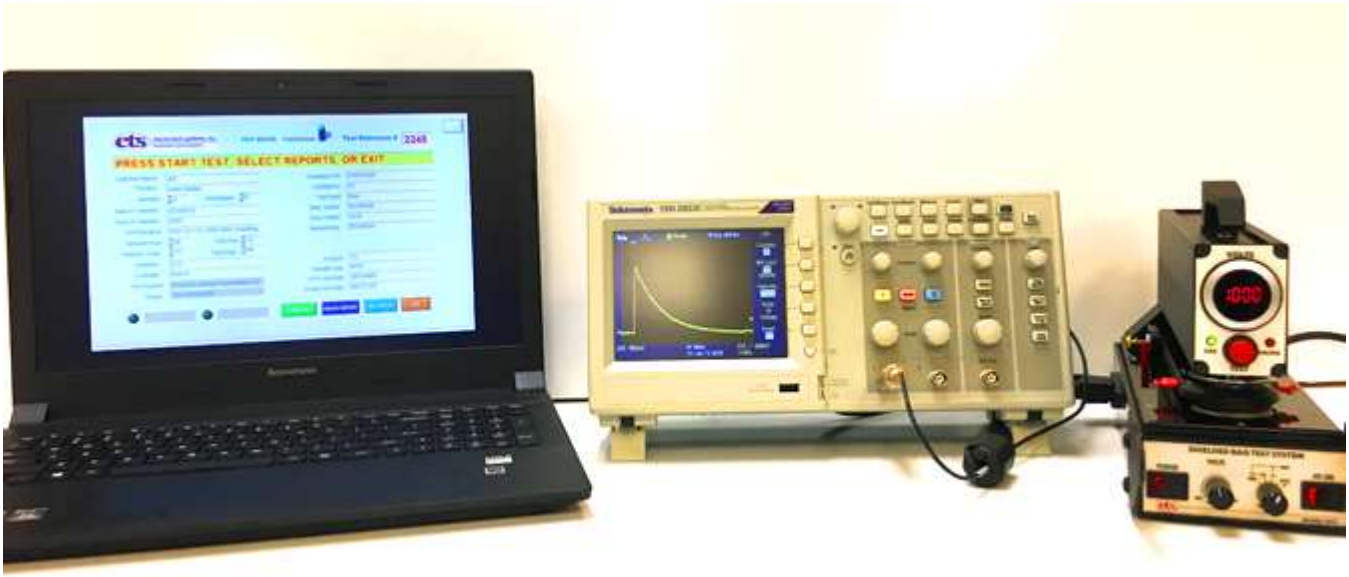
SHIELDED BAG TEST SYSTEM

Turnkey ESD Energy & Voltage Test

Model 4431T – Software Revision H

Operating Manual – Revision K



electro-tech systems, inc.

Table of Contents

IMPORTANT SAFETY INSTRUCTIONS 3
1.0 INTRODUCTION 5
2.0 EQUIPMENT DESCRIPTION 6
4.0 ENERGY TESTING - TEST METHODS 9
5.0 ENERGY TESTING - SET-UP 12
6.0 ENERGY TESTING – MANUAL MODE 13
7.0 ENERGY TESTING - AUTOMATIC MODES 15
APPENDIX A – Waveform Verification 26
APPENDIX B - Communications via the USB ports. 27
APPENDIX C – COMPUTER SETUP 29
APPENDIX D – ETS4431 File Formats 30
WARRANTY 31

Document Revision History:

- D000003 Rev. H released 2017/03/15 with Ets4431 Test Manager software revision H.
- D000003 Revision G released 2016/12/08 with ETS4431T Test Manager software revision G.
- D000003 Revision F released 2016/08/10 with ETS4431T Test Manager Software revision F.
- Original ETS 4431 Operating manual released 2013/10.

IMPORTANT SAFETY INSTRUCTIONS

WARNING: Equipment contains High Voltage.

The equipment described in this Manual is designed and manufactured to operate within defined design limits. Any misuse may result in electric shock, damage to equipment, or fire. To prevent these unwanted events, the following rules should be observed for installation, use and maintenance. Read the following safety instructions before operating the instrument. Retain these instructions in a safe place for future reference.

POWER

POWER CORD: Use only the power cord specified for this equipment and certified for the country of use. If the power (mains) plug is replaced, follow the wiring connections specified for the country of use. When installing or removing the power plug **hold the plug, not the cord.**

The power cord provided is equipped with a United States standard **3-prong grounded plug (a plug with a third grounding pin).** This is both a safety feature to avoid electrical shock and a requirement for correct equipment operation. If the outlet to be used does not accommodate the 3- prong plug, either change the outlet or use a grounding adapter.

FUSES: Replace fuses only with those having the required current rating, voltage and specified type such as normal blow, time delay, etc. **DO NOT** use makeshift fuses or short the fuse holder. This could cause a shock or fire hazard or severely damage the instrument.

POWER LINE VOLTAGE (MAINS): If the line (mains) voltage is changed or isolated by an autotransformer the common terminal **must** be connected to the ground (earth) terminal of the power source.

OPERATION

CAUTION:

All equipment designed to simulate a high voltage electrostatic discharge, including the Model 4431 Shielded Bag Test System, utilizes high voltage, high frequency pulses. The basic nature of an ESD event will result in electromagnetic radiation in addition to the high level, short duration current pulse. **Therefore, personnel with a heart pacemaker must not operate the instrument or be in the vicinity while it is being used.**

DO NOT OPERATE WITH COVERS OR PANELS REMOVED. Voltages inside the Model 4431 can be as high as 2,000 V. In addition, equipment may contain capacitors up to 100pF charged to 2kV. Capacitors can retain a charge even if the equipment is turned off.

DO NOT OPERATE WITH SUSPECTED EQUIPMENT FAILURES. If any odor or smoke becomes apparent turn off the equipment and unplug it immediately. Failure to do so may result in electrical shock, fire, or permanent damage to the equipment. Contact the factory for further instructions.

DO NOT OPERATE IN WET/DAMP CONDITIONS: If water or other liquid penetrates the equipment, unplug the power cord and contact the factory for further instructions. Continuous use in this case may result in electrical shock, fire or permanent damage to the equipment.

DO NOT OPERATE IN HIGH HUMIDITY: Operating the equipment in high humidity conditions will cause deterioration in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AREAS WITH HEAVY DUST: Operating the equipment in high dust conditions will cause deterioration in performance, system failure, or present a shock or fire hazard. Contact the factory for further instructions.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE: Operating the equipment in the presence of flammable gases or fumes **CONSTITUTES A DEFINITE SAFETY HAZARD**. For equipment designed to operate in such environments the proper safety devices must be used such as dry air or inert gas purge, intrinsic safe barriers and/or explosion-proof enclosures.

DO NOT USE IN ANY MANNER NOT SPECIFIED OR APPROVED BY THE MANUFACTURER: Unapproved use may result in damage to the equipment or present an electrical shock or fire hazard.

MAINTENANCE and SERVICE

CLEANING: Keep surfaces clean and free from dust or other contaminants. Such contaminants can have an adverse effect on system performance or result in electrical shock or fire. To clean use a damp cloth. Let dry before use. Do not use detergent, alcohol or antistatic cleaner as these products may have an adverse effect on system performance.

SERVICE: Do not attempt to repair or service the instrument yourself unless instructed by the factory to do so. Opening or removing the covers may expose you to high voltages, charged capacitors, electric shock and other hazards. If service or repair is required, contact the factory.

1.0 INTRODUCTION

HISTORICAL BACKGROUND

The rapid advancement in the electronics industry during the past decade has placed increasing importance on the understanding of electrostatics and its effect on electronic devices and systems. Electrostatic Discharge (ESD) is a common cause of microelectronic circuit failure. Many of these devices can be seriously damaged or destroyed by an electrostatic discharge below 30 Volts, or as a result of an electrostatic field of only a few hundred Volts.

The static shielding bag was developed to provide a package that would protect static sensitive components placed inside from external ESD events. Many different bag constructions are now available that, when properly used, provide a Faraday cage (electrostatic field attenuation) around the objects placed inside.

The most common bags are constructed from transparent polyethylene film with a metalized layer of mylar laminated to either the outside or the inside of the bag. The metalized side is either on the outside (metal out) or buried between the mylar and the polyethylene film (metal in or buried metal layer). The metalized layer that provides the shield is usually aluminum or nickel with a thickness limited to approximately 100 Angstroms to maintain bag transparency. Other constructions are available, however, that consist of carbon grids or conductive fibers such as carbon or copper. Static shielding is also provided by nontransparent bags that are either carbon loaded polyethylene or foil laminated such as the MIL PRF 81705E Type 1 water vapor-proof shielded bag.

Various commercial and military specifications and test standards now exist for evaluating the different electrical and physical characteristics of the bag and/or its material. The static dissipative characteristics of the bag material is determined by measuring the surface resistance in accordance with Electrostatic Discharge Association test standard ANSI/ESD S11.11. The antistatic (ability to resist tribocharging) characteristic is determined using procedures outlined in ESD ADV 11.2.

The Electronics Industries Association Test Standard EIA 541-1988 "Packaging Material Standards For The Protection Of ESD Sensitive Items" references test methods in place in 1988. However, ESD Association test standards developed since then are now specified.

The shielding effectiveness of the bag was previously evaluated using the voltage differential test method specified in EIA 541. However, **the energy test method specified in ANSI/ESD S11.31 supersedes the voltage test and is now the specified test method**. MIL PRF 81705E and ANSI/ESD S11.4 specify the ANSI/ESD S11.31 test. The ETS Model 4431-T Shielded Bag Test System meets the requirements of **only** the ANSI/ESD S11.31 test standards.

The following sections will focus on the energy test, per ANSI/ESD S11.31.

2.0 EQUIPMENT DESCRIPTION

The ETS Model 4431-T ESD Test System is supplied with a laptop computer and an oscilloscope as shown in Figure 3-1.

