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- 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- ensure that obsolete pages are withdrawn and either disposed of immediately, or marked as superseded and placed in a superseded document file, and;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.

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<td>3.13-1</td>
<td>4-26-01</td>
<td>General update</td>
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Symbols Used In This Manual

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<thead>
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<th>Symbol</th>
<th>Description</th>
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<tbody>
<tr>
<td>!</td>
<td>Caution (Refer to accompanying documents) (See NOTE)</td>
</tr>
<tr>
<td>⚡</td>
<td>Caution, Risk of Electrical Shock (see NOTE)</td>
</tr>
<tr>
<td>——</td>
<td>Earth (ground) TERMINAL</td>
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</table>
1. **Introduction**

This chapter describes the QA-90 Electrical Safety Tester’s features and specifications.

### 1.1 QA-90 Features

The QA-90 represents a new generation of safety testing equipment. It is the only automatic safety analyzer that can test units with different classes of protection in one test run (e.g., cardiac float and body float defibrillators). It is simple to use. All you need do is select the type and class of equipment to test. When you press START, QA-90 executes the tests prescribed to the selected standard.

Test results may be printed out immediately, or stored internally in the unit for later use. QA-90 has full remote control, and may be operated from PRO-Soft QA-90 software. PRO-Soft QA-90 enables you to make your own test protocols, store the information on disk, and export formatted data to any other database or equipment management program. Individual test sequences may be compiled to satisfy national and international standards.

The following standards may be compiled either fully or in part:

IEC 60601.1, UL 2601.1, IEC 60601.1.1, UL 2601.1.1, IEC 60601.2.4, IEC 61010-1, EN 60601-1, VDE 0750 TI/12-91, BS 5724, CAN/CSA-C22.2 No 601.1-M90, AS 3200.1, NZS 6150:1990, VDE 0751 TI/12-90, ÖVE 0751, UL 544, HEI 95, HEI 158 among others.

### 1.2 Specifications

#### 1. Voltage Measurement

Measurements may be obtained in the following ways:

- Between leads 1 and 2 (in the power contact).
- Between lead 1 and ground (in the power contact).
- Between lead 2 and ground (in the power contact).
- Between input/output E+ and E- (floating inputs/outputs).

<table>
<thead>
<tr>
<th>Range</th>
<th>0 - 400V true RMS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>0.1V</td>
</tr>
<tr>
<td>Accuracy</td>
<td>DC - 100 Hz, 1% of full scale +1 LSD</td>
</tr>
<tr>
<td></td>
<td>100 Hz-10 kHz, 2% of scale +1 LSD</td>
</tr>
<tr>
<td>No. of Tests</td>
<td>4 or multiple (LSD = least significant digit)</td>
</tr>
</tbody>
</table>

#### 2. Current Consumption
The current measurement may be executed in lead no. 1 (live).

**Range 1**
- **0 - 1000 mA RMS (@ <250VAC)**
- **Resolution**: 1 mA
- **Accuracy**: ±2% of full scale ±1 LSD
- **No. of Tests**: 1 or multiple

**Range 2**
- **1 - 16A RMS (@ <250VAC)**
- **Resolution**: 1 mA
- **Accuracy**: ±1% of full scale ±1 LSD
- **No. of Tests**: 1 or multiple

3. **Protective Earth**

The test current is selectable from 25A or 1A, delivered from a transformer with a maximum idle voltage of 6V. The measurement can be performed on ground leads or between E+ and E- (floating inputs/outputs).

**Range**
- **0 - 2000 mOhm**
- **Resolution**: 1 mOhm
- **Accuracy**: ±2% of full scale ±1 LSD
- **No. of Tests**: 1, 2, or multiple

4. **Insulating Resistance**

The measurement of the insulating resistance may be executed between casing and power unit, or between patient module and power unit.

**Test voltage**: 500VDC through a 130 kOhm limiting resistor.
- **No. of Tests**: 1, 2 or multiple

**Range**
- **1 - 50 mOhm**
- **Resolution**: 1 mOhm
- **Accuracy**: ±2% of full scale ±1 LSD

**Range**
- **51 - 200 mOhm**
- **Resolution**: 1 mOhm
- **Accuracy**: ±2% of full scale ±1 LSD

5. **Leakage Currents**

All measurements can be performed with a IEC 601.1 filter (patient equivalent), or without (flat frequency response). The filter can be exchanged with filters covering other standards. All measurements can be performed as true RMS measurements, or AC/DC measurements.

The following leakage currents can be measured:

- **Ground leakage current**
  - **No. of Tests**: 4
- **Enclosure leakage current**
  - **No. of Tests**: 6 or multiple
The following leakage currents are measured for each module:

- **Patient leakage current**
  - No. of Tests: 6

- **Mains on applied part leakage current**
  - No. of Tests: 2

- **Patient Auxiliary current**
  - No. of Tests: 6

- **Floating dual lead measurement of leakage currents**
  - No. of Tests: Multiple

In one test run a maximum of 11 modules with different protection classes may be tested.

### 6. Accuracy

- **Range 1**
  - 0 - 100 µA
  - Resolution: 1 µA
  - Accuracy: ±2% of full scale ±1 LSD

- **Range 2**
  - 100 - 1000 µA
  - Resolution: 1 µA
  - Accuracy: ±2% of full scale ±1 LSD

- **Range 3**
  - 1,000 - 10,000 mA
  - Resolution: 1 µA
  - Accuracy: ±1% of full scale ±1 LSD

### 7. Frequency Response

DC - 1 MHz (-3dB) with a crest factor of >2

The applied test voltage for patient leakage current is 110% of the line voltage, delivered through a limiting resistor of 47 kOhm.

### 1.3 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: 4 lines, 40 characters

**Data Input/ Output (2)**
- Parallel printer port (1); Bi-directional RS-232C (1) for computer control

**Power**
- From 110 VAC to 240 VAC, 47/63 Hz 3900 VA
- Do not exceed 16 Amps of current at any voltage within the operating range.

**Fuses**
- Two 16 Amp, 250V slow blow fuses
**Mechanical Specifications**

- **Housing**: Metal case
- **Height**: 13.2 cm (3.9 in.)
- **Width**: 34.2 cm (9.8 in.)
- **Depth**: 30.5 cm (11.0 in.)
- **Weight**: 5.8 kg (4.1 lbs.)

**Standard Accessories**

- User and Service Manual QA-90 (P/N 11025)

**Additional Accessories**

- Carrying Case (P/N 11100)
- Carrying case, ext. printer (P/N 10500)
- Bar Code Reader (P/N 11400)
- Isolating transformer 400VA (P/N 11401)
- Isolating transformer 800VA (P/N 11410)
- Test unit (ESA) (P/N 11402)
- E input measuring cable (2m) (P/N 11411)
- E input measuring cable (5m) (P/N 11415)
- Clamp - crocodile type (P/N 11412)
- PRO-Soft QA-90 software (P/N 11200)
- PRO-Soft QA-90 DEMO (P/N 11201)
- User/Service Manual PRO-Soft QA-90 (P/N 11225)

**Storage**

Store in the carrying case in dry surroundings within the temperature range specified. 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 initial QA-90 setup. Example test setup procedures are contained in Chapter 4, Example Test Measurements.

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-90 Electrical Safety Tester (P.N. 11200)
   - QA-90 User and Service Manual (P.N. 11025)

3. If you note physical damage, or if the unit fails to function according to specification, inform the supplier immediately. When METRON AS or the company’s representative, is informed, measures will be taken to either repair the unit or dispatch a replacement. The customer will not have to wait for a claim to be investigated by the supplier. The customer should place a new purchase order to ensure delivery.

4. When returning an instrument to METRON AS, 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:
   - 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.

METRON’s 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 METRON A.S or its representative.
2.2 Setup

1. Equipment connection is as shown in the typical setup below. Attach the printer cable to the 25-pin outlet port.

![Diagram of equipment connection]

2. If PRO-Soft QA-90 is being used, attach an RS-232C (null modem/data transfer configured) cable to the 9-pin D-sub outlet port located at the rear of the QA-90. Do not attach the printer cable to the QA-90. See below.

