PMX-III

X-ray multimeter version 6.0
oRTIgo version 3.0

RTI Electronics

Declaration of conformity

We, RTI Electronics AB, Göteborgsvägen 97 / 50, SE-431 37 MÖLNDAL, Sweden,

declare under our sole responsibility that the product:

Product name: PMX-III **Model name:** R/M, R/CT, PH

Type of equipment: X-ray multimeter; kVp, exposure time, and dose meter

Intended use of this product: Accessory to diagnostic X-ray equipment, to be used for service and quality control.

is in conformity with the following standards:

Medical electrical equipment
Part 1: General requirements for safety (COUNCIL DIRECTIVE 93/42/EEC, Annexes V and VII)
Part 2: Collateral standard: Electromagnetic compatibility - Requirements and tests (EN 60601-1-2: 1993)

following the provisions of the 93/42/EEC Medical Devices Directive.

CE 0413

Mölndal, 1998-11-13,

.....
Lars Herrnsdorf, Vice President

Address: RTI Electronics AB • Göteborgsvägen 97 / 50 • SE-431 37 MÖLNDAL • Sweden
Phone: +46 (0)31 746 36 00 • Fax: +46 (0)31 27 05 73 • E-mail: info@rti-e.se • Web: www.rti-e.se

NOTICE

RTI Electronics AB reserves all rights to make changes in the PMX-III family of meters and the information in this document without notice.
RTI Electronics AB assumes no responsibility for any errors or consequential damages that may result from the use or misinterpretation of any information contained in this document.

NOTE!
This user manual is valid for PMX-III with the following version: 6.0

RTI Electronics AB
Göteborgsvägen 97 / 50
SE-431 37 MÖLNDAL
Sweden
Phone: **Int +46 31 746 36 00**
Fax: **Int +46 31 270 573**
E-mail: **info@rti-e.se**
Web: **http://www.rti-e.se**

PREFACE

Chapter 1	Gives an introduction to the PMX-III. Description of ADI, applications and typical use
Chapter 2	Describes general functions and connectors
Chapter 3	Set up the system for measurements
Chapter 4	Learn to make basic QC measurements.
Chapter 5	Service and Maintenance related measurements II,, Dose/frame, DSI, and light measurements.
Chapter 6	Remote control of the PMX-III using oRTIgo.
Chapter 7	Display code list and kVp correction graph.
Chapter 8	Precautions and maintenance.
Chapter 9	Detector range and detector selection guide, problem report document.
Chapter 10	Hints and troubleshooting, backup of calibration data
Index	Important words are listed in alphabetical order.

It is advisable to read through the user manual at least once to gain familiarity with the terms used and the capabilities of the PMX-III. It is possible to make measurements quickly with a minimum of reading. To do this read the instructions on the top panel of the instrument. Consult the PMX-III reference manual for more specific information.

Note! The PMX-III is intended for service and quality control of diagnostic X-ray equipment. It is not intended for for use during or together with diagnostic examinations of patients.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Overview

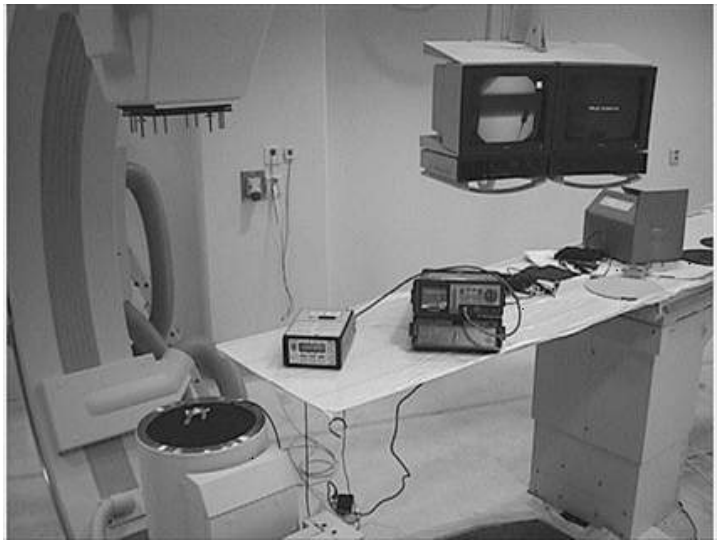
PMX-III is a combined dosimeter and multimeter with a waveform analyzer for both stand alone and remote control use.

PMX-III operates in four different main modes:

- As a **dosimeter,** measuring dose and dose rates simultaneously.
  The PMX-III can be operated from the control room. Functions as hold, normalize, auto range, and auto reset are available. Use of light detectors or current detectors makes it possible to measure , cd/m^2, lx , mA, and mAs.
- As a **multimeter** measuring kVp, time, dose, and dose rate simultaneously.
- As a **waveform analyzer**
- **Remote controlled** by the oRTIgo software.

PMX-III can be used to measure the following:

- Dose, dose rate, and dose/frame
- Light output from monitors and film viewing boxes using L100 light detector
- mA and mAs using optional current probes
- Mammo kVp and diagnostic kVp accuracy
- Exposure time accuracy
- Reproducibility of kVp, time, and output
- mAs-linearity
- HVL
- kV and radiation output waveform
- Dose rate, mA and light waveforms
- Dose/frame, frame/s and monitor frequency (Hz) automatically using waveform analyzer



PMX-III version 6.0 can be programmed to always start up in dosimeter mode or multimeter mode or what mode was used when last powered off.

1.2 Package Information and Changes Version 6.0

Please read the addendum to the reference manual.

1.3 Options and Accessories

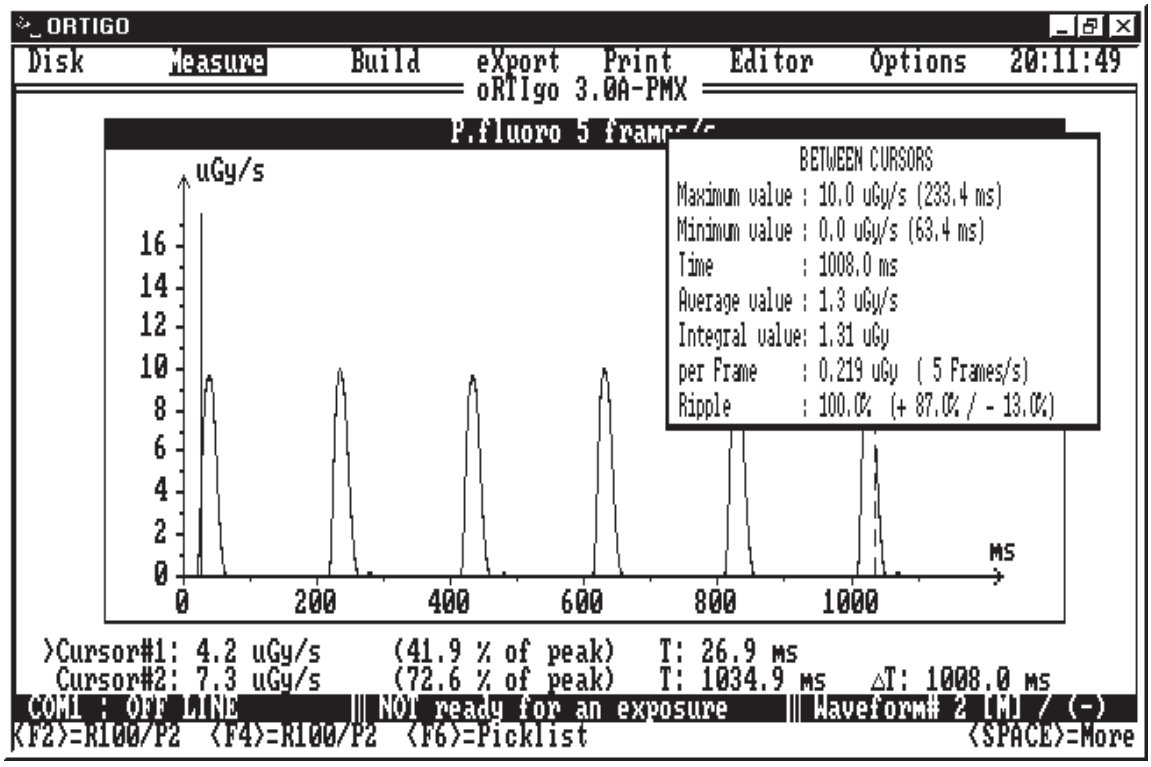
Please study the RTI's product catalogue that should be included in the package. The latest information can be found on RTI's web site www.rti-e.se.

1.4 Application Notes

For A list of available application notes, see chapter 9 "Notes and Reports". All application notes can be downloaded from our web page . They are stored as pdf files.

1.5 About oRTIgo Version 3.0

This manual briefly describe oRTIgo version 3.0 in chapter 6, for detail information please study the oRTIgo user manual.



Example of dose rate waveform with automatic calculation of dose/frame and frame/s

1.6 About ADIs

1.6.1 What is the Function of an ADI

The ADI contains the calibration factors for the detector with the same serial number. It also informs the PMX which detector is being used and transfers data to PMX-III for optimize the use of the detector.
As an example the selected ADI can inform if PMX-III should display dose rate or dose values after power on.

ADI multi module (replaces the need for up to 5 separate R100 ADIs, option)

1.6.2 What to do when Changing an ADI

The PMX reads the ADI at power on, after each exposure in multimeter mode and when pressing Reset. The display will indicate the type of ADI. Pressing reset longer than 2 s in dosimeter mode will make a new offset calibration. A “c” is displayed after reset to indicate calibration.
Do not expose during the time “c” is displayed.

1.6.3 Any Precautions?

The ADI contains an EEPROM with the probe calibration data. The calibration data can be downloaded to your PC by the oRTIgo program delivered with the PMX. In case of deletion (Er.30 message) this data can then be restored again. Also the internal Eeprom can be restored the same way. See chapter 10 “Hints and Troubleshooting” for more information.

1.6.4 How to Choose the Correct ADI Module

See the **Short form Detector Selection Guide** below.

1.7 Shortform Detector Selection Guide

Type	ADI Code	Beam Quality	Typical Use	Typical Range (rate)
R100	8/A	50-150 kV W/23 mm Al	film dose / rate	0,001-40 mGy/s
R100	8/A(P1)	50-150 kV W/23 mm Al	II dose rate input	0,03-0,46 µGy/s
R100	8/A(P2)	50-150 kV W/23 mm Al	II dose rate input	0,10-46 µGy/s
R25	7/B	50-150 kV W/ 3 mm Al	Skin dose / rate	0,004-160 mGy/s
R100	8/D	25-35 kV Mo/ 30m Mo	skin dose to breast	0,002-90 mGy/s
L100	6/U	Luminance CIE filter	Monitor adapter Film viewing box	0,1 cd>1000 cd/ m^2 0,5 cd>9999 cd/ m^2
L100	6/Y	Illuminance, diffusor	LUX adapter	0,25 - 4000 lx
MAS-1	5	Invasive mA & mAs (use the mA test socket)	mA and mAs	0,10-2000 mA
MAS-2	4	Non-invasive mA & mAs	mA and mAs	50-2000 mA
MAS-3	J	State of the art non-invasive mA & mAs	mA and mAs	0,10-2000 mA

The R25 and R100 are ideal for field service situations. They do not need corrections for temperature or pressure an need no bias voltage.

1.8 Typical Use

(ADI=Automatic Detector Identification)

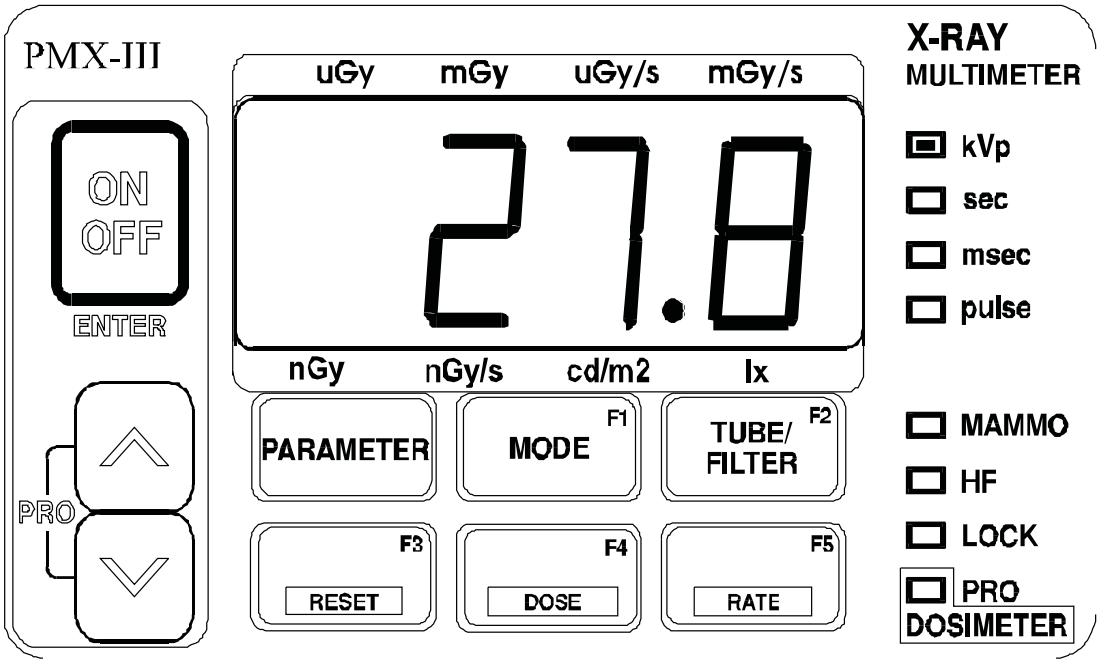
Application	ADI	Measurements	Power on Display	PMX Display code
Cont. fluoroscopy 3/6 mA	8/A(P1)	Dose rate only	rate	8.AP1
DSI/spotfilm fixed current	8/A(P2)	Dose rate & dose	rate	8.A.P2
DSI/spotfilm falling load	8/A	Dose rate & dose *(less sensitive)*	dose	8.-A-
Ambient light level	6/Y	Illuminance, (lx)	rate	6.-y-
Skin dose	7/B	Unfiltered beam (3mm Al.)	dose	7.-B-
Monitor light output with test pattern	6/U	Luminance (cd/m^2)	rate	6.-Y-
mA, mAs, and mA waveform check	5	with MAS-1 current probe	dose	MAS.1
Determine dose/frame and number/frames per second	8/A(P2)	oRTIgo waveform analyzer (see record news1.dta)	-	Not valid
Determine monitor vertical frequency	6/U	oRTIgo waveform analyzer (see record news1.dta)	-	Not valid

This page is intentionally blank.

2 DESCRIPTION OF PMX-III

2.1 Front Panel

PMX-III is equipped with a membrane switch panel with 9 different switches, one LCD display, and 8 LED indicators,4. Each time a key is pressed a beep is generated to indicate that PMX-III has recognized the key.



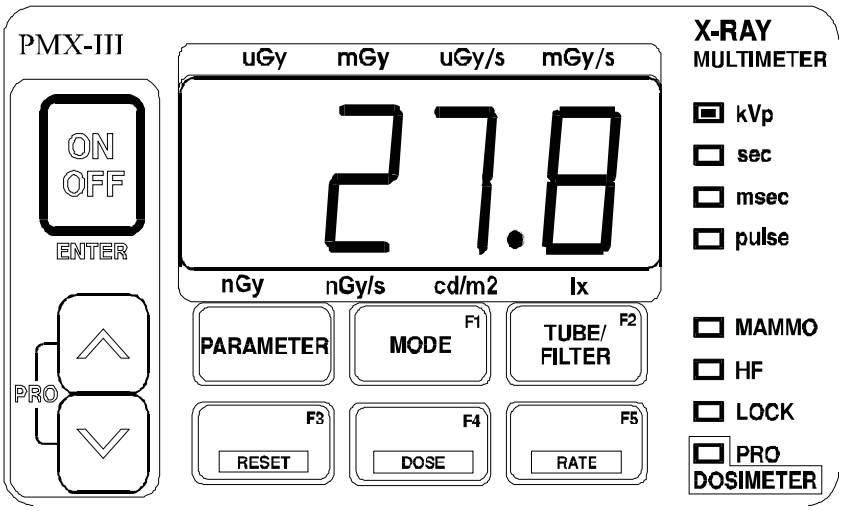
2.2 The Display

The display is a four digit LCD (liquid crystal display). The display is used to show digits and text and to indicate dose and dose rate units. Dose and dose rate are indicated at the top and bottom of the display.
The character “c” in the first position indicates that PMX-III is performing internal calibrations. This is done after each exposure in multimeter mode and when RESET is pressed in dosimeter mode.

When PMX-III operates in multimeter mode and is turned upside-down the display information is automatically turned around. This function can be turned off by means of the programming feature.

2.3 The LED Indicators

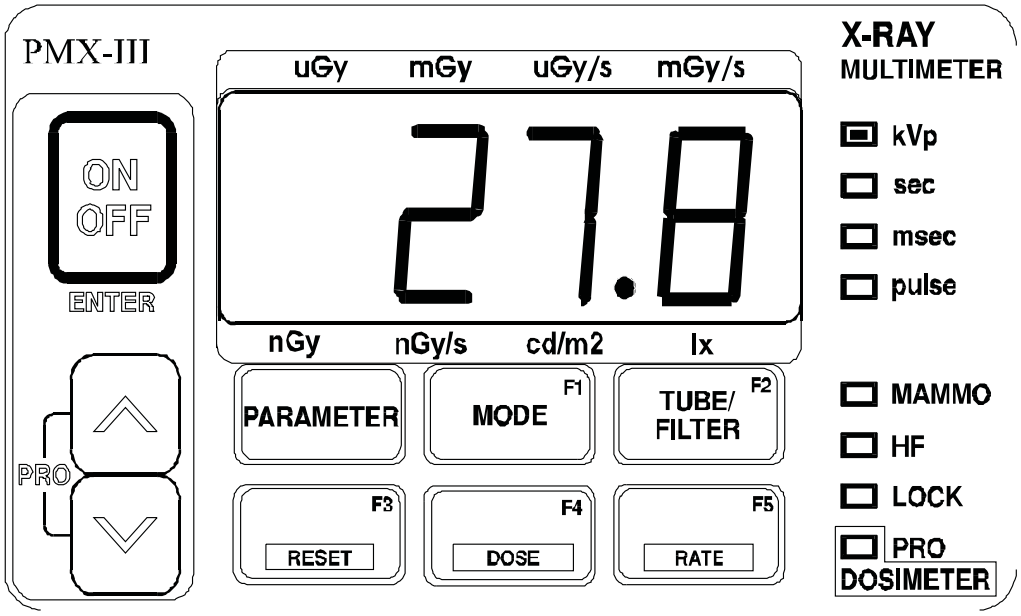
Eight LED indicators are used to indicate different parameters and modes of operation. The LED indicators are turned on each time a measurement is performed or a function is selected. In multimeter mode the LEDs are on for 10 seconds and then turned off to save power. If the LEDs are off, they can be turned on again by pressing the upper cursor key.



In dosimeter mode the LEDs are on continuously.

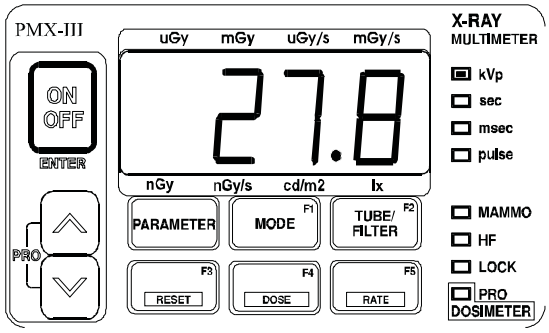
The following LED indicators are on the front panel:

kVp	Indicates tube voltage.
sec	Indicates exposure time, measured in seconds.
msec	Indicates exposure time, measured in milliseconds.
pulse	Indicates exposure time, measured in pulses.



MAMMO	ON:	Indicates that the selected tube/filter combination corresponds to a mammo X-ray unit, i.e. the MAM sensor area is used.
	OFF:	Indicates that the selected tube/filter combination corresponds to a conventional X-ray unit, i.e. the RAD sensor area is used.
HF	ON:	Indicates high frequency mode.
	OFF:	Indicates low frequency mode.
LOCK	ON:	Indicates LOCK or manual LOCK mode.
	OFF:	Indicates SET mode.
PRO	ON:	Indicates PROGRAMMING mode (the ON/OFF key acts as ENTER key) or that the dosimeter is activated.
DOSIMETER	OFF	Indicates multimeter measuring mode.

2.4 Front Panel Keys



The front panel keys are used to choose different operating modes. The same key may have different functions in multimeter and dosimeter modes.

The following keys are on the front panel, see figure.

ON/OFF (ENTER) Power on/off and enter key in programming mode.

PARAMETER Multimeter: Selects parameter to be displayed after an exposure. Dosimeter: No function.

MODE Changes operating mode

TUBE/FILTER Multimeter: Selects tube/filter combination. Dosimeter: No function

F3/RESET Multimeter: Activates a setup table. Dosimeter: Performs reset of the electrometer.

F4/DOSE Multimeter: Activates a setup table. Dosimeter: Selects dose.

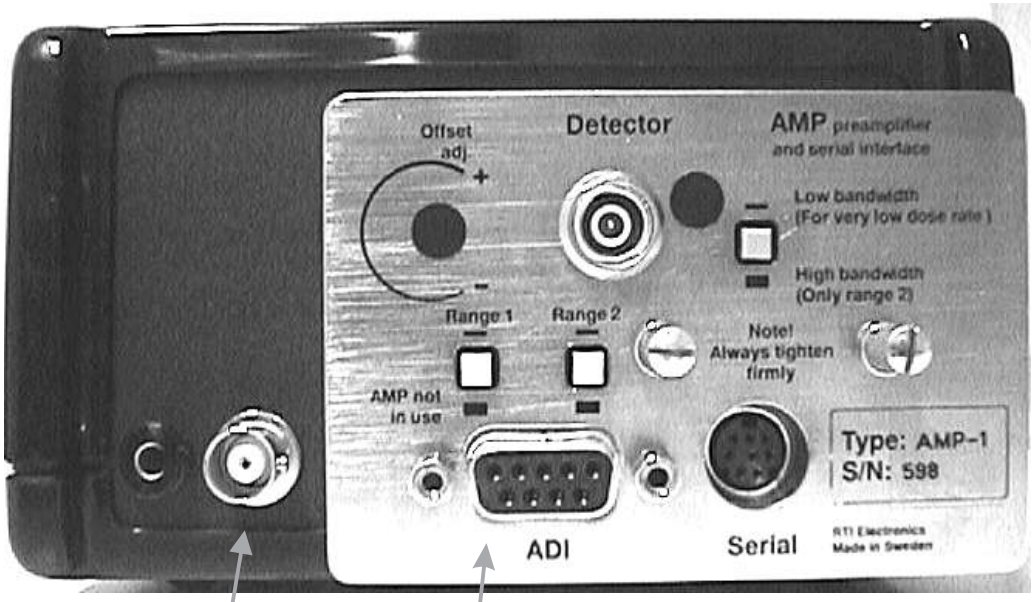
F5/RATE Multimeter: Activates a setup table. Dosimeter: Selects rate.

UPARR and DNARR Select different entries when moving around in the menus.

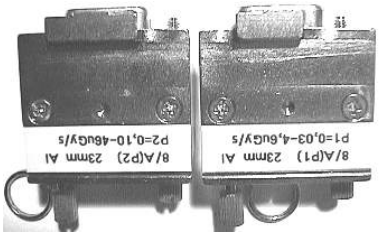
2.5 Back Panel and AMP-1

On the back panel the AMP-1 preamplifier/serial interface, there are four connectors:

- Detector connector input
- 9-pin ADI connector
- 8- pin MINI-DIN serial connector
- BNC output



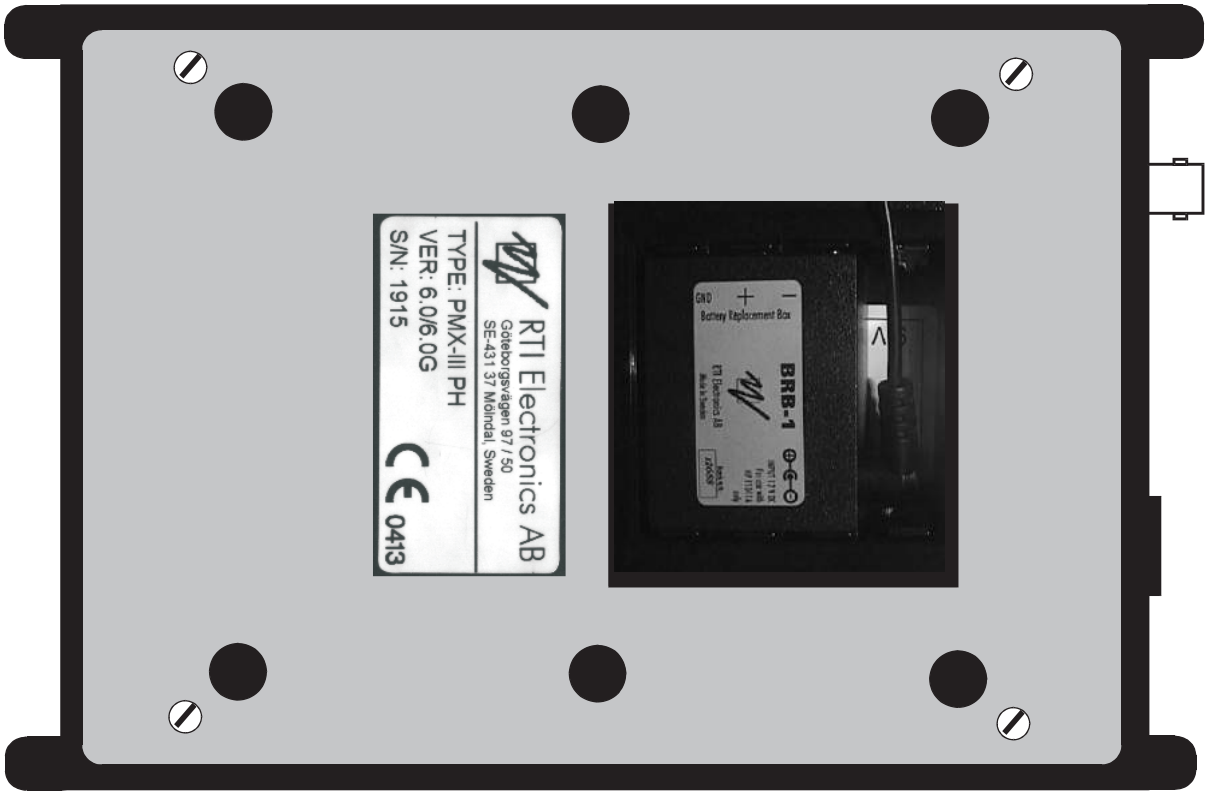
A BNC connector for connection to an oscilloscope or voltmeter.