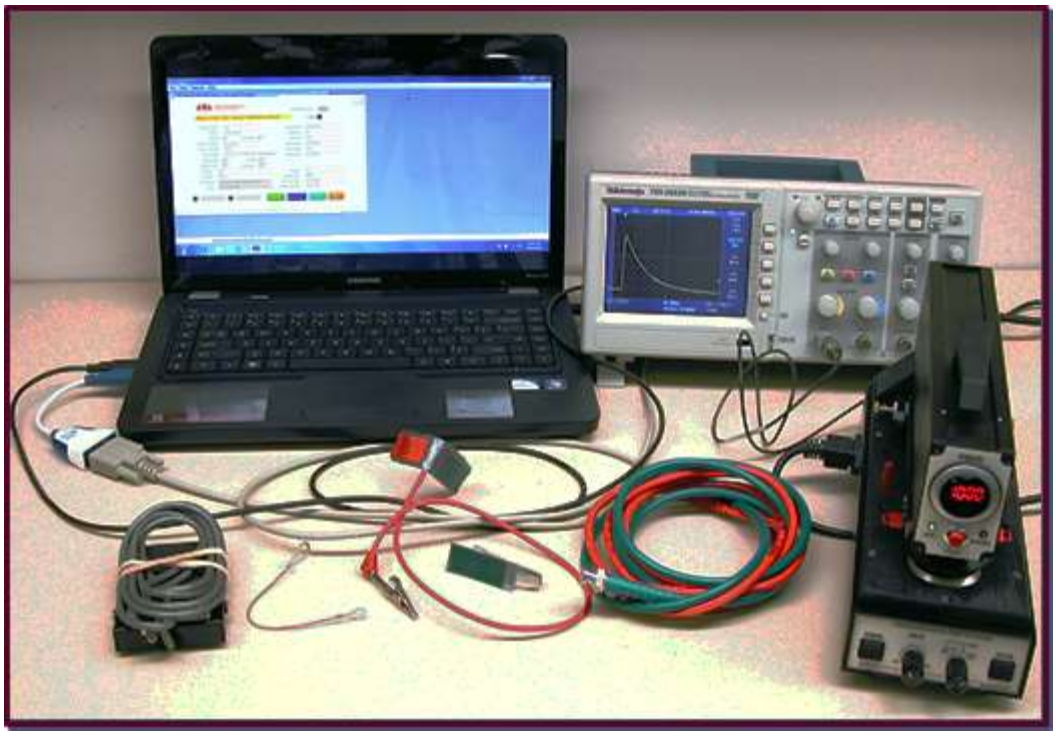


Figure 3-1: Model 4431-T Shielded Bag Test System

This is a turnkey system that performs the ANSI/ESD S11.31 shielding bag tests. The 4431 Discharge Unit provide the correct discharge current pulse for both tests. The capacitive sensor detects the current pulse and sends the signal(s) to the included oscilloscope for detection and display. Oscilloscope waveform information may be sent to the included computer for processing, display, and calculation of energy.

The Model 4431-T Shielded Bag Test System consists of the following components:

3.1 The 4431 Discharge Unit

- High voltage power supply, adjustable from approximately 850 to 1,250 Volts DC with 3½-digit LED display, allows the user to make minor corrections to obtain the specified discharge current and energy.
- Universal switching power supply, may be operated directly from 90 – 260 VAC, 50/60 Hz line voltage (mains) with 0.5A resettable fuse that is reset by powering down the unit, and after several seconds turning it back on.
- Separate ON/OFF switches on the front panel for overall power and high voltage. Note: Discharge only occurs if high voltage is ON.
- A green LED point source indicates CHARGE (HV is ready).

- A red LED point source illuminates during each DISCHARGE.
- Function switch on the front panel used to select MANual or AUTO operation of nJ (Energy) test per ANSI/ESD STM11.31.
- Selection of discharge network: 100 pF/1.5KΩ **only**.
- Lever actuated spring- loaded design provides easy insertion and removal of the sample. The lever clamps the discharge electrode against the bag, capacitive sensor and spring loaded ground electrode with approximately 5 pounds of force, ensuring consistent and repeatable results.
- Mercury wetted discharge relay
- TEST button on the front panel provides manual initiation of the discharge pulse. Foot switch connection provides hands free operation, duplicating the function of the TEST button.
- Capacitive sensor - a floating arm consisting of upper and lower 0.875" diameter precision ground stainless steel electrodes mounted in a 0.5" Acrylic base with nominal capacitance of 8 ±2 pF, a CT-1 current transducer, and 500 Ohm resistor.
- Discharge electrode grounding relay to remove residual charge between tests.
- Adjustable bag insertion stops for configuring the System for different bag sizes per specification.

3.2 Oscilloscope

- Tektronix Model TDS2022C. 200 MHz, 2GS/s

3.3 Computer

- Laptop computer running windows 10.

3.4 Software

- ETS MODEL 4431 Test Manager Revision H.

3.5 Included Accessories

Included with the Model 4431-T are the interconnect cables and accessories shown in Figure 3-2:

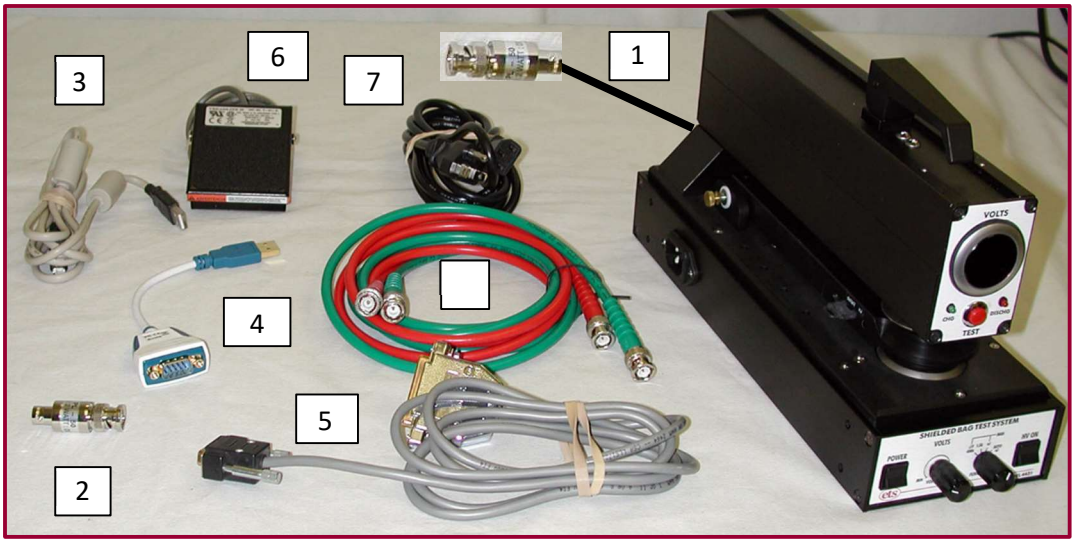


Figure 3-2: Model 4431-T cables and accessories

1. BNC cable from CT-1 to oscilloscope (Integral to Discharge Unit)
2. 50 Ohm terminator
3. USB-USB cable from computer to the oscilloscope (Model 4431-T only)
4. USB to serial converter with 9-pin sub-D from computer to communications cable (Model 4431-T only) **NOTE: Do not substitute**
5. 9-pin sub-D from Converter to 25-pin sub-D to Model 4431-T
6. Foot switch
7. IEC Line Cord (North American plug)

4.0 ENERGY TESTING - TEST METHODS

4.1 ANSI/ESD S11.31 ESD Association standard for evaluating the performance of electrostatic discharge shielding materials - Bags

This test method evaluates the performance of electrostatic discharge shielding bags. The purpose of this standard is to ensure that testing laboratories, using this test method to evaluate a given packaging material, will obtain similar results.

This standard specifies the discharge waveform characteristics, probe configuration, probe capacitance and bag size. Figure 4-1 shows the generic schematic of the test system configured for the energy test.

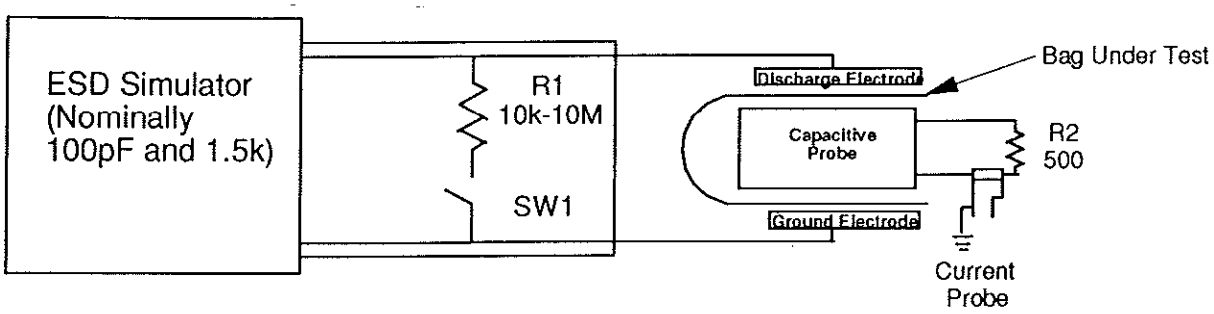
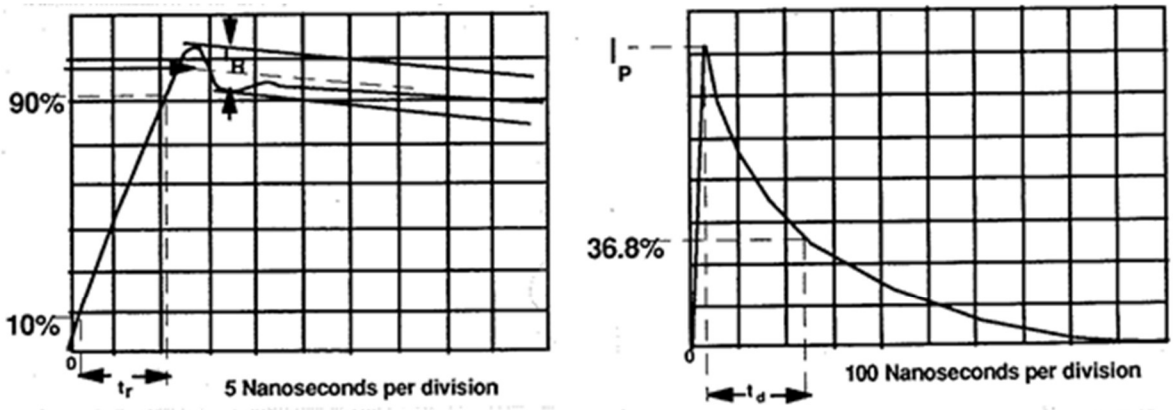


Figure 4-1: System generic schematic

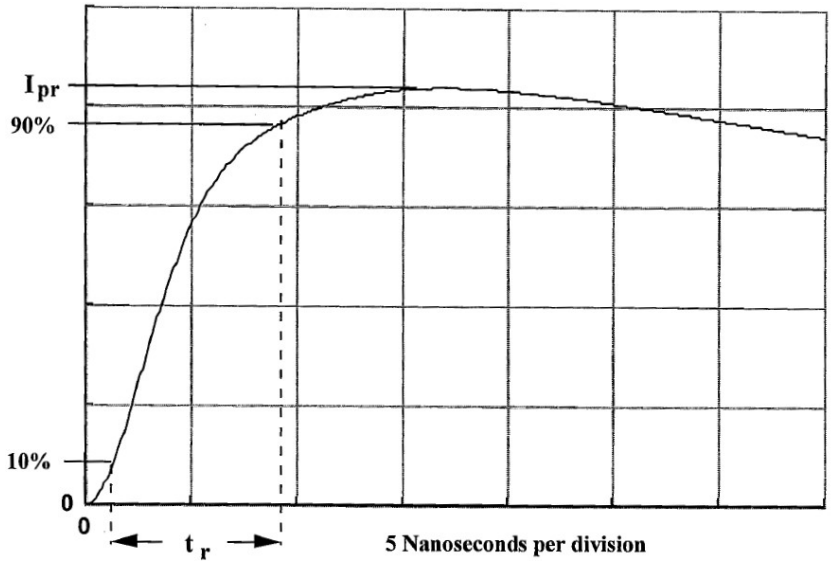
Figure 4-2a shows the discharge current waveform requirement at the specified 1000 Volts when measured with R2=0, a short to ground.



