



DATREND
Systems Inc.

vPad-NFPATM

**Automation Application for
vPad-ES Electrical Safety Analyzer**

Operating Manual

vPad-NFPATM
Automation Application for
vPad-ES Electrical Safety Analyzer
Operating Manual

© 2013-2017 Datrend Systems Inc.
Unit 130 - 4020 Viking Way
Richmond, BC • CANADA • V6V 2L4
Tel: 800.667.6557 (North America Only) or
604.291.7747 • Fax 604.294.2355
e-mail: customerservice@datrend.com



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Abbreviations and Definitions

The following abbreviations, terms and acronyms may be used throughout this manual:

μA	Micro-ampere
A	Ampere
AAMI	American Association of Medical Instrumentation
AP	Applied Parts (patient leads)
App	Software application for a mobile device
Cct.	Abbreviation for circuit (ie. electrical circuit in a power distribution system)
Earth	See GND
EUT	Equipment Under Test. The electrical device being tested.
GND or Ground	The line (conductor) connected to a place that is maintained at "Ground" or "Earth" voltage. Same as Protective Earth.
Hz	Hertz
IEC	International Electrotechnical Commission
IME	Android input method (e.g. keyboard)
kHz	kilohertz
L1 or Line 1	Line 1 of the AC supply voltage, or "mains". In North America, the "Hot" or "Live" line (conductor) of the AC supply.
L2 or Line 2	Line 2 of the AC supply voltage, or "mains". In North America, the "Neutral" line (conductor) of the AC supply.
LA	left arm ECG lead
LL	left leg ECG lead
MAINS	The voltage provided by the building installation, nominally 120 VAC or 230 VAC depending on the country
M.A.P. / MAP	Mains on applied part(s)
Measurement Category I Terminal	Intended for measurements on circuits with no direct connection to MAINS (CAT I)
Measurement Category II Terminal	Intended for measurements on circuits which may have a direct connection to MAINS (CAT II)
MHz	Megahertz
NC	Normal Condition of AC supply to EUT: ground and neutral are both connected

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PE	Protective Earth. The line (conductor) connected to a place that is maintained at “Ground” or “Earth” voltage.
RA	right arm ECG lead
RL	right leg ECG lead
RMS	Root-Mean-Square measurement of a parameter (eg. V_{rms} , A_{rms} ,....)
Safety Standard	Standards established by various national and international agencies. The most recognized Standards Organizations include: AAMI - Association for Advancement of Medical Instrumentation IEC - International Electrotechnical Commission
SFC	Single-fault condition of AC supply to EUT: either ground or neutral is disconnected, but not both
Type B (Body)	IEC protection class referring to patient-applied parts (leads) which are not isolated from ground
Type BF (Body Floating)	IEC protection class referring to patient-applied parts (leads) which are isolated from ground
Type CF (Cardiac Floating)	IEC protection class referring to patient-applied parts (leads) which are isolated from ground and also intended for direct cardiac application
V	Volt
V1-V6	Precordial (chest) ECG leads
Vrms	Volts rms

Symbol Definitions

The following symbols may be found on vPad-ES, which is used in conjunction with the vPad-NFPA App:



CONSULT MANUAL FOR PROPER OPERATION

The operating manual provides valuable information on the proper use of vPad-ES. It is highly recommended the operator read the instructions thoroughly before operating the device. It is possible to damage the Equipment Under Test (EUT) and/or cause harm to the operator if vPad-ES is used incorrectly.



Patient Leads: Hazardous Voltage: 264 VAC or 500 VDC max

This warning appears on the label for the patient lead connections, located at the rear of vPad-ES. During testing of the isolation of the EUT patient applied parts leads with respect to either ground, or to the power input leads, a voltage of either 100% of the AC line voltage may be present on the (CAT I) lead connectors. This voltage may reach a maximum of ~264 VAC and, while current limited, represents a serious shock hazard to the operator. Proper precautions should be taken when performing a test which includes the application of this voltage to the EUT patient leads. The display of vPad-ES will indicate when a hazardous voltage is present at the patient lead connectors.



CAUTION: Electrical Shock Hazard, Refer Servicing to Qualified Personnel
CAUTION: Consult Accompanying Documents

These warnings appear on the serial number label of vPad-ES. vPad-ES contains hazardous electrical voltages internally which WILL BE present when the covers are removed. The operator should read the Operating Manual to determine what actions to take in the event of failure of vPad-ES. Refer to the Troubleshooting and Maintenance Section of the Operating Manual.



Kelvin Cable

The Kelvin Cable (CAT I) is used to measure the Line Cord Grounding Resistance, using a pulsed 1 amp current (200 mA RMS). The voltage present at these terminals is below 6 volts. Consult the Operating Manual for the proper operation of the Grounding Resistance test.



DO NOT EXCEED THE FOLLOWING CURRENT LOAD ON THE EUT RECEPTACLE:

15AMPS @ 100 - 120 VAC, 60 Hz (in 20A circuit)
11AMPS @ 100 - 120 VAC, 60 Hz (in 15A circuit)
12AMPS @ 230 VAC, 50 Hz (in 16A circuit)

The regulatory requirements for loading a circuit (cct.) in a power distribution system sets a current limit on

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any individual receptacle to 80% of the value of the circuit breaker on that circuit. For instance, in a circuit with a 15A circuit breaker (or fuse), the maximum current allowed to be drawn from any individual receptacle is 12A. Allowing 1A for the vPad-ES circuitry, the load current for the Equipment Under Test (EUT) should not exceed 11A. These limits are set by the Electrical Code in most jurisdictions in an attempt to avoid unexpected circuit overloads and subsequent circuit failure. If the EUT load is expected to approach the maximum value on a routine basis, it is recommended that a circuit with only a single receptacle be provided for use with vPad-ES.



WARNING: OPENING THE vPad-ES MAY COMPROMISE USER SAFETY. REFER SERVICING TO DATREND AUTHORIZED AGENT.

vPad-ES is a complex instrument which contains internally distributed line voltages and other high voltages for specific measurement purposes. Failure to observe appropriate measures when the instrument has been opened, or failure to reassemble correctly may compromise the safety of the user.



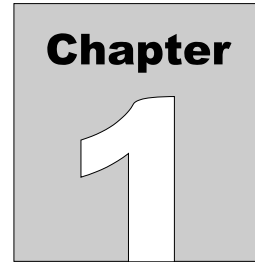
WARNING: GROUNDING CIRCUIT CONTINUITY IS VITAL FOR SAFE OPERATION. NEVER OPERATE THE vPad-ES WITH GROUNDING CONDUCTOR DISCONNECTED.

Proper grounding is essential to ensure operator safety. Do not bypass the grounding provisions inherent in the design of vPad-ES, otherwise, the operator may be subjected to an electrical shock risk.



WARNING: HAZARDOUS VOLTAGES OR CONDITIONS MAY EXIST DURING TESTS. CONSULT THE ACCOMPANYING DOCUMENTS FOR APPROPRIATE PRECAUTIONS.

During the execution of an electrical safety test on the EUT, vPad-ES may apply a high voltage (up to 264 VAC) to the EUT. While this voltage is current limited, it does represent a shock hazard to the operator if precautions are not followed. Consult the instructions in this manual regarding Isolation Leakage Current tests (MAP test) for further information.



1 Specifications

vPad-NFPA is a software application used in conjunction with the vPad-ES Electrical Safety Analyzer. The following specifications relate to the vPad-ES when used with the vPad-NFPA App.

Equipment Performance Specifications

1.1 Electrical Safety Testing Standards

- NFPA99-2012

1.2 Safety Tests

- Line Voltage
- External (point-to-point) Voltage
- External (point-to-point) Micropotential
- Equipment Load Current
- Equipment Power Consumption
- Line Cord Resistance
- External (point-to-point) Resistance
- Chassis Leakage Current (IEC touch current)
- Ground Leakage Current (IEC earth leakage current)
- External (point-to-point) Leakage Current
- Patient Lead Leakage to Ground (earth)

1.3 Instrument Specifications

1.3.1 Voltage Measurement

Line voltage	
Range.....	90 to 264 V rms
Accuracy	$\pm(2\% \text{ of reading} + 0.2 \text{ V})$
External (point-to-point) voltage	
Range.....	0 to 300 V rms
Accuracy	$\pm(1\% \text{ FS} + 0.2 \text{ V})$
External (point-to-point) micropotential	
Ranges.....	0 to 199.9 mV rms
	200 to 1,999 mV rms
	2000 to 19,999 mV rms
Accuracy	$\pm(1\% \text{ of reading} + 1 \text{ mV})$

1.3.2 Load Current Measurement

Ranges	0 to 1.999 A ac rms
	2.00 to 19.99 A ac rms
Accuracy	$\pm(2\% \text{ reading} + 0.2\text{A})$
Duty cycle	0 A to 10 A, continuous
	10 A to 15 A, 7 min. on/3 min. off
	15A to 20 A, 5 min. on/5 min. off

1.3.3 Power Measurement

Range	0 to 2400 watts
Accuracy	$\pm(5\% \text{ reading} + 5\text{W})$

1.3.4 Resistance Measurement

Modes	Four-terminal, fully isolated
Test Current	1A pulsed, 0.2A rms
Range	0.000 to 2.000
Accuracy	$\pm(1\% \text{ of reading} + 0.015 \text{)}$

1.3.5 Leakage Current Measurement

Modes.....	AC+DC (True-rms) AC only DC only
Patient Load Selection.....	AAMI ES1-1993 IEC 60601
Crest factor	≤ 3
Ranges.....	0.0 to 199.9 μA 200 to 1,999 μA 2,000 to 19,999 μA
Accuracy	
DC to 1 kHz.....	$\pm(1\% \text{ of reading} + 1\text{ }\mu\text{A})$
1 to 100 kHz	$\pm(2\% \text{ of reading} + 1\text{ }\mu\text{A})$
100 kHz to 1 MHz.....	$\pm(5\% \text{ of reading} + 1\text{ }\mu\text{A})$

1.3.6 ECG Simulator

Output	
Amplitude.....	1 mV QRS into Lead II
Impedance.....	500 ohms
Accuracy	
Frequency.....	$\pm 1\%$
Amplitude.....	$\pm 2\%$
Waveforms	
ECG Complex.....	30, 60, 120, 180, 240 and 300 BPM
Square wave.....	0.125 Hz, 2 Hz and 1 kHz
Pulse wave.....	63 msec, 30PPM and 60PPM
Triangle wave.....	2 Hz
Sine wave.....	0.5, 10, 40, 50, 60 and 100 Hz
CMRR tests.....	SQR 2Hz & 1 kHz, PUL 4 sec, SIN 0.5, 50 & 60Hz
Arrhythmias.....	VFIB, AFIB, SVT, VTACH, PVC and ASYS

1.4 Measurement Terminals

1.4.1 Test Receptacle

Category.....	CAT II
Maximum Voltage	
North America.....	132 VAC
Maximum Current	
North America.....	15A AC

1.4.2 Current Source Terminals (SRC+/-)

Category.....	CAT I
Maximum Voltage.....	6V
Maximum Current.....	200 mA RMS

1.4.3 Meter Input Terminals (EXT+/-)

Category.....	CAT I
Maximum Voltage	
External μ A/mV mode.....	20V
External voltage mode.....	300V
Maximum Current.....	0.2 mA @ 300V

1.4.4 ECG Terminals (APx)

Category.....	CAT I
Maximum Voltage.....	264 VAC (Isolation Test)
Maximum Current.....	14mA AC @ 264 VAC



Connect measurement terminals **ONLY** as instructed in this manual.
See Chapter 4, Operation

1.5 User Interface

Display.....	10.1" colour LCD (1280 x 800)
User Controls.....	Capacitive touchscreen
Wired Connectivity.....	Micro USB 2.0 Type B USB 2.0 Type A XBUS Interface (RJ11-6)
Wireless Connectivity.....	802.11 b/g/n Bluetooth 2.1+ EDR
Memory, Internal.....	16GB Maximum †
Memory, Expansion.....	16GB to 32GB Micro SD Card (optional)
Modes of Operation.....	Manual (standard) Automatic (accessory option)

†16 GB is the maximum amount of internal memory installed in the tablet. The internal memory is formatted similar to a hard disk to facilitate storage and access to data including the Operating System, Programs, and Data. The formatting process reduces that amount of storage available for use by the tablet. Additionally, the Operating System can consume up to 4 GB of storage. The nominal internal storage available for users is approximately 12 GB as shipped from Datrend.

If additional storage is required, an SD card can be installed in the tablet. Upon initial installation of an SD card, check for proper operation and that the correct size is reported. It may be necessary to format your SD card. If so, ensure that the card is formatted for the FAT32 file system, and that the long format mode is used (do NOT use “quick format”).

Equipment Technical Specifications

1.6 Electrical Ratings

Country Specific: 120 VAC \pm 10%, 60 Hz, 16A in 20A circuit
 120 VAC \pm 10%, 60 Hz, 12A in 15A circuit
 230 VAC \pm 10%, 50 Hz, 13A

Notes:

- This instrument has been designed to test equipment that meets local power distribution standards, which limit devices to draw no more than 80% of the specified current capacity of a circuit. For instance, a single device should draw no more than 16A from a single receptacle on a 20A circuit.
- Transient overvoltages typically present on the mains supply are expected to be impulse withstand (overvoltage) category II of IEC 60364-4-443

1.7 Externally-Accessible Fuses

20A / 250V AGC

1.8 Environment for Use

15 to 40 °C
10% to 90% RH
Altitude: 2000m max.
Indoor use only
Pollution Degree 2

1.9 Dimensions

Base unit.....	11.8 x 8.9 x 3.3 in. (30 x 23 x 8.4 cm)
Tablet PC (detachable).....	10.5 x 6.7 x 0.5 in. (27 x 17 x 1.3 cm)

1.10 Weight

5.5 lb (2.5kg)

1.11 Standard Accessories

vPad Kelvin Cable.....	P/N 3140-475
vPad Tablet USB Cable.....	P/N 3140-478
vPad Tablet (5V) DC Cable.....	P/N 3140-477
Power Cord (country specific)	
North America 15A.....	P/N 3000-009
North America 20A.....	P/N 3000-010

1.12 Optional Accessories

For a complete list of available accessories, visit www.datrend.com or contact Datrend Customer Service (see Chapter 5 for contact details)

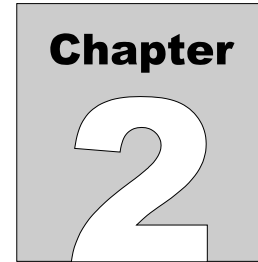
1.13 Compliance With Standards

vPad-ES has been certified to meet the following safety standards:

CAN/CSA-C22.2 No. 61010-1-(2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements

UL Std. No. 61010-1 (2nd Edition) - Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

Following manufacture, all units are subjected to, and have passed the requirements of the ‘Routine Tests’ defined in Annex F of the above Standard(s).



2 Overview

vPad-NFPA™ is an application (App) which adds automation capabilities to the vPad-ES™, a manually-operated electrical safety analyzer providing basic electrical safety testing of medical devices with patient leads. This chapter provides an overview of vPad-NFPA features and test modes. This manual assumes the reader has a good understanding of electrical safety principles, and is knowledgeable in the operation of the vPad-ES™ Electrical Safety Analyzer. A summary of testing requirements specified by NFPA®, AAMI and IEC safety standards is included at the end of this chapter.

2.1 Features

2.1.1 Automation Autosequences

The vPad-ES safety analyzer is comprised of an Android™-powered tablet which provides the user interface, and a Base Unit which provides the analyzer instrumentation. vPad-NFPA is an accessory App for vPad-ES that adds a basic level of automation to the manual safety analyzer through ***AutoSequences***.

An “AutoSequence” is a user-configurable test template which causes the analyzer to execute a sequence of electrical safety measurements, where each measurement value in the sequence is automatically recorded and may also be compared to a pass/fail acceptance limit. Advantages of AutoSequences are:

- Reduced testing time
- Reduced human error (e.g., forgot to perform a particular measurement; "passed" a measured value when it should have been a "fail"; etc)
- Objective assessment of equipment performance (pass/fail limits are quantitative)
- Increased labour efficiency (technician can do something else while instrument is running a test)
- Automated data recording (Test Record files provide documented evidence that equipment was tested and was found acceptable)

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AutoSequences are stored as data files on the tablet. The files are numbered in the order in which they are created, and in addition to the test settings each file will contain both a Title and a Description. Although the Title can have unlimited length, it is generally limited to a few words that summarize the test application. The Description is intended to provide a detailed explanation of the test, and although it can also have unlimited length the Description is generally limited to 2 or 3 lines for ease of reading.

There can be a virtually unlimited number of AutoSequence files stored on the tablet. Existing AutoSequence files can be edited with vPad-NFPA, or new AutoSequences can be created by editing an existing file and saving the AutoSequence under a new name/number.