ADI

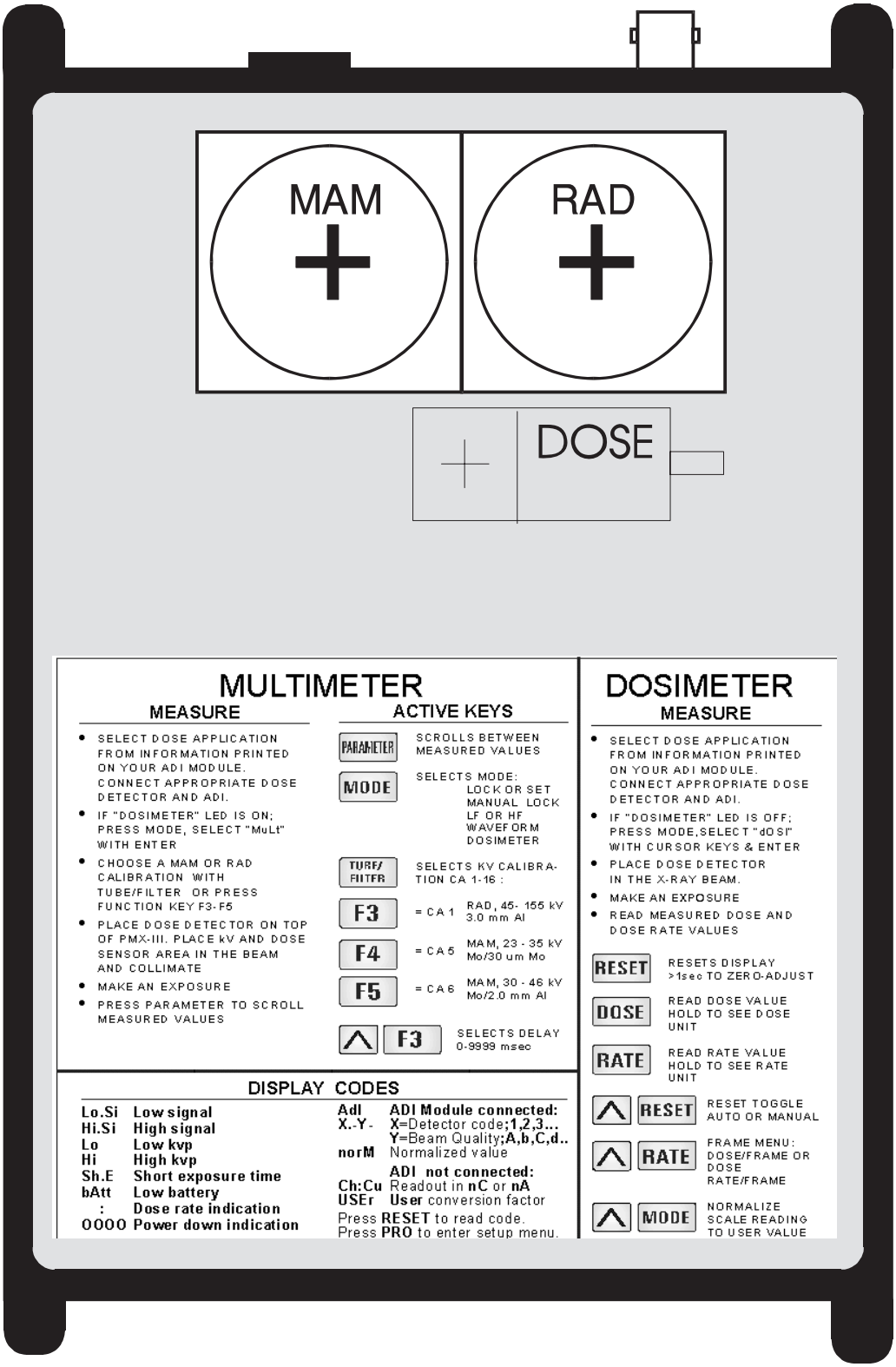
2.6 The Battery Case

Two high power alkaline “6LR61” 9 V batteries should be used if battery is used. Preferable a Battery Replacement Box “BRB” for mains power could be used instead of the two batteries.



2.7 Top Panel

On the top you will find indications for two sensor areas for MAM and RAD and indication where to place the dose detector (in multimeter mode), and user instructions for PMX-III



2.8 Special Remarks for Use of ADI 8/A(P1)

The remarks are valid for PMX-III working in dosimeter mode:

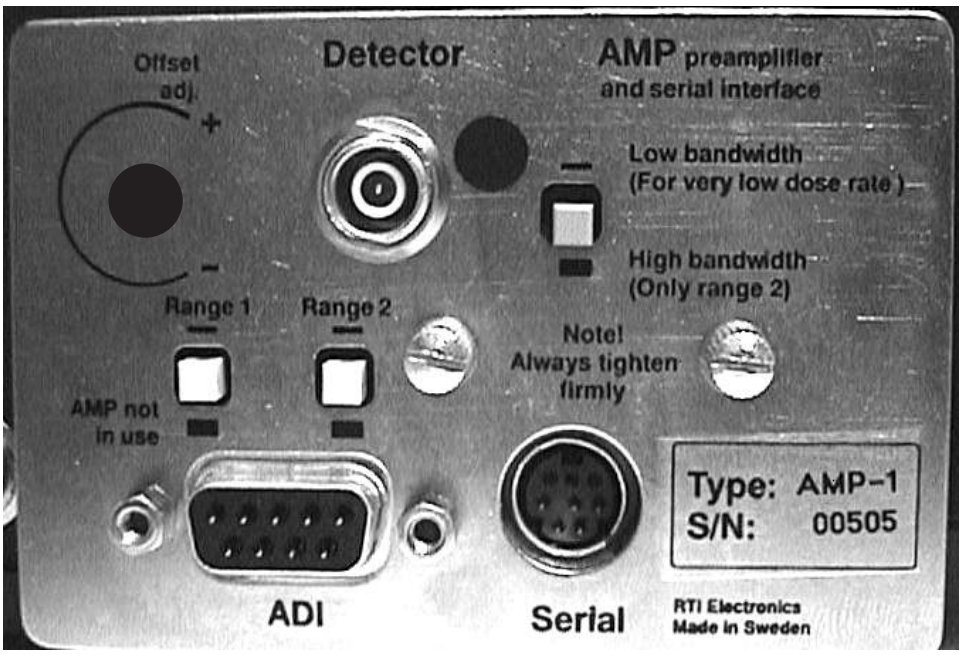
- Check that the correct ADI and detector is connected and that the detector is not radiated during the time RESET is pressed.
- Always press RESET until "c" appears, when a detector has been connected, to read the ADI information. PMX-III then automatically selects Range 3 and then makes a check that the correct offset level exists before the instrument is ready to measure.
- A few picoampere current spike can create a doserate overflow that make the dose display indication show HI.SI. This situation can typically happen when the user connects or changes detector and ADI with power on, and the preamplifier circuitry at the same time is activated. Press RESET to clear. This is not seen if the user selects RATE before changing to 8/A(P1) ADI since the current spike happens only once, and when the display updates the value is back to zero again. In the new release of PMX-III version 6.0 PMX-III automatically starts up in dose-rate mode for 8/A(P1) and therefore the message HI.SI is not seen anymore.
- The offset adjustment potentiometer hole on the back is only for **service purposes** for detectors where the detector offset level can change dramatically between different types. This is not the case for the R100, R25, and L100 detectors. The hole should normally be sealed.

  If the offset value is negative the PMX-III cannot work properly. If the offset value is to high then the measuring range value will be limited.
  A voltmeter have to be connected to BNC output on the back panel to be able to test the offset level correctly. Normal working levels for R100 using 8/A(P1) is between 100 and 300 mV.

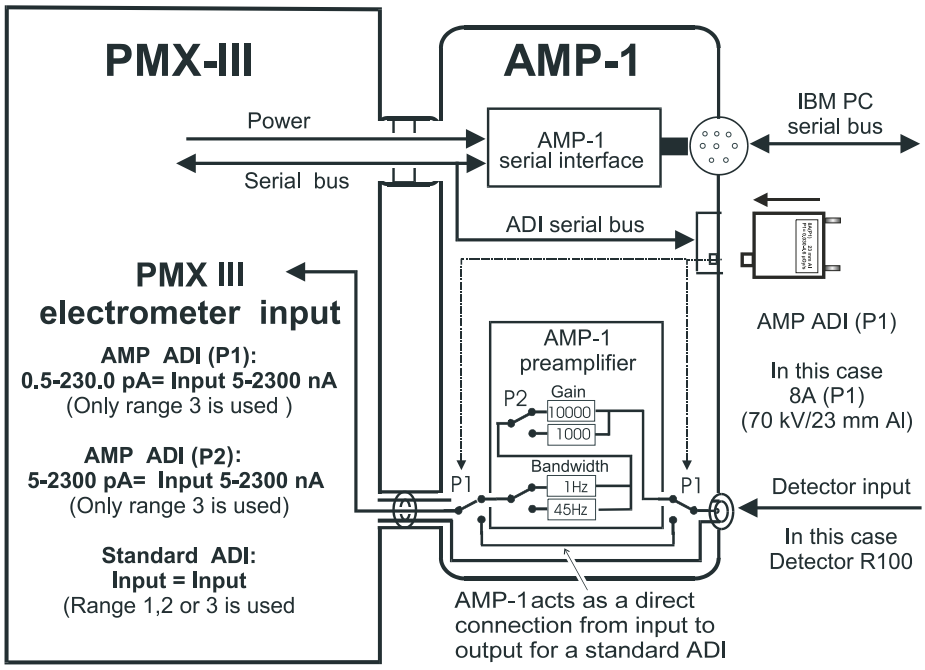
  A correct value is 200 ±30 mV after reset and normal working condition .
  (Without any ADI connected and after Reset the normal level is 100 ±20 mV.)

  Only adjust the potentiometer if you are sure that the real offset level is outside the accepted range that is valid for the ADI used.

2.9 AMP-1 Front Panel



2.10 Operation of Principle of the Electrometer



This page is intentionally blank.

3 HOW TO SET UP THE SYSTEM

- Place PMX-III in the X-ray field for multimeter measurements.
- For dosimeter measurements place the PMX-III as convenient for you as possible and use the 8 meter extension cable and the probe holder to put the detector in the measurement field.
- If a computer is used, connect the interface cable between your PMX-III AMP-1 and the computer (com l or Com 2), use serial extension cable if needed.
- Connect the ADI-module and detector, use detector extension cable if needed.
- Connect the power supply to the BRB-1.
- Power on the PMX-III, start oRTIgo or follow instructions on top panel.

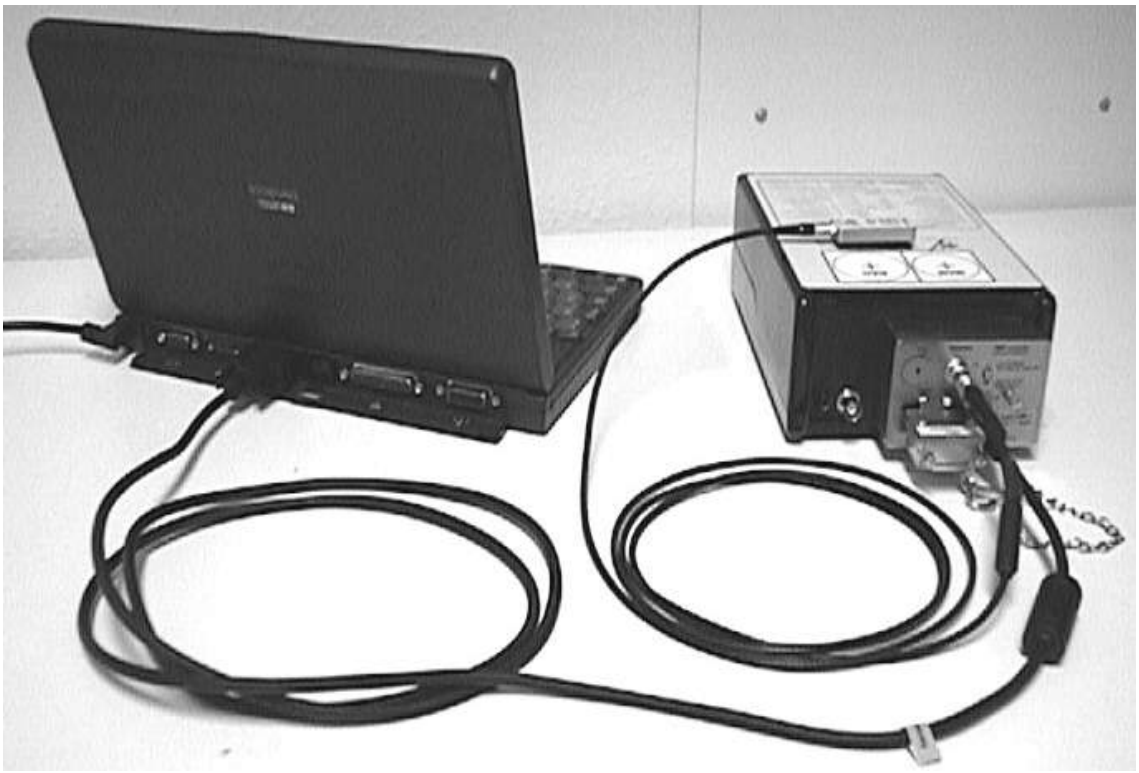


Figure 1. Correct connection of the serial cable, the detector cable, and ADI.

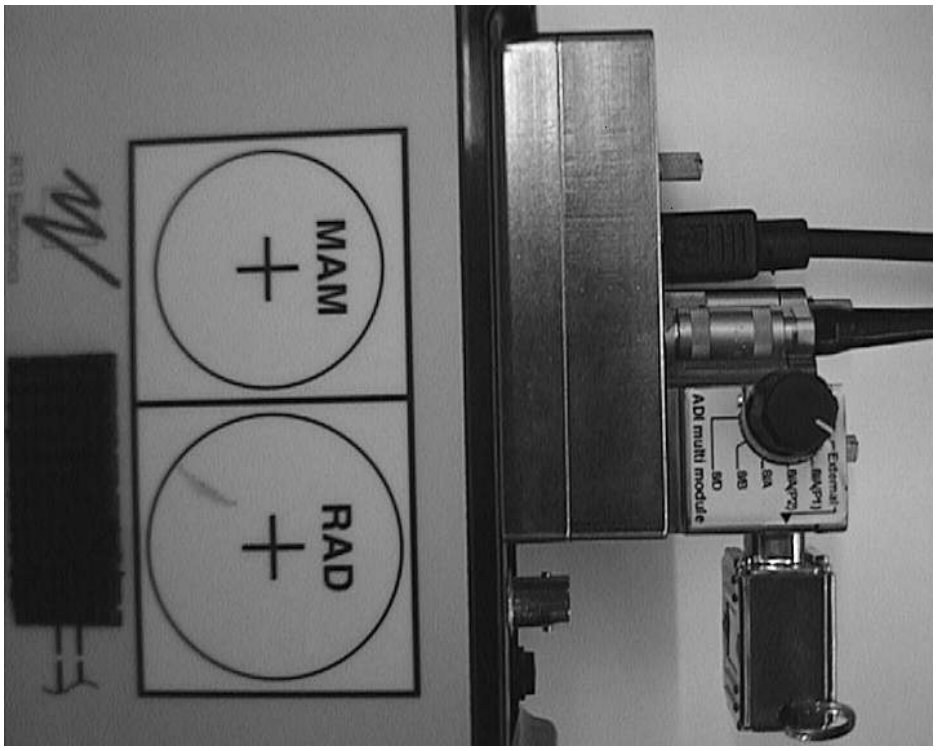


Figure 2. Detail picture of connection of the serial cable, the detector cable, and ADI Multi module (option).

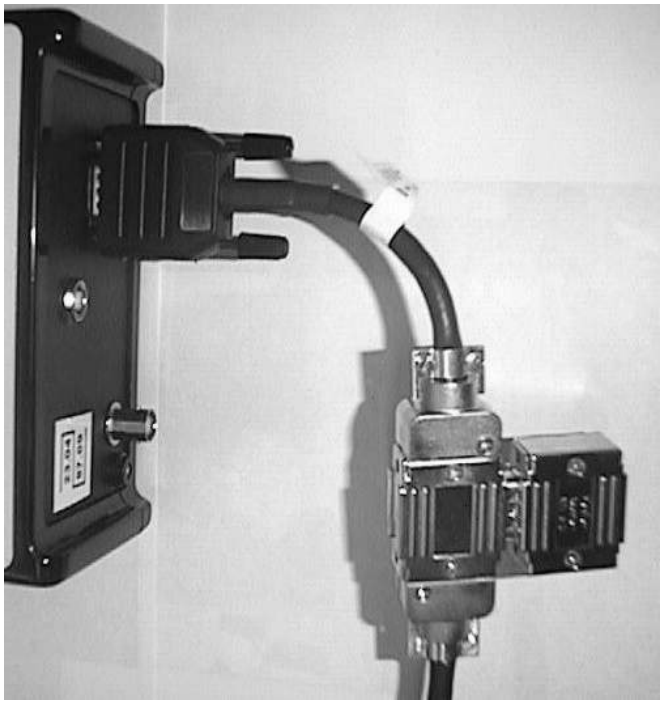


Figure 3. Correct connection of the serial cable, and ADI for the old serial interface.

4 BASIC QC MEASUREMENTS

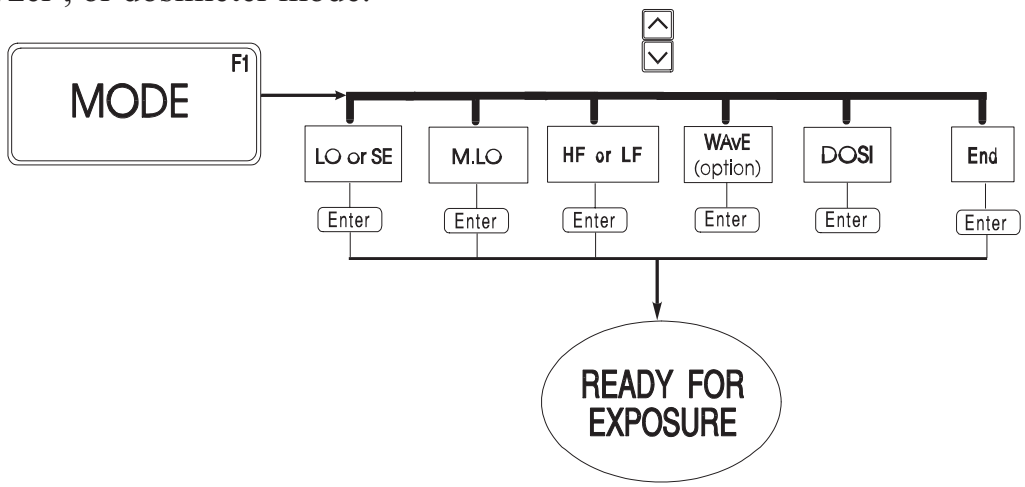
4.1 kVp and Time (Multimeter Mode)

4.1.1 PARAMETER

This key selects the measuring parameter to be displayed.
Each time the key is pressed the display changes between kVp, exposure time, dose, and dose rate.

4.1.2 MODE

This key selects the type of measuring mode:
SET or LOCK mode, manual LOCK mode, LF or HF mode, waveform analyzer , or dosimeter mode.



4.1.3 When to use SET and LOCK modes

SET	basic measuring mode (>50 ms exposure times).
LOCK-	kVp and time measurements for short exposure times. **(See also manual LOCK mode)**

Two exposures must be done when using LOCK Mode. One to set PMX gain and range and one to get the values.

Use LOCK Mode to

- Study the beginning of the exposure waveform using the BNC output
- Measure exposure time by counting pulses.

4.1.4 When and how to use manual LOCK mode

- When it is impossible to make a set exposure because of too short exposure time.
- When the user wants to control how PMX-III selects kV-range and gain:

  Press **DNARR** to select between:

  F1:G1 to F1:G4 - F2:G1 to F2:G4

  F1= kV range 45-90 kV
  F2= kV range 85-155 kV
  G1= Very low X-ray output
  G2= Low X-ray output
  G3= Average X-ray output
  G4= High X-ray output

  The electrometer always uses range **rA:3** .

4.1.5 When to use LF and HF:

LF - single phase

- three phase 6-pulse

- 12-pulse, DC, and mammo units

- HF > 5 kHz and ripple less than 5 %

- Most modern DC/DC X-ray units**.**

HF - 0.8-5 kHz, only when ripple > 5 %.

The analog output bandwidth for PMX-III is 800 Hz in LF mode and 10 kHz in HF mode.

4.1.6 TUBE/FILTER

This button selects valid calibration tables for different tube/filter combinations.

Up to 16 different calibration tables can be selected.
1-4 are dedicated for the diagnostic 45-155 kV range.
5-12 are dedicated for mammo use. 13-16 for CT.

Calibration table numbers which are stored into PMX-III are indicated after the text CA in the display (Ex. CA -1). Use cursor keys to select correct tube/filter combination from the existing calibration table. Store with the ENTER key.

F3, F4, and F5.

Factory set function keys for direct setup of measuring conditions. The keys can also be user defined.

⍓+F3

Press UPARR and while still pressing UPARR, press F3, use cursors to select delay 0-9999 ms.

Press ENTER to store the new value.

4.1.7 Measurement with the MAM/RAD version

- Connect the dose detector/ADI module.
- Each ADI module holds information for one beam quality only (See also the “Detector Selection Guide” chapter 9 if you need additional help).
- Power on PMX-III. The “DOSIMETER” indicator must be off. If the indicator is on, press the MODE key and enter “MuLt”.
- Choose a calibration table with the TUBE/FILTER key, or press a function key to upload a setup table.
- Position the sensor area (MAM or RAD) in the X-ray beam, and collimate the light field.
- Put the dose detector on top of the PMX-III, and add desired additional filtration.
- Set desired generator values and make an exposure.
- Read the measured values from the display.
- After the results have stopped flashing, and the character “c” has disappeared, PMX-III is ready for another exposure.
- Press the PARAMETER key to alter between kVp, exposure time, dose, dose rate, or light.

4.1.8 Default values for F3-F5 (MAM/RAD version)

F3 Setup table #1; (CA:1 diagnostic)
W/Al 3.0 mm, 45 - 155 kV

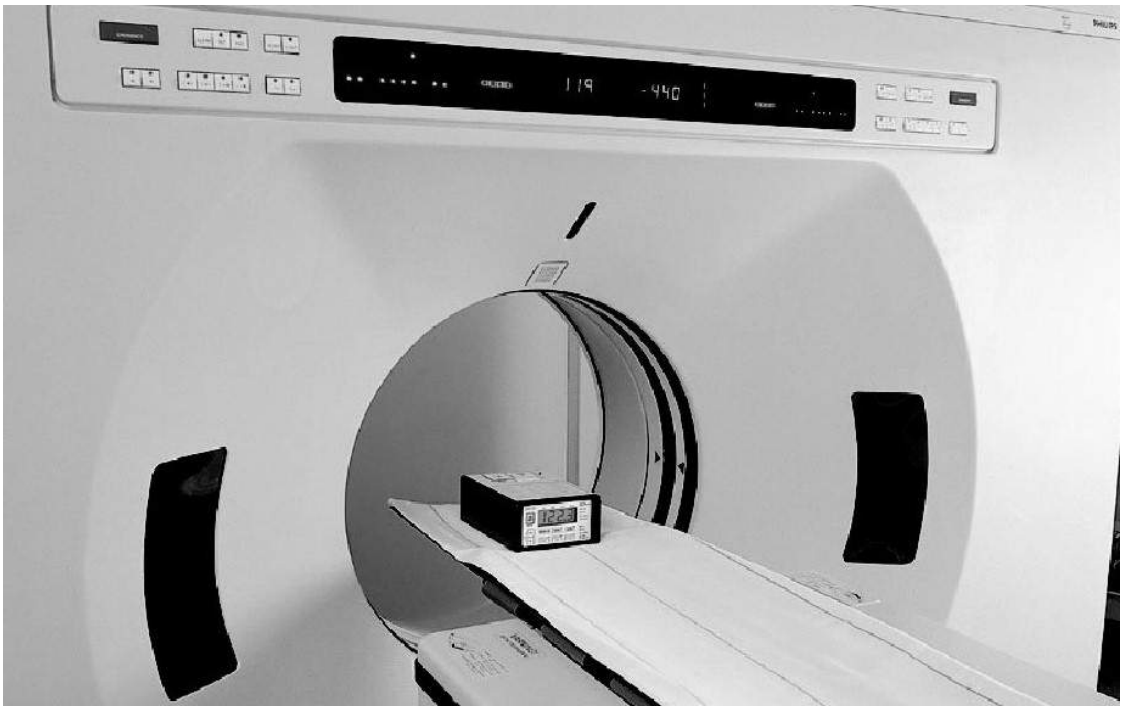
F4 Setup table #4; (CA:5 mammo)
Mo/Mo 30 um, 23 - 35 kV)

F5 Setup table #5; (CA:6 mammo)
Mo/Al 2.0 mm, 30 - 46 kV

Setup table #1 is always uploaded when the PMX-III is powered on.

