QA-45 Mk III
User Manual

QA-45 Mk III
Defibrillator and Transcutaneous Pacemaker Analyzer

P/N 13061

Warranty and Product Support

Fluke Biomedical warrants this instrument against defects in materials and workmanship for one full year from the date of original purchase. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to Fluke Biomedical. This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by other than Fluke Biomedical. IN NO EVENT SHALL FLUKE BIOMEDICAL BE LIABLE FOR CONSEQUENTIAL DAMAGES.

Only serialized products and their accessory items (those products and items bearing a distinct serial number tag) are covered under this one–year warranty. PHYSICAL DAMAGE CAUSED BY MISUSE OR PHYSICAL ABUSE IS NOT COVERED UNDER THE WARRANTY. Items such as cables and non-serialized modules are not covered under this warranty.

Recalibration of instruments is not covered under the warranty.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state, province to province, or country to country. This warranty is limited to repairing the instrument to Fluke Biomedical's specifications.

Warranty Disclaimer

Should you elect to have your instrument serviced and/or calibrated by someone other than Fluke Biomedical, please be advised that the original warranty covering your product becomes void when the tamper-resistant Quality Seal is removed or broken without proper factory authorization. We strongly recommend, therefore, that you send your instrument to Fluke Biomedical for factory service and calibration, especially during the original warranty period.

Notices

All Rights Reserved

Copyright Release

Fluke Biomedical agrees to a limited copyright release that allows you to reproduce manuals and other printed materials for use in service training programs and other technical publications. If you would like other reproductions or distributions, submit a written request to Fluke Biomedical.

Unpacking and Inspection

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.

Technical Support

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

Claims

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.

Standard Terms and Conditions

Refunds and Credits

Please note that only serialized products and their accessory items (i.e., products and items bearing a distinct serial number tag) are eligible for partial refund and/or credit. Nonserialized parts and accessory items (e.g., cables, carrying cases, auxiliary modules, etc.) are not eligible for return or refund. Only products returned within 90 days from the date of original purchase are eligible for refund/credit. In order to receive a partial refund/credit of a product purchase price on a serialized product, the product must not have been damaged by the customer or by the carrier chosen by the customer to return the goods, and the product must be returned complete (meaning with all manuals, cables, accessories, etc.) and in “as new” and resalable condition. Products not returned within 90 days of purchase, or products which are not in “as new” and resalable condition, are not eligible for credit return and will be returned to the customer. The Return Procedure (see below) must be followed to assure prompt refund/credit.

Restocking Charges

Products returned within 30 days of original purchase are subject to a minimum restocking fee of 15 %. Products returned in excess of 30 days after purchase, but prior to 90 days, are subject to a minimum restocking fee of 20 %. Additional charges for damage and/or missing parts and accessories will be applied to all returns.

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, go to 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: 1-800-850-4606
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.

Restrictions and Liabilities

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 QA-45 Mk III is manufactured in Norway for Fluke Biomedical, Everett, WA, U.S.A.

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Manual Revision Record

This page is for recording revisions to your *QA-45 Mk III User Manual* that have been published by Fluke Biomedical or its authorized representatives. We recommend that only management or the primary facility representative be authorized to process changes and revisions to publications:

- Make the pen changes or insert the revised pages;
- Ensure that obsolete pages are withdrawn and either disposed of immediately, or marked as superseded and placed in a superseded document file; and
- Enter the information below reflecting that the revisions have been entered.

Rev No	Date Entered	Reason	Signature of Person Entering Change
3.00-1	2005.06.06	First revision for QA-45 Mk III	MCB Fluke Biomedical BMS GS Fluke Biomedical Europe

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1. Introduction

This chapter describes the QA-45 Mk III Defibrillator / Transcutaneous Pacemaker Analyzer features and specifications.

1.1 QA-45 Features

The QA-45 Mk III is a precision instrument for testing external defibrillators and transcutaneous pacemakers. It is intended to be used 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 QA-45 Mk III defibrillator functions measure delivered energy output, cardioversion sync-delay time and charge time of the defibrillator under test. The QA-45 Mk III has an internal, non-inductive, 50-ohm test load which approximates the impedance of the human chest or thoracic cavity. The high-voltage defibrillator output is applied across the QA-45 Mk III internal test load via its two top panel contact plates. The QA-45 Mk III is compatible directly 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), a wide range of shock advisory ECG waveforms, including polymorphic ventricular tachycardia, can be generated by the
QA-45 Mk III. When the defibrillator is discharged, the QA-45 Mk III calculates and displays results.

The QA-45 Mk III pacer function tests all types of transthoracic pacemakers. The QA-45 Mk III measures and displays output pulse: amplitude, rate, energy 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 pacer input variable load (26 selections) is available to simulate the impedance of the human chest or thoracic cavity.

Additionally, the QA-45 Mk III has a wide range of ECG normal, performance and arrhythmia simulation selections for testing ECG monitors and recorders in formats up to 12-lead.

1.2 Defibrillator Analyzer Specifications

1. Energy Output Measurement

High Range

Maximum voltage	5000 volts
Maximum current	120 amperes
Maximum energy	1000 Joules
Accuracy	± 2 % of reading for >100 Joules
	± 2 Joule of reading for <100 Joules
Trigger level	100 volts
Playback amplitude	1 mV/1000 V Lead I
Test pulse	125 ± 20%

Low Range

Maximum voltage	1000 volts
Maximum current	24 amperes
Maximum energy	50 Joules
Accuracy	± 2% of reading for >20 Joules
	± 2 Joule of reading for <20 Joules
Trigger level	20 volts
Playback amplitude	1 mV/200 V Lead I
Test pulse	5 Joules ± 20%
Load Resistance	50 ohms ± 1%, non-inductive (<1 μH)
Display Resolution	0.1 Joules
Measurement Time Window	100 ms (4 uS sample rate)
Absolute Max. Peak Voltage	6000 volts
Maximum pulse width	100 ms
Sample rate	250 kHz (4 us slice width)

Oscilloscope Output

High measure range	1000:1 amplitude-attenuated
Low measure range	200:1 amplitude-attenuated

Waveform Storage And Playback

Discharge can be viewed via ECG outputs and paddles.

Output: 200:1 Time Base expansion.

Cardioversion / Sync Time Measurements

Timing window	Starts - 40 ms at each R-wave peak.
Test waveforms	All waveform simulations available.
Range	0 to 99.9 ms
Delay time accuracy	± 1 ms

Charge Time Measurement

From 0.1 seconds to 99.9 seconds.