The current waveform shall have the following characteristics:

- pulse rise time (t_r) 5 nanoseconds to 20 nanoseconds
- pulse decay time (t_d) 200 nanoseconds ±20 nanoseconds
- maximum peak to peak ringing (I_R) shall be less than 15% of I_P with no observable ringing 100 nanoseconds after the start of the pulse
- peak current (I_P) shall be within 10% of the value specified in section 5(E)

Figure 4-2a: Discharge waveform through short per ANSI/ESDA-JEDEC-JS-001



Parameter	Value
I_{PR} (ampere)	375 mA – 550mA for 1000 volt pre-charge
I_{PR} (ampere)	1.5 A – 2.2 A for 4000 volt pre-charge
I_{PR}/I_{PS}	≥ 63%

Requirement:

9. The current pulse shall meet the following characteristics:

   t_r Pulse rise time 5 nanoseconds to 25 nanoseconds.

   I_r The maximum allowable peak-to-peak ringing must be less than 15% of $I_{pr,}$ when measured parallel to the current waveform, with no observable ringing 100 nanoseconds after the start of the pulse.

   I_{pr} Peak current through the 500 ohm resistor shall be between 375mA and 550mA for a pre-charge voltage of 1000 Volts and between 1.5A and 2.2A for a pre-charge voltage of 4000V. I_{pr} shall not be less than 63% of the previously measured I_{ps} value for the same stress level.

Notes:

5. The peak current and risetime into the 500 ohm resistor will vary, depending upon the capacitive loading of the socket and peripheral wiring.
6. It is not necessary to measure td, pulse decay time of the current through the 500 ohm resistor, as this will vary, depending upon how the tester forms the pulse.
7. The 500 ohm waveform standard is intended to assure that socket capacitance is limited. But for a given component, socket capacitance within those limits could still influence ESD withstand voltage.

Figure 4-2b: Discharge waveform through 500Ω per ANSI/ESDA-JEDEC-JS-001

The current pulse detected between the upper and lower electrodes of the capacitive probe is used to calculate the energy inside the bag. Figure 4-3 shows the raw data in milliAmps from the current sensor. This is the customary way to view and compare bag performance. From this data, the total energy in nanoJoules is computed.

Figure 4-3: Typical Model 4431-T shielded bag waveform

For S11.31, six specimens (samples) of a given product are required. Six measurements per specimen is specified. Testing is to be performed at both 12% and 50% ±3% RH at a temperature of 73 ±3 ºF (23 ± 2 ºC) after a conditioning period of 48 hours minimum. Bag size for this test is specified to be 8 x 10 inches (20 x 25 cm).

ANSI/ESD S11.31 specifies that the test conditions, peak current, minimum, maximum and average energy levels of all 36 measurements be reported for bag qualification.

4.2 ANSI/ESD S11.4 Static Control Bags

This standard defines the performance of static shielding bags used in manufacturing and commercial applications. It defines an acceptable bag as having **<20nJ** when tested in accordance with S11.31.

4.3 MIL PRF 81705E

This military standard defines the performance of Type 1 water-vapor proof and Type 3 static shielding bags. The acceptable energy limit when tested in accordance with S11.31 is **<10nJ**.

5.0 ENERGY TESTING - SET-UP

5.1. The AC line cord of the Model 4431 is a standard IEC cord with North American grounded plug. It should be plugged into a grounded outlet. For non-North American locations, a line cord having the correct mains plug can be obtained from a local computer or electronics store. Otherwise, cut off the plug and install the appropriate plug for the location.

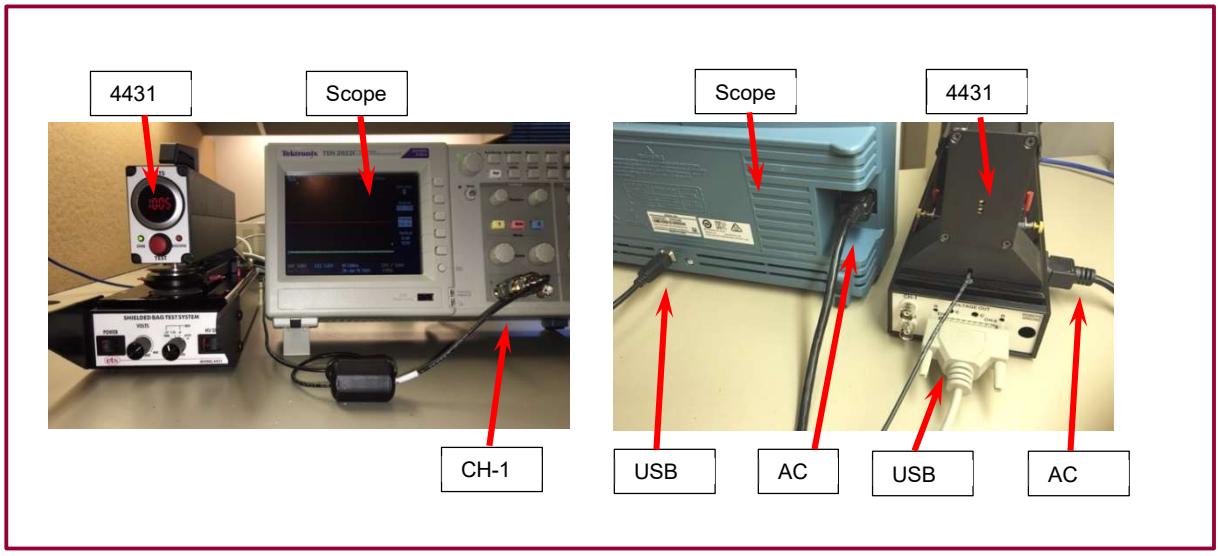


Figure 5-1: System set up for Energy test

5.2 Connect the BNC connector from the Model 4431 Discharge Unit into CH-1 of the oscilloscope. The 50 Ohm Terminator provided must be used in order to match the 50 Ohm output impedance of the CT-1 to the 1 MegOhm impedance of the scope.

5.3 Turn on the computer and verify you are using Windows 10. If you purchased the system and computer from ETS, the software has already been loaded. Verify that there is an ETS4431 Test Manager icon on the screen, and there is a C:\ETS\ folder on the hard drive. If not, see Appendix C in this manual for the setup procedure.

If using computer control, plug the following connections into the computer after the computer is on and finished booting.

- Connect the 25 pin-to-9-pin cable to the 9-pin-to-USB adapter. Connect the 25-pin end of this cable to the DB25 connector on the rear of the Model 4431. Connect the USB end of this cable to the 1st computer USB port.
- Connect the USB-to-USB cable from the oscilloscope to the 2nd USB port on the computer.
- If a printer is used, connect it to the 3rd USB port on the computer.
- In case of miscommunication with the computer, unplug and re-plug the USB connector and try again. Also see Appendix B for USB information.

5.4 If the red jumpers are present, confirm that they are located on the sides of the capacitive sensor are plugged in the front (“nJ”) position. This programs the capacitive sensor for energy measurements.

5.5 If using the Foot Switch, then with the Model 4431 Discharge Unit powered OFF, plug the phono plug from Foot Switch into the REMOTE DISCHARGE jack on the rear panel of the unit.

5.6 Power up all instruments.

5.7 Set the FUNCTION select switch to **AUTO nJ** if the test is to be controlled by the computer (Automatic Continuous Testing), or **MAN nJ** if not (Manual or Automatic Monitored Testing).

5.8 For waveform verification in the MAN mode, set the oscilloscope VERTICAL sensitivity to 500mV, the time base to 100nsec and the trigger level to 500mV. For bag testing start with settings of 20 or 50mV, 20nsec and 50 or 75mV respectively. Note that these settings are necessary only for Manual Testing. For Automatic Testing the computer automatically sets the correct scope parameters, for typical "good" bags. If the waveform extends off the scope screen, the vertical scale must be manually adjusted so that a complete waveform is displayed.

6.0 ENERGY TESTING – MANUAL MODE

This chapter covers the details of manual product testing per ANSI/ESD S11.31 – Energy Test, using only the 4431 Discharge Unit and the Oscilloscope. Data can be saved from the USB port of the scope for later processing by user software (not supplied). See the next chapter on AUTOMATIC ENERGY TEST for automated control of this test.

6.1 Test Waveform considerations.

ANSI/ESD STM11.31 requires verification of the discharge current pulse both through a short to ground and through a 500 Ohm resistor. See Appendix A for the details of the verification process. The waveform is carefully set up at the factory and should require minimal maintenance. Below is a plot of a typical discharge pulse.

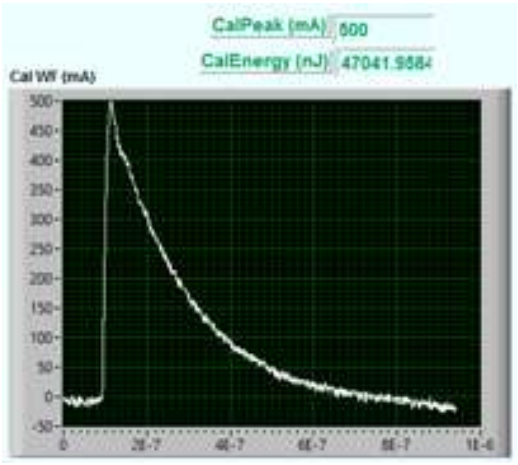


Fig. 6-1. Calibration Waveform

6.2 Sample sizes

ANSI/ESD S11.31 specifies an 8" x 10" bag size (20 x 25 cm) with the capacitive sensor placed in the center. The Model 4431 incorporates adjustable stops to correctly locate 4", 6", 8" and 10" bag lengths (10, 15, 20, and 25 cm). For the standard size bag insert the two red plastic stops into the third hole from the front of the unit.

