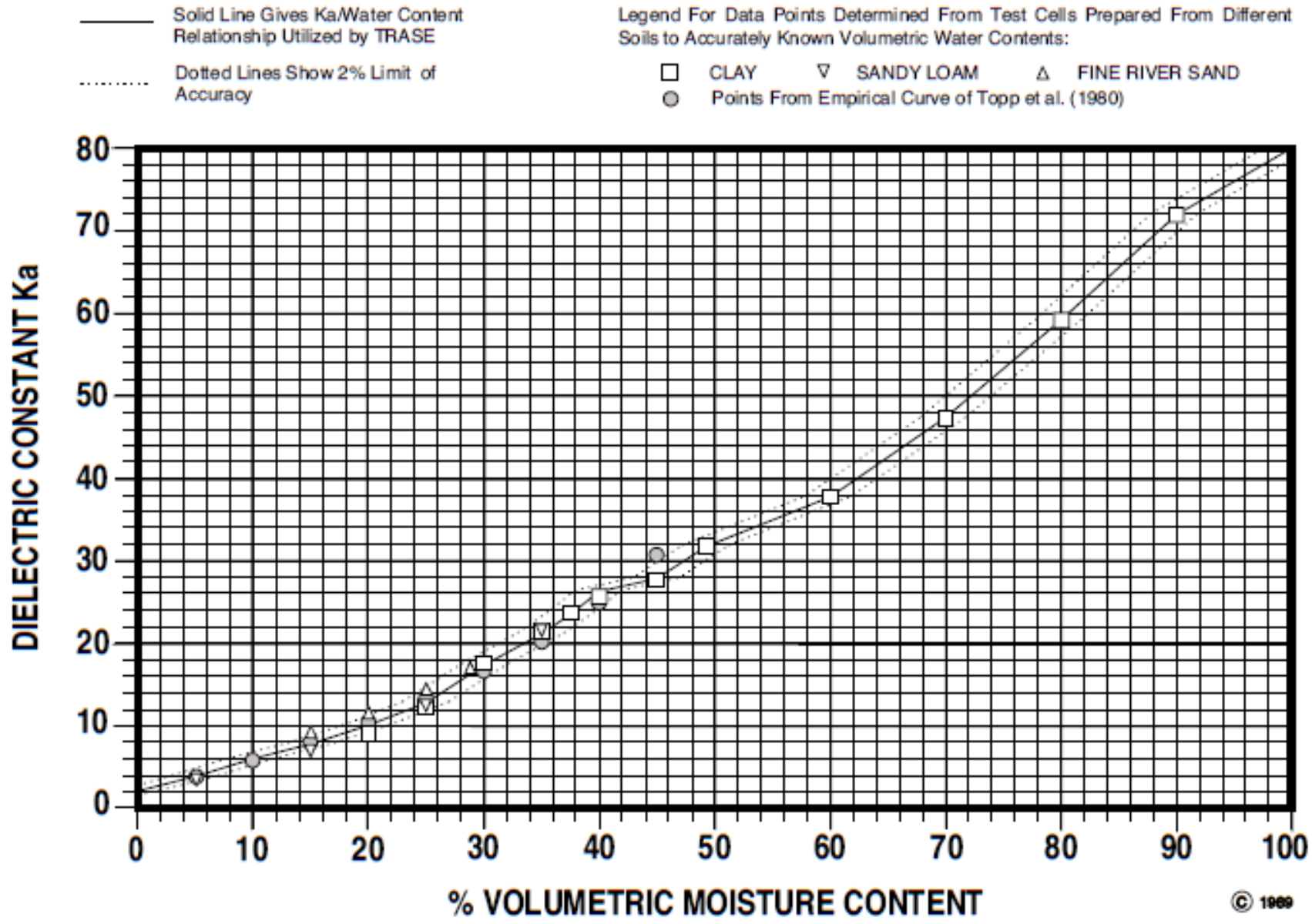
Graph 2-1

RELATIONSHIP OF DIELECTRIC CONSTANT, KA TO VOLUMETRIC WATER CONTENT OF SOILS

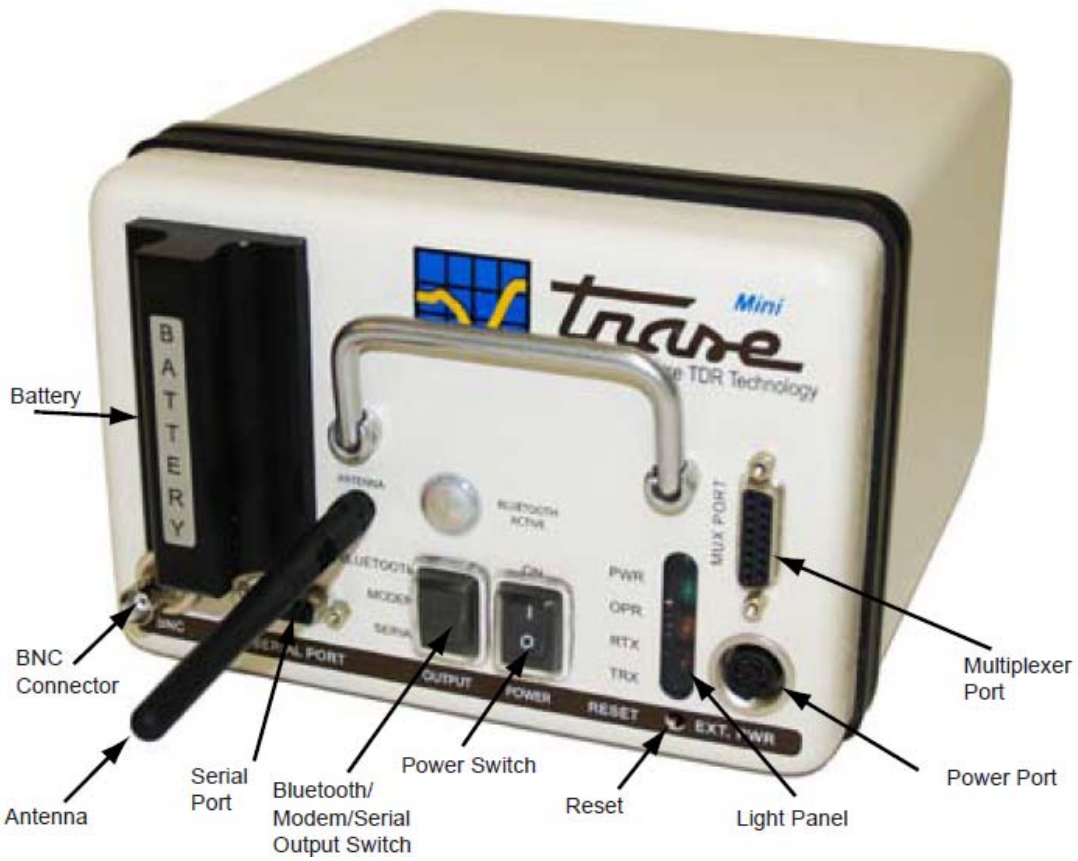


Graph 2-2

RELATIONSHIP OF DIELECTRIC CONSTANT, KA TO VOLUMETRIC WATER CONTENT OF SOILS



3. ACQUAINT YOURSELF WITH THE PARTS



Battery and Battery Charger

The MiniTrase utilizes a rechargeable NiCad battery. To replace an old battery, grasp the black plastic holder firmly and pull straight out. Use set screw wrench (MSL083) to slide handle off and replace new battery. The battery can be recharged easily in the unit.

The MiniTrase has internal power charging capability. With the battery installed simply connect the power supply (6051V100-120) to the MiniTrase and then to an active 100 to 240 VAC power source. (It is recommended that power sources, such as the charger, are disconnected from the MiniTrase when it is not connected to an active power source). Depending on the battery's condition, the unit will charge a good but drained battery in 12 hours. The MiniTrase will continue to supply a charging current to the battery whether the MiniTrase is switched on or off. The MiniTrase can be used with or without the power supply but a battery should be inserted. When the battery is especially low and in need of recharging a low volume beeping sound will alert the user.

Power Switch

With the battery securely in place, turn on the MiniTrase using the black rocker switch located on the face of the unit (Fig. 3-1). When the unit is powered on, the Power LED will

blink green (PWR). If the unit is activated in the operational mode, the operating LED will blink green (OPR).
When operating, transmitting and receiving of data will cause both the red and amber LEDs to blink.

Serial Port

The Serial Port, located just below the Battery Handle, is used for connecting the MiniTrase to the PC or a modem. Use the PC Cable (MEZ011) for connecting the MiniTrase to the PC. (See PALM and Bluetooth instructions for Bluetooth communication use.)

Multiplexer Port

The Multiplexer, or Mux Port (DB-15) provides for optional connection to external multiplexing instrumentation. The internal Multiplexer communication board is supplied as a standard part with the MiniTrase and is already installed.

Power Port for External Power Charger

The 8-Pin DIN Power Port allows for the use of auxiliary power and accepts the plug on the MiniTrase Power Supply supplied with the instrument. The External Power Charger (6051V100-240) accepts any input, 100-240 Volts AC. U.S. (MEZ021) and Foreign (Euro - MEZ022) Plugs are available. SEC will supply the plug appropriate for your location.

The Power Charger is plugged into a wall outlet and the charger cable is plugged into the Power Port on the front of the MiniTrase. Output switch positions and port (Bluetooth, modem, and serial port)*

Bluetooth/Modem/Serial Output Switch (3-Positions)

The Bluetooth/Modem/Serial Output Switch is used when connecting the MiniTrase to a PC to download data or using the palm modem (optional). The Rocker Switch should remain in the Serial Position when not using Bluetooth or Modem.

Output switch positions and port (Bluetooth, modem, and serial port)*

- The Output Switch UP position on the MiniTrase is Bluetooth (if MiniTrase is on) (See section 5 to learn more about the Android Tablet and Bluetooth)
- The Output Switch MIDDLE position is for connection to a modem (cable with null adapter)
- The Output Switch DOWN position is for RS-232 serial connection (WinTrase: ports 1-4). WinTrase may utilize some computers' Bluetooth ports 1-4, consult your computer technician

**It is recommended that when Bluetooth power is switched on that you attach the provided cover to the serial port (and not use the port).*

Light Panel

There are four lights on the Light Panel Display:

- PWR Green light to indicate power is fully functional.

- OPR Operational light to indicate that the MiniTrase is operating or performing a function. When the MiniTrase Battery is low, the user will be alerted by a beeping sound, indicating the battery is low and needs recharging.

- RTX Indicates that the MiniTrase is receiving data.
- TRX Indicates that the MiniTrase is transmitting data.

When operating, the Red and Amber LED's will blink when the unit is either transmitting or sending data.

BNC Port

Fig. 3-2

The BNC port located just under the Battery handle of the MiniTrase (Fig. 3-2) accepts the standard BNC connector on the coaxial cable of all Soilmoisture waveguides (Waveguide Connector, Buriable Probes, Slammer, Extension Cables) when making a reading.

Reset Button

Should the MiniTrase lock up for any reason, the internal Reset button below panel is utilized to "cold boot" the unit. This function is used as a last resort to restart the unit, as all data will be erased from memory if the Reset button is pushed.

Waveguide Connector and Waveguides

The Waveguide Connector is specifically engineered to minimize soil disturbance and simplify the procedure for making numerous and repeated measurements. The rugged, polycarbonate housing is hermetically sealed to prevent moisture damage to internal electronic components as well as providing protection for the circuitry during field use. A convenient electrical fitting allows for easy replacement of the Coaxial Cable Assembly when necessary.

To insert the Waveguides, turn the Clamping Knob counterclockwise (Fig. 3-3) until it stops. The end of the Waveguide that has the groove (Fig. 3-4) is then inserted into the Waveguide Sockets. You must always insert both Waveguides into the Connector for proper clamping operation. After the waveguides are inserted, turn the Clamping Knob clockwise to tighten the Waveguides into the Waveguide Sockets. Hand tightening is sufficient. Do not over tighten. When the Clamping Knob is turned clockwise, an internal

mechanism forces two stainless steel balls into the Waveguide grooves to lock them securely in place and to make excellent electrical connection.

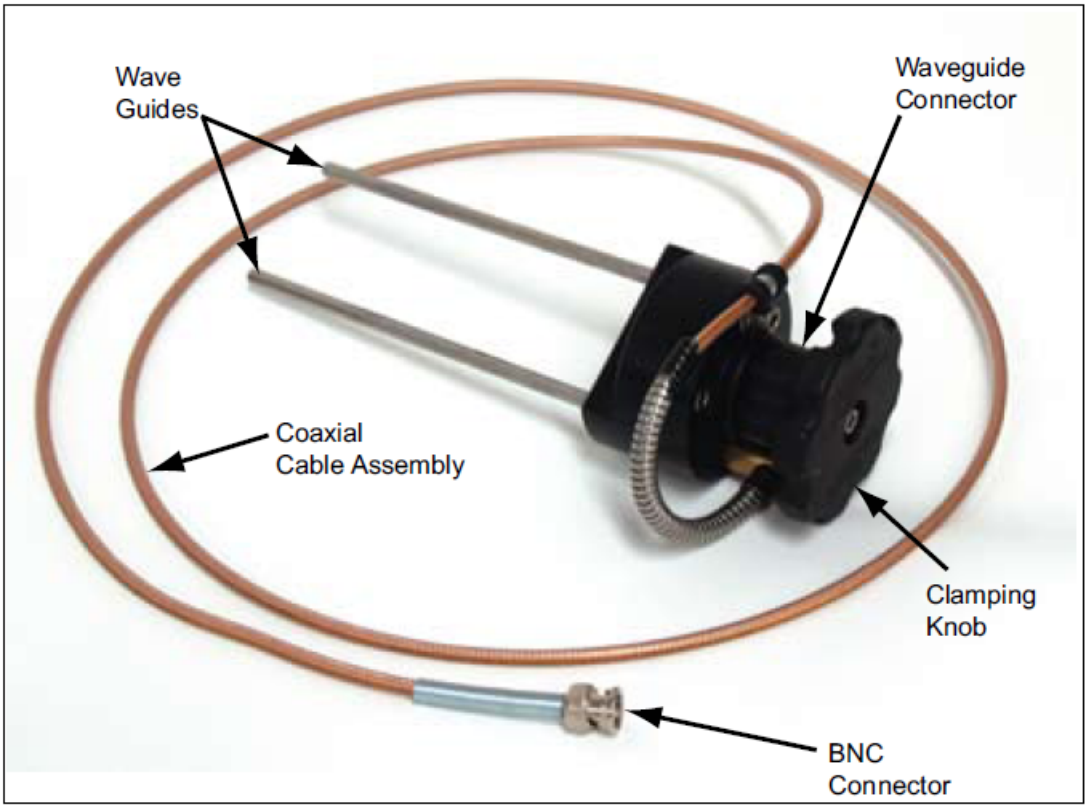


Fig. 3-3

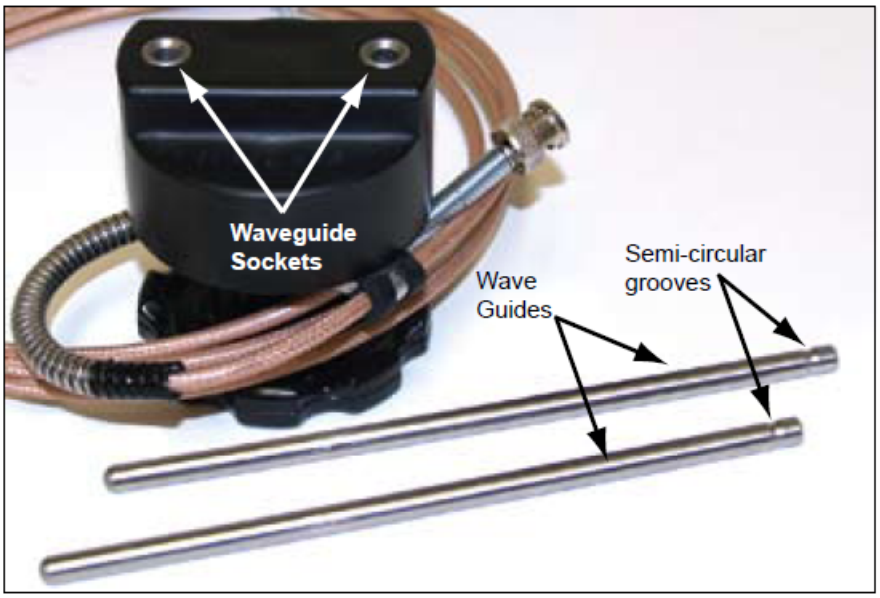


Fig. 3-4

To prevent measurement errors, ensure that the Waveguides are fully inserted into the sockets before tightening the Clamping Knob.