2.1.2 Test Instructions

One of the features of vPad-NFPA is the ability to present detailed instructions to the user during a test. These instructions can explain how a test is to be performed, how the equipment should be set up, cautions that should be observed during test, and other details of the test that may be relevant. Instructions can combine text with drawings, photographs or video. An Instruction file which is relevant to the device under test may be selected for inclusion in an AutoSequence. If suitable instructions do not exist for the device under test, vPad-NFPA enables the user to edit an existing Instruction file or create a new one. Similar to AutoSequence data files, there can be a virtually unlimited number of Instruction files stored on the tablet.

2.1.3 Equipment Inspection

vPad-NFPA also provides an option for including an equipment inspection as part of the AutoSequence. In the manual safety analyzer, vPad-ES, the test inspection is a generic 25-point inspection based on the ECRI procedure 438-20081015-01. vPad-NFPA expands this capability to include up to 50 steps, with each step fully editable by the user to meet the specific requirements of the device under test. Equipment Inspection files can be saved and re-used in multiple sequences. Similar to AutoSequence data files, there can be a virtually unlimited number of Equipment Inspection files stored on the tablet.

2.1.4 Test Parameters

vPad-NFPA provides a test template which lays out all of the electrical safety parameters which can be tested, and allows the user to simply check each parameter which is to be included in the AutoSequence. The template provides a quick and easy method to see what has been included or excluded from a sequence. Section 2.2 provides an overview of the electrical safety tests specified in NFPA99, AAMI and IEC standards.

2.2 Safety Test Standards

vPad-NFPA may be used to automate electrical safety tests of medical devices with patient leads, following the NFPA® 99-2012 standard. TABLE 2.3-1 relates test nomenclature displayed by vPad-NFPA to nomenclature of this and other standards. TABLE 2.3-2 defines additional terms which pertain in general to electrical safety testing of medical equipment.

TABLE 2.2-1: Safety Test Nomenclature

vPad-NFPA	NFPA 99:2012	AAMI-ES1:1993	IEC60601-1:2007 (Ed. 3)
Line voltage Hot (L1) Neutral (L2) Ground (G)	Line Voltage Hot (H) Neutral (N) Ground (G)	Line Voltage Hot (H) Neutral (N) Ground (G)	Mains voltage Line 1 (L1) Line 2 (L2) Protective earth (PE)
Line cord resistance	Power cord resistance	(n / a)	Protective earth resistance
Chassis leakage current	Touch current	Enclosure risk current	Touch current
Ground leakage current	(n / a)	Earth risk current	Earth leakage current
Lead leakage to ground (GND)	Lead leakage current	Patient-applied risk current, source	Patient leakage current
Lead-to-lead leakage	(n / a)	Patient-applied risk current, source	Auxiliary leakage current
Lead isolation test	(n / a)	Patient-applied risk current, sink	Mains-on-applied-part (MAP) test

TABLE 2.2-2: Safety Test Terminology

Term	Definition
EUT	Equipment Under Test
NC	Normal operating condition. AC supply to EUT has ground and neutral both normal (closed).
SFC	Single-Fault Condition. AC supply to EUT has ground or neutral disconnected (open).
AP	Applied Part(s). IEC term referring to patient / ECG leads of EUT
Type B	IEC applied part protection class, type "Body" (non-isolated)
Type BF	IEC applied part protection class, type "Body-Floating" (isolated)
Type CF	IEC applied part protection class, type "Cardiac-Floating" (isolated, rated for direct cardiac application)

Leakage current testing is performed by connecting a measuring device, or "**MD**", to the EUT chassis and/or patient leads. The vPad-ES analyzer incorporates measuring devices specified by AAMI and IEC standards, which are shown in **Figure 1**. Each MD incorporates a low-pass filter between the 1k test resistance and millivoltmeter to compensate for an allowable increase in leakage limits with increasing frequency. NFPA does not specify the configuration of the MD, so both are allowed. Under most circumstances, the AAMI load would be used.

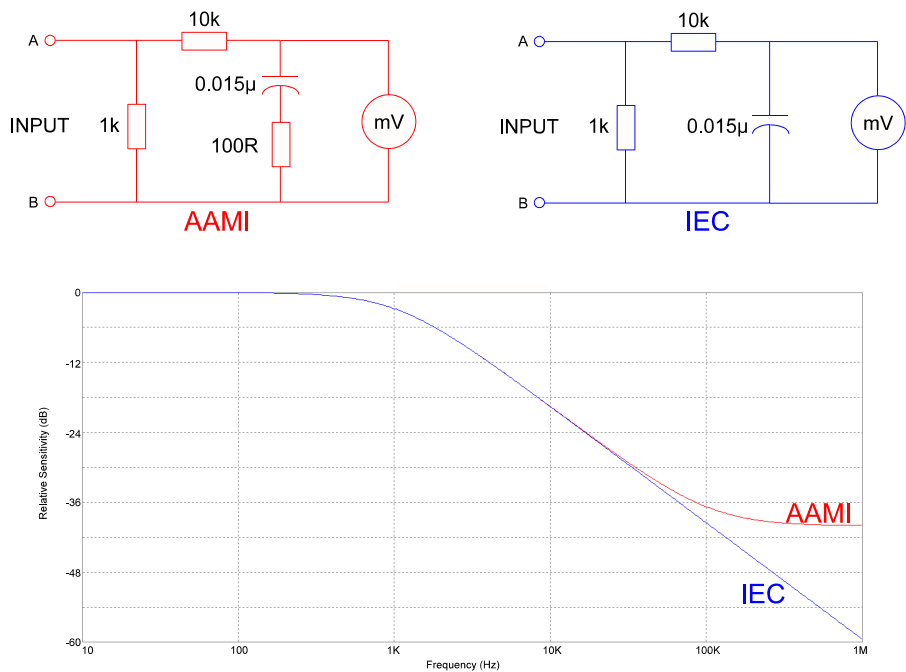


Figure 1 - Measuring devices (MD) for AAMI and IEC standards.

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In addition to differences in the measuring device, NFPA, AAMI and IEC safety standards specify different testing methods, which are summarized in TABLE 2.3-3. vPad-NFPA encompasses requirements of the standards by providing the necessary test settings that enable you to follow the standard of your choice.

TABLE 2.2-3: Leakage Test Requirements by Standard

Leakage Test	NFPA 99:2012	AAMI-ES1:1993	IEC60601-1:2007 (Ed. 3)
Chassis	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal polarity only• Test SFC open ground only	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground• Test SFC, open neutral• Test with AP floating and to PE
Ground	Not required	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open neutral	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open neutral• Test with AP floating and to PE
Lead(s) to Ground	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal polarity only• Test normal condition (NC)• Test SFC, open ground• Test all leads shorted	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground• Test all leads shorted together• Test each lead individually	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground• Test SFC, open neutral• Test APs in groups, by medical function<ul style="list-style-type: none">- Type B: test whole group shorted- Type BF: test whole group shorted- Type CF: test each AP individually• Test total leakage, by protection class<ul style="list-style-type: none">- Test all B AP's shorted together- Test all BF AP's shorted together- Test all CF AP's shorted together
Lead-to-lead(s)	Not required	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground• Test each lead to all others shorted together	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test normal condition (NC)• Test SFC, open ground• Test SFC, open neutral• Test each AP to all others shorted together

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Leakage Test	NFPA 99:2012	AAMI-ES1:1993	IEC60601-1:2007 (Ed. 3)
Lead isolation test	Not required	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test each lead individually	<ul style="list-style-type: none">• Test with EUT ON and OFF• Test normal/reverse polarity• Test APs in groups, by medical function<ul style="list-style-type: none">- Type BF: test whole group shorted- Type CF: test each AP individually• Test total leakage, by protection class<ul style="list-style-type: none">- Test all BF AP's shorted together- Test all CF AP's shorted together

Acceptance limits differ according to safety standard. TABLE 2.2-4 may be used as a reference when configuring AutoSequences for use with vPad-NFPA.

Note the following with respect to TABLE 2.2-4:

- EUT ON or OFF and supply polarity reversed are considered to be normal operating conditions and have no bearing on limits specified.
- RMS values are listed for cord-connected equipment with a ground conductor (Class I), having isolated patient connections of protection class Type CF. Refer to the standard of interest for alternative limits if any of the following apply to the EUT or testing method:
 - DC-only leakage measurement
 - Cord-connected equipment without ground conductor (IEC Class II)
 - Non-isolated patient leads (IEC Type B)
 - Patient leads of IEC protection class Type BF (body-floating, isolated)
 - Permanently-installed equipment
 - Self-powered (battery) equipment

TABLE 2.2-4: Maximum Limits by Standard

Test	NFPA 99:2012	AAMI-ES1:1993	IEC60601-1:2007 (Ed. 3)
Line cord resistance	0.5 Ω	Not specified	0.2 Ω
Chassis leakage	NC: 100 μ A SFC: 500 μ A	NC: 100 μ A SFC: 300 μ A	NC: 100 μ A SFC: 500 μ A
Ground leakage	Not specified	NC: 500 μ A SFC: 1000 μ A	NC: 5,000 μ A SFC: 10,000 μ A
Lead to ground leakage	All leads shorted: NC: 100 μ A SFC: 500 μ A	All leads shorted, or each lead tested individually: NC: 10 μ A SFC: 50 μ A	Each lead tested individually: NC: 10 μ A SFC: 50 μ A All leads shorted (total leakage): NC: 50 μ A SFC: 100 μ A
Lead-to-lead leakage	Not specified	Each lead tested individually: NC: 10 μ A SFC: 50 μ A	Each lead tested individually: NC: 10 μ A SFC: 50 μ A
Lead isolation test	Not specified	Each lead tested individually: 50 μ A	Each lead tested individually: 50 μ A All leads shorted (total leakage): 100 μ A

Note: vPad-ES is a manual safety analyzer and does NOT automatically assess a PASS or FAIL based on the limits of TABLE 2.3-4. vPad-NFPA provides automated electrical safety testing, including automatic pass/fail assessment.

3 Setup

The following instructions relate to the hardware platform used with the vPad-NFPA automation App. Refer to the vPad-ES Operator Manual for any additional information required.

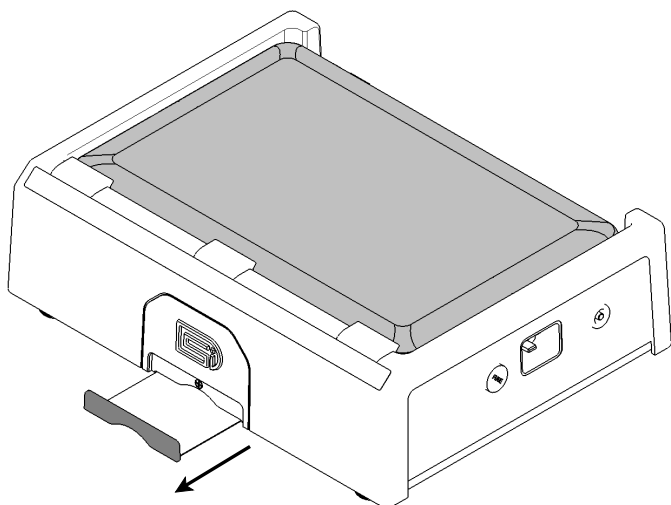


Figure 2

After placing the Analyzer Base Unit on a stable, flat surface, pull out the tablet tray on the front of the unit.

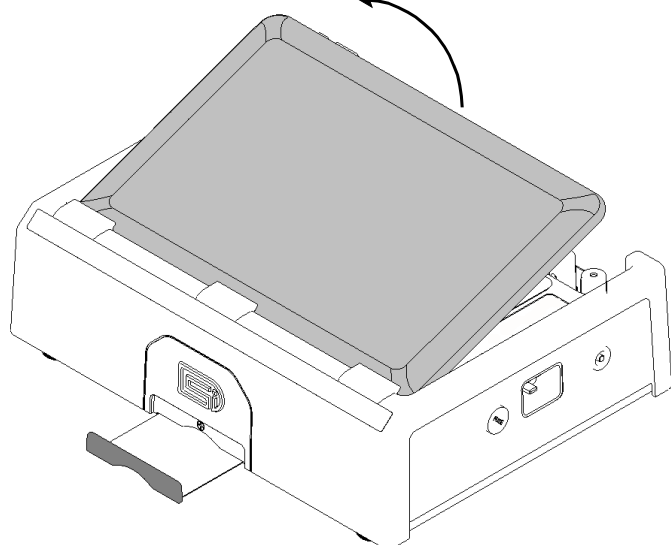


Figure 3

At the back of the Base Unit above the binding posts, grab the tablet and carefully lift it away from the unit.

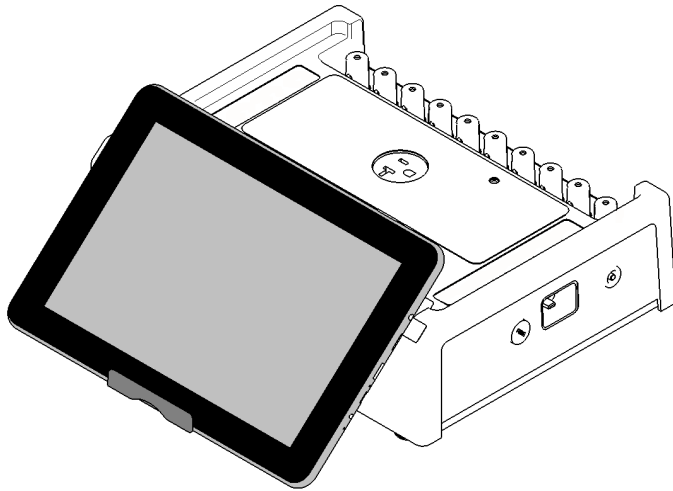


Figure 4

Place the bottom of the tablet on the tray and rest the rear of the tablet on the front of the base unit.

The tablet may also be held in place without the tray, using the inherent 'sticky' characteristics of the labels on the back of the tablet and the front of the base unit.

Connect the power cable from the TABLET DC jack of the Base Unit to the DC IN jack of the tablet. The cable provided with vPad-ES is P/N 3140-477.

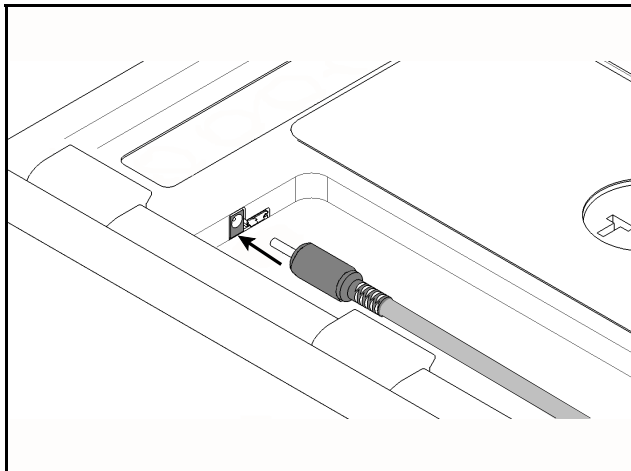


Figure 5

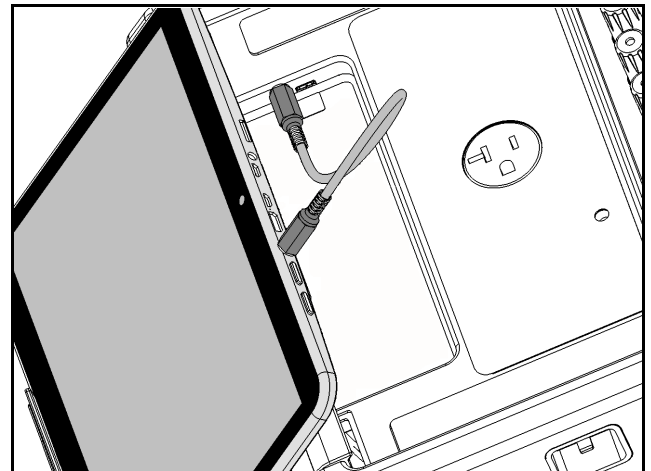


Figure 6

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Connect the USB cable provided with vPad-ES (P/N 3140-478) from the TABLET USB jack of the Base Unit to the USB port of the tablet.