![Diagram showing alternative connection]

**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-90. Refer to the PRO-Soft QA-90 Users Manual for more information.

2.3 Power

**Main On/Off Switch.** QA-90 should remain off for at least 5 seconds before switching on again, in order to allow the test circuits to discharge fully.

2.4 PRO-Soft QA-90

PRO-Soft QA-90 is a front-end test automation and presentation tool for METRON's QA-90 Electrical Safety Analyzer. It allows you to conduct the same tests, but by remote control via an IBM-compatible PC/XT with MS Windows (Version 3.1 or later). Additionally, the
program has additional features to automate and enhance your electrical safety testing.

Each of the QA-90 tests can be run independently from PRO-Soft in the “Manual” test mode. Results are shown on the PC screen during testing, and the user is prompted to set the tested equipment accordingly. At the conclusion of tests, the user may print a report, store the test and results on disk, or both. Combinations of tests can be created and stored as “Test Sequences.” The program maintains a library of these sequences. In this way you can store and retrieve sequences that are appropriate for each kind of equipment being tested at your facility.

Sequences can then be used independently, or can be attached to a checklist, written procedure, and equipment data in the form of a test “Protocol.” The equipment data can be entered manually into the protocol, or it may be retrieved by PRO-Soft from a database program or other equipment files. Protocols can be created easily for each item of equipment in your inventory, and stored for use. Test protocols with results can be printed, or stored on disk, and the results of testing can be sent back to the equipment database to close a work order and update the service history.

**NOTE**

PRO-Soft QA-90 has its own user manual, which contains all the information concerning the program. If you order a demonstration version of the program you also receive the manual.
This page intentionally left blank.
3. Operating QA-90

This chapter explains the operating controls, switches and menus of the QA-90, details how to use them in testing, and provides general information on printouts and operator maintenance.

### 3.1 Control Switches and Connections

**Front Panel**

1. **Key Pad**
   - 11 alphanumeric keys, used to enter information.
   - **PL**
   - **CLR**
   - **Return**
   - **Enter**
   - **Patient Leads**: New window for recording patient inputs.
   - **Clear**: Clears the whole display
   - **Return**: Deletes the last character
   - **Enter**: Records entered data

2. **Function Keys**
   - F1-F4 are used to select the functions shown in the menu bar at the bottom of the display, i.e., for selecting the function that is directly above the key. F5-F7 are used to select the function, or enter information in the message field in the same line.

3. **LCD Display**
   - Shows messages, test results and function menus.
4. Patient Leads

For connecting patient inputs.

Caution: Max 256 VAC Max 500 VDC can be present during specified tests

5. Dual

E+ and E-, floating inputs/outputs. These function in the manner of standard multimeter leads.


Enclosure (for connecting to the casing of the instrument under test).

7. Earth

Extra earth connection for calibrating measuring leads.

8. Contact

For connecting the power plug of the instrument to be tested.

Rear Panel

9. Power Switch

Turns power ON and OFF.

10. RS-232 Serial Port

9-pin D-sub

11. Bar Code Port

9-pin D-sub. HP-Smartwand Interface (TTL).

12. Printer Outlet Port

25 pin D-sub. Centronic output.

13. Mains QA-90

Mains connection for test instrument.

14. Auxiliary Power

Auxiliary power connection for instrument under test.

15. Fuse

Mains fuses 2 x 16 Amps @ 220V
16. Earthing Contact

Extra earthing point.

3.2 Key Pad Functions

The alphanumeric keys comprise both numbers and letters. Hold the key in and it moves automatically from character to character.

3.3 Function of The Bar Code Reader

The bar code reader may be used in the main menu and in the patient lead to record respectively the instrument code and class, module code, number of leads and type. The program will select the correct screen display, depending on the bar code format.

The program will give a beep if a wrong format is read.

<table>
<thead>
<tr>
<th>INSTRUMENT CODE FORMAT</th>
<th>FIELD DESC.</th>
<th>VALUE ACCEPTED</th>
<th>MAX. CHARACTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instrument code</td>
<td>alphanumeric</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Separator</td>
<td>+</td>
<td>1 (must be included)</td>
<td></td>
</tr>
<tr>
<td>Instrument class</td>
<td>CLI, CL2, I.P</td>
<td>3 (must be included)</td>
<td></td>
</tr>
</tbody>
</table>

Example: abedefg + CL2  
Instrument code = abedefg  
Instrument class = CL2

<table>
<thead>
<tr>
<th>PATIENT LEAD FORMAT</th>
<th>FIELD DESC.</th>
<th>VALUE ACCEPTED</th>
<th>MAX. CHARACTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module code</td>
<td>alphanumeric</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Separator</td>
<td>+</td>
<td>1 (must be included)</td>
<td></td>
</tr>
<tr>
<td>No. of leads</td>
<td>numeric (0-99)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Separator</td>
<td>+</td>
<td>1 (must be included)</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>BF, CF, B</td>
<td>2 (must be included)</td>
<td></td>
</tr>
</tbody>
</table>

Example: mnopqrst + 2 + B  
Module code = mnopqrst  
Number of leads = 2  
Module type = B
3.4 Menu and Function Keys

The QA-90 uses displays, function keys and a keypad to provide flexibility and control over operations. The top three lines in the display are used for messages, status and results. The menu bar is shown at the bottom of the display. Function keys are numbered from F1 to F7.

A function/menu is selected by pressing that key which is directly below/to the right of the menu unit shown in the display.

3.5 Display Menus and Messages

1. **Startup Screen**. The following screens will be displayed in sequence for the first 10 seconds after the QA-90 has been switched on.

```
METRON QA-90                   F7
Boot software version: X.XX         F5
```

```
METRON QA-90                   F7
Version: X.XX  Date: DD/MM/YYYY         F5
```

```
METRON QA-90 Electrical Safety Analyzer     F7
TOTAL MEMORY              :       114688        F6
TOTAL MEMORY USED         :         6884    F5
TOTAL FREE SPACE          :       107804
```

2. **Main Menu**
3. **MORE (F1).** When **MORE (F1)** is pressed, the following display will appear:

![Display with options]

This window offers the following functions:

- Press **Test according to (F7)** to select either IEC 601.1, IEC 601.2.4, IEC 1010-1, UL 2601.1, IEC61010, AS 3200.1, HEI 95, ANSI/AAMI, VDE 751 or VDE 751-DEF Standard.
- Press **Test Type (F6)** to select either Rapid or Normal test type.
- Press **Test Mode (F5)** to choose between Automatic and Manual test.
- Press **GO BACK (F2)** to return to the previous display.
- Press **START (F4)** to start the test.

4. **MEMORY (F2)**

QA-90’s memory is divided into two parts: tests and sequences. If you have several equivalent instruments to test, you can define one test sequence for all the instruments and store it as a sequence. You use this sequence to test all the instruments and store each of the test results with the instrument’s respective equipment code.

The functions in the MEMORY menus enable you to store, retrieve, transfer, print and delete test results and sequences from the memory. The four main memory displays are as follows.
The F5 and F6 function keys generate new displays as confirmation of an executed function or error message.

- Press GO BACK (F2) to return to the previous display.
- Press MAIN MENU (F4) to start the test.

The three main sequence displays are shown below.
5. SETUP (F3)

This function is used for entering general information in connection with the test. Seven main displays are shown below.

- **System Setup**
  - Operator: ...
  - Establishment: ...
  - QA-90 Serial no: XXXX
  - IT-Net: N
  - Power-up delay time: 2 Seconds

- Sequence name: ...
  - Delete sequence in memory
  - Delete all sequences in memory

- List all sequences in memory
  - Print all sequences in memory

- More
  - Go back
  - Main menu

- Press **PL** on the keypad to obtain the window for recording patient modules and leads.