2. **ECG Wave**

ECG General

Lead configuration	12-lead simulation. RL, RA, LA, LL, V1-6	
Output impedance	Limb leads	1000 ohms to RL
	V Leads	1000 ohms to RL

All other signals are in relative proportion to Lead amplitude as follows: The amplitudes are shown for a Lead I amplitude by 1 mV:

Lead I	1.0 mV (LA - RA)
Lead II	1.5 mV (LL - RA)
Lead III	0.5 mV (LL - LA)
V Lead	1.5 mV (V - 1/3 (LL+LA+RA))

High Level Output (ECG Jack)

1/4" 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 seconds 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 second DC pulse and 0.5 Hz sine
Band Pass	10 Hz sine
Monitor-3dB	40 Hz sine
Diagnostic-3dB	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
blk II	Second degree A-V block
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
SVTa_90	Supraventricular Tachycardia @ 90 BPM
PVT_140	Polymorphic Ventricular Tachycardia @ 140 BPM
PVT_ 160	Polymorphic Ventricular Tachycardia @ 160 BPM
MVT_140	Monomorphic Ventricular Tachycardia @ 140 BPM
MVT_160	Monomorphic Ventricular Tachycardia @ 160 BPM
CVF	Coarse Ventricular Fibrillation
FVF	Fine Ventricular Fibrillation

1.3 Transcutaneous Pacemaker Analyzer Specifications

1. TEST LOAD SELECTIONS

Pacer input fixed load: 50 ohms ± 1%, non-inductive (<1 μH) (Defib load)

Pacer input variable load:

50 to 2300 ohms and open circuit

50 to 200 ohms: 50-ohm steps

200 to 2300 ohms: 100-ohm steps

Open circuit simulation = 43.8k-ohms

Accuracy	50 - 1300 ohm ±2.5%
	1400 - 2300 ohm ±5 %

Oscilloscope Output

50 - 150 ohm	10.24:1 amplitude attenuation
200 - 500 ohm	41:1 amplitude attenuation
600 - 2300 ohm	164:1 amplitude attenuation

2. PULSE MEASUREMENTS

Amplitude	4 to 250 mA (100 ohm load)
Accuracy	±5 % or ±0.5 mA
Max. Amplitude	300 mA all loads
Rate	30 to 250 ppm
Accuracy	±1% or 2 ppm
Pulse width	1 to 50 ms
Accuracy	±0.5 ms

3. DEMAND SENSITIVITY TEST

Waveforms	Square(SQR), Triangle(TRI), and Haversine (SSQ)
ECG output	Amplitude 0 - 4 mV
	Resolution 40 μV
Pacer input (Load depended)	
Amplitude (50 ohm)	0 - 10 mV
Resolution (50 ohm)	40 μV
Amplitude: (≥500 ohm)	0 - 100 mV
Resolution: (≥500 ohm)	1 mV
Defib. Pads Amplitude	0 - 10 mV
Resolution	0.1 mV
Waveform width	10, 25, 40, 100 and 200 ms
Pacer rate	30 to 120 ppm

4. IMMUNITY TEST

50/60 Hz Interference Signal

ECG output	0 - 4 mV peak in steps of 0.4 mV
Pacer input	(Load dependent)
	0 - 10 mV peak in steps of 1 mV (50 ohm)
	0 - 100 mV peak in steps of 10 mV (≥500 ohm)
Defibrillator pads	0 - 10 mV peak in steps of 1 mV

5. REFRACTORY PERIOD MEASUREMENT

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

1.4 General Information

Temperature Requirements

+15°C to +35°C when operating

0°C to +50°C in storage

Display

Type	LCD graphic display
Alphanumeric format	6 lines, 40 characters

Data Input/ Output (2)	Parallel printer port (1); Bi-directional RS -232C (1) for Computer control
Power	6xAA 1.5 volt alkaline batteries Duracell® PC1500 for 25 hours (approx) or Battery Eliminator

Mechanical Specifications

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)	HP DeskJet 500C HP DeskJet 550C Canon BJ -10SX.

Standard Accessories	Model	Item#
110 VAC Adapter (9V Battery Eliminator)	17027	2462085
Internal paddle-contact adapter	13403	2461709
Snap-to-banana adapters (Set of 10)	17024	2462072
User Manual QA-45	13061	

Optional Accessories

Defib/Pace Adapter (Physio-Control Quik Combo)	13411	2461711
Pace Adapter (Physio-Control Quik Pace)	13428	2461753
240 VAC Adapter (9V Battery Eliminator)	17021	2462060
Data Transfer Cable (RS-232)	15703	2461993
Carrying Case (QA-40M/45)	13422	2461730
ANSUR QA-45 Mk III software	13600	

Storage

Store in the carrying case in dry surroundings within the temperature range specified, without battery. There are no other storage requirements.

Periodic Inspection

The unit should be calibrated every 12 months.

2. Installation

This chapter explains unpacking, receipt inspection and claims, and the general procedures for QA-45 Mk III setup.

2.1 Receipt, Inspection and Return

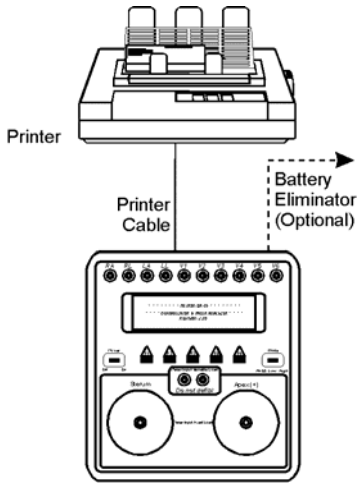
1. Inspect the outer box for damage.
2. Carefully unpack all items from the box and check to see that you have the following items:
   - QA-45 Mk III Defibrillator/Transcutaneous Pacemaker Analyzer
   - Battery Eliminator (115V or 220V)
   - Internal paddle-contact adapters (2)
   - Snap-to-banana adapters (10 pack)
   - QA-45 Mk III User manual
   - 6xAA 1.5 V batteries
3. If you note physical damage, or if the unit fails to function according to specification, inform the supplier immediately. When Fluke Biomedical or the company's representative, is informed, measures will be taken to either repair the unit or dispatch a replacement.
4. When returning an instrument to Fluke Biomedical, or the company representative, fill out the address label, describe what is wrong with the instrument, and provide the model and serial numbers. If possible, use the original packaging material for return shipping. Otherwise, repack the unit using the following:
   - A reinforced cardboard box, strong enough to carry the weight of the unit.
   - At least 5 cm of shock-absorbing material around the unit.
   - Nonabrasive dust-free material for the other parts.

   Repack the unit in a manner to ensure that it cannot shift in the box during shipment.

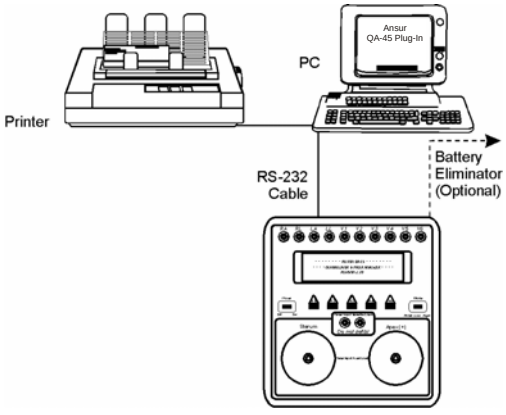
   The product warranty is on page ii of this manual. The warranty does not cover freight charges. C.O.D. will not be accepted without authorization from Fluke Biomedical or its representative.

