

FLUKE®

Biomedical

QA40 III

Defibrillator Analyzer

QA45 III

Defibrillator/Transcutaneous Pacemaker Analyzer

Users Manual

PN 2749099
October 2006, Rev.1, 5/07
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Follow standard receiving practices upon receipt of the instrument. Check the shipping carton for damage. If damage is found, stop unpacking the instrument. Notify the carrier and ask for an agent to be present while the instrument is unpacked. There are no special unpacking instructions, but be careful not to damage the instrument when unpacking it. Inspect the instrument for physical damage such as bent or broken parts, dents, or scratches.

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For application support or answers to technical questions, either email techservices@flukebiomedical.com or call 1-800- 648-7942 or 1-425-446-6945.

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Our routine method of shipment is via common carrier, FOB origin. Upon delivery, if physical damage is found, retain all packing materials in their original condition and contact the carrier immediately to file a claim. If the instrument is delivered in good physical condition but does not operate within specifications, or if there are any other problems not caused by shipping damage, please contact Fluke Biomedical or your local sales representative.

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Return Procedure

All items being returned (including all warranty-claim shipments) must be sent freight-prepaid to our factory location. When you return an instrument to Fluke Biomedical, we recommend using United Parcel Service, Federal Express, or Air Parcel Post. We also recommend that you insure your shipment for its actual replacement cost. Fluke Biomedical will not be responsible for lost shipments or instruments that are received in damaged condition due to improper packaging or handling.

Use the original carton and packaging material for shipment. If they are not available, we recommend the following guide for repackaging:

- Use a double-walled carton of sufficient strength for the weight being shipped.
- Use heavy paper or cardboard to protect all instrument surfaces. Use nonabrasive material around all projecting parts.
- Use at least four inches of tightly packed, industry-approved, shock-absorbent material around the instrument.

Returns for partial refund/credit:

Every product returned for refund/credit must be accompanied by a Return Material Authorization (RMA) number, obtained from our Order Entry Group at 1-800-648-7952 or 1-425-446-6945.

Repair and calibration:

To find the nearest service center, goto www.flukebiomedical.com/service or

In the U.S.A.:

Cleveland Calibration Lab

Tel: 1-800-850-4606

Email: globalcal@flukebiomedical.com

Everett Calibration Lab

Tel: 1-888-99 FLUKE (1-888-993-5853)

Email: service.status@fluke.com

In Europe, Middle East, and Africa:

Eindhoven Calibration Lab

Tel: +31-402-675300

Email: ServiceDesk@fluke.com

In Asia:

Everett Calibration Lab

Tel: +425-446-6945

Email: service.international@fluke.com

Certification

This instrument was thoroughly tested and inspected. It was found to meet Fluke Biomedical's manufacturing specifications when it was shipped from the factory. Calibration measurements are traceable to the National Institute of Standards and Technology (NIST). Devices for which there are no NIST calibration standards are measured against in-house performance standards using accepted test procedures.

WARNING

Unauthorized user modifications or application beyond the published specifications may result in electrical shock hazards or improper operation. Fluke Biomedical will not be responsible for any injuries sustained due to unauthorized equipment modifications.

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Information in this document is subject to change and does not represent a commitment by Fluke Biomedical. Changes made to the information in this document will be incorporated in new editions of the publication. No responsibility is assumed by Fluke Biomedical for the use or reliability of software or equipment that is not supplied by Fluke Biomedical, or by its affiliated dealers.

Manufacturing Location

The QA40 III Defibrillator Analyzer and the QA45 III Defibrillator/Transcutaneous Pacemaker Analyzer are manufactured in Norway for Fluke Biomedical, 6920 Seaway Blvd., Everett, WA, U.S.A.

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Defibrillator Analyzer

Introduction

The QA40 III is a precision instrument for testing external defibrillators. The QA45 III adds transcutaneous pacemaker testing to the QA40 III capabilities. This manual refers to either instrument as the “Analyzer.” Where the additional pacemaker testing capability is applicable, this manual qualifies the description with “QA45 III only.”

The Analyzer is for use by trained service technicians to perform periodic inspections on a wide range of cardiac resuscitation equipment. The testing procedures are menu-driven, and the Analyzer is simple to operate.

The Analyzer measures delivered energy output, cardioversion sync-delay time, and charge time of the defibrillator under test. The Analyzer utilizes an internal, non-inductive, 50-ohm test load, which approximates the impedance of the human chest or thoracic cavity. The operator applies the high-voltage defibrillator output across the Analyzer internal test load via its two top-panel contact plates. The Analyzer is directly compatible with

both the traditional defibrillator “metal paddles” and optional adapters available to interface defibrillators equipped with disposable, adhesive electrodes. To facilitate the testing of automatic external defibrillators (AED), the Analyzer can generate a wide range of shock advisory ECG waveforms, including polymorphic ventricular tachycardia. After defibrillator discharging, the Analyzer calculates and displays the results.

The Analyzer pacemaker function tests all types of transcutaneous pacemakers (QA45 III only). The Analyzer measures and displays output pulse amplitude, rate, and width. It also conducts demand sensitivity, paced and sensed refractory period, and 50/60 Hz line immunity tests. Either the internal high-energy 50-ohm test load or the pacemaker input variable load (26 selections) is available to simulate the impedance of the human chest or thoracic cavity.

Additionally, the Analyzer features a wide range of ECG normal, performance, and arrhythmia simulation selections for testing ECG monitors and recorders in formats up to 12-lead.

Specifications

General Specifications

Temperature, Operating	+15 °C to +35 °C (59 °F to 95 °F)
Temperature, Storage	0 °C to +50 °C (32 °F to 122 °F)
Display	LCD graphic display; Alphanumeric format (8 lines, 40 characters)
Data Input/ Output (2)	Parallel printer port (1); Bi-directional RS232 (1) for computer control
Power	6xAA 1.5-volt alkaline batteries for 25 hours (approx) operation or Battery Eliminator

Mechanical

Housing	High impact plastic case
Height	9.8 cm (3.9 in)
Width	24.8 cm (9.8 in)
Depth	28.0 cm (11.0 in)
Weight (w/o batteries)	2.245 kg (5.02 lbs)
Weight (w/ batteries)	2.4 kg (5.2 lbs)

Recommended Printer(s)

Use a printer with a Centronics Parallel interface capable of ASCII printouts without any external drivers.

Standard Accessories

9 VDC Battery Eliminator	2647372
Internal paddle-contact adapter (2)	2461709
Snap-to-banana adapters (set of 10)	2462072
Protection covers (2)	2461696
Users Manual (printed)	2749099
Users Manual (CD)	2749105
Batteries (6x1.5 V alkaline)	PC1500

Optional Accessories

Defib/Pace test cable
(Physio-Control Quik Combo)2461711
Pace only test cable
(Physio-Control Quik Pace) QA45 III only2461753
Defibrillator paddle adapter, Marquette (2)2568628
Defib/Pace test cable, HP/Agilent/Codemaster...2461727
Defibrillator paddle adapter, Laerdal2772390
FR2 paddle contact adapter, Philips2772408
Data transfer cable (RS232).....2461993
Carrying case (QA40/45).....2461730
Ansur QA40/45 III Plug-In2461775
QA40/45 Calibration Manual2765768

Storage

Store (without batteries) in the carrying case in dry surroundings within the temperature range specified in "General Specifications".