A test bag is inserted by sliding it over the capacitive sensor until it hits the stops, making certain that the sensor is inside the bag. Center the bag laterally as shown in Figure 6-2.

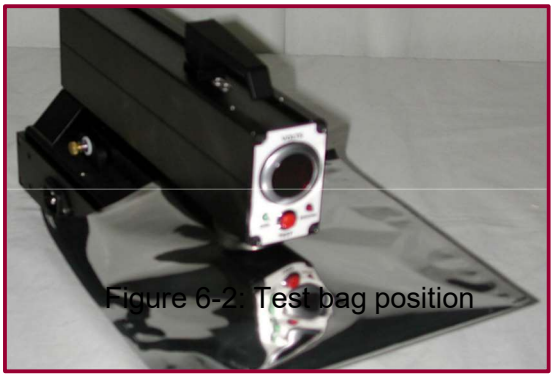


Figure 6-2: Test bag position

6.3 Running the test.

This section describes manual testing. (See the next section for automatic testing.)

- Set the FUNCTION switch on the front panel of the 4431 Discharge Unit to MAN nJ.
- Adjust the Voltage on the Discharge Unit for a reading of 1,000 ±10 Volts.
- Set the oscilloscope CH1 vertical sensitivity to 50mV/div, Horizontal time base to 50nsec/div, and CH1 trigger level to 50mV. Trigger mode is NORMAL.
- Turn on the HV.
- Press the SINGLE button on the oscilloscope, then initiate a discharge, using either the 4431 Discharge Unit front panel TEST button or the foot switch. Each time these two steps are done, a discharge will occur.
- The current pulse generated by the discharge will be detected by the capacitive sensor and will be displayed on the oscilloscope. Typical waveforms for a static shielding bag are shown in Figure 6-3.

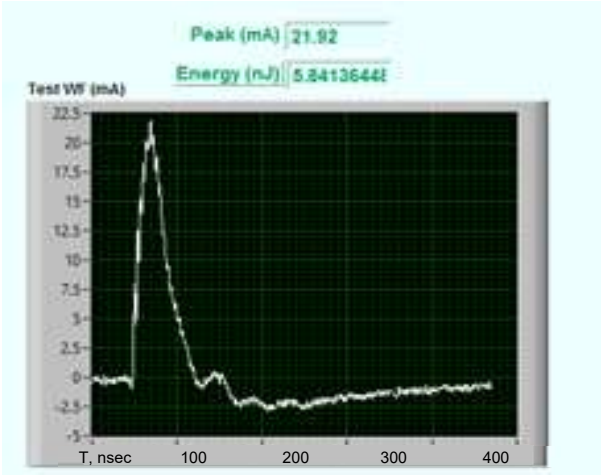


Figure 6-3: Typical shielded bag waveform

- The waveform data may be transferred from the oscilloscope onto a FLASH memory device or to a computer via USB, for processing by user software.

7.0 ENERGY TESTING - AUTOMATIC MODES

The ETS Model 4431-T Test Manager control software is preloaded in the supplied laptop computer. (A backup flash drive is included with the system.) It communicates with the 4431 Discharge Unit and the oscilloscope via two USB ports. See Appendix B for some tips on the USB ports.

The system will provide on-screen display of the test data, in addition to 3 types of output: (1.) Printed reports to the default windows printer. Use the computer's control panel to set up your printer as the default printer. (2.) Reports saved to .pdf files. (3.) Test data in .txt files.

The system is installed with its own folder on the root (C-drive) directory. This folder, C:\ETS\, contains the 4431 system setup file 4431SETUP.txt, and will be the repository for test data. When you print or save a .pdf report file, the system will ask where to store the file.

The Test Manager software is the hub of all automatic S11.31 operations, providing the main functions of organizing samples and discharges, testing, printing and saving data. Below is a roadmap to these functions.

ETS MODEL 4431 TEST MANAGER
AUTOMATIC TESTING ROADMAP

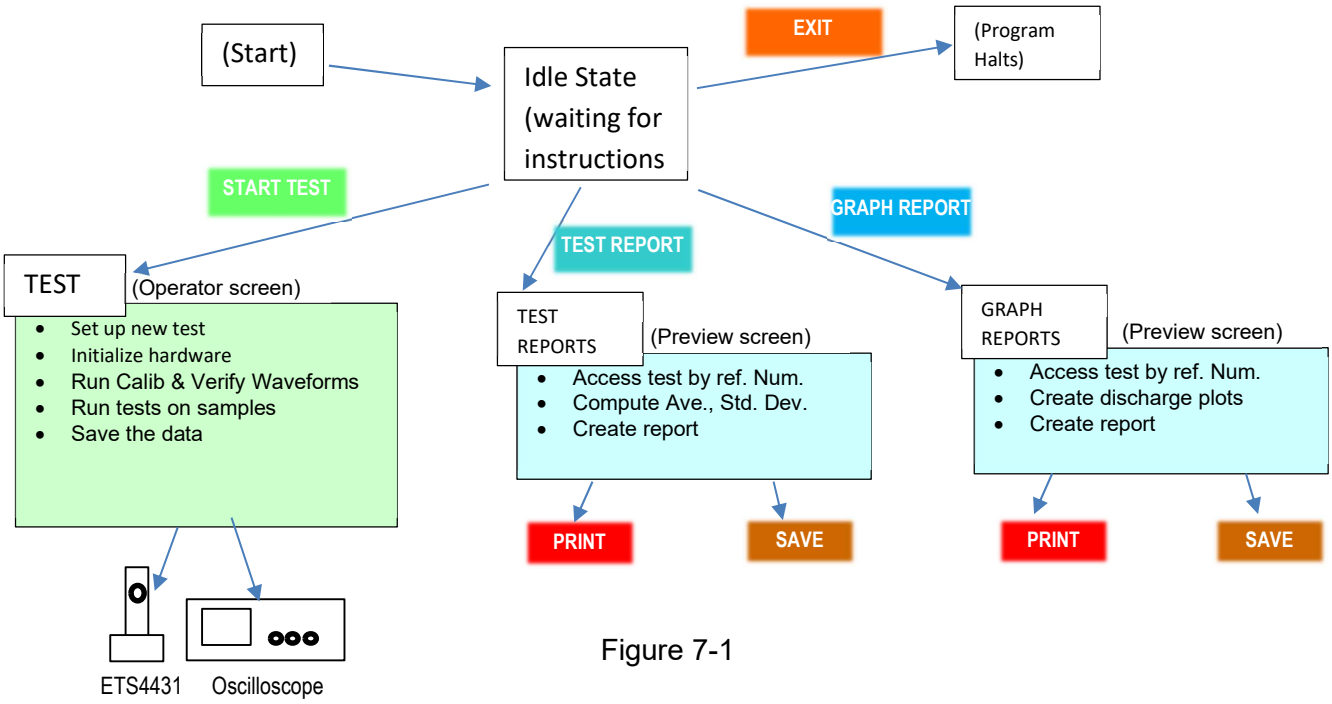


Figure 7-1

The program provides two distinct modes of automatic testing: Monitored and Continuous

- In Automatic Monitored mode, the computer keeps count of discharges and samples, and the operator triggers each discharge and approves or repeats each step of the test.
- In Automatic Continuous mode, the computer keeps count of discharges and samples, and creates discharges automatically. All test results are stored without approval.

7.1 Starting a test with the ETS Model 4431 Test Manager

Make sure all cables are installed before turning on the system and starting the program. To run the program, switch on the scope, laptop, and 4431 Discharge Unit. Switch the 4431 to AUTO, Power ON, and HV ON. Proceed as follows:

7.1.1 From your windows desktop, double-click the ETS MODEL 4431 TEST MANAGER icon. You will see the Operator screen shown below. Instructions are always shown in the yellow highlighted field.

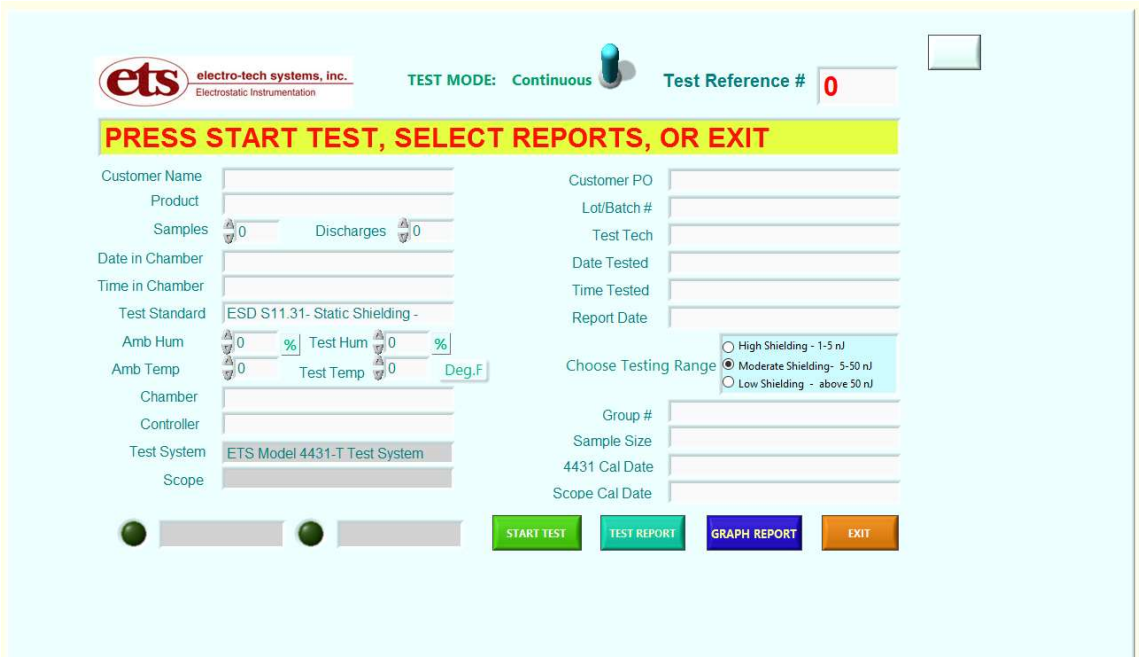


Figure 7-2 – Operator Screen

7.1.2 A few manual setup steps are necessary to set up the USB devices, since the windows system prevents software from performing this automatically.