2.2 Setup

1. Equipment connection is as shown in the typical setup below.



2. If automation software is being used, attach an RS-232 (null modem/data transfer configured) cable to the 9-pin D-sub outlet port located at the rear of the QA-45 Mk III. Do not attach the printer cable to the QA-45 Mk III. *See below*. However, if you are not using automation software, and are sending directly to a printer for printouts, attach the printer cable to the 25-pin outlet port.



NOTE
Some RS-232C cables are missing the connection between the seventh and the eighth wires in the cable. The cable may still be called NULL-modem, but it will not work with the QA-45. Refer to the Automation Software Users Manual for more information.

2.3 Power

1. **Main On/Off Switch.** QA-45 Mk III should remain off for at least 5 seconds before switching on again, in order to allow the test circuits to discharge fully.

2. **Low Battery Power.** If battery power falls below 6.9 volts (± 0.3 volts), the display will show 'Change battery, and reset system'. This means that the battery should either be replaced or the instrument should be connected to a battery eliminator. The main switch has to be switched off and then on again in order to use the instrument.

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

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

4. **Battery Eliminator**
The AC Adapter plug-in power supply transformer allows you to use the QA-45 Mk III anywhere a standard electrical outlet is available. To attach the AC Adapter, insert the adapter's small connector into the micro jack labeled "Batt. Elim. 9V DC" on the right rear of the unit. Plug the large connector into the nearest standard electrical outlet.

NOTE
Remove the batteries and disconnect the AC Adapter if you do not intend to use the QA-45 for an extended period

2.4 Internal Paddles

To be able to test defibrillators with internal paddles, an internal paddle adapter has to be used. These contacts have a banana plug that is attached to the standard paddle contact and is protected by a plastic insulation washer.

2.5 Special Contacts

Certain defibrillators (automatic models and those with pacer options) have special contacts that are fastened to the electrodes attached to the patient. Fluke Biomedical has special adapters to suit most of these defibrillators. These are available as optional accessories. Consult factory for availability.

2.6 Ansur Software Plug-in Module for the QA-45 Mk III

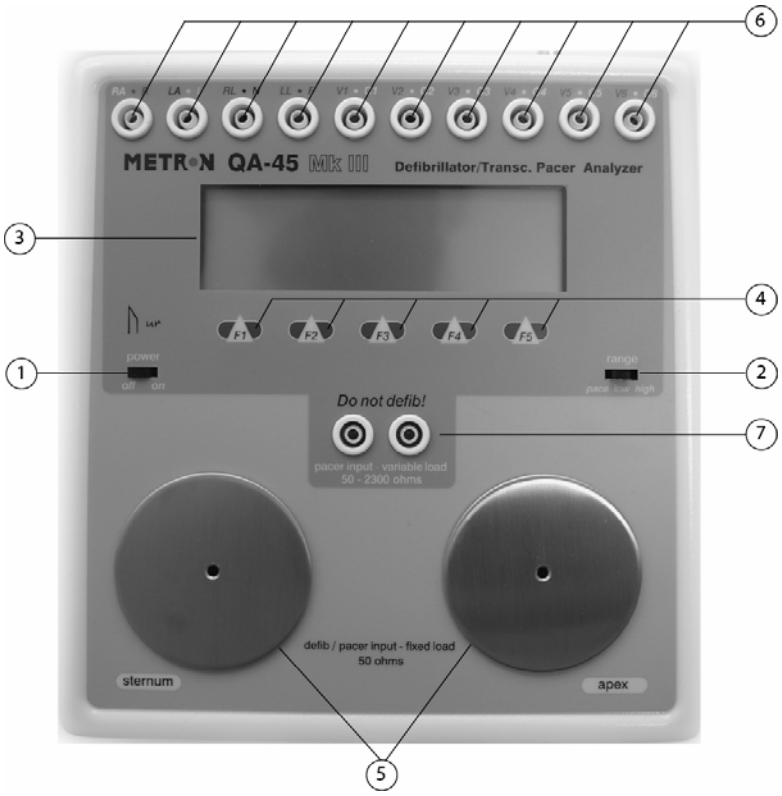
Test automation software for the QA-45 Mk III Defibrillator / Transcutaneous Pacemaker Analyzer is available from Fluke Biomedical. The program features can be used to enhance your defibrillator and pacemaker maintenance program. Contact factory for availability and pricing information.

3. Operating QA-45

This chapter explains the operating controls, switches and menus of the QA-45 Mk III, details how to use them in testing, and provides general information on printouts and operator maintenance.

3.1 Control Switches and Connections

Top Panel

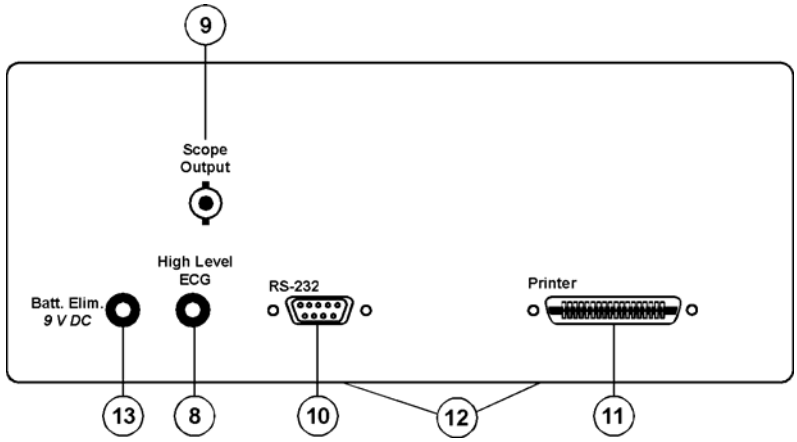


1.	**Power Switch**	Turns the power on and off.
2.	**Mode Switch**	Switches between PACE and Low / High ranges of defibrillator energy.
3	**LCD Display**	Shows messages, test results and function menus.
4	**Function Keys**	Fl - F5 are used to select the functions shown on the bottom line of the LCD display, i.e., for selecting the function that is directly above the key.
5.	**Contact Surfaces**	The defibrillator's paddles are placed on these so that the discharged energy passes through the instrument in defib. mode and that the pacer signal passes through the instru-

ment with a fixed 50 ohm load in the PACE mode.

6.	**Low Level ECG Connectors**	10 color-coded 4 mm safety terminals with snap-to-banana adapters.
7.	**Pacer Input Connectors**	The pacer output cables are connected to these so that the pacer signal passes through the instrument with a variable load selectable from 50 to 2300 ohms.

Rear Panel



8.	**High Level ECG Jack**	1/4” standard phone-jack for amplitude of 1 V/mV of low level Lead 1 signal.
9.	**Oscilloscope Output**	BNC-contact for attenuated signal in real time.
10.	**RS-232 Serial Port**	9-pin D-sub
11.	**Printer Outlet Port**	14-25 pin D-sub
12.	**Location of Batteries**	2 compartments in the base of the instrument can be opened to replace the batteries.
13.	**Battery Eliminator Socket**	Battery contact for connecting battery eliminator.