Periodic Inspection

Calibrate the Analyzer every 12 months.

Defibrillator Analyzer Specifications

Energy Output Measurement

High Range

Maximum voltage5000 V
Maximum current.....120 A
Maximum energy.....1000 J

QA40 III/QA45 III

Users Manual

Accuracy	± 2 % of reading for >100 J, ± 2 J of reading for <100 J
Trigger level	100 V
Playback amplitude	1 mV/1000 V Lead I
Test pulse.....	125 ± 20 %

Low Range

Maximum voltage	1000 V
Maximum current	24 A
Maximum energy.....	50 J
Accuracy	± 2 J of reading
Trigger level	20 V
Playback amplitude	1 mV/200 V Lead I
Test pulse.....	5 J ± 20 %
Load resistance.....	50 Ω ± 1 %, non-inductive (<10 μ H)
Display resolution.....	0.1 J
Measurement time window	100 ms (4 μ s sample rate)
Absolute maximum peak voltage	6000 V
Maximum pulse width.....	100 ms
Sample rate.....	250 kHz (4 μ s slice width)

Oscilloscope Output

High measure range.....	3000:1 amplitude-attenuated
Low measure range	700:1 amplitude-attenuated

Waveform Storage and Playback

View discharge via ECG outputs and paddles.

Output	200:1 Time Base expansion
--------------	---------------------------

Cardioversion / Sync Time Measurements

Timing window.....Starts 40 μ s before each R-wave peak
Test waveformsAll waveform simulations available
Range.....0 to 99.9 ms
Delay time accuracy \pm 1 ms

Charge Time Measurement0.1 to 99.9 s

ECG Wave

ECG General

Lead configuration.....12-lead simulation. RL, RA, LA, LL, V1-6

Output impedance

Limb leads.....1000 Ω to RL

V Leads1000 Ω to RL

All other signals are in relative proportion to Lead amplitude (the amplitudes appear for a Lead I amplitude of 1 mV) as follows:

Lead I1.0 mV (LA - RA)

Lead II1.5 mV (LL - RA)

Lead III0.5 mV (LL - LA)

V Lead1.5 mV ($V - 1/3 (LL+LA+RA)$)

High Level Output (ECG Jack)

¼ in. standard phone-jack with an amplitude of 1V/mV of low level Lead II signal

Defibrillator Contact Plates

Same amplitude as Lead I low level ECG

1 mV between contact surfaces

Playback

200 to 1 time-base expansion of defibrillator pulse by playback to ECG Leads

Manual ECG Performance Test

DC Pulse	4 s 1.0 mV
Square wave	2 Hz 1.0 mV p-p bipolar
Triangular wave.....	2 Hz 1.0 mV
Sine	0.1, 0.2, 0.5, 10, 40, 50, 60, and 100 Hz
Amplitude	0.5, 1.0, 1.5, 2.0 mV (Lead II)
Accuracy	±5 % (Lead II 1.0 mV)

ECG Performance Test

Gain/Damping	2 Hz square wave
Frequency Response	
Low Frequency	4 sec. dc pulse and 0.5 Hz sine
Band Pass.....	10 Hz sine
Monitor-3 dB.....	40 Hz sine
Diagnostic-3 dB.....	100 Hz
Power Line Filter	50 and 60 Hz sine
Linearity.....	2 Hz triangle wave

Normal Sinus

Rates.....	30, 60, 80, 120, 180, 240, and 300 BPM
Accuracy	±1 % of selection
Amplitudes	0.5, 1.0, 1.5 and 2.0 mV (Lead II)
Accuracy	±5 % (Lead II 1.0 mV)

Arrhythmia Selections

vfib.....Ventricular Fibrillation
afib.....Atrial Fibrillation
2BLKI.....Second Degree Block Type I
RBBB.....Right Bundle Branch Block
PAC.....Premature Atrial Contraction
PVC_E.....Early PVC
PVC_STD.....PVC
PVCronT.....R on T PVC
mfPVC.....Multifocal PVC
bigeminy.....Bigeminy
run5PVC.....Bigeminy Run of 5 PVCs
vtach.....Ventricular Tachycardia

Shock Advisory Test Algorithms

ASYS.....Asystole
NSR90.....Normal Sinus Rhythm 90 BPM
PVT1.....Polymorphic Ventricular Tachycardia1
PVT2.....Polymorphic Ventricular Tachycardia2
MVT1.....Monomorphic Ventricular Tachycardia1
MVT2.....Monomorphic Ventricular Tachycardia2
CVF.....Coarse Ventricular Fibrillation
FVF.....Fine Ventricular Fibrillation

Transcutaneous Pacemaker Analyzer Specifications

(QA45 III only)

Test Load Selections

Pacemaker Input Fixed Load 50 Ω \pm 1 %, non-inductive (<10 μ H) (Defib load)

Pacemaker Input Variable Load (50 to 2300 Ω and open circuit)

50 to 200 Ω 50 Ω steps

200 to 2300 Ω 100 Ω steps

Open circuit simulation..... 43.8 k Ω

Accuracy 50 to 1300 Ω \pm 2.5 %, 1400 to 2300 Ω \pm 5 %

Oscilloscope Output

50 to 150 Ω 10.24:1 amplitude attenuation

200 to 500 Ω 41:1 amplitude attenuation

600 to 2300 Ω 164:1 amplitude attenuation

Pulse Measurements

Amplitude 4 to 250 mA (100 Ω load)

Accuracy \pm 5 % + 0.5 mA, 100 to 500 Ω

\pm 5 % + 1.0 mA, <100 Ω

\pm 5 % + 1.0 mA, >500 Ω

Maximum amplitude 300 mA all loads

Rate 30 to 250 ppm

Accuracy \pm 1 % or 2 ppm

Pulse Width 1 to 50 ms

Accuracy \pm 0.5 ms

Demand Sensitivity Test

Waveforms Square (SQR), Triangle (TRI), and Haversine (SSQ)

ECG Output

Amplitude 0 to 4 mV

Resolution 40 μ V

Pacemaker Input (Load dependent)

Amplitude (50 Ω) 0 to 10 mV

Resolution (50 Ω) 40 μ V

Amplitude: ($\geq 500 \Omega$) 0 to 100 mV

Resolution: ($\geq 500 \Omega$) 1 mV

Defibrillator Pads

Amplitude 0 to 10 mV

Resolution 0.1 mV

Waveform width 10, 25, 40, 100, and 200 ms

Pacemaker rate 30 to 120 ppm

Immunity Test

50/60 Hz Interference Signal

ECG output 0 to 4 mV peak in steps of 0.4 mV

Pacemaker input (Load dependent) 0 to 10 mV peak in steps of 1 mV (50 Ω), 0 to 100 mV peak in steps of 10 mV ($\geq 500 \Omega$)

Defibrillator Pads 0 to 10 mV peak in steps of 1 mV

Refractory Period Measurement

Waveforms Square (SQR), Triangle (TRI), and Haversine (SSQ)

20 to 500 ms (Pacing and Sensing) Accuracy ± 2 ms

Unpacking

Carefully unpack all items from the box and check that you have the following items:

- QA45 III Defibrillator/Transcutaneous Pacemaker Analyzer or QA40 III Defibrillator Analyzer
- Battery eliminator
- Internal paddle-contact adapters (2)
- Snap-to-banana adapters (10 pack)
- QA40/45 III Users Manual (print and CD)
- 6xAA 1.5 V batteries

Setup

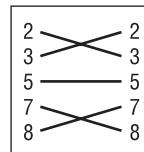
If you are not using automation software and are sending results directly to a printer, attach the printer cable to the 25-pin outlet port.