4.1.9 CT kVp Measurement with the CT/RAD version

- Power on PMX-III. The “DOSIMETER” indicator must be off. If the indicator is on, press the MODE key and enter “MuLt”.
- Choose a calibration table with the TUBE/FILTER key, or press a function key to upload a setup table.
- Press F4 or F5 according to the table below:
- **F4** Setup table #13; (CA:13 CT without comp.filter)
W/see calibration record,75-145 kV
- **F5** Setup table #14; (CA:14 CT with comp.filter)
W/see calibration record, 75-145 kV



- Open the beam width to 10 mm. Use the patient positioning light to align the CT sensor area horisontally within the beam.
- Disable the motion of the tube and table. Place the tube in the top position.
- Make the exposure, both kVp and time will be displayed after the exposure is finished. Use the PARAMETER key to select kVp and time.
- Make corrections of the kVp value for the filtration dependence if needed,

Consult the PMX-III reference manual, Appendix E for more information how to correct for filtration depencence and how to make kVp measurements with rotating CT units and oRTIgo

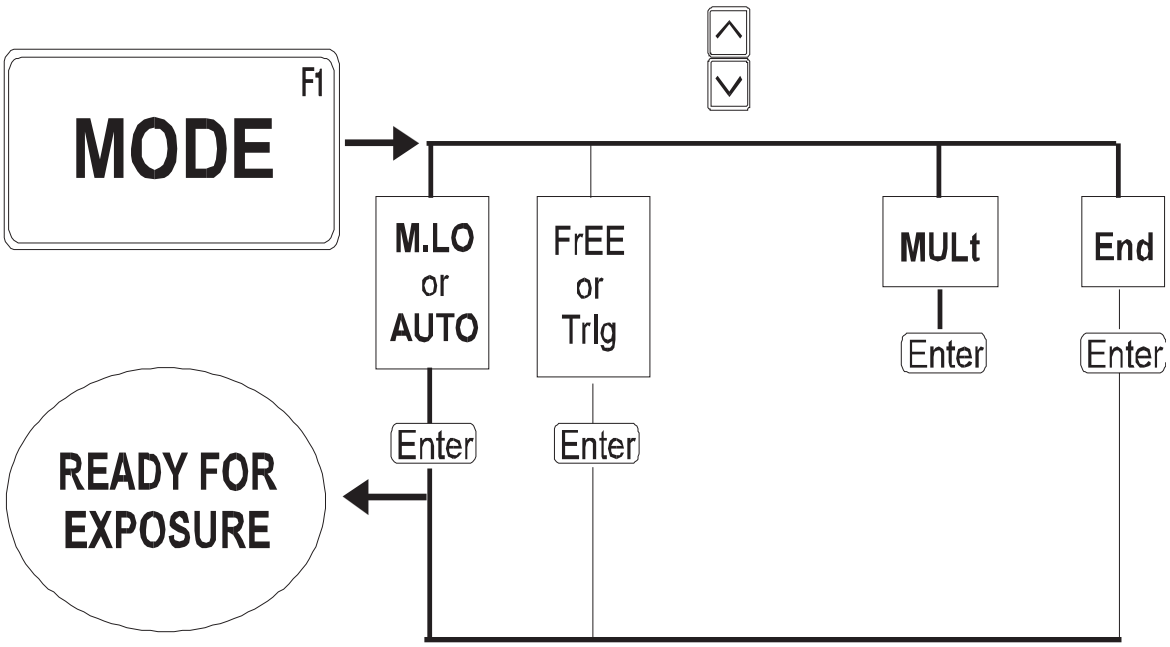
4.2 Dose and Dose Rate (Dosimeter Mode)

PMX-III is normally supplied with two small durable and accurate solid state detectors for X-ray and light measurements, and a number of ADI modules.

(See the "Detector Selection Guide; Chapter 9" if you need additional help.)

In dosimeter mode dose and dose rate are measured simultaneously. Press the DOSE key and the measured dose value is displayed. Press the RATE key and the measured dose rate is displayed. Rate is indicated on the display with a ":" sign.

MODE The MODE key is used to select manual LOCK, free run, or trig level, or return to multimeter mode.



4.2.1 When and How to Use Manual LOCK Mode

Press **DNARR** to manually select electrometer range if manual LOCK mode is selected:

RA:1	This is the most sensitive range for low dose rate measurements.
RA:2	Middle range.
RA:3	This range should be used for high dose rate measurements.

It is recommended to use the manual LOCK mode when the exposure time is less than 50 ms.

Press **MODE , select Auto** to select auto range.

4.2.2 How to Use Free Run/Trig Mode

In the free run mode no trig levels exist. This makes it possible to measure down to zero signal in the display. In trig run mode, measured dose rate value is started to be displayed when the signal is above a set trig level determined by the selected ADI. Please note that PMX-III is not powered down automatically when “Free run” is activated.

4.2.3 Active Keys

DOSE Press to read measured dose in specified dose unit.Press again to display dose unit.

RATE Press to read measured dose rate value in specified dose unit.
Press again to display dose unit.

RESET Press <1 s to reset display to zero.
Press >1 s for internal zero-adjustment.

The ADI code X.-Y- where
X= Detector identification 1, 2, 3 .6.7.8 .. and
Y= Beam quality A, b, C, d, U,Y.
is displayed for 1 s to indicate valid ADI.

The ADI code for AMP is XY.PZ where
X and Y is defined as above . P indicate AMP-1
Z =1 for range 1 , Z=2 for range 2

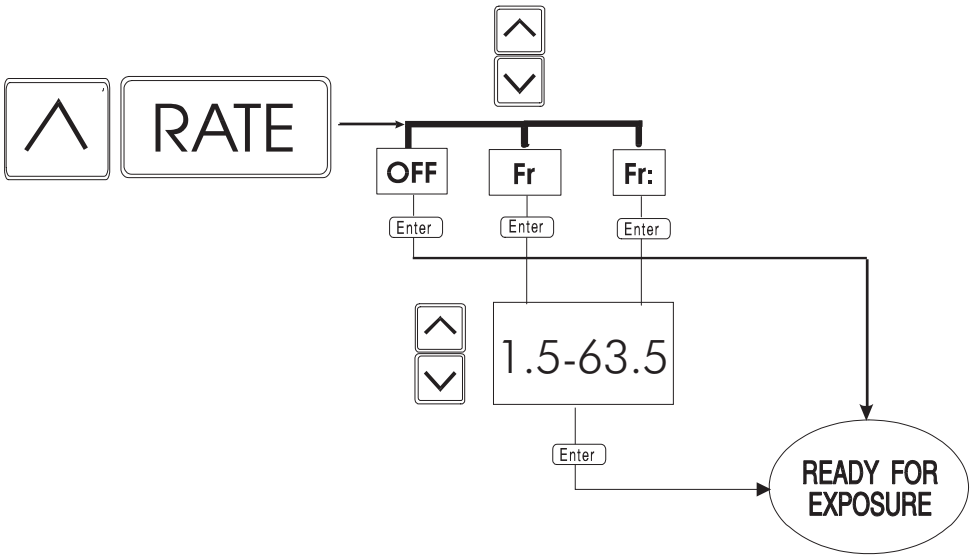
⍓+MODE Press to normalize the display value to a predefined value. Can be used to calculate a ratio between two detector signals. Abort normalize mode by pressing **⍓+MODE** again.

⍓+RESET Press to toggle between manual and auto-reset modes.
Manual: Dose values are accumulated
Auto: Previous dose value is cleared

⍓+DOSE Press to hold display value. Abort by pressing **⍓+DOSE** again.

+RATE Press to select the dose/frame menu:

Use the cursor keys to select:



OFF Normal dose and dose rate measurement

Fr Selects the frame mode.
Press ENTER and current number of frames during the exposure is shown in the display.
Use the cursor keys to select a new value.
Press ENTER to store the new value,measuring mode is activated again.

The measured and displayed dose is divided with the number of frames.

Fr.: Selects the frames/second mode.
Press ENTER and current number of frames during one second is shown in the display.
Use the cursor keys to select a new value.
Press ENTER to store the new value,
measuring mode is activated again.

The measured and displayed dose rate is divided with the number of frames/s.

It is recommended to use the manual LOCK mode when using the frame mode.

An alternative method is to use the waveform analyzer and oRTIgo. The number of pulses, number of frames/s or Hz, and dose/frame are automatically calculated from the stored dose rate wave form.

4.2.4 How to Make a Measurement

- Connect the dose detector/ADI module.
  Each ADI module holds information for one beam quality only.

- Power on PMX-III. The “DOSIMETER” indicator must be on. If the indicator is off, press the MODE key, scroll with the cursor keys and select “dOSI” with the ENTER key.

- Position the dose detector in the X-ray beam.

- Set desired generator values and make an exposure.

- Read measured values on the display. Both dose rate and dose value are stored after the exposure.

4.3 The Waveform Analyzer

It is strongly recommended to use oRTIgo to collect waveform if possible since it is much easier to handle. If used without computer it is recommended to read sections 6.1 to 6.3 in the reference manual at least once before using the analyzer:

- Connect a BNC cable between the connector on the rear of the PMX-III and your oscilloscope (amplification: 0.5 V/div, time: 5 ms/div).
- Use the MODE key to enter the mode menu and be able to switch the waveform analyzer on and off.
- The waveform analyzer has three main levels indicated on the display:

  “Set”:
  All PMX-III keys are valid. The PMX-III waits for an exposure to adjust gain and filter to current generator settings.

- “SAMP”:
  Waiting for an exposure. Gain and filter adjustment are set from an earlier exposure or by the user if manual lock mode is selected.
  The PMX-III samples the detector to be able to measure the initial part of the exposure.

  “PA:1":
  Sending sampled kV and radiation waveforms to the oscilloscope.

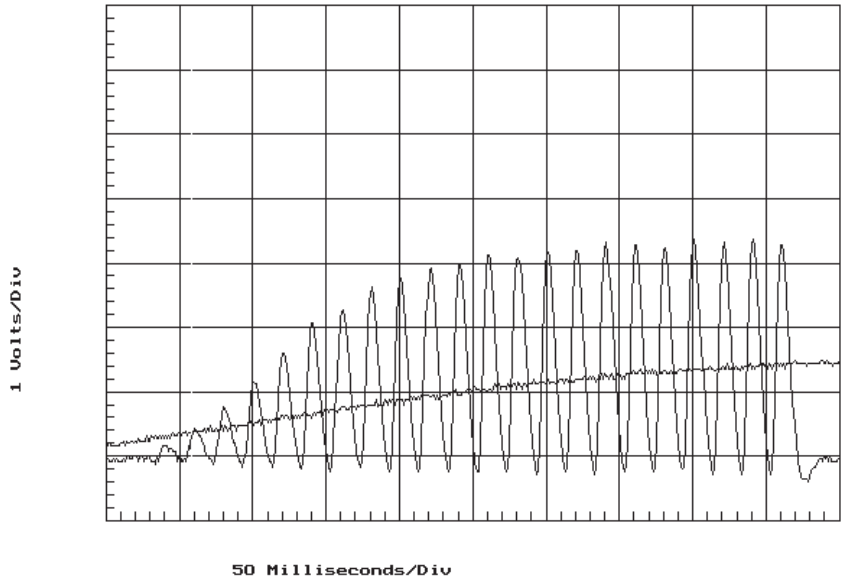
  “RY:1”:
  Sending sampled electrometer and radiation waveforms to the oscilloscope

- Make exposures, and the PMX-III automatically adapts to the measurement situation.

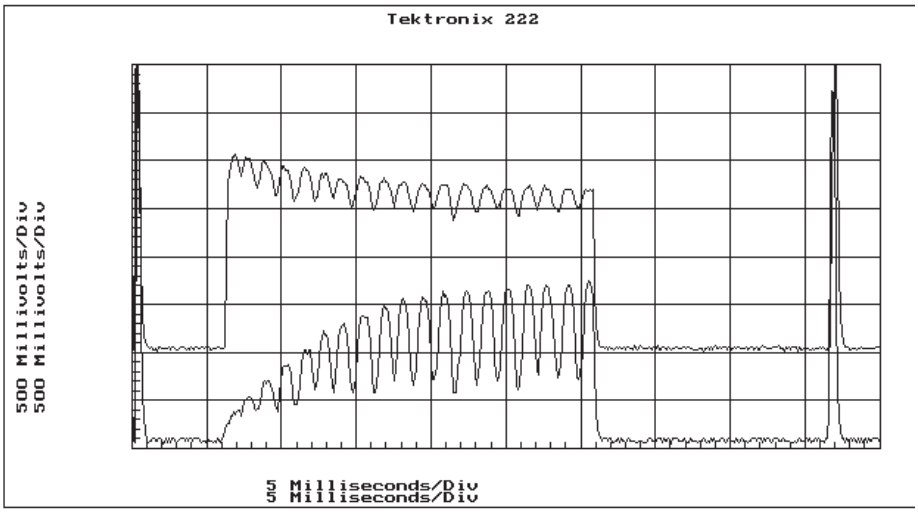
- Use the:
  -PARAMETER key to toggle between kV and radiation or electrometer waveforms.
  -cursor keys to select different memory parts of the measured exposure.
  -F3 key to calibrate the kV or electrometer rate waveform on the oscilloscope.
  -ENTER key to go to “SEt” level.

Please consult Section 6.3.2 and 6.5 in the reference manual to use the programming features.

4.3.1 Examples of waveforms

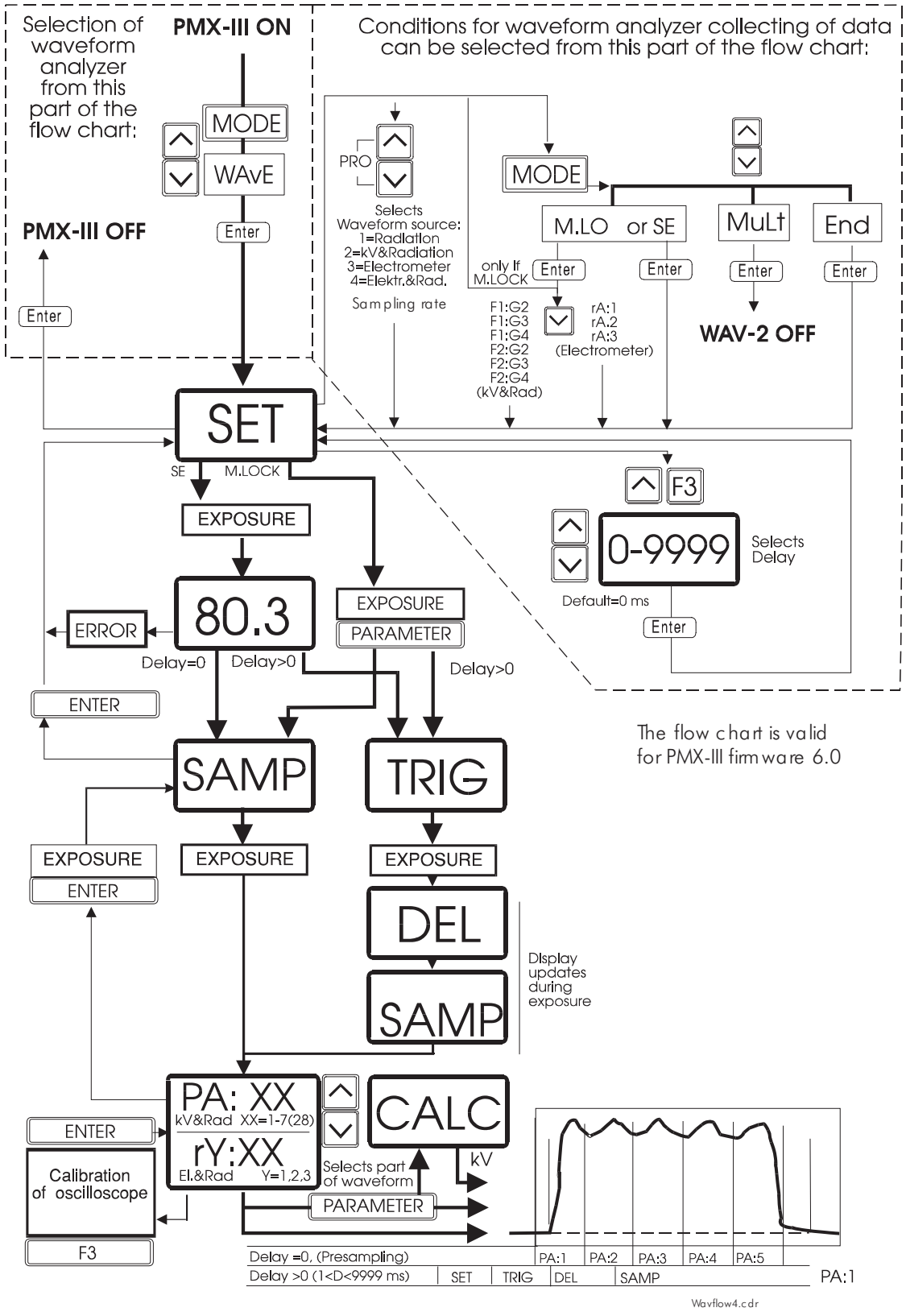


Dose rate response from a dental unit at two bandwidth
60 kV, 3 mA, 23 mm Al, SSD=30cm, 8/A(P2)
45 Hz and 1 Hz are selected using the AMP-1 filter knob.

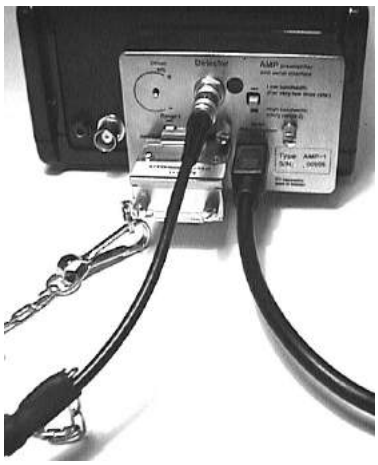


Upper: Dental kV, compressed mode
Lower: Dental output, simultaneously sampled

4.3.2 Waveform flowchart



4.4 Using preamplifier AMP-1



AMP-1 consists of a preamplifier for the PMX-III electrometer and a serial interface. See Chapter 2 for an overview of the AMP-1 functions.

AMP-1 makes it possible to increase the sensitivity 100 times when used with PMX-III. This sensitivity is needed for acceptance test and adjustment of modern Image Intensifier systems.

AMP-1 should only be used with the PMX-III in Dosimeter mode.

The AMP-1 is specially designed to measure the very low entrance dose rate levels to an Image Intensifier (II). An optimised range for II of 0.030 µGy/s to about 46 µGy/s is obtained when the detector R25/R100 is used together with AMP-1. The preamplifier is simply “piggy backed” directly on the PMX-III back panel, eliminating connecting cables. The AMP-1 is powered by the PMX-III.

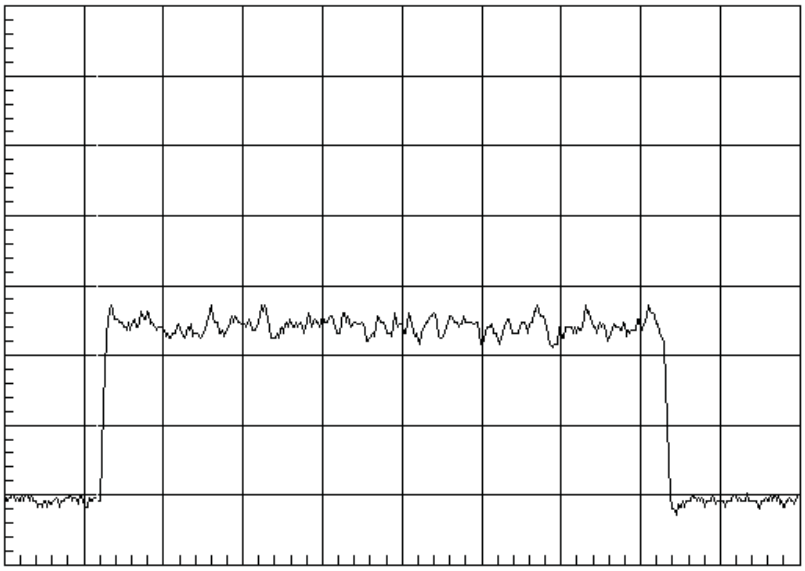
Furthermore there is no need to disconnect the AMP-1 and the detector from PMX-III since the AMP-1 only is activated when a special made AMP-1 ADI is used.
The special AMP-1 ADI (Automatic Detector Identification) combines the features of storing the detector data in use into the ADI and simultaneously activate and select range of the AMP-1. The AMP-1 has two measurement ranges, P1 and P2.

AMP-1 has a built-in second order low-pass filter with two ranges, DC-1 Hz and DC-45 Hz.

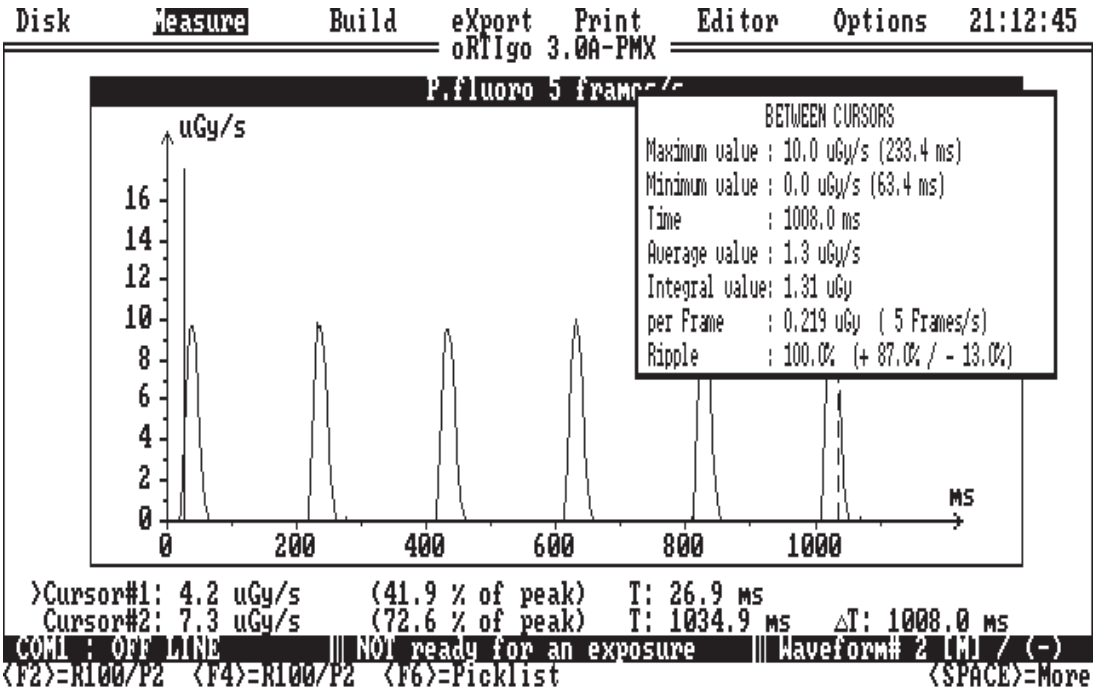
The special ADI connected to the AMP-1 makes it possible to read directly in µGy/s (or µR/s) and µGy (µR) on the display depending on AMP-1 range and detector. The II dose rate waveform can also be collected and displayed using the oRTIgo wave form analyser or with an oscilloscope.
A handy method to adjust the II entrance dose rate level (typically 0.10-0.50 µGy/s) is to look at the dose rate level with an oscilloscope. The scale factor is 1 µGy/s / V, if the AMP-1 and R100 is used and the oscilloscope is connected to PMX-III BNC output.

Example:

The picture below shows a measurement with a dose rate of 0.13 µGy/s ocilloscope settings: 0.05 µGy/s /div. 1 s/div.



Using oRTIgo a certain portion of the dose rate waveform can be selected using the radiation waveform as reference. This part of the dose rate waveform is then integrated and the dose/frame, dose rate value and number of frames/s value is automatically calculated and displayed.



4.5 Measurements with the AMP-1

4.5.1 General

It is recommended that only dosimeter mode is used with the AMP-1. Select reading in dose rate by pressing the RATE knob.

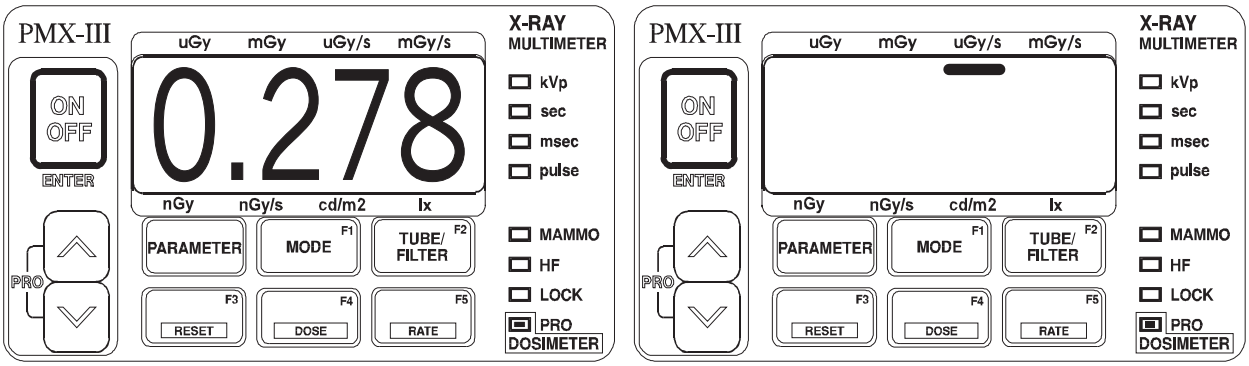
Be aware that the limited bandwidth of 1 Hz is optimised for Image Intensifier measurements measuring the dose rate signal. If pulsed fluoroscopy should be measured you must select higher bandwidth. Select range 2 and 45 Hz or deactivate the AMP-1 to get 700 Hz bandwidth to be able to follow the individual pulses.