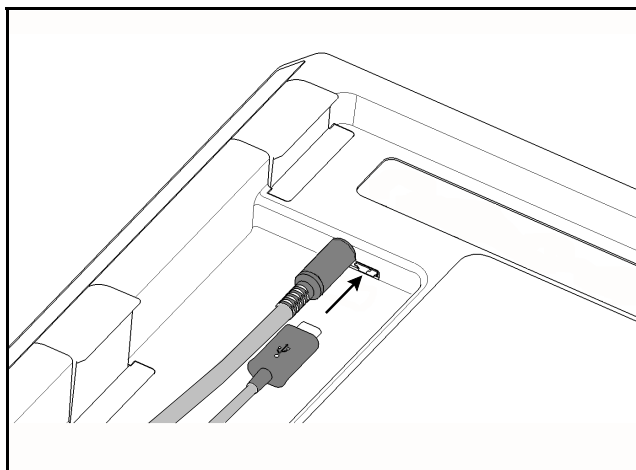


Figure 7

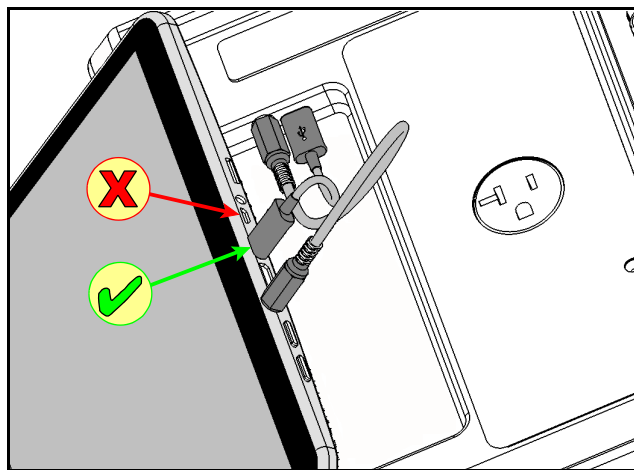


Figure 8

Connect the power cord provided with vPad-ES to the right side panel of the unit, then plug the cord into a power outlet (*Figure 9*). If the AC outlet has power, the indicator lamp on the left panel of the Analyzer Base Unit should now be lit (*Figure 10*).

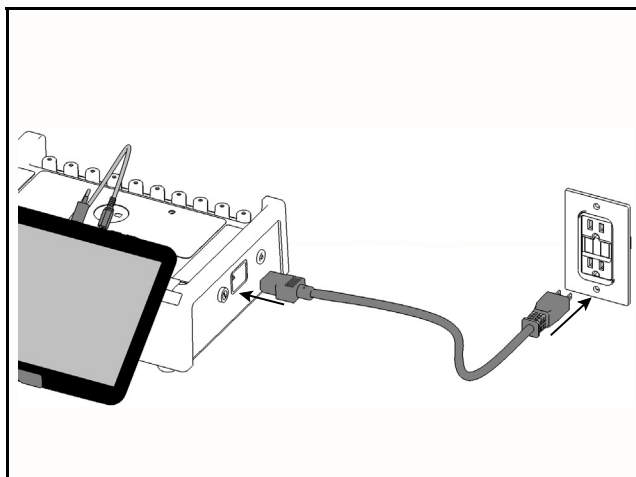


Figure 9

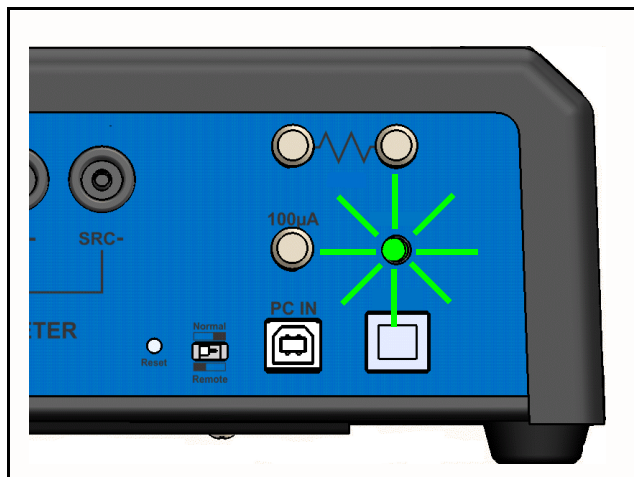


Figure 10

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With the Base Unit now powered up, switch the tablet ON by pressing and holding the power button on the top of the tablet for approximately 15 - 20 sec). Approximately 60 seconds after switching ON, the Android HOME screen should appear on the tablet.

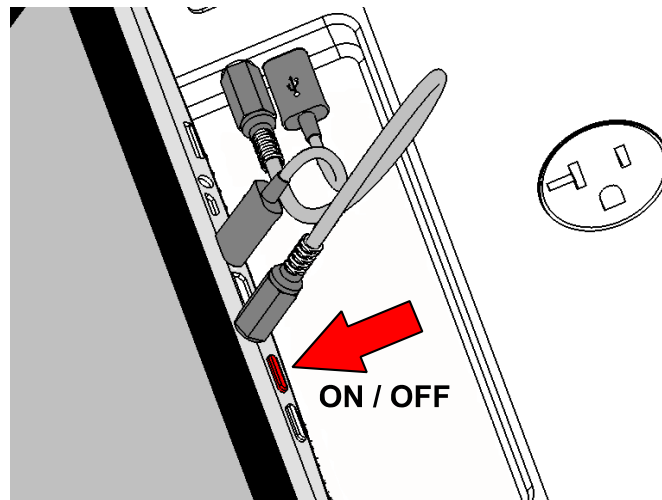


Figure 11

The foregoing instructions are for the standard tablet model. Alternative tablet models may have DC and USB connections and the Power button in different locations; one example is shown in *Figure 12*. If necessary, refer to the tablet operator manual provided with vPad-ES for further guidance.

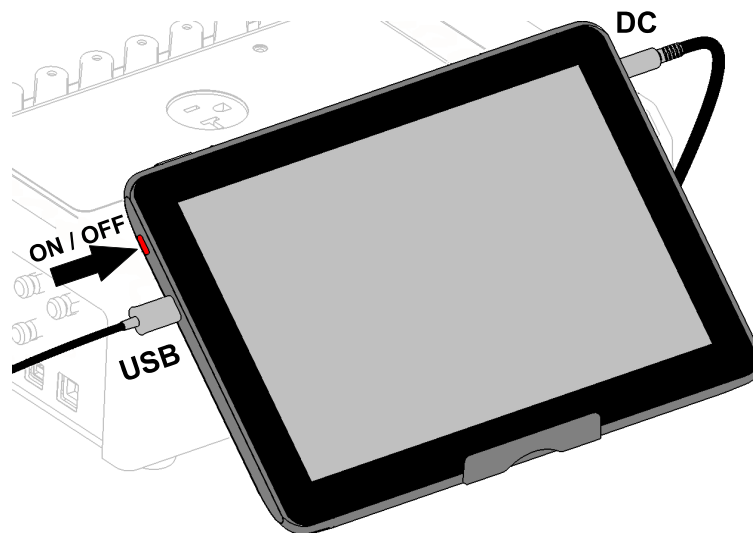


Figure 12

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Switch the tablet OFF when vPad-ES will not be in use for an extended period of time. Press and hold the ON/OFF switch until a confirmation message appears on the tablet screen. Select the appropriate response to complete the Power Off sequence.

When it is not necessary to have the tablet display on, it is good practice to turn the display OFF temporarily. Pressing and releasing the Power ON/OFF button momentarily will put the tablet in a 'sleep' mode. Press the ON/OFF button momentarily again to 'wake' the tablet. This is NOT the same as OFF, but it will reduce power consumption and extend the usable battery life of the tablet.

To store or transport vPad-ES, reverse the setup procedure by starting at **Figure 9** and proceeding to **Figure 2** above.

Note: vPad may be operated wirelessly, via an optional Bluetooth connection between the tablet and the measurement platform. Consult Datrend for further information.

Chapter 4

4 Operation

This chapter explains how to use vPad-NFPA to perform electrical safety tests and inspections of medical equipment, following a predefined sequence of steps referred to as an Autosequence. Test Record management is also covered in this chapter.

4.1 HOME Screen

The (typical) Android HOME screen (*Figure 13*) is displayed approximately 60 seconds after switching the tablet ON.



Figure 13 - HOME screen.

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Initiate actions on the tablet by pressing the corresponding icon or button. For example:



Press to launch the vPad-NFPA software application, or "**app**". Use this app to perform automated electrical safety testing.



Press to launch the vPad-ES software application, or "**app**". Use this app to perform manual electrical safety testing.



Press to launch the vPad Record Manager app. Use this app to copy, print, convert or delete Test Records saved by vPad-NFPA.



Press to access Settings. Use this menu to configure sound, display, touchscreen, and wireless setup.



By default, vPad-NFPA is supplied with both WiFi and Bluetooth connectivity **disabled**. Use the Settings menu to enable wireless connectivity, in accordance with policies of your institution or organization.



At bottom middle or top right on the screen*, press this **Apps** icon to access more apps which are installed on the tablet.



On bottom task bar, middle or left on the screen*, press this **Home** icon to return from an app to the Home screen.



On bottom task bar, middle or left on the screen*, press this **Back** icon to navigate back one step, from the app or screen currently being displayed, to a previous one. For some apps, this button's function may be disabled.



On bottom task bar, middle or left on the screen*, press this **Recents** icon to jump from the current app to a different app that was started earlier, but is currently on pause

* Android operating system version dependent, subject to change without notice. For more information on how to use the Android tablet, refer to the tablet operator manual supplied with vPad-ES.

4.2 Startup


Press the vPad-NFPA icon, , on the Android Home screen to start the app. A splash screen will display the product name and the software version.



Figure 14 - vPad-NFPA startup screen.

As the splash screen is displayed, the app will "connect" to the Analyzer Base Unit and cause it to perform a number of internal self-tests. The AC supply which powers vPad-ES Base Unit is also tested. Normally, all tests will complete successfully and the AutoSequence selection screen of the vPad-NFPA App will then be displayed.

Faults in the Base Unit or the AC supply may be detected during the self-test, in which case an alarm message is displayed below the software version number. In the event of a Base Unit fault, the app will automatically exit to the Home screen. In the event of an AC supply fault, in addition to the alarm message the app will display an Alert Dialog, which you must then acknowledge by pressing "Continue", "Exit" or "OK" (see **Figure 15**). Refer to TABLE 4.2-1 for recommended actions in the event of a startup alarm message.

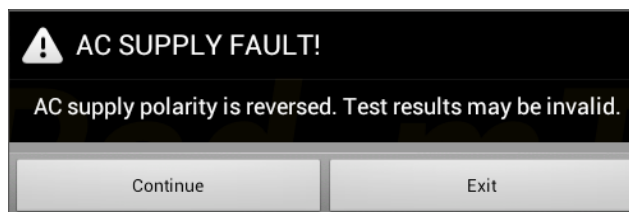


Figure 15 - Alert Dialog: AC supply fault.

TABLE 4.2-1: Startup Alarms and Corrective Actions

Alarm Message	Cause	Actions
USB COMM ALERT (safety analyzer not communicating)	App is unable to send messages to one or more instrument systems inside the Base Unit	<ul style="list-style-type: none"> • Check Base Unit has power (check power indicator, left panel - see Figure 10 on page 19) • Check Base-to-tablet USB connection (see Figure 8 on page 19) • If AC power and USB cables are OK, press and hold RESET button of Figure 10 for 3 seconds, then press RETRY on error dialog • If error persists, contact Datrend Customer Service (see Chapter 5 for contact information)
BLUETOOTH ALERT: (safety analyzer not communicating)	App is unable to send messages to one or more instrument systems inside the Base Unit	<ul style="list-style-type: none"> • Check Base Unit has power (check power indicator, left panel - see Figure 10 on page 19) • Check Bluetooth is enabled on tablet • If AC power and Bluetooth status are OK, press and hold RESET button of Figure 10 for 3 seconds, then press RETRY on error dialog • If error persists, contact Datrend Customer Service (see Chapter 5 for contact information)
BLUETOOTH ALERT: (Bluetooth not available)	Another app is using the Bluetooth connection to Base Unit	<ul style="list-style-type: none"> • Quit other Datrend apps running on the tablet, then try restarting vPad-NFPA
AC SUPPLY FAULT (polarity reversed)	AC outlet incorrectly wired	<ul style="list-style-type: none"> • Do not use vPad-ES with incorrect or unsafe AC supply • Connect Base Unit to a different outlet
AC SUPPLY FAULT (ground disconnected)	AC outlet incorrectly wired	<ul style="list-style-type: none"> • Do not use vPad-ES with incorrect or unsafe AC supply • Connect Base Unit to a different outlet
AC SUPPLY FAULT (ground disconnected)	Isolated power system	<ul style="list-style-type: none"> • Do not perform leakage testing as results will be invalid • Optionally, vPad-ES may be used to perform tests other than leakage (e.g., voltage, resistance or ECG simulator tests) • If possible, change to grounded power outlet
RMS zero calibration failure	Unable to zero voltmeter	<ul style="list-style-type: none"> • Press RESET button of Figure 10 for 3 seconds, then try restarting app • If problem persists, contact Datrend Customer Service (see Chapter 5 for contact information)

4.3 Test Selection

Following application start-up, vPad-NFPA will display the AutoSequence selection screen:

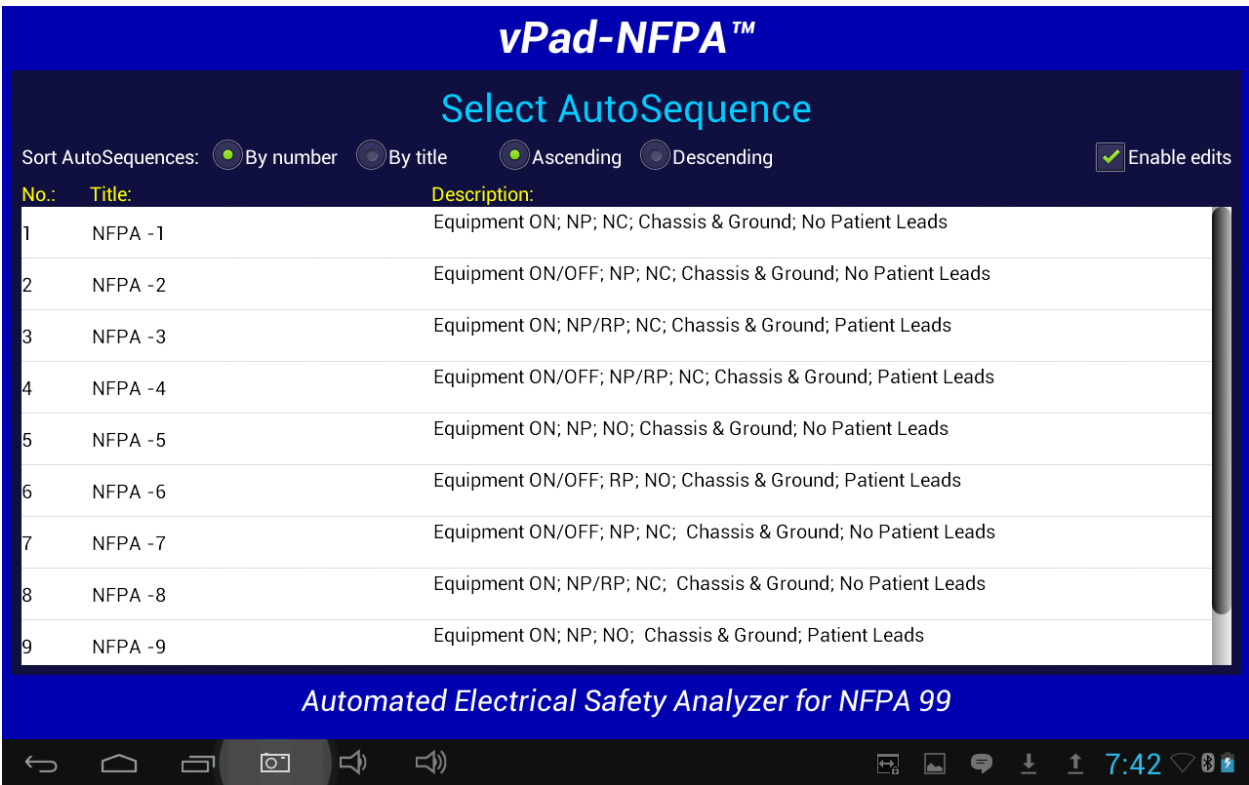


Figure 16 - AutoSequence Selection Screen.

When first delivered, vPad-NFPA will have a number of sample AutoSequences pre-installed. Each AutoSequence has a title and a description. The Title will normally be reasonably short so that is easy to read. The Title attempts to represent the general test application. The Description can expand on the Title to be much more descriptive of the test, describing differences between Titles that appear similar. The Description can be virtually any length, but generally, keeping the Description to two lines or less is a good idea for readability.

The list of AutoSequences can be sorted by number or by Title, and can be listed in ascending or descending order to assist in location the sequence of interest. Once the list has been created and you have started to use the sequences, it is a good idea not to delete or overwrite existing sequences as it may affect other user's expectations, or their use in other Apps (e.g. vPad-Check).

There is a checkbox in the upper right of the display labelled **Enable Edits**. If checked, vPad-NFPA will proceed to the **AutoSequence Editor** (section 4.4) when a sequence is selected. If *not* checked, the editor screen(s) will be skipped, and vPad-NFPA will proceed directly to running the sequence steps. This setting affects all Apps which can call vPad-NFPA (vPad-Check, vPad-mT and vPad-EQM).