PC and Automation Software

If you are using automation software, attach an RS232 (null modem/data transfer configured) cable to the 9-pin D-sub outlet port located at the rear of the Analyzer. Do not attach the printer cable to the Analyzer.

Note

Some RS232 cables are missing the connection between the seventh and the eighth wires in the cable. This arrangement may still constitute a NULL-modem cable, but it will not work with the Analyzer. Use a standard RS232 NULL-modem cable with the pin layout shown below. Most NULL-modem cables require connection to 9-pin male connectors.



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Power

Main On/Off Switch

Power on the Analyzer by pressing the front panel POWER (0/1) switch. An introductory screen displays for about two seconds, after which the Analyzer is ready to use. Allow the Analyzer to remain off for at least five seconds before switching it on again to allow the test circuits to discharge fully.

Battery Eliminator

The battery eliminator plug-in power supply transformer allows you to use the Analyzer anywhere a standard electrical outlet is available. Attach the battery eliminator by inserting its small connector into the micro jack labeled "Batt. Elim. 9V DC" on the right rear of the Analyzer. Plug the large connector into the nearest standard electrical outlet.

Note

Remove the batteries and disconnect the battery eliminator if you do not intend to use the Analyzer for an extended period.

Note

Do not use mercury, air, or carbon-zinc batteries.

Low Battery Power

If battery power falls below 6.9 V \pm 0.3 V, the display shows 'Change battery, and reset system'. Either replace the batteries or connect the Analyzer to a battery eliminator. In either event, you must switch the main switch off and then on again in order to use the Analyzer.

Changing Batteries

Remove the compartment covers in the base of the Analyzer, replace the old batteries with new ones, and attach the compartment covers. Use six fresh 1.5-volt alkaline batteries (Duracell PC1500 or equivalent).

Internal Paddles

Test defibrillators with internal paddles using an internal paddle adapter. These contacts feature a banana plug attached to the standard paddle contact and protected by a plastic insulation washer.

Special Contacts

Certain defibrillators (automatic models and those with pacemaker options) use special contacts fastened to the electrodes that attach to the patient. Fluke Biomedical provides special adapters to suit most of these defibrillators. These are available as optional accessories.

Ansur Software Plug-in Module

Test automation software for the Analyzer is available from Fluke Biomedical. Use the program features to enhance your defibrillator and pacemaker maintenance program. Order Ansur QA40/45 III Plug-In (PN 2461775.)

Controls and Connectors

Use the keys, softkeys, and LCD display to control the Analyzer locally.

Refer to Figures 1 and 2 and Table 1 for an overview of the Analyzer controls and connectors.

Menu and Function Keys

The Analyzer uses the display and programmable function keys to provide flexibility and control over the operations. The upper part of the screen displays messages, status,

and results. The menu bar appears at the bottom of the LCD display.

The function keys are labeled **F1** through **F5**, allowing control of extended menu choices.

Select a function by pressing the key located directly under the menu bar Item. A menu bar item appears in capital letters.

The menu extends across three pages. Navigate between pages of the menu by pressing **F5 (more-2, more-3, or more-1)**.

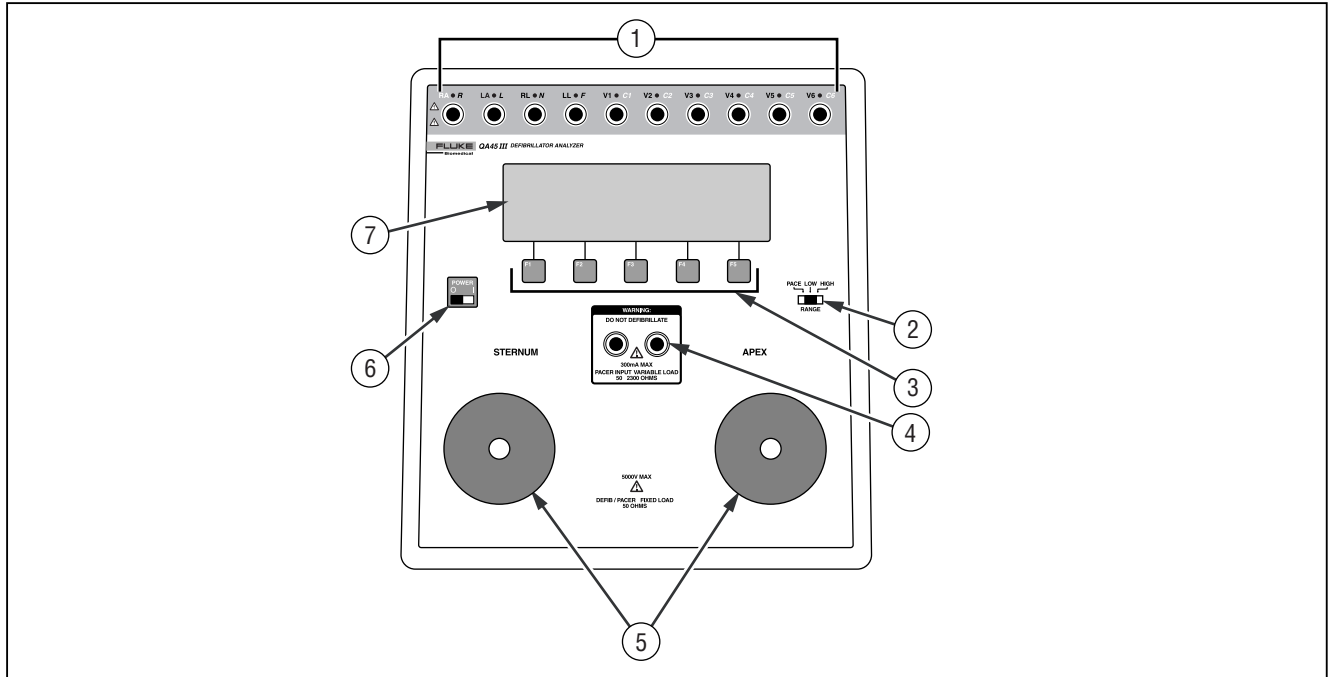


Figure 1. Front Panel

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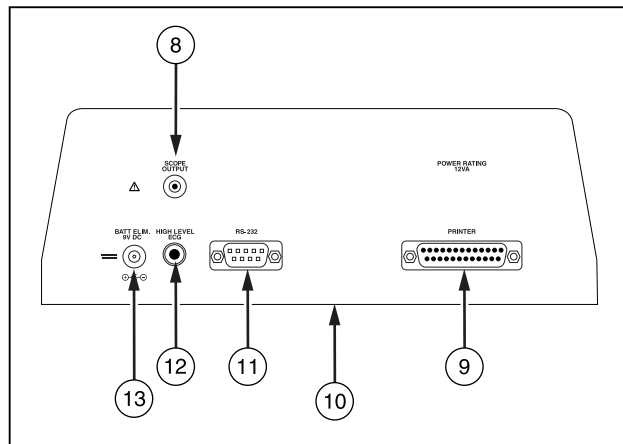


Figure 2. Back Panel

eqb004f.eps

Table 1. Controls and Connectors

Number	Name	Description
①	Low Level ECG Connectors	10 color-coded 4 mm safety terminals with snap-to-banana plug adapters.
②	RANGE Switch	Switches LOW and HIGH ranges of defibrillator energy. Also selects PACE mode with the QA45 III only.