The PMX-III starts to measure when the dose rate signal is greater than approximately 0.050 µGy/s when using the AMP-1 8/A(P1) ADI (0.030-4.600 µGy/s for R100).

Select “Free” run mode if the AMP-1 should start to measure all the way from zero.

For short exposure times or pulsed radioscopy please deactivate the AMP-1 by selecting the appropriate ADI and select multimeter mode or use the waveform analyzer to be able to measure the individual dose rate pulses.
When selecting multimeter mode you should and must “gate” the dose rate signal by using the PMX-III kV detector as a trigger. This method makes the measurement easy to do. You can even combine the dose rate and dose reading with kVp and exposure time measurements.

4.5.2 Detector Range and Identification Codes



On the above display the **colon** indicates that **rate mode is selected.**

As long as the RATE key is pressed, **the sign above µGy/s** is shown to indicate that the unit is **µGy/s.** The reading is **0.278 µGy/s.**
The measuring range and unit is indicated on the ADI.

Chapter 4

An identification code for the selected conversion factor is shown during approximately one second after reset and zero adjust.

X.-Y- Standard ADI, for detector X and beam quality Y.

XY.PZ AMP ADI, for detector X, beam quality Y, range Z (1 or 2).

5 SERVICE / MAINTENANCE

5.1 Introduction

The default function of PMX-III was earlier to start up with Multimeter or Dosimeter mode, depending on the mode used when it was powered off. This is sometimes inconvenient, especially when having specific written instructions for certain measurements.
You can now program the PMX-III to start up in either Multimeter or Dosimeter mode. You activate this function by pressing the MODE and ENTER key when choosing the measuring mode you want to be default after power on. It is done in the following way:

- Activate the measuring mode, Multimeter or Dosimeter, you **don't** want to have as default. Use the MODE menu if you have to change measuring mode.
- Press MODE to activate the MODE menu.
- Move to the entry corresponding to the mode you want to have as default, i.e. "Mult" or "dOSI".
- While keeping the MODE key pressed, press the ENTER key.
- Release both keys.

The PMX-III will now start up with the measuring mode you selected.
To disable the above described function:

- Press the MODE key.
- Move to the entry End.
- While pressing the MODE key, press Enter.

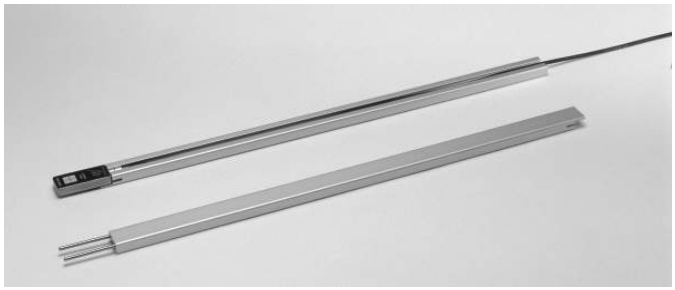
5.1.1 New Version of Firmware for PMX-III.

- Automatically selects dose rate when ADI 7A(P1) or 7A(P2) is detected
- All dose rate measurements with ADI 7A(P1) and 7A(P2) will be displayed in the same unit (µGy/sec or µR/sec)
- The measured dose rate is "freezed" in the display until a new exposure starts or reset is pressed (not in Free Run mode, without trig level)
- Possibility to select half of frame number, for example 12.5 (consequently the maximum value will be 63.5 instead of 125)
- The Hi-YES-Lo message related to the offset adjustment (when AD 7A(P1) is used) is removed (see: "Offset potentiometer" chapter 2)

5.1.2 Extension Cable.

An extension cable (8m) connected to the R25/R100 probe enables the engineer to position the PMX-III at a convenient place (i.e. near to control desk in control room of the PMS system). This makes PMX-III frontpanel operation and reading of the display easier during testing. Furthermore the engineers radiation load is kept as low as possible. Avoid work near the radiation field.

5.1.3 Probe Holder.



The R25/ R100 probe is attached to the probe holder. This support makes positioning of the probe in the X-ray beam much more easy (i.e. in Scopomat). It also prevents the probe to rotate by the force of the cable which can result in considerable measuring inaccuracy.

5.1.4 ADIs Removed from Detector Cables.

Since there are too many ADIs connected to the cable-chain of the detector cables (both R100 and L100) they are removed and stored in a separate storage area in the case.

5.1.5 Maintenance.

In order to prevent damage to the probes during transport a protection cover is supplied with the R25/R100 dose probe and L100 light probe.

5.2 Entrance Dose Rate Measurements

5.2.1 Very Low Entrance Dose Rate to an Image Intensifier

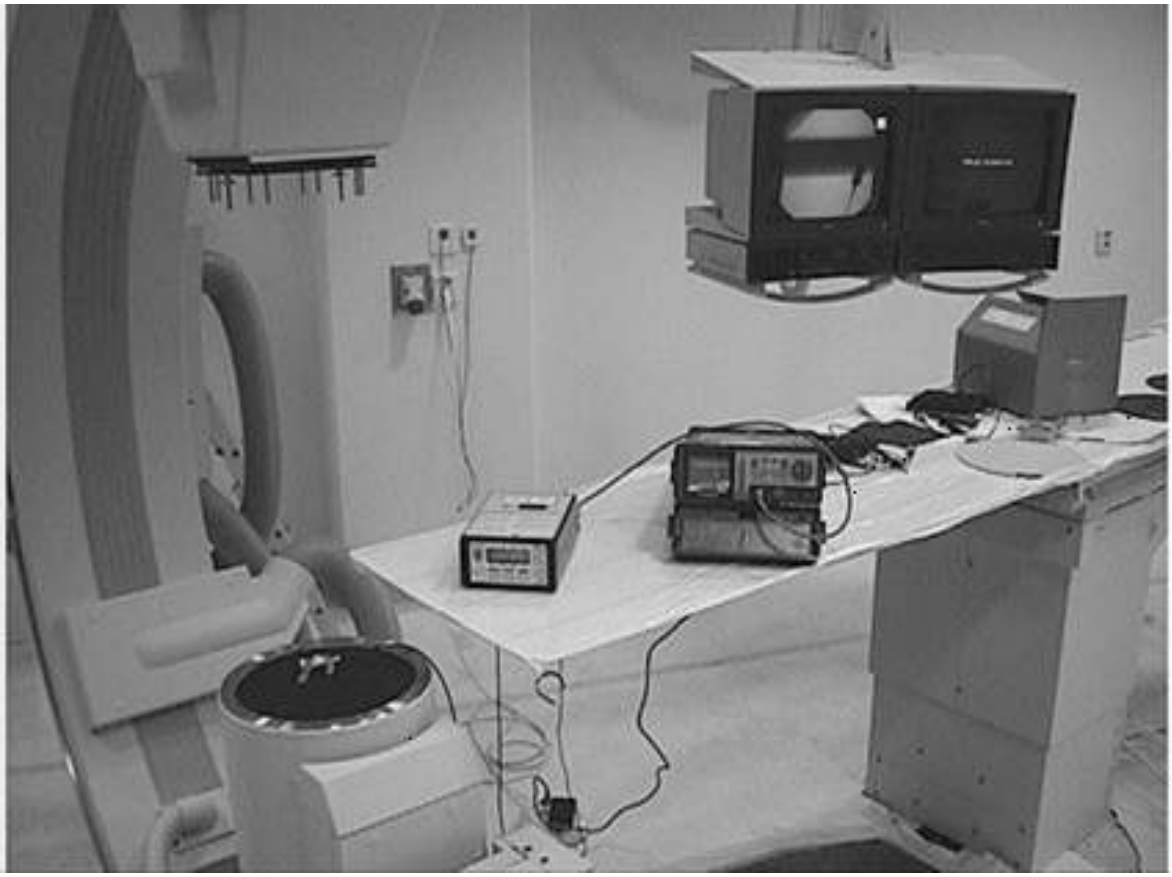
See also on top of PMX-III for a very short instructions

- Put 20 mm Al or equivalent copper filter (appr. 1.4 -2.1 mm Cu plate) to simulate a patient thickness. Use the probe holder to fixate the R100 so it is easy to move it over the II input area. Place it on the II so that is not affecting the feedback system. As a guideline, do not place the detector in the centre of the field, rather somewhere near a circle with half the the diameter of the field diameter.
- Use the EXT-1 extension cable if needed.
- Select high dose rate bandwidth with the little tiny red button on the rear panel (the button should be “out”
- For continuos fluoro select ADI 8/A (P1) The range is now 0,030-4,600 µGy/s and the reading is directly in µGy/s, on the PMX-III.

  For pulsed fluoro measurements select 8/A (P2) The range is now 0,1-46 µGy/s range instead and also the higher bandwidth (DC to 45 Hz).
- Power on PMX-III and select free run mode (see section 2.3), then select RATE. By selecting free run mode PMX-III deactivates the trig level so the user is able to measure all the way down to zero .
- Verify by pressing RESET that the correct ADI is selected.
- Start the fluoro exposure. The dose rate is updated on the display during the exposure. You can freeze the display during the measurements using the hold mode, see Chapter 4 but since the display values are stored after the exposure both for dose rate and dose there are normally no need to use this function anymore.
  Pressing the RATE button during or after the measurements displays the measuring unit.

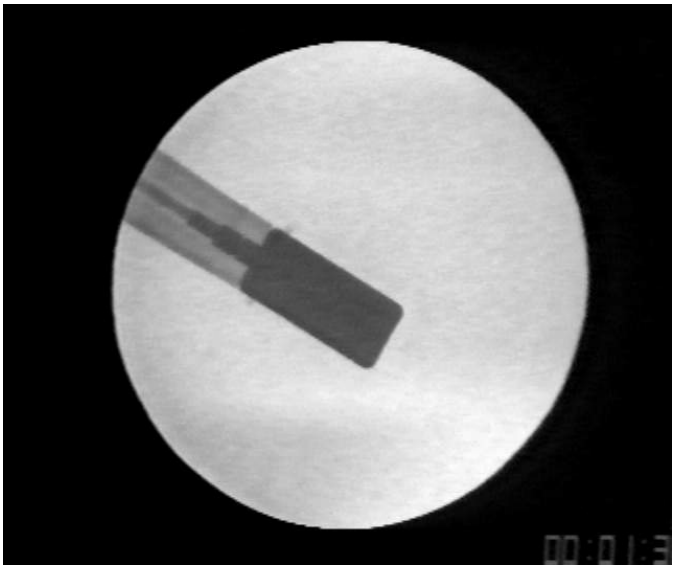
Note:
Other detectors and measuring units are also supported.
In this chapter the dose detector R100 and use of Gray units have been used.
See Chapter 9 and the Shortform Detector Selection Guide for use of other units.

Hints:If the dose rate output also needs to be monitored during adjustment, please connect an oscilloscope to the PMX-III BNC connector. Select 100 mV/Div. and 1s/Div. on the scope. A change of the dose rate of 0.1µGy/s is then equal to 1 Div. on the y-axis. The bandwidth is approximately 1 Hz or 45 Hz.



Dose rate measurement on II fluoro system with PMX-III/AMP-1.

5.2.2 Hints



The R100 on rod in image intensifier field.

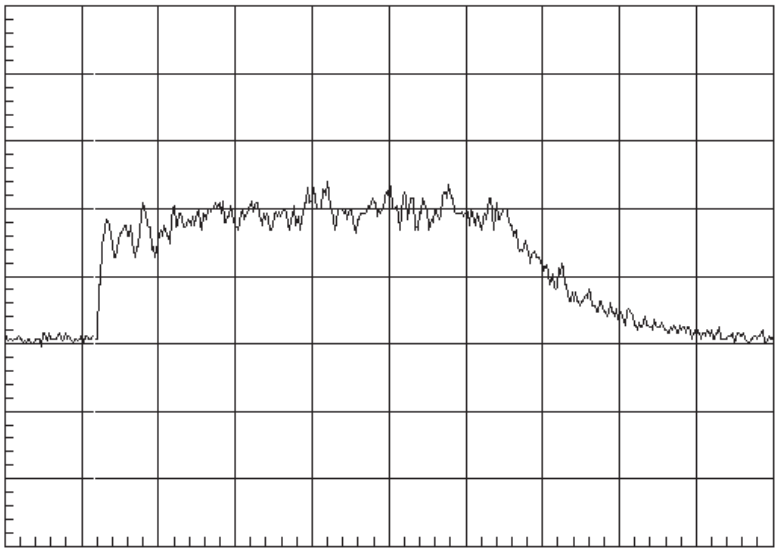
- Use the probe holder together with R25/R100 to be able to place the detector in a suitable place on the II input screen. By observing the dose rate measured during slow movement of the detector above the II you can check if the detector is altering the feedback system or not.
- Use the “free” run mode in dosimeter mode to deactivate the internal trig level. This makes it possible to measure linearly all the way down to zero in the display.
  It is therefore easier to adjust small dose rate values since the display reading will not suddenly change to zero or freeze.

- If no dose rate can be measured, please check that the current is greater than 0.05 µGy/s or select “free” run mode.
- The AMP-1 can be mounted all the time on the PMX-III. The AMP-1 is only activated when the special ADI that “power on” the AMP-1 mechanically is used. When a normal ADI is used the current signal is passed directly to the PMX-III electrometer input without using AMP-1’s signal amplification.
- Use the 8 meter extension cable EXT-1 to be able to place PMX-III in the control room for easy readout and change of ADI.
- Use the BRB-1 and AC/DC adapter to avoid battery drain.
- Select “free” run mode to avoid PMX-III to power off.
  It is recommended to use BRB-1 in this situation.
- Use High bandwidth (45 Hz)allways if possible .
- Test have been done with R100 8A(P2) 45 Hz on pulsed fluoro/dental system indicating that measurements with pulse rate of up to approximately 30 pulses/s can be measured.
- The AMP-1 ADI automatically selects gain 3 on PMX-III electrometer.
  This is indicated by the “Manual Lock” LED. Trying to use gain 1 or gain 2 easily result in a"HI.Si" message.
- If problems should appear with the serial communication transfer, please check that the PMX-III BRB power supply and the computer power supply is connected to the same power outlet.

5.2.3 Example of Dose Rate Waveforms

An oscilloscope was connected to the analog output of the PMX-III.

The external detector R100 was placed in the X-ray field so dose rate waveform could be collected using the PMX-III waveform analyzer. Only the dose rate waveform was displayed on the oscilloscope. 100 nGy/s was measured. (50 nGy/s/div and 1s/div)



5.3 Fluoroscopy low mA

5.3.1 II-Entrance Dose Rate (µGy/s)

- Connect dose detector R100 and **ADI 8/A(P1)** to the input on the rear panel of the PMX . Make sure that the range 1 or 2 switches are correctly depressed.
- Select high bandwidth with tiny red button (pull out) on rear panel.
- Add 1.5 mm Cu or 20 mm Al filtration.
- Power on the PMX and wait until the internal checks are completed.
- The dosimeter LED should be on now and PMX-III is ready to measure dose rate. A "**:**" in the middle of the display indicates that dose rate is selected **(1)**.
- Press MODE select **Free run** with the cursor keys, and press **Enter** to activate "Free"run mode.
- Give fluoroscopy command, wait for stable reading.
- Read desired value during or after the exposure **(2)**
- The unit of measurement is shown when pressing RATE or DOSE .

(1) The lower third dot indicates the deciml dot !

(2) ⍁**+RESET**
Press to toggle between manual and auto reset modes.
Manual: Dose values are accumulated
Auto: Previous dose value is cleared

⍁**+DOSE**
Press to hold display value. Abort by pressing ⍁**+DOSE** again.

Note: If the display indicates a dash (-) or (Hi Si) ,then press reset longer then 1 second until c appears and now PMX corrects for internal zero-adjustment., It is normal that the display still indicates a dash(-) after reset sometimes if the drift is slightly negative.

5.4 Exposure Dose

5.4.1 Fluorography and Radiography

- Connect dose detector R100 and **ADI** for:
  Falling load ADI: 8A
  Fixed current ADI: 8A(P2) (1)
- Select high bandwidth by releasing the tiny **red button** on the rear panel.
- Add 1.5 mm Cu or 20 mm Al filtration.
- Select an appropriate exposure time >=50 ms (2)
- Power on the PMX and wait until the internal checks are completed, this means the dosimeter LED is on.
- Make a single exposure
  Both the measured dose and dose rate value have been collected and are available on the display. Use RATE or DOSE to move between measured rate or dose value. By holding down the same key the unit of measurement is indicated.

(1) In case of Hi Si display code, take the less sensitive ADI 8A
(2) If exposure time is less than 50 ms, program manual lock mode. (Section 4.2)

5.5 Measurement of kVp

5.5.1 Long Exposure time, Skin Dose, and Dose Rate (SET MODE)

- Connect dose detector R25 and ADI 7/B (this means no extra filtration in the beam) to the input on the rear panel of the PMX .
- Power on the PMX and wait until the internal checks are completed, this means the character “c” has disappeared.
- If dosimeter LED stays on after power on, press **Mode**. The display shows “M.LO”. Select “MuLt” with the cursor keys and press **Enter** to activate multi meter mode.
- Place dose detector on the velcro strip on top of the PMX and position it in the beam.
- Select for the RAD sensor area a beam quality of 3 mm(ADI:8/B)
- Set kVp, mA.
- Exposure time (1) may be as low as:
  50 ms for good kV measurement.
  10 ms for good exposure time measurement.
- Make an exposure.
- Read the values which are displayed automatically in the following sequence:
  kVp
  time
  unit for dose(rate)
  skin-dose(rate)

“c” indicating auto reset performed after each exposure

After this the display returns to one of the values measured .

Press **PARAMETER** button to scroll measured values.

Note: collimate X-ray field to protect the AMP-1 module at rear of PMX against direct radiation! It is important to irradiate the complete RAD field on top of the PMX.

Note: If the total filtration is not 3.0 mm Al, measured kV should be corrected to achieve maximal accuracy, see chapter 7.

5.5.2 Short Exposure Time, Skin Dose and Dose Rate (MANUAL LOCK MODE)

- Select manual LOCK mode, in this mode the internal filter and gain range combination are user selectable.
- Make an exposure.
- Exposure time (1) may be as low as:
  3 ms for good kV measurement.
  0.3 ms for good exposure time measurement.
- In case of over- or under flow the default filter/gain combination for PMX is not correct.
- Press **DNARR** to select between:

  F1:G1 to F1:G4
  F2:G1 to F2:G4

  F1= kV range 45-90 kV
  F2= kV range 85-155 kV
  G1= Very low X-ray output
  G2= Low X-ray output
  G3= Average X-ray output
  G4= High X-ray output

  The electrometer always uses range **rA:3** .

(1) Exposure times are specified for HF and DC generators, for 12 pulse (or lower) generator types see Reference manual page 7-4.

If you only want to use the PMX-III as an exposure timer, you can select a display mode (disp) and parameter (Par) that only display the exposure time after each exposure, see reference manual chapter 4 section 4.9.4.

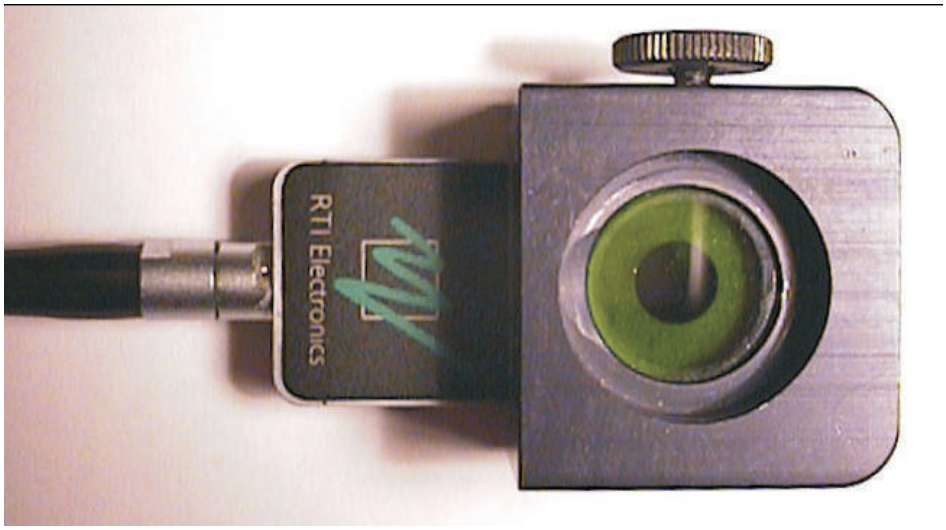
5.6 Light Measurements, Detector and Adapters

5.6.1 Introduction

For more general information about light measurements a separate L100 manual can be ordered from RTI Electronics AB

L100

The L100 detector is the fundamental part of the light meter system from RTI Electronics AB. On top of the actual detector a filter house is attached. This is shown in below. The filter house contains the CIE filter that makes the silicon chip have the same response as the human eye. The purpose of the filter house is also to fit the different adapters that make the L100 measure the desired quantity. The actual L100 without any adapters is not calibrated for any quantity.



The basic L100 detector which include the CIE filter house

Monitor Adapter

The monitor adapter is intended for luminance measurements on CRTs and film viewing boxes, i.e. to measure cd/m², and it is referenced to as L100-M. It consists of two parts: a metal tube with a light shutter and an ambient light shield made of rubber. This is shown on next page. A luminance meter must have a limited field of view. In the case of L100-M this is accomplished by **pressing** the tube against the surface to be measured.

The purpose of the ambient light shield is to prevent non-wanted light to interfere with the measurements. This could otherwise be a problem when measuring on not so bright sources like e.g. a CRT. Without the ambient light shield non-wanted light, e.g. from the room, would be reflected via the glass surface of the CRT and would be added to the measured light. A smaller shield is also included to make the easier to position the monitor when the ambient light level is not a big error source.This is also a part of the reason why RTI Electronics AB has chosen not to design a traditional luminance meter, with optics that let you measure at a distance. Such a measurement would obviously be a measurement of not only the source itself but also of the ambient light reflected by e.g. the glass surface of the CRT.

The monitor adapter with light shutter and ambient light shield..

Lux Adapter

To measure illuminance the detector must be able to collect light from every direction in a half sphere. The contribution from an incidence light beam must follow the cosine function. This is quite natural if we consider how we apprehend the surface of a spot on e.g. a desk. Seen from above at an incidence angle of 0° the projected area of the spot is the same as the real one. When we increase the angle of incidence to 60° the projected area decreases by a factor of 0,5, just like cosine 60° equals 0,5. When we have increased the angle of incidence to 90° we of course cannot see the spot, just as cosine 90° equals 0.

In theory this sounds easy but in practice there are a few things to consider when designing a lux detector.

- First: The surface of the silicon chip will always be shiny. This means that light that hits the detector from a very large angle of incidence will be reflected by the surface of the silicon chip, thus neglecting the cosine function.
- Second: The actual silicon chip can in most cases not be placed at the surface of the detector. An example of this is the L100 with its CIE filter.

The solution to these problems is the lux adapter, see figure below. The white plastic inside the aluminium is called a *cosine diffuser*.

The Lux adapter with its cosine diffuser

The surface of the cosine diffuser is, as the name implies, diffuse. Thus preventing light with a large angle of incidence from being reflected by the surface. The cosine diffuser also leads the light down to the silicon chip, more or less in the same way as an optical fibre can lead light. The lux adapter is referenced to as L100-L.

Collimator Adapter

The collimator adapter is a piece of plastic with a 1 mm hole, and it is referenced to as L100-C. Its purpose is to allow you to check the contrast ratio of the edge of the collimator light field. You measure the “light level” just inside the edge of the light field and divide this value with the “light level” outside the edge of the light field. This ratio should be sufficiently large.

Since this is a relative measurement there is no need to define what the quantity “light level” means. You simply measure the current that the L100-C produces. This also means that there is no need for a calibration of the collimator adapter.

Contact RTI Electronics AB for further information about the collimator adapter.

5.6.2 Measurement of Luminance (cd/m²)

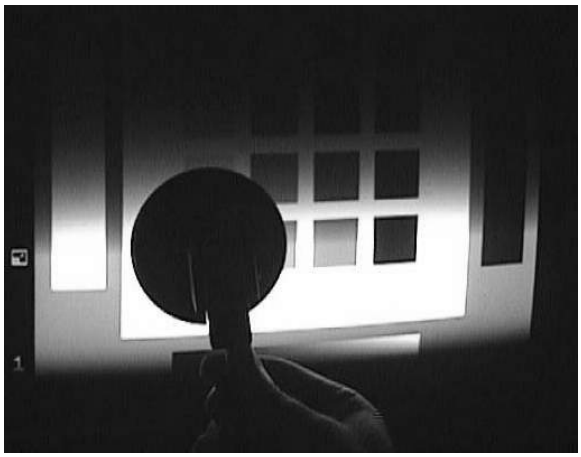
Connecting the L100-M to the PMX-III

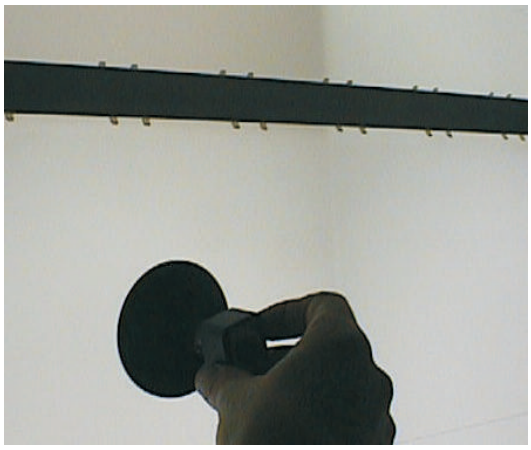
Follow these steps to prepare a measurement.