- Go to the next patient module stored.
- Go to the previous patient module stored.
- Return to the previous menu
  Press **ADD** (**F1**) to save in the memory
- Press **Module Code** (**F7**) to record the code/name of a new patient module.
- Press **ENTER** (**↵**).
- Press **No of leads** (**F6**) to enter the number of patient leads.
- Press **ENTER** (**↵**).
- Press **Type** (**F5**) to select protective class (B, BF, CF).
• Press **ADD (F1)** to save in the memory. The number of modules stored will be shown in parenthesis in the Module Code line.

• Repeat the above guidelines to enter the next module.

• Press **NEXT (F4)** to go to the next patient module stored.

• Press **PREV (F3)** to go to the previous patient module stored.

• Press **GO BACK (F2)** to return to the previous menu.

7. **START (F4).**

This function starts the test sequence. Manual or automatic test sequences are selected under **MORE (F1)** in MAIN MENU.

---

**3.6 Measurements with Several Modules in Manual Mode**

When you perform measurements on several modules in **Manual Mode** and want to select which module to measure, use the following procedure:

1. Press **MORE (F1)** in MAIN MENU.

2. Press **Test Mode (F5)** and select **Manual**. Press **START (F4).**

3. Press **MORE (F1)** in repeatedly until you find the desired measurement, e.g., **Mains on applied part (F5).**

---

3-10
4. Press **PL** on the keypad to obtain the recording window for **Module Code and No of leads**.

   **Module Code**: ............> **F7**
   **No of leads**: .................> **F6**
   **Type**: CF........................> **F5**

   **ADD**  **GO BACK**  **PREV.**  **NEXT**
   **F1**  **F2**  **F3**  **F4**

5. Select which **Module Code** to be measured with **NEXT (F4)** or **Prev. (F3)**.

6. Press **GO BACK (F2)**.

7. Press **START (F1)** to start the test.

8. Press **STOP (F1)** to stop the test.

9. To select a new module, press **PL** and repeat the same procedure.

---

**3.7 Storing Setup Parameters in Flash Memory**

The following parameters can be stored in Flash memory:

- Operator
- Establishment
- Serial Number
- Language
- Calibration parameters

To store the setup parameters in Flash memory, go to **SETUP (F3)** in **MAIN MENU**.
Press **STORE (F2)** in SYSTEM SETUP and the display will show you the setup parameters stored in flash.
3.8 Upgrading the QA-90 Software Program

For installing software, version 2.00 or higher, use the following procedure:

1. Preparation
   - Turn on the unit.
   - Press SETUP (F3) from the Main menu.
   - Press CAL (F3) from the System Setup.
   - Then go to the hidden menu under (F1), in the menu for Self Calibration.

   IMPORTANT!
   When upgrading the software on calibrated units, you should note the calibration constants in the unit. There are seven constants that can be read on the unit display.
• Note the values on the three constants that appear on the display.
• Press MORE (F1) to get the three next constants.
• Press MORE (F1) to get the last constant. NB: Automatic MAP calibration: ONLY for production calibration.

The QA-90 software upgrade contains two files: comqa90.exe, the communication between computer and the QA-90, and; qa90-xxx.a07 is the program for QA-90. (XXX indicates the version of the firmware.)

2. Prepare the QA-90 for the software upgrade.
• Reading the program to Flash memory in the QA-90.
• Press and hold PL and CLR at the same time while turning the QA-90 on.
• The display will show the following:

```
The software in the QA-90 is missing.
To download new software, run COMMQA90 on the PC and press ENTER on QA-90
```

• The QA-90 is ready to receive data.

3. Prepare the PC for the upgrade.
• Connect an RS-232 cable between PC and QA-90.
• Insert the disk that contains the QA-90 upgrade program.
• Write COMQA90.EXE (DOS)
• Press ENTER (↵)

A menu will appear on the computer:
• Choose menu 1 SET PARAMETERS and choose new parameters or default values.
• Choose menu 2 START COMMUNICATION by pressing 2. Enter filename QA90-XXX.A07 where XXX is the version of the firmware. Check the file.
• Press ENTER (↵) on the computer.
• Press **ENTER (↵)** on the QA-90 and the transmission will start.

If the communication is successful, >>>>>> will appear continuously at the display on the QA-90. When the program is transmitted, a normal startup menu will appear on the QA-90. The computer will either show a picture for program transmission, or a clear screen.

4. **Check the Calibration Constants**

Check the calibration constants in the QA-90 through the hidden menu. If necessary, press **F5, F6 or F7** to type your noted calibration constants, then press **ENTER (↵)**.

To store in Flash memory, go back to **SYSTEM SETUP**.

![SYSTEM SETUP Menu](image)

Press **STORE (F2)** and the display will show you setup parameters stored in flash.

### 3.9 Cleaning the QA-90

The outside of the instrument may be cleaned using a damp cloth and mild detergent. Please note that solvents like Methanol may damage the overlay and cabinet.
4. Example Test Measurements

This chapter contains test examples for the QA-90, illustrating equipment connections for the tests, as well as step-by-step procedures for obtaining desired test measurements. For more information on safety testing, and an explanation of protective classes, refer to Appendix A, IEC 601.1, UL 2601.1 AND VDE 0751 Testing.

4.1 Test Lead Calibration

The self-calibration function of the QA-90 is used to determine test lead resistance, and for the values to be taken into account during subsequent testing.

1. Prior to performing self-calibration connect a test lead between the enclosure and earth connectors, or the dual lead inputs on the front face of the QA-90 (see below). Disconnect all other leads.

![Diagram of QA-90 with test leads]

2. Press SETUP (F3) in MAIN MENU.

3. Press CAL (F3) in SYSTEM SETUP.

4. In the SELF CALIBRATION window select an option by pressing either Calibrate test lead, enclosure/ground (F6) or Calibrate test lead, dual float (F5).

   Equipment Code : ...> F7
   Sequence Name : ...> F6
   Class: CL1 ,0 leads in 0 modules.....> F5
   MORE MEMORY SETUP START

F1 F2 F3 F4
5. The test result for the calibration appears in the display when the test is complete.

4.2 Connecting an Instrument without Patient Inputs

Connect the mains plug of the instrument to be tested to the QA-90’s terminal on the front panel. Then, connect a calibrated test lead between the ENCL connector on the front panel of the QA-90 and the casing of the instrument to be tested. (See below)
1. Press **Equipment Classification (F6)** and select classification.
2. Press **MORE (F1)**.
3. Press **Test according to (F7)** and select test standard.
4. Press **Test Type (F6)** and select either Rapid or Normal.
5. Press **Test Mode (F5)** and select either Automatic or manual.
6. Press **START (F4)** to start the test.

4.3 **Connecting an Instrument with Patient Inputs**

This includes IEC Classifications Body (B), Body Float (BF), and Cardiac Float (CF).

Connect the mains plug of the instrument to be tested to the QA-90’s terminal on the front panel. Then, connect a calibrated test lead between the ENCL connector on the front panel of the QA-90 and the casing of the instrument to be tested. Following that, connect patient lead between the instrument to be tested and Patient leads on the QA-90. *(See below)*
1. Press **Equipment Classification (F6)** and select classification.

2. Press **MORE (F1)**.

3. Press **Test according to (F7)** and select test standard.

4. Press **Test Type (F6)** and select either **Rapid** or **Normal**.

5. Press **Test Mode (F5)** and select either **Automatic** or **Manual**.

6. Press **PL** on the keypad to obtain the recording window for patient lead.

7. Press **Module Code (F7)** if you wish to record the name of a new module.

8. Press **ENTER (..j)**.

9. Press **No of leads (F6)** to enter the number of leads.

10. Press **ENTER (..j)**.

11. Press **Type (F5)** to select protective class.

12. Press **ADD (F1)** to accept. The number of modules stored will be shown in parenthesis in the Module Code line.

13. Repeat, as required, to enter a new patient module.

14. Press **GO BACK (F2)** to return to the menu.

15. Press **START (F4)** in the MAIN MENU to start the test.
4.4 Power Cable Test

The earth lead in the power cable is tested as follows. Plug the power cable into the front panel of the QA-90, then connect a calibrated test lead between ENCL. and the each pin on the power cable.