Table 1. Controls and Connectors (cont.)

Number	Name	Description
③	Function Keys	F1 through F5 allow for selecting the functions shown on the bottom line of the LCD display.
④	Pacemaker Input Connectors	Connect the pacemaker output cables here so that the pacemaker signal passes through the Analyzer with a variable load selectable from 50 to 2300 ohms (QA45 III only).
⑤	Contact Surfaces	Place the defibrillator paddles directly on these contact surfaces to discharge energy. The energy passes through the Analyzer in the LOW or HIGH defibrillator range. The pacemaker signal (QA45 III only) passes through the Analyzer with a fixed 50 ohm load in the PACE mode.
⑥	Power Switch	Switches the power on and off (1 and 0).
⑦	LCD Display	Shows messages, test results, and function menus.
⑧	Oscilloscope Output	BNC contact for attenuated signal in real time.
⑨	Printer Outlet Port	25 pin D-sub connector
⑩	Location of Batteries	Two compartments in the base of the Analyzer to hold the batteries.
⑪	RS232 Serial Port	9-pin D-sub connector
⑫	High Level ECG Jack	¼ in. standard phone jack for amplitude of 1 V/mV of low level Lead 1 signal.
⑬	Battery Eliminator	Battery eliminator connection.

Startup Screen

The screen shown in Figure 3 appears for two seconds after you have switched the Analyzer on.

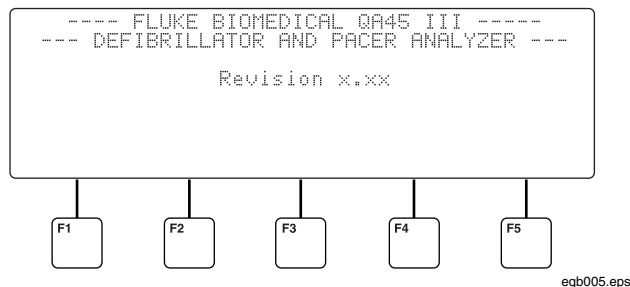


Figure 3. Startup Screen

Defibrillator Mode - Menu and Messages

The menus and messages shown in this section are available when the RANGE switch is in the LOW or HIGH position.

Main Menu

Press **F5** to navigate between pages of the Main menu. For each page, press **F1**, **F2**, **F3**, or **F4** to select the function identified immediately above the key in the LCD

display. Refer to Figures 4, 5, and 6 for views of the available Main menu pages in Defibrillator mode.

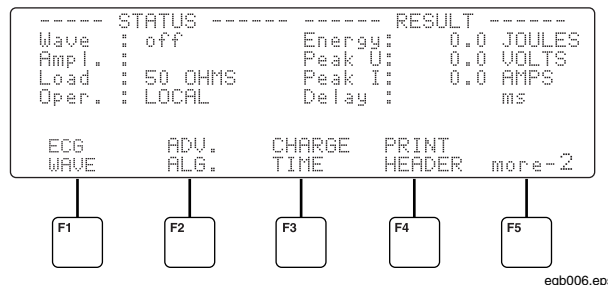


Figure 4. Main Menu Page 1 - Defibrillator

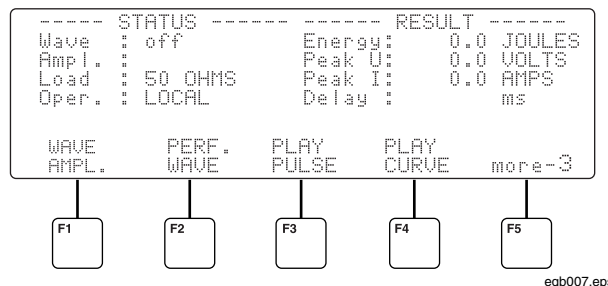
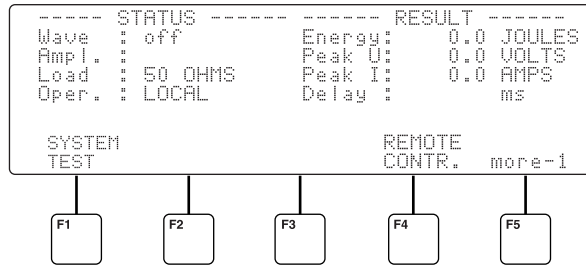


Figure 5. Main Menu Page 2 - Defibrillator



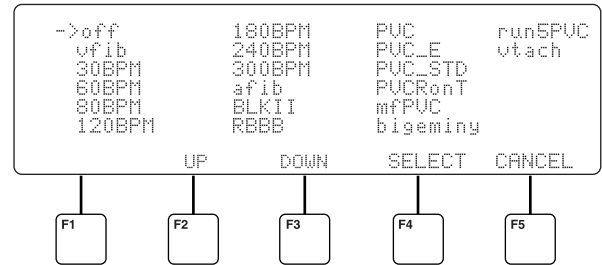
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Figure 6. Main Menu Page 3 - Defibrillator

The following paragraphs and figures describe each selection on the three Main menu pages.

ECG Wave (F1 - Page 1)

Refer to Figure 7 for wave selection.



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Figure 7. ECG Wave - Defibrillator

Select a wave by pressing **UP (F2)** or **DOWN (F3)**, then save this selection under 'Wave' in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

ADV. ALG. (Advisory Algorithms) (F2 – Page 1)

These ECG algorithms test the analysis and prompting feature of automatic and semi-automatic defibrillators. Refer to Figure 8.

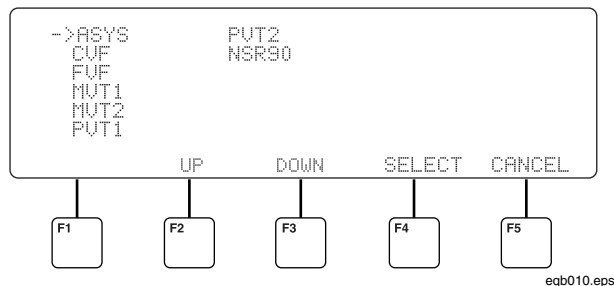


Figure 8. Advisory Algorithms - Defibrillator

Select an algorithm by pressing **UP (F2)** or **DOWN (F3)**, then save this selection under ‘Wave’ in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

CHARGE TIME (F3 – Page 1)

Use **CHARGE TIME** to test the batteries and charging capacitor in the defibrillator. This selection changes the text ‘Delay’ to ‘Chrg T’ in the RESULT field in the Main menu.