3.2 QA-45 Menu and Function Keys

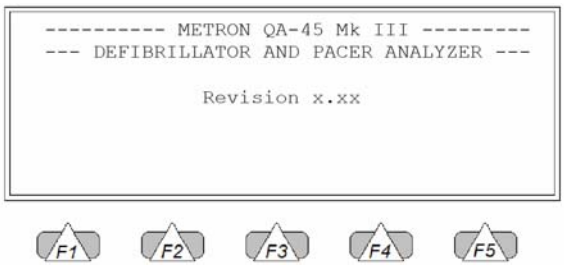
The QA-45 Mk III uses display and programmable function keys to provide flexibility and control over the operations. The upper part of the screen displays messages, status and results. The menu bar is at the bottom of the display. The function keys are numbered from Fl to F5.

A function is selected by pressing the key located directly under the Menu Item displayed in the menu bar. A menu unit is written in capital letters.

The menu comprises three pages. The next pages of the menu are selected by pressing **more-2**, **more-3** or **more-1**.

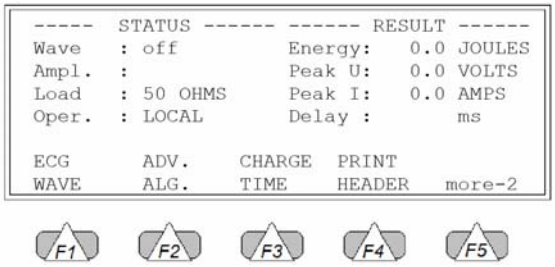
3.3 Menu and Messages: Defibrillator Mode

1. **Startup Screen**. The following screen will be displayed for 2 seconds after the QA-45 Mk III has been switched on.

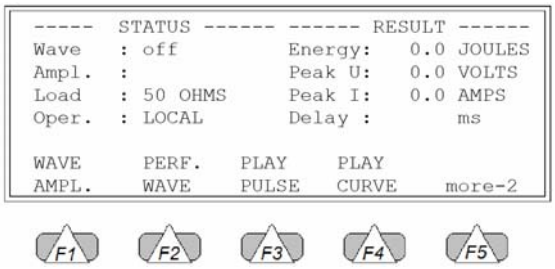


2. **Main Menu**

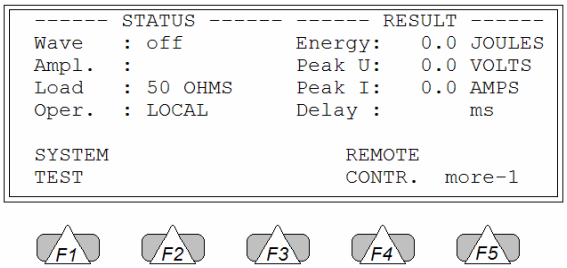
   a. Main Menu Bar (Page 1) - Mode switch in Low or High position.



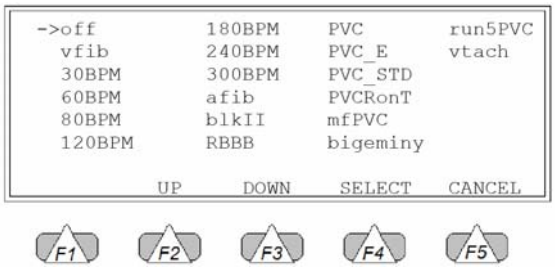
   b. Second Menu Bar (Page 2)



   c. Third Menu Bar (Page 3)

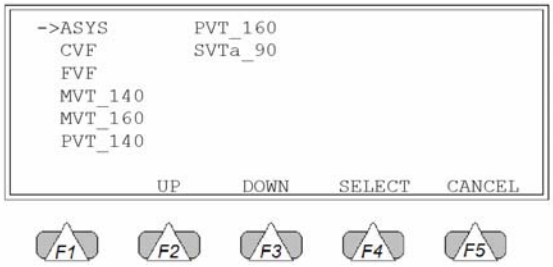


3. **ECG WAVE (F1)**



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

4. **ADV. ALG. (Advisory Algorithms) (F2)**.

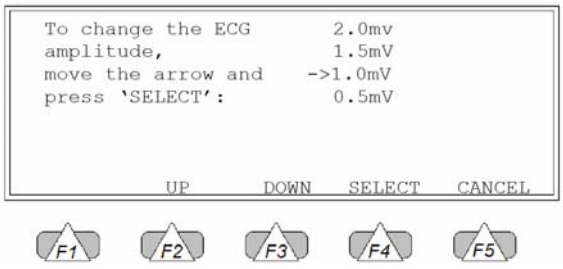


These ECG algorithms are meant to test the analysis and prompting feature of automatic and semi-automatic defibrillators. Choose desired selection by pressing **UP (F2)** or **DOWN (F3)**. Save this under 'Wave" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

5. **CHARGE TIME (F3).** Used to test the battery and charging capacitor in the defibrillator. It changes the text 'Delay' to 'Chrg T' in the RESULT field in the main menu.

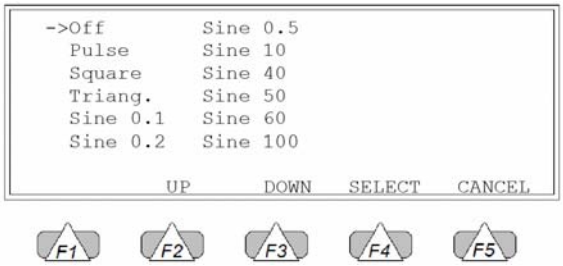
6. **PRINT HEADER (F4).** Automatically writes a heading for the new test protocol.

7. **WAVE AMPL. (Wave Amplitude) (F1).**



Choose desired amplitude by pressing **UP (F2)** or **DOWN (F3)**. Save this under 'Ampl" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

8. **PERF. WAVE (Performance ECG) (F2).**

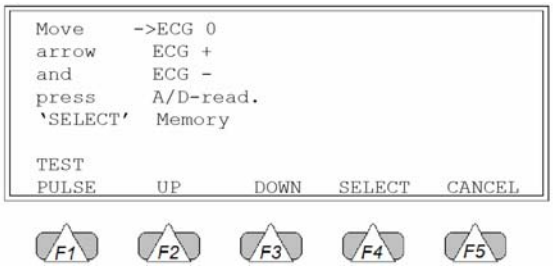


Choose desired wave by pressing **UP (F2)** or **DOWN (F3)**. Save this under 'Wave" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

9. **PLAY PULSE (F3)** enables playback of the last discharge.

10. **PLAY CURVE/NO CURVE (F4)** toggles automatic playback of the recorded discharge curve. The button text indicates the current setting.

11. **SYSTEM TEST (F1) .**



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

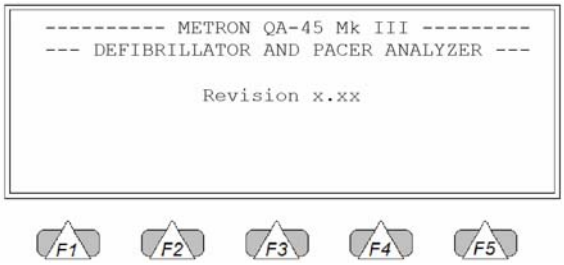
12. **REMOTE CONTR. (Remote Control) (F4)** enables communication with a PC with test automation software. Required software: PRO-Soft QA-40/45 or ANSUR Software plug-in.