4.4 AutoSequence Editing

After an AutoSequence has been selected from the list, and if the **Enable Edits** box has been checked, the contents of the AutoSequence are then displayed (see *Figure 17* through *Figure 30*). This menu allows the user to review and optionally change the settings and then initiate the testing sequence via the **"Run Test"** button. If changes are made to the AutoSequence, they can be saved to the original file or to a new file. If changes are made but not saved, the changes will apply only to the current test.

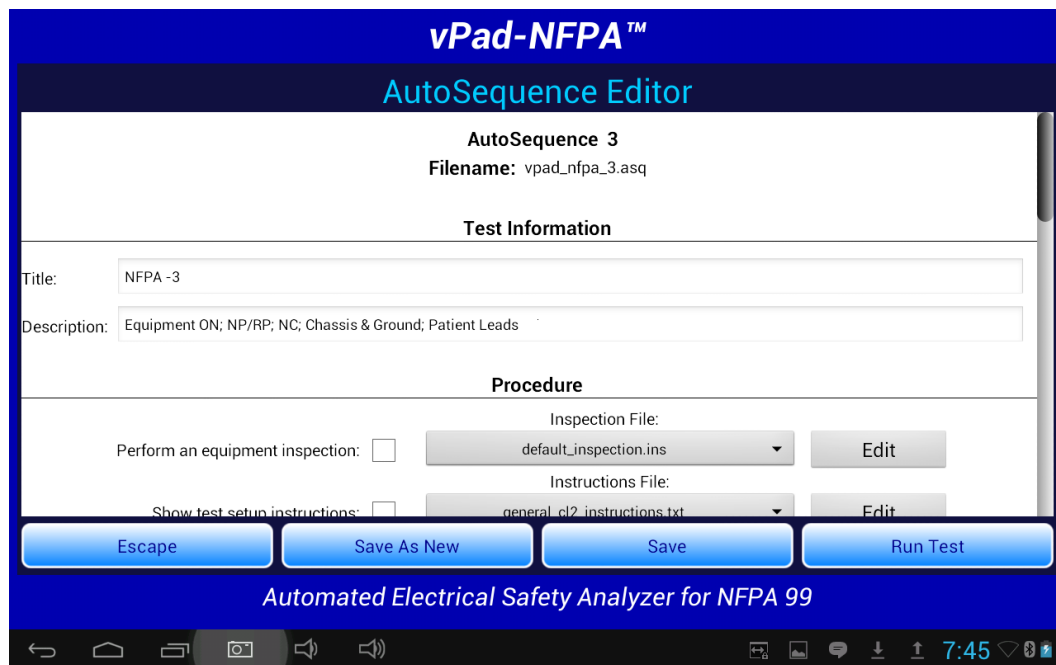


Figure 17

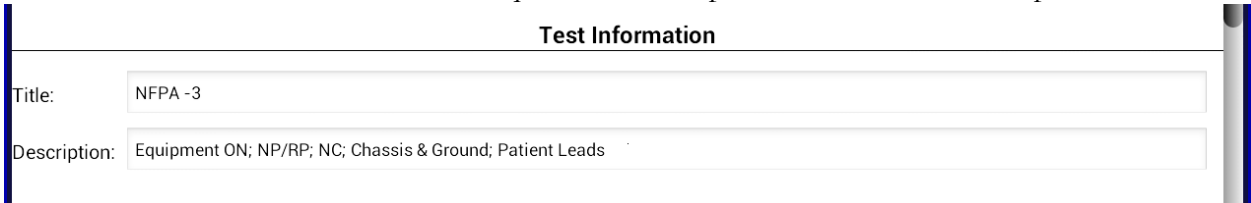
An AutoSequence is displayed before it is run, when Enable Edits is checked, so that the user can verify the test setup. This may be useful during the initial learning curve with vPad-NFPA to confirm that the AutoSequence selected matches your expectations. It also initially allows the user to adjust settings of the factory-default AutoSequences to match the methods and procedures you normally follow.

The AutoSequence controls are placed within a Vertical ScrollView, allowing the AutoSequence to be viewed in sections. This is done by placing a finger on the screen and simply dragging the ScrollView up or down as required. CheckBoxes, Spinners and other controls will indicate the settings of the AutoSequence which has been selected.

The AutoSequence setup is divided into 5 sections: Test Information; Procedure; Sequencer Control; Voltage, Resistance and Load Tests; and Leakage Current Tests. These are explained in the following sections.

4.4.1 Test Information

The Test Information section of the AutoSequence allows input of a Title and a Description:



Test Information	
Title:	NFPA -3
Description:	Equipment ON; NP/RP; NC; Chassis & Ground; Patient Leads

Figure 18

The key to easily finding the AutoSequence you need is to keep the title as short as possible. In the above example, the name “NFPA-3” has been used. Although a little cryptic, it is short and easy to remember. The Description field provides lots of space to expand upon the meaning of the cryptic title, and can be of any length, although it is recommended to keep it to 2 - 3 lines at most.

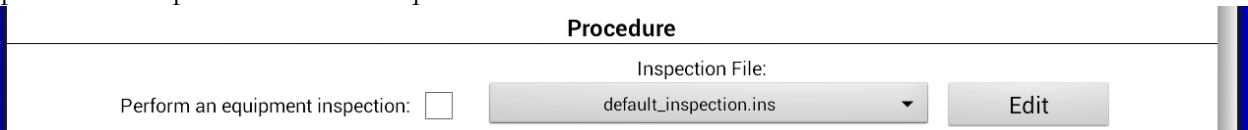
4.4.2 Procedure Settings

The Procedure section of the AutoSequence provides settings for performing an inspection, displaying instructions, running a ECG waveform sequence and displaying results at the end of the test.

4.4.2.1 Equipment Inspection

An equipment inspection can be defined in an Inspection File. This is a text file comprised of up to 50 lines, each no longer than 40 characters. The first line is the inspection title, and each additional line is a step in the inspection. The original, fixed Equipment Inspection included with the manual analyzer, vPad-ES, is based on the ECRI *General Devices Acceptance Procedure* (no. 438-20081015-01). With vPad-NFPA, an inspection file can be tailored for a specific device type, and instructions can be placed in any order.

If ‘Perform an equipment inspection’ of the AutoSequence is ‘checked’, the Equipment Inspection, as defined by a filename shown in the adjacent dropdown selection box, will be performed as part of the AutoSequence.



Procedure	
Perform an equipment inspection: <input type="checkbox"/>	Inspection File: default_inspection.ins ▼ Edit

Figure 19

If the file shown is not correct for the device under test, a different file can be selected from the dropdown list, or the current file can be edited by pressing the ‘Edit’ button. This displays the Inspection Editor.

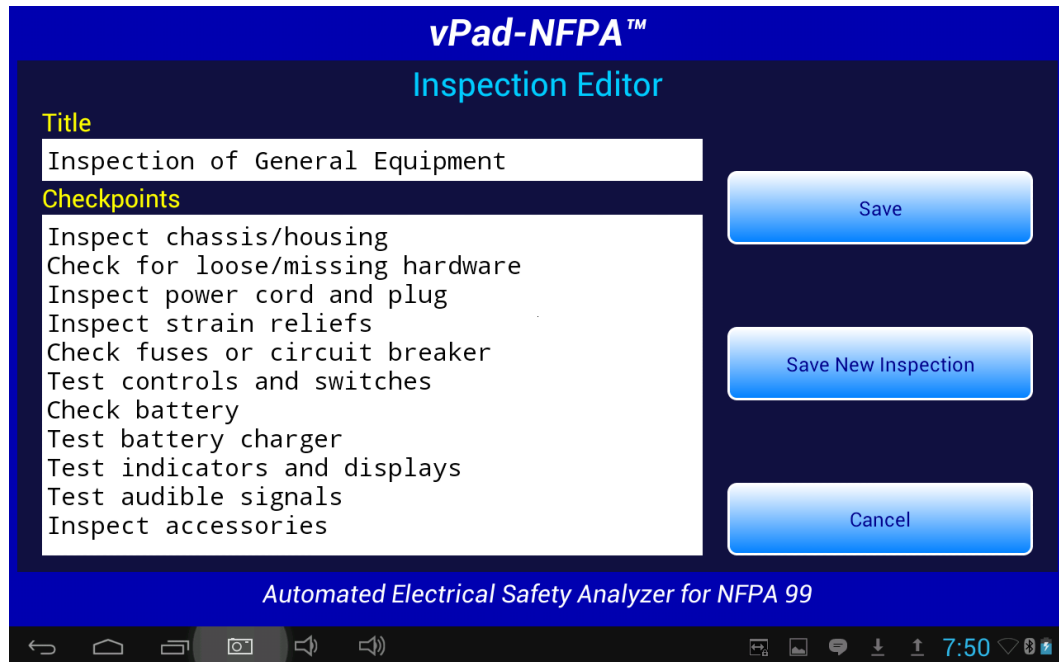


Figure 20

Inspection files have a file format: "Inspection Title", "Task1", "Task2", etc.,; with as many as 50 individual tasks. Tasks should be of the form "Do this....", with keywords indicating what to 'do'; such as 'Inspect...', 'Check...', 'Test...', etc. The user will be able to respond to the task with a 'Done' and 'OK' indication, and an optional 'Comment'. The comment can be used for general test explanations or for input of values, such as a battery voltage.

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Here is an example, which is called "default_inspection.ins":

Inspection of General Equipment	(Inspection Title)
Inspect chassis/housing	(Task #1)
Check for loose/missing hardware	(Task #2)
Inspect power cord and plug	(Task #3)
Inspect strain reliefs	(Task #4)
Check fuses or circuit breaker	(Task #5)
Test controls and switches	(Task #6)
Check battery	(Task #7)
Test battery charger	(Task #8)
Test indicators and displays	(Task #9)
Test audible signals	(Task #10)
Inspect accessories	(Task #11)

The lower text window has cut/copy/paste functions enabled, allowing this window to act as a simple text editor:

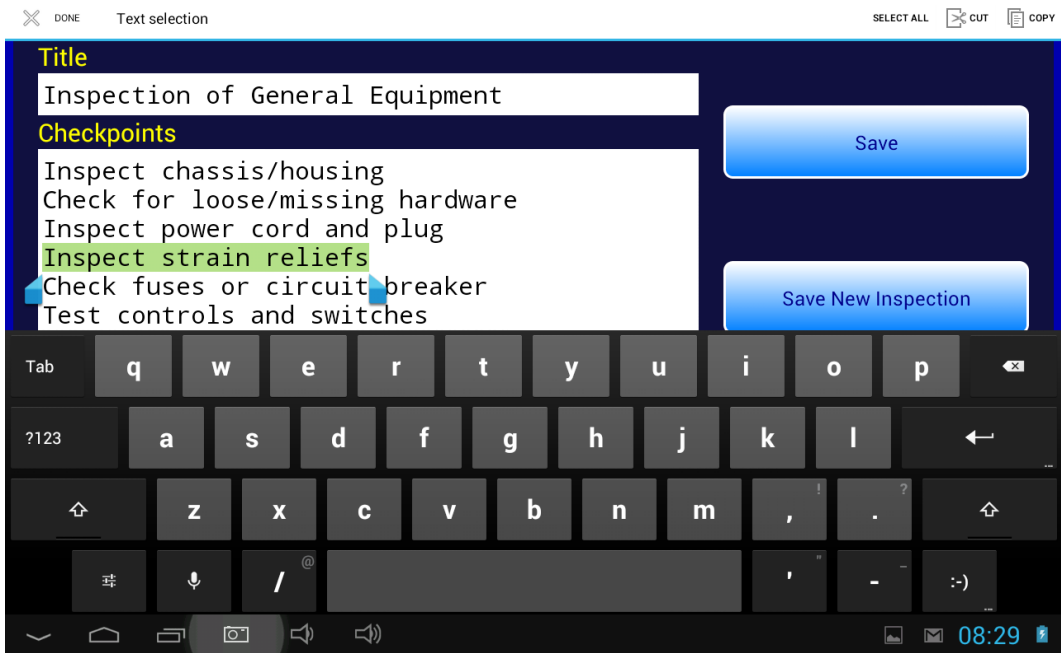


Figure 21

To select text, touch and hold a word until it is highlighted and pointer bars are enabled at the end of the selected word. Move the pointer bars using a touch and drag motion to surround the total text to be selected. Use the icons on the top menu bar to complete the desired action.

Buttons on the right of the Inspection Editor have these functions:

- Cancel*

This button quits the editor and returns to the AutoSequence screen, without updating the ***.ins** file.
- Save*

Pressing this button causes an Alert Dialog to be displayed. If the user presses **"No"** on the Dialog, the file is not saved. If **"Yes"** is pressed, the current contents of the screen are saved to the existing file. The activity is finished and display returns to the AutoSequence screen.



Figure 22

- Save New Inspection*

Pressing this button causes a dialog box to be displayed which prompts the user to input an alternative name for the ***.ins** file. The **"Cancel"** button on this small dialog aborts the save operation. The **"Save"** button saves the inspection contents to the new file.

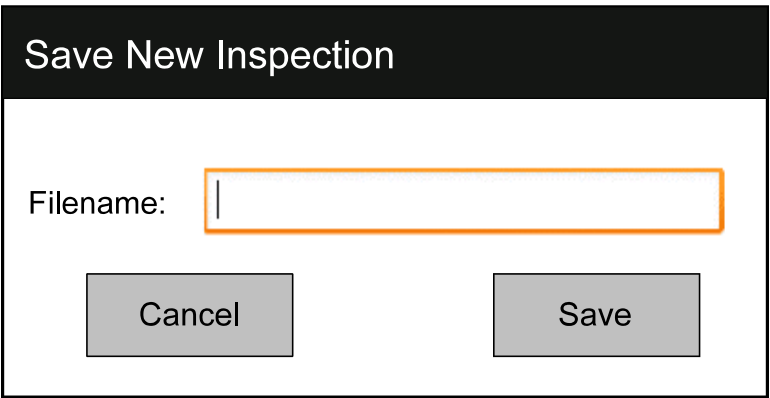


Figure 23

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Although the Inspection Editor may be used to modify or create inspections files as described above, *.ins files are simple text files that can also be viewed or edited with any text editor, for example, Jota. The files are located in the Datrend/vPad-ES/Inspections folder of the tablet. If using a text editor to modify a *.ins file, be sure to follow the file format as described in this section (title first, followed by up to 50 tasks; title and tasks not exceeding 40 characters in length).

4.4.2.2 Test Setup Instructions

If ‘Show test setup instructions’ of the AutoSequence is ‘checked’, the Instructions File, as defined by the filename shown in the adjacent dropdown selection box, will be performed as part of the AutoSequence.

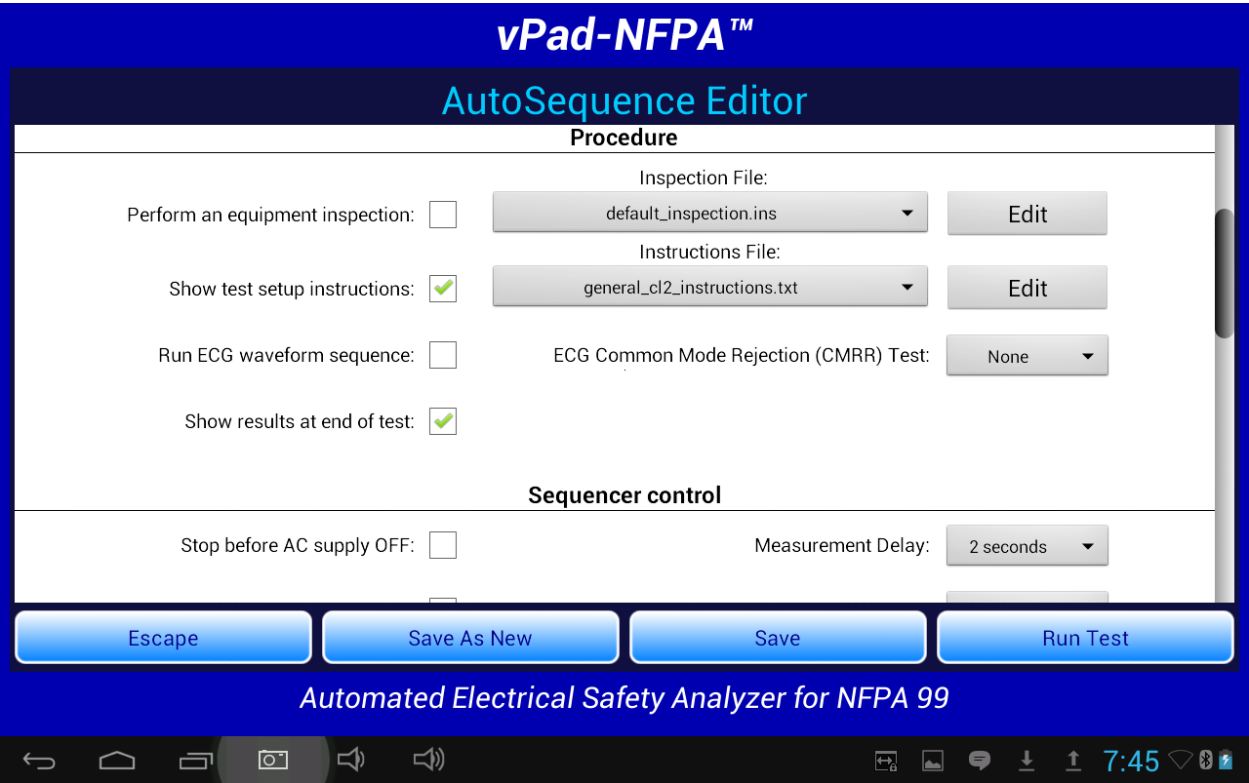


Figure 24

If the filename shown is not correct for the device under test, a different file can be selected from the dropdown list, or the current file can be edited by pressing the ‘Edit’ button. This will display the Instruction Editor.