PRINT HEADER (F4 – Page 1)

This selection automatically writes a heading for the new test protocol.

WAVE AMPL. (Wave Amplitude) (F1 – Page 2)

Refer to Figure 9 for wave amplitude selection.

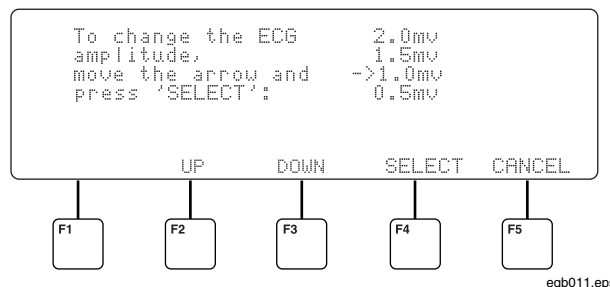
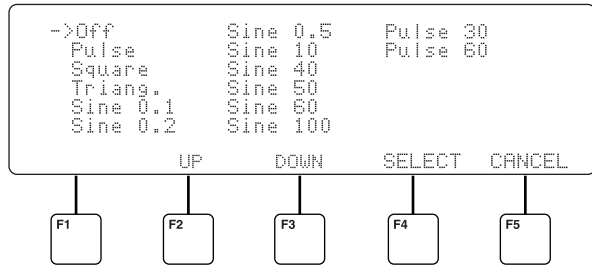


Figure 9. Wave Amplitude - Defibrillator

Choose an amplitude by pressing **UP (F2)** or **DOWN (F3)**. Save the selection under ‘AmpI’ in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

PERF. WAVE (Performance ECG) (F2 – Page 2)

Refer to Figure 10 for wave selection.



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Figure 10. Performance ECG - Defibrillator

Choose a wave by pressing **UP (F2)** or **DOWN (F3)**. Press **SELECT (F4)** to save this selection under 'Wave' in the STATUS field. Press **CANCEL (F5)** to cancel the selection.

Note

The Analyzer uses an internally generated test pulse. The control pulse is set at 5 joules in the low range and 125 joules in the high range. The test pulse is not a calibration pulse; do not use it as an indication of the general accuracy of the Analyzer. The test pulse is a good control for testing functions.

PLAY PULSE (F3 – Page 2)

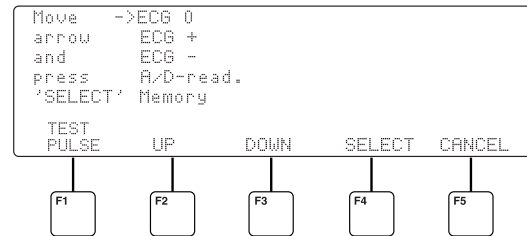
This selection enables playback of the last discharge.

PLAY CURVE/NO CURVE (F4 – Page 2)

This selection initiates automatic playback of the recorded discharge curve. If the menu text is "PLAY CURVE," the Analyzer plays the curve back automatically. If the menu text is "NO CURVE," there is no curve playback.

SYSTEM TEST (F1 – Page 3)

Refer to Figure 11 when selecting System Test.



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Figure 11. System Test - Defibrillator

Choose a test variant by pressing **UP (F2)**, **DOWN (F3)**, or **TEST PULSE (F1)**. Press **CANCEL (F5)** to cancel the selection. ('ECG0', 'ECG+' and 'ECG-' 'A/D-read' Memory' selections are for factory calibration and testing. Refer to the QA40/45 Calibration Manual PN 2765768 for details.)

REMOTE CONTR. (Remote Control) (F4 – Page 3)

This selection enables communication with a PC running test automation software. Required software: Ansur software plug-in.

Pacemaker Mode - Menu and Messages

(QA45 III only)

The menus and messages shown in this section are available when the RANGE switch is in the PACE position.

Main Menu

Refer to Figures 12 and 13 for views of the available Main menu bars in PACE mode.

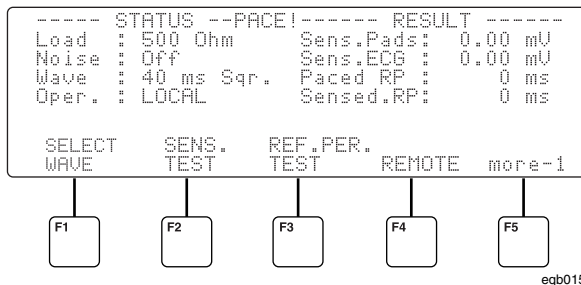


Figure 13. Main Menu Page 2 - Pacer

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SELECT LOAD (F1 – Page 1)

Refer to Figure 14 for load selection.

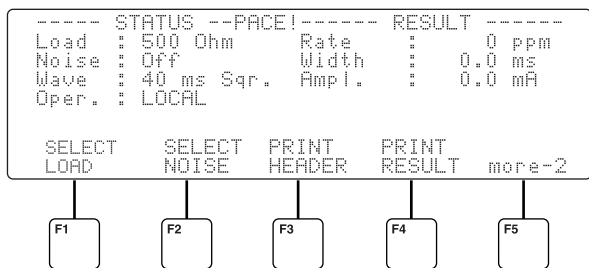


Figure 12. Main Menu Page 1 - Pacer

eqb014.eps

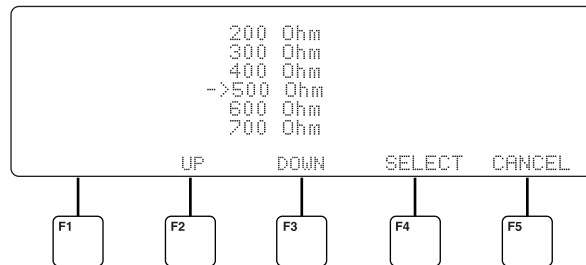


Figure 14. SELECT LOAD (F1) - Pacer

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Select the pacemaker load by pressing **UP (F2)** or **DOWN (F3)**, and then press **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

SELECT NOISE (F2 – Page 1)

Refer to Figure 15 for noise selection.

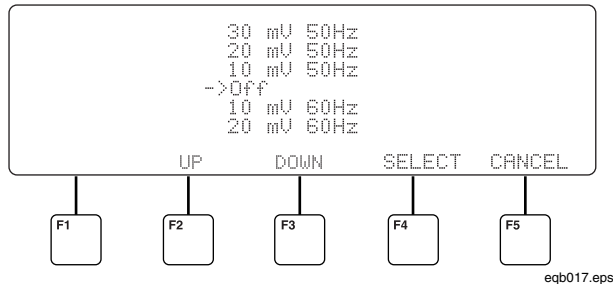


Figure 15. SELECT NOISE (F2) - Pacer

Choose the noise for the immunity test by pressing **UP (F2)** or **DOWN (F3)**, and then press **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

PRINT HEADER (F3 – Page 1)

This selection automatically writes a heading for the new test protocol.

PRINT RESULT (F4 – Page 1)

Use this selection to print measurement results.