Note

QA-45 MK III has an internally generated test pulse. The control pulse is set at 1.2 Joules in the Low range and 28.5 Joules in the High range. The test pulse is not a calibration pulse, and should not be used as an indication of the general accuracy of the instrument. The test pulse is a good control for testing functions.

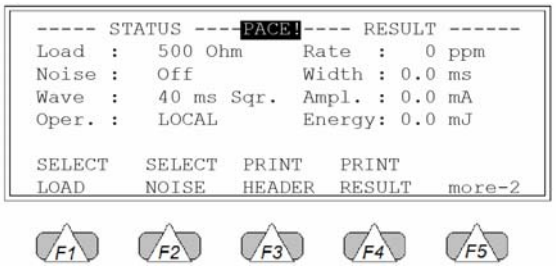
3.4 Menu and Messages: Transcutaneous Pacemaker Mode

1. **Startup Screen**. The following screen will be displayed for 2 seconds after the QA-45 has been switched on.

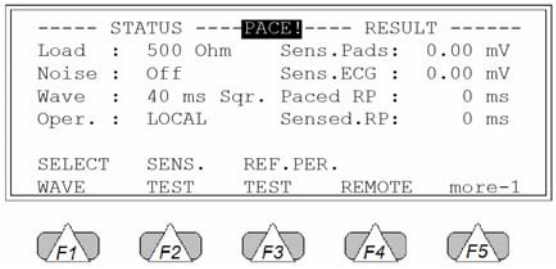


2. **Main Menu**

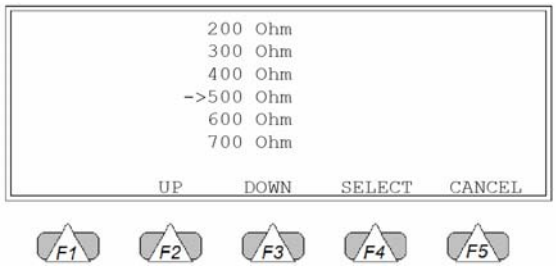
a. Main Menu Bar (Page 1) - Mode switch in PACE position.



b. Second Menu Bar (Page 2)

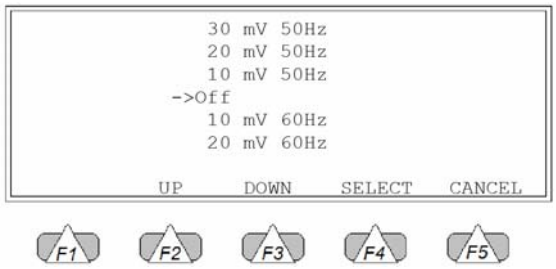


3. **SELECT LOAD (F1)**



Choose desired PACER load by pressing **UP (F2) or DOWN (F3)** and then **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

4. **SELECT NOISE (F2)**

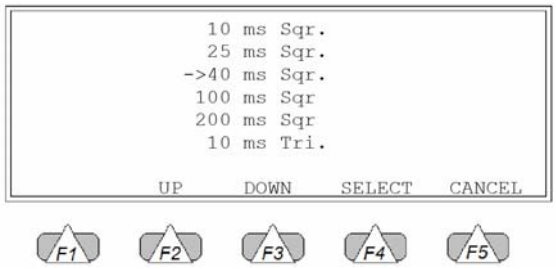


Choose desired noise for the immunity test by **UP (F2) or DOWN (F3)** and then **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

5. **PRINT HEADER (F3).** Automatically writes a heading for the new test protocol.

6. **PRINT RESULT (F3).** Prints the results of measurements.

7. **SELECT WAVE (F2)**



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

8. **SENS. TEST (Sensitivity Test) (F2).** Sensitivity is the QRS minimum amplitude (mV) required to cause the pacemaker to operate in the demand mode. This waveform is delayed from the pacer pulse so that it is outside the pacing refractory period. See 'Sensitivity Measurements' in Chapter 5.

9. **REF. PER TEST (F3).** Used to test time interval (ms) if the pacemaker is insensitive to any external inputs, the maximum time interval after the generation of a pacer pulse and maximum time interval after a QRS wave. See 'Pacing Refractory Period' and 'Sensing Refractory Period' in Chapter 5.

10. **REMOTE (Remote Control) (F4)** enables communication with a PC with test automation software. Required software: PRO-Soft QA-40/45 or ANSUR plug-in software module.

3.5 Test Result Printouts

1. **Defibrillator Mode.** QA-45 automatically prints out the test results, via the printer output, after each discharge generated. Select **PRINT HEADER (F4)** if you want to print out a page with a new header.

2. **Pace Mode.** QA-45 prints out the test results, after the measurements, when you press **PRINT RESULT (F4)** in the Main menu.

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4. Defibrillator Mode Testing

This chapter describes QA-45 Mk III defibrillator mode testing.

4.1 Introduction

The defibrillator function of the QA-45 Mk III measures the energy output and ensures that the defibrillator complies with specified requirements. QA-45 Mk III has a built-in load resistance of 50 ohm, which roughly corresponds to the impedance of the human body. The defibrillator pads are placed on the QA-45 Mk III contact plates. Thus, the defibrillator is connected through the load resistance. When the defibrillator is discharged, QA-45 Mk III will calculate and display the energy delivered.

Defibrillator energy is defined as 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.

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

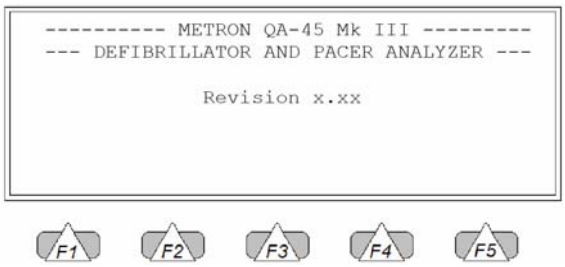
QA-45 measures and records the voltage pulse every 100 μs, 1000 times, for a total time of 100 ms. The squares of the voltages are then summed, multiplied by 100 μs, and divided by the load resistance, 50 ohms.

$$E = \int_0^{1000} (V^2) \bullet dt / R = \int_0^{1000} (V^2) \bullet 100\ \mu s / 50\ ohms$$

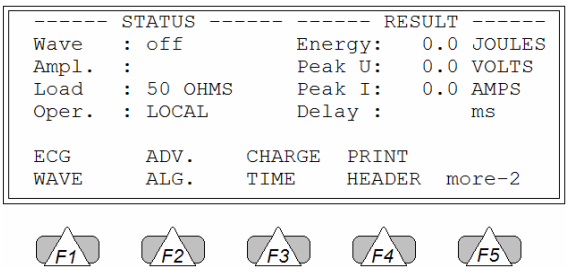
The unit for energy is ‘joule’, which is equal to Ws (Watt second).

4.2 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 standard phone jack, as appropriate.
2. Switch the QA-45 Mk III on. The following will be displayed in the LCD display for about two seconds:



3. The following main menu will then appear. It will show LOCAL, indicating that the testing is not remotely controlled by the test automation software.