The Waveguides supplied with the unit are 15 cm long Accessory waveguide sets are available in 8, 10, 20, 30, 45, 60, 70, 90 and 100 cm lengths. Waveguides are made entirely from stainless steel. For long wave guides, an alignment block is available (6012).

Coaxial Cable Assembly

Fig 3-5

NOTE

The Coaxial Cable Assembly is a part of the Waveguide Connector. It can readily be replaced with a new cable when required. (Do not coil cable more than 3 loops).

If it becomes necessary to replace the Coaxial Cable Assembly, use a 5/16-inch open-end wrench to loosen the hex nut on the coaxial fitting (Fig. 3-5). The hex nut can then be unscrewed.

For proper compatibility with Trase software, it is necessary to use Soilmoisture's Waveguide Connector Cable, 6003F1L78, as a replacement.

Android Tablet

The Android Tablet and its use are described in Chapter 5, "Acquaint Yourself with the Operation of the Android Tablet".

MiniTrase Backpack

All MiniTrase items fit conveniently inside the MiniTrase Backpack, with sufficient room for other items such as notepads, pencils, etc. A special foam insert holds the MiniTrase securely in place. The foam insert provides a comfortable cushion between the user and the unit while being transported in the field and helps to protect the unit from damage.

4. REQUIREMENTS PRIOR TO USE

Fig 4-1

Charge Batteries

After unpacking your MiniTrase, the first step in putting it into operation is to charge the removable battery.

An internal power charging unit has been incorporated in the MiniTrase. Connecting the Power Supply (6051V100-240) to the unit will charge the battery without having to remove it.

The battery can also be removed and charged if you have purchased the optional external battery charger.

It may require approximately 12 hours to initially internally charge the battery.

Charging the Battery In the Unit

Locate and then connect the Power Supply to the MiniTrase's Power Port (marked Ext. Power) on the front of the unit (Fig. 3-1).

Make sure the battery is fully seated in the unit, then plug the power supply into an electrical wall socket. It will take up to 12 hours to fully charge.

Charging the Battery with the External Battery Charger

Remove the Battery from the MiniTrase unit, as shown (Fig 4-1). Insert the battery into the external battery charger. Read the manufacturer's instructions first regarding proper battery charging procedures. It generally requires 12 hours to recharge a fully discharged battery internally, but 45 minutes in the external charger.

Once the battery is fully charged, reinsert it in the MiniTrase unit. As a precaution, we recommend that you carry at least one extra, fully charged battery with you into the field, should you be taking extensive readings.

Verifying Battery Charge

You can verify that the battery is charged. With the external power disconnected, turn the unit on by pressing the black Power rocker switch to the "ON" position. If the battery is

charged, then the green indicator light will come on and blink. Nominal voltage of a new charged battery is above 13.7 VDC.

Fig. 4-2

Install Software on your PC

In order to use the Android Tablet with the MiniTrase and your personal computer, you should install the software on the enclosed Flash Drive to the PC. Insert the Flash Drive into any available USB Port. Follow the prompts to install the software.

Download TraseTerm Application from Google Play Store

Next, you will need to download the TraseTerm Application from Google Play Store. To download, you will need a Google account.

For instructions on the use of the particular Android Tablet supplied with your MiniTrase, please read the Tablet's manual and/or visit the manufacturer's website.

5. ACQUAINT YOURSELF WITH THE ANDROID TABLET

The MiniTrase utilizes an Android Tablet as a handheld terminal to make measurements.

In order to operate the MiniTrase correctly, we recommend that you thoroughly read the Android Tablet Operation Guide *prior* to taking reading with the MiniTrase.

Soilmoisture's TraseTerm Application is specialized software for taking readings with the Android Tablet and MiniTrase and for downloading the data to your PC.

TraseTerm Application

The TraseTerm Application is downloaded from Google's Play Store. If you purchased your unit recently, then you will need to download the free version, SEC AT, from the Play Store (*). To download the application you will first need to log on with your Google Account (if you don't have one you will need to create one). By downloading the TraseTerm Application from the Google Play Store, you will be automatically notified of any updates to the application program.

You received a Flash Drive with your MiniTrase Kit that contains the following files:

1. "DownloadTraseReadingsfromAndroid" program: Install this program on your PC to download readings directly from the Trase Unit to the PC.
2. WinTrase Program: this is for viewing Graphs on your PC. Current version is 2.07.

You don't need any software to use the Android Tablet with your PC. Please refer to the Tablet's Operating Instructions regarding charging the tablet, connecting to a PC, etc.

Activating the Android Tablet

1. Read the enclosed User's Manual for the unit thoroughly.
2. Fully charge the Tablet prior to use.
3. If you do not already have a Google account, create one now in order to be able to download the TraseTerm application from Google's Play Store.

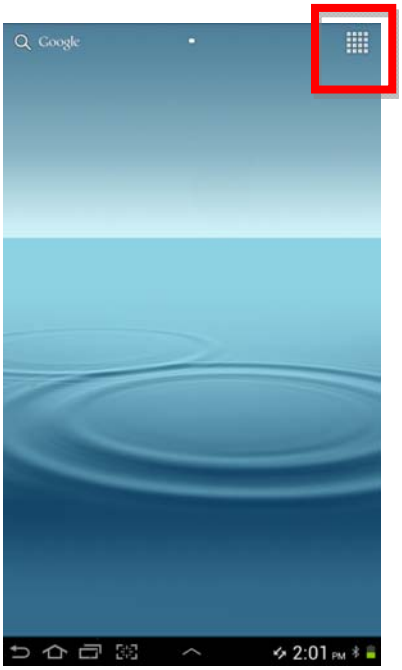
Steps for Downloading the TraseTerm Application from Google Play Store to your Android Tablet

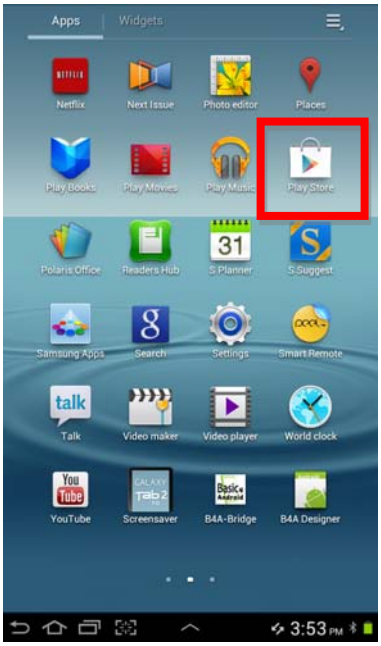
There are two versions of the TraseTerm application on the Play Store. One is a free version that is supplied to customers who purchased a new MiniTrase Kit. The second is a pay program for those who wish to switch from a Palm to an Android Tablet, and they have their own Tablet for use.

If you just purchased your MiniTrase Kit, the TraseTerm for Android program is a downloadable App from Google Play on the Internet. To download the application, you will need your Google account or, if you don't have one, you will need to create a Google account to download the file and to automatically receive notifications of any software updates.

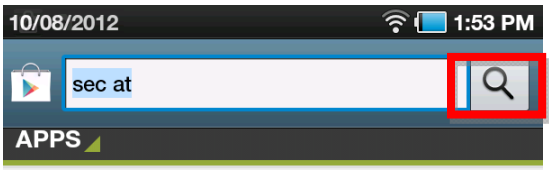
To download, connect to the internet from the Android Trablet. Please refer to your Android Tablet's operating instructions on how to connect to the internet if you have not already done so.

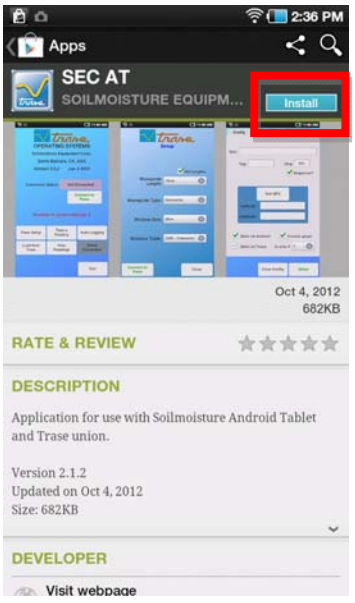
Once you have connected to the Internet, Tap on the Applications Icon in the Home Screen. Then locate the Play Store Icon in the Menu, and tap to go to Google Play Store to download the TraseTerm Software.





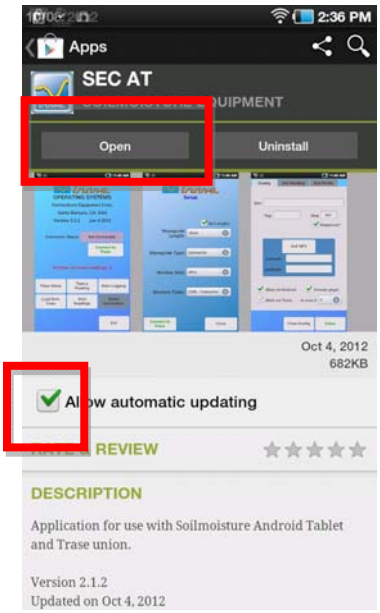
In the Play Store, search for SEC AT and/or Soilmoisture to locate the application. Then Tap on the SEC AT Application to download, then tap Install to install the program to your AT.





Once the download is complete, we recommend that you check the "Allow Automatic updating" box to be notified of updates to this application.

Tap on Open to start the TraseTerm Program.



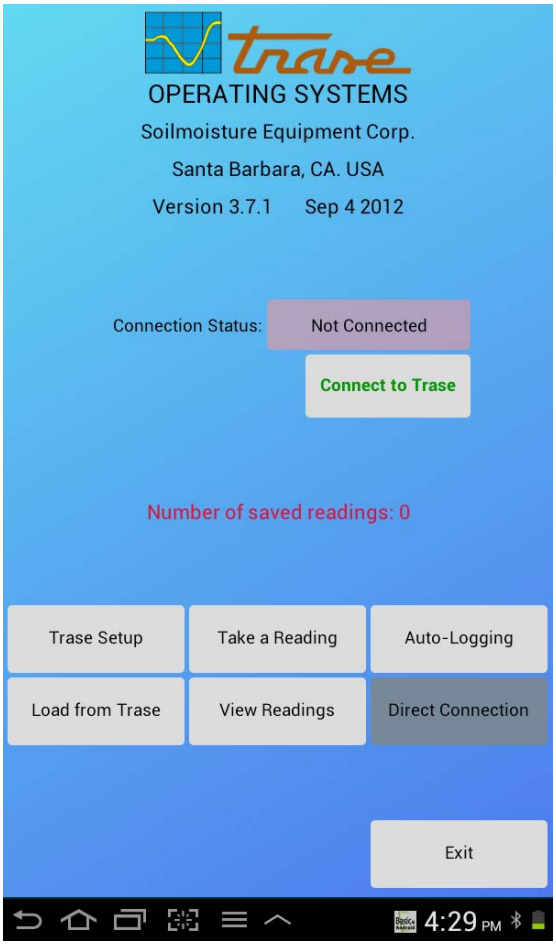
You will now see the following Home Screen for the TraseTerm Application

(*) If you have an older Trase Unit that used the Palm and related Palm Software, and you now want to use your own Android Tablet, you will need to purchase the TraseTerm program from Google's Play Store.

TraseTerm Application

Trase Home Screen

The Trase Home Screen has 8 buttons:



1. Connection Status: "Not Connected" and "Connect to Trase"
2. Trase Setup
3. Take a Reading
4. Auto-Logging
5. Load from Trase
6. View Readings
7. Direct Connection
8. Exit

Connection Status

This button will display either **"Not Connected"**, if no Trase Unit has been previously connected either through a Bluetooth Connection or directly via cable, or **"Connected"** if a connection has been established.

Connect To Trase

When you have established a connection either through Bluetooth connection or directly via cable, and you have also established the parameters for making measurements (type of waveguide being used, etc.) in the Trase Setup Screen, then you are ready to press the "Connect to Trase" button to start taking readings.

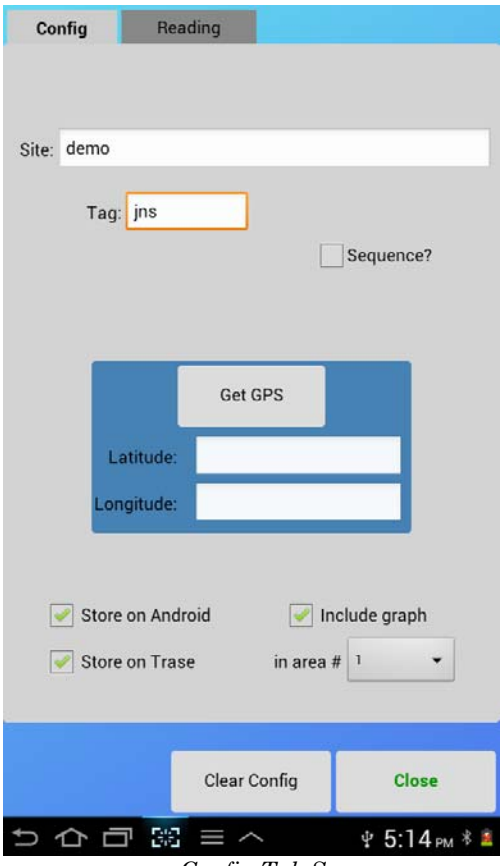
Trase Setup

This button will take you to the Trase Setup Screen. Before taking moisture readings, it is necessary to set various internal operational parameters which are used in calculations and in the recording of data. In the Trase Setup Screen there are four drop down menus for selecting the parameters for making measurements. These menus are: Waveguide Length, Waveguide Type, Window Size, and Moisture Table.