SELECT WAVE (F2 – Page 2)

Refer to Figure 16 for wave selection.

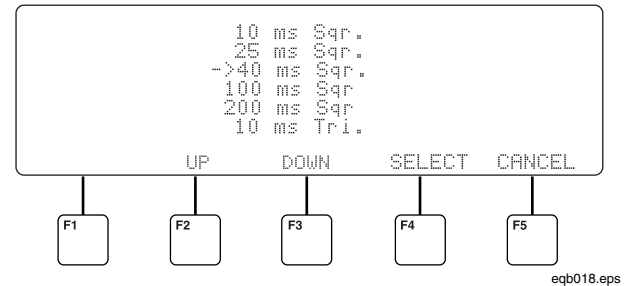


Figure 16. SELECT WAVE (F2) - Pacer

Choose a waveform for the sensitivity test by pressing **UP (F2)** or **DOWN (F3)**, and then press **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

SENS. TEST (Sensitivity Test) (F2 – Page 2)

For this test, sensitivity is the QRS minimum amplitude (mV) required to cause the pacemaker to operate in demand mode. The Analyzer delays this waveform from the pacemaker pulse so that it is outside the pacing refractory period.

REF. PER TEST (Refractory Period) (F3 – Page 2)

Use REF. PER to test the time interval (ms) if the pacemaker is insensitive to any external inputs. It can also measure the maximum time interval after the generation of a pacemaker pulse or the maximum time interval after a QRS wave. See 'Pacing Refractory Period' and 'Sensing Refractory Period'.

REMOTE (Remote Control) (F4 – Page 2)

This selection enables communication with a PC running test automation software. Required software is Ansur plug-in software module.

Test Result Printouts

Defibrillator Mode

The Analyzer automatically sends test results to the printer after each discharge generated. Press **PRINT HEADER (F4)** to print out a page with a new header.

Pace Mode

Press **PRINT RESULT (F4)** in the Main menu to print out the test results after the measurements.

Defibrillator Mode Testing

The defibrillator function of the Analyzer measures the energy output and ensures that the defibrillator complies with specified requirements. The Analyzer includes a built-in load resistance of 50 ohms, which roughly corresponds to the impedance of the human body. Place the defibrillator pads on the Analyzer contact plates to connect the defibrillator through the load resistance. When the defibrillator discharges, the Analyzer calculates and displays the energy delivered.

Defibrillator energy is an integral of the moment of the discharged energy from the defibrillator. The energy is equal to the square of the voltage divided by the load resistance.

$$E = \int p \, dt = \int V^2 / R \, dt = \int V^2 \, dt / R$$

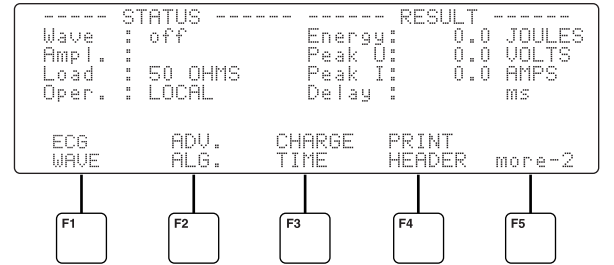
The Analyzer measures and records the voltage pulse 1000 times (every 100 μ s) for a total time of 100 ms. The squares of the voltages are then summed, multiplied by 100 μ s, and divided by the load resistance of 50 ohms.

$$E = \int (V^2) \cdot dt / R = \int (V^2) \cdot 100 \mu\text{s} / 50 \text{ ohms}$$

The unit for energy is *joule*, which is equal to watt/second.

Test Preparation

1. If checking ECG monitoring, prompting, or triggering from the ECG, connect the low-level or high-level ECG connectors to the ten 4 mm AHA color-coded safety terminals or a standard phone jack, as appropriate.
2. Switch on the Analyzer. The startup screen displays for about two seconds.
3. The Main menu then appears (Figure 17). The 'Oper. : LOCAL' line indicates that the test automation software does not remotely control the testing.



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Figure 17. Defibrillator Mode Main Menu

Energy Test

1. Select the energy range using the RANGE switch on the Analyzer front panel.
 - Select the HIGH range for normal adult testing.
 - Select the LOW range for low energy testing, where the energy does not exceed 50 joules and the peak voltage does not exceed 1200 V.

Note

If the input exceeds the maximum voltage for a selected range, the LCD display indicates 'WARNING! Overload'.

- Place the defibrillator paddles securely on the Analyzer contact plates to discharge the defibrillator. Connect the APEX (+) pad to the right-hand plate and the STERNUM pad to the left plate. This arrangement ensures correct signal polarity for the oscilloscope output. A reversal of this configuration does not damage the Analyzer, nor does it give incorrect energy readings. However, the polarity of the oscilloscope output simply reverses. The discharge from the defibrillator transfers to the Analyzer load resistance.
- The Analyzer calculates the energy delivered over the load resistance and displays the result in joules under **RESULT**, as shown in Figure 18.

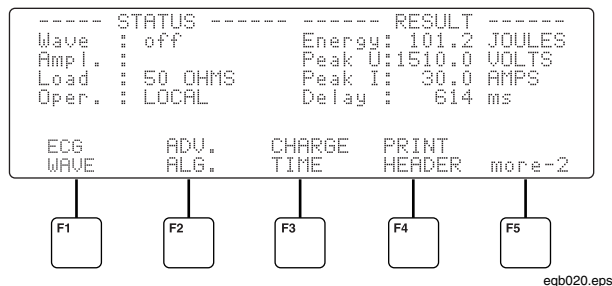


Figure 18. Energy Test Results

The Analyzer also shows the energy measured, the maximum voltage, and the maximum current in the energy wave. Following a discharge from the defibrillator, the Analyzer shows a playback of the wave from the ECG output. The display is in playback mode, and the Analyzer automatically prints out the result. The Analyzer can generate a new pulse again when the LCD display shows 'Oper. : LOCAL'.

- Repeat the discharged pulse by pressing **more-2 (F5)** to advance to page 2 of the Main menu as shown in Figure 19.

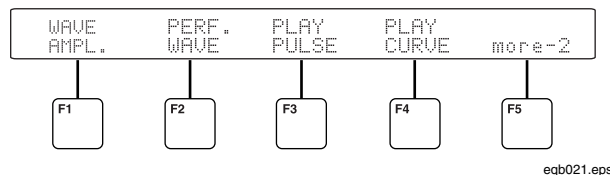


Figure 19. Main Menu - Page 2

- Press **PLAY PULSE (F2)**. The display shows 'Oper: Playback' and displays the result in joules under **RESULT**, as shown in Figure 20.