1. Press MORE (F1) in MAIN MENU.
2. Press Test Mode (F5) and select Manual.
3. Press START (F4).
4. Press MORE (F1) in MANUAL TEST SETUP.
5. Press Protective Earth (F7).
6. Press START (F1).

NOTE
Ensure that the test leads are calibrated BEFORE the test.
4.5 Current Measurement Test (Dual Lead)

This test measures leakage current from one instrument to another instrument.

1. Press MORE (F1) in MAIN MENU.
2. Press Test Mode (F5) and select Manual.
3. Press START (F4).
4. Press MORE (F1) in MANUAL TEST SETUP.
5. Press MORE (F1) three more times.
6. Press Current Measurement Dual Lead (F7).
7. Press START (F1).

![DIAGRAM]

- **Equipment Code:**
- **Sequence Name:**
- **Class:** CL1 , 0 leads in 0 modules
- **Test according to:** IEC60601.1
- **Test Type:** Rapid
- **Test Mode:** Automatic
- **GO BACK**
- **START**
- **Mains Voltage**
- **Current Consumption**
- **Current Measurement Dual Lead**
- **Voltage Measurement Dual Lead**
- **Resistance Measurement Dual Lead**
- **Open Supply**
- **Result:** µA
- **Measure between E+ and E- inputs**

---

4-8
4.6 Voltage Measurement Test (Dual Lead)

Measuring voltage potentials to a specified reference.

1. Press MORE (F1) in MAIN MENU.
2. Press Test Mode (F5) and select Manual.
3. Press START (F4).
4. Press MORE (F1) in MANUAL TEST SETUP.
5. Press MORE (F1) three more times.
6. Press Voltage Measurement Dual Lead (F6).
7. Press START (F1).
MANUAL TEST SETUP

- Mains Voltage
- Current Consumption

MORE       MAIN MENU

F1       F2       F3       F4
4.7 Resistance Measurement (Dual Lead)

Measuring protective earth on fixed installations.

1. Press MORE (F1) in MAIN MENU.
2. Press Test Mode (F5) and select Manual.
3. Press START (F4).
4. Press MORE (F1) in MANUAL TEST SETUP.
5. Press MORE (F1) three more times.
6. Press Resistance Measurement Dual Lead (F5).
7. Press START (F1).
### 4.8 Connecting Auxiliary Power Source / Isolating Transformer

External power cable gives power out on the contact on the front panel to the instrument under test.
If the equipment under test is to be tested for voltages and/or frequencies that differs from the nominal mains supply, the test voltage must be connected to the auxiliary inlet. To route the auxiliary power to the contact on the front panel, the procedure below must be executed.

1. Press SETUP (F3) in MAIN MENU.
2. Press MORE (F1) in SYSTEM SETUP.
3. Press MORE (F1) three more times.
4. Press External Isolating Transformer (F7) and select Y (Yes).

NOTE
The QA-90 power cable must also be connected.
5. Control and Calibration

This chapter explains the QA-90 maintenance procedures, including testing and calibration.

5.1 Required Test Equipment

- Power source with a range of 0 - 10 mA (Variref VF12).
- Digital multimeter: Range 0 - 16 A.
- Digital multimeter: Range 0 V and 500 V (HP34401 or similar).
- Metron calibrating unit for earth protection, MΩ.
- Metron calibrating unit for insulation resistance, MΩ.
- Adjustable equipment with an effective output ranging from 0 to 16A for calibrating current consumption.
- Test leads.
- Insulated transformer.

5.2 Preparation and Adjustments

1. Startup Preparation
   a. Press MORE (F1) in MAIN MENU.
   b. Press Test according to (F7), and select UL 2601.1.
   c. Press Test Type (F6), and select Rapid.
   d. Press Test Mode (F5), and select Manual.
   e. Press START (F4) then press MORE (F1) twice to advance to Manual Test Setup Window 3.

   ! IMPORTANT!
   BEFORE TESTING
   THE QA-90 MUST BE POWERED ON FOR AT LEAST 30 MINUTES PRIOR TO CONDUCTING ANY TESTING.
2. **Patient Lead Definition.** To facilitate some calibration measurements patient leads need to be defined. To do so:

a. Press the PL key on the keypad, and the following window appears:
b. For Patient Leads 1-10 (white leads) press No. of leads (F6) and key in “10”. Press the Enter key.

c. Press ADD (F1), then NEXT (F4).

d. For Patient Lead 11 (blue lead) press No. of leads (F6) and key in “1”. Press the Enter key.

e. Press ADD (F1), then GO BACK (F2) to return to Manual Test Setup Window 3.

3. Display Contrast Adjustment

   a. Remove the case housing.

   b. Set the contrast in the display by adjusting the potentiometer located to the left of the CPU.

4. Offset Adjustments. Before conducting measurements offset adjustments must be made to the measuring devices. (Refer to schematic diagram E160.20.2600.U3, Prog. Amplifier/Lowpass QA-90)

   a. RMS-DC Converter. The RMS-DC converter output offset may be adjusted if S2630 pins 1 and 2 are shunted. If S2630 pins 2 and 3 are shunted, the offset of U2630 is disabled. Never move this jumper on a calibrated QA-90, because it will cause a fault of about 1.5% on the measurements. However, if the QA-90 is not yet calibrated, the jumper may be moved. The offset adjustment of U2630 is not mandatory, but it results in small measuring improvements.

   Before offset adjustment we recommend you remove measuring amplifier U2600 from its socket. Make a short between SGND and pin 1 of U2630. Measure the voltage of output pin 6 and SGND. Adjust R2630 to an offset value as close to zero as possible.

   b. Measuring Amplifier. Adjustment is possible if S2600 pins 2 and 3 are shunted. The adjustment is disabled if the jumper is between pins 1 and 2.

      1) Select Enclosure Leakage Current (F7).

      2) Select Normal Condition (F7).

      3) Press START (F1) and generate a current of 1 mA between ENCL. and Chassis. Note the result and limits readout on the QA-90’s display.

---

1 The offset adjustment capability is unavailable in QA-90 firmware versions before 2.xx.
4) Change polarity and take a new measurement. Adjust values for both polarities to be equal. Several adjustments in both directions may have to be made.

5) Select **GO BACK (F2)** to return to Manual Test Setup Window 3.
5.3 Calibration

1. Enclosure Leakage Current
   a. Select Enclosure Leakage Current (F7).
   b. Select Normal Condition (F7).
   c. Press START (F1) and generate a current (10 µA - 10 mA) between ENCL. and Chassis. Then, press STOP (F1).
   d. Check that both the level of this current, and the readout on the QA-90 display, are equal.
   e. Press GO BACK (F2) twice to go to Manual Test Setup Window 2.

2. Earth Leakage Current
   a. Press Earth Leakage Current (F5).
   b. Select Normal Condition (F7).
   c. Press START (F1) and generate a current (10 µA - 10 mA) between EARTH and Chassis. Then, press STOP (F1).
   d. Check that both the level of this current, and the readout on the QA-90 display, are equal.
   e. Press GO BACK (F2), then MORE (F1) to advance to Manual Test Setup Window 3.

3. Patient Leakage Current AC
   a. Press Patient Leakage Current AC (F6).
   b. Select Normal Condition (F7).
   c. Press the PL key on the keypad to ensure that the module with Patient Leads 1-10 (white leads) is active. If not, press PREV (F3) or NEXT (F4) so that it is active.
   d. Press GO BACK (F2) to return to the test window, then press START (F1).

WARNING!
HIGH VOLTAGES ARE CAPABLE OF CAUSING DEATH!
USE EXTREME CAUTION WHEN PERFORMING TESTS AND CALIBRATION. USE ONLY INSULATED TOOLS WHEN THE UNIT IS PLUGGED IN, AND THE CASE HOUSING IS OFF.
e. Use a current source to generate an AC current between Patient Leads 1-10 and EARTH. Check that both the level of this current, and the current readout on the QA-90 display, are equal. Press STOP (F1).

f. Press the PL key on the keypad, then press PREV (F3) or NEXT (F4) to ensure that the module with Patient Lead 11 (blue lead) is active.

g. Press GO BACK (F2) to return to the test window, then press START (F1) and run the same test between Patient Lead 11 and EARTH. Repeat the test with different current values. Press STOP (F1).

h. Press GO BACK (F2) to return to Manual Test Setup Window 3.

