INTRODUCTION

The Model 234A and the Model 235A Electrical Safety Analyzers are precision voltage, current, and resistance meters that perform safety and performance checks on a wide assortment of medical devices. Both models, the 234A and the 235A, perform the following tests:

- System voltage.
- Power cord resistance.
- Environmental point to point resistance.
- Case leakage current.
- Equipment load current.
- External meter (µA or mV, and mΩ).

Additional Testing Capabilities of the Model 235A

The Model 235A has the additional capability of making measurements on ECG leads, such as:

- ECG lead leakage.
- ECG lead isolation.

Also, the 12 ECG performance waveforms of the Model 235A allow the following parameters of ECG monitoring and recording devices to be checked:

- Gain.
- Damping.
- Frequency response.
- Linearity.
- ECG rate meter response.

Additional Product Features for the Model 234A and the Model 235A

Other product features that are common to both the Model 234A and the Model 235A are:

- Front panel with 3 "ENABLE" buttons to select the type of test.
- Rotary "SELECT" switch to select a specific test.
- The "Ω ZERO" button for cable calibration.
- The option to use Test Probes or Kelvin Cables.
- Readings = True RMS (AC+DC or DC only).

Furthermore, you can automate test sequences by using the Model 234A and the Model 235A in conjunction with a computer.

Manual Addenda

Information concerning improvements or changes to the instrument which occur after the printing of this manual will be found on an addendum sheet included with the manual. Be sure to review these changes before attempting to operate or service the instrument.

MODEL 234A and MODEL 235A INSTRUMENT SPECIFICATIONS

PARAMETER	SPECIFICATION
Power Requirements	115 VAC (±10%) @ 50-60 Hz. 230 VAC (±10%) @ 50-60 Hz. Test receptacle: 115 VAC, continuous current load maximum 16 Amps with power factor of 1840 VA. Intermittent current load 19 Amps with a duty cycle of 20% (2 min "ON", 8 min "OFF"). 230 VAC, 10 Amps. Internal: 3/8 Amp @ 115 VAC. 3/16 Amp @ 230 VAC.
Temperature Range	Operating: 59°F to 95°F, 15°C to 35°C. Storage: 32°F to 122°F, 0°C to 50°C.
Display	3.5 digit red LED display. Appropriate range is selected automatically. Units of measure are indicated by illuminated LED annunciators.
Power Cord	Permanently attached to the back of the instrument.
Weight	9.5 lb, 4.31 kg.
Dimensions	13"L x 9.5"W x 3.5"H. 33.02cm L x 24.13cm W x 8.89cm H.
Accessories	Standard: Test Probes (9501-0049). Ground Pin Adapter (9503-0004). 20/15 Amp Adapter (2719-0154). Operating/Service Manual (9508-0231). Optional: 202A Isolation Test Module (9519-0137). Automate Software Package (9519-0213). Kelvin Cables (9501-0032). RS-232 Cable (3010-0250).

Electrical Safety Tests

SAFETY TEST	DESCRIPTION
System Voltage	Measurement of: L1 - ground. L2 - ground. L1 - L2 (system voltage).
Resistance	Power cord and environmental point to point with Test Probes or optional Kelvin Cables.
Case Leakage Current	Case to ground with Test Probe. Case to ground via power cord ground conductor.
Equipment Current	Current drawn by device: 20 Amp/115 Volt or 10 Amp/230 Volt USA.
External Meter	µA/mV mΩ
ECG Lead Leakage (Model 235A only)	ECG leads to ground. Single leads: RL, RA, LA, LL, and V1-V6 to ground. Interlead leakage: RA-RL, LA-RL, and LA-RA. ECG lead isolation: All leads at a voltage equal to system but isolated and limited to 1 mAmp. Other lead combinations available via serial port.

ECG Performance Tests (Model 235A only)

PERFORMANCE TEST	RATES	AMPLITUDE (Lead I)
DC Pulse	4.0 s	+1.0 mV
Square Wave	2 Hz	1.0 mV
Sine Waves	10 Hz, 40 Hz, 60 Hz, 100 Hz	1.0 mV_{p-p}
Triangle Wave	2 Hz	1.0 mV_{p-p}
NSR (Normal Sinus Rhythm)	30 BPM, 60 BPM, 120 BPM, 180 BPM, 240 BPM	1.0 mV

Autosequence Performance Test (Model 235A only)

The autosequence performance test is a sequence through each of the waveforms listed below, in the order shown, on a continuous basis. Each waveform is output for 4 seconds, except for the square waveform.