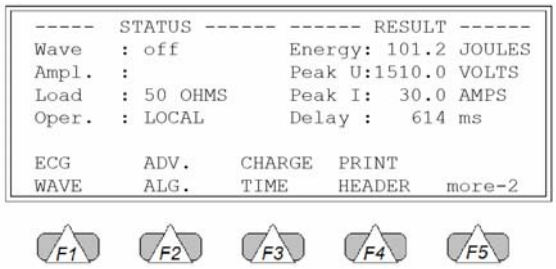
4.3 Energy Test

Note
If the maximum voltage for a selected range is exceeded, the LCD display will show 'WARNING! Overload'

1. Select a suitable energy range using the mode switch.
   - Use the HIGH range for normal adult testing.
   - Use the LOW range for low energy testing, where the energy does not exceed 50 Joule and the peak voltage does not exceed 1200 volts.
2. Securely place the defibrillator paddles on the QA-45 Mk III contact plates, and discharge the defibrillator. The APEX (+) pad should be connected to the right-hand plate, and the STERNUM pad to the left plate. This ensures correct signal polarity for the oscilloscope output. A reversal of this configuration will not damage the QA-45 Mk III, nor will it give incorrect energy readings. However, the polarity of the oscilloscope output will simply be reversed. The discharge from the defibrillator is transferred to the QA-45 Mk III's load resistance.

APEX (+) pad → right plate
STERNUM pad → left plate

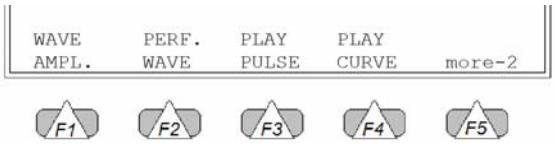
3. QA-45 Mk III calculates the energy delivered over the load resistance and displays the result in joules under RESULT. See below:



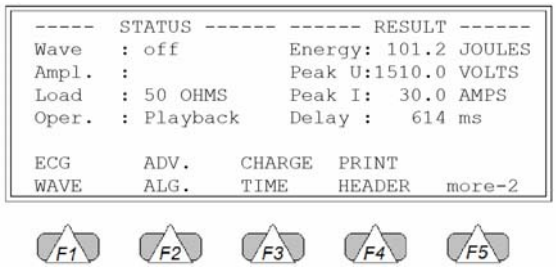
QA-45 Mk III also shows the energy measured, the maximum voltage and the maximum current in the energy wave. Following the discharge from the defibrillator, QA-45 Mk III shows a playback of the wave from the ECG output. A new pulse can be generated when the LCD display shows 'LOCAL'.

4. Following a discharge from the defibrillator, the instrument shows a playback of the wave from the ECG output. The display will thus be in playback mode. When this is shown in one line, QA-45 Mk III automatically prints out the result.

5. The discharged pulse can be repeated. To do this press **more-2 (F5)** to advance to page 2 of the main menu.



Press **PLAY PULSE (F2)**. The display will show 'Oper: Playback,' and displays the result in joules under RESULT.

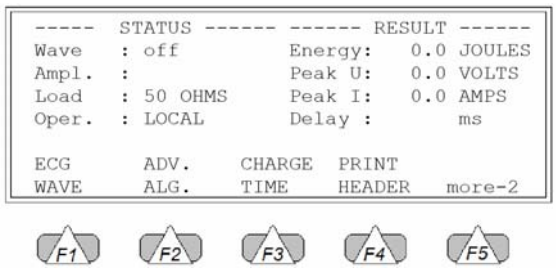


Following playback, the apparatus is ready to receive a new discharge from the defibrillator. The display will show 'LOCAL'.

6. When testing automatic defibrillators, it is quite common to have to select 'vfib' from the ECG menu 'ECG WAVE' for the 'ventricular fibrillation' wave. Automatic defibrillators typically do not fire without seeing 'v-fib'.

4.4 Cardioversion Test

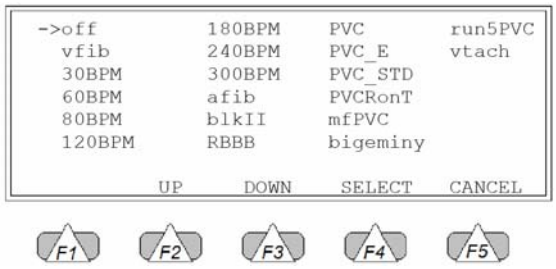
1. Select **ECG WAVE (F1)** from the main menu.



2. The ECG Wave menu opens. QA-45 Mk III includes the following ECG wave selection for cardioversion tests, or for the testing of electrocardiograph monitors.

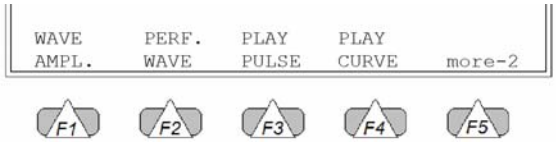
Normal Sine Rates: 30, 60, 80, 120, 180, 240 and 300 BPM.
ECG Arrhythmia types as follows:

vfib	Ventricular Fibrillation
afib	Atrial Fibrillation
blk II	Second degree A-V block
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

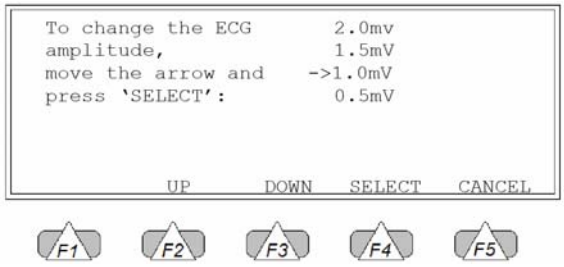


Select a desired wave by pressing **UP (F2) or DOWN (F3)**. Save this under 'Wave" in the STATUS field by pressing **SELECT (F4)**. Press **CANCEL (F5)** to cancel selection.

3. QA-45 includes the following ECG wave amplitude options: 0.5 mV, 1.0 mV, 1.5 mV and 2.0 mV. To change wave amplitude select **more-2** on the main menu. Select **WAVE AMPL. (F1)**.



The Wave Amplitude Menu appears:



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

4. Set the defibrillator to synchronized cardioversion mode. Discharge the defibrillator over the instrument's load resistance.

5. QA-45 Mk III measures the time delay in milliseconds (ms) between the top of the 'R' wave and the discharging of the defibrillator pulse. This delay will be shown in the LCD display as: 'Delay: xxx ms'.

   QA-45 Mk III also shows the energy measured, the maximum voltage and the maximum current in the energy wave. Following the discharge from the defibrillator, QA-45 shows a playback of the wave from the ECG output. A new pulse can be generated when the LCD display shows 'LOCAL'.

4.5 Maximum Energy Charging Time Test

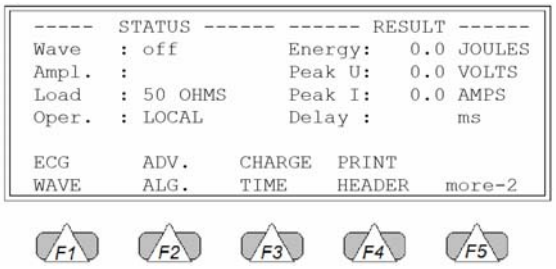
1. The charge time function is used to test the battery and the charging capacitor in the defibrillator.