4. Patient Leakage Current DC

a. Press Patient Leakage Current DC (F5).

b. Select Normal Condition (F7).

c. Press the PL key on the keypad to ensure that the module with Patient Leads 1-10 (white leads) is active. If not, press PREV (F3) or NEXT (F4) so that it is active.

d. Press GO BACK (F2) to return to the test window, then press START (F1).

e. Use a current source to generate an DC current between Patient Leads 1-10 and EARTH. Check that both the level of this current, and the current readout on the QA-90 display, are equal. Press STOP (F1).

f. Press the PL key on the keypad, then press PREV (F3) or NEXT (F4) to ensure that the module with Patient Lead 11 (blue lead) is active.

g. Press GO BACK (F2) to return to the test window, then press START (F1) and run the same test between Patient Lead 11 and EARTH. Repeat the test with different current values. Adjust the General l-constant if the values between UUT and reference are not equal. Press STOP (F1).

h. Press GO BACK (F2) until you return to Manual Test Setup Window 3. Then, press MORE (F1) to advance to Manual Test Setup Window 4.
5. **Patient Auxiliary Current DC**
   a. Press Patient Auxiliary Current DC (F6).
   b. Select Normal Condition (F7).
   c. Press the PL key on the keypad to ensure that the module with Patient Leads 1-10 (white leads) is active. If not, press PREV (F3) or NEXT (F4) so that it is active.
   d. Press GO BACK (F2) to return to the test window, then press START (F1).
   e. Use a current source to generate an DC current (20 µA) between Patient Leads 1-9 and Lead 10, and between Patient Leads 1-8 and Lead 9. Check that both the level of this current, and the current readout on the QA-90 display, are equal. Press STOP (F1).
   f. Press GO BACK (F2), then press MORE (F1) to advance to Manual Test Setup Window 5.

6. **Current Measurement Dual Lead**
   a. Press Current Measurement Dual Lead (F5).
   b. Select Normal Condition (F7).
   c. Press START (F1).
   d. Use a current source to generate a current between the DUAL (Red and Black) inputs.
   e. Press STOP (F1).
   f. Check that both the level of this current, and the current readout on the QA-90 display, are equal.
   g. Press GO BACK (F2) to Manual Test Setup Window 5.

7. **Voltage Measurement Dual Lead**
   a. Press Voltage Measurement Dual Lead (F7).
   b. Select Normal Condition (F7).
   c. Press START (F1).
d. Use a power/voltage source to generate an AC voltage.

e. Press STOP (F1).

f. Check that the level of this current, and the current readout on the QA-90’s display are equal. If necessary, adjust the voltage to be equal on UUT and reference. The constant used is the SP/VDML U-constant.

g. Repeat the measurement, but with DC voltage.

h. Press GO BACK (F2) four times to go to Manual Test Setup Window 1.

8. **Supply Voltage.** An insulated transformer is used for this measurement, except for step 7.f. below.

   a. Press Supply Voltage (F6).

   b. Check the voltage between LIVE and NEUTRAL on the front panel terminals with a calibrated instrument.

   c. Select Live - Neutral (F7) and press START (F1).

   d. Press STOP (F1). Check the voltage.

   e. Select Neutral - Ground (F7) and press START (F1).

   f. Press STOP (F1). Check the voltage.

   g. Connect a variac to the terminals on the front panel and check the voltage. The **Live - Neutral** setting is used to measure, for example, 70 and 250 VAC. It is not necessary to use an insulated transformer.

   h. Press GO BACK (F2) to return to Manual Test Setup Window 1.

9. **Current Consumption.** This measurement is done with a resistive load connected to the mains outlet on the front panel of the QA-90. The reference digital multimeter (HP34401 or similar), in current (AC) mode, is in series with the load. Use the digital multimeter in the 0 - 3 A range, and the same instrument with a current probe (HP34330A or similar) in the range > 3 A. The probe and digital multimeter are calibrated together.

   a. Press Current Consumption (F5).

   b. Press START (F1).

   c. Press STOP (F1). Check that the UUT and the reference digital multimeter values are equal. If they are not equal, adjust the CC I-constant.
d. Press GO BACK (F2), then press MORE (F1) to advance to Manual Test Setup Window 2.

10. Protective Earth

![Important Notice]

ENSURE THAT THE TEST LEADS ARE CALIBRATED BEFORE CONDUCTING THIS MEASUREMENT. METRON RECOMMENDS THAT, WHEN CALIBRATING THE QA-90, TEST LEAD CALIBRATION BE DONE AT LEAST TWICE.

a. Press Protective Earth (F7).

b. Connect the test leads between EARTH and ENCL.

c. Press START (F1). QA-90 will time the measurement and stop automatically. Take measurements at 0, 100, 500, 1000 and 2000 mΩ with a Metron calibrating unit. Note that the test current is delivered by a transformer located on the right side of the cabinet. In low mains voltage, this transformer will not deliver the IEC/UL-recommended 10 A. If you are doing repetitive testing and the transformer gets hot, it may turn off for a while to prevent overheating. It is not rated to deliver in excess of 25 A in short circuit condition. A transformer for 100-120 V mains is available from METRON.

d. Press GO BACK (F2) to return to the previous display.

11. Insulating Resistance. Insulation resistance measurements are done in both the Mains to Case and Applied Part to Case modes.

a. Ensure the QA-90 is ON for at least 30 minutes.

b. Press Insulating Resistance (F6).

c. Select Mains To Case (F7).

d. Connect a voltmeter or a digital multimeter, with an input impedance of 10 MΩ, between ENCL. and the mains outlet on the front panel. Press START (F1).

e. Measure the test voltage.

f. Trim the test voltage to within 500 ± 1 V. Then, use a calibrated resistor to measure values in the range 1-200 MΩ.
5.4 Other Calibration Procedures

1. **Bar Code Reader** (Optional). This checks the QA-90 Bar Code Reader function and its ability to properly accept scan and con-

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2 On older QA-90 firmware versions there is only one constant IR U-constant for insulation resistance measurements. On version series 0.xx there are six constants, while on version series 1.xx there are seven. Also with the 1.xx series, the IR U- and IR R-constants are used for insulation resistance measurements.
vert the bar codes into machine-readable format. *(See paragraph 3.3 for more information on this feature.)*

a. Attach the scanning wand’s TTL interface to the 9-pin D-sub port on the QA-90’s rear panel.

b. Return to the Main Menu.
c. Scan an improperly formatted instrument bar code. The QA-90 should beep to indicate this error.

d. Scan a properly formatted instrument bar code. Check to see that the Equipment Code and Equipment Class are entered in the display.

e. Follow the procedure in paragraph 3.6 to advance to the display window containing the Module Code, No. of Leads and Type.

f. Scan an improperly formatted patient lead bar code. The QA-90 should beep to indicate this error.

g. Scan a properly formatted patient lead bar code. Check to see that the Module Code, No. of Leads and Type are entered in the display.

2. Automatic Test Sequence with Printout. This checks the QA-90’s sequence testing function. For the printout function a printer must be connected to the QA-90, and be ON. See chapter 2 for additional information.

a. Return to the QA-90’s main menu, then press MORE (F1) twice to arrive at page 3.
b. Select **Automatic** in **Test Mode** (F5). Press **START** (F4). QA-90 will then commence an automated sequence test.

c. When the test is completed the following Test Results Window appears.

```
---TEST FAILED---              F7
Print Test Results .................> F6
Print Failed Results ...............> F5
SHOW TEST SHOW FAILED STORE MAIN MENU
```

d. Press **Print test results** (F6). Check the printout for legibility. Then, press **Print failed results** (F5). Check the printout for legibility.