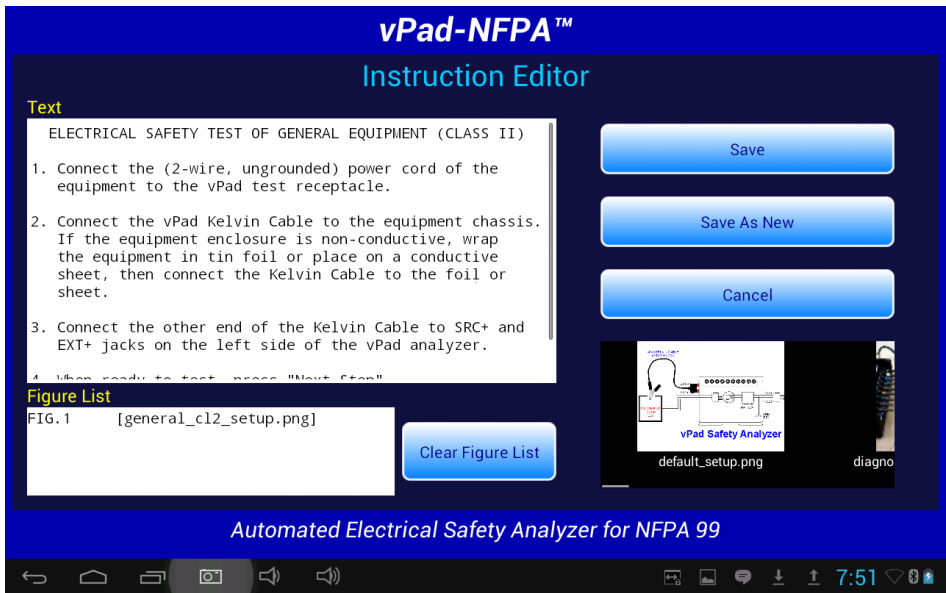


Figure 25

A set of test instructions can be defined in an Instructions file which can be tailored for a specific device type. As shown above, an Instructions file contains descriptive text with optional embedded references to "figures", which are, in fact, filenames of JPG or PNG files. These filenames are included in the Instructions file, surrounded by '[' and ']' characters.

The Instruction Editor consists of a multi-line text box on the upper left where the descriptive text is displayed. Editing functions (cut/copy/paste) of the upper text box are enabled, allowing this window to act as a simple text editor. At the lower left, a list box displays the names of image files which have been embedded in the instructions.

The contents of the lower list may be cleared via the **"Clear Figure List"** button. New figures can then be placed in the list by selecting them from the horizontally-sliding Gallery of thumbnail images on the right. Note the filename of each Gallery image is located underneath its corresponding thumbnail, allowing the user to confirm that the correct file has been selected and appears in the list on the left. Image and Instruction files are located in the Datrend/vPad-ES/Instructions folder.

Buttons on the right of the Instruction Editor have these functions:

- Cancel

This button quits the editor and returns, without updating the Instructions file.
- Save

Pressing this button causes an Alert Dialog to be displayed (see below). If the user presses **"No"** on the Dialog, the file is not saved. If **"Yes"** is pressed, the current contents of the editing screen are saved to the current Instructions file, followed by images (JPG or PNG files, if any).

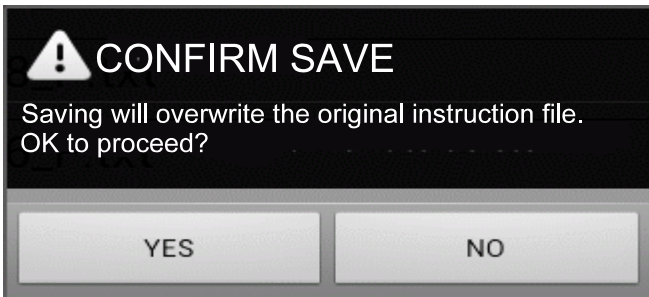


Figure 26

**Save As
New**

This button activates a dialog box which prompts the user to input a new name for the Instructions file (see below). The **"Cancel"** button on this screen aborts the save operation. The **"Save"** button saves the edited contents on the screen to a new Instructions file.

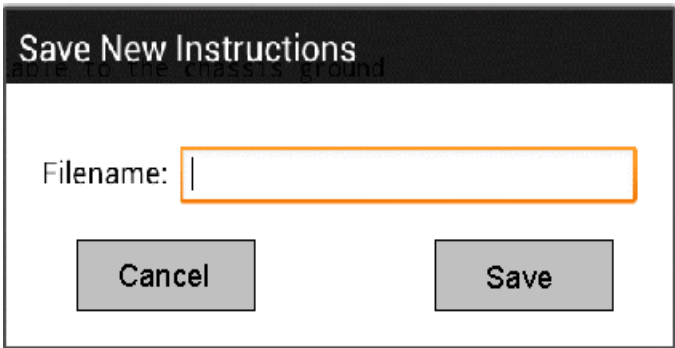


Figure 27

Although the Instructions Editor may be used to modify or create Instructions files as described above, these file are simple ***.txt** files that can also be viewed or edited with any text editor, for example, Jota. The files are located in the Datrend/vPad-ES/Instructions folder of the tablet. If using a text editor to modify an Instructions file, be sure to follow the file format as described in this section.

4.4.2.3 ECG Waveform Sequence

If **'Run ECG waveform sequence'** of the AutoSequence is 'checked', vPad-NFPA will step through each of the waveforms listed below in TABLE 4.4-1. As the ECG waveform is displayed, the user will have an opportunity to Pass, Fail or Skip the waveform. vPad-NFPA does not allow you to change the number of steps or the waveforms in the sequence, however, other automation Apps such as vPad-Check will enable you create customized ECG waveform sequences having any number of steps if this should be necessary.

If it is desired to do a Common Mode Rejection test, the AutoSequence provides a pop-up list for selecting a test frequency of 50 or 60 Hz. Selecting 'None' will disable the test.

TABLE 4.4-1: ECG Waveform Sequence

Step	Simulator Waveform Description	vPad-ES Name
1	Square wave, 2 Hz, 1 mV p-p (-0.5 to +0.5 mV)	SQR 2Hz
2	'DC' Pulse, +1 mV for 4 seconds, 0 mV for 4 seconds	PUL 4sec
3	Sine wave, 10 Hz, 1 mV p-p (-0.5 to +0.5 mV)	SIN 10Hz
4	Sine wave, 40 Hz, 1 mV p-p (-0.5 to +0.5 mV)	SIN 40Hz
5	Sine wave, either 50 Hz or 60 Hz (per CMRR test setting), 1 mV p-p (-0.5 to +0.5 mV)	SIN 50 or 60Hz
6	Sine wave, 100 Hz, 1 mV p-p (-0.5 to +0.5 mV)	SIN 100Hz
7	Square wave, 1 kHz, 1 mV p-p (-0.5 to +0.5 mV)	SQR 1KHz
8	Triangle wave, 2 Hz, 1 mV p-p (-0.5 to +0.5 mV)	TRI 2Hz
9	ECG normal sinus rhythm, 60 beats/minute, 1 mV QRS	60 BPM
10	ECG normal sinus rhythm, 30 beats/minute, 1 mV QRS	30 BPM
11	ECG normal sinus rhythm, 120 beats/minute, 1 mV QRS	120 BPM
12	ECG normal sinus rhythm, 240 beats/minute, 1 mV QRS	240 BPM
13	Common Mode Rejection Ratio Test, 50 or 60 Hz (10 mV)	CMRR 50 or 60

4.4.2.4 Show Results at End of Test

If **'Show results at end of test'** of the AutoSequence is 'checked', results acquired during the test will be displayed at the end of the sequence, allowing the user to review and ensure they are complete and accurate, and possibly consider if a final comment should be added to the test record to explain any unusual results.

4.4.3 Sequencer Control

The Sequencer Control settings of the AutoSequence define test conditions of the AC input to the Equipment Under Test (EUT).

4.4.3.1 Stop Before AC Supply OFF

At different points during an electrical safety test, it is necessary to turn the AC power OFF. In some instances it may be detrimental to the equipment to do this without performing some additional action. For instance, if the EUT has an internal personal computer, it may require an orderly shutdown in order to prevent corruption of memory. Stopping to allow the user to follow the correct shutdown procedure is possible when this option is enabled.

4.4.3.2 Stop After AC Supply ON

At different points during an electrical safety test, it is necessary to turn the AC power ON. In some instances, it may be necessary to re-boot the EUT; in others, the ON switch may be a 'soft' key which electronically powers the EUT ON; or in others, it may take some time to get up to operating speed. If this option is enabled, it is possible to allow the EUT to reach operational condition before proceeding.

4.4.3.3 Measurement Delay

The 'measurement delay' setting is the length of time a measurement will be displayed before proceeding to the next measurement. The default setting will be 2 seconds, however this may be extended up to 5 seconds if additional time is deemed useful.

4.4.3.4 Polarity Switching Delay

The 'polarity switching delay' is the length of time between the 'last' measurement in one polarity before switching to the alternate polarity. This can reduce the strain on systems with motors or large inductive loads. The default setting will be 2 seconds, however this may be extended up to 8 seconds if additional time is deemed useful.

4.4.4 Voltage, Resistance and Load Tests

In this section of the AutoSequence setup, the user can define which of the voltage, resistance and load measurements will be enabled for this sequence. In addition, the Line Cord resistance limit can be defined.

The screenshot displays the 'vPad-NFPA™ Ver: 1.92.0' AutoSequence Editor interface. The 'Sequencer control' section includes checkboxes for 'Stop before AC supply OFF' and 'Stop after AC supply ON', both currently unchecked, and dropdown menus for 'Measurement Delay' and 'Polarity Switching Delay', both set to '2 seconds'. The 'Voltage, Resistance and Load Tests' section features checkboxes for 'Line Cord Resistance' (checked), 'External (point-to-point) Resistance' (unchecked), 'AC Supply Voltage' (checked), and 'Equipment Power Consumption' (unchecked). A 'Resistance Limit' of '500 mΩ' is entered in a text box. Below the settings are four buttons: 'Escape', 'Save As New', 'Save', and 'Run Test'. The footer of the interface reads 'Automated Electrical Safety Analyzer for NFPA 99'.

Figure 28

4.4.4.1 Line Cord Resistance

This selection will enable testing the Line Cord resistance, and compare the measured value against the Resistance Limit entered in the box below. The limit is not automatically set, but is input by the user when the sequence is created/edited. The limit is normally based on the Standard used, NFPA99:2012, however, it can be any value the user deems appropriate based on experience or a risk analysis. During the actual test, multiple readings can be taken.

4.4.4.2 External (point-to-point) Resistance

Where necessary, point-to-point resistance measurements can be enabled. During the actual test, multiple readings can be taken.

4.4.4.3 Resistance Limit

See comments under Line Cord Resistance.

4.4.4.4 AC Supply Voltage

This setting enables measurement of the three AC supply voltages (L1-L2; L1-GND and L2-GND). The supply voltage test will be automatically enabled by the App if any leakage current test has been enabled in the AutoSequence setup.

During a test, vPad-NFPA will analyze the measured supply voltages and will warn of any AC supply fault that may potentially invalidate subsequent measurement of leakage currents. See **Figure 15** on page 25 for an example of an AC supply fault Alert Dialog. If users choose to proceed with leakage measurements despite a reverse polarity fault, the app will configure the test receptacle so that test conditions (Normal or Reverse Polarity) are reported correctly.

4.4.4.5 Equipment Load Current

This setting enables measurement of the current drawn from the AC supply by the EUT. Although not a requirement of any standard, it is good practice to measure load current as the value can be used to indicate equipment performance or warn of pending malfunction.

4.4.4.6 Equipment Power Consumption

This setting enables measurement of power (watts) taken from the AC supply by the EUT. It can be considered an alternative to load current measurement and may be useful for monitoring higher-powered equipment.

4.4.5 Leakage Current Tests

There are a large number of leakage current testing options, as shown in **Figure 29** and **Figure 30**. Tests are enabled by checking the associated box, and measurements are evaluated against the respective value in the limits box.

The screenshot displays the 'vPad-NFPA™ Ver. 1.91.0' interface, specifically the 'AutoSequence Editor' window. The title bar is blue with the software name and version. Below the title bar, the main window has a dark blue header with the text 'AutoSequence Editor' in white. The central area is titled 'Leakage Current Tests' and contains several configuration options. At the top, 'Measuring Device' has two radio buttons: 'AAMI' (selected) and 'IEC'. To the right, 'Limits per NFPA' is checked. Below this, there are two columns of options. The left column includes: 'Test with equipment set to 'OFF' and to 'ON':' (unchecked), 'Test for Secondary Earth:' (unchecked), 'Chassis/Touch Leakage:' (checked), 'Chassis Leakage Limit, NC:' (100 μ A), and 'Chassis Leakage Limit, SFC:' (500 μ A). The right column includes: 'Test Power Reverse Polarity:' (checked), 'Test Power Line2 Open:' (unchecked), 'Lead Leakage, All Leads:' (checked), 'Lead Leakage Limit, NC:' (100 μ A), and 'Lead Leakage Limit, SFC:' (500 μ A). At the bottom of the configuration area, 'Ground/Earth Leakage:' is checked. Below the configuration area are four blue buttons: 'Escape', 'Save As New', 'Save', and 'Run Test'. The footer of the window is blue with the text 'Automated Electrical Safety Analyzer for NFPA 99' and a row of navigation icons.

Figure 29

4.4.5.1 Measuring Device

The 'Measuring Device' radio buttons allows either the AAMI or the IEC test load to be selected. The difference between the loads is shown in Figure 1 on page 12. If the 'Limits per NFPA' is checked, the default leakage limits for either the NFPA99:2012 standard will be used. The limits will be displayed for Normal Condition (NC) and for Single Fault Condition (SFC).

4.4.5.2 Chassis/Ground Wire Leakage

In an AutoSequence you can select one or both of these leakage tests. The leakage limits are shown for both Normal Condition and Single Fault Condition according to the standard. If you wish to use limits which are not according to the Standard, uncheck the Limits per Standard box and the individual limits can then be edited.

4.4.5.3 Test for Secondary Earth

Select this option to perform a test for Secondary Earth for every set of Chassis/Touch Leakage tests. Secondary Earth is an error condition that results in artificially low leakage measurements, specifically when leakage currents bypass the measuring device (*MD*) through alternative pathways to earth ground. It is often caused by erroneous connections in the physical test setup.

The Secondary Earth test is only available when '**Chassis/Touch Leakage:**' is enabled. If the test detects a Secondary Earth, the AutoSequence will pause and display an Alert Dialog so that users can correct the test setup. Choosing "Retry" from the Alert Dialog will repeat all leakage tests for the same polarity condition. Choosing "Abort" will immediately halt execution of the AutoSequence.

4.4.5.4 Equipment ON and OFF

If '**Test with equipment set to 'OFF' and to 'ON'**' is 'checked', the leakage current tests will be performed with the EUT turned OFF, and then the user will be prompted the turn the EUT ON.

4.4.5.5 Case and Lead Leakage Limits

The user can enter the limits for the appropriate standard or any values that experience of a risk analysis warrants. The limits for the standards are available under General Reference in Datrend Docs.

4.4.5.6 Test Power Reverse Polarity

The NFPA standard does not require tests to be performed in Reverse Polarity condition. If testing with Reverse Polarity is desired, check this selection.

4.4.5.7 Test Power Line2 Open

The NFPA standard does not require tests to be performed in Power Line2 (Neutral) Open condition. If testing with Neutral Open is desired, check this selection.

4.4.5.8 Lead Leakage, All Leads

The NFPA standard only requires lead leakage tests to be performed with all leads connected together, to ground. If testing Lead Leakage is desired, check this selection.

Figure 30

4.4.6 Saving the AutoSequence

If changes have been made to the AutoSequence, the modified setup can be saved to the original file or to a new file. Press the **‘Save’** button to overwrite the existing file so the modified setup is available for future use.

If an AutoSequence has been used historically, however, it is best not to modify it arbitrarily since it may become difficult to determine exactly how equipment was tested in ‘older’ records.