- Waveguide Length: Tap to open the drop down menu. You will see the following lengths to choose from: 8 cm, 15 cm, 20 cm, 25 cm, 30 cm, 35 cm, 40 cm, 45 cm, 50 cm, 60 cm and 70 cm. Waveguide Length refers to the length of the waveguides to be used in a particular measurement. To select, simply tap on the round button next to the specific length you wish to use.
- Waveguide Type: Tap to open the drop down menu. You may choose one of the following: Connector, Buriable, and Field. "Connector" is utilized for the standard Waveguide Connector supplied with the MiniTrase Kit; "Buriable" is selected for any type of buriable probe being utilized; and "Field" is selected when making measurements with the Slammer Heavy Duty Waveguide. To select, simply tap on the round button next to the waveguide type you wish to use.
- Window Size: Tap to open the drop down menu. You may choose one of the following Capture Window Sizes: 10 ns, 20 ns, or 40 ns. The window size you select will be important if you choose to view graphs utilizing the WinTrase software on your PC for waveform analysis. To learn more about this important function, please refer to Section 11, "Using WinTrase Software for Data Collection and Analysis." Note Most measurements made in soils with waveguides 30 cm or less read very well with the default 10 ns setting. However, should you encounter a Time Measurement failure warning, check the cable or change the Window size to 20 ns and repeat the reading. You will need to perform a zero set again if using a standard Waveguide Connector or Slammer. To select, simply tap on the round button next to the window size you wish to use.
- Moisture Table: Tap to open the drop down menu. You may choose one of the following:
    - CUN Connector, Uncoated waveguides
    - CCT Connector, Coated waveguides
    - BUN Buriable, Uncoated waveguides
    - BCT Buriable, Coated waveguides
    - FUN Field, Uncoated waveguides
    - FCT Field, Coated Waveguides
    - SUN Special, Uncoated Waveguides
    - SCT Special, Coated waveguides
- To select, simply tap on the round button next to the Moisture Table you wish to use based on the type of connector to be used.

Take A Reading

This button will take you to the Take a Reading Screen where you will see two tabs at the top of the screen: Config and Reading.



Config Tab Screen

Reading Tab Screen

Config Tab

In the Config Tab you will enter the Site Name that you wish to attach to your readings. You may add a Tag to the readings and also specify the sequencing desired for storing readings. If you wish the readings to be sequenced, be sure to check the "Sequence?" Box (this box is checked as a default).

You can either manually enter the GPS coordinates for the site where you are taking your readings, or you can simply press the Get GPS readings and the Tablet will automatically enter them for you.

There are two boxes in the bottom left corner of the screen:
"Store on Android" and "Store on Trase". The "Store on Android" is checked as a default. We recommend that you also check the "Store on Trase" box as well. This way, all readings will be stored on both the Tablet and the Trase unit so that your data is backed up in the case that the Tablet quits working or the Trase unit malfunctions.

There is also a check box "Include Graph" (this is checked as a default). Check this box if you wish to store graphs for your readings. NOTE: Be sure that you have sufficient memory on your Tablet as the files that contain both readings and graphs can be quite large.

There are 4 storage areas on the Trase Unit for storing your data. You will need to select the desired area prior to taking readings. If you do not select an area, then data will be stored in Area #1 as a default.

At the bottom of the Screen you can select "Clear Config" to clear all entries and return to the default settings.

Reading Tab

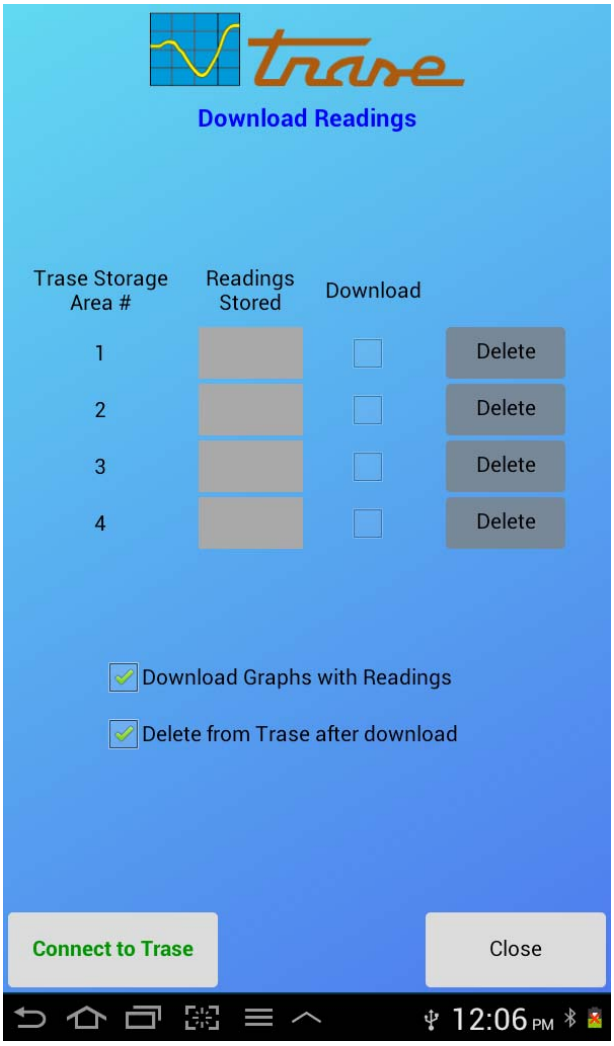
This is the screen that you will use to start taking readings. If a Site Name and Tag have been pre-entered, then these will appear in the screen. You have the option to enter a tag name if you have not already done so.

Please refer to the section, "How to Make a Reading" for more details on this screen.

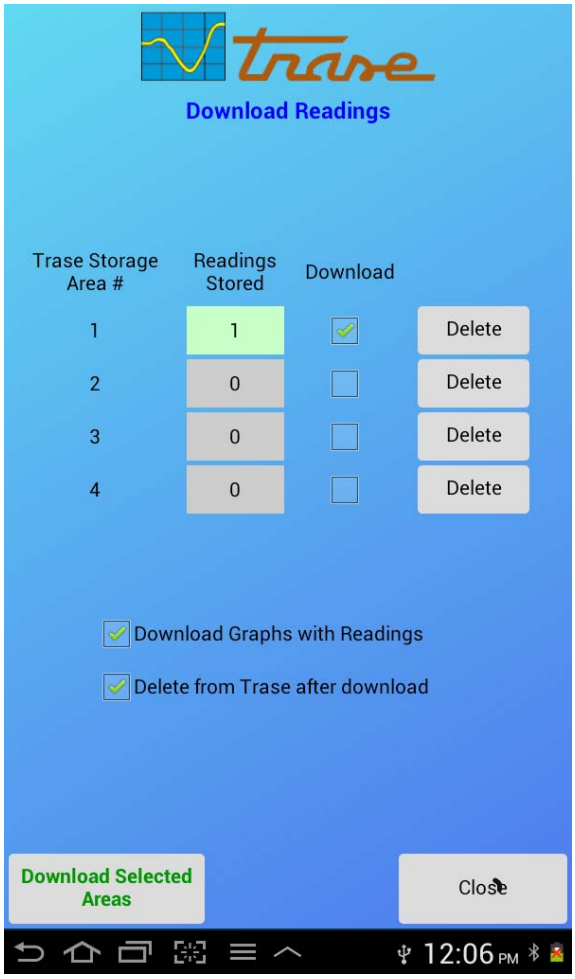
Auto Logging

This will take you to the Auto Logging Screen where you can enter the parameters desired for an auto logging cycle.

Load from Trase



If you are not connected to the Trase Unit, the Download from Trase Screen will look like this. The button "Connect to Trase" will appear in the window. If you are connected, then you will see the following screen:



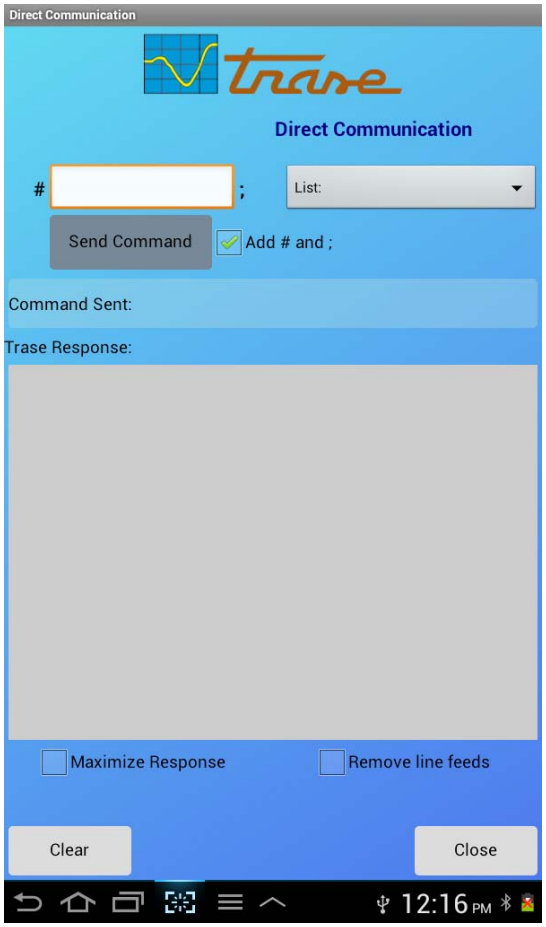
Any readings that are stored on the Trase Unit will be automatically downloaded to the Android Tablet. By default, the "Download Graphs with Readings" button is checked and the "Delete from Trase after download" is unchecked by default.

View Readings

This screen allows the user to view Readings taken with the Trase Unit. Please refer to the section, “Using the View Readings” screen for more information.

Direct Connection

Direct Connection allows the user to send 3-Letter Code directly to the Trase Unit. Please refer to the 3-Letter Code Instructions on how to use this option.



NOTE: The "Direct Connection" button will be greyed out and not function if the Tablet is not connected to the Trase unit.

CONNECT TO TRASE

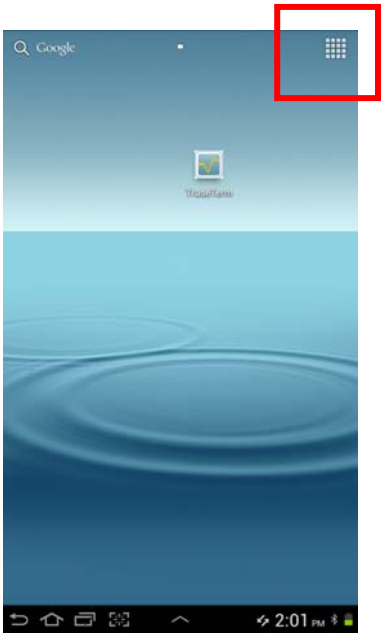
Once all of the proper selections have been made from the drop down menus, you are now ready to connect the Android Tablet to your Trase Unit.

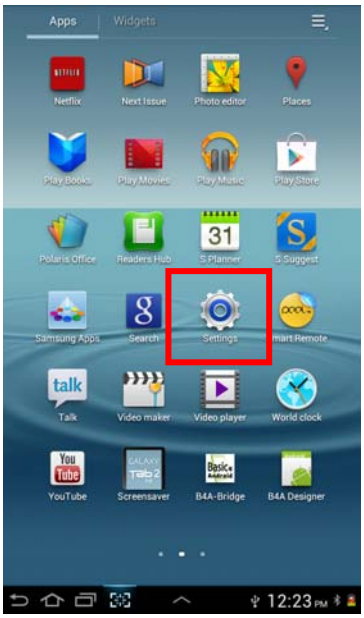
Bluetooth Connection and Pairing Devices

In order for the Tablet and MiniTrase to be connected, each must have their Bluetooth function turned on and be paired.

First, you will need to turn on the Bluetooth function on your Android Tablet.

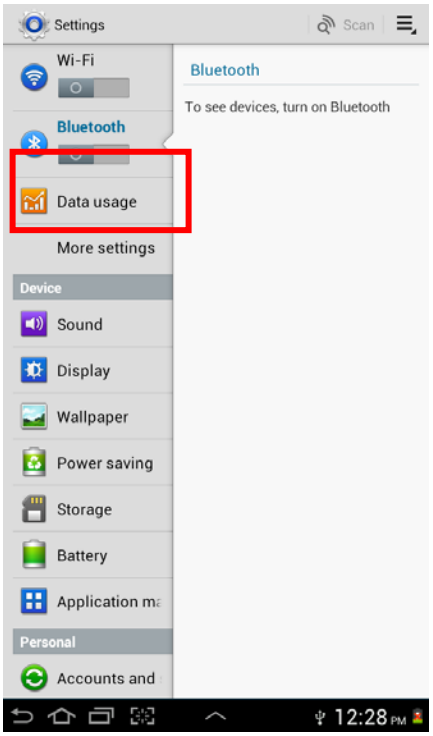
To do this, exit the TraseTerm application if open. You will be returned to the Tablet's Main Page. Tap the Applications button at the top of the screen, and then locate the Settings Menu.

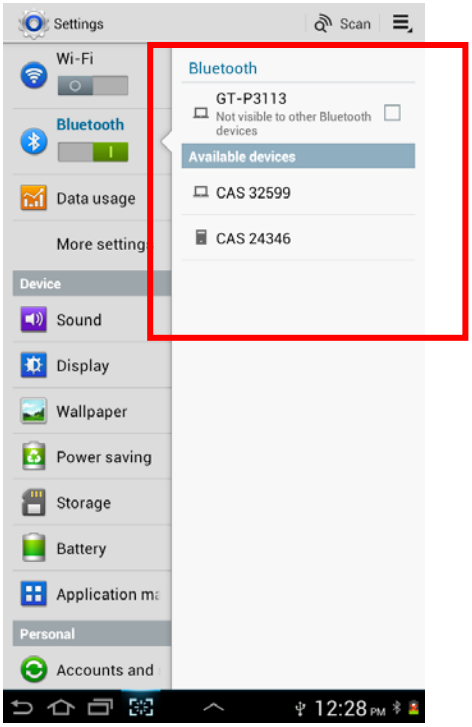




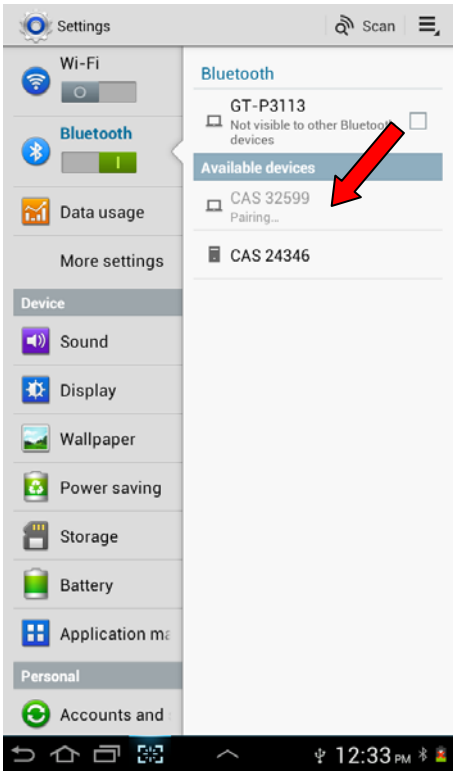
Tap on the bar Under "Bluetooth" to turn on the Tablet's Bluetooth function. Tap the check box next to "Bluetooth" to Turn on Bluetooth functionality. Once on, the Tablet will automatically scan for Bluetooth compatible devices. We recommend that you turn on the Trase Unit's Bluetooth function so that the Tablet will "see" it during the scan. Trase units are identified starting with the letters CAS, then a space, then 5 digits, example: CAS 32279).