--- IMPORTANT ---

**ENSURE THAT YOU SAVE THE CALIBRATION CONSTANTS TO FLASH.**

5.5 **Calibration Constants**

1. **SP/VMDL U-constant.** Adjusts the voltage measurement for Supply Voltage and Voltage Measurement Dual Lead. When the parameter value increases, the measurement value decreases. Calibrates at 200 - 230 V alternating voltage. This is best done at Dual Lead. Measure with AC voltage with polarity changed. Add the measurements to get the average and calculate the correct constant.

2. **PEIRMDL U-constant.** Adjust the voltage measurement for Protective Earth and Resistance Measurement Dual Lead. When the parameter value increases, the measurement value decreases. This value does not usually change. The default value is 84.30.

3. **IR U-constant.** Adjust the resistance measurement for insulating resistance. When the parameter value increases, the measurement value increases. The calibration occurs with a calibrating resistance of 90 - 110 mΩ. Ensure the power of 500 V is set correctly, and that the QA-90 has reached its operating temperature.

4. **General I-constant.** Adjust the current measurement for PLC, ALC, MAP, EnLC, ELC, CMDL and the IR tests. When the parameter value increases, the measurement value decreases. The
calibration and calculation of the parameter occurs with a current of 1000 - 10000 µA from the calibration instrument.

5. **PE/RMDL I-constant.** Adjust the current measurement for the PE and RMDL tests. When the parameter value increases, the measurement value increases.

6. **CC I-constant.** Adjust the current measurement for Current Consumption. When the parameter value increases, the measurement value decreases.

7. **IR R-constant.** Adjust the resistance measurement for Insulating resistance. When the parameter value increases, the measurement value decreases. The calibration occurs with a calibrating resistance of 190 - 210 mΩ. Make sure that the power of 500 V is set correctly and that the apparatus has reached its operating temperature.
6. Component Functions and Parts

This chapter provides a detailed description of the functions of the main components of the QA-90, as well as a parts list for cross-reference.

The QA-90 comprises three printed circuit boards: a metering board, processor and keypad board. There are two sets of schematic diagrams in Appendix B for the measuring system (comprising eight schematic diagrams) and a set for the processor/keypad system (comprising six pages).

The circuit boards are supplied from a 40 W "medical grade" power source, which delivers +12 Volt and +5 Volt. In addition, a temperature-protected transformer is connected to the mains to supply a test current of up to 30A for "protective earth" measurements.

6.1 Theory of Operation

The QA-90 is an electrical safety analyzer based on a 68HCll Motorola microprocessor and a measuring system that is galvanically isolated from the processor. The unit is controlled from the front panel and it is possible to select either manual mode for measuring voltage, current and resistance, or an automatic test cycle that provides full safety testing in accordance with specified standards.

The following standards may be compiled either fully or in part: IEC 601.1, UL 2601.1, IEC 601.1.1, UL 2601.1.1, IEC 601.2.4, IEC 1010-1, EN 60601-1, VDE 0750 T1/12-91, BS 5724, CAN/CSA-C22.2 No 601.1-M90, AS 3200.1, NZS 6150:1990, VDE 0751 T1/12-90, ÖVE 0751, UL 544, HEI 95, HEI 158 among others.

The measurement results, which are shown in the unit's LCD display, may be stored in the unit's internal memory, or printed out on an external printer. A serial port (RS-232c) enables the unit to be controlled from a PC, simply by using the PRO-Soft QA-90 soft, rare program.

The unit has a separate input for a bar code pen, which may be used to record instrument code and class, module code, and number of patient leads and classes.

The instrument is controlled from an alphanumeric keypad, containing nine blue "soft-keys," and seven function keys located around the LCD display. These are used to select the functions shown in the display. In addition, there is a separate key for selecting patient leads, a CLR a return key and a confirmation <ENTER> key.
All terminals for connecting the machine under test are located on the front panel. The mains contact is located on the rear panel adjacent to the mains switch marked Power QA-90.

6.2 Measuring System


The measuring board covers the entire base of the cabinet housing. Test currents are generated from the rear-left edge of the metering board. The forward section to the left is the measurement amplification unit with power to frequency conversion against the processor component. Approximately two-thirds of the right-hand side of the board comprises relay (sequence) drives and related relays for setting up the various measurement modes and measurement inputs. All communications with the CPU board occur via optical isolators, which isolate the measurement and CPU components from one another.

Refer to Schematic Diagram E160.20.2000. U1 (High Voltage Interface QA-90) (Measuring Preparation QA-90). The metering system is divided into six function blocks. The diagram contains the function blocks, as well as the sequence functions for power and auxiliary terminals on the rear panel of the QA-90. The T2070 Measurement Transformer is used for "current consumption" measurements.

Refer to Schematic Diagram E160.20.2100.U3 (High Voltage Interface QA-90). The high voltage (mains) interface component has several functions. T2110 gives the power frequency and synchronization signal to the High-Voltage Logic (U2210). U2210 generates a 50-60 Hz rectangular signal respectively to U2220A (to give 253 VAC to VDE measurements and to Mains on applied part measurements) and to U2220C (which gives 500 VDC to insulation resistance measurements). 2220D emits a rectangular signal with a DC offset. The amplitude is adjusted by respectively R2224 for AC and R2228 for DC. U2240 is a screening circuit with a center frequency set by D2240 depending on the mains frequency. The screen converts the DC signal to almost a sinus signal. This then goes to an amplifier/buffer, referred to as the "High Voltage Drives" (refer to Schematic Diagram E160.20.2300.U3 (High Voltage Drives QA-90)), which in turn feeds T2150 (page 2).

For measuring mains on applied part (253 VAC) the signal goes from T2150, through the S2151 relay and 47 kOhm series resistor (R2150, R2151), to the measuring object. For measuring insulation resistance (500 VDC), the signal passes through the S2151 relay to the rectifier.
module comprising D1, D2 and C2150, C2151 and out to the measuring object via a 102 kOhm series resistance. The series resistances protect the voltage generators, the equipment under test, and users against the high test voltages.

*Schematic Diagrams E 160.20.2400.U3 (Applied Part Matrix) and E 160.20.2500.U3 (Measurement Matrix)* comprise relays that are set up in accordance with the different measurements to be performed. Diagram 5 includes relays that belong to measurements on the patient leads. Diagram 6 includes relays for other measurement items, relays for connecting an attenuator and for a filter (patient equivalent).

*Schematic Diagram E160.20.2600.U3 (Prog. Amplifier and Lowpass)* is the measuring unit itself with a balanced measurement amplifier B&B PGA202 CU2600) with variable gain controlled by μP via optical isolators. The measurement amplifier module is supplied by a separate power supply, based on a DC-DC converter that provides +15 Volt. The SGND earth system for this power is isolated from GND and the mains. OPA602 and R2616 are used to offset adjustment of the measurement amplifier. Normally this is unnecessary, thus there is a jumper between pins 1 and 2 on S2600 to avoid using the DC offset function. U2610 is a filter that is operated by the S2420 relay during "insulating resistance" measurements. Signals from the measurement amplifier continue to an RMS to DC converter AD536AK, which in turn generates a DC signal on a circuit for voltage to frequency conversion (U2641) LM231WM. The output signal (A/D frequency) goes to μP via optical isolators.

**6.3 Microprocessor System**

Refer to Drawing No. E160.20.1000. U1, containing six schematic diagrams.

Refer to Schematic Diagrams 1 through 3 (QA-90; Integrated Keyboard QA-90; and CPU QA-90). The processor system is divided into 5 function blocks comprising a CPU, memory, display, printer interface, serial and keypad interface, and keypad board.

The QA-90's CPU and keypad board are located behind the front panel. The unit comprises a processor system, display, control components, connection to the metering board, an RS-232 port, printer port, and a port for the bar code pen.

The processor controls the measurement process in the QA-90. Measured analogue values are converted to an A/D frequency that is
transferred to the processor where the measurements are calculated and presented in the display.

The CPU comprises a Motorola 68HC11A1 operating at 8 MHz, which gives a BUS frequency of 2 MHz. The UART in µP is used only during boot up. The pulse accumulator in µP is used to record measurement data.