Click on the unmarked button in the upper right corner of the screen.

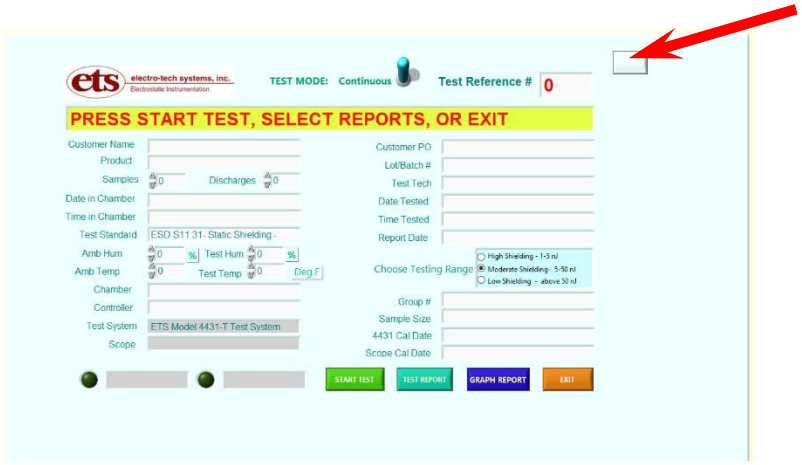


Figure 7-3 – Activating the tabs.

This activates tabs which you will see along the top of the screen.

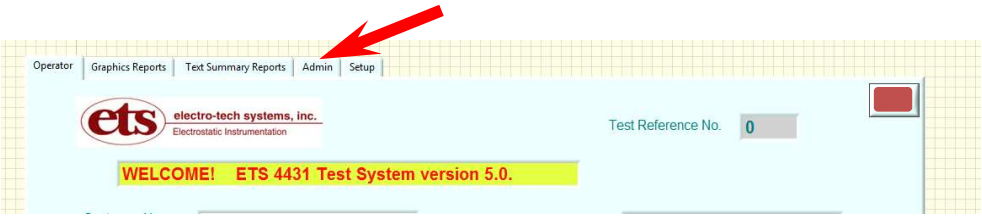


Figure 7-4 – The ADMIN tab.

Click on the ADMIN tab. You will see two "Path" fields. "ETS4431 Path" is the connection to the Discharge Unit; "Scope Path" is the connection to the oscilloscope..

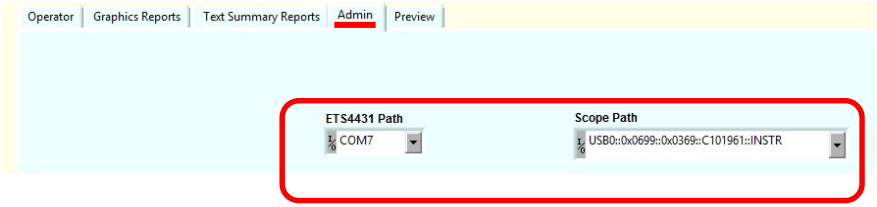


Figure 7-5 – Communications Paths

Each resource field has a pull-down menu. Follow this update procedure:

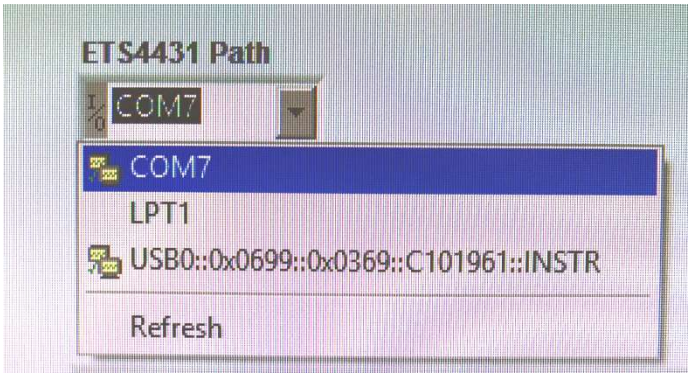


Figure 7-6 – Path selection for the Discharge Unit

- Pull down the ETS4431 menu. You will see a "COM" entry and a "USB0::…" entry. Click on the COM entry. This may be "COM3". In some systems this may be COM4, COM6, etc..
- Pull down the ETS4431 menu again and click on "Refresh"

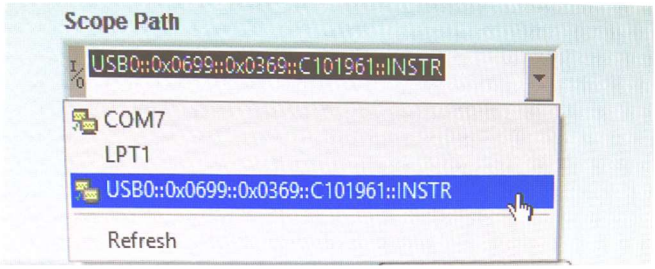


Figure 7-7 – Path selection for the Oscilloscope.

- Pull down the Scope menu and click on the “USB0::0x….” entry.
- Pull down the Scope Menu again and click on “Refresh”

The USB devices should now be properly set up in the system. Click on the tab labeled OPERATOR, and you will return to the Operator screen.

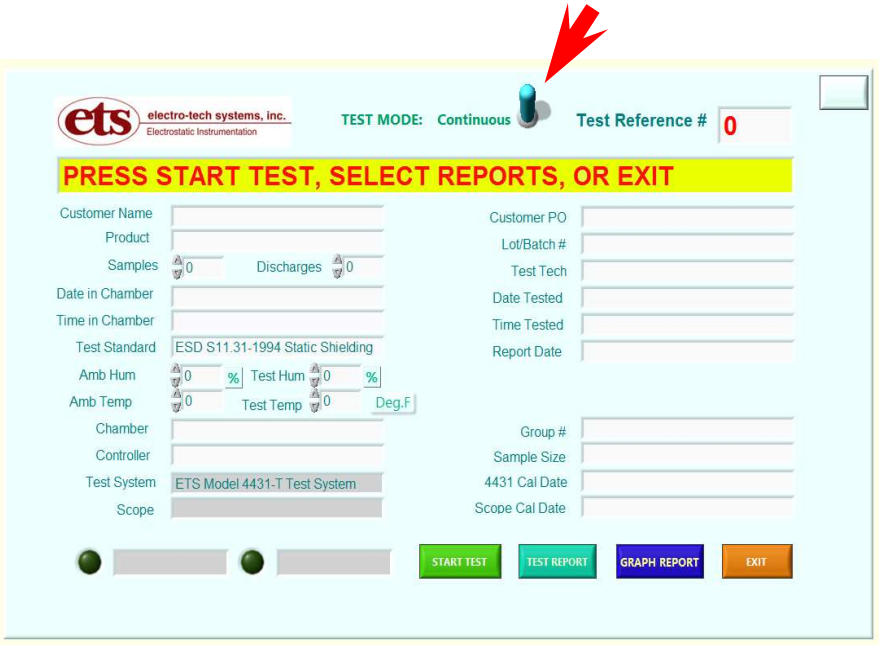


Figure 7-8 – Selection Switch for Monitored or Continuous

7.1.3 Select “Monitored” or “Continuous” testing. Locate the TEST MODE switch at the top of the screen. To change the mode, click once on the switch icon. See the red arrow above.

Monitored mode: Select MONITORED on the screen and switch the 4431 Discharge Unit selector switch to MAN nJ. The user will be asked to insert samples and initiate each discharge by pressing the red TEST button on the front panel of the Discharge Unit. After each waveform is captured, the user will be asked to approve the waveform.

Continuous mode: Select CONTINUOUS on the screen and switch the 4431 Discharge Unit selector switch to the AUTO setting. The user will be asked to insert each sample, then the computer will sequence through the number of discharges entered for the test. (NOTE: If the Discharge Unit is switched to a manual setting, the computer is not controlling the discharges and will automatically run in Monitored mode.)

7.1.4 To start a new test, click on the “START TEST” button.

7.1.5 The system automatically assigns a new Test Reference Number for the test, which appears at the upper right of the screen. (Denoted by “xxxx” in this manual)

7.1.6 Enter all desired test profile information. This is for future reference – It is not edited or checked by the system. Make sure to study and follow your laboratory’s protocol for entering this information. Always adhere to consistent technique for entering dates, temperatures (F vs. C), etc.

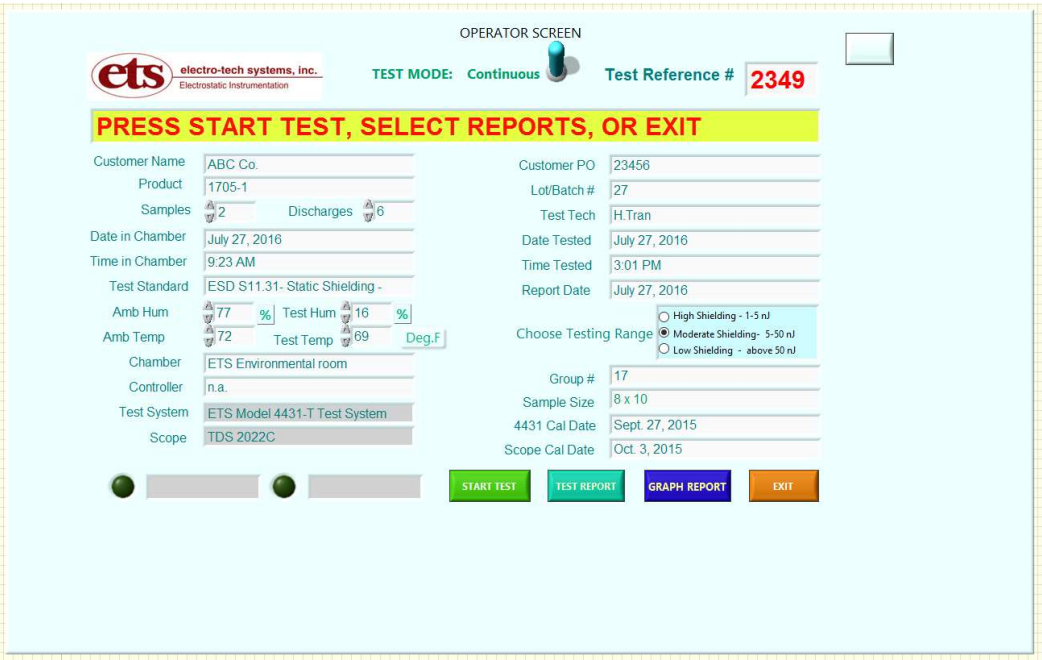


Figure 7-9. Operator screen with Test Profile data

- Enter the number of samples in the SAMPLES field. Any number from 1 to 20 can be entered by typing it in, or by utilizing the up/down arrows at the left of the field.
- Enter the number of discharges in the DISCHARGES field. Any number from 1 to 6 can be entered using the same technique.
- All date fields are free-form. Dates may be entered as July 26, 2016, 7/26/2016, etc. Special care should be taken to adhere to a single date system.
- All time fields are free-form. Times should be consistently entered in either AM/PM format or 24 hour format.
- Note the “DegF” button adjacent to the temperature fields. Click on this to set the system which is in use. This does not convert or change any numbers, but is stored with the test data to identify temperature entries.
- Choose the testing range according to the energy reading expected. This sets up the oscilloscope to a reasonable starting range. The system may optimize this if needed to provide a better display.