PERFORMANCE TEST	RATES	AMPLITUDE (Lead I)
Square Waveform	.125 Hz (4.0 second pulse)	1.0 mV_{peak}
Sine Wave Bursts	10 Hz, 40 Hz, 50 Hz, 60 Hz, 100 Hz	1.0 mV_{p-p}
Triangle Wave	2 Hz	1.0 mV_{p-p}

Measurement Methods

TYPE OF MEASUREMENT	DESCRIPTION
Voltage and Current	True root mean square (RMS).
Resistance	Two and four terminal techniques.
Input Load	DC to 1 MHz (ANSI/AAMI ES1-1993 test load).
Resistance Test Current	80 mAmps.
Isolation Test	Voltage equal to system but isolated and limited to 1 mAmp.

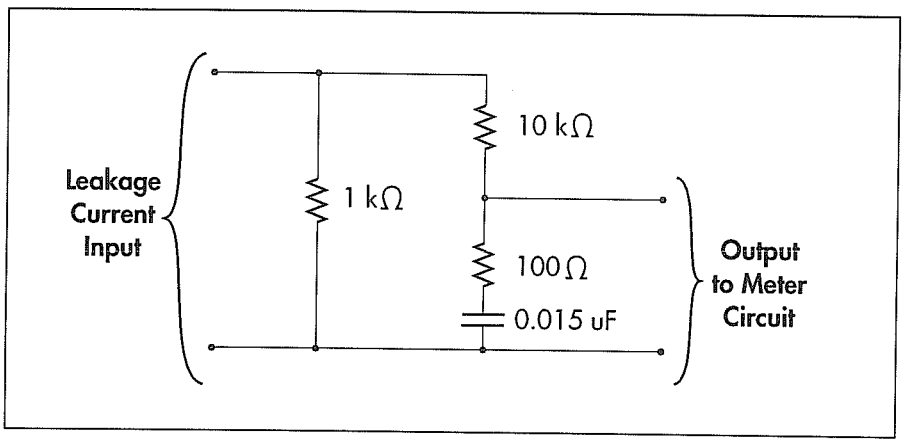
Full Scale Instrument Measurement Ranges

MEASUREMENT	RANGE
System Voltage	85-299 VAC
Milliohms	0-1999 mΩ
Microamps	0-199.9 µA / 200-1999 µA
Millivolts	0-199.9 mV / 200-1999 mV
Equipment Current	0-19.9 Amps

AAMI Load

The ANSI/AAMI Standard load is the simulated patient impedance as developed by the Association for the Advancement of Medical Instrumentation and approved by the American National Standards Institute: Safe Current Limits for Electromedical Apparatus ANSI/AAMI ES1-1993, which is a revision of the previous ANSI/AAMI ES1-1985 and ANSI/AAMI SCL-12/78 publications.

Specifications for leakage current measurements are listed in Test Equipment Section 5.2.1.1 of the ANSI/AAMI Standard ES1-1993.



ANSI/AAMI Standard Load Configuration

Accuracy of Instrument Measurements

MEASUREMENT	ACCURACY
System Voltage	±[2% of reading + 2 counts]
Resistance	±[2% of reading + 2 counts]
Leakage Current	±5% of reading ±1 µAmp DC and 48 Hz to 100 kHz.
Equipment Current	±[10% of reading + 2 counts]
ECG Rate	±0.5%
ECG Amplitude	±10% on Lead I, square wave
AAMI Load	1 kΩ ±1% @ DC

Input / Output Connectors

CONNECTOR	DESCRIPTION
ECG Inputs/Outputs	10 AHA color coded posts compatible with 4.0 mm electrodes and disposable snaps. Input mode is for ECG leads leakage tests. Output mode is for ECG performance tests.
Test Lead Jacks	Standard Banana Jacks: Two for meter input. Two for current source. It is necessary to install a set of Test Probes and shorting straps or Kelvin Cables to the four terminals for all tests. The current source is connected internally only for resistance measurements, therefore it will not interfere with the leakage measurements. All test lead jacks are protected against the accidental application of voltage.
100 µA Test Point	Constant 100 µAmp DC current source for testing leakage functions.
0.5 Ω Test Points	0.5 Ohm test resistance for verifying resistance functions.
Ground Stud	Earth ground.
RS-232	There are two ports and each port utilizes a standard 25 pin "D" connector: Pin 2 - transmits. Pin 3 - receives. Pin 7 - ground.

Test Receptacle

DESCRIPTION	OPERATION
Front panel selection.	Open or closed neutral. Open or closed ground. Normal, off, or reversed polarity.
Supplies power to the EUT; fuse protected.	Refer to the instrument specifications shown previously in this chapter.

Ground Fault Interrupter

PARAMETER	DESCRIPTION
Function	Detects test receptacle ground fault: >10 mA ±10% (5 mAmps selectable on serial port).
Detection of Fault	Power is removed from test receptacle and the E6 error code LED illuminates.
Reset Position	Reset by setting the polarity switch to center, "OFF/ GFCI RESET".