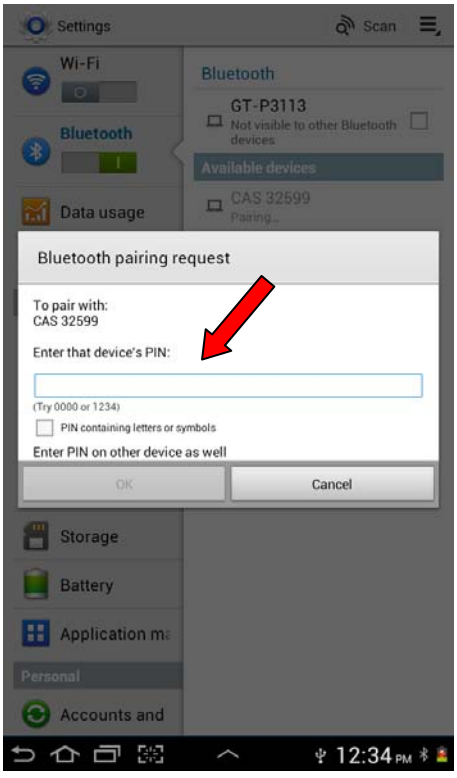
NOTE: if you do not see your Trase unit, tap on Scan at the top of the screen to rescan for Bluetooth devices.



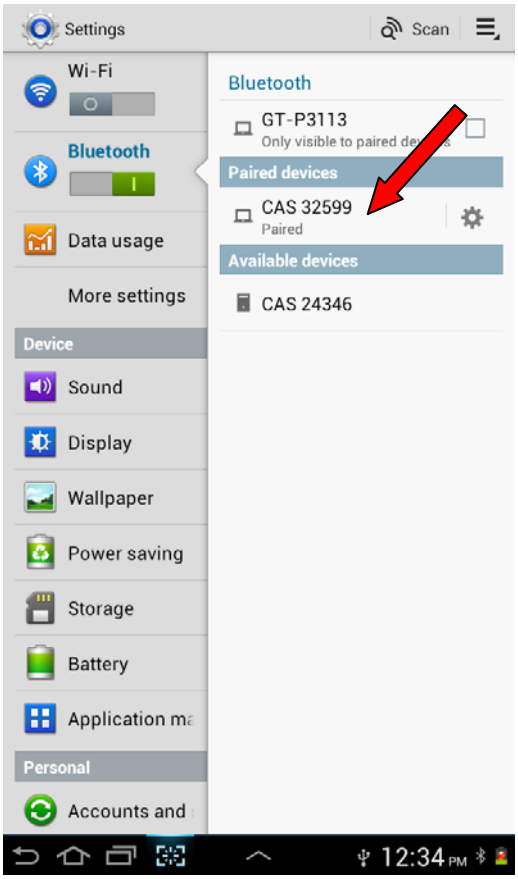


Once you locate your Trase Unit in the list tap on it to select it for pairing.
A “Bluetooth pairing request” window opens.





To Pair, enter PIN “1234” and tap “OK”. You will be returned to the Settings Menu. You should now see PAIRED under the Trase Unit’s CAS ID #



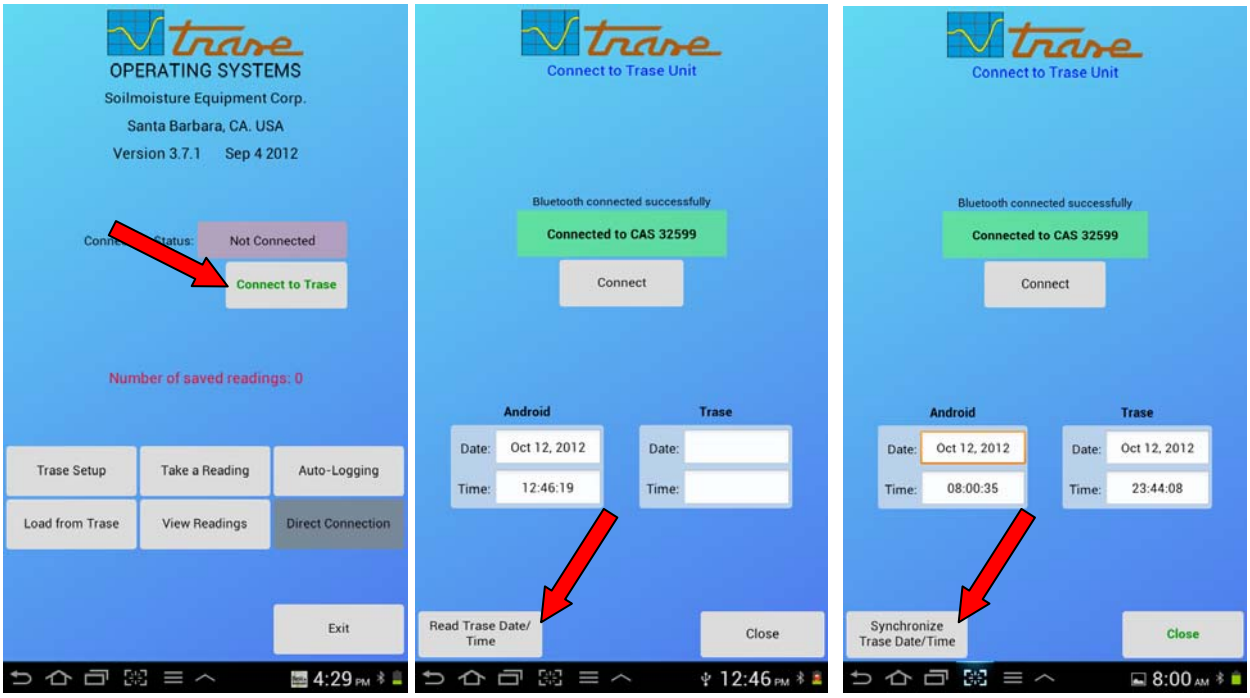
You may now exit out of the Settings Menu by tapping on the House Icon at the bottom of the Screen.

Synchronize the Tablet with the Trase Unit

Before you take a reading we recommend you synchronize the MiniTrase time/date stamp with your Android Tablet. Synchronization prior to making measurements will ensure that all measurements taken have the correct time and date automatically recorded with each reading.

Return to the TraseTerm Application, you should now be connected to your Trase Unit via Bluetooth.

Tap on the “Connect to Trase” button.



This will open a new screen. In the bottom left hand corner of the screen you will see a button “Read Trase Date/Time”. Tap this button to view the Trase Unit’s Date/Time. Once the Trase Unit’s date and time have been read, tap the new “Synchronize Trase Date/Time” to sync.

6. USING THE TRASE MEASURE SCREEN

Taking a Reading with the Waveguide Connector

After all the correct parameters have been selected in the Trase Setup Screen, the MiniTrase is now ready for taking and recording moisture readings.

Fig. 6-1

From the TraseTerm Home Screen, press the "Take a Reading" button (Fig 6-1). Before making a series of readings with the Waveguide Connector (Fig.3-3), it may be necessary to "Zero Set" the TDR Processor for the Waveguide and cable to be used. If you are taking readings with either a Slammer or the Standard Waveguide, these will need to be zeroed before you can take any readings. To zero, simply tap the "Zero" button. Should you be using a waveguide that does not require zeroing, the "Zero" button will be disabled. This process establishes the zero time reference for the start of the microwave pulse down the waveguides.

Zero Set

Before you perform the Zero Set, attach the BNC fitting of the Waveguide Connector to the BNC Port on the front of the MiniTrase, as shown (Fig. 6-2).

Fig 6-2

If there are any waveguides in the Connector handle, remove them, and place the Connector upright on its Clamping Knob so that the Waveguide Sockets are in the air, and not touching any object. (NOTE: For the Slammer model DO NOT REMOVE the waveguides). To "Zero Set", tap the "Zero" button on the Tablet (Fig. 6-3). The Zero Set process will take a few seconds. When the process is complete, "Zero Set" will appear in the terminal screen to confirm that the Zero Set was made correctly

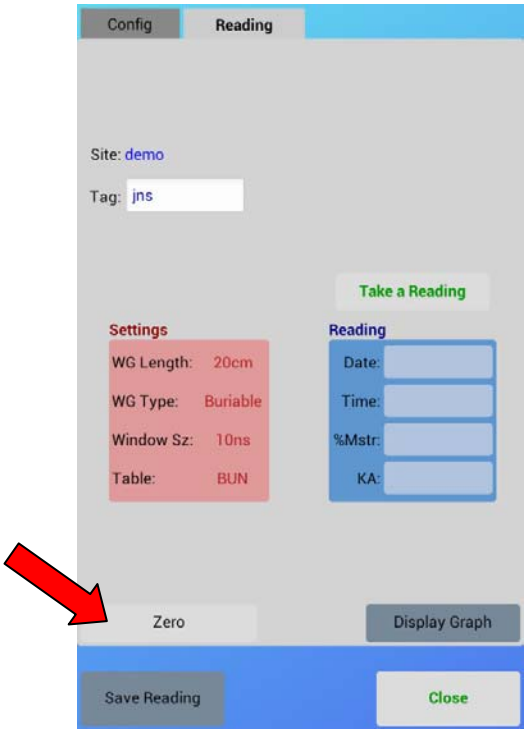


Fig 6-3

Zero Set Failure

If the Zero Set is not completed successfully, an error message will appear on the screen (Fig. 6-3). The most common error during the Zero Set process is not removing the waveguides from the Waveguide Connector before starting the process. Check the connections and repeat the Zero Set process.

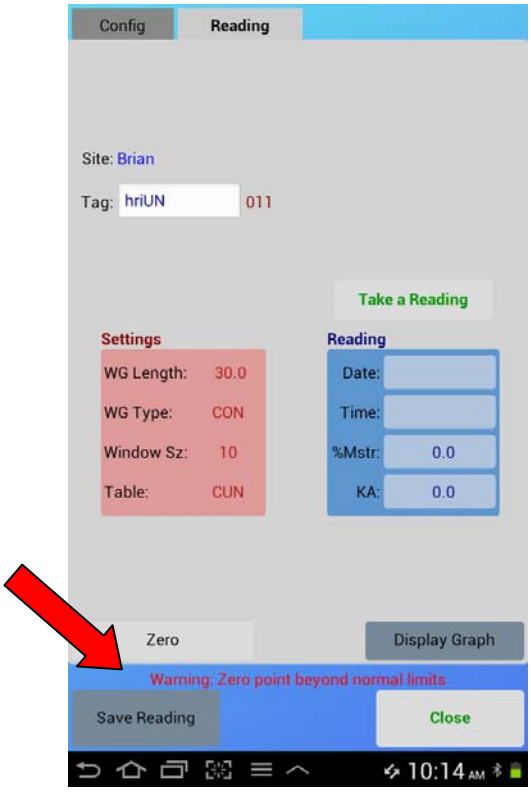


Fig. 6-4

Once the Zero Set is completed successfully, the Waveguides may now be inserted into the Connector. Be sure to mount them properly as described in "Waveguide Connector and Waveguides" in Section 3, "Acquaint Yourself with the Parts." NOTE: If the cable is changed you must "zero" again.

Insert the Waveguides into the Soil

Fig. 6-5

Push the Waveguides into the soil until their full length is in the soil (Fig. 6-5).

Waveguides must be in intimate contact with the soil along their entire length to give accurate moisture readings. Both standard stainless steel or coated waveguides must be in intimate contact with the soil. Air gaps will be interpreted as air space and will reduce the estimated moisture content value.

Taking a Reading

NOTE: Tapping on the "Take a Reading" button will immediately start the measurement process.

The Waveguide Connector must be inserted in the soil and ready for the measurement reading BEFORE tapping the "Take a Reading" button. If the connector is not attached to the MiniTrase and the waveguides are not inserted in the soil, then a "Timeout" error message will appear in the screen.

To start the measurement process, tap the "Take A Reading" button (Fig. 6-6a) from the Reading Tab in the Take a Reading Screen. This will immediately start the measurement process. "Taking Reading" will appear at the bottom of the screen and it will take a few seconds for the process to be completed.

Fig. 6-6a

Fig. 6-6b

Fig. 6-6c

Then "Loading Reading from Trase…" will appear (Fig 6-6b). The reading is now being uploaded to the Tablet's memory and saved (Fig 6-6c).

Tag the Reading

Once the moisture reading has been taken, the date and time will appear in the screen, as well as the moisture value in percent and the Ka value of the reading (Fig. 6-6b). The reading may now be tagged before saving the data.

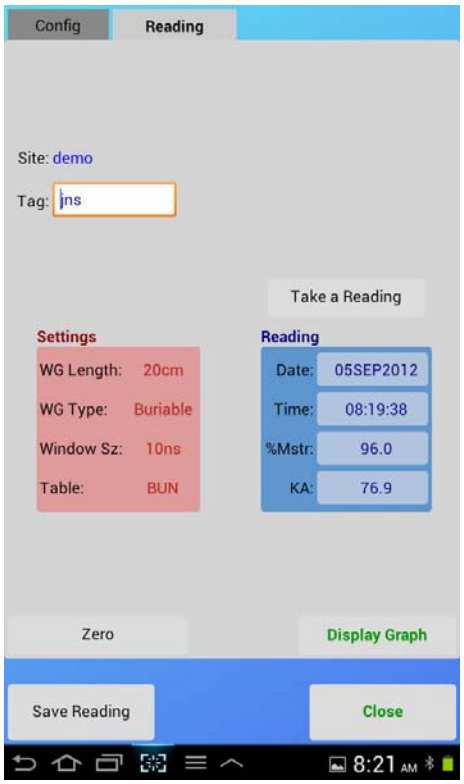


Fig. 6-7

If you did not previously specify a Tag for your readings in the Trase Setup Screen, you can enter a Tag for your reading now. The "TAG" input field (Fig. 6-7) is provided for you to further identify the reading such as the location where the reading was made or for other particulars associated with the reading. This is an 8-digit, alphanumeric field.

To enter a Tag, tap in the box next to Tag on the Screen. Using the onscreen keyboard that pops up, enter the desired tag label. The tag entered for this reading may now be saved with the reading. If no tag is entered, then the reading will be given a default ID numeric value, starting with "1".

Save Readings and Graphs

To store the moisture reading, together with its associated identification tag, tap the "Save Reading" button. If you selected Save Graph in the Trase Setup Screen prior to taking the reading, both the Moisture value and the graph will be saved.

Graphs can be viewed on the Tablet. To view the Graph, tap on the "Display Graph" button. If, for any reason, you are not satisfied with the reading, simply repeat the measurement.