7.1.7 Quite often profiles are repetitive and duplicate a previous test. To use a profile you have used before, simply call up the Test Report from that test (See section 7.5), which populates the desired profile fields, then click on BACK to return to the Operator screen, and start a new test. CAUTION: This shortcut saves time, but make sure to update any dates, etc. which have changed.

7.1.8 When you have completed the profile information, click “START TEST” again.

7.1.9 The system will initialize the scope and the 4431 hardware. This is a point at which you may see USB messages. If so, check that both USB cables are firmly plugged into the laptop, and see Appendix A for more information.

7.2 CALIBRATION.

You will then be asked to “Remove sample and close latch”. Make sure there is no sample is in the clamp and the clamping lever is down, then click “START TEST”.

7.2.1 The screen will switch to a preview screen to do the Calibration Waveform.

IF the system is in MONITORED mode, you will be asked to create a discharge by pressing the red “TEST” button on the 4431 Discharge Unit.

IF the system is in CONTINUOUS mode, the Cal discharge and waveform capture will occur automatically

7.2.2 This creates a direct measurement of the discharge, and produces the characteristic exponential plot, confirming proper operation of the electronics as shown below. This plot should show a peak above 420 milliAmps, and an energy total of 50,000 nanoJoules, ± 3,000 nJ.

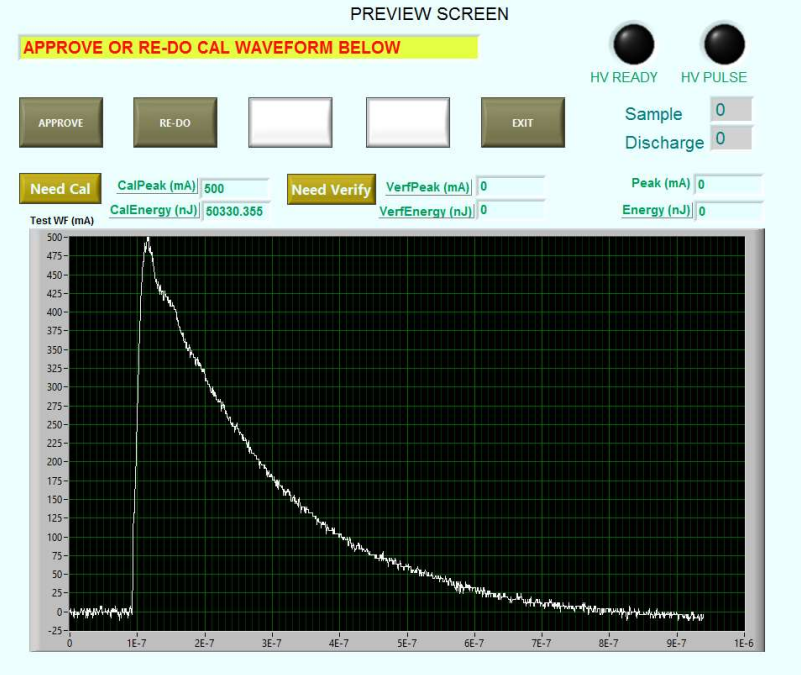


Figure 7-10. Preview Screen showing Cal Waveform

7.2.3 If the Cal waveform is acceptable, click on APPROVE, otherwise readjust the voltage on the 4431 Discharge Unit and click on RE-DO. Increase the voltage by 10 volts to raise the energy reading – decrease the voltage by 10 volts to lower the energy reading. Repeat until the Cal waveform is within range.

7.4 TEST DISCHARGES.

You will then be asked to insert a sample, close the latch, and press START TEST.

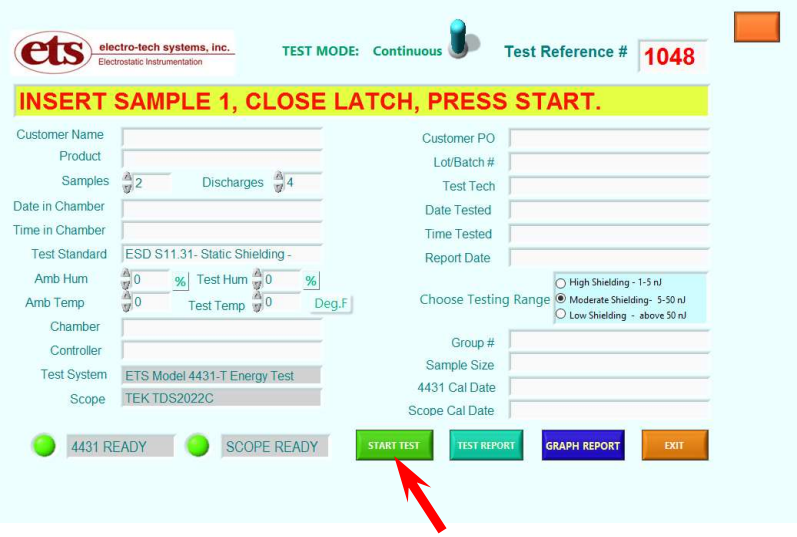


Figure 7-13. Operator Screen requesting a sample.

7.4.1 The system is ready to perform the test discharges and capture the waveform data for this sample, and will switch to the Preview Screen.

IF the system is in MONITORED mode, you will be asked to create each discharge. Watch for the "HV READY" indicator to turn green, then press the red "TEST" button on the 4431 Discharge Unit front panel.

Figure 7-14 – Waiting for Discharge.

IF the system is in CONTINUOUS mode, the HV discharge will occur automatically and the red “HV Pulse” indicator will flash at each discharge.

7.4.2 You will see the captured waveforms on the preview screen as they are acquired:

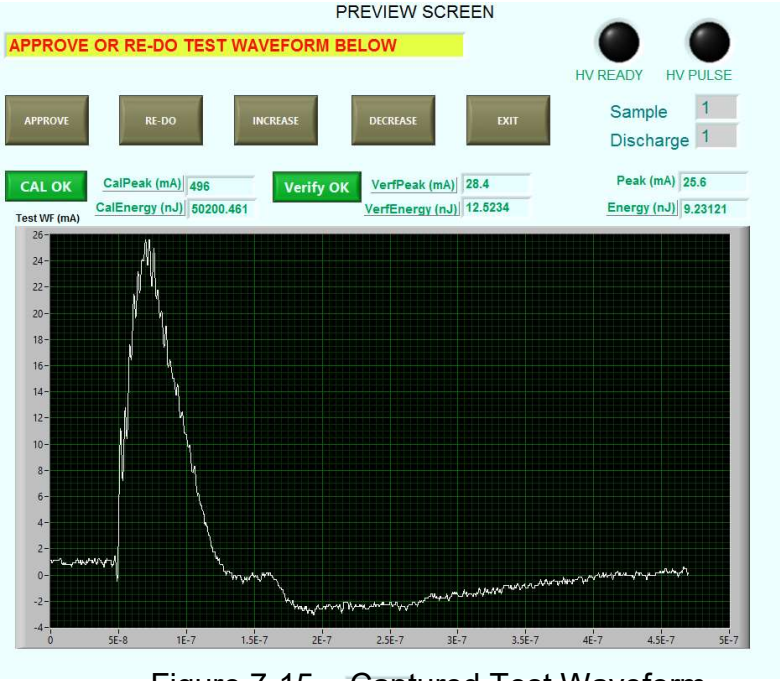


Figure 7-15 – Captured Test Waveform

IF the system is in MONITORED mode, you will be asked to APPROVE or RE-DO each discharge.

IF the system is in CONTINUOUS mode, the complete set of discharges will occur automatically for this sample.

7.4.3 Based on the number of samples entered in the test profile, the previous 3 steps will be repeated until all samples have been tested.

7.5 Test Data.

All test data is saved at C:\ETS\:

Each test sequence generates a Summary File named C:\ETS\ETS4431SUMMARYxxxx.txt containing peak and energy totals. (“xxxx” is the test reference number.)

Each test sequence generates a Data File named C:\ETS\ETS4431-TESTxxxx.txt containing all waveform data.

These are easily readable text files. Files can be easily identified and maintained by windows file name. It is not recommended that any editing be done on these original files. They can be accessed at any time by the ETS 4431-T Test Manager or other programs such as wordpad or excel for reports or analysis.

7.6 Producing a Test Report.

On the Operator screen, click on “TEST REPORT”. The Test Report screen will appear and a dialog box will ask for a test number:

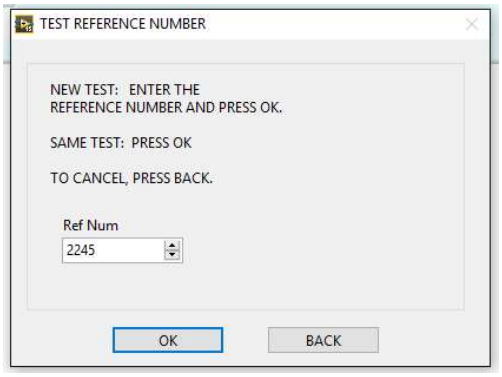


Figure 7-16 – Choosing a test by Reference Number

- To select a new test, type the 4-digit reference number of the test you want and click OK.
- To use the same test reference number you have been using, just press OK.
- To abandon the request, click BACK.