A Maxim µP supervisory circuit, with a 4.65 Volt reset, is also used to monitor the 12 Volt power, and to ensure battery power to the RAM when the unit is switched off. U1080 and DS2404 are timer circuits. These provide the system with real time. U1160 is an address decoder. U1120 is an address latch for the multiplex address bus. µP has a 64 KB address range. U1130, together with U1150, is used as a bank switch to address the process circuit’s RAM and flash ROM.

Refer to Schematic Diagram 4 (Memory QA-90). The memory component comprises 128 KB RAM and 512KB flash ROM for storing programs. The CPU module is programmable, and may be reprogrammed with new software supplied by Metron. All transistors in the memory circuit are used to supply the flash ROM with a 12 volt programming voltage.

Refer to Schematic Diagram 5 (Printer and Display IF QA-90). The printer and display interface comprises PD71055, PIO that is used to write to display and to the Centronics output. Data to Centronics goes via LS05, which has an open collector output. A strobe pulse to the Centronics port is established through U1410A-D.

Keypad scanning and the RS-232 interface are established by UI300, DUART. The keypad is a standard keypad matrix.

U13 I0, MAX238 is a RS-232 transmitter/receiver between DUART and the RS-232 port.

### 6.4 Component Parts

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APPENDIX A:  IEC 601.1, UL 2601.1 AND VDE 0751 TESTING

This appendix describes International Electrotechnical Committee (IEC) Standard 601.1, Underwriters Laboratories (UL) Standard 2601.1, and Verband Deutscher Elektrotechniker e.V. (VDE) 0751 Standard tests, their functions, applicability, and equipment connections.

A.1 Classification of Equipment

Electrical safety begins with considering the mains electricity supply, and how to feed that into an item of equipment so that it is able to power the electronics internally and, at the same time, ensure that there is no possibility of the mains power coming into contact with either the patient, user or a third person.

The classification of equipment under IEC 601.1 and UL 2601.1 describe how the mains part insulation is achieved. The techniques used include: air clearance; insulating materials (basic or functional insulation); creepage distances, and; double insulation

1. **Class 0.** The mains part is completely separated from any of the accessible parts. The separation is achieved by basic insulation. This is not used in medical applications.

2. **Class 1.** In addition to the basic insulation, there is protection via the protective earth conductor in the mains lead. This is intended to connect all the equipment’s accessible parts to earth. The majority of electromedical equipment is Class 1 equipment.

3. **Class 2.** Equipment of this class is constructed with double insulation, i.e., two distinct insulating layers around the mains part. The purpose is that, should the basic insulation of the mains part fail, and then a second insulating barrier exists to prevent the mains from coming into contact with the user or patient. *(See illustration below.)*
4. **Class 3.** Equipment of this classification is no longer manufactured, and the classification was removed from IEC 601.1 in 1988. The equipment was powered via an isolating, or safety transformer, which generated at its secondary winding a “Medical Safety Extra Low Voltage (MSELV).

5. **Symbols.** A particular degree of protection afforded a patient against an electric shock, arriving from the applied part, defines the type of applied part. The symbols for each type of protection are shown below:

<table>
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<th>Symbols</th>
<th>Description</th>
<th>Symbols</th>
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**B** = Classes 1, 2 or 3 equipment, or I.P. equipment providing an adequate degree of protection against electrical shock, particularly regarding allowable leakage currents and reliability of the protective earth connection.

**BF** = Type B equipment with an F-type isolated (floating) applied part.

**CF** = Classes 1 or 2 equipment, or I.P. equipment providing a high degree of protection against electrical shock, particularly with regard to allowable leakage currents, and having an F-type isolated (floating) applied part (cardiac protection).
6. **Generic Safety Tests**
   - Power Supply Tests: Classes 1 and 2
   - Enclosure Tests
   - Applied Parts Tests: Types B, BF and CF
   - Systems Tests
A.2 Tests on Mains Powered Class 1 & 2 Equipment According To IEC 601.1/UL 2601.1

1. Test P.E. 1 - Protective Earth Continuity
   - Applicable to Class 1, Types B, BF and CF.
   - Measures impedance of Protective Earth Terminal to all exposed parts of the instrument under test, which are connected to the Protective Earth.
   - Normally includes the wiring in the mains cable (maximum 0.2 Ohms). Without the mains cable, the maximum is 0.1 Ohms.
   - Test current: 25 Amps, applied for a minimum of five seconds.

2. Test I.R. 1 - Insulation Resistance - Mains Part to Case
   - Applicable to Class 1, Types B, BF and CF.
   - Measures insulation resistance of power leads (live and neutral wires together) to the Protective Earth terminal of the instrument under test.
   - Minimum: 2.0 MOhms.

3. Test I.R. 2 - Insulation Resistance - Applied Part to Case
   - Applicable to Class 1, Types BF and CF.
• Measures insulation resistance between the Applied Part, to the Protective Earth terminal of the instrument under test.
• Minimum: 10.0 MOhms.

![Diagram showing test setup]

4. **Test E.L.C. 1 - Earth Leakage Current: Normal Condition**
   • Applicable to Class 1, Types B, BF and CF.
   • Measures earth leakage current of the instrument under test connected to the mains power supply; normal and reversed polarity using S2.
   • For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
   • Maximum leakage current: 500 µA (Range: DC and AC up to 1 kHz).

![Diagram showing test setup with switches S1, S2, and S3]

5. **Test E.L.C. 2 - Earth Leakage Current: S.F.C. Open Supply**
   • Applicable to Class 1, Types B, BF and CF.
   • Measures earth leakage current of the instrument under test, with one open supply lead interrupted (S1 = open); normal and reversed polarity using S2.
6. **Test ENCL. 1 - Enclosure Leakage Current: Normal Condition**

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures leakage current of the exposed metal parts of the instrument under test; normal and reversed polarity using S2.
- For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
- Maximum leakage current: 100 µA (Range: DC and AC up to 1 kHz).

7. **Test ENCL. 2 - Enclosure Leakage Current: S.F.C. Open Supply**

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures leakage current of the exposed metal parts of the instrument under test, with one open supply lead interrupted (S1 = open); normal and reversed polarity using S2.
- For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
- Maximum leakage current: 500 µA (Range: DC and AC up to 1 kHz).
8. **Test ENCL. 3 - Enclosure Leakage Current: S.F.C. Open Earth (Ground)**

- Applicable to Class 1, Types B, BF and CF.
- Measures leakage current of the exposed metal parts of the instrument under test with Protective Earth open circuit (S4 = open); normal and reversed polarity using S2.
- For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
- Maximum leakage current: 500 µA (Range: DC and AC up to 1 kHz).

9. **Test P.L.C. 1 - Patient Leakage Current: Normal Condition**

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures patient leakage current to earth from all Applied Parts in parallel; normal and reversed polarity using S2.
- Maximum leakage current Types B and BF: 100 µA (Range: DC and AC up to 1 kHz). For Type CF: 10 µA (Range: DC and AC up to 1 kHz).

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures patient leakage current to earth from all Applied Parts in parallel with one supply lead interrupted (S1 = open); normal and reversed polarity using S2.
- Maximum leakage current Types B and BF: 500 µA (Range: DC and AC up to 1 kHz). For Type CF: 50 µA (Range: DC and AC up to 1 kHz).

11. **Test P.L.C. 3 - Patient Leakage Current: S.F.C. Open Earth**

- Applicable to Class 1, Types B, BF and CF.
- Measures leakage current to earth from all Applied Parts in parallel with the Protective Earth open circuit (S4 = open); normal and reversed polarity using S2.
- Maximum leakage current Types B and BF: 500 µA (Range: DC and AC up to 1 kHz). For Type CF: 50 µA (Range: DC and AC up to 1 kHz).
12. **Test P.L.C. 4 - Patient Leakage Current: S.F.C. Mains on Applied Part**

- Applicable to Classes 1 and 2, Types BF and CF.
- Measures leakage current to earth from Applied Part to earth caused by external mains voltage on Applied Part, and with switch S5 open and closed.
- Each polarity combination possible is tested using S5 and S6.
- Maximum leakage current Type BF: 5000 µA (Range: DC and AC up to 1 kHz). For Type CF: 50 µA (Range: DC and AC up to 1 kHz) (100 µA for CF defibr paddles: IEC 601-2-4).