7. USING THE VIEW READINGS SCREEN

In the View Readings Screen, the readings are stored in columns. The data, once stored properly, will be listed in columnar form, in this order:

ID	This is a sequential number, assigned to a reading
Graph	G Confirms if a graph was saved with the reading
Date	Date that the reading was taken
Time	Time that the reading was taken
% (Moisture)	Moisture Content value (%) of reading
Ka	The Ka Value of the reading
Type	Type of waveguide used for the reading
Len	Waveguide length used for the reading
Win	Window Size used for the reading
Tag	Tag associated with the reading (specified in the Setup Screen)

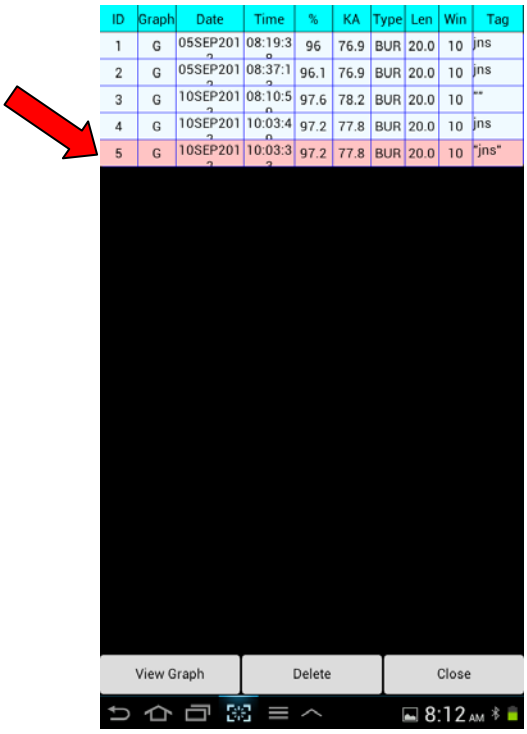


Fig. 7-1

To select a reading, simply tap on the reading and it will be highlighted (Fig. 7-1)

If you have taken many readings, you can scroll up and down the Stored Readings list by simply touching the screen and moving your finger up or down.

Deleting Readings

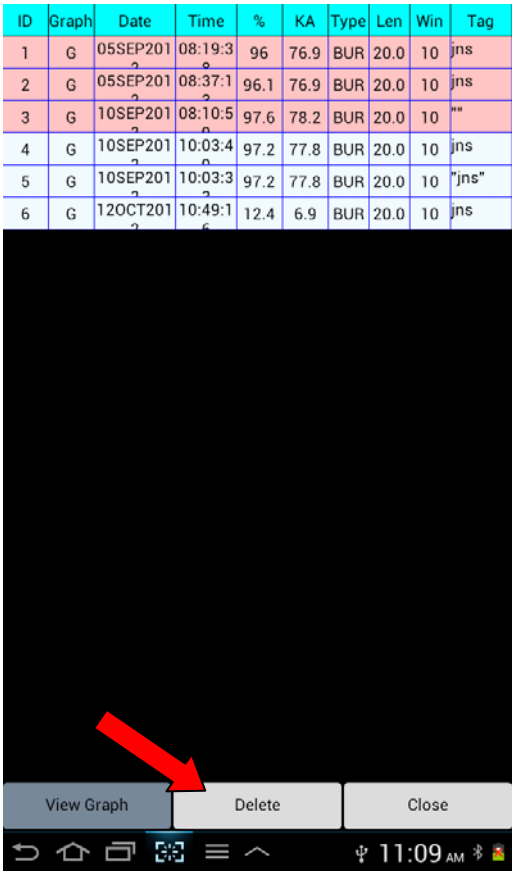


Fig. 7-2

If, for any reason, a reading must be deleted, tap on Reading you wish to delete. The reading will be highlighted. To delete multiple readings, simply tap each reading, holding your finger down slightly longer than a simple tap, to select more than one reading (Fig 7-2). To deselect, simply tap that reading again.

NOTE: This method will only delete readings from the Tablet, not from the Trase Unit.

To Delete, tap the Delete Button at the bottom of the screen (Fig 7-2).

A box will pop up asking which readings you want to delete: All Selected, All Readings, or Cancel (Fig 7-3).

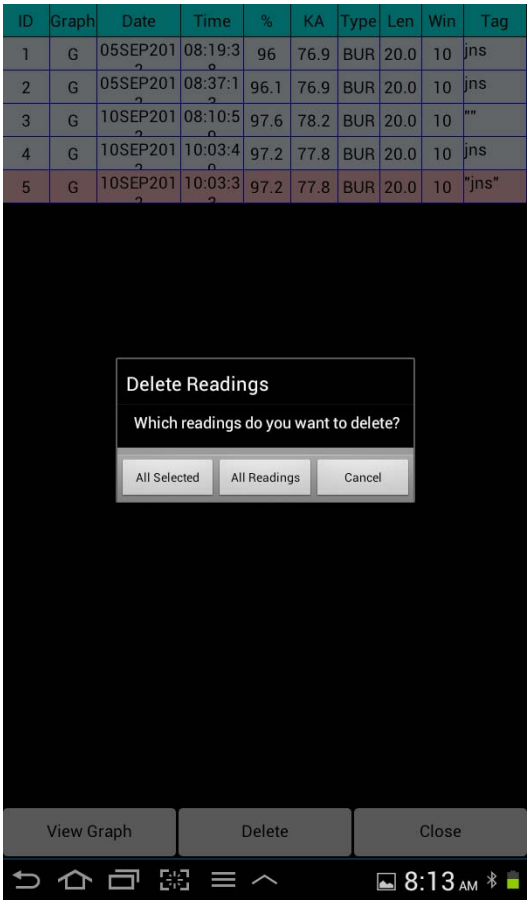


Fig 7-3

CAUTION: Once deleted, it cannot be recovered (if you specified that Readings also be saved on the Trase Unit, then the readings can be retrieved from the Trase Unit). Refer to Section 5, "Acquaint Yourself with the Operation of the Android Tablet" for more information on how to save readings to both the Tablet and Trase Unit.

View Graph

To view the Graph of any reading that was saved with its graph, simply tap the View Graph button (Fig 7-4).

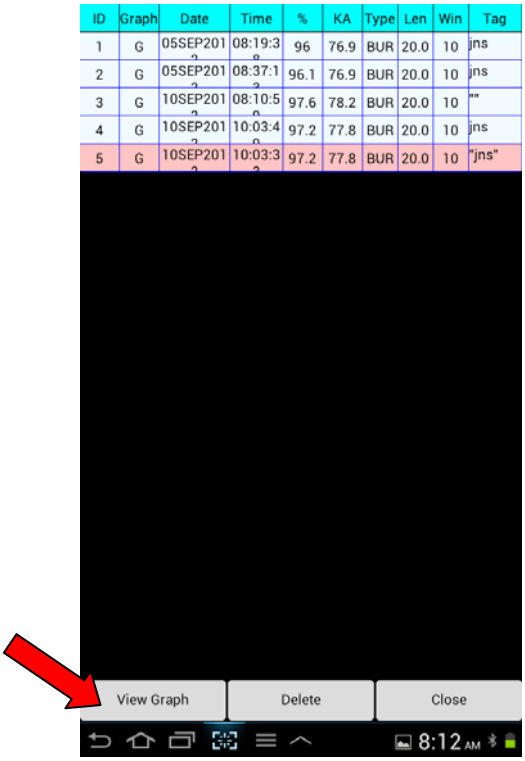


Fig 7-4

A new window (Fig 7-5) will open showing the reading in Graph form (Note: the screen will be displayed in Landscape mode for better viewing). You can zoom in to a particular section of a Graph by simply dragging and holding down with your finger across the screen. Red lines will appear to select a section. To zoom in, simply tap the shaded area created.

Fig 7-5

8. DOWNLOADING DATA

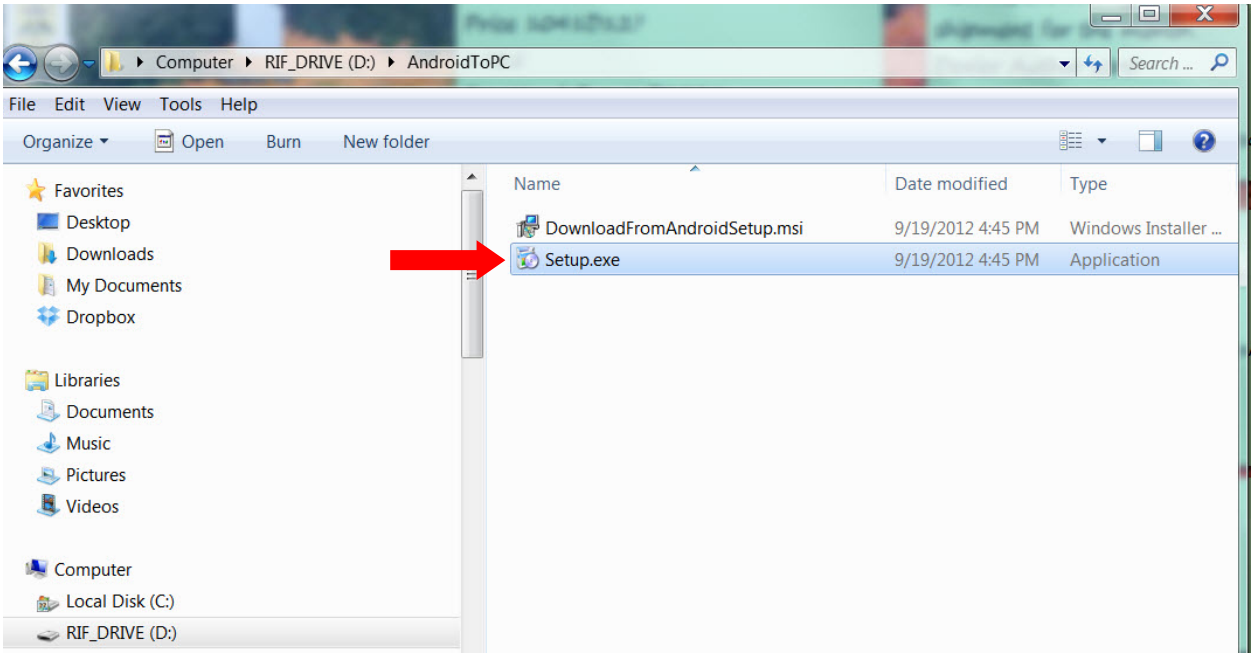
There are two methods for downloading data. First, readings can be easily and quickly downloaded by connecting the Android Tablet to your PC and viewed in Excel or WinTrase. Both readings and graphs will be downloaded.

The second method is to download the data directly from the MiniTrase to the PC using a DB-9 cable (MEZ036) to connect to a COM port (1 to 4 only) on the PC.

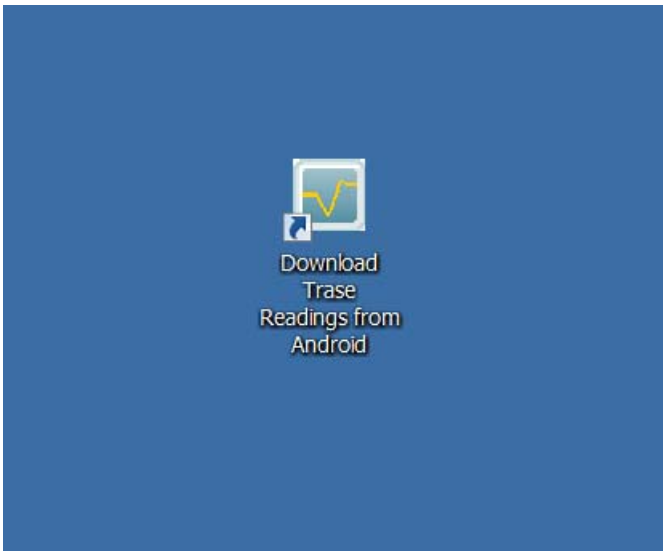
Transferring Readings from the Android Tablet to Your PC

In order to transfer readings from the Android Tablet to your PC, you must first install the "DownloadTraseReadingsfromAndroid" program. The installation program is on the RIF Flash Drived provided when you purchased your MiniTrase Kit.

Insert the RIF Drive into any available USB port on your computer. Open the Drive and locate the Setup program and follow the prompts to install.

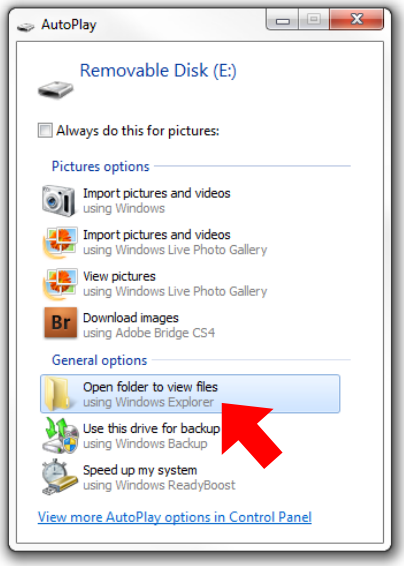


The program will automatically install a shortcut icon for this program onto your Desktop.



To transfer your readings and/or readings/graphs to your PC, follow these steps:

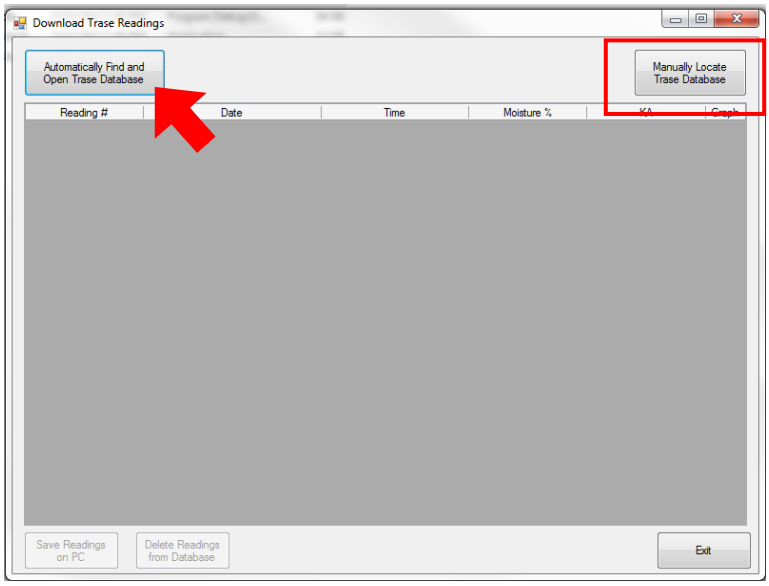
- Connect the Android Tablet to the PC using the Android Tablet to USB cable provided (for more details refer to Galaxy Tab2 Quick Start Guide). This is the same cable used to connect the Android Tablet to its charger.
- The "Autoplay" window will appear on your PC monitor; select the "Open Folder to View Files" option.