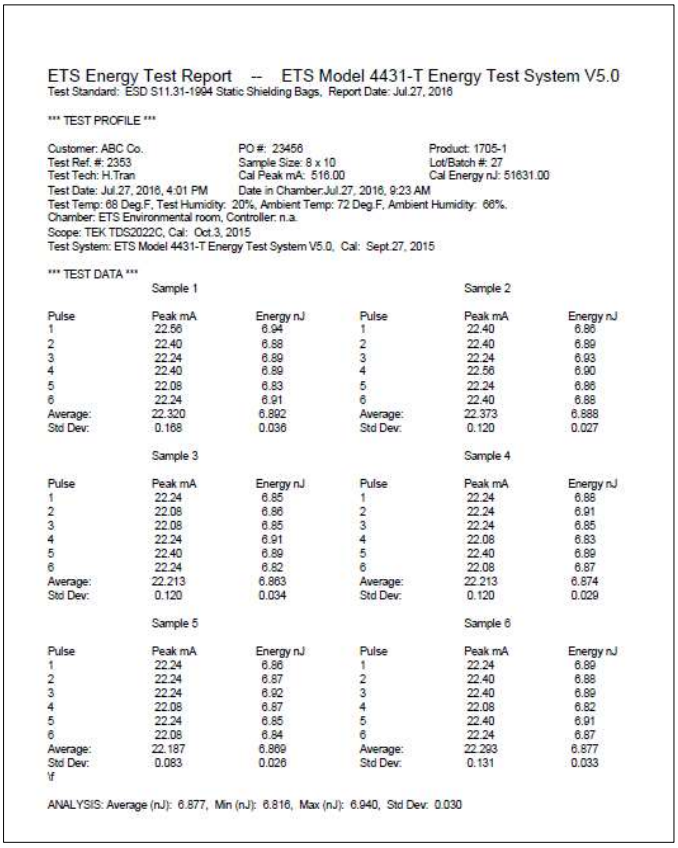
You will see the Test Report screen with preview data from the requested test.

.

Figure 7-17 – Test Report screen.

- Click PRINT to produce a formatted report on the present system printer.
- Click SAVE to store a .pdf copy of the report at C:\ETS\.
- Click BACK to return to the Operator screen.

The PRINT and SAVE options produce the following formatted report:



ETS Energy Test Report -- ETS Model 4431-T Energy Test System V5.0

Test Standard: ESD S11.31-1994 Static Shielding Bags, Report Date: Jul.27, 2016

*** TEST PROFILE ***

Customer: ABC Co. PO #: 23456 Product: 1705-1
Test Ref. #: 2353 Sample Size: 8 x 10 Lot/Batch #: 27
Test Tech: H.Tran Cal Peak mA: 516.00 Cal Energy nJ: 51631.00
Test Date: Jul.27, 2016, 4:01 PM Date in Chamber:Jul.27, 2016, 9:23 AM
Test Temp: 68 Deg.F, Test Humidity: 20%, Ambient Temp: 72 Deg.F, Ambient Humidity: 66%.
Chamber: ETS Environmental room, Controller: n.a.
Scope: TEK TDS2022C, Cal: Oct.3, 2015
Test System: ETS Model 4431-T Energy Test System V5.0, Cal: Sept.27, 2015

*** TEST DATA ***

Sample 1

Pulse	Peak mA	Energy nJ
1	22.56	6.94
2	22.40	6.88
3	22.24	6.89
4	22.40	6.89
5	22.08	6.83
6	22.24	6.91
Average:	22.320	6.892
Std Dev:	0.168	0.036

Sample 2

Pulse	Peak mA	Energy nJ
1	22.40	6.86
2	22.40	6.89
3	22.24	6.93
4	22.56	6.90
5	22.24	6.86
6	22.40	6.88
Average:	22.373	6.888
Std Dev:	0.120	0.027

Sample 3

Pulse	Peak mA	Energy nJ
1	22.24	6.85
2	22.08	6.86
3	22.08	6.85
4	22.24	6.91
5	22.40	6.89
6	22.24	6.82
Average:	22.213	6.863
Std Dev:	0.120	0.034

Sample 4

Pulse	Peak mA	Energy nJ
1	22.24	6.88
2	22.24	6.91
3	22.24	6.85
4	22.08	6.83
5	22.40	6.89
6	22.08	6.87
Average:	22.213	6.874
Std Dev:	0.120	0.029

Sample 5

Pulse	Peak mA	Energy nJ
1	22.24	6.86
2	22.24	6.87
3	22.24	6.92
4	22.08	6.87
5	22.24	6.85
6	22.08	6.84
Average:	22.187	6.869
Std Dev:	0.083	0.026

Sample 6

Pulse	Peak mA	Energy nJ
1	22.24	6.89
2	22.40	6.88
3	22.40	6.89
4	22.08	6.82
5	22.40	6.91
6	22.24	6.87
Average:	22.293	6.877
Std Dev:	0.131	0.033

\f

ANALYSIS: Average (nJ): 6.877, Min (nJ): 6.816, Max (nJ): 6.940, Std Dev: 0.030

Figure 7-18 Printed Test Report

7.7 Producing a Graph Report.

Click on “GRAPH REPORT”. The Graph Report screen will appear and a dialog box will ask for a reference number:

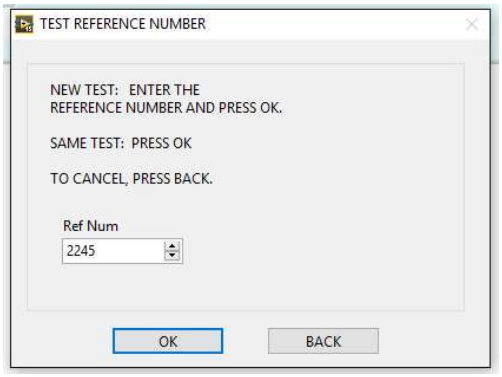


Figure 7-19 – Choosing a test by Reference Number

- To select a new test, type the 4-digit number of the test you want and click OK.
- To use the same test reference number you have been using, just press OK.
- To abandon the request, click BACK.

You will see the Graph Report preview screen with data from the requested test. Sample 1 from the test will be displayed. Use the slider at the right of the screen to slide up or down to other samples.

.

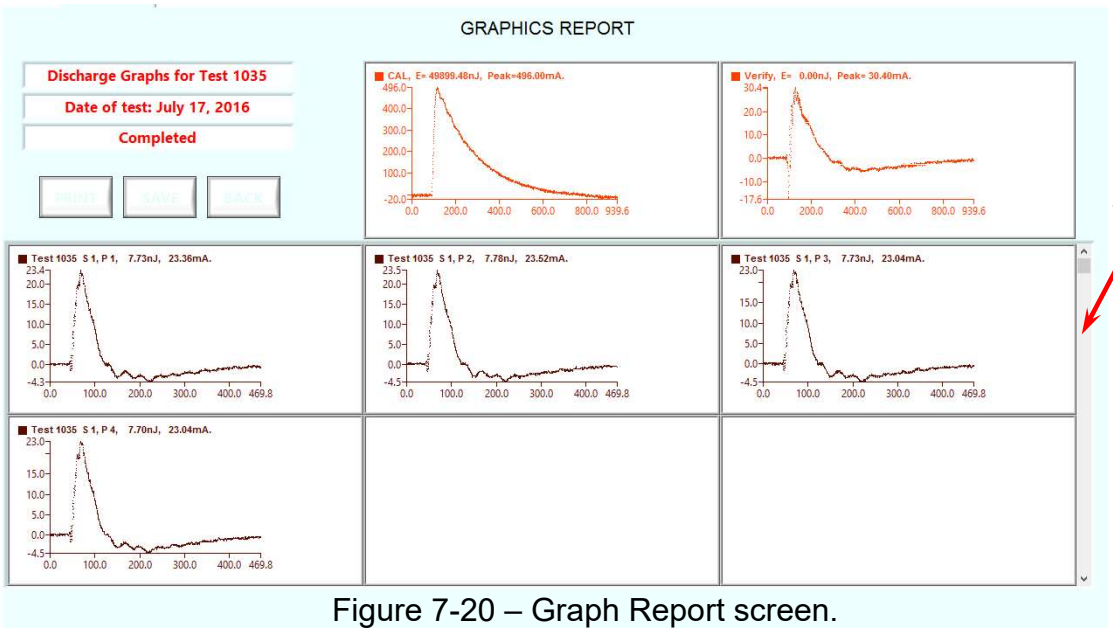


Figure 7-20 – Graph Report screen.

- Click PRINT to produce a report on the present system printer.
- Click SAVE to store a .pdf copy of the report at C:\ETS\.
- Click BACK to return to the Operator screen.

APPENDIX A – Waveform Verification

AA.1 Test Waveform considerations

ANSI/ESD STM11.31 requires verification of the discharge current pulse both through a short to ground and through a 500 Ohm resistor. This requirement is based on a test apparatus where the Discharge Simulator and the electrode assemblies are separate components. The Model 4431-T is an integrated system where the discharge waveform at the discharge electrode is designed and set up at the factory to meet the specified requirement. This section provides instructions for verification of the energy pulse using the built-in components of the system, and using external independent measurement equipment.

AA.2 Waveform verification using the 4431-T built-in components.

Waveform energy and peak current are verified automatically prior to each test series in Automatic mode. To perform verification testing in Manual mode, measurement of the waveform may be performed with the built-in capacitive sensor, CT-1 current sensor, and 500 Ohm resistor. This measurement is performed by simply discharging directly to the capacitive sensor with no sample in place and the latch closed. This waveform is shown in Figure 11-1 and should have a peak value of approximately 500 milliamps and have an energy of 50,000 ±3,000 nanoJoules at a 1,000 Volt discharge. Adjust the VOLTS control on the 4431 Discharge Unit to bring the energy reading within range.

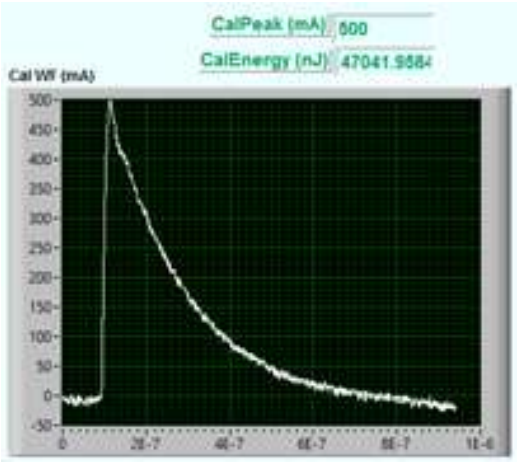


Fig. AA-1. Calibration Waveform

APPENDIX B - Communications via the USB ports.