- If it is not already done, attach the monitor adapter tube to the detector housing. It is important that the monitor adapter is pressed all way down in the detector housing when the screw fixate the tube.
- Connect the light detector L100-M to the input on the rear panel of the PMX-III.
- Connect the Monitor Adapter ADI module marked 6/U to the connector on the rear panel of the PMX-III
- Power on the PMX-III and select DOSIMETER mode, then choose RATE mode. That is normally done automatically for firmware 6.0 and later.
- Make an Reset
  You have to perform a reset before you can start to measure.
  It is VERY IMPORTANT that no light reaches the detector during the reset procedure. To ensure that the instrument is reset while the detector is held in complete darkness you must press the light detector to a completely black surface, e.g. the surface of the ambient light shield, while pressing the reset key on the instrument.
  With the new monitor adapter with light shutter this is a easy task since the monitor adapter signal is zero until the shutter knob is pressed down.
  To perform a reset (actually a zero level adjustment) on the PMX-III you have to:
- Press the reset key and keep it pressed until the character “c” is shown on the display.
- Wait until the character “c” has disappeared.
- Start to measure
  Move the light detector to the measuring point and open the shutter by pressing the knob to stop, hold to collect a light value.
  After you have released the knob, the PMX-III is stored the value in the display until next measurement.

5.6.3 Measurements on CRTs and Film Viewing Boxes

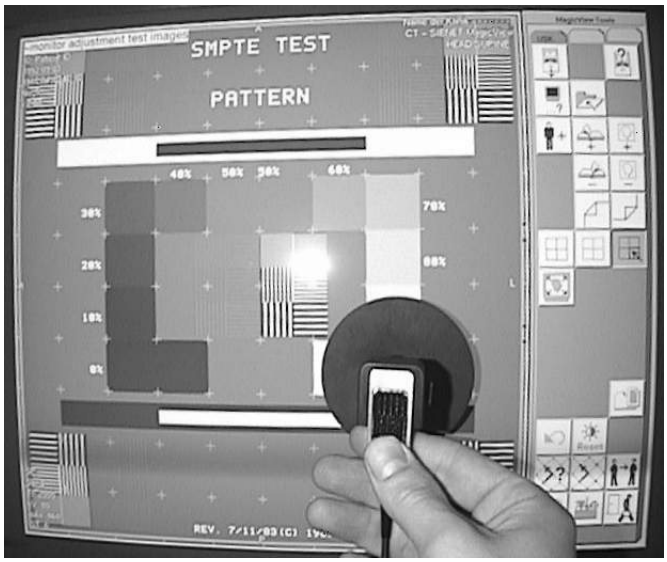
Attach the ambient light shield to the monitor adapter. You can select between a small and big shield. Place the light detector on the CRT or the film viewing box. Make sure the ambient light shield is held flat on to the surface to prevent ambient light from reaching the detector. Press and hold the shutter knob. Read the value on the display of the instrument. Two sample measurements are shown in below.





Checking the luminance of a monitor, in this case different grey-level areas.

SMPTE Test Pattern



A common test pattern used when testing CRT is the test pattern specified by the Society of Motion Picture and Television Engineers, SMPTE. This test pattern has, among other features, 11 different areas of grey-scale intensity, ranging from 0 % to 100 %.

When measuring on these different grey-scale areas you should have in mind that the luminance of an area **NOT** is proportional to its grey-scale value.

Instead the luminance (L) is related to the grey-scale level (G) by:

$$L \propto G^{\gamma} \qquad \textit{(Equation 1)}$$

Equation is equivalent to:

$$\log(L) = \gamma \log(G) + C \qquad \textit{(Equation 2)}$$

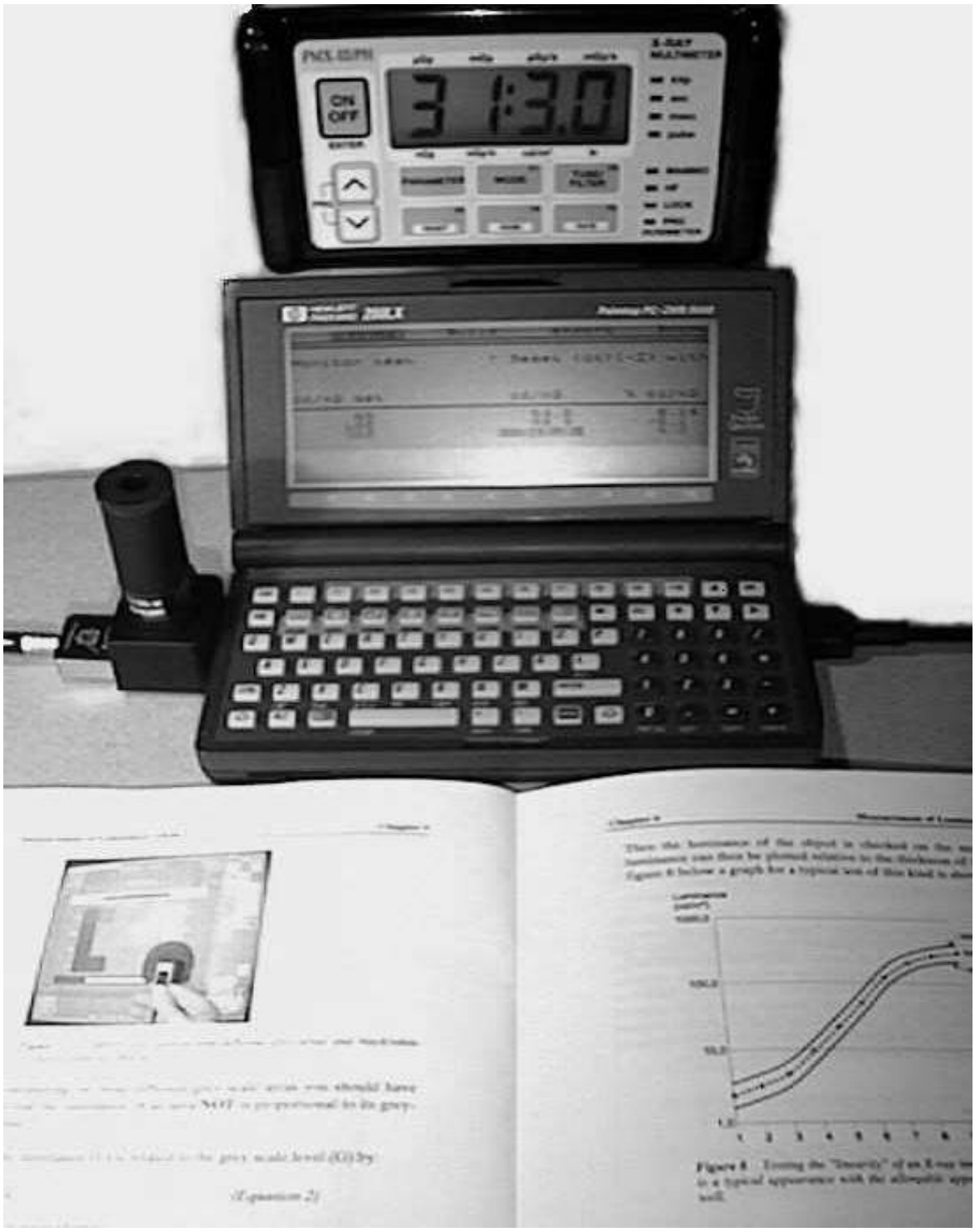
In equation 2, C is a constant and γ is the gamma value of the monitor that characterises the relationship between luminance and grey-scale value.

5.6.4 Ambient Light and Other Sources of Error

As mentioned above ambient light will strongly affect the measurement if it is not taken care of in an appropriate way. To examine how much the ambient light effects the measurements you could perform a simple experiment and measure without the ambient light shield. Measure on a CRT that is completely black, i.e. not powered on, and compare the result with measurements performed with the ambient light shield attached. Also measure with and without reduced room illumination. You will notice that the values achieved without the ambient light shield and with normal room illumination differ considerably from the ideal value. Imagine the percentage error you would achieve if you were to measure in this way on the 10 % grey-scale area!

Other sources of error are fingerprints and dust on the CRT. Investigations have shown that these smudges can decrease the luminance by as much as 10 %.

If the CRT is not sufficiently warmed up the luminance can vary during the measurements. Some monitors need several hours to stabilise. Even if the monitor has stabilised its output luminance will vary over different areas of the surface. To exclude this error source from your grey-scale measurements you can perform the measurements from the same location on the screen. Zoom the test pattern as large as possible and pan the selected grey-scale area to the centre of the screen. If necessary you can mark the place to put the ambient light shield with a piece of adhesive tape. The tape must of course be placed in such a way that it does not affect the measurements.



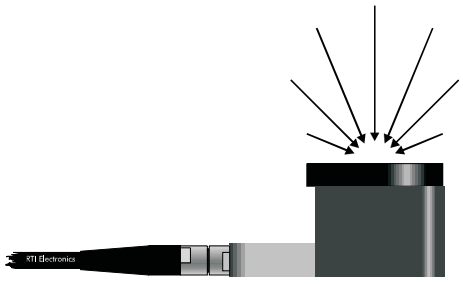
Example of very compact monitor test system based on oRTIgo.

5.7.3 Measurement of Illuminance (lx)

Follow these steps to prepare a measurement.

- If it is not already done, attach the lux adapter tube to the detector housing. It is important that the lux adapter is pressed all way down in the detector housing when the screw fixate the lux adapter.
- Connect the light detector L100-L to the input on the rear panel of the PMX-III
- Connect the LUX Adapter ADI module marked 6/Y to the connector on the rear panel of the PMX-III.
- Power on the PMX-III and select DOSIMETER mode, then choose RATE mode. That is normally done automatically for firmware 6.0 and later.
- Make a reset
  You have to perform a reset before you can start to measure. It is VERY IMPORTANT that no light reaches the detector during the reset procedure. To ensure that the instrument is reset while the detector is held in complete darkness you must press the light detector to a completely black surface while pressing the reset key on the instrument.

  To perform a reset (actually a zero level adjustment) on the PMX-III you have to:
- Press the reset key and keep it pressed until the character “c” is shown on the display.
- Wait until the character “c” has disappeared.
- Start to measure
  Remove the light detector from the black surface , place the detector where you want to measure and read the value on the display.



5.7 Examples of Field Measurements

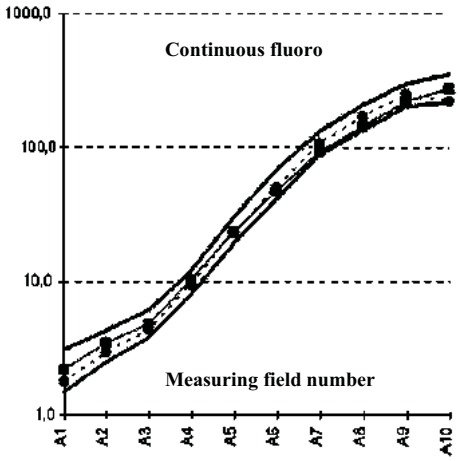
5.7.1 Check the total Contrast Range for the System, From the Image Intensifier to the Monitor.

Setup:	
Grid mounted Table-top mounted SID grid mark ±1 cm	1,5 mm Cu on the X-ray collimator Contrast phantom is placed in front of II covering the whole entrance screen. Light is measured on the monitor with the L100 light monitor adapter.

Measuring Results:

Measuring Field Phantom II=17 cm	Continuous fluoro IQ APR Low (cd/m²)	Pulsed fluoro IQ APR Normal (cd/m²)	Exposure IQ APR 25 frames/s (cd/m²)
A1	2,2	3,0	2,7
A2	3,5	4,2	4,0
A3	4,8	5,5	5,4
A4	10,3	10,6	10,7
A5	23,3	22,2	19,9
A6	47,1	49,7	47,8
A7	92,7	98,7	92,5
A8	144,6	155,7	144,6
A9	222,6	240,5	221,5
A10	279,5	281,0	273,0
Centre	28,3	28,4	28,7

Monitor adapter with light shutter to simplify the collecting of the luminance values to PMX-III and oRTIgo.



5.7.2 Check that the Dose and Dose Rate Level is within Specification for all II Formats.

Setup:	
Grid not mounted	2.0 mm Cu on the X-ray collimator
Table-top mounted	R100 detector is placed in front of II outside measuring field.
SID grid mark ±1 cm	Please make kV and Cu correction according to calibration record.

Measuring results			
ADI	8/A(P1)	8/A(P2)	8/A
II Format **cm**	Continuous fluoro IQ APR Low (µGy/s)	Pulsed fluoro IQ APR Normal (µGy/frame)	Exposure IQ APR 25 frames/s (µGy/frame)
23	0,70	0,026	0,10
18	1,06	0,040	0,14
13	1,37	0,058	0,22

Example made for Philips Medical System by RTI, Sweden
Based on protocol made by Roland Carneborn, PMS Sweden

This page is intentionally blank.

6 REMOTE CONTROL USING ORTIGO

6.1 Introduction

oRTIgo is a Quality Assurance software package which offers you maximum freedom in managing and documenting X-ray measurements. Using the software is simple, just choose predefined measurement templates or create them to suit your own specifications.

Main Features

- Customized measurement records with user selected template structure
- Fully user designable templates.
- Automatic calculations: % or Δ error, variation of coefficient, reproducibility, HVL, mGy/mAs, linearity, mean value, and more
- kVp reading are automatically compensated for total filtration
- Dose and dose reading are automatically compensated for the energy response of the dose detector
- Min/Max acceptance limits for all data, with automatic warnings
- Waveform analysis of kVp, radiation output, and dose rate
- Waveform analysis of light and tube current
- User designable print-out formats
- Can be run from a DOS shell in WINDOWS
- Export of data
- Built-in notepad for adding comments to your measurements
- Text editor
- Pull-down menus
- Context-sensitive help texts
- Hotkeys for easy access to different functions
- DOS file structure for all storage of data
- Personal password for protection of data and template structure
- Interface to PMX-III for automatic measurements

6.2 oRTIgo version 3.0

A new version of the DOS based oRTIgo software was released in November 1998.

Major difference, compared to version 2.20:

- Improved user interface, Information about the template settings for detector , detector range, beam quality and PMX-III is now displayed on a “template screen” to assist the user for the measurement.
- Improved communication interface with PC
- Autoread of dose and dose rate values in dosimeter mode
  (Pressing INS stores the value in the active template)
- Set dose, set dose rate, % dose and % dose rate (mA, Cd/m²..)
- The display is continuously updated in multimeter mode during exposure (kVp, time, dose, dose-rate (mA, Cd/m²..))
- Start up of oRTIgo directly from window explorer by double-clicking the appropriate *.DTA file
- Installation procedure under Windows (W 3.1 / W '95)
- Manual Trig in the waveform analyzer
  The possibility to manually trig the waveform analyzer is added. This new function is available when measuring the electrometer signal (dose, dose rate, light, mA and mAs) and in combination with MANUAL LOCK mode.
  There is sometimes a need for the ability to start the sampling manually, for example when measuring a very low signal, using the light detector L100, or when the signal you want to measure need a certain time to stabilize.
  You can activate this by changing measuring mode in the build mode before entering the waveform analyzer. You can also change measuring mode by pressing "M" after entering the waveform analyzer.
  You start the sampling by pressing the INS key.
- Calculation of frames and frames/s or pulses and Hz in the waveform Analyzer
  The possibility to calculate frames has been changed to give more possibilities when measuring on fluoroscopy and with the light detector L100. It is now possible to use Frame mode to calculate the total number of frames or frame rate frames/s between the two cursors. When enabling frame mode you can now choose between:
  "ON (Frames)", "ON Frames/s" for dose detectors
  "ON (Pulses)", "ON (Hz)" for all other detectors and probes.
  The trig level (Calculation level) can be set between 5 % and 95 %.
- Possibility to print to COM1, COM2, LPT1, LPT2,and FILE.
- Bugfix on printout and use of the waveform.

6.3 Connecting PMX-III to a Computer

- Place the PMX-III in the X-ray field for multimeter measurements
- Connect the interface cable between PMX-III AMP-1 and the computer (COM l or COM 2), use serial extension cable if needed.
- Connect the ADI-module and detector, use detector extension cable if needed.
- Power on the PMX-III
- Start oRTIgo (see next page)

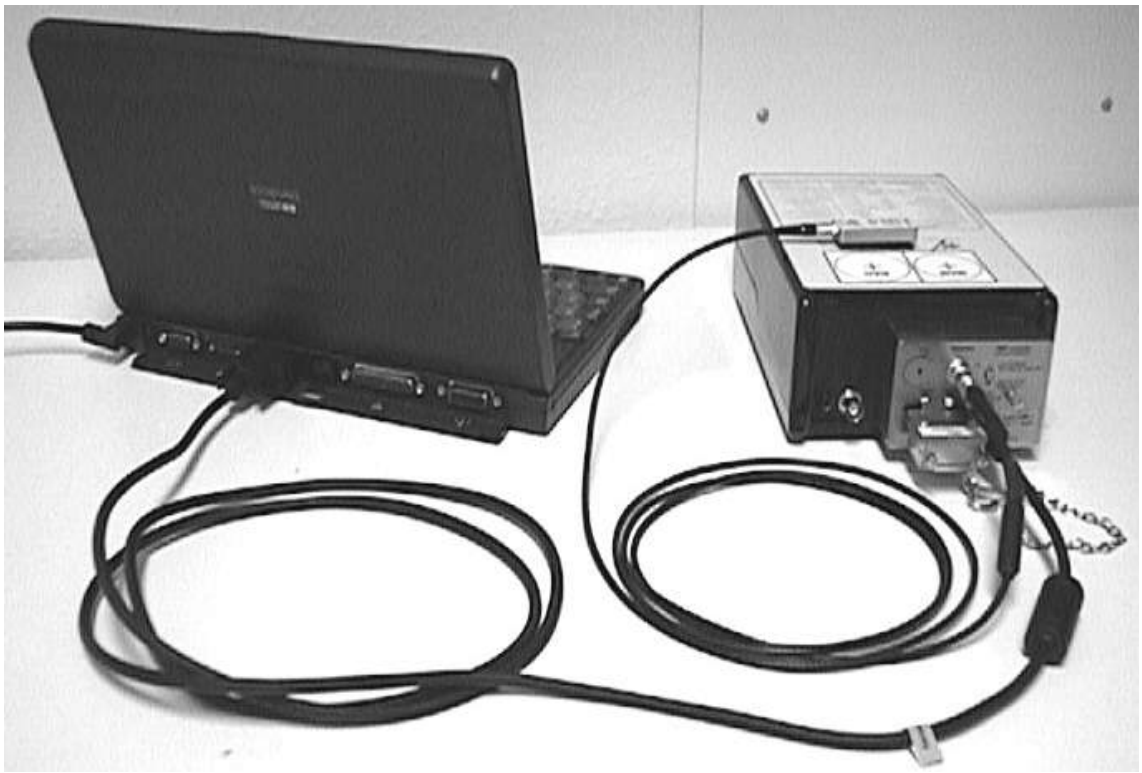
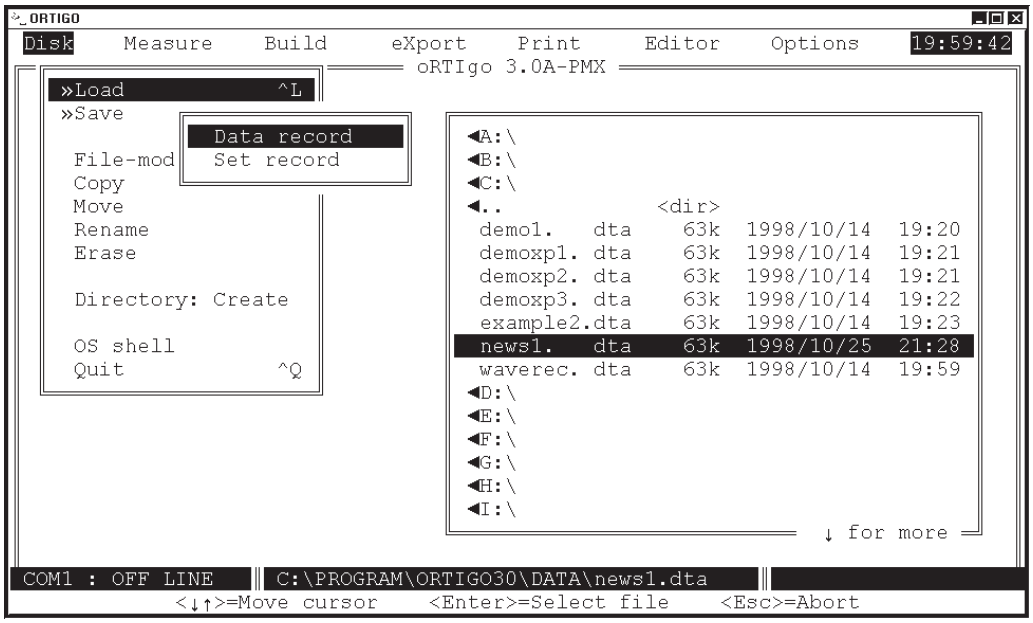


Figure 2. Correct connection of the serial cable, the detector cable, and the ADI.

6.4 Start oRTIgo 3.0

- Power on the computer.
- Place the PMX-III in the X-ray field for multimeter measurements
- Connect the interface cable between PMX-III AMP-1 and the computer (COM l or COM 2), use serial extension cable if needed.
- Connect the ADI-module and detector, use detector extension cable if needed.
- Power on the PMX-III
- Navigate to the directory where you have stored the oRTlgo software, normally “C:\windows\program\ORTIGO30" for windows installation (normally pressing the oRTIgo icon) or ”C:\ortigo30" for dos installation
- Start by typing “ORTIGO’ followed by < Enter >.
- Press < ^L > Move the cursor to a record name, press <Enter> to load it.



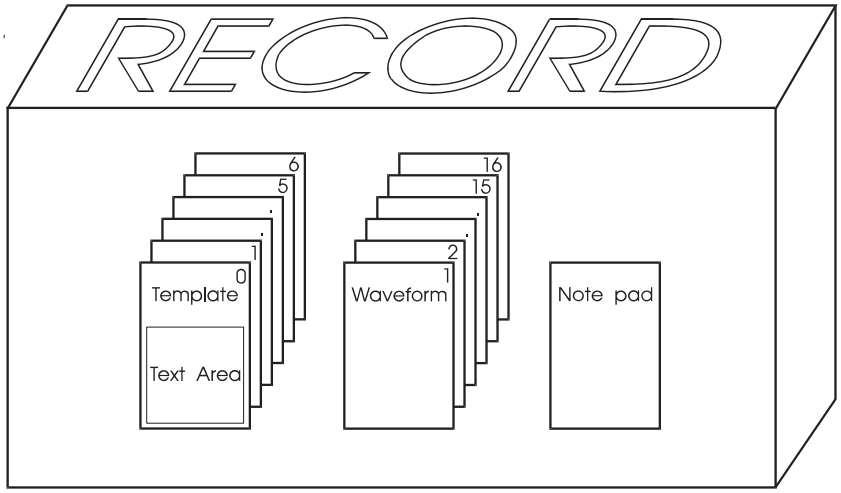
The < Fl > key is always available for instant help on current action.

- Press < Enter > to accept record.
- Press < Alt M> to activate the Measure menu You can now start to select a measured template from the menu. Follow the instructions on the screen to start to measure.

Please observe that “old” set records with the extension *.set must be renamed to *.std to be able to read in version 3.0

6.5 What is a Record

The data structure, that oRTIgo uses for data storage, is called a “record”. A record can be divided into the following parts, see figure below:



An oRTIgo record

Template #0 — Template with general information about the measuring conditions.

Templates #1 to #6 — A template performs a specific measurement. Set values for the X-ray generator and PMX-III and results are stored here. The templates, except for the waveform template, are fully user- design able. A record has six templates and one dedicated waveform template.

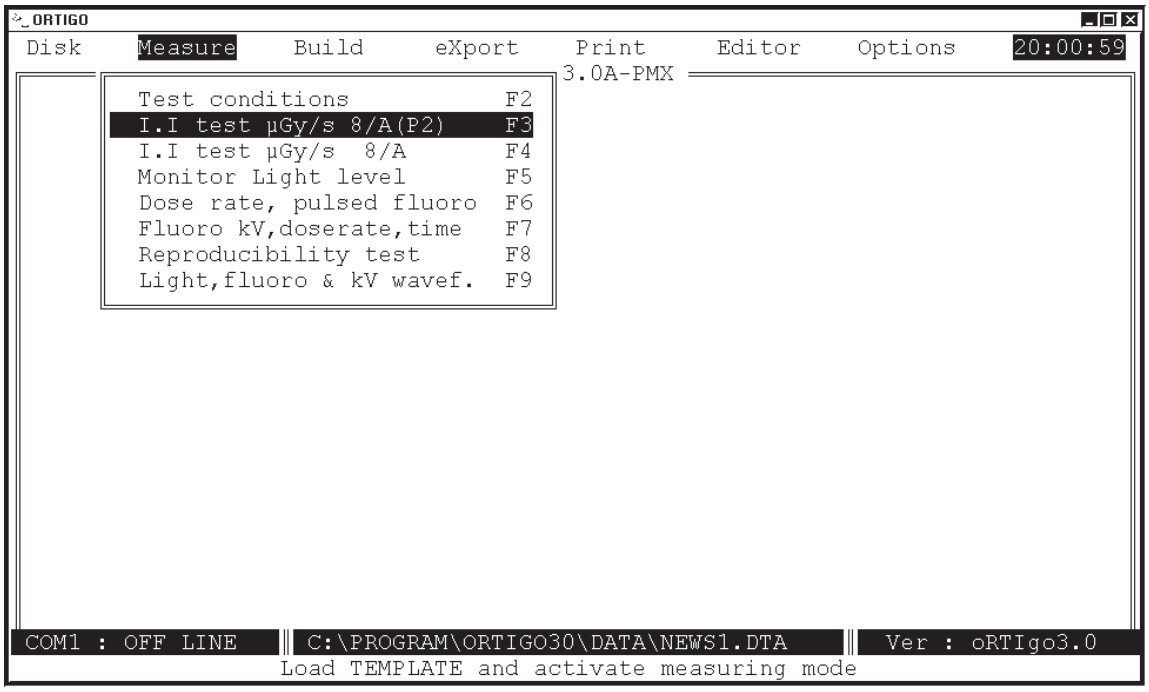
Waveform data — Measured waveforms are stored here. Up to sixteen different waveform measurements can be stored in each record.