Periodic Maintenance

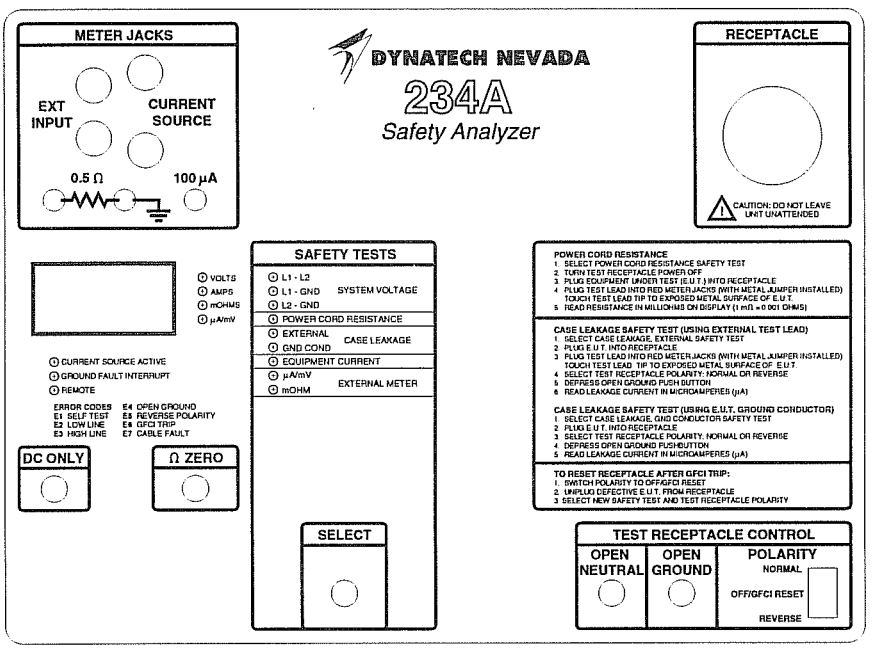
It is important to have the Model 234A and the Model 235A calibrated once a year to ensure their accuracy and proper operation. We recommend that your instrument be returned to Dynatech Nevada for its yearly calibration.

Attention AutoMate Users

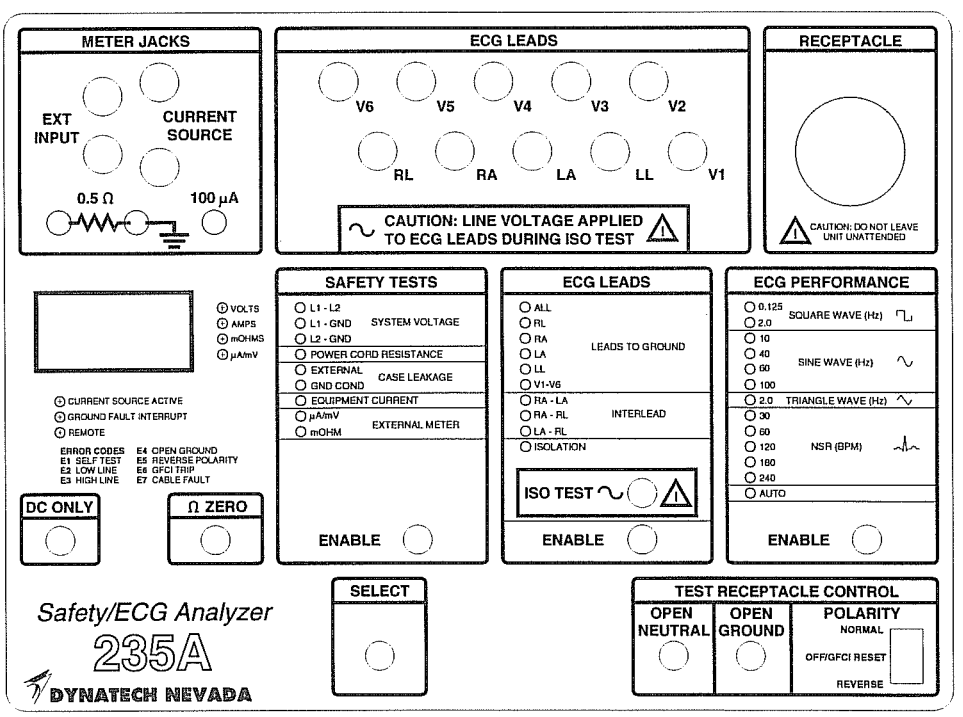
If you are using the AutoMate software package, the reference to the "CABLE CAL" button is the same as the "Ω ZERO" button on later models of the 234A and the 235A.