2. Set the defibrillator to maximum energy.

3. Securely place the defibrillator paddles on the QA-45 contact plates, and discharge the defibrillator. The APEX (+) pad should be connected to the right-hand plate, and the STERNUM pad to the left plate. This ensures correct signal polarity for the oscilloscope output. A reversal of this configuration will not damage the QA-45 Mk III, nor will it give incorrect energy readings. However, the polarity of the oscilloscope output will simply be reversed. The discharge from the defibrillator is transferred to the QA-45 Mk III's load resistance.

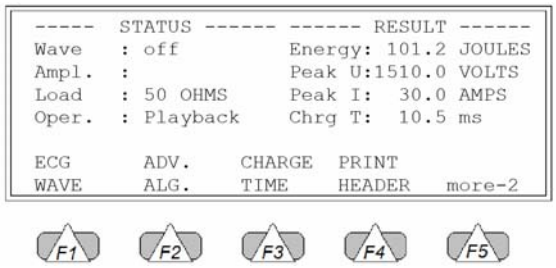
APEX (+) pad → right plate
STERNUM pad → left plate

4. Select **CHARGE TIME (F3)** from the main menu and the charge button on the defibrillator simultaneously.



When the defibrillator is charged, discharge it through the instrument.

5. Charging time will be shown in the display as 'Chrg T: xx.x MS' under RESULT.

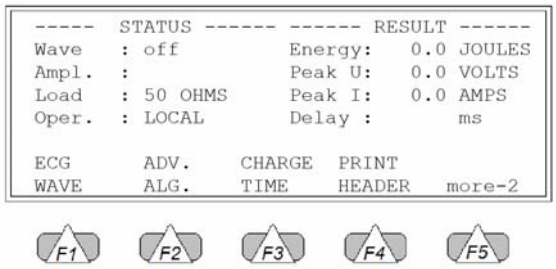


4.6 Shock Advisory Algorithm Test

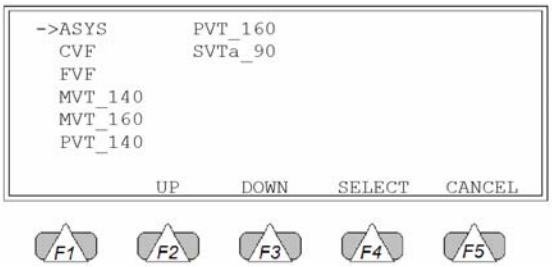
1. This tests the analysis and prompting of automatic and semi-automatic defibrillators. A series of arrhythmia is available for analysis by the defibrillator that should then prompt the user to 'shock' of 'no shock,' in accordance with national and international guidelines, as shown below:

ASYS	No shock
SVTa_90	No shock
PVT_140	No shock
MVT_140	No shock
CVF	Shock
FVF	Shock
PVT_160	Shock
MVT_160	Shock

2. Select **ADV. ALG. (F2)** from the main menu.



3. The Advisory Algorithms Menu opens.



Select the desired rhythm by pressing **UP (F2) or DOWN (F3)**. Save this under 'Wave" in the STATUS field by pressing **Select**. Press **CANCEL (F5)** to cancel selection. The ECG signal is output through the low-level ECG connectors, high-level ECG connector, and paddle contact plates on the QA-45 Mk III.

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

5. Records the defibrillator's response.

5. Transcutaneous Pacemaker Mode Testing

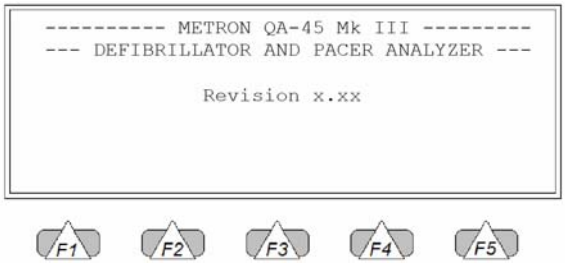
This chapter explains QA-45 transcutaneous external pacer mode testing.

5.1 Introduction

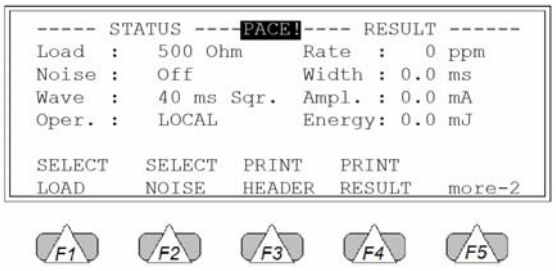
The QA-45 Mk III tests all types of transthoracic pacemakers. The testing is menu driven, and simple to operate. QA-45 Mk III measures and displays a pacer pulse's amplitude, rate, energy and width. It also conducts demand sensitivity tests, measuring and displaying refractory periods, and immunity tests, which determine the pacemaker's susceptibility to 50/60 Hz interference.

5.2 Testing Preparation

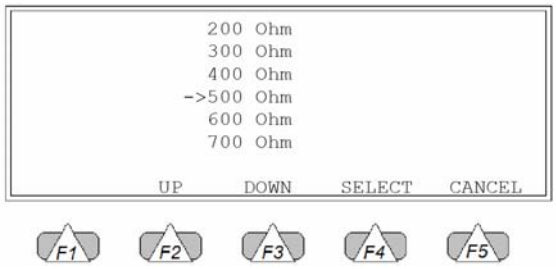
1. Connect the pacer output cables to the pacer input connectors.
2. Switch the mode switch to 'PACE' mode.
3. Turn the QA-45 Mk III on. The following will be displayed in the LCD display for about two seconds:



4. The following main menu will then appear:



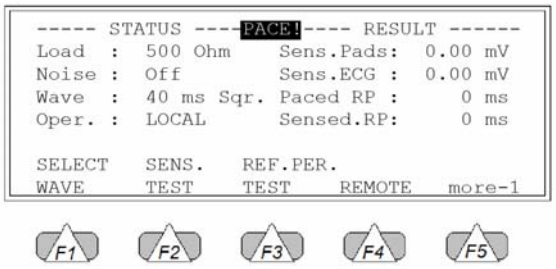
5. Press **SELECT LOAD (F1)**. The following load options will appear:



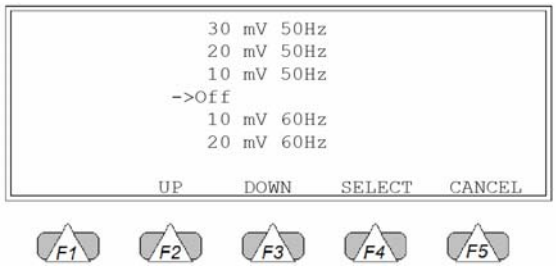
The load range is 50 to 2300 ohms in steps of 50 ohms up to 200 ohms, and 100 ohms from 200 up to 2300 ohms

Select the desired noise form by pressing **UP (F2) or DOWN (F3)** and then **Select (F4)**. Press **CANCEL (F5)** to cancel the selection. After selection the main menu will reappear.