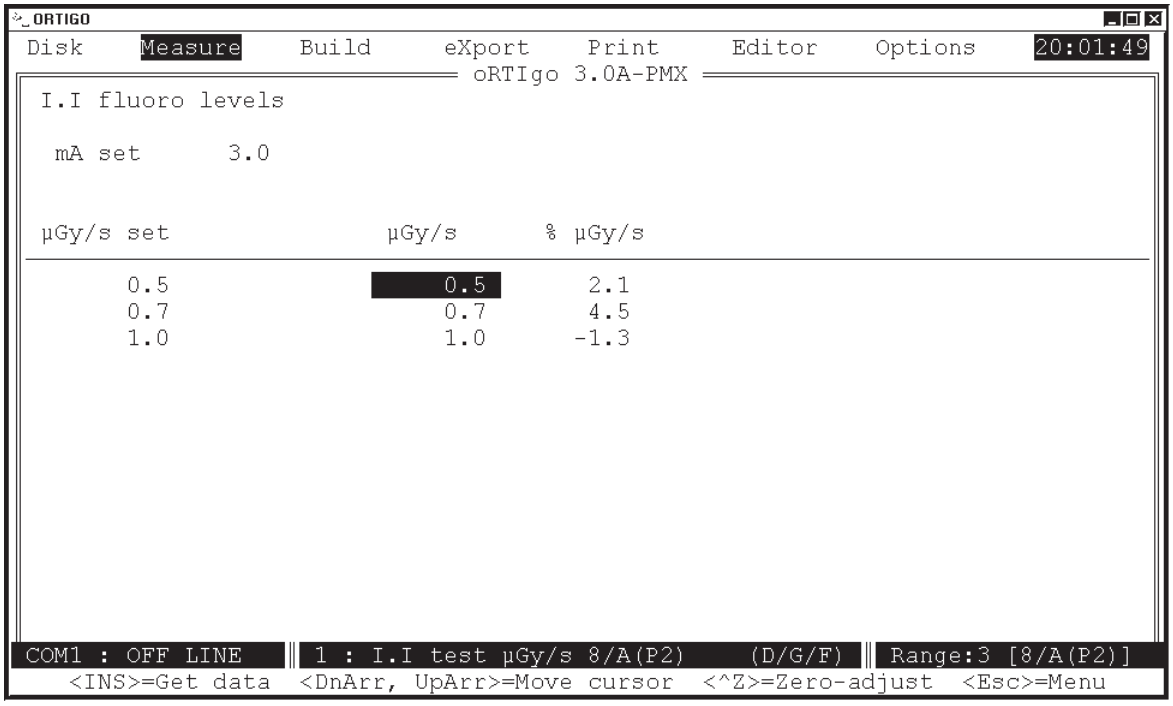
Note pad — Text entered in the note pad is stored here.

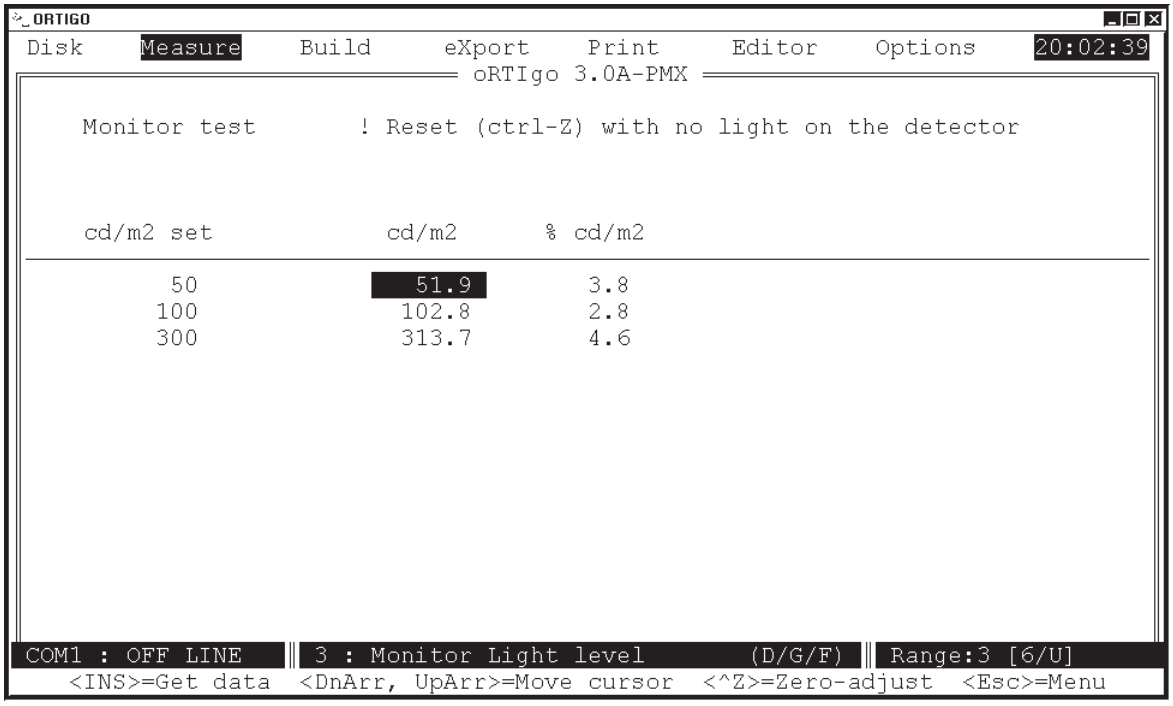
6.6 Application example

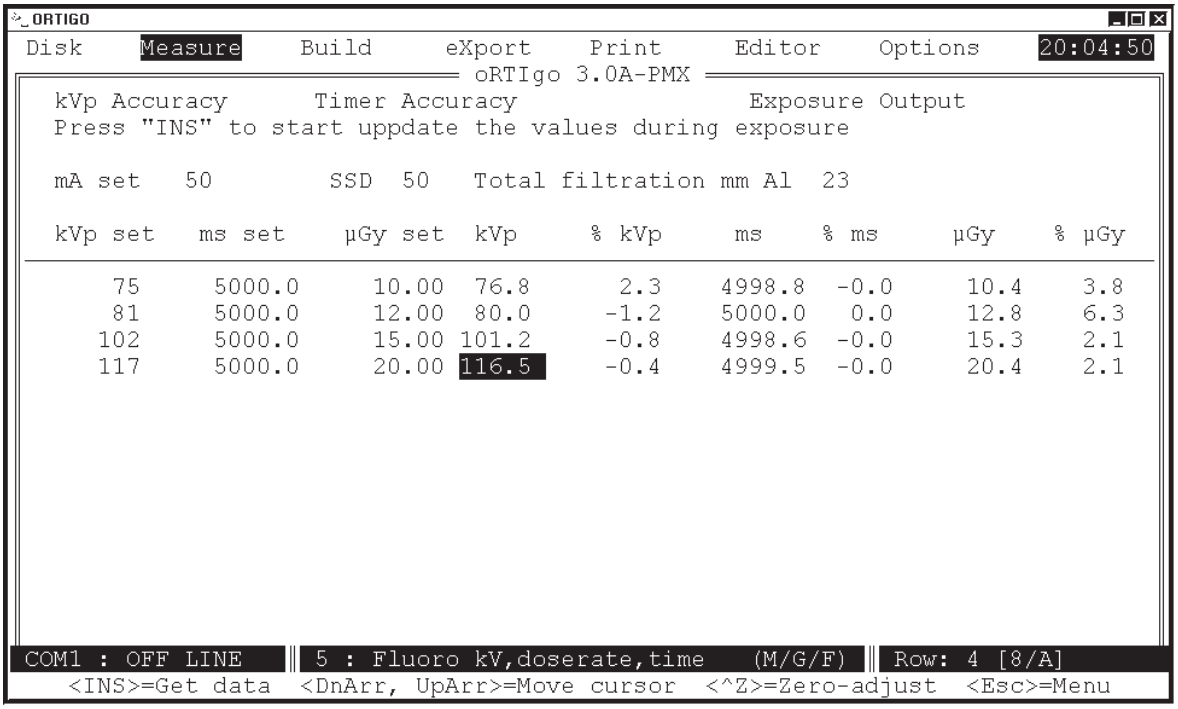
The record file NEWS1 contains templates that show how the new features can be used. The templates are:

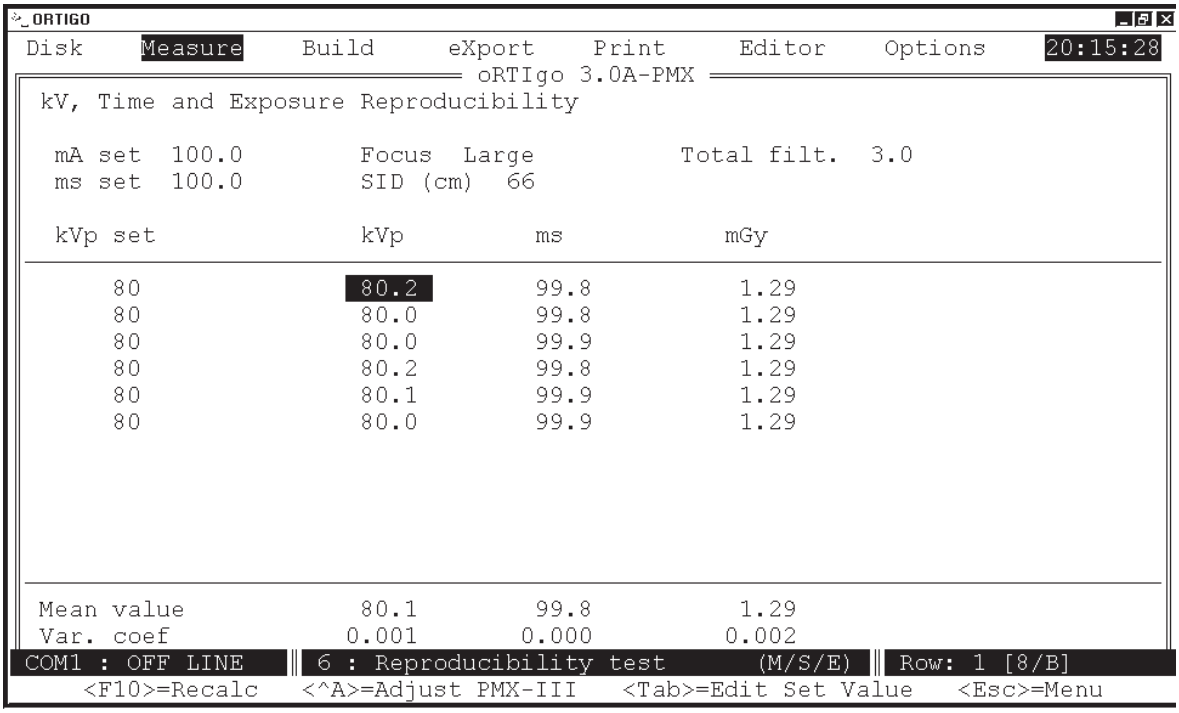
Template name	Function
I.I test µGy/s 8/A(P2)	Shows how the new measuring text “% unit” has been used to calculate the accuracy of measured dose rate.
Monitor light level	Shows how the light detector L100 and the monitor adapter has been used to measure the light output from a monitor screen.
Dose rate, pulsed fluoro	Shows how the accuracy of dose rate has been measured during pulsed fluoro.
Fluoro kV, dose rate, time	Shows how the new measuring mode “Fluoro” is used to measure kVp, time and dose rate during fluoroscopy.




ORTIGO
Disk Measure Build eXport Print Editor Options 20:01:49
oRTIgo 3.0A-PMX
I.I fluoro levels
mA set 3.0
µGy/s set µGy/s % µGy/s
0.5 0.5 2.1
0.7 0.7 4.5
1.0 1.0 -1.3
COM1 : OFF LINE
1 : I.I test µGy/s 8/A(P2) (D/G/F)
Range:3 [8/A(P2)]
<INS>=Get data <DnArr, UpArr>=Move cursor <^Z>=Zero-adjust <Esc>=Menu


ORTIGO
Disk Measure Build eXport Print Editor Options 20:02:39
oRTIgo 3.0A-PMX
Monitor test ! Reset (ctrl-Z) with no light on the detector
cd/m2 set cd/m2 % cd/m2
50 51.9 3.8
100 102.8 2.8
300 313.7 4.6
COM1 : OFF LINE
3 : Monitor Light level (D/G/F)
Range:3 [6/U]
<INS>=Get data <DnArr, UpArr>=Move cursor <^Z>=Zero-adjust <Esc>=Menu


ORTIGO
Disk Measure Build eXport Print Editor Options 20:04:50
oRTIgo 3.0A-PMX
kVp Accuracy Timer Accuracy Exposure Output
Press "INS" to start uppdate the values during exposure
mA set 50 SSD 50 Total filtration mm Al 23
kVp set ms set µGy set kVp % kVp ms % ms µGy % µGy
75 5000.0 10.00 76.8 2.3 4998.8 -0.0 10.4 3.8
81 5000.0 12.00 80.0 -1.2 5000.0 0.0 12.8 6.3
102 5000.0 15.00 101.2 -0.8 4998.6 -0.0 15.3 2.1
117 5000.0 20.00 116.5 -0.4 4999.5 -0.0 20.4 2.1
COM1 : OFF LINE
5 : Fluoro kV,doserate,time (M/G/F)
Row: 4 [8/A]
<INS>=Get data <DnArr, UpArr>=Move cursor <^Z>=Zero-adjust <Esc>=Menu


ORTIGO
Disk Measure Build eXport Print Editor Options 20:15:28
oRTIgo 3.0A-PMX
kV, Time and Exposure Reproducibility
mA set 100.0 Focus Large Total filt. 3.0
ms set 100.0 SID (cm) 66
kVp set kVp ms mGy
80 80.2 99.8 1.29
80 80.0 99.8 1.29
80 80.0 99.9 1.29
80 80.2 99.8 1.29
80 80.1 99.9 1.29
80 80.0 99.9 1.29
Mean value 80.1 99.8 1.29
Var. coef 0.001 0.000 0.002
COM1 : OFF LINE
6 : Reproducibility test (M/S/E)
Row: 1 [8/B]
<F10>=Recalc <^A>=Adjust PMX-III <Tab>=Edit Set Value <Esc>=Menu

In the waveform template you find the following waveforms:

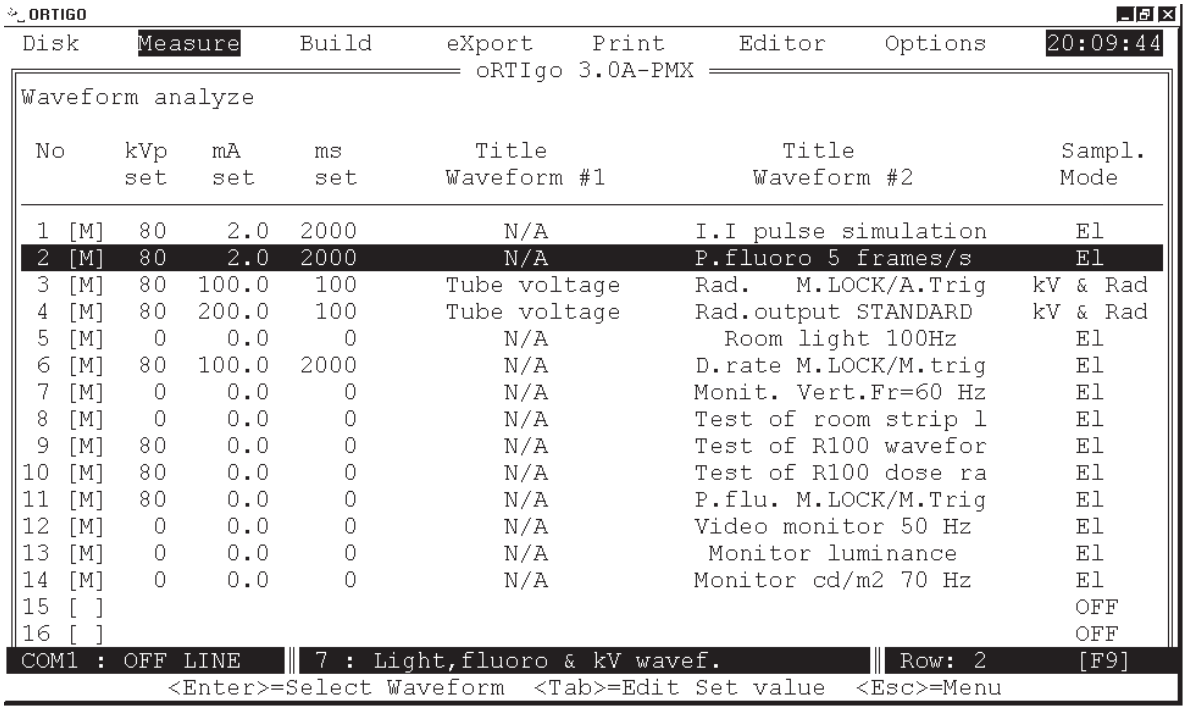
Waveform name	Function
I.I Pulse simulation	Shows a pulse waveform, 25 frames/s
P.fluoro 5 frames/s	Shows a pulsed waveform, 5 frames/s
Rad. M.Lock/A.trig	Shows kV and radiation output waveform (manual lock mode)
Rad output, standard	Shows kV and radiation output waveform (standard measuring mode)
Room light, 100 Hz	Shows the light output from a light source. Use part mode (Ctrl-G) when you look at this waveform.
D.rate M.Lock/M.Trig	The same as above, but manual lock mode and manual trig has been used. Use part mode (Ctrl-G) when you look at this waveform.
Monit. Vert.Fr 60 Hz	Shows the output from a monitor with a vertical frequency of 60 Hz.
Test of room strip light	Shows the light output from a light source.
Test of R100 waveform	Shows the dose rate waveform measured with a R100.
Test of R100 dose rate	Shows the dose rate waveform measured with a R100.

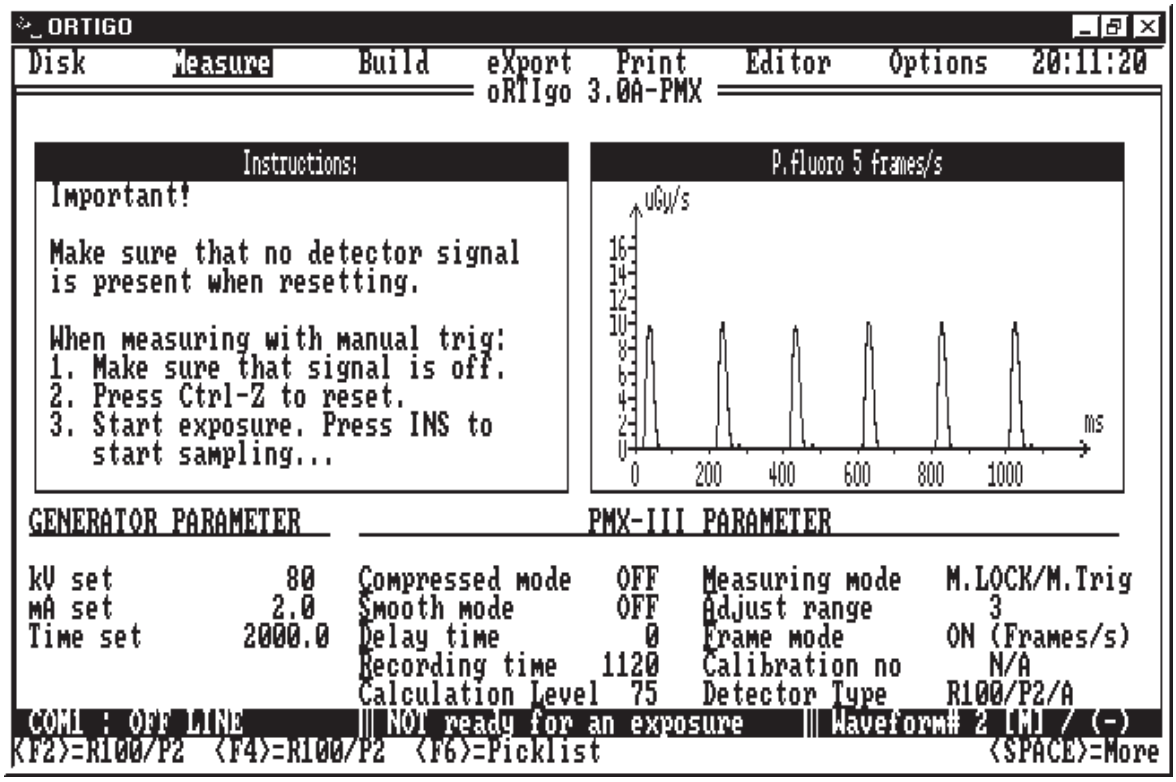
P.flu. M.Lock/M.Trig — Shows pulsed fluoro, measured with manual lock mode and manual trig.

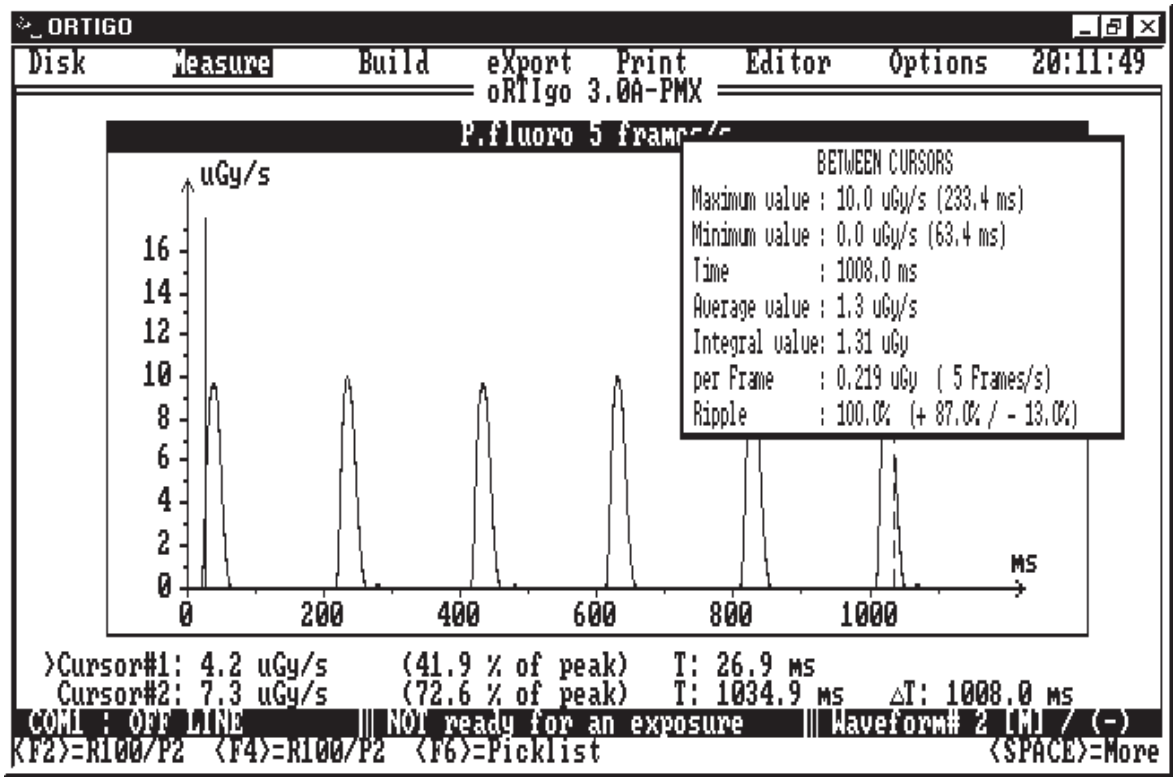
Video monitor 50 Hz — Shows measurement of light output from a video monitor with a vertical frequency of 50 Hz.

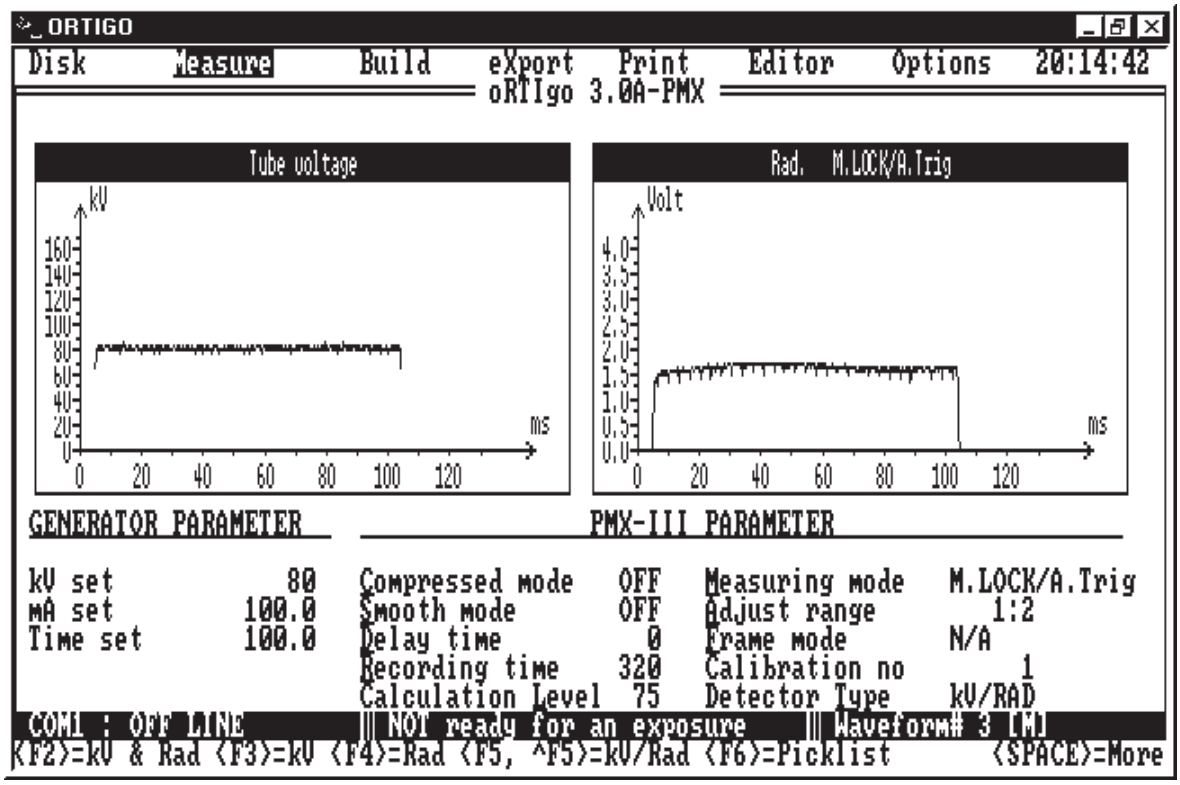
Monitor luminance — Same as above.