INSTRUMENT FAMILIARITY FOR THE MODEL 234A AND THE MODEL 235A

This section describes the operating controls and indicators of the Model 234A and the Model 235A Safety Analyzers. A description of each of the controls and indicators follows the illustrations below.
Note: The "Ω ZERO" button on earlier models is called "CABLE CAL".



Model 234A Controls and Indicators



Model 235A Controls and Indicators

Front Panel Controls and Indicators

DISPLAY

Both instruments have a 3.5 digit LED display to indicate measurement results with the decimal points being placed automatically. The display is located on the left side of the front panel, below the meter jacks. There are annunciator LEDs located to the right of the display which indicate the unit of measure.

TEST RECEPTACLE

The test receptacle is located in the upper right corner of the front panel. The test receptacle supplies power to the equipment under test (EUT). The type of receptacle depends on the factory installed system voltage option as listed below:

115 VAC; continuous current load maximum 16 Amps with power factor of 1840 VA. Intermittent current load 19 Amps with a duty cycle of 20% (2min "ON", 8min "OFF").

230 VAC; 10 Amps maximum.

TEST RECEPTACLE CONTROL

The test receptacle control panel is located on the lower right corner of the front panel. Following is an explanation of how each of the buttons and the switch operate.

- "OPEN NEUTRAL" — Opens the neutral line to the test receptacle as long as the button is depressed.
- "OPEN GROUND" — Opens the ground line to the test receptacle as long as the button is depressed.
- "POLARITY" — This 3-position switch selects normal or reverse polarity of the hot and neutral lines to the test receptacle. The center position shuts the power to the test receptacle off and resets the ground fault.

WARNING! *Do not leave the Model 234A or the Model 235A unattended when power is applied to the TEST RECEPTACLE.*

ATTENTION! *NE PAS LAISSER SANS SURVEILLANCE PENDANT L'ESSAI.*

ENABLE BUTTONS

The enable buttons are located at the bottom of each test group. Depressing one of these buttons selects a particular test group.

SELECT DIAL

Rotating this dial selects a specific test within the test group.

SAFETY TESTS

The Model 234A and the Model 235A perform safety analyzer tests on a wide assortment of medical devices. The safety tests include:

- System voltage.
- Power cord resistance.
- Environmental point to point resistance.
- Case leakage current.
- Equipment load current.
- External meter (µA or mV, and mΩ).

ECG LEADS TEST (MODEL 235A ONLY)

After the ECG leads test group has been chosen, there are three types of tests to select from:

- "LEADS TO GROUND".
- "INTERLEAD".
- "ISOLATION".

WARNING! *Voltage, equal to system but isolated and limited to 1 mAmp, is present on the ECG leads while the "ISO TEST" button is depressed. Do not touch the ECG leads at this time.*

ECG PERFORMANCE TESTS (MODEL 235A ONLY)

There are 12 ECG performance waveforms that allow the following parameters of ECG monitoring and recording devices to be checked:

- Gain.
- Damping.
- Frequency response.
- Linearity.
- ECG rate meter response.

DC ONLY BUTTON

Pressing this button changes the measurement mode from AC+DC to DC only.

Ω ZERO (CABLE CAL) BUTTON

The cable calibration function cancels the resistance of the Test Probes when measuring resistance.

METER JACKS

There are four external meter binding posts:

- "EXT INPUT" is used to measure millivolts or microamperes.
- "CURRENT SOURCE" is an 80 milliamperes source used to measure resistance.
- The "0.5 Ω" test points are used to verify the operation of the resistance measurement circuitry.
- The "100 μA" test point is a constant current source delivering 100 microamperes and is used to verify the operation of the leakage measurement circuitry.
- The ground stud is connected to earth ground.

ECG LEADS (MODEL 235A ONLY)

There are 10 ECG lead binding posts on the top of the front panel of the Model 235A. The ECG leads are used for connecting patient leads to the Model 235A. Snap connectors may be used for the binding post tops or rotate the sleeves in a counterclockwise direction to expose the 4 mm hole that accepts diagnostic pin electrodes (including banana plugs).

Rear Panel Controls and Indicators

POWER SWITCH

Use to turn the instrument on by setting the power switch to the "1" position.

POWER CORD

The power cord is permanently attached to the rear of the instrument.

SERIAL TAG

This is the location of the Model 234A and the Model 235A serial numbers.

FUSE HOLDERS

There are three fuse holders located on the rear panel. The size of each of the fuses is specified on the rear panel of the instrument. One fuse protects the Model 234A and the Model 235A circuitry. The other two fuses protect the test receptacle.

CAUTION: *For continued fire protection replace only with specified type and rated fuse as specified on the rear panel of the instrument.*

RS-232 PORTS

There are two RS-232 ports on the rear panel. A computer can be used to control the Model 234A and the Model 235A via COM 1. The computer can also communicate with another device that is connected to COM 2.