6. Select the desired waveform by pressing **UP (F2) or DOWN (F3)** and then **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection. After selection the main menu will reappear.



7. **For Immunity Testing Only**. The immunity test determines the pacemaker's susceptibility to 50/60 Hz interference signals. If you desire to test immunity simultaneously with other testing, press **SELECT NOISE (F2)**. The following load options will appear:



Select the desired noise form by pressing **UP (F2) or DOWN (F3)** and then **SELECT (F4)**. Press **CANCEL (F5)** to cancel the selection. After selection the main menu will reappear.

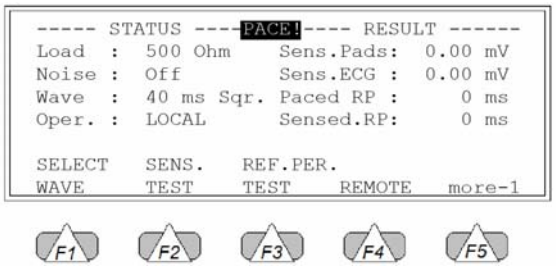
5.3 Demand Sensitivity Test

1. **General.** 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. This waveform is delayed from the pacer pulse so that it is outside the pacing refractory period. QA-45 Mk III then checks whether this wave is sensed or not by the pacemaker.

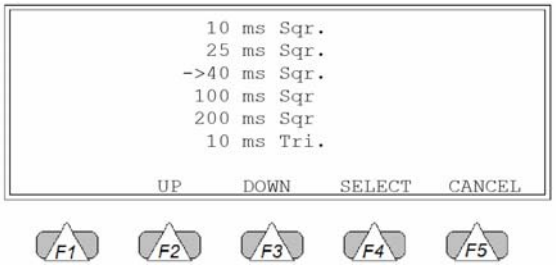
   If it is not sensed, a message 'exceeded' is displayed which means that the pacemaker needs an amplitude more than 100 mV for sensing at that setting. If the wave is sensed, QA-45 Mk III then reduces the amplitude in steps until it reaches the lowest value required for the pacemaker to sense it. (The internal algorithm used converges to the lowest value in the least number of cycles.) This lowest value is the sensitivity.

2. **Procedure**

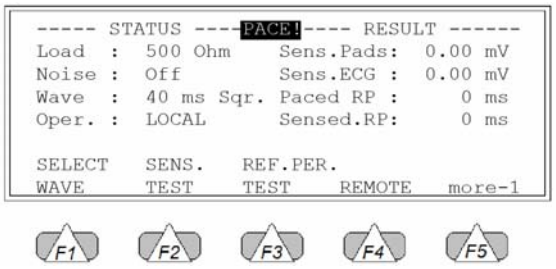
   a. From the main menu press **more-2**, then **SELECT WAVE (F1)**.



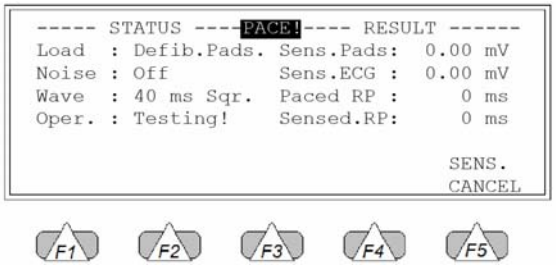
   b. The following menu will be displayed:



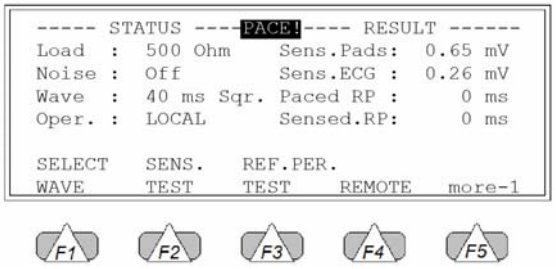
   c. Select the desired waveform by pressing **UP (F2)** or **DOWN (F3)** and then **Select (F4)**. Press **CANCEL (F5)** to cancel the selection. After selection the main menu will reappear.



d. Select **SENS. TEST (F2)**. The following display will appear:



e. Upon completion of testing the results will be displayed under RESULT. Press **SENS. TEST. CANCEL (F5)** to cancel the test.



5.4 Refractory Period Test

1. **General.** This test is used to test the time interval in milliseconds (ms) during which the pacemaker is insensitive to any external inputs. The QA-45 Mk III does this by measuring the maximum time interval after the generation of a pacer pulse, and maximum time interval after a QRS wave.

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

b. **Paced Refractory Period.** The maximum time interval after the generation of a pacer pulse during which time the presence of a QRS wave is ignored.

The measurement of paced refractory period takes a few cycles of the pacemaker output. First, QA-45 measures the pacer-to-pacer interval T. Then, it puts out a square wave 40 milliseconds wide, delayed by delay time D, which is more than the pacing refractory period, from the last pacer pulse. The pacemaker senses this square wave. The delay time D is gradually decremented in subsequent cycles until the square waveform is not sensed by the pacemaker. The maximum value of the delay time D, for which the pace maker does not sense the square wave, is the paced refractory period.

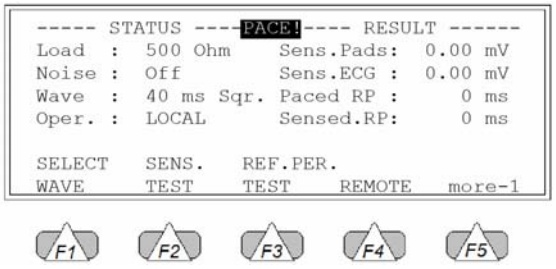
c. **Sensed Refractory Period.** The maximum time interval after a QRS wave is sensed by the pacemaker during which time the presence of a second QRS wave is ignored.

The sensed refractory period is measured in a similar manner, except that QA-45 Mk III now generates two square waves instead of one. The first square wave is generated at a fixed time delay from a pacer pulse, which is greater than the paced refractory period. The pacemaker always senses this square wave.

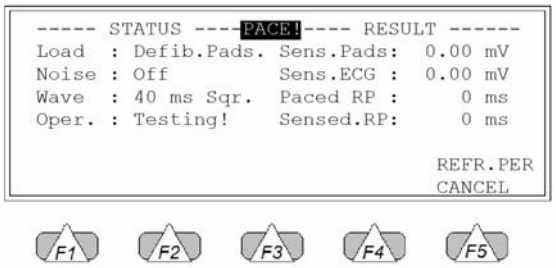
The second square wave is generated at a delay D from the first square wave. The initial value of D is selected to be greater than the sensed refractory period. Therefore the first time the pacemaker is on it also senses the second square wave. In subsequent cycles, the delay 'D' is gradually reduced 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.

2. **Procedure**

a. From the main menu press **more-2**. Press **REF. PER. TEST (F3)**.



b. The following display will appear while testing:



c. Upon completion of testing the results will be displayed under RESULT. Press **REF. PER. CANCEL (F5)** to cancel the test.