The **‘Save As New’** button allows you to save the displayed AutoSequence to a new file. The new AutoSequence will be assigned the next number after the last sequence in the AutoSequence Selector list. This is the preferred way to save a modified test setup. The large memory of the tablet provides virtually unlimited storage for AutoSequence files, allowing you to create and save as many as you like. Note that if saving as **‘New’**, you should update Title and Description accordingly to reflect the changes you have made.

If you want a modified setup to be temporary, for this test only, do not save the edits, simply **‘Run’** the test. The edited values will be used in this test only, and will not be available again without re-entering them.

4.5 Running a Test

To initiate a test sequence from the AutoSequence Editor menu, press the ‘Run Test’ button.

The first screen shown is for entering information about the equipment. This screen will always appear.



Figure 31 - Equipment information editor.

Tap on a text field to display the Android keyboard and enter information. If an external keyboard or barcode scanner is connected to the tablet, the Android keyboard is not displayed and data entry is then accepted from the external input device. Refer to Section 4.6 for detailed instructions on using the Android keyboard.



Figure 32

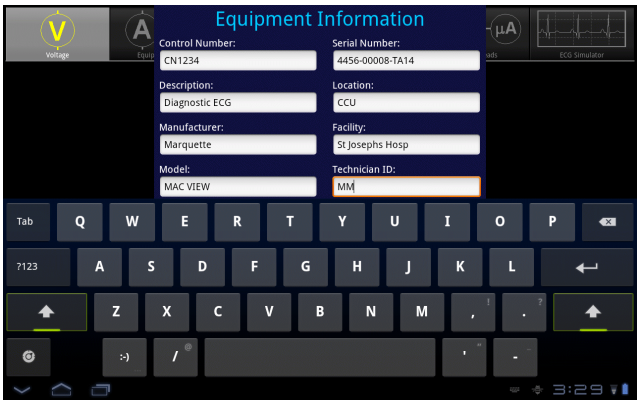
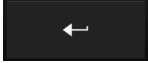


Figure 33


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Pressing ENTER  on the keyboard advances data input to the next text field on the screen.

Alternatively, use  to navigate the text fields, or simply tap a field to jump immediately there.

Note: At a minimum, an equipment control number, or other ID, must be entered in the **Control Number** field in order to save a Test Record.

"**Facility**" and "**Technician ID**" fields are backed up in permanent storage on the Android tablet. These information fields may be modified, but the last values are maintained after power to vPad-ES is switched off, and are restored on subsequent use of the app.

When done entering information, press  to dismiss the keyboard and expose the following buttons at the bottom of the menu:

<i>Escape</i>	Cancel the current AutoSequence and return to the list of available sequences.
<i>Clear</i>	Clear the contents of all fields except Facility and Technician ID. Useful in some instances where data may have been carried over from another test.
<i>Next Step</i>	Press to proceed with the next step of the test.

'**Escape**' and '**Next Step**' are provided on many screens of the test sequence, where they provide the functions described above.

After '**Next Step**' is pressed, following screens will be displayed, in the following order, IF they have been activated in the AutoSequence:

- Equipment Inspection
- Test Instructions
- Ground/External Resistance Measurements
- Line Voltage Measurements
- Leakage Current Measurements
- Load Current/Power Measurements
- ECG Waveform Sequence
- View Test Results

When the test sequence has completed, you will be prompted to save a test record. The following sections explain each step of the AutoSequence test in detail.

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4.5.1 Equipment Inspection

The Inspection file selected in the AutoSequence will be displayed. An Inspection file can contain up to 50 steps which are tailored toward the device being tested. The example AutoSequence shown below is set up to perform a Diagnostic ECG Inspection and will contain steps which are directly related to this device, as opposed to the generic 25 point inspection provided with the manual tester, vPad-ES.

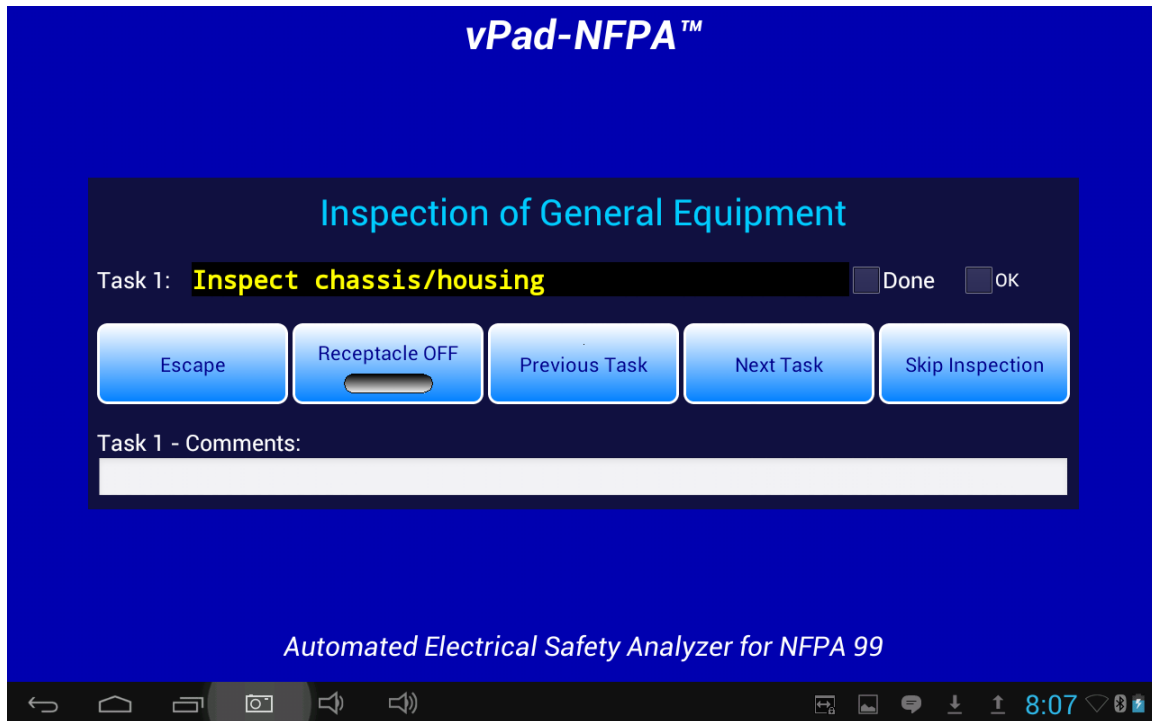


Figure 34 - Inspection comment entry.

While doing this Inspection, it is possible to turn the power **ON** or **OFF** to the receptacle, if the inspection step requires the EUT to be powered. To complete a Task, press '**Done**' if the EUT '**Failed**' the task, or '**OK**' if it Passed. Pressing '**OK**' will also check '**Done**', signifying the task is complete and it '**Passed**'.

Before going on to the '**Next Task**', the user can enter '**Comments**' to indicate anything important or unusual that was experienced when performing the task.

When a Task is complete, press the '**Next Task**' button to continue. If an error has been made, '**Previous Task**' can be pressed to go back and repeat a Task.

If, for some reason, the Inspection does not need to be done, '**Skip Inspection**' can be pressed.

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4.5.2 Test Instructions

If enabled, the Test Instruction screen will appear next. Test setup instructions are displayed on the left and referenced figures or video, if any, will appear in the window on the right. If more than one figure is referenced, navigation buttons will appear below the image window.

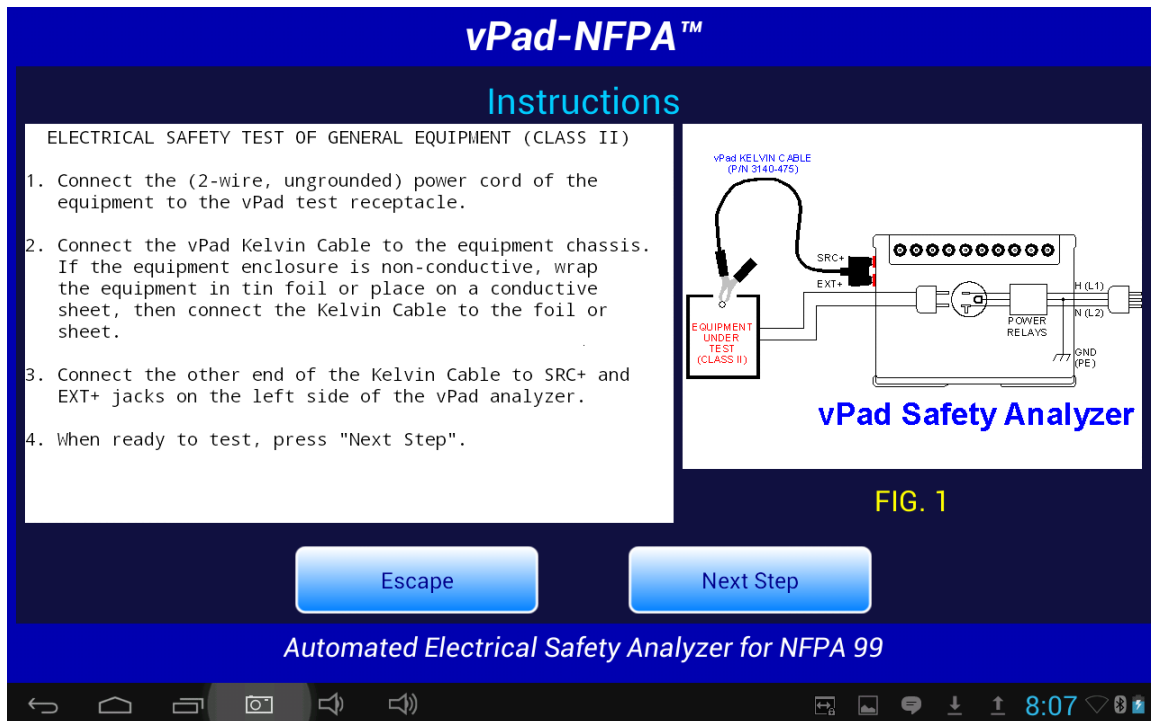


Figure 35 - Instruction Screen.

4.5.3 Line Cord Resistance

Following the Test Instructions, the Line Cord Resistance will be measured if it has been enabled.

vPad will continuously measure the Line Cord Resistance and display the result on the screen approximately every second. This continuous measurement allows the cord to be flexed, as necessary, to determine if there are any intermittent faults in the cord. The resistance limit is displayed on the screen, as defined in the AutoSequence. The measured value is compared to the limit and a **PASS** or **FAIL** is assigned to the result.

It is possible to make more than one resistance test. On the screen there is an indication of how many results have been recorded (saved). To save a value to the test record, press the **'Save Resistance'** button. The measurement on the display will be recorded to memory and the **'Data Count'** will increment. The number on the screen represents the number of resistance values that have been saved to the test record. The test results that have been recorded can be viewed by pressing the **'View Data'** button.



Figure 36 - Line Cord Resistance.

At least one Line Cord Resistance must be recorded if the test has been enabled, and so the **'Next Step'** button is disabled until a resistance value has been saved. Once a resistance value is saved, the **'Next Step'** button is enabled.

4.5.4 External Resistance

If enabled, the External Resistance measurement screen will appear next. Except for the title, it is identical to the Line Cord Resistance screen. To make external resistance measurements, a second Kelvin Cable is required which is connected to SRC- and EXT- jacks on the vPad Base Unit (refer to vPad-ES operator manual). For ease of measurement, it may be best to have one clamp type cable and one probe type cable. Make the connections between the points of interest, and press the **'Save Resistance'** button. Multiple measurements can be saved.

4.5.5 Line Voltages

When enabled, vPad will go through a series of three voltage tests: L1 - L2; L1 - GND; and L2 - GND. During each of these three tests, the user will have the opportunity to **'Pause'** the test. When the test is paused, it is possible to **'Repeat'** a test, **'Escape'** completely from the AutoSequence, or **'Continue'** with the next measurement in the sequence.

After all three voltage tests, an Alert Dialog similar to *Figure 15* on page 25 may be shown in case of an AC supply fault such as a reversed polarity or disconnected earth. If users choose to continue with a reversed polarity AC supply, the AutoSequence will configure test conditions so that they are accurately shown on screen and in Test Records.

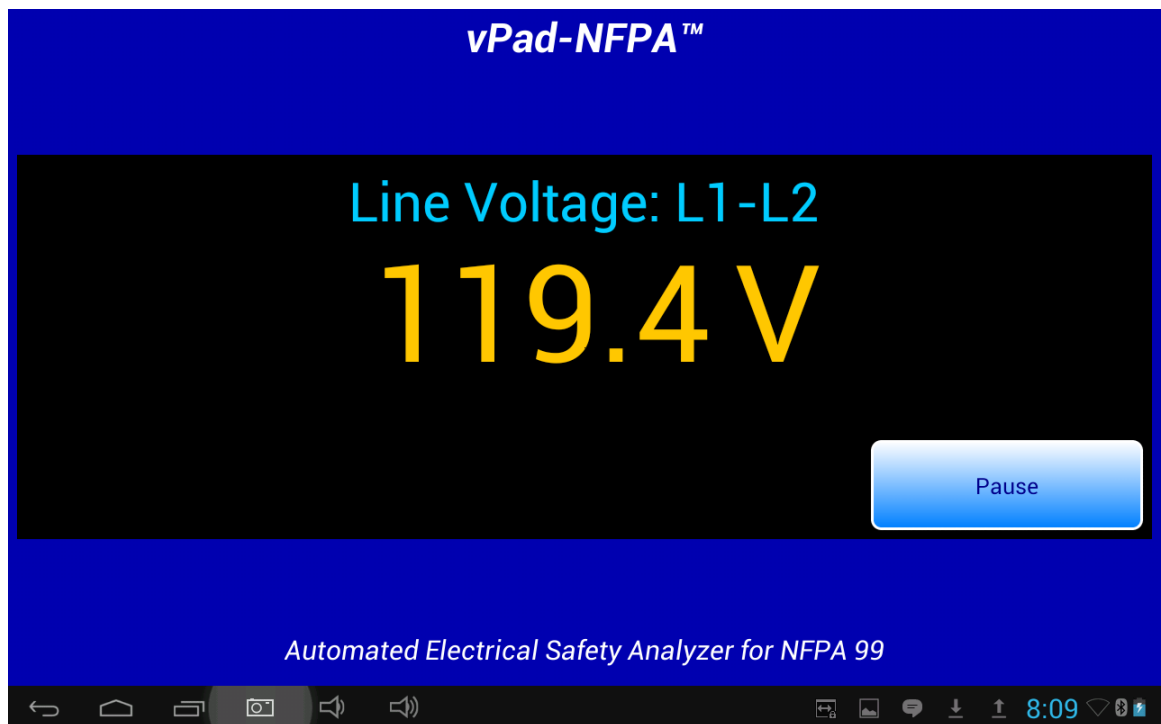


Figure 37 - Line Voltage Measurement.

4.5.6 Leakage Current

Leakage current tests selected in AutoSequence settings will be measured after the AC supply voltages. If all three leakage measurements are enabled, they will proceed in this order:

- Ground Leakage, or alternatively Earth Leakage
- Chassis Leakage, or alternatively Touch Leakage
- Patient Leads (All Leads) to Ground Leakage

The AutoSequence will automatically configure the test receptacle to set up all enabled test conditions in every valid combination, as shown below in order from top to bottom. Note that Ground Leakage current will always be measured with supply ground open.

Equipment ON/OFF	AC Supply Neutral	AC Supply Ground	AC Supply Polarity
OFF	OPEN	NORMAL	REVERSE
	NORMAL	OPEN	
		NORMAL	
	OPEN	NORMAL	NORMAL
	NORMAL	OPEN	
		NORMAL	
ON	OPEN	NORMAL	REVERSE
	NORMAL	OPEN	
		NORMAL	
	OPEN	NORMAL	NORMAL
	NORMAL	OPEN	
		NORMAL	

For example, the first test in the sequence is completed with equipment OFF, supply neutral OPEN, supply ground NORMAL, and supply polarity REVERSE, provided that all these conditions are enabled in the AutoSequence settings. Figures below show typical displays for a measurement sequence.

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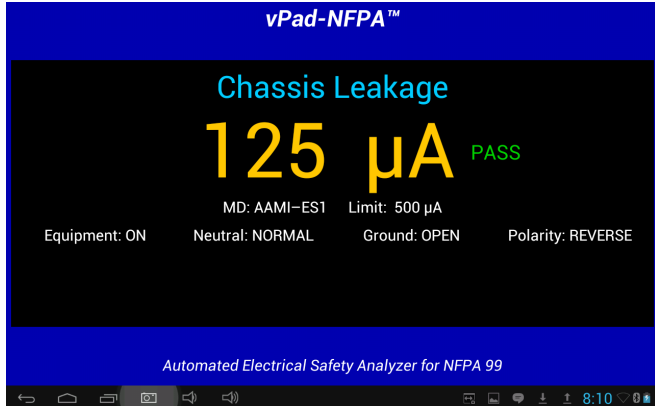


Figure 38 - Chassis Leakage.