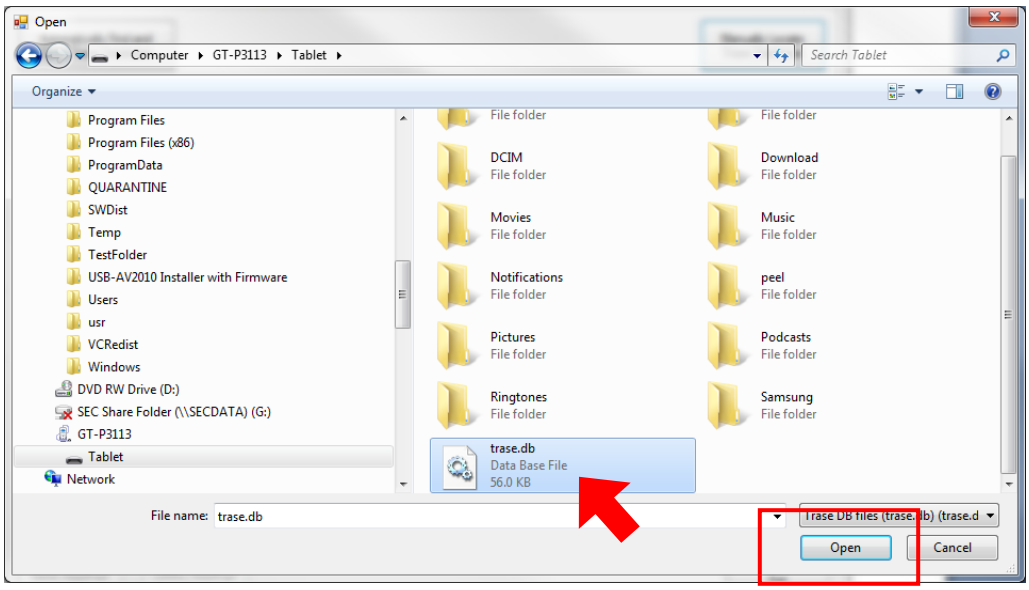
- A Windows Explorer window will open and you will now have access to your Android Tablet as an external hard drive. In the Android Tablet root folder, you will see your readings data file (trase.db). This file contains all the Trase readings that have been saved on the Android Tablet. (If you did not originally save your readings to the Android Tablet, please refer to the "Load Readings and Graphs from Trase" section.

Here you can save your readings to the Android Tablet from the Trase, and then open the files from your PC.

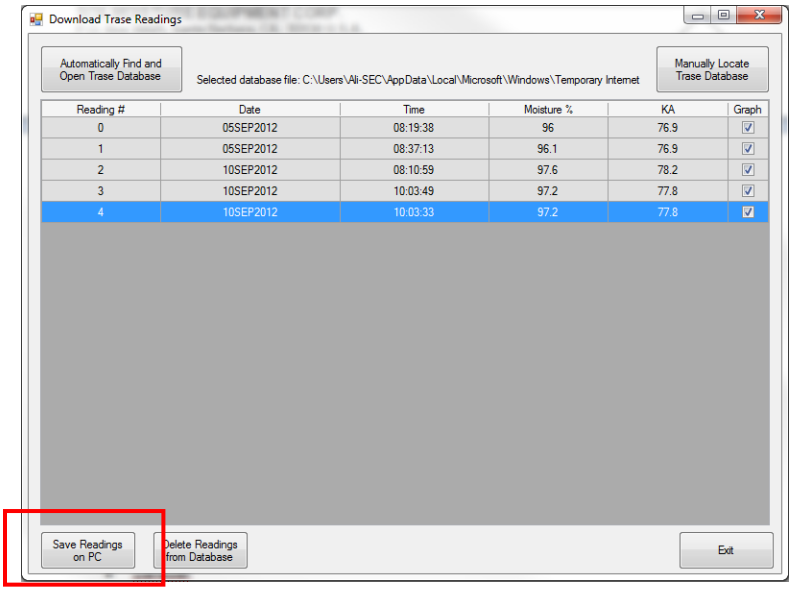
- Click on the “DownloadTraseReadingsFromAndroid” Icon on the desktop to run the program.
- Click “Automatically Find and Locate Trase Database”.



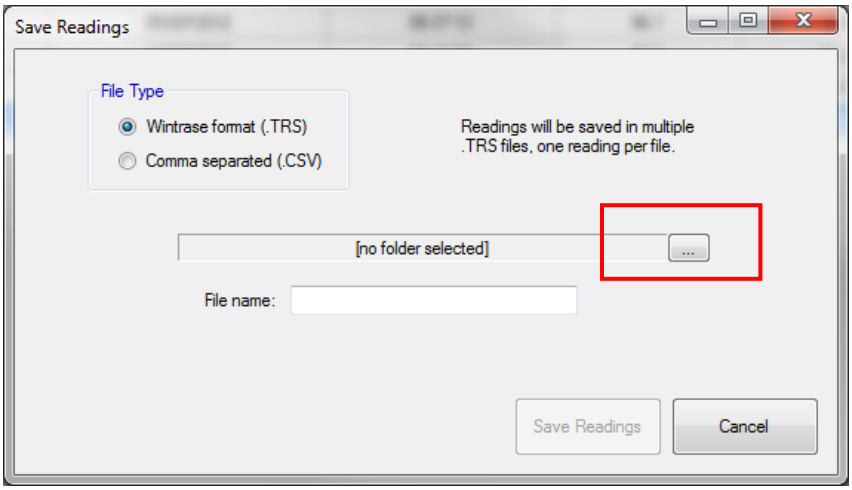
- If the software is not able to find the "trase.db" readings file, Click the “Manually Locate Trase Database” button and locate the “trase.db” file manually. Once located, click Open.



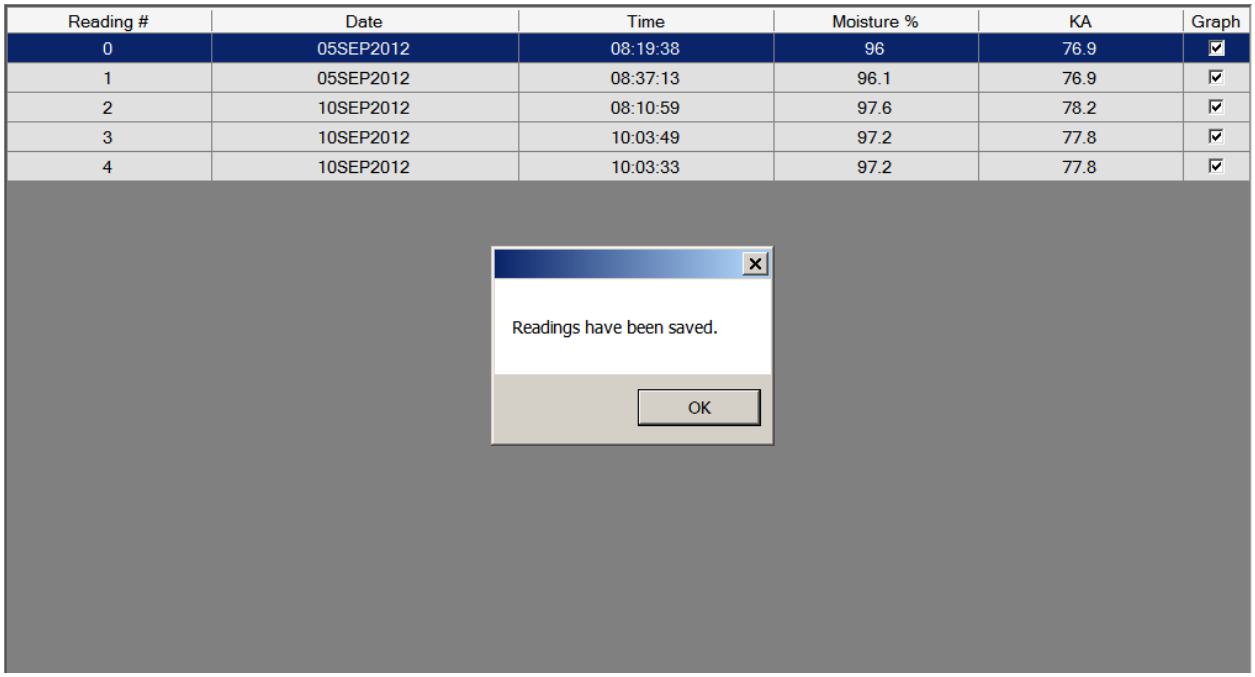
- In the “Download Trase Readings” window, click “Save Readings on PC”.



- The “Save Readings” window pops up.



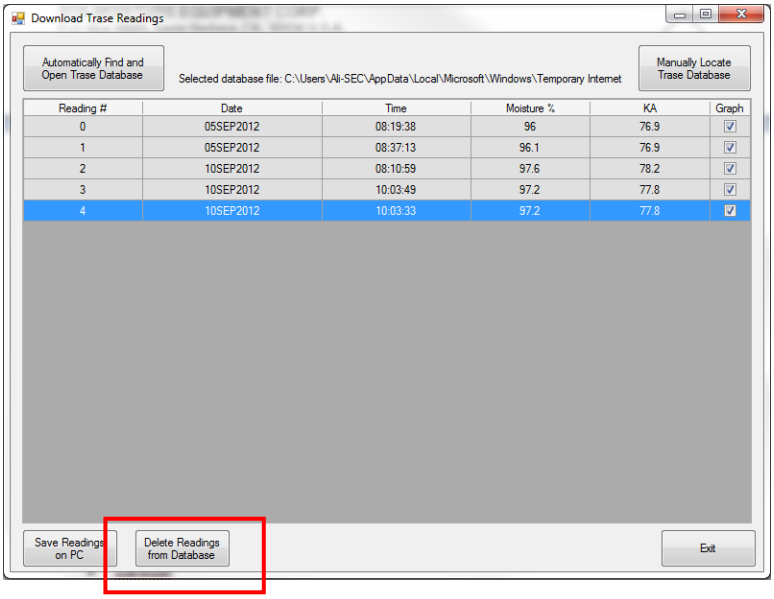
- First specify either the “.TRS” format (Trase standard format) or the “.CSV” format which is a more universal format and readable by most standard software applications (e.g. MS-Excel). Then click on the … box to specify the folder where your readings are to be saved. Once specified click OK to return to the above screen. Then enter the name for your file and click Save Readings. A box will pop up to confirm your readings have been saved to your hard drive.



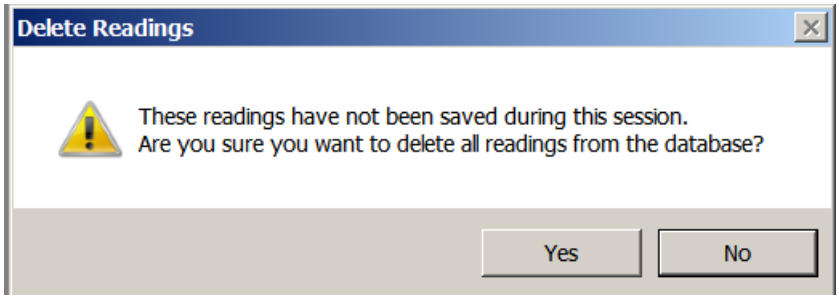
Click OK to return to the Main Screen.

You can now safely delete all or some of the Readings from the "trase.db" file on your Android Tablet. To delete, click on "Delete Readings from Database". This will delete all readings stored on your Android Tablet, but will not affect any readings you may have just saved on your PC.

NOTE: Deleted files are permanently removed and cannot be retrieved.



NOTE: If you have not saved your readings, a warning box will pop up to alert you that the readings have not been saved.



- To Delete readings, simply select Yes. Readings will be deleted permanently from the Android Tablet.
- Exit to return to the Home Screen on your PC.
- Your files can now be viewed either using WinTrase or Excel, depending on the format used to save the readings.

WinTrase is a comprehensive software program designed for the remote use of MiniTrase via modems and DB-9 links (for possible Bluetooth links on ports 1-4 consult a computer technician). The software package is provided with your unit from Soilmoisture or local Soilmoisture dealers or the website for the Trase, Trase BE, and MiniTrase.

Setting Up MiniTrase and WinTrase Software for Data Transfer

Using the same mathematical processes incorporated into MiniTrase, WinTrase can automatically fit tangents to the waveforms, provide movable time bars to adjust transit times, provide multiple custom lookup tables for specialized waveguides and material allowing for quick analysis and determinations.

In order to download collected data from the MiniTrase to WinTrase, you must first install WinTrase software on your PC. Follow the instructions that are included with the WinTrase software for proper installation and use the serial number code on the CD jewel case. Items needed to download data from the MiniTrase to the PC:

1. Before beginning, first verify that the MiniTrase Battery is either fully charged or connect the MiniTrase to the Power Supply plugged into a wall socket.
2. Locate the Output Bluetooth/Modem/Serial Switch on the MiniTrase front panel. Set the rocker switch to the Serial Setting. You were provided with an MEZ036 Cable that has a male DB-9 connector on one end and a female DB-9 connector on the opposite end. Connect the MiniTrase to your PC's serial port using this cable. You may need a connector adapter, depending on the type of serial port on your computer.
3. Once the MiniTrase is properly connected to the PC, turn the MiniTrase on with the Power Rocker switch in the ON position, and the Output rocker switch to Serial.
4. From your PC, start the WinTrase software. From the pull down menu, select Remote, then select Settings. In settings you will need to indicate which com port is being used. Generally, this is Com Port 2, but this may differ in your particular

situation (must use from COM Ports 1-4). Also note that you may be able to utilize the Bluetooth rather than the cables. (see page 3-2).

NOTE: Once the readings have been saved, graphs may now be viewed by selecting File, Open Graph, from the WinTrase main menu.

Graphs may be selected one at a time for viewing and moisture content calculations.

Collected moisture readings may also be downloaded directly from the MiniTrase to the PC using 3-letter command protocol and a communications program such as HyperTerminal terminal emulator, Windows Terminal or TeraTerm.

WinTrase Check the Direct Connection box. All other default communications settings remain the same (Baud Rate: 9600, Stop Bit: 1, Parity: None, Flow Control: Xon/Xoff and Data Bits: 8). Once the settings have been made, WinTrase is ready to download the collected data from the MiniTrase.

Software Settings

From WinTrase's main pull down menu, select Get Remote Readings. WinTrase will automatically connect with the MiniTrase. The user is prompted by WinTrase to save readings at this time.

When prompted to save readings, you may either append this information to a file already created or you may overwrite a file, deleting previous data and replacing it with the new data to be saved. To save data to a new file, leave Append selected and click OK. WinTrase will now prompt for a file folder and file name to be entered. From the folder menu, select the file folder where you want to save the data and enter a file name using the WinTrase extension (.trs).

9. FIELD MEASUREMENTS - STANDARD WAVEGUIDE CONNECTOR

Using Standard Waveguides in Spot Measurements

The standard waveguide connector and waveguides, in conjunction with accessory items, are capable of measuring moisture in virtually all types of soils.

When the soil can be readily penetrated, the measuring waveguides, are commonly 15 cm, 30 cm or 45 cm long. After "zero setting", mount the waveguides in the connector and insert them in the soil. Always make sure that the waveguides are fully inserted in the soil to obtain an accurate moisture measurement (see Fig. 9-1).

Fig. 9-1

The waveguide connector is ruggedly built and considerable force can be used to push the waveguides into the soil.

CAUTION

Do not hammer or stamp on the connector since sharp blows can disturb internal electronic components. Contact our Sales Department regarding our heavy duty "Slammer" waveguide connector.

Using Long Waveguides for Spot Measurements

When longer waveguides, such as 45 cm and 60 cm long, are mounted in the waveguide connector, the ends of the waveguides can be flexed considerably during the insertion process. Proper spacing between the two waveguides is necessary to obtain accurate moisture measurements. When using long waveguides, it is important to guide the ends of the waveguides when they enter the soil. Our accessory Alignment Block, 6012, should be used for this purpose (Fig. 9-2).