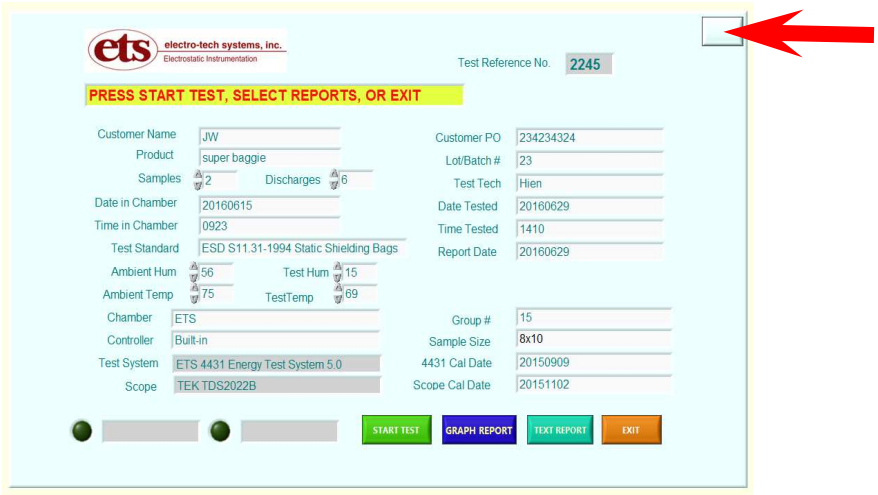
The system will generally be able to assign the two USB ports required:

COM3 – USB connection to the ETS4431 Discharge Unit

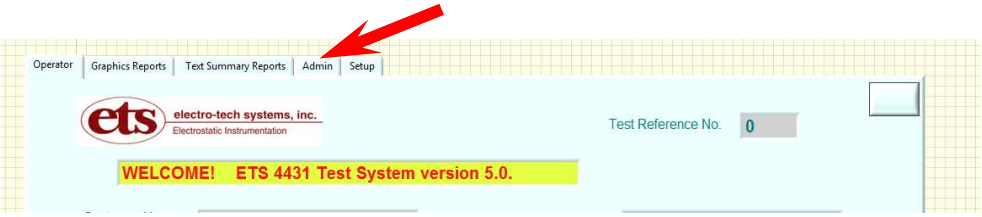
USB0 – USB connection to the Tek 2022C oscilloscope

If the USB plugs are moved or other USB devices are plugged in, windows may exhibit confusion about the USB ports and you may need to help. Also “COM3” may be “COM4” or other numbers.

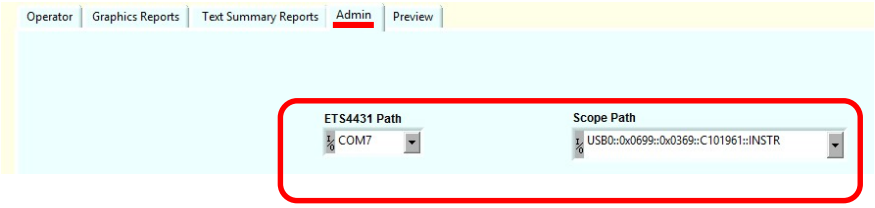
If you see any error messages mentioning “USB”, stop the program, restart the program, then click on the unmarked button in the upper right corner of the screen.



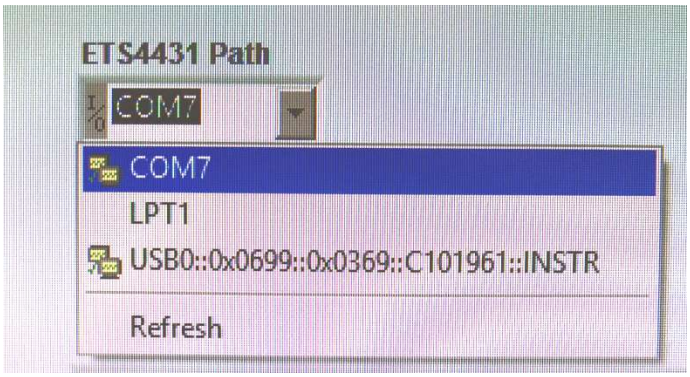
This activates tabs which you will see along the top of the screen.



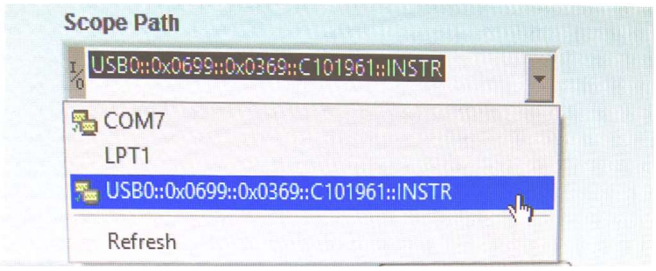
Click on the ADMIN tab. You will see two “Path” fields.



Each resource field has a pull-down menu. Follow this update procedure:



- Pull down the ETS4431 menu and click on “COM3”. If COM7 does not appear, select a different COM port that does appear in the list. This may be COM4, COM6, etc.
- Pull down the ETS4431 menu again and click on “Refresh”



- Pull down the Scope Menu and click on “USB0::0::….”
- Pull down the Scope Menu again and click on “Refresh”
- Click on the tab marked OPERATOR to return to the Operator screen.

This should resolve the difficulty – we have not known it to fail. If not, please stop the program, restart your computer, and do the above procedure once again.

APPENDIX C – COMPUTER SETUP

Revised 2017/03/14 ETS4431T System revision H released 2017/03/09
Program: ETS4431 Test Manager Rev.H – 2017/03/09

Verify that the computer is running Windows 10 and revisions are current.

1 Software is pre-installed on the laptop PC supplied with the 4431T system. If you need to reinstall the software, look for the folder titled D00138H-4431 ship image and open this folder. If you receive the software in the form of a zip file titled ETS4431H-20170315ship.zip, extract the zip file to a folder on your desktop and open it. Copy the two folders ETS4431Test ManagerH-20170309-App and NI-RTE-2016-32 to your desktop.

2. On your desktop open the folder NI-RTE-2016-32. In this folder, double click on the file LVRTE2016_f2Patchstd.exe to run it.

- Click OK to create installation image.
- Click UNZIP to extract the files
- Click YES to allow changes to the PC
- A LabView window will appear – Click NEXT
- Click NEXT to approve destination
- Click NEXT to approve features
- Click NEXT to check for updates
- Click Next to begin the installation

3. In the folder ETS4431TestManagerH-20170313, find the file \ETS4431H\ETS4431Test ManagerH.exe. Make a shortcut for this file and place the shortcut on your desktop.

4. In the same folder ETS4431TestManagerH-20170313, Open folder ETS4431Support, then open folder Volume, and double click on setup.exe to run it.

4. **IMPORTANT:** Copy the folder \ETS\ from the flash drive or zip file onto your C-drive. It will become C:\ETS\. All printed reports and test results will be saved in this folder.

5. Double click on the ETS4431 Test Manager shortcut on your desktop to start the program.

6. A .PDF copy of the 4431 User's Manual is included on the Flash Drive. Consult the manual for instructions on setting up the USB / COM ports.

7. There is a copy of the USB-to-RS232 device driver included on the flash drive.

8. Make sure there is a printer selected in your system as the default system printer. Printed reports will be sent to this printer.

NOTE: Revision designation skipped from 5 to G to utilize an alphabetic revision system.

APPENDIX D – ETS4431 File Formats

SETUP FILE: J.Willson 2016/09/26

Location: C:\ETS\ETS4431SETUP.txt.

Contents:"ETS 4431 Bag Test System 5.0,2158,2,2,TEK TDS2022B"

- Test system name & rev:
- Test ref. Number
- # samples
- # discharges
- Scope ID

TEST FILE:

Location: C:\ETS\ETS4431TESTxxxx.txt

Contents:

- Record 1: Test System, Test ref.no., Samples, Discharges, Scope. Example:
  ETS 4431 Bag Test System 5.0,2158,2,2,TEK TDS2022B
- Record 2: Title, Test ref.no., ReportDate, Cust. name, Cust.PO, ChamberDate, ChamberTime, TestDate, TestTime, Controller, Chamber, TempAmb, HumAmb, TempTest, HumTest. Example:
  ETS 4431 Energy Test ,2158,5/25,joe,5678987,5/24,16:22,5/25,09:23,built-in,Env.room,70,35,72,36
- Record 3: Title, Test ref.no., ReportDate, Test Tech, Sample Size, Product, Lot/Batch, 4431 Cal Date, Scope Cal Date, Test Standard, Group#. Example:
  ETS 4431 Energy Test ,2158,5/25,hien,8x10, SCC 1000, 18020307, 2015-05-02, 2016-03-02, ESD S11.31-1994 Static Shielding Bags, 25
- Record 4: Title, Test ref.no., ReportDate, Cal Waveform Energy, Cal WF Peak mA, Verf WF Energy, Verf WF Peak mA. Example:
  ETS 4431 Energy Test, 2158, 5/25, Cal waveform energy (nJ), 49,543, Peak current, (mA) 500, Verf Waveform Energy (nJ), 12.345, Verf Peak Current (mA), 29.876.
- Record 5: Cal WF Data, 2500 points. Example:
  0.16,0.32,0.32,0.16,0.16,0.32,0.16,0.16,0.16,0.32,0.32,0.16,0.16,0.00,0.00,0.16,0.16,0.32,0.16,0
- Record 6: Verify WF Data, 2500 points. Example: (If Verify not in use, this will be "0 0 0 0 0")
  0.16,0.32,0.32,0.16,0.16,0.32,0.16,0.16,0.16,0.32,0.32,0.16,0.16,0.00,0.00,0.16,0.16,0.32,0.16,0

FOR EACH TEST DISCHARGE:

- (Records 7,9,11…) ETS 4431 Test, Test ref. no., Sample, Sample#, Discharge, Discharge#, Energy, Energy (nJ), Peak (mA), Peak (mA)
- (Records 8,10,12…) Test WF data, 2500 points.

SUMMARY FILE:

First 6 records same as Test Data File above. Followed by:

FOR EACH TEST DISCHARGE:

- ETS 4431 Test, Test ref. no., Sample, Sample#, Discharge, Discharge#, Energy (nJ), Energy (nJ), Peak (mA), Peak (mA)

WARRANTY

Electro-Tech Systems, Inc. (“Seller”) warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from date of invoice and will, at the discretion of Seller, either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

Seller's warranty with respect to those parts of the equipment that are purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null and void should the equipment, or any part thereof, be abused or modified by the customer of if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties and the Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories and, in particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products which it may produce and the buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner’s responsibility.

NOTE:

ELECTRO-TECH SYSTEMS, INC. WILL NOT ASSUME RESPONSIBILITY FOR ADDITIONAL COST OF REPAIR DUE TO DAMAGE INCURRED DURING SHIPMENT AS A RESULT OF POOR PACKAGING.

Customer Support

For customer support, contact ETS at 215-887-2196 or by e-mail: **hient@ets2.com**.