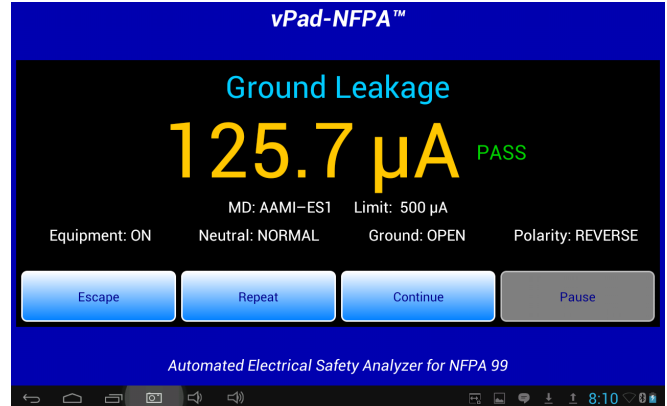


Figure 39 - Ground Leakage (paused due to 'FAIL').

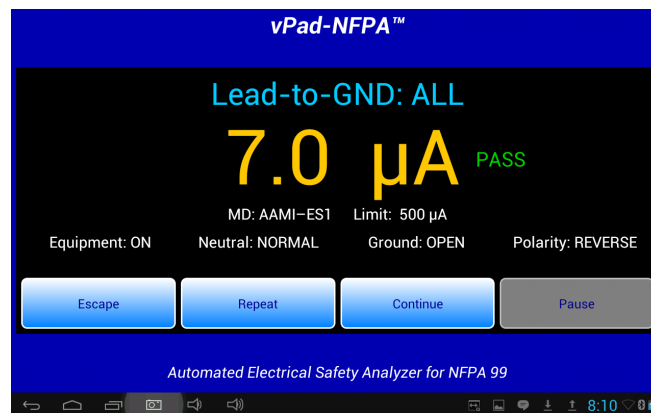


Figure 40 - Lead-to-GND Measurement.

Each measurement is compared to a corresponding limit which has been defined in the AutoSequence setup. Provided the measurement is below its limit, a "PASS" result is shown and the test sequence continues automatically. If a measurement exceeds the limit, "FAIL" is shown and the sequence stops. The user is given the option of escaping the test, repeating the measurement, or continuing the sequence which then causes the "FAIL" result to be recorded.

Time required to complete a leakage measurement is set by the "Measurement Delay" parameter of the AutoSequence. By default, this is set to 2 seconds but may be extended by editing the AutoSequence. During the "Measurement Delay", the user may press the **'Pause'** button to stop the sequence. Then, the user may **'Escape'** the test, **'Repeat'** the measurement, or **'Continue'**.

Depending on AutoSequence settings, the test sequence may stop periodically and display instructions to the user. One of the more commonly-seen prompts will instruct the user to set the power switch of the equipment under test either 'OFF' or 'ON'. Equipment 'OFF' and 'ON' are test conditions which are required by NFPA99 safety standard, although 'OFF' tests may be optionally disabled in the AutoSequence setup to cut the testing time in half.

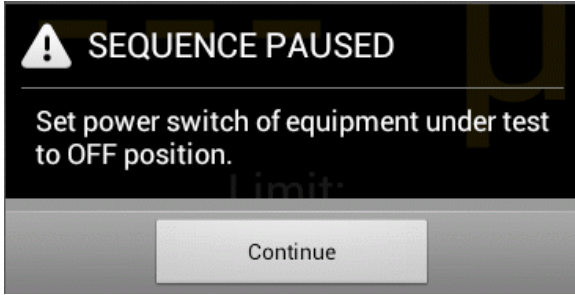


Figure 41 - Prompt to switch equipment OFF.

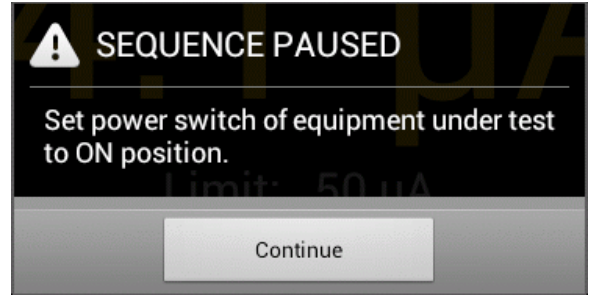


Figure 42 - Prompt to switch equipment ON.

An AutoSequence can also be set to stop and prompt the user before a change is made to the AC supply. "Stop before OFF" is an optional setting which is intended to protect equipment that may require a special shut-down procedure before the power can be safely disconnected. "Stop before ON" is another optional setting which is intended for testing equipment that has special startup requirements after AC power has been restored.

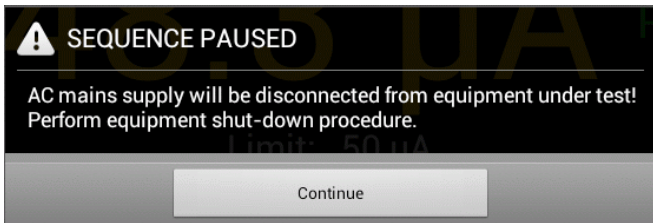


Figure 43 - "Stop-before-OFF" prompt.

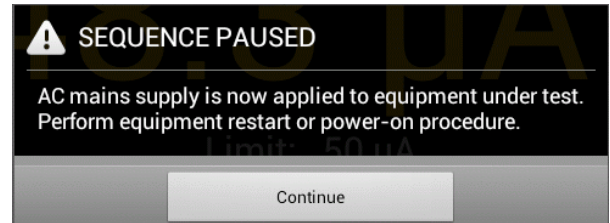


Figure 44 - "Stop-after-ON" prompt.

If the Secondary Earth test discovers a possible Secondary Earth fault, the sequence will pause and display a warning dialog. Users must correct the physical test setup and then repeat the previous set of leakage measurements, or else abort and restart the AutoSequence. Common causes of Secondary Earth faults include erroneous test lead connections, conductive mounting or fluid supply fixtures, and cables leading to other devices or accessories.

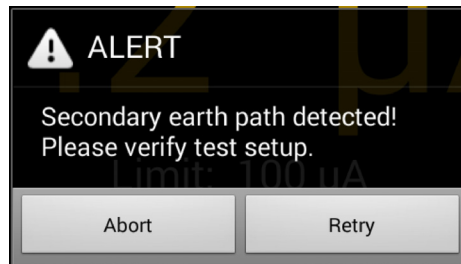


Figure 45 - Secondary Earth alert dialog.

For more information on leakage test settings of the AutoSequence, refer to Section 4.4.5.

4.5.7 Load Test

If enabled, the Load Current Test will measure the amount of current drawn by the EUT. If AutoSequence settings are such that AC power has not been previously applied to the EUT, the sequence will stop and prompt you to switch the EUT on. This allows the EUT to reach its operational mode prior to the current measurement. Pressing **'Continue'** enters the current measurement mode.

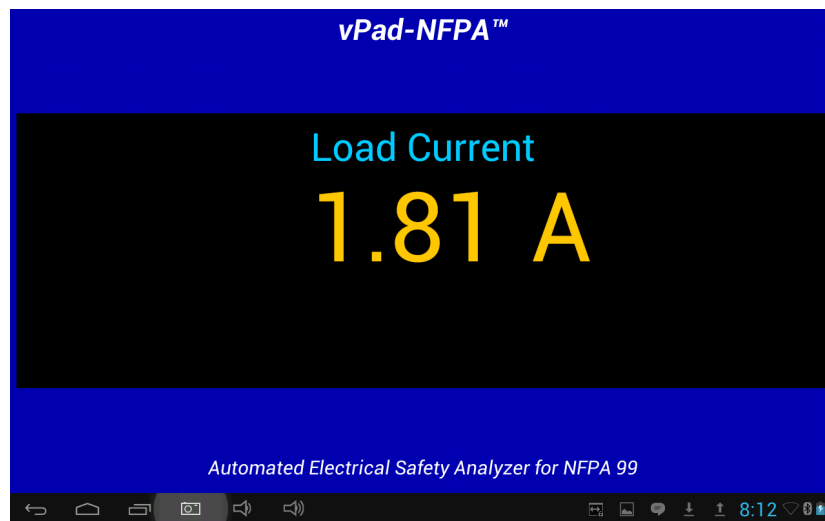


Figure 46 - Load Current Measurement.

Measurement of the load current may be optionally followed by a power consumption measurement, if this has been enabled in the AutoSequence.

4.5.8 ECG Waveform Sequence

Following the load tests, the ECG waveform sequence will begin if this function has been enabled. The ECG simulator will output a series of waveforms in the order specified in TABLE 4.4-1.

The **'Skip ECG Test'** button will quit the ECG waveform sequence and go to the next enabled function of the AutoSequence. During the ECG sequence, the user can choose *not* to test a waveform by accepting the default Test Result setting **'Not Tested'**, by pressing either the **'Next Waveform'** button or the **'Skip ECG Test'** button. If it is desired to record a test result for the waveform in use, activate either the **PASS** or **FAIL** radio button, as appropriate, and then **'Next Waveform'** or **'Last Waveform'** button. Pressing the **'Escape'** button will abort the AutoSequence completely, as previously described.

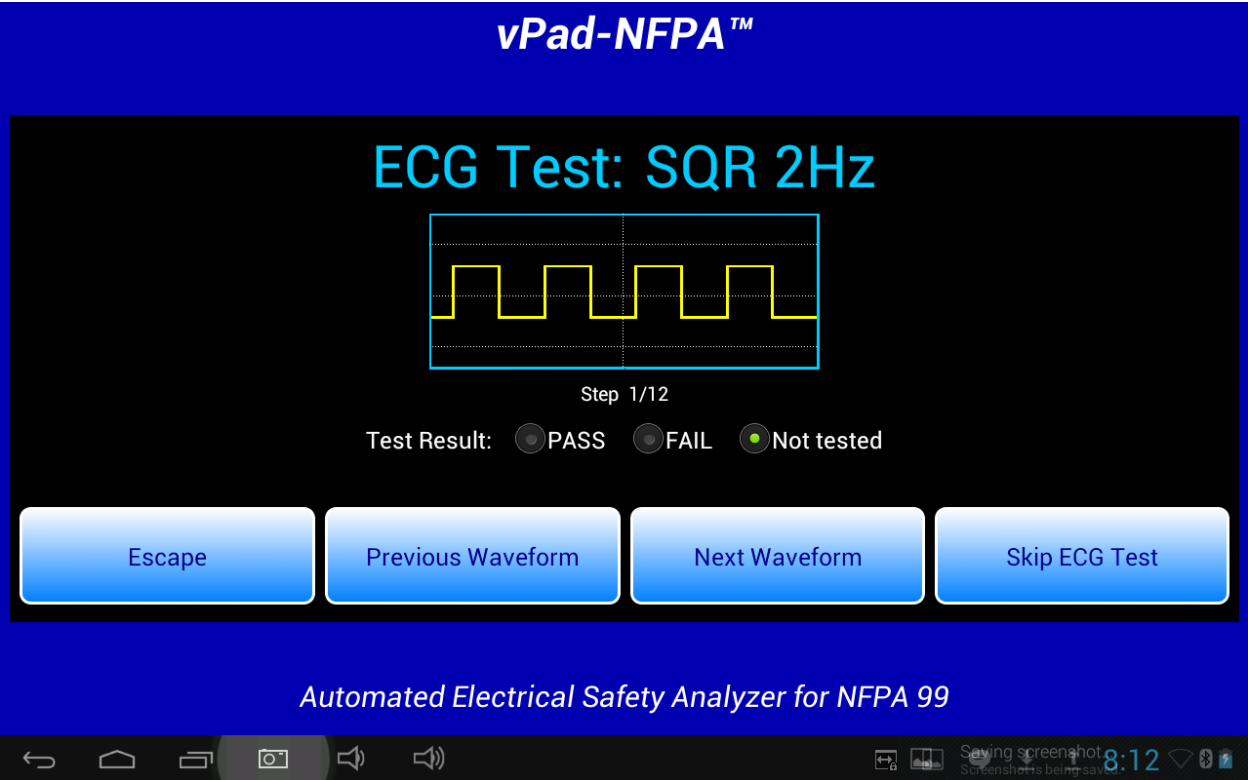


Figure 47 - ECG Test Waveforms.

4.5.9 Test Results Preview

When the measurements section of the AutoSequence is complete, a preview of the results will be displayed if the ‘Show results at end of test’ setting has been enabled. The measurements taken during the test will be displayed in a ScrollView, as shown in the example below.

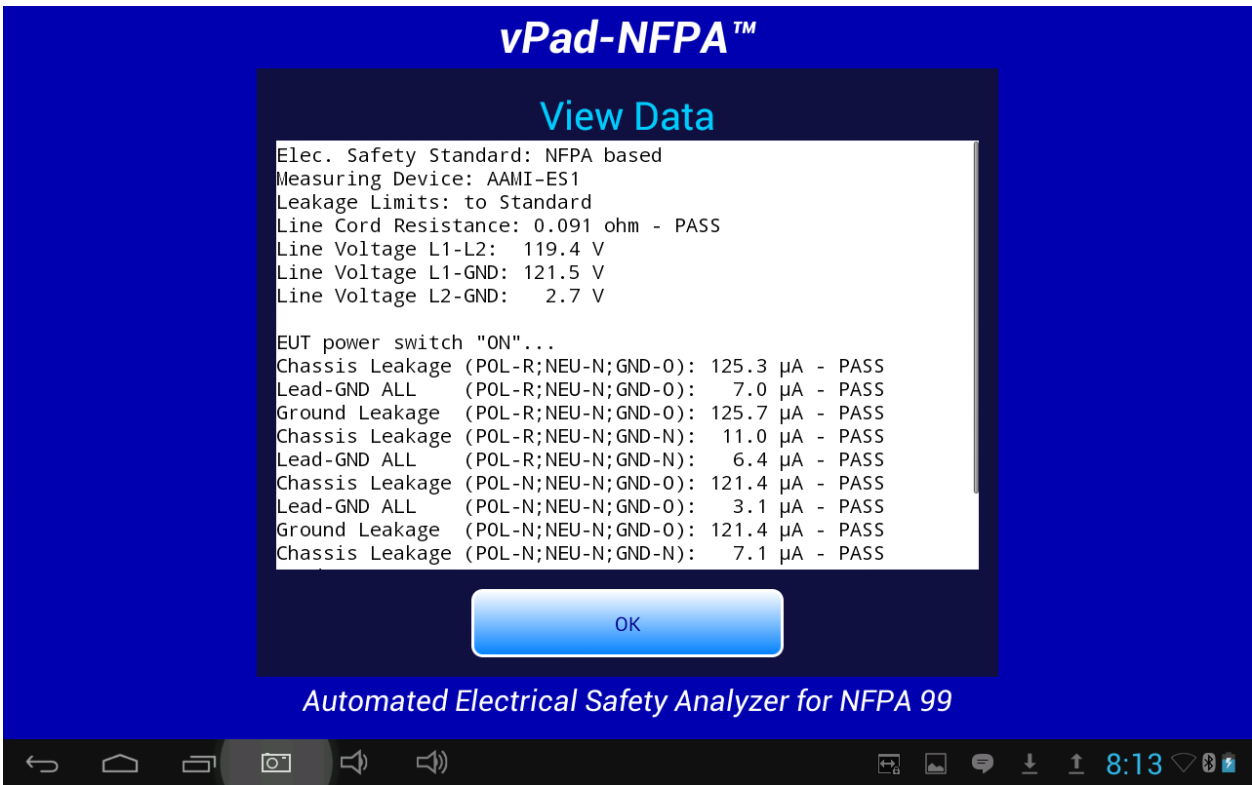


Figure 48 - Test Result Preview.

If necessary, the window can be scrolled up or down using a up/down touch-and-drag gesture. When done, press ‘OK’ to proceed to the Create Record menu.

4.5.10 Creating a Test Record

When all of the test results have been collected, the final step is to create a record of the test. Test reports are stored in text files which have a name beginning with the EUT Control ID. The remainder of the file name includes a date and time stamp. The general format of the file name is:

```
<control-id>_<yyyymmdd>_<hhmmss>_<r>.txt
```

Where <r> can be a **F** for a failed test or **P** for a passed test.

In the event a Control ID has not yet been entered, a reminder warning will be displayed, as shown in *Figure 49*. Pressing 'Continue' will return to the Equipment Information screen, *Figure 31*. Otherwise, the 'Create Test Record' screen, *Figure 50*, will be displayed.