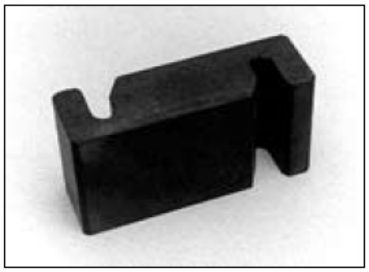


Fig. 9-2

The ends of the Waveguides are inserted into the Alignment Block as they starT to enter the soil (Fig. 9-3).

Fig. 9-3

The alignment block starts the waveguide entry into the soil with exactly the same spacing as in the waveguide connector and helps assure that they will be paralleled as they move down into the soil.

When the waveguides are well into the soil, the alignment block can be twisted to free it from the waveguides and removed.

Insertion of Waveguides in Dense Soils

Soils of high plasticity, compacted soils, very dry soils, and cemented soils require the use of our Installation Tool, 6010 (Fig. 9-4).

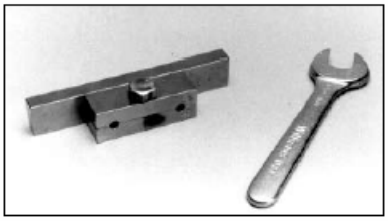


Fig. 9-4

The installation tool is made from steel and plated for corrosion resistance. A wrench is provided with the installation tool. The waveguides are mounted in the installation tool by first loosening the hex head bolt, slipping the grooved end of the waveguides all the way down to the bottom of the holes, and then tightening the bolt securely (Fig. 9-5).

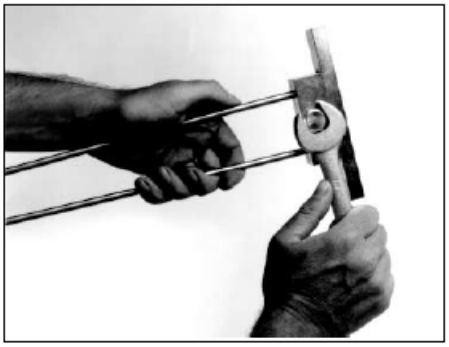


Fig. 9-5

Use the alignment block to space the waveguides, as shown (Fig. 9-6). Drive the waveguides into the soil. A mallet or similar heavy tool can be used.

Fig. 9-6

When the waveguides are mostly driven into the soil, remove the Alignment Block (Fig. 9-7).

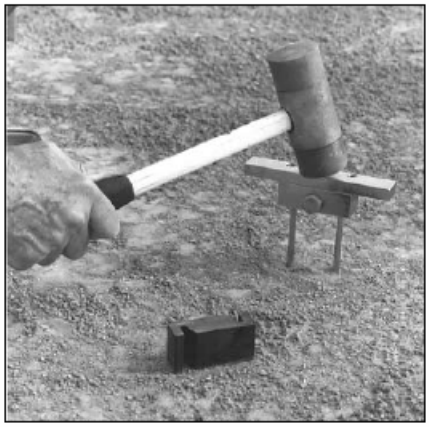


Fig. 9-7

Drive the waveguides all the way into the soil until the bottom of the installation tool is in contact with the soil surface (Fig. 9-8).

Fig. 9-8

Disconnect the installation tool by loosening the hex bolt with the wrench and lifting the tool off the waveguides. The ends of the waveguides will project slightly above the soil surface (Fig. 9-9).

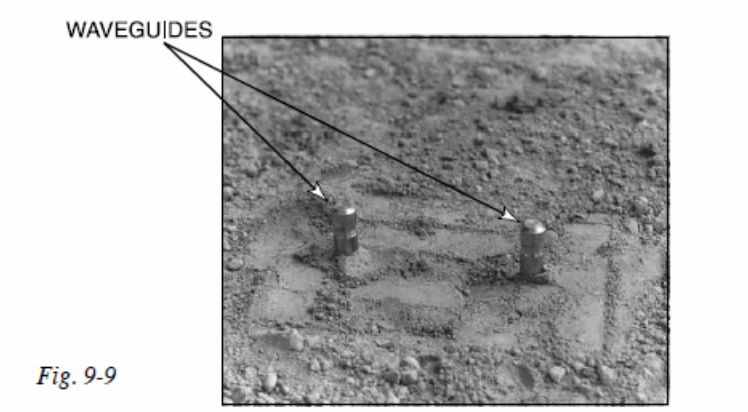


Fig. 9-9

Align the Waveguide Connector over the ends of the waveguides, as shown in Fig. 9-10, and press down until the waveguides are fully seated in the waveguide sockets of the connector. Then tighten the clamping knob on the waveguide connector to secure contact with the waveguides. The moisture reading can now be made.

Fig. 9-10

To remove the waveguides, loosen the clamping knob on the waveguide connector and remove. Fit the protruding ends of the waveguides into the holes of the installation tool. Make sure the waveguides seat on the bottom of the holes in the installation tool. Tighten the hex bolt securely with the wrench. Use the installation tool to pull or pry the waveguides out of the soil (Fig. 9-11).

Fig. 9-11

Repeat Readings At The Same Location

After installing waveguides in the soil, as described above, they can be left in the field and tagged for identification and returned to for subsequent readings. The waveguides are made of stainless steel and can be left in the field indefinitely.

Insertion In Containers

In order to obtain accurate results when making measurements in containers or pots, caution must be exercised regarding the size of the container. The waveguide spacing (5 cm) is such that a volume of soil approximately the shape of a cylinder with radius of 4 cm is sampled.

CAUTION

Inserting the waveguides too close to the wall of the container will introduce errors in the moisture measurement. Measuring too close to the wall of the container will average, not only the soil, but, the dielectric of the container and the air outside the container. It is recommended that the waveguides be inserted at least 2-3 cm (approx. 1 inch) from the wall of the container.

Special Measurement Conditions

Measurements with Long Waveguides in Wet Soils

When working with long waveguides in wet soil it may be necessary to select a longer capture window size in order to make the moisture reading. Selection of the window length is made in the Setup Screen.

Measurements in Saline Soils

Any of the coated waveguides made by Soilmoisture are for use in very conductive saline soils. Their specific Moisture Tables are selected in the Setup Screen.

10. FIELD MEASUREMENTS

USING BURIABLE WAVEGUIDES OR THE SLAMMER HEAVY-DUTY WAVEGUIDE

Installing Buriable Waveguides

The standard 6005L Series Buriable Waveguides (Fig. 10-1) and the 6005CL Series Coated Buriable Waveguides are 20 cm long with a 2-meter cable attached. Extension cables for use with the buriables come in a variety of lengths, up to 45 meters long.

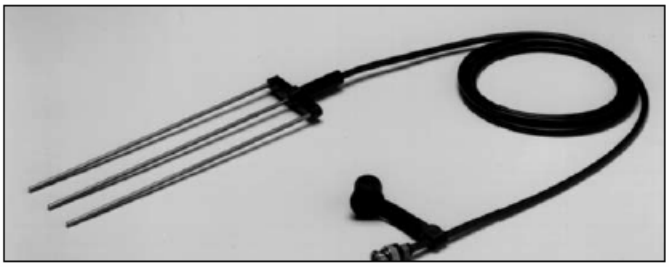


Fig. 10-1

The Buriable Waveguide is designed to be buried permanently in the soil. The waveguides can be buried and accessed by the MiniTrase from the surface. The cable can simply run up to a designated access point in the sampling area or they can be better protected by first inserting them into PVC tubing and then buried (Fig. 10-2). Extension cables up to 45 meters are available. These are constructed of special Soilmoisture "low loss" RG-58 type cable.

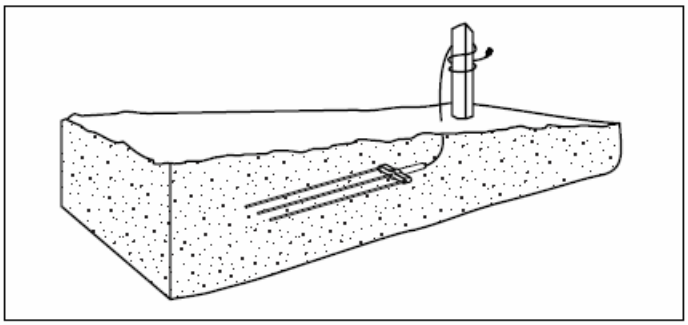


Fig. 10-2

A group of buriable waveguides can be installed at various depths to monitor moisture in the soil horizon to program irrigation frequency and amount (Fig. 10-3).

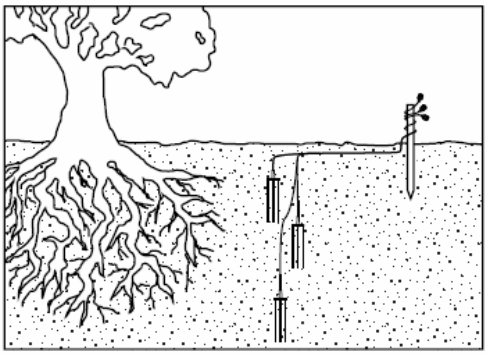


Fig 10-3

In light soils, and in many containers used in the nursery business and in research work, the Buriable Waveguide can be inserted from the surface by hand to its full depth for rapid evaluation of the moisture content (Fig. 10-4).

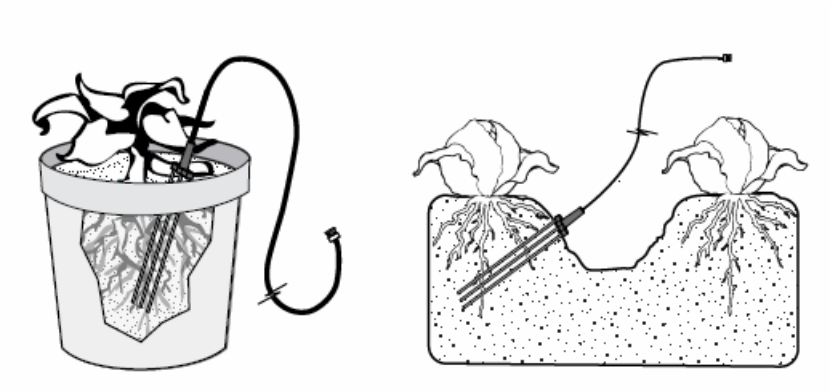
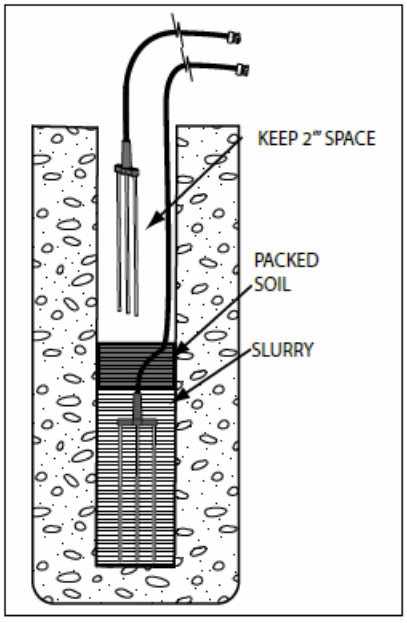


Fig. 10-4

Precautions When Installing Buriable Waveguides

To secure an accurate moisture measurement it is essential that the metal rods of the buriable waveguide be in tight, intimate contact with the soil. This means that rods be inserted directly into the soil to retain bulk density characteristics or tightly packed around with native soil taken from the hole. In deep installations, a heavy slurry of water and native soil may be poured down the hole after inserting the buriable waveguide. Sufficient slurry should be used to completely cover the buriable waveguide. This should be followed by a small amount of soil which is then tamped in place with a small diameter rod.



CAUTION

When packing around the buriable waveguide, never use silica flour or other materials that differ in dielectric or volumetric character from the native soil in your location, since this can result in readings that are not representative of your soil.

When installing one buriable waveguide above another, make sure that the coaxial cable from the lower unit is kept at least 2 inches away from the metal rods of the upper unit (Fig. 10-5).

When installing buriable waveguides horizontally near the surface, such as in seed beds, make sure that the metal rods are at least 2 inches below the surface in order to obtain accurate volumetric moisture content readings (Fig. 10-6).

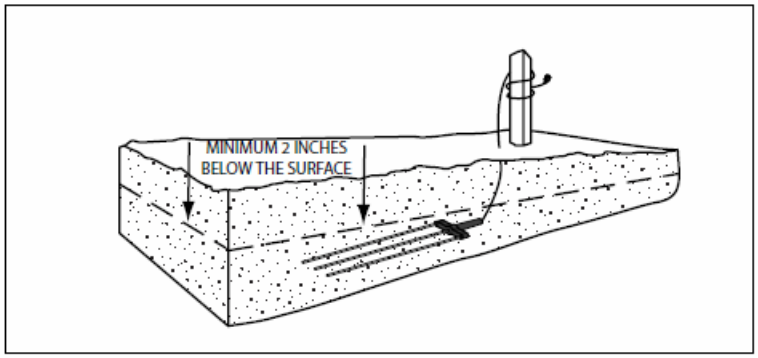


Fig. 10-6

Using the Handheld Terminal

From the Trase Setup Screen, select the appropriate Waveguide Length. From the Waveguide Type drop down menu, select Buriable. Next, select the appropriate Capture Window Size. Note that the 10 nS length set at the factory since this gives the greatest resolution when working with waveguides of 20 or 30 cm lengths. When using longer (40-60 cm) waveguides, you must select the 20 nS window. The 40 nS window size is used for saturated soils or unusual conditions.

Finally, select the Moisture Table. Select either BUN (Buriable, Uncoated) or BCT (Buriable, Coated) depending on the type of waveguide being used.

Now that the TraseTerm software has been properly set for making measurements with the buriable, tap the Home button on your handheld terminal.

Zero Set Not Required for Buriable Waveguides

When you are using the Buriable waveguides, the Zero Set Process, previously described for use with the standard Waveguide Connector, is NOT required. The Buriable Waveguide has a built-in electronic feature, which the Trase software recognizes, for its computation of percent of moisture. Therefore, after entering the desired parameters and synchronizing the time between the Palm and the MiniTrase in the Trase Setup Screen, tap the Home button.

Before proceeding, be sure that the Buriable Waveguide is attached to the MiniTrase and inserted in the soil. The BNC fitting on the cable of the Buriable Waveguide is protected by a soft plastic cap. The cap provides the BNC fitting protection in the field from soil, water, and other possible contaminants. To make a reading, remove the protective cap from the end of the BNC fitting, connect the fitting to the BNC Port on the front of the MiniTrase. Then, skipping the Zero Set Process, tap the Measure button to immediately initiate the measurement process.

As described earlier, once the measurement has been successfully taken, the reading may now be tagged for identification purposes and then either only the moisture reading may be stored or both the Reading and Graph together may be stored.

Making Measurements with the Slammer

Insertion of the Slammer Waveguides into the Soil

For assembly and use of the Slammer, please refer to the separate instructions for the Slammer. The Slammer was designed for rough use in agricultural environments where the soils vary in texture, structure, hardness, or moisture content. In moist soils, Waveguides up to 40 cm may be pushed into the soil without much difficulty. Most or all of the insertion may be achieved in one or two pushes.