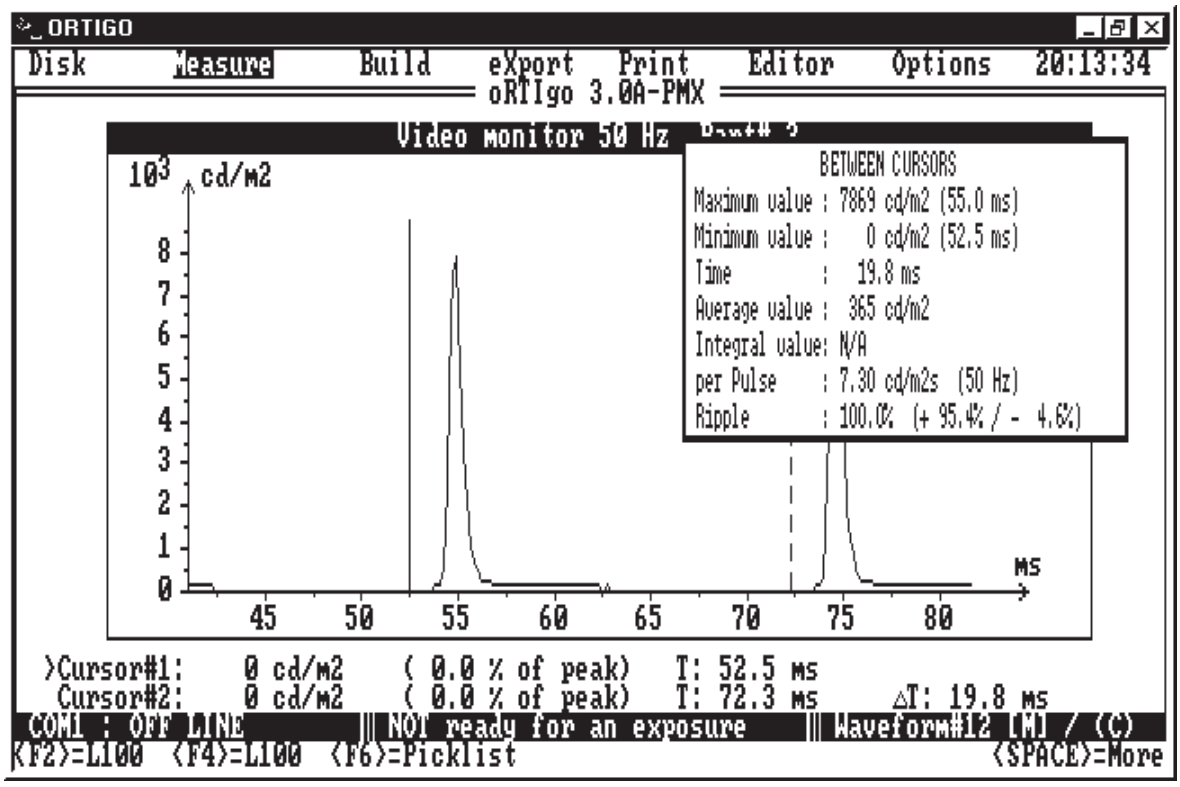
Monitor cd/m^2, 70 Hz — Shows measurement of light output from a monitor with a vertical frequency of 70 Hz.

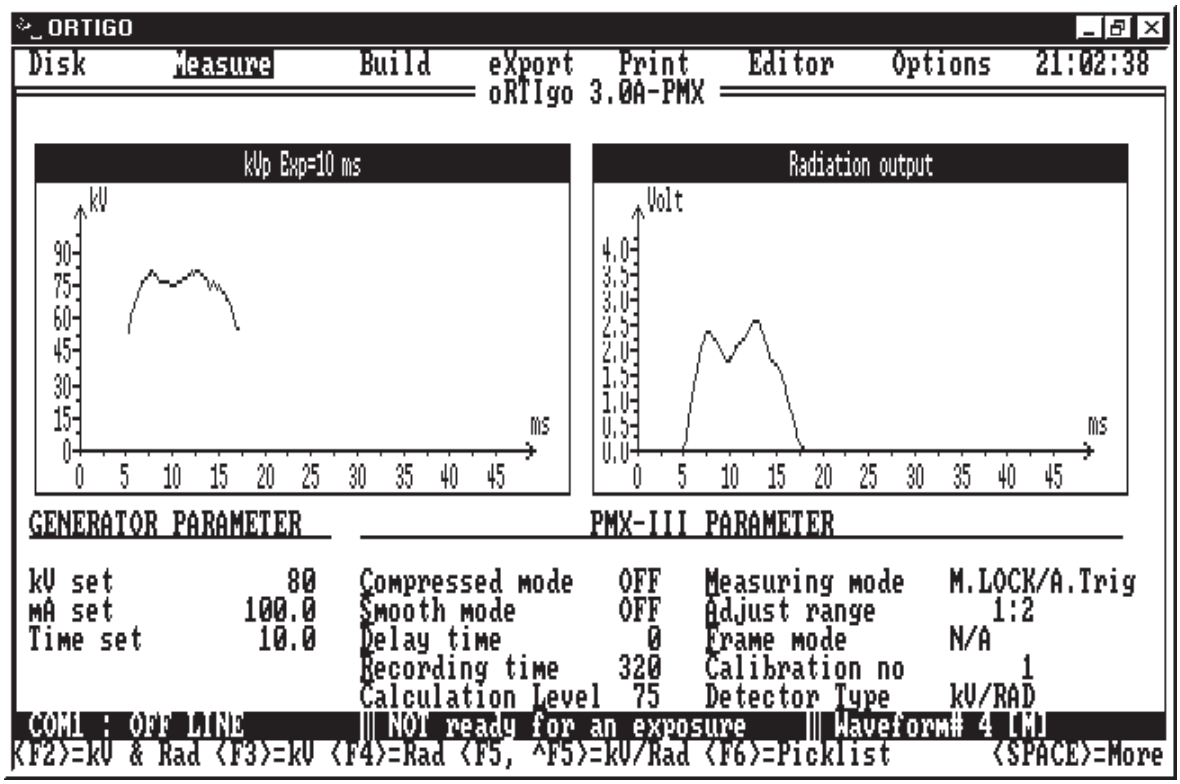


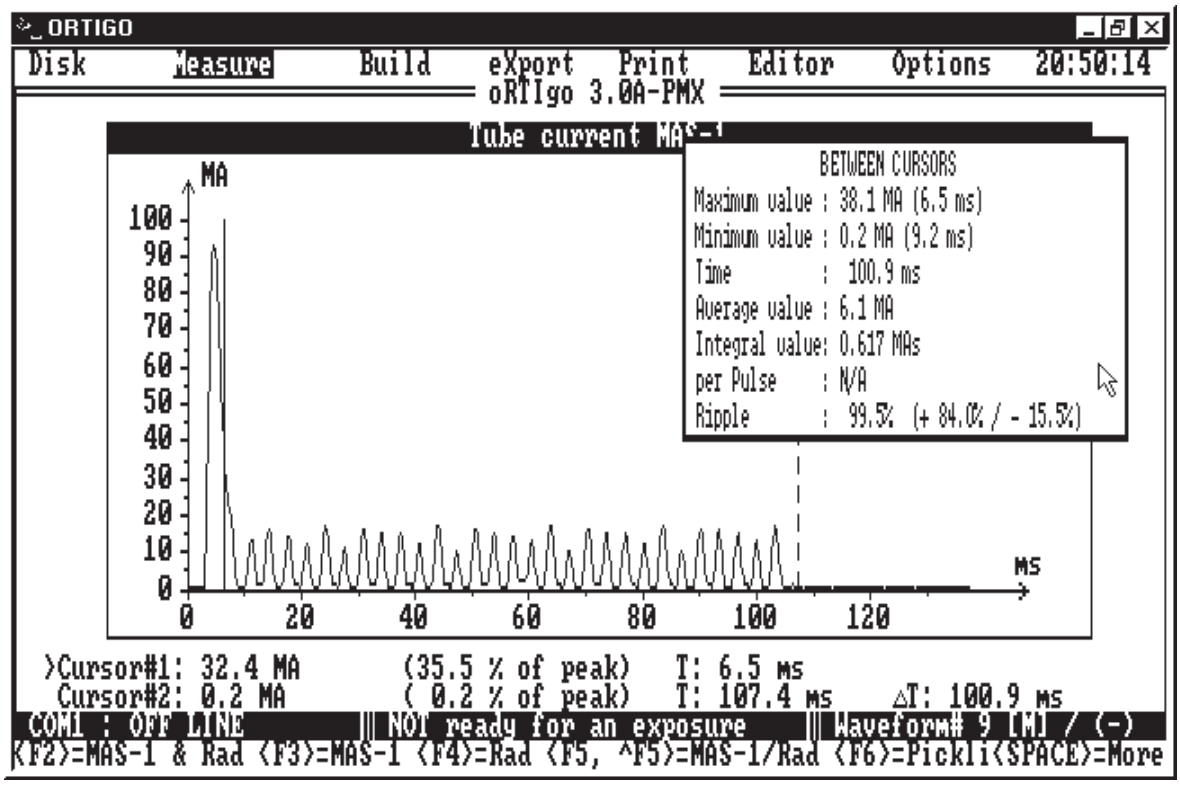

ORTIGO
Disk Measure Build eXport Print Editor Options 20:11:20
oRTIgo 3.0A-PMX
Instructions:
Important!
Make sure that no detector signal is present when resetting.
When measuring with manual trig:
1. Make sure that signal is off.
2. Press Ctrl-Z to reset.
3. Start exposure. Press INS to start sampling...
P.fluoro 5 frames/s
uGy/s
ms
GENERATOR PARAMETER
PMX-III PARAMETER
kV set 80
mA set 2.0
Time set 2000.0
Compressed mode OFF
Smooth mode OFF
Delay time 0
Recording time 1120
Calculation Level 75
Measuring mode M.LOCK/M.Trig
Adjust range 3
Frame mode ON (Frames/s)
Calibration no N/A
Detector Type R100/P2/A
COM1 : OFF LINE
NOT ready for an exposure
Waveform# 2 (M) / (-)
(F2)=R100/P2 (F4)=R100/P2 (F6)=Picklist
(SPACE)=More


ORTIGO
Disk Measure Build eXport Print Editor Options 20:11:49
oRTIgo 3.0A-PMX
uGy/s
ms
BETWEEN CURSORS
Maximum value : 10.0 uGy/s (233.4 ms)
Minimum value : 0.0 uGy/s (63.4 ms)
Time : 1008.0 ms
Average value : 1.3 uGy/s
Integral value: 1.31 uGy
per Frame : 0.219 uGy (5 Frames/s)
Ripple : 100.0% (+ 87.0% / - 13.0%)
Cursor#1: 4.2 uGy/s (41.9 % of peak) T: 26.9 ms
Cursor#2: 7.3 uGy/s (72.6 % of peak) T: 1034.9 ms ΔT: 1008.0 ms
COM1 : OFF LINE
NOT ready for an exposure
Waveform# 2 (M) / (-)
(F2)=R100/P2 (F4)=R100/P2 (F6)=Picklist
(SPACE)=More


ORTIGO
Disk Measure Build eXport Print Editor Options 20:14:42
oRTIgo 3.0A-PMX
Tube voltage
kV
ms
Rad. M.LOCK/A.Trig
Volt
ms
GENERATOR PARAMETER
PMX-III PARAMETER
kV set 80
mA set 100.0
Time set 100.0
Compressed mode OFF
Smooth mode OFF
Delay time 0
Recording time 320
Calculation Level 75
Measuring mode M.LOCK/A.Trig
Adjust range 1:2
Frame mode N/A
Calibration no 1
Detector Type kV/RAD
COM1 : OFF LINE
NOT ready for an exposure
Waveform# 3 [M]
(F2)=kV & Rad (F3)=kV (F4)=Rad (F5, ^F5)=kV/Rad (F6)=Picklist
(SPACE)=More


ORTIGO
Disk Measure Build eXport Print Editor Options 20:13:34
oRTIgo 3.0A-PMX
Video monitor 50 Hz
10³ cd/m2
ms
BETWEEN CURSORS
Maximum value : 7869 cd/m2 (55.0 ms)
Minimum value : 0 cd/m2 (52.5 ms)
Time : 19.8 ms
Average value : 365 cd/m2
Integral value: N/A
per Pulse : 7.30 cd/m2s (50 Hz)
Ripple : 100.0% (+ 95.4% / - 4.6%)
>Cursor#1: 0 cd/m2 (0.0 % of peak) T: 52.5 ms
Cursor#2: 0 cd/m2 (0.0 % of peak) T: 72.3 ms ΔT: 19.8 ms
COM1 : OFF LINE
NOT ready for an exposure
Waveform#12 [M] / (C)
(F2)=L100 (F4)=L100 (F6)=Picklist
(SPACE)=More


ORTIGO
Disk Measure Build eXport Print Editor Options 21:02:38
oRTIgo 3.0A-PMX
kVp Exp=10 ms
kV
ms
Radiation output
Volt
ms
GENERATOR PARAMETER
PMX-III PARAMETER
kV set 80
mA set 100.0
Time set 10.0
Compressed mode OFF
Smooth mode OFF
Delay time 0
Recording time 320
Calculation Level 75
Measuring mode M.LOCK/A.Trig
Adjust range 1:2
Frame mode N/A
Calibration no 1
Detector Type kV/RAD
COMI : OFF LINE
NOT ready for an exposure
Waveform# 4 [M]
(F2)=kV & Rad (F3)=kV (F4)=Rad (F5, ^F5)=kV/Rad (F6)=Picklist (SPACE)=More


ORTIGO
Disk Measure Build eXport Print Editor Options 20:50:14
oRTIgo 3.0A-PMX
Tube current MA
MA
ms
BETWEEN CURSORS
Maximum value : 38.1 MA (6.5 ms)
Minimum value : 0.2 MA (9.2 ms)
Time : 100.9 ms
Average value : 6.1 MA
Integral value: 0.617 MAs
per Pulse : N/A
Ripple : 99.5% (+ 84.0% / - 15.5%)
>Cursor#1: 32.4 MA (35.5 % of peak) T: 6.5 ms
Cursor#2: 0.2 MA (0.2 % of peak) T: 107.4 ms ΔT: 100.9 ms
COMI : OFF LINE
NOT ready for an exposure
Waveform# 9 [M] / (-)
(F2)=MAS-1 & Rad (F3)=MAS-1 (F4)=Rad (F5, ^F5)=MAS-1/Rad (F6)=Picklist (SPACE)=More

6.7 List of Hotkeys and Short Cuts

6.7.1 General

← , → ↑ , ↓	Move cursor
PgUp/PgDn	Within a template: Move the cursor 5 rows up/down
Home.End	Within a template: Move cursor to top/bottom of template
Esc	Within the menu system: Move to previous menu level Within a template: Return to the menu system
Enter	Within the menu system: Select menu item
Alt D	Pull down the DISK menu
Alt M	Pull down the MEASURE menu
Alt B	Pull down the BUILD menu
Alt X	Pull down the EXPORT menu
Alt P	Pull down the PRINT menu
Alt E	Pull down the EDITOR menu
Alt O	Pull down the OPTIONS menu
TAB	Within the menu system: Return to the template Within a template: Toggle cursor between measure/set
Fl	Help
F2/Ctrl F2	Activate tempate #0 for text entering/build
F3/CtrlF3	Activate template #1 for measure/build
F4/Ctrl F4	Activate template #2 for measure/build
F5/Ctrl F5	Activate template #3 for measure/build

F6/Ctrl F6	Activate template #4 for measure/build
F7/Ctrl F7	Activate template #5 for measure/build
F8/Ctrl F8	Activate template #6 for measure/buiid
F9/Ctrl F9	Activate the waveform template for measure/huild
F10	Recalculation (Measuring mode)
F10	Waveform Settings (Building a waveform template)

Ctrl A	Adjust parameters
Ins	Dosimeter mode: Read a value from the dosimeter
Ctrl Z	Dosimeter mode: Reset of the dosimeter
Ctrl L	Load a record
Ctrl S	Save current record
Ctrl E	Activate the text editor
Ctrl N	Activate the notepad
Ctrl R	Toggle PMX-III ON/OFF line
Ctrl P	Print current record
Ctrl X	Export current record
Ctrl QQ	Quit oRTlgo

Within a submenu all commands can be accessed by pressing the first letter of the corresponding command.

6.7.2 Waveform Analyzer

F2	Show measured waveforms in two separate graphs
F3	Show measured kV waveform
F4	Show radiation output waveform
F5/Ctrl F5	Dual waveform plot. absolute/relative plot
F6	Show “Waveform Pick List”
F7	If F3 or F4 has been pressed: Calculate between cursors
F8	If F3 or F4 has been pressed: Toggle the active cursor
F9	If F6 has been pressed: Activate multi-plot
F10	If F3 or F4 has been pressed: Print a hard copy
Ctrl ← , **Ctrl →**	If F3 or F4 has been pressed: Move the cursor fast
Home/End	If F3 or F4 has been pressed: Move the cursor to the beginning/end of the waveform
PgUp/PgDn	Go to the previous/next part
Ctrl G	Go to part number ...
Ctrl W	Save the waveform
Ctrl Z	Dosimeter reset
Ctrl T	Toggle between the whole waveform and the active part
Ctrl X	Activate SET mode

6.7.3 Text Editor and NotePad

← , → ↑ , ↓	Move the cursor
Ctrl ← , **Ctrl →**	Move the cursor one word
Home/End	Move the cursor to the beginning/end of the line
PgUp/PgDn	Scroll the display one page up/down
Ctrl PgUp	Move the cursor to the beginning of the file
Ctrl PgDn	Move the cursor to the end of the file
Ctrl y	Delete the current line
Ins	Toggle insert mode on and off
F2	Mark the beginning of block
F3	Mark the end of block
F4	Delete the marked block
F5	Move the marked block to the current cursor position
F6	Copy the marked block to the current cursor position
F7	Read a file from disk and insert at the current cursor position
F8	Write the marked block to a file
Shift F3	Resize text window (only valid for the notepad)

This page is intentionally blank.

7 DISPLAY CODES, SENSITIVITY AND FILTRATION

7.1 Display codes

7.1.1 Most Common Display Codes

New Name	Description	Old Name
Lo.Si	Low signal	Er.1
Hi.Si	High signal	Er.2
Lo	Low kVp	Er.3
Hi	High kVp	Er.4
Sh.E	Short exposure time	Er.5
BAtt	Low battery	Er.20
O. FL	Display overflow (electrometer reading > 9999)	Er.2
OF.Er	Offset error due to negative input signal	New
Er. 11	Wrong ADI unit (Gy or R) compared to front panel text	New
:	Rate indication in the display	:
X.-Y-	ADI defined, for detector X and beam quality Y	X.-Y-
MAS.X	ADI defined, for MAS-1/MAS-2/MAS-3 probe	MAS.X
norM	Display reading normalised to user factor	norM
Ch.Cu	Charge/current (only without ADI)	Ch.Cu
Auto	Indicates that electrometer selects range automatically	Auto
RA:1	This is the most sensitive range for low dose rate meas.	RA:1
RA:2	Middle dose rate range	RA:2
RA:3	High dose rate range (default for use of AMP-1)	RA:3
c	PMX-III performs a RESET, wait to exposure until the “c” disappear	c

7.1.2 Description of the Display Codes

Lo. Si Low signal.
The detector signal is too low during the measurement. Increase mA or decrease the distance between PMX-III and the tube. For dental/ fluoro units try to use a time delay using setup tables #9 and #10.

Hi. Si High signal.
The kVp detector signal is too high. Decrease mA or increase the distance between PMX-III and the tube;
or

The measured range in manual LOCK mode is to low.
or

Measured dose is higher than 9999 expressed in the current unit:
or

The dose rate signal is too high. If the measured dose rate signal is too high you can increase the distance between the detector and the tube. Otherwise you can lower the tube current or deactivate the AMP-1 by selecting a "normal" ADI that does not activate the AMP-1. Using gain 1 or gain 2 instead of gain 3 on PMX-III together with AMP-1 gives a dose rate overflow

Lo Low kVp
The measured kVp is lower than the lower limit set by the selected tube/filter combination.

Hi High kVp.
The measured kVp is higher than the maximum limit set by the selected tube/filter combination.

Sh.E Short exposure time.
The exposure time is too short or the detector detects the start trig but not the time trig. PMX-III cannot calculate a correct kVp value. This measuring situation may occur for a combination of a low X-ray output and low kVp. Try to use longer exposure time and/or increase signal level. For dental/fluoro units try to use a
time delay using setup tables #9 and #10.

Batt Low battery (Flash in dose rate mode)
Please exchange all batteries for new ones. Also negative current input to the electrometer gives this error.

O.Fl Display overflow (electrometer reading > 9999). oRTIgo can still collect and display the measured values as long as no **Hi.Si** code appear

Dose rate is greater than 4.6 µGy/s ("8.AP1" ADI) or 46 µGy/s ("8.AP2" ADI) .

OF.Er Offset error due to negative input signal to the electrometer. The reason for this can be that AMP-1 or one of the active mA-probes offset level are outside permitted range.

Er. 6 Time trig error.
Random error, make a new exposure. If the error is repeated please make a check of the waveform to confirm that there is no error.

Er. 7 Pulses can not be calculated.
The exposure time is too short, PMX-III can not calculate the correct number of pulses.

Note !!
If PMX-III at any time indicates an code 1 to 7 that will not disappear after appropriate changes, it would be advisable to try the following:

- Use manual LOCK mode to "help" PMX-III to make the correct selection of kV range and gain.
- Longer delay
- Longer exposure time
- Higher mA

This may occur when it is impossible to predict the waveform, for example if the overshoot is much longer than 5 ms.
For dental/fluoro units try to use a time delay using setup table #9 (or #11) with a delay of 200 ms or setup table #10 (or #12) with a delay of 2000 ms. You can also try to use long delay times if you know that the X-ray unit has an long start-up sequence (longer than 5 ms), when the output level not is stable.

Er. 8 Not allowed to select LOCK mode until SET exposure done.
Make a new exposure in SET mode before using LOCK mode.

Er. 10 Dose rate error.
Dose rate cannot be calculated (only in multimeter mode).

Er.11 Wrong ADI unit (Gy or R) compared to frontpanel text.

Er. 25 Hardware offset level outside permitted range.
The most common reason for this error code is that PMX-III has been exposed to cold or heat, for example during transportation or storage. Please allow PMX-III to return to normal temperature (+20 °C, 68 °F) before it is switched on. A PMX-III heated up to +40 °C (+104 °F) will need at least two hours to return to normal temperature.

Er. 21-23,28,29,31,32 Hardware errors.
Please study appendix A in the reference manual for more detailed information of the self test procedure at power on and the meaning of the different error code numbers. Write down the error codes if still present. Please contact your dealer if needed.