(*) Not present in Class 2

13. **Test P.A.C. 1 - Patient Auxiliary Current: Normal Condition**

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures the current flowing between one of the Applied Parts and all of the others in parallel, e.g., patient leads; normal and reversed polarity using S2.
- AP switch is used to obtain all AP combinations.
- Maximum auxiliary current Types B and BF: 10 µA DC; 100 µA (Range: AC 0.1 Hz up to 1 kHz). For Type CF: 10 µA (Range: DC and AC up to 1 kHz).

(*) Not present in Class 2

- Applicable to Classes 1 and 2, Types B, BF and CF.
- Measures the current flowing between one of the Applied Parts and all of the others in parallel with one supply lead interrupted (S1 = open); normal and reversed polarity using S2.
- AP switch is used to obtain all AP combinations.
- Maximum auxiliary current Types B and BF: 50 µA DC; 500 µA (Range: AC 0.1 Hz up to 1 kHz). For Type CF: 50 µA (Range: DC and AC up to 1 kHz).
15. **Test P.A.C. 3 - Patient Auxiliary Current: S.F.C. Open Earth (Ground)**

- Applicable to Class 1, Types B, BF and CF.
- Measures the current flowing between one of the Applied Parts and all of the others in parallel with the Protective Earth open circuit (S4 = open); normal and reversed polarity using S2.
- AP switch is used to obtain all AP combinations.
- Maximum auxiliary current Types B and BF: 50 µA DC; 500 µA (Range: AC 0.1 Hz up to 1 kHz). For Type CF: 50 µA (Range: DC and AC up to 1 kHz).

(*) Not present in Class 2
A.3 Tests on Internally Powered Equipment According To IEC 601.1/UL 2601.1

1. Test I.P. 1 - Enclosure Leakage Current: Normal Condition
   - Applicable to internally powered equipment, Types B, BF and CF.
   - Measures leakage current of the exposed metal parts of the instrument under test.
   - For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
   - Maximum leakage current: 100 µA (Range: DC and AC up to 1 kHz).

2. Test I.P. 2 - Patient Leakage Current: Normal Condition
   - Applicable to internally powered equipment, Types B, BF and CF.
   - Measures the patient leakage current from the Applied Parts to the enclosure.
   - For Type BF and CF equipments, measures with the AP/GND switch S3 open and closed.
   - Maximum auxiliary current Types B and BF: 100 µA (Range: DC and AC up to 1 kHz). For Type CF: 10 µA (Range: DC and AC up to 1 kHz).
   - Applicable to internally powered equipment, Types BF and CF.
   - Measures the patient leakage current from the Applied Parts to the enclosure caused by the external mains voltage on the Applied Part.
   - Maximum auxiliary current Type BF: 500 µA (Range: DC and AC up to 1 kHz).
   - Maximum auxiliary current Type CF: 50 µA (Range: DC and AC up to 1 kHz).

4. **Test I.P. 4 - Patient Auxiliary Current: Normal Condition**
   - Applicable to internally powered equipment, Types B, BF and CF.
   - Measures the current flowing from one of the Applied Parts and all the others in parallel.
   - AP switch is used to obtain all AP combinations.
   - Maximum auxiliary current Types B and BF: 10 µA DC; 100 µA (Range: AC 0.1 Hz up to 1 kHz).
   - Maximum auxiliary current Type CF: 10 µA (Range: DC and AC up to 1 kHz).
A.4 System Tests Based on IEC 601.1/UL 2601.1

1. Test SYS. 1 - Enclosure Leakage Current: Normal Condition
   - Applicable to Classes 1 and 2, Types B, BF and CF.
   - Measures leakage current of the exposed metal parts of the instrument under test and between parts of the system within the patient environment; normal and reversed polarity using S2.
   - Maximum leakage current: 100 µA (Range: DC and AC up to 1 kHz).

2. Test SYS. 2 - Enclosure Leakage Current: S.F.C. Open Earth (Ground)
   - Applicable to Class 1, Types B, BF and CF.
   - Measures leakage current of the exposed metal parts of the instrument under test with Protective Earth open circuit (S4 = open), and between parts of the system within the patient environment; normal and reversed polarity using S2.
   - Maximum leakage current: 500 µA (Range: DC and AC up to 1 kHz).
A.5 Tests According To VDE 0751-1, 10/1990

1. Test VDE 0751-1 Test 1 - Replacement Leakage Current Fig. 9. (Ersatz - Ableitstrom nach Bild 9)
   • Applicable to Classes 1 and 2, Types B, BF and CF. (For Class 1: Protective Earth conductor is not connected.)
   • Measures replacement leakage current to earth from all Applied Parts and enclosure in parallel; normal and reversed polarity using S.
   • Maximum leakage current: 1000 µA (Range: DC and AC up to 1 kHz).

2. Test VDE 0751-1 Test 2 - Replacement Equipment Leakage Current (Ersatz - Geräteableitstrom)
   • Applicable to Class 1, Types B, BF and CF.
   • Measures replacement leakage current to mains part from all Applied Parts and enclosure in parallel, with Protective Earth wire connected.
   • Maximum leakage current: 1000 µA (Range: DC and AC up to 1 kHz).
3. Test VDE 0751-1 Test 3 (Replacement Patient Leakage Current) (Ersatz - Patientableitstrom)

- Applicable to Classes 1 and 2, Types BF and CF.
- Measures replacement leakage current to mains part from all Applied Parts and enclosure in parallel.
- Maximum leakage current Type BF: 5000 µA. For Type CF: 50 µA (100 µA for CF defibrillator paddles).

(*) Not present in Class 2
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APPENDIX B: DIAGRAMS

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Measuring System Schematic Diagram Part 2 (High Voltage Interface) ...................... B-6
Measuring System Schematic Diagram Part 3 (High Voltage Logic) ............................ B-7
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Measuring Board Component Location Layer 2
Measuring System Schematic Diagram Part 1 (Measuring Preparation)
Measuring System Schematic Diagram Part 2 (High Voltage Interface)
Measuring System Schematic Diagram Part 3 (High Voltage Logic)
Measuring System Schematic Diagram Part 4 (High Voltage Drivers)
Measuring System Schematic Diagram Part 6 (Measurement Matrix)
Measuring System Schematic Diagram Part 7 (Program Amplifier and Lowpass)
Measuring System Schematic Diagram Part 8 (Relay Drivers)
Microprocessor Board Component Location
Microprocessor System Schematic Diagram Part 1 (QA-90)
Microprocessor System Schematic Diagram Part 2 (Integrated Keypad)
Microprocessor System Schematic Diagram Part 3 (CPU)
Microprocessor System Schematic Diagram Part 4 (CPU)
Microprocessor System Schematic Diagram Part 5 (Printer and Display Interface)
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# APPENDIX C: ERROR REPORT FORM, QA-90

## QA-90 ELECTRICAL SAFETY ANALYZER ERROR REPORT FORM

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<td>Travbaneanveien 1</td>
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<tr>
<td>Grand Rapids, MI 49505</td>
<td>91000 Evry, France</td>
<td>N-7044 Trondheim, Norway</td>
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<tr>
<td>Phone: (+1) 888 863-8766</td>
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<td>Fax: (+1) 616 454-3350</td>
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<tr>
<td>E-mail: <a href="mailto:metronus@aol.com">metronus@aol.com</a></td>
<td>E-mail: metronfrance@inфонie.fr</td>
<td>E-mail: <a href="mailto:support@metron.no">support@metron.no</a></td>
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**Description of the error:**  

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APPENDIX D: SUGGESTION FORM, QA-90

**QA-90 ELECTRICAL SAFETY ANALYZER SUGGESTION FORM**

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<td>E-mail: <a href="mailto:metronfrance@infonie.fr">metronfrance@infonie.fr</a></td>
<td>E-mail: <a href="mailto:support@metron.no">support@metron.no</a></td>
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Version:  

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