NOTE

It is important to apply the "pushing" force directly over and vertical to the Waveguides, as all of this force is translated to the Waveguides (Fig. 10-7).

Fig. 10-7

If rapid insertion is not permitted by the soil, then it is best to use the sliding Hammer to aid in the insertion process. Move the Hammer up and down the Handle Stem to "drive" the Waveguides into the soil. (See Figure 10-8).

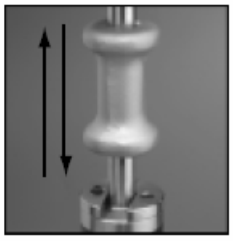


Fig. 10-8

In the toughest situations, we have found it most effective to almost sit on the T-handle while using the sliding Hammer. The Hammer Plate must be attached to the Top Cap of the Handle Assembly to prevent damage to the welded Handle Assembly. Make sure to grasp the Hammer tightly with **all** your fingers to prevent a finger being smashed under the Hammer's blow (Fig 10-9).

Fig. 10-9

Making a Measurement

From the Trase Setup Screen, select the appropriate Waveguide Length. From the Waveguide Type drop down menu, select Field.

Next, select the appropriate Capture Window Size. Note that the 10 nS length is preset at the factory since this gives the greatest resolution when working with waveguides of 20 or 30 cm lengths. When using longer (40-60 cm) waveguides, you must select the 20 nS window. The 40 nS window size is used for saturated soils or unusual conditions.

Finally, select the Moisture Table. Select either FUN (Field, Uncoated) or FCT (Field, Coated) depending on the type of waveguide being used.

Now that the TraseTerm software has been properly set for making measurements with the Slammer, tap the Home button on your handheld terminal.

Zero Set Required

Attach the Slammer Connector Cable to your MiniTrase unit and to the Slammer.

Unlike our standard connector-type waveguide, the waveguides MUST be inserted in the Slammer during the zero setting process. With the waveguides in air, tap the ZeroSet key. The process takes a number of seconds. When the process is complete, the message "Zero set" is displayed.

If for any reason you need to change the configuration of your Slammer setup, either changing cables, resetting the Capture Window Size, etc. you MUST zero set the system again.

If you have not already done so, tap the Sync Trase Time button in the top right hand corner of the terminal screen. This will ensure that the MiniTrase time/ date stamp is synced with the handheld terminal.

From the Home Screen, tap the Measure button. Once the measurement has been made, you may now choose to tag and store your reading.

11. CUSTOM LOOKUP (MOISTURE) TABLES

Standard Moisture Table

The Trase software incorporates 4 Standard Moisture Tables (CUN, CCT, BUN, and BCT) which are used to convert the measured apparent dielectric constant, Ka, to volumetric moisture content, as explained in Section 2, "Principles and Techniques of Operation".

The Standard Moisture Tables are located in a fixed place in memory and cannot be modified. The tables can be transferred, however, to an external terminal for review.

Custom Moisture Tables

When moisture measurements are required in materials or unusual soils, where the relationship of Ka to percent of moisture is radically different from conventional soils, a Custom Moisture Table can be prepared in WinTrase and entered into the MiniTrase software. The MiniTrase system provides a separate place in memory to store one (SUN OR SCT) Custom Moisture Table which is separate from the Standard Moisture Tables.

To make up a Custom Moisture Table it is necessary to prepare a series of samples of the material with known volumetric moisture contents to span the range of moisture content that is of interest. The samples must be of sufficient volume so that the dielectric constant, Ka, of the samples can be measured using Trase with standard waveguides inserted into the samples.

The development of the table relating the known volumetric moisture content to the dielectric constant, Ka, at a series of increasing moisture contents must be done carefully to maintain measurement accuracy in the field.

A Custom Moisture Table needs to consist of a series of volumetric moisture content values and the corresponding Ka values. To enter a Custom Moisture Table you must first have WinTrase software installed on a computer to use as a terminal and the PC must be connected to the MiniTrase.

Steps:

1. From the WinTrase Main Menu, select the Remote -> Trase Control Panel from the Pull Down menu. A simulated keypad and Trase screen will appear.
2. Using your mouse pointer on the alphanumeric keypad on your screen, key to the Setup Screen.
3. Press the "SAVE GRAPH" key.
4. The following prompt will appear on the terminal:
   " Type each table entry as Ka, moisture. Press "ON/ENTER" after each entry.

   Example: 15.3,.351<ENTER>. Press "ON/ENTER" again after last entry.
   Begin!"
   1 = T01
   2 = T02
   3 = T03
5. Type in the entries. After the last entry, press the "ON/ENTER" key again.
6. The following prompt will appear on the terminal:

XX entries.
Enter the table destination.
1 = T01
2 = T02
3 = T03
4 = T04 Selection (default = 1). (enter 1, 2, 3, or 4 to select the destination for your new custom table).

6. After you have entered the table number, you will be prompted as follows:
"Enter table label (8 characters alphanumeric maximum): (You will now enter the name for your custom table).
7. The following message will confirm that your custom table has been entered: "New table values stored in table TXX (the x's designating the table number selected).

Steps:

1. Prepare the file. The file should contain one entry per line. Each entry is the Ka value, a comma, then the moisture value. The moisture value is expressed as a three place decimal. For example, 5.0% is written .050, and 27.5% is written as .275. Ka is carried to a one place decimal. The following example of the first four lines of our standard table are: (see Graphs at the end of Chapter 2)
   2.0, 0.000
   3.8, 0.050
   6.0, 0.100
   7.8, 0.150
2. As with entering a custom moisture table by hand, you must have a terminal, or a computer used as a terminal, connected to the DB-9 Port of the Trase unit with the baud rate set to match the Trase setup - the default is 9600. See "Setting the Data Transfer Parameters" in this section for further details.
3. Key to the Setup Screen.
4. Press the "SAVE READING" key.
5. The following message will appear on the terminal:
" Type each table entry as Ka, moisture. Press "ON/ENTER" after each entry.
Example: 15.3,.351<ENTER>. Press "ON/ENTER" again after last entry.
Begin!"
6. Using the ASCII upload feature of your communication program, send the file to Trase.
7. After the file has been uploaded to your Trase unit the following message will appear on your terminal: " XX entries.

   Enter the table destination.
   1 = T01
   2 = T02
   3 = T03
   4 = T04
   Selection (default = 1): (You will enter either 1, 2, 3, or 4 to select the destination for your new custom table).
8. After you have entered the table number, you will be prompted as follows:
"Enter table label (8 characters alphanumeric maximum): (You will now enter the name for your custom table).

9. The following message will appear on the terminal confirming your custom table has been entered: "New table values stored in table TO# (the #'s designating the table number selected).

If you have problems transferring data, you may have to set your communication program upload to "line at a time". The communication program will not send the next line until it has received the echo from the previous line.

To transfer a Moisture Table you must have the PC connected to the MiniTrase using the DB-9 Serial Port with the baud rate set to match the MiniTrase setup - the default is 9600. See "Setting the Data Transfer Parameters" in this section for further details.
Steps:

1. Key to the Setup Screen.
2. Select either one of the 4 Standard or one of the 4 Custom Tables in the "Moisture Table" field.
3. Press the "SEND DATA" key.
4. The table will be displayed on the screen in the same format as used in entering a moisture table.

When Trase software calculates the moisture content it considers that there is a linear relationship of Ka to moisture content between two adjacent Ka values in the table.

If the Custom Moisture Table you are entering only covers a part of the full range of moisture, for example 0-40%, where, say, 40% corresponds to a Ka value of 26.0, then, if in the course of making measurements a Ka value of greater than 26.0 is encountered, MiniTrase will always report 40% moisture. If you want to know that a measurement exceeds the range of your moisture table, you can assign a Ka value of, for example, 26.5 just slightly above 26.0, and relate this to 99.9% moisture. Then when making a reading, if MiniTrase reports 99.9% moisture, you will know that the moisture value measured is beyond the range of your Custom Moisture Table.

12. MULTIPLEXING

The MiniTrase comes standard with 6022 Multiplexer Control Board installed, therefore, your MiniTrase unit has the capability of selectively reading and/or autologging installed waveguides at many locations.

Each installed waveguide, together with its connecting cable, is referred to as a “channel”. The 6020B05 Enclosure, which handles a maximum of 76 channels, and the 6020B17 Enclosure, which handles a maximum of 256 channels with desired quantities of 6021C16 boards, is used in conjunction with any Trase unit to accomplish the multiplexing operation.

These enclosures have an interconnect board, Z6020-100K1. For another enclosure or for lab use, the Multiplexer Interconnect Board Assembly Kit, part number Z6020-100K1 may be ordered.

For more information Search Product Information for “6020” at www.soilmoisture.com.

13. MAINTENANCE AND TROUBLESHOOTING

Care And Maintenance

- MiniTrase requires very little maintenance other than periodic charging of the batteries.
- Clean plastic surfaces with a moist, clean, soft cloth.
- Store the unit in a dry environment. Excessive moisture may damage internal circuits and cause the unit to fail.

Troubleshooting

MiniTrase Will Not Turn On When You Press Power Switch to "ON" position

- Check to see that the Power Switch is in the "ON" position and that the Battery is properly seated. Refer to Section 4, "Requirements Prior to Use."
- If you are using auxiliary power, make sure power cable connections are properly made.

MiniTrase Will Not Zero Set

- Is the Waveguide Connector handle plugged into MiniTrase? If you are using a buriable probe, do you have the correct waveguide type selected in the Setup Menu?
- Make sure that waveguides have been removed from the connector if using the Standard Waveguide Connector, and make sure the waveguides are installed if using the Slammer.
- Be sure Waveguide sockets are not touching any surface.
- Make sure all cable connections are properly made, see Section 3, "Acquaint Yourself with the Parts".
- Check your entries in the Trase Measure Screen to make sure entries are all properly and completely entered. Refer to Section 6, "Using The Trase Measure Screen".

Unable To Measure Moisture

- Check to make sure plug and cable connections to the Waveguides connector or buried Waveguide are intact.
- Check the Capture Window. If you are working with very long Waveguides in very wet soils, the Transit Time through the Waveguides may exceed windowing time of the Capture Window. You must select a time capture window size of 10ns, 20ns or 40ns, which will encompass the full TDR waveform. Refer to Section "The Measuring System", under Section 2, "Principles and Techniques of Operation."
- If you are working with shorter waveguides or standard buriable waveguides, make sure you are using a 10ns capture window.
- Use correct "connector", "field", or "buriable" setting.

Cold Booting the MiniTrase

The MiniTrase Processor can be returned to its initial state. The process is sometimes referred to by the computer industry as a "cold start" or a "cold boot". The process erases all stored data and returns all fields to their original default conditions. This process is

normally used only if a computer appears to be malfunctioning in the sequencing of operations or handling of data.

MINITRASE PARTS / REPLACEMENT PARTS

Parts

0898-6050X3-CD	Minitrase Instructions On mini CD
2805D20-004	Carrying Case Backpack
6075-5000	Backpack Support Foam Insert
6002F1	Wave Guide Connector
6005L2	Buriable Waveguide 2 Meter Cable
6008-001L15	15 cm Waveguide (2 Needed Per 6002F1)
Y6050X3K7B	MiniTrase With Multiplexer Card and charger
6051V100-240	External Power 100-240vac Input, No Plug
6075-3004	Card Ejector Tool
6075-6000	Null Modem Adapt Db9 M-m (For Modem)
6911T07	Android Tablet
8001	WinTrase CD In Case 2.07
MEZ021	USA Plug North American Power Cord
MEZ022	Europlug Power Cord (Non-USA)
MEZ036	9 Pin Male To Female 5 Foot Cable RS232
MEZ067	Tablet USB/Power Cable
MSL083	Short Arm Hex Key 1/16" (For Handle)
0898-6050-3LC-1	Three Letter Code Instructions (2100)
8008	TraseTerm Version 2.10 For Palm

Accessories

6008L08	Standard Waveguides, 08 cm (set of 2)
6008L10	Standard Waveguides, 10 cm (set of 2)
6008L15	Standard Waveguides, 15 cm (set of 2)
6008L30	Standard Waveguides, 30 cm (set of 2)
6008L45	Standard Waveguides, 45 cm (set of 2)
6008L60	Standard Waveguides, 60 cm (set of 2)
6008L70	Standard Waveguides, 75 cm (set of 2)
6008L90	Standard Waveguides, 90 cm (set of 2)
6008L100	Standard Waveguides, 100 cm (set of 2)
6008CL15	Coated Waveguides, 15 cm (set of 2)
6008CL30	Coated Waveguides, 30 cm (set of 2)
6010	Waveguide Installation Tool, for 6008 Series Waveguide
6012	Waveguide Alignment Block
6053V120	MiniTrase Battery Charger USA Style Plug
7005A	External Bluetooth Module for Trase

Buriable Waveguides

6005L2	Buriable Waveguide, 20 cm probe, 2 meter cable
6005CL2	Coated Buriable Waveguide, 20 cm probe, 2 meter cable
6111	Mini Buriable Waveguide, 8 cm probes

Slammer & Accessories

6101GL20	Slammer with 20 cm waveguides
6101GL30	Slammer with 30 cm waveguides
6101GL40	Slammer with 40 cm waveguides
6101GL50	Slammer with 50 cm waveguides
6101GL60	Slammer with 60 cm waveguides
6101-4000	Slammer Alignment Block
6009L20	Heavy-Duty Slammer Waveguides, 20 cm
6009L30	Heavy-Duty Slammer Waveguides, 30 cm
6009L40	Heavy-Duty Slammer Waveguides, 40 cm
6009L50	Heavy-Duty Slammer Waveguides, 50 cm
6009L60	Heavy-Duty Slammer Waveguides, 60 cm

Extension Cables

6006L02	Extension Cable, 2 meters
6006L05	Extension Cable, 5 meters
6006L10	Extension Cable, 10 meters
6006L15	Extension Cable, 15 meters
6006L20	Extension Cable, 20 meters
6006L25	Extension Cable, 25 meters
6006L30	Extension Cable, 30 meters
6006L35	Extension Cable, 35 meters
6006L40	Extension Cable, 40 meters
6075-0000-03	Stopper for reset hole and 8-pin DIN Cover Leash

Multiplexing

6020B01	Multiplexer Enclosure, 16 channel
6020B05F1	Multiplexer Enclosure, 76 channel For connection of up to 5 16-channel switching boards
6020B17	Multiplexer Enclosure, 256 channel For connection of up to 16 16-channel switching boards
6021C16	16-Channel TDR Switching Board
6022	Multiplexer Control Board (included with MiniTrase) Controls all functions of the multiplexer switching boards.
6023	Multiplexer Coaxial Connection Cable
MEZ011	Multiplexer Control Cable
Z6020-100K1	Multiplexer Interconnect Board with DB15 and Coax Cables

MiniTrase Replacement Parts

6075-0000-02	Black Battery Handle (6075-3006 inset)
MEB006	AA-Size Alkaline Batteries (internal to MiniTrase for memory)
MZL032	Plastic Dust Cover for 8-pin DIN Power Port

MZL034	Plastic Dust Cover for DB-9 port Terminal Port
MZL035	Plastic Dust Cover for DB-15 Multiplexer Port
ZMEB009	NiCad 12 Volt Replacement Battery (1.3 to 2.0 Amp Hr)