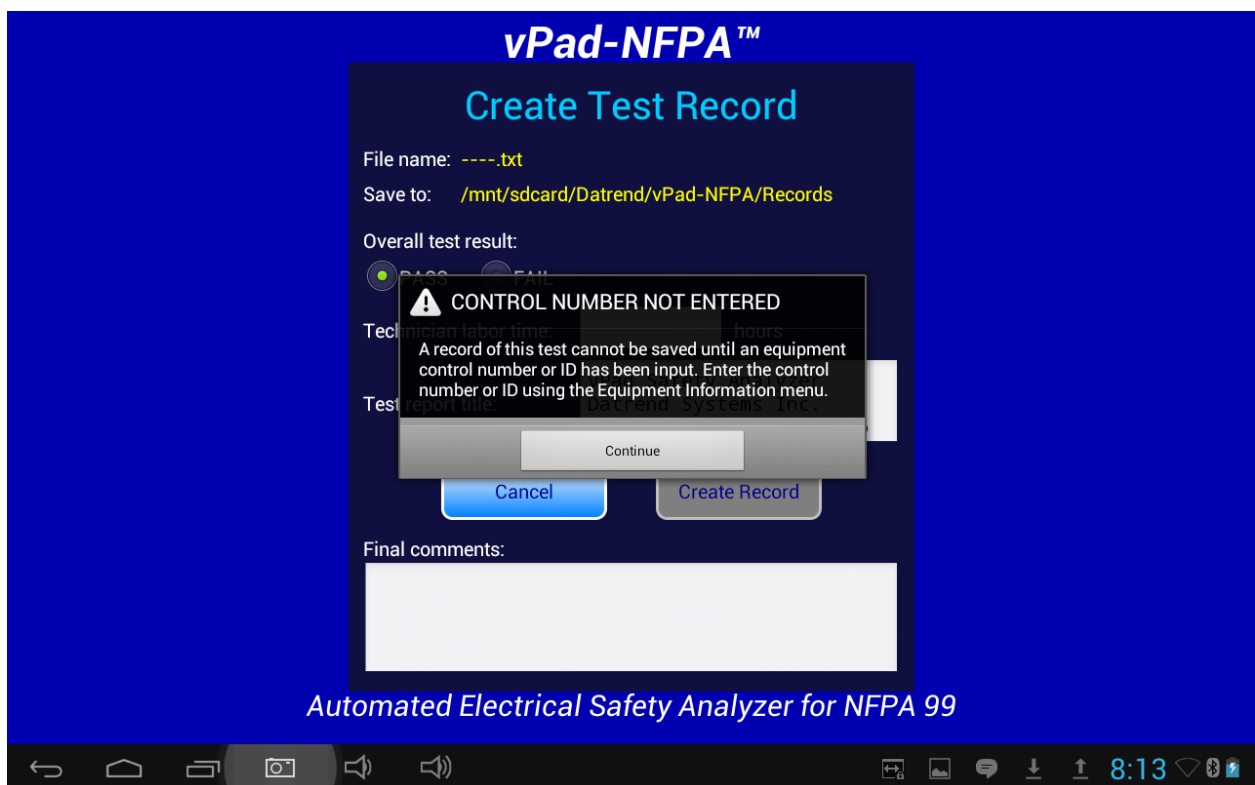


Figure 49 - Control ID Reminder Screen.

Once the EUT has been identified by Control Number, it is possible to complete the creation of the Test Record (*Figure 50*). The filename and destination are displayed at the top of the screen and are not user editable.

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During the test, certain measurements may have been recorded as a **FAIL** result. If this is true, the '**Overall Test Result:**' will activate the **FAIL** radio button. If there were no failures recorded during the test, the **PASS** radio button will be activated. It is possible to override a **PASS** since there may be circumstances not evident from the test measurements which could recommend a **FAIL** assessment. Reasons for changing a **PASS** to a **FAIL** can be recorded in the '**Comments:**' field.

vPad-NFPA™
Create Test Record

File name: A00321_20140822_081338_P.txt
Save to: /mnt/sdcard/Datrend/vPad-NFPA/Records

Overall test result:
☒ PASS ☐ FAIL

Technician labor time: [] hours

Test report title: vPad Safety Analyzer
Datrend Systems Inc.
NFPA Standard

Cancel Create Record

Final comments:

Automated Electrical Safety Analyzer for NFPA 99

Figure 50 - Create a Record.

Time spent by the technician/user can be recorded by entering a value in the '**Technician labor time:**' field. Touching this field space will result in the display of a numeric keypad to allow data entry, per **Figure 51**. Note that this time is intended to encompass ALL of the time spent by the user in preparing for and completing the requirements of the work order. The actual time spent using vPad-NFPA to take and record measurements is recorded separately in the Test Record under the heading 'AutoSequence Run Time'. This is the time from the initial selection of the AutoSequence until the Test Record is created.

Test Record files include a Title at the beginning of the file. This may be modified from default "**vPad Safety Analyzer**" after tapping the **Test report title** field. Optionally, enter the name of your institution or business, address, phone number and so on. Up to 16 lines may be entered into this text field, of which the first three lines will be shown when the menu is initially displayed (to view or edit additional lines, scroll the window using a press-and-drag gesture). The **Test report title** is backed up in permanent memory storage on the Android tablet; the title is maintained after power to vPad-ES is switched off, and is then restored on subsequent use of the app.

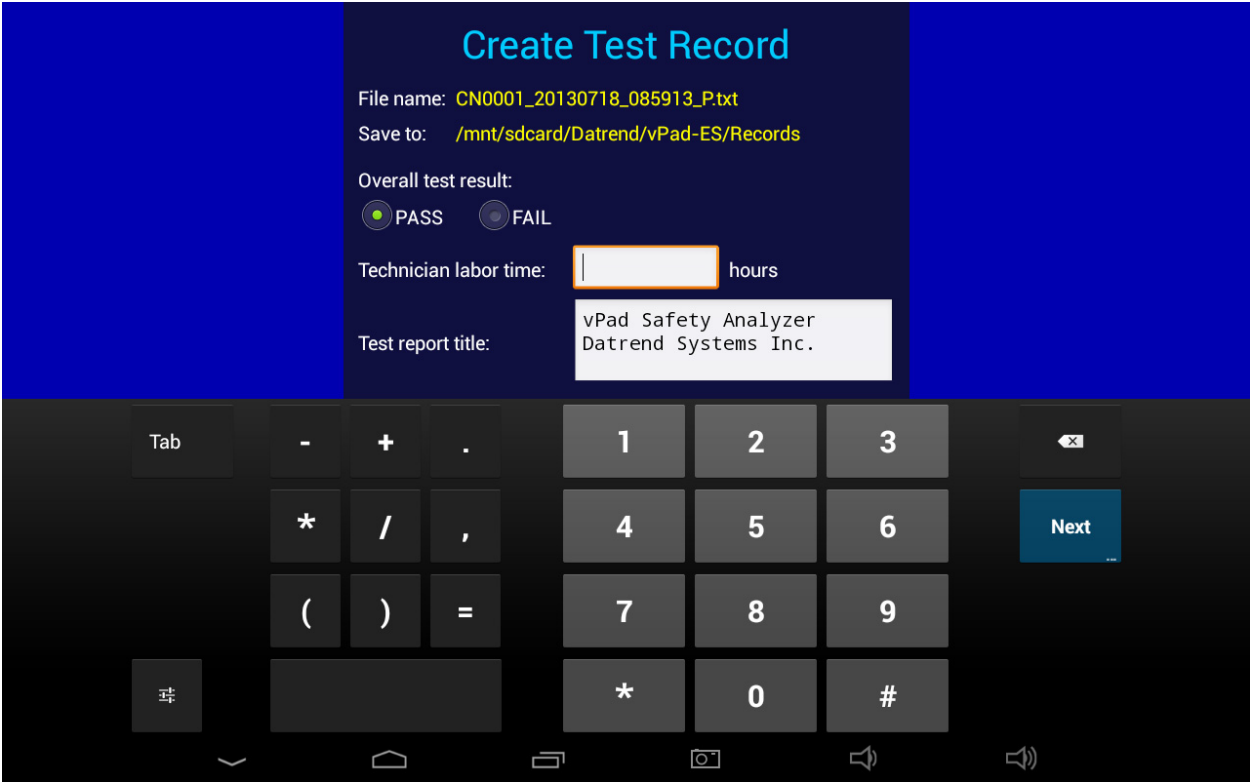


Figure 51 - Entering Technician Time.

In the event there is other relevant information concerning the test, the ‘Final Comments’ field provides a means of recording the information. This could be reasons that a test result was changed from PASS to FAIL, notes regarding additional work that should be done in the future, requirements to order parts, etc.

Once all of the information has been input, press the **‘Create Record’** button to save the record to file.

An example of a Test Record file saved by vPad-NFPA is given in APPENDIX A.

Note that all test records created by vPad-NFPA are stored in the `/mnt/sdcard/Datrend/vPad-Check/Records` folder

4.6 Using the Android Keyboard

When you press a text field, the Android keyboard is displayed at the bottom of the screen.



Figure 52 - Android onscreen keyboard.

The onscreen keyboard is the default method used by Android to enter information. If you have connected an alternative input device to the tablet (e.g. Bluetooth/USB keyboard or barcode scanner), then the Android keyboard will not appear when a text field is pressed and data entry will then be from the external input device. To switch back to the default keyboard, disconnect the external input device.

The text field which is currently accepting data from the Android keyboard will be highlighted:

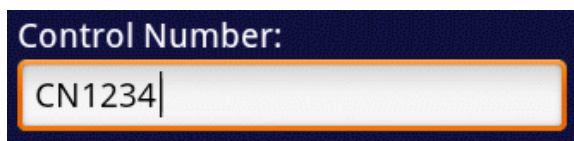
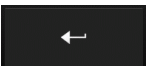
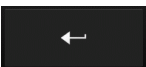



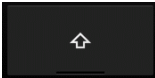

Figure 53 - Single-line text field.

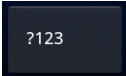
Android text fields may be either single- or multi-line. A practically unlimited amount of text may be typed for either single- or multi-line fields.


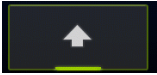
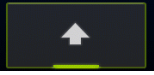
Pressing ENTER  (or **Next**) for a single-line text field causes data entry to jump to the next text field on the screen.

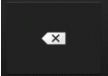
Pressing ENTER  on a multi-line text field inserts a new line. To move from a multi-line field to a different text field on the screen, tap on the desired field.

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Press  to navigate forward through multiple text fields on a screen. Press   to navigate backward. You can also jump to a particular field on a screen simply by tapping the field.

Switch the Android keyboard from alpha to numeric modes by pressing .

In alpha mode, to activate Caps Lock press and hold  until the indicator lights up: . Once activated, press  to switch Caps Lock off.

To correct a mistake in typing, tap the text field to the right of the error. This will activate the Android edit cursor. Erase with backspace/correct  then retype.

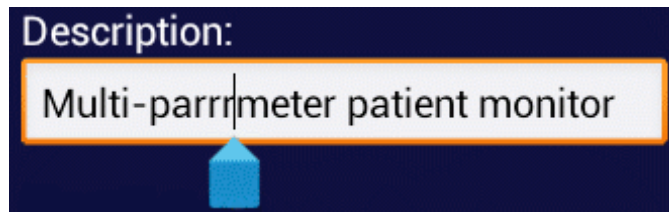



Figure 54 - Error correction with edit cursor.

When done entering text, the Android keyboard may be removed from the screen by pressing  at bottom left.



Note: **sdcard** refers to *internal memory* of the Android tablet.

sdcard is **NOT** a removable "SD Card" memory device, which may be optionally plugged into the external card slot of the tablet.

Any accessory SD Card which may be plugged into the tablet's card slot is referred to as **extsd** in the Android file system.

4.7 Record Manager App

vPad Record Manager is an app which is installed on the Android tablet and which may be run independently of, or simultaneously with, the vPad-NFPA app.

Record Manager may be used to copy, print, and/or delete Test Record files saved by vPad-NFPA. Record Manager can also be used to convert Test Records to Adobe PDF documents. Note that PDF is a format which enables vPad Record compatibility with other Android apps, for example, e-book readers and document printing apps.


 Press on the Android HOME screen to launch the Record Manager app.



Figure 55 - File browser of vPad Record Manager.

Refer to **MN-087a 6100-081 vPad-RM Operators Manual** for further information on use of the Record Manager.

5 Calibration and Maintenance

vPad-NFPA is a software App designed for the Android operating system and is used in conjunction with the vPad-ES hardware platform. As an App, there are no calibration or maintenance requirements, however, there may from time-to-time be upgrades which provide enhanced features or improvements. Contact Datrend or your local dealer for information on these upgrades. Upgrades which significantly improve the functionality of the App may be subject to charge, solely at the discretion of Datrend.

With regard to the vPad-ES hardware platform, calibration by a Datrend Authorized Service facility is recommended on an **annual** basis, and is **required** to extend the product warranty. The basic one (1) year warranty on the Analyzer Base Unit can be extended to a maximum of two (2) years provided that annual calibration is performed by a Datrend Authorized Service Center on an **annual** basis. Refer to the Calibration Decal applied to the rear panel of the unit to determine calibration status of your vPad-ES.

vPad-ES contains no user serviceable parts, other than a 20 Amp/250V AGC fuse located on the right side panel of the Analyzer Base Unit. Any other failure will require return of vPad-ES to an authorized service facility for repair. ***Opening the case of vPad-ES for any reason will void the warranty and may compromise user safety.***



Service must be performed by a factory trained, authorized service agent. This unit contains hazardous voltages which may cause injury if correct service procedures are not followed.

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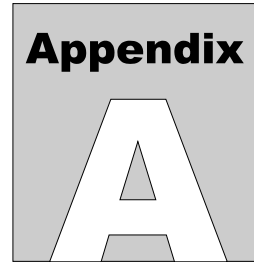
For calibration or service assistance, contact Datrend for a Return Materials Authorization (RMA) number and the location of the nearest Service Facility.

Datrend Systems Inc.
Unit 130 - 4020 Viking Way
Richmond, BC • CANADA • V6V 2L4
Tel 604.291.7747 or 800.667.6557 • Fax 604.294.2355
e-mail customerservice@datrend.com
www.datrend.com

The vPad-ES may be cleaned with the microfiber cloth provided originally with the system (or equivalent type cloth intended for cleaning glass surfaces); or, a soft, lint free, damp cloth using a mild detergent. Use of other cloth materials or cleaning agents on the touchscreen may result in scratching, discolouration, streaking or even failure.



Electrical safety protection of the operator may be compromised if the instructions in this manual are not followed, or if vPad-ES is used for a purpose not specified in this manual.



APPENDIX A. Sample Test Record

This appendix provides an example of a vPad-ES Test Record (created using vPad-NFPA automation App), illustrating the data representation for voltage, current, resistance and leakage measurements, as well as ECG waveform data. Inspection data and example notes have been recorded for some measurements to show how these typically appear in a record.

vPad Safety Analyzer
Datrend Systems Inc.
Verification of NFPA App

File: Test_ID_20140822_092556_P.txt
Date: 2017 Jan 23
Time: 09:25:56
vPad ID: My vPad
vPad SN: VPES16060000 Cal Date: 2016-06-30

Equipment Information...
Control Number: Test ID
Description:
Manufacturer:
Model:
Serial Number:
Location:
Facility: Viking Way

Technician ID: RE
Tech Time (hrs): 0.3

Overall Result: PASS

Signature: _____ Date: _____

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Detailed Test Data...

AutoSequence Filename: vpad_nfpa_3.asq (modified)
Title of AutoSequence: NFPA -3
AutoSequence Run Time: 2 minutes

Elec. Safety Standard: NFPA99:2012
Measuring Device: AAMI:ES1
Leakage Limits: to Standard
Reverse Polarity Tests: No
Open Neutral Tests: No
Ground Resistance Limit: Maximum 0.500 ohms
Chassis Leakage Limits: Maximum 100 μ A NC; 500 μ A SFC
Ground Leakage Limits: Maximum 500 μ A NC;1000 μ A SFC
Lead Leakage Limits: Maximum 100 μ A NC; 500 μ A SFC

Line Cord Resistance: 0.092 ohm - PASS

EUT power switch "OFF"...

Chassis Leakage (POL-N;NEU-N;GND-O): 121.3 μ A - PASS
Lead-GND ALL (POL-N;NEU-N;GND-O): 3.0 μ A - PASS
Ground Leakage (POL-N;NEU-N;GND-O): 121.6 μ A - PASS
Chassis Leakage (POL-N;NEU-N;GND-N): 7.0 μ A - PASS
Lead-GND ALL (POL-N;NEU-N;GND-N): 2.4 μ A - PASS

EUT power switch "ON"...

Chassis Leakage (POL-N;NEU-N;GND-O): 121.4 μ A - PASS
Lead-GND ALL (POL-N;NEU-N;GND-O): 3.1 μ A - PASS
Ground Leakage (POL-N;NEU-N;GND-O): 121.4 μ A - PASS
Chassis Leakage (POL-N;NEU-N;GND-N): 7.1 μ A - PASS
Lead-GND ALL (POL-N;NEU-N;GND-N): 2.5 μ A - PASS

Final comment optional

END OF RECORD