Table 2. ECG Wave Selections

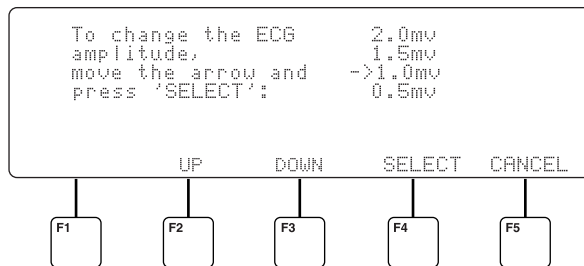
Selection	ECG Arrhythmia Type
vfib	Ventricular Fibrillation
afib	Atrial Fibrillation
BLKII	Second Degree Block Type I
RBBB	Right Bundle Branch Block
PAC	Premature Atrial Contraction
PVC_E	Early PVC
PVC_STD	PVC
PVCRonT	R on T PVC
mfPVC	Multifocal PVC
bigeminy	Bigeminy
run5PVC	Bigeminy Run of 5 PVCs
vtach	Ventricular Tachycardia
Normal Sine Rates: 30, 60, 80, 120, 180, 240, 300 BPM	

- Select a wave by pressing **UP (F2)** or **DOWN (F3)**. Save this selection under "Wave" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

The Analyzer includes the following ECG wave amplitude options: 0.5 mV, 1.0 mV, 1.5 mV, and 2.0 mV.

- To change wave amplitude, press **more-2** on the Main menu, and then press **WAVE AMPL. (F1)**.

The Wave Amplitude menu appears, as shown in Figure 22.



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Figure 22. Wave Amplitude Menu

- Select the amplitude by pressing **UP (F2)** or **DOWN (F3)**. Save this selection under 'Ampl' in the STATUS

field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

5. Set the defibrillator to synchronized cardioversion mode. Discharge the defibrillator over the Analyzer load resistance.

The Analyzer measures the time delay in milliseconds (ms) between the top of the R wave and the discharging of the defibrillator pulse. This delay appears in the LCD display as 'Delay: xxx ms'.

The Analyzer also shows the energy measured, the maximum voltage, and the maximum current in the energy wave. Following the discharge from the defibrillator, the Analyzer shows a playback of the wave from the ECG output. You can generate a new pulse when the LCD display shows 'Oper. : LOCAL'.

Maximum Energy Charging Time Test

The Analyzer uses the charge time function to test the batteries and the charging capacitor in the defibrillator.

1. Set the defibrillator to maximum energy.
2. Securely place the defibrillator paddles on the Analyzer contact plates, and discharge the defibrillator. Connect the APEX (+) pad to the right-hand plate and the STERNUM pad to the

left-hand plate. This arrangement ensures correct signal polarity for the oscilloscope output. A reversal of this configuration does not damage the Analyzer, nor does it give incorrect energy readings. However, the polarity of the oscilloscope output simply reverses. The discharge from the defibrillator transfers to the Analyzer load resistance.

3. Simultaneously press **CHARGE TIME (F3)** from the Main menu and the charge button on the defibrillator.
4. When the defibrillator is charged, discharge it through the Analyzer.
5. Charging time appears in the display as 'Chrg T: xx.x ms' under RESULT. See Figure 23.

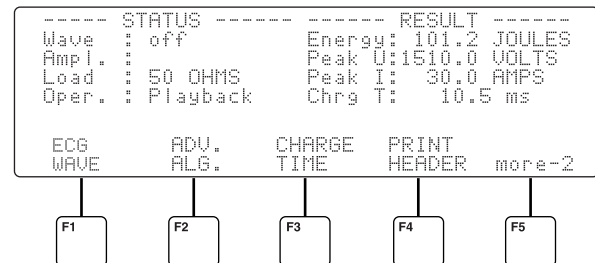


Figure 23. Charging Time

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Shock Advisory Algorithm Test

This test checks the analysis and prompting of automatic and semi-automatic defibrillators. A series of arrhythmia types is available for analysis. The defibrillator should prompt the user to 'shock' or 'no shock,' in accordance with national and international guidelines, as shown in Table 3.

Table 3. Shock Advisory

Arrhythmia	Action
ASYS	No shock
NSR90	No shock
PVT1	No shock
MVT1	No shock
CVF	Shock
FVF	Shock
PVT2	Shock
MVT2	Shock

1. Press **ADV. ALG. (F2)** from the Main menu.

The Advisory Algorithms menu opens. See Figure 24.

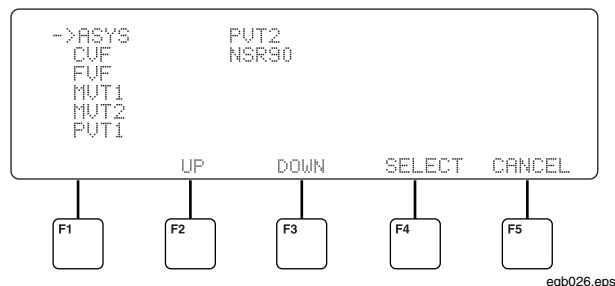


Figure 24. Advisory Algorithms Menu

2. Select the rhythm by pressing **UP (F2)** or **DOWN (F3)**. Save this selection under "Wave" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection.

The ECG signal passes through the low-level ECG connectors, high-level ECG connector, and paddle contact plates on the Analyzer.

3. Set the defibrillator to analyze the ECG rhythm and operate in the automatic and semi-automatic mode.
4. Record the defibrillator response.

Pacemaker Mode Testing

(QA45 III only)

The Analyzer tests all types of transcutaneous pacemakers. The testing is menu-driven and simple to operate. The Analyzer measures and displays pacemaker pulse amplitude, rate, and width. It also conducts demand sensitivity tests, measures and displays refractory periods, and conducts immunity tests, which determine pacemaker susceptibility to 50/60 Hz interference.

Test Preparation

1. Connect the pacemaker output cables to the pacemaker input connectors.
2. Switch the RANGE switch to PACE mode.
3. Switch on the Analyzer.

After two seconds, the Main menu appears.
4. Press **SELECT LOAD (F1)** to display the load options shown in Figure 25.

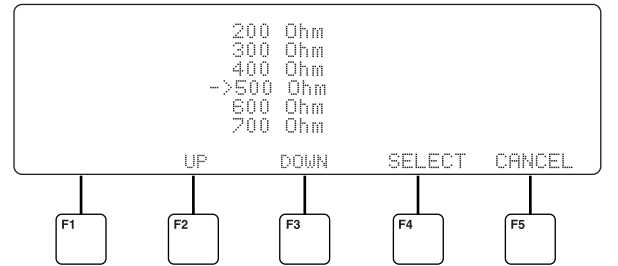


Figure 25. Load Options

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- The load range is 50 to 2300 ohms in steps of either 50 ohms from 50 to 200 ohms or 100 ohms from 200 to 2300 ohms
5. Select the load by pressing **UP (F2)** or **DOWN (F3)** and then press **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection. After you select the load, the Main menu reappears.
 6. Select the waveform by pressing **UP (F2)** or **DOWN (F3)** and then press **SELECT (F4)**. After you select the waveform, the Main menu reappears. Press **CANCEL (F5)** to cancel the selection.

Immunity Testing

The immunity test determines pacemaker susceptibility to 50/60 Hz interference signals.

- To test immunity simultaneously with other testing, press **SELECT NOISE (F2)** from the Main menu. The options shown in Figure 26 appear.

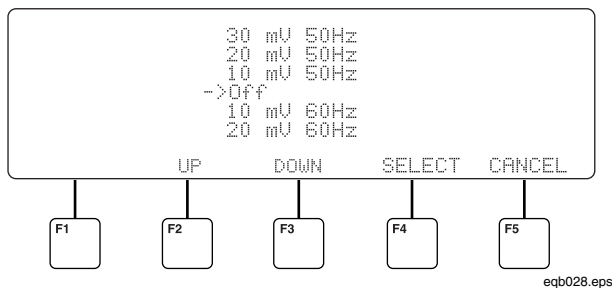


Figure 26. Immunity Test

- Select the noise form by pressing **UP (F2)** or **DOWN (F3)** and then press **SELECT (F4)**. After you select the noise, the Main menu reappears. Press **CANCEL (F5)** to cancel the selection.

Demand Sensitivity Test

Demand sensitivity is the minimum QRS amplitude (mV) required to cause the pacemaker to operate in the demand mode. During sensitivity measurement, three different waveforms are selectable with widths varying in steps from 10 to 200 ms. The Analyzer delays this waveform from the pacemaker pulse so that it is outside the pacing refractory period. The Analyzer then checks whether the pacemaker senses this wave.

With a non-sensed wave, an "exceeded" message appears indicating that the pacemaker needs an amplitude of more than 100 mV for sensing at that setting. With a sensed wave, the Analyzer reduces the amplitude in steps until it reaches the lowest value required for the pacemaker to sense it. The internal algorithm used converges to the lowest value in the least number of cycles. The lowest value is the sensitivity.

- Press **more-2** in the Main menu, and then press **SELECT WAVE (F1)**.

The menu shown in Figure 27 appears:

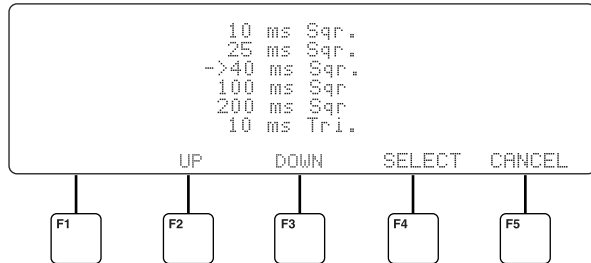


Figure 27. Select Wave Menu

2. Select the waveform by pressing **UP (F2)** or **DOWN (F3)** and then press **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection. After you select the waveform, the Main menu reappears.
3. Press **SENS. TEST (F2)**. The screen shown in Figure 28 appears.

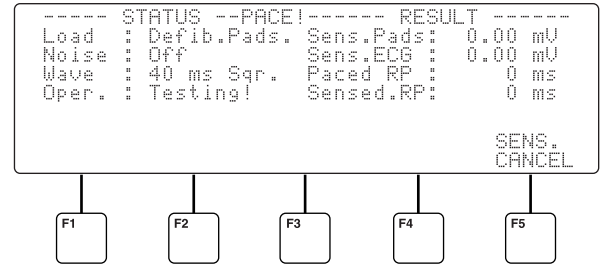


Figure 28. Sens. Test

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4. Upon completion of testing, the results appear under **RESULT** as shown in Figure 29. Press **SENS. CANCEL (F5)** to cancel the test.

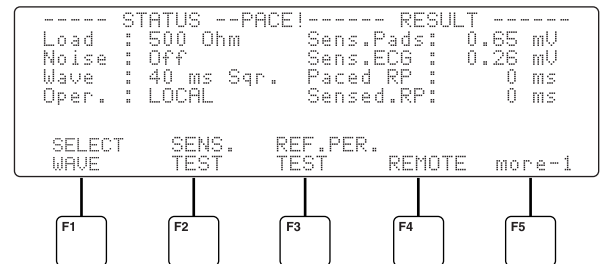


Figure 29. Sens. Test Results

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Refractory Period Test

Use this test to measure the time interval in milliseconds (ms) during which the pacemaker is insensitive to any external inputs. The Analyzer does this by measuring the maximum time interval after the generation of a pacemaker pulse and the maximum time interval after a QRS wave.

The Refractory Period is a time interval in milliseconds, during which a pacemaker is insensitive to any external inputs. If a QRS occurs during this period, the pacemaker ignores it. On the other hand, if a QRS occurs outside the refractory interval, the pacemaker resets its internal timer, and the next pacemaker pulse begins after a delay of one time period from this QRS wave.

Paced Refractory Period

The paced refractory period is the maximum time interval (after the generation of a pacemaker pulse) during which the pacemaker ignores the presence of a QRS wave.

The measurement of the paced refractory period requires a few cycles of the pacemaker output. First, the Analyzer measures the pacer-to-pacer interval T. The Analyzer then puts out a square wave 40 ms wide that is delayed by delay time D. Delay time D is more than the paced refractory period, measured from the last pacemaker pulse.

The pacemaker senses this square wave. The delay time D is gradually decremented in subsequent cycles until the pacemaker ceases sensing the square wave. The paced refractory period is the maximum value of the delay time D (during which the pacemaker does not sense the square wave.)

Sensed Refractory Period

The sensed refractory period is the maximum time interval after the pacemaker senses a QRS wave during which it ignores the presence of a second QRS wave.

The Analyzer measures the sensed refractory period in a similar manner, except that the Analyzer now generates two square waves instead of one. It generates the first square wave at a fixed time delay from a pacemaker pulse, which is greater than the paced refractory period. The pacemaker always senses this square wave.

The Analyzer generates the second square wave at a delay D from the first square wave. It selects the initial value of D to be greater than the sensed refractory period. Therefore, the first time the pacemaker is on, it also senses the second square wave. In subsequent cycles, the Analyzer gradually reduces delay D until the pacemaker is unable to sense the second square wave.

The maximum value of D, for which the pacemaker does not sense the second square wave, is the sensed refractory period.

1. From the Main menu, press **more-2** and then press **REF. PER. TEST (F3)**.

The display shown in Figure 30 appears while testing.

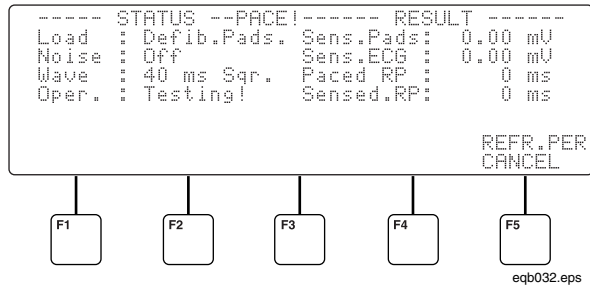


Figure 30. Refractory Period Test

2. Upon completion of testing, the results appear under **RESULT**. See Figure 31. Press **REF. PER. CANCEL (F5)** to end the test.

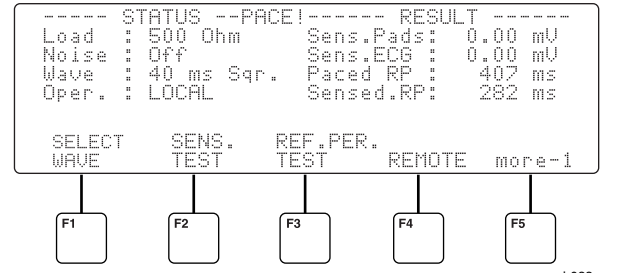


Figure 31. Refractory Period Test Results