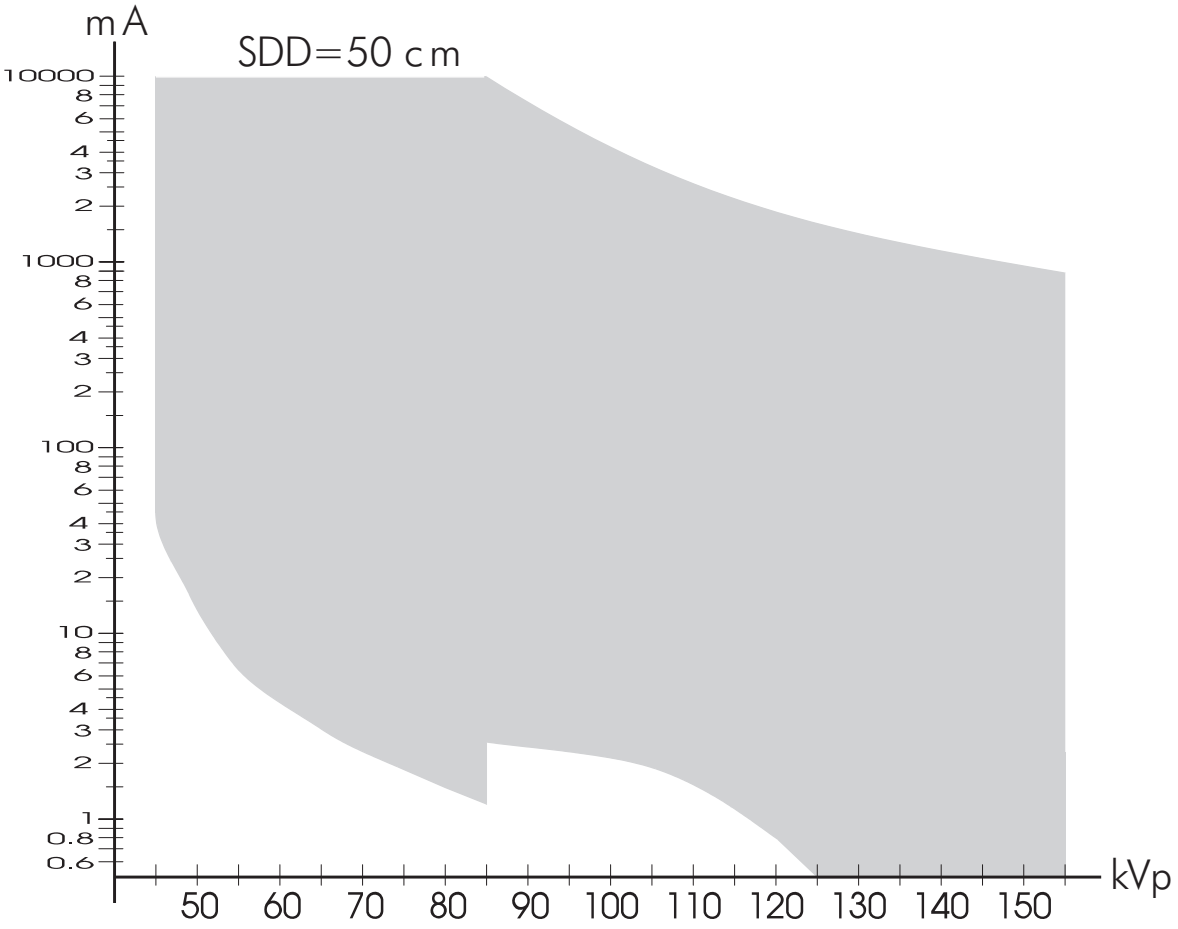
Er.30 ADI or internal EEprom checksum error

Important calibration data are stored both in the ADI and in an internal EEprom. The PMX-III firmware checks the checksum of this two areas when power on the instrument for safety reasons.
See Chapter 10 how to fix this errors yourself with help of the “SAVEEPR5 oRTIgo software.
Please contact your nearest dealer or RTI to get help how to fix this error if you don’t can download the backup data into PMX-III.

Er. 50 Serious error
Please make sure that you are using the correct sensor area corresponding to the active tube/filter combination and that the X-ray field covers the kVp sensor (RAD or MAM).

7.2 KVp Sensitivity Graph

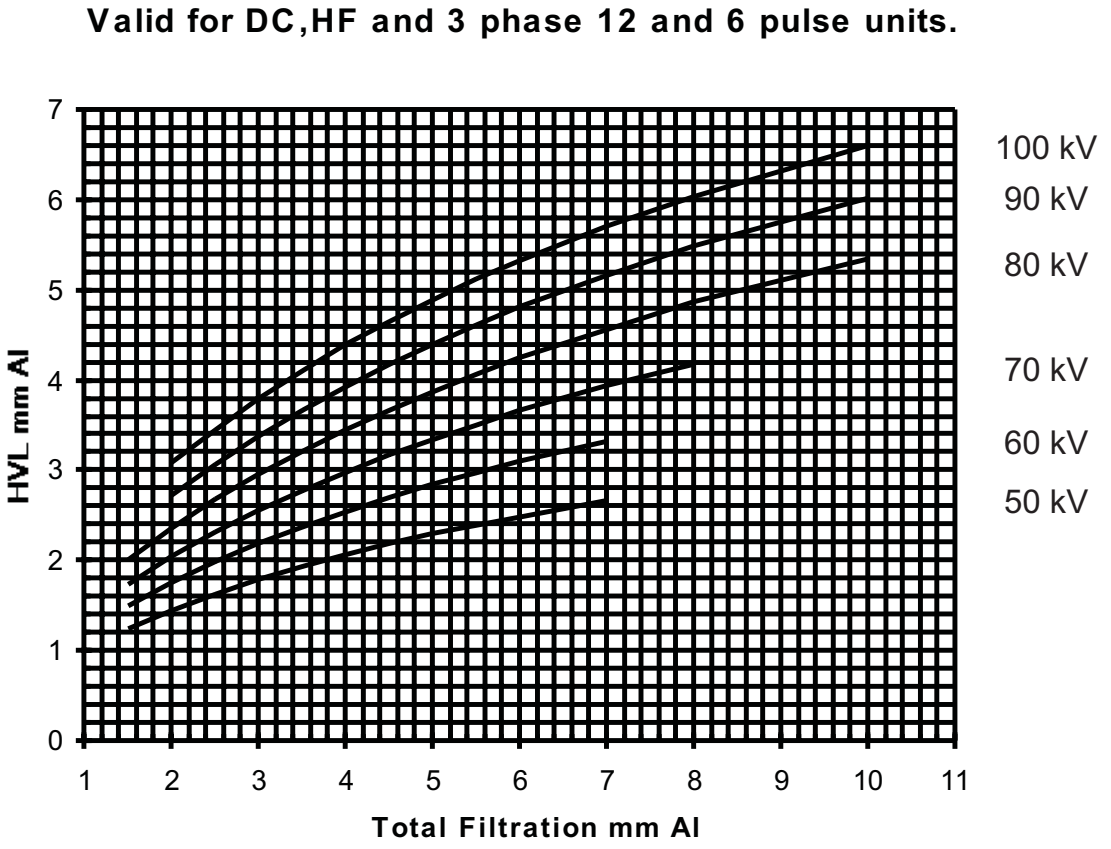
Typical sensitivity for PMX-III using CA 1 with a total filtration of 3.0 mm Al at a distance of 50 cm between the tube and the kV detector.



Typical sensitivity for the PMX-III.

7.3 Filtration Dependence

The calibration is performed with known parameters such as true kVp, total filtration, and X-ray tube target material. If measurements are made under the same conditions as during the factory calibration, the best accuracy will be achieved. If not, it is necessary to make corrections to the displayed kVp value.



Conversion between total filtration and HVL.

The X-ray tube material and the total filtration must be known to be able to make the correction. To convert from HVL value to total filtration; use the graph in above figure. An HVL value from a half wave rectified unit can be converted to DC-HVL by multiplying it with 1,15.

The two graphs on next page gives the corrections for different total filtrations.

First graph is valid from 45 to 90 kV and the second graph is valid from 80 to 145 kV. Within the range 80 to 90 kV, it is necessary to use the special display mode that indicates which graph to use

EXAMPLE:
You are measuring on a generator with a total filtration of 4,0 mm Al and you are going to measure at kV settings between 80 and 90 kV.

1. Select setup table #13 to enable the display of filter pair used for kVp measurement, or enable it manually.
See section 4.9 and page 4-53 and 4-59 in the reference manual for details.

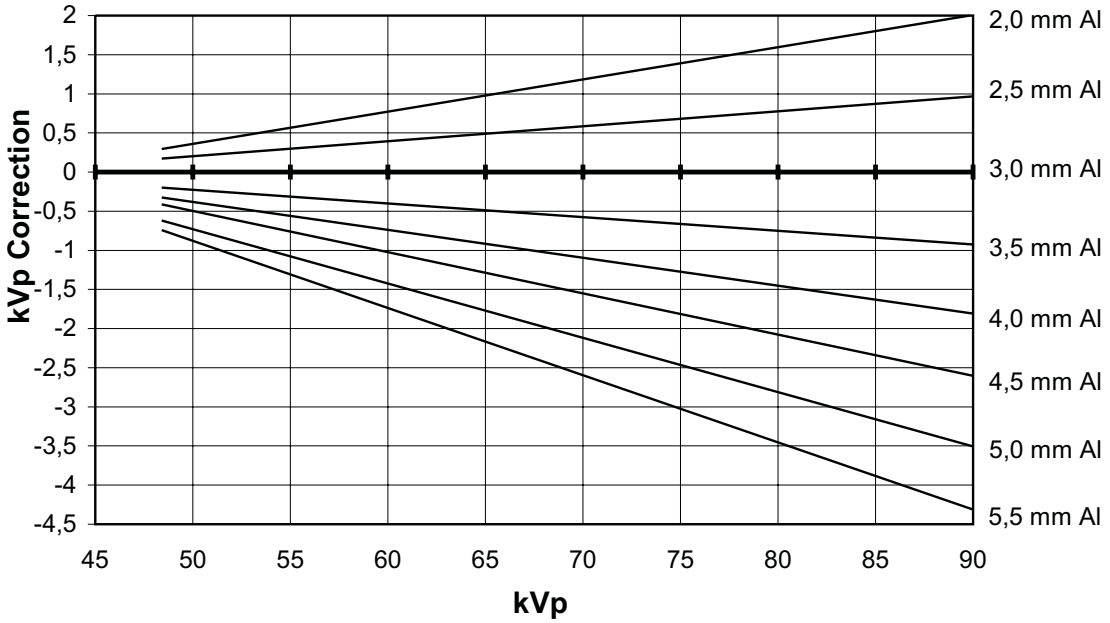
2. Make an exposure.

3. If measured kVp is between 80 and 90 kVp, information will be displayed to inform which graph to use. The display will show “Fi.1" or ”Fi.2".

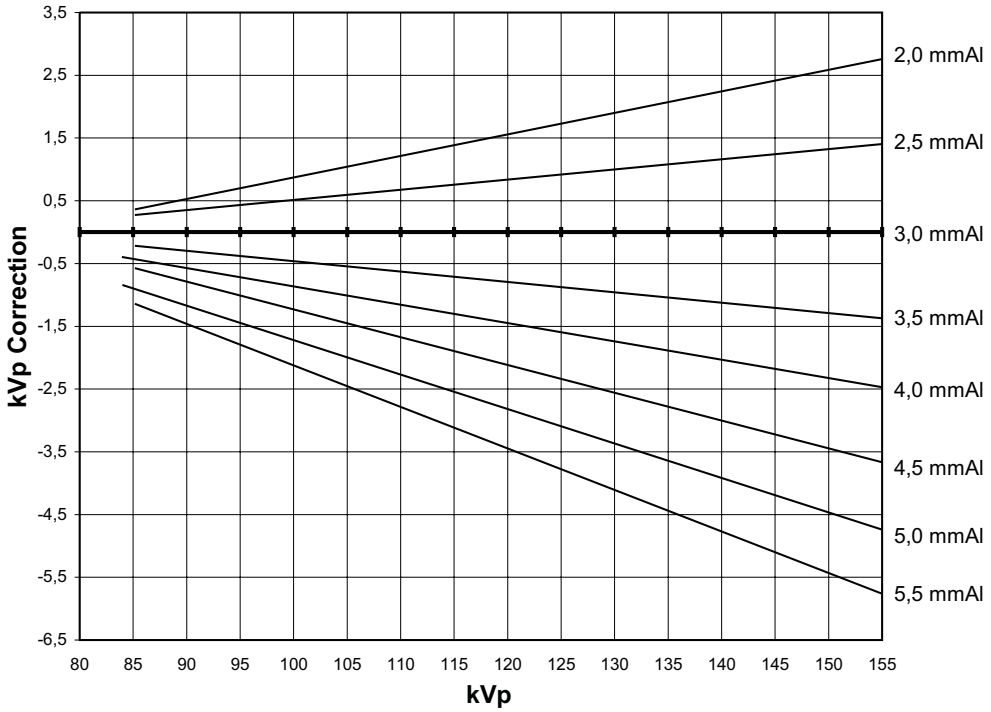
Assume the following: Read kVp value in the PMX-III display = 83,5 kVp and “Fi.1”.Known total filtration = 4,0 mm Al.kVp correction from graph #1 = -1,6 kVp.True kVp = 83,5 - 1,6 = 81,9 kVp.

7.4 KVp Correction Graphs

7.4.1 Radiographic - CA-1, 2.0-5.5 mm Al

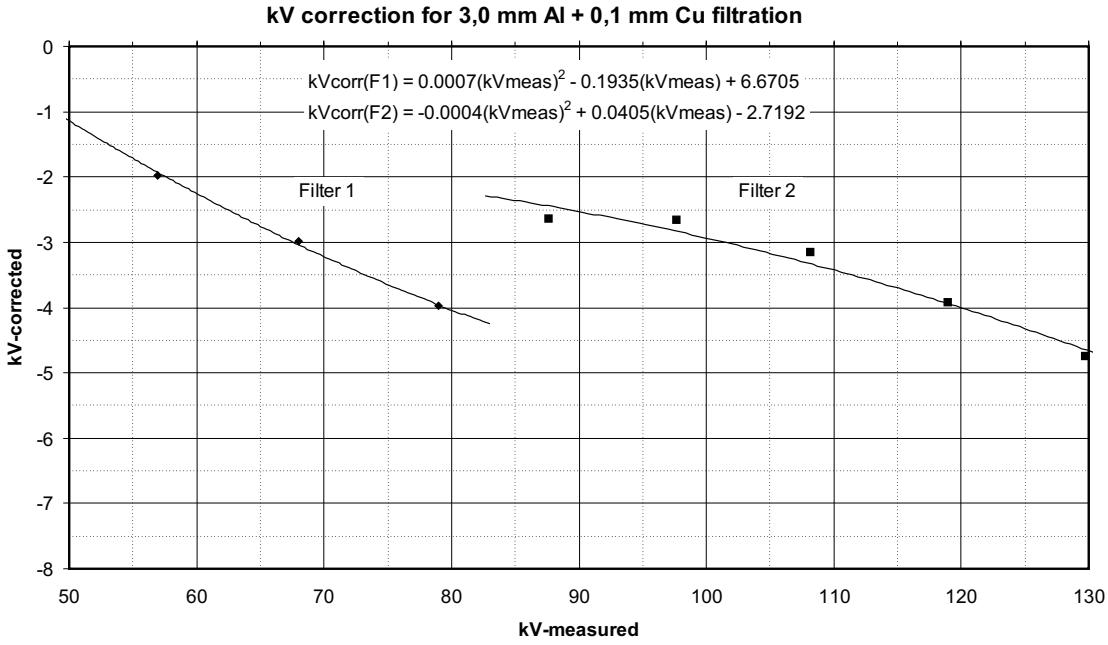


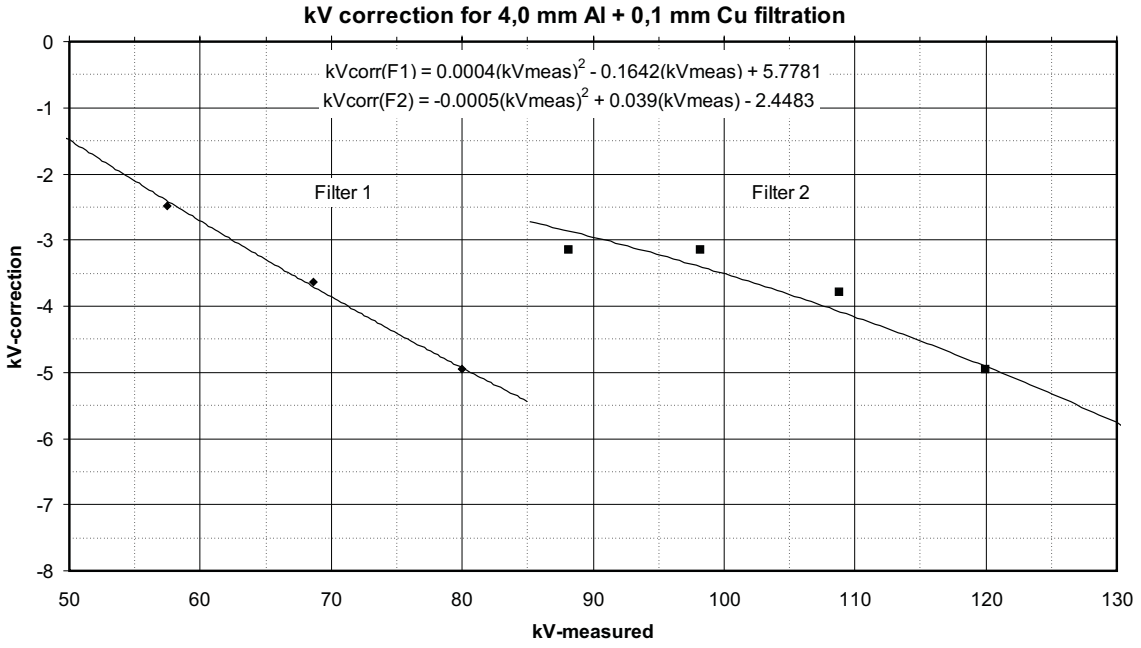
kVp corrections for different filtrations in the range 45 - 90 kVp, i.e. for **FILTER 1**

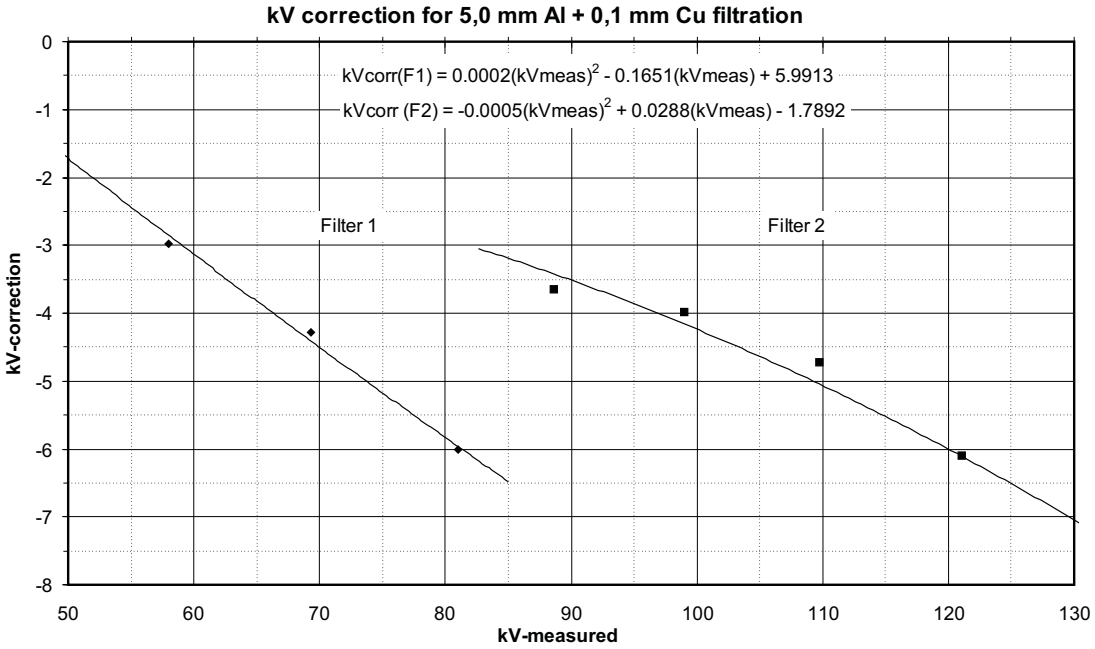


kVp corrections for different filtrations in the range 85 - 155 kVp, i.e. for **FILTER 2**

7.4.2 Radiographic CA-1, 3.0, 4.0, and 5.0 mm Al+0.1 mm Cu







EXAMPLE:

Read kVp value on the PMX-III display = 100.0 kV

Read filter pair on the PMX-III display = Fi:2

Known total filtration = 4 mm Al + 0,1 mm Cu

kVp correction from the graph or from the equation above = -3.5 kV

True kVp value = 100.0 - 3.5 = 96.5 kV

Please note that the absolute accuracy for each instrument is stated in the kVp calibration record. The inaccuracy of the correction graph information is less than ±3 %.

8 PRECAUTIONS AND MAINTENANCE

8.1 Safety Rules

- The PMX-III family of kVp meters is intended for service and quality control of diagnostic X-ray equipment. It is not intended for use during or together with diagnostic examinations of patients.
- RTI Electronics AB takes no responsibility for misuse of any instrument of the PMX-III family or use together with instruments that the PMX-III family is not intended for.
- RTI Electronics AB assumes no responsibility to customers not following these safety precautions.
- Only authorized personnel are permitted to open the instrument.

8.2 Precautions

- Do NOT exceed the DC input limits specified (max. 15 V).
- Remember to make all connections when the power is off.
- Do NOT expose the instrument to direct sunlight, extremes of temperature and humidity, or dew fall.
- Do NOT input any voltage signal to the electrometer terminals.
- Do NOT use the AMP-1 with a current source higher than 1 μA.
- Be carefully NOT to hold the PMX-III only by the AMP-1 itself.
  You may break the back panel or connectors on the PMX-III/AMP-1.
- Do NOT use the AMP-1 and the AMP-1 ADI without using the existing two knobs to fasten the parts together.
- Do NOT make battery replacement or change BRB-1 with the power switch set to ON position.
- Do NOT use the old external serial interface cable with two 9 pin connectors.
- Do NOT select gain 1 or 2 on the PMX-III electrometer when AMP-1 ADI's is used. AMP-1 only uses gain 3 on the PMX-III electrometer.
- Avoid to expose the AMP-1 to high dose rates. Especially when the P1 or P2 ADIs is used. Put only the detector in the field in in this case to minimize the risk of self ionisation inside the AMP-1 that may effect the very sensitive electrometer. When normal ADIs are used the AMP-1 electrometer is not activated and therefore the above situation is not relevant.
- Carefully insert power detector plug into PMX meter to avoid damage of measuring pin, also, when removing, do not pull the cable but move the plug housing backwards.

Do NOT try to adjust the offset level on the AMP-1. This should only be done by authorised service personnel.

8.3 Maintenance

- Remember to take out the batteries, to avoid leakage, if the instrument is not to be used for a longer period of time.

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. Clean the top panel and front panel with a mild solution of detergent and water.

9 Notes and Reports

9.1 Application Notes Related to PMX-III

Name and Issue Date	Description	Included
5-AN-52003-19 September 1998	Shortform Detector Selection Guide	Yes
5-AN-52003-18 September 1998	Dosimeter Ranges for PMX-III Used with the Dose Detectors R25 and R100	Yes
03-017/01 December, 1996	Typical energy correction for R25 and R100 when measuring with Cu filtration	Yes
03-016/01 October, 1996	Extended graph for HVL-Total filtration conversion	
03-015/01 September, 1996	Maximum mA Settings at Different kVp When Using the R25 or R100 Dose Detector with PMX-III	Yes
03-014/01 September, 1996	Measurements of luminance using the L100/M light Detector	
03-011/01 November,1994	Quality control of automatic exposure control (AEC) system	
03-010/01 September, 1994	Energy corrections factors for the R100 solid state detector	
03-009/01 March, 1994	HVL measurements using the PMX-III kit	
03-006/01 March, 1993	HVL-total filtration conversion in oRTIgo PMX	

For a complete list of application notes, visit our web page www.rti-e.se.

Please observe that useful detector information also is include in the red calibration record envelope that is delivered with each PMX-III.

Standard calibrations and measuring ranges with PMX-III

Type	ADI code	Beam Quality	Typical use	Typical rate range with PMX-III	
R25	7/A	50-150 kV, W/23 mm Al	Film dose & dose rate	4,0-185000 [A] µGy/s r1: 4,0-1850 r2: 250-18500 [A] r3: 2000-185000 [A]	0,027-1260 R/min r1: 0,027-12,6 r2: 1,64-126 r3: 13,7-1260
R25	7/AP1	50-150 kV, W/23 mm Al	Image I. dose rate input	0,120-18,4 µGy/s	13,7-2100 µR/s
R25	7/AP2	50-150 kV, W/23 mm Al	Image I. dose rate input	0,40-185 µGy/s	46-21000 [A] µR/s
R25	7/B	50-150 kV, W/3 mm Al	Skin dose & dose rate	0,004-185 mGy/s r1: 0,004-1,85 r2: 0,25-18,5 r3: 2,0-185	0,027-1260 R/min r1: 0,027-12,6 r2: 1,64-126 r3: 13,7-1260
R25	7/D	25-35 kV, Mo/30 µm Mo	Skin dose & dose rate (breast)	0,008-370 mGy/s r1: 0,008-3,7 r2: 0,5-37 r3: 4,0-370	0,055-2520 R/min r1: 0,055--25 r2: 3,3-252 r3: 27,4-2520
R100	8/A	50-150 kV, W/23 mm Al	Film dose & dose rate	1,0-46000 [A] µGy/s r1: 1,0-460 r2: 60-4600 r3: 500-46000 [A]	0,007-315 R/min r1: 0,007-3,15 r2: 0,41-31,5 r3: 3,4-315
R100	8/AP1	50-150 kV, W/23 mm Al	Image I. dose rate input	0,030-4,6 µGy/s	3,3-525 µR/s
R100	8/AP2	50-150 kV, W/23 mm Al	Image I. dose rate input	0,10-46 µGy/s	11-5250 µR/s
R100	8/B	50-150 kV, W/3 mm Al	Skin dose & dose rate	0,001-46 mGy/s r1: 0,001-0,46 r2: 0,06-4,6 r3: 0,5-46	0,007-315 R/min r1: 0,007-3,15 r2: 0,41-31,5 r3: 3,4-315
R100	8/D	25-35 kV, Mo/30 µm Mo	Skin dose & dose rate (breast)	0,002-92 mGy/s r1: 0,002-0,92 r2: 0,12-9,2 r3: 1,0-92	0,014-630 R/min r1: 0,014-6,3 r2: 0,82-63 r3: 6,85-630
L100	6/U	Luminance, MON adapter	Film viewing box CRT [B]	0,5-23000 [A] cd/m^2 r1: 0,5-230 r2: 30-2300 r3: 250-23000 [A] 0,05-1000 cd/m^2	
L100	6/Y	Illuminance, diffuser	Ambient light levels	0,25-4000 lx r1: 0,25-40 r2: 5-400 r3: 45-4000	
MAS-1	5	Invasive mA and mAs	mA and mAs	0,10-2000 mA r1: 0,1-20 r2: 3-200 r3: 25-2000	
MAS-2	4	non-invasive mA & mAs	mA and mAs	50-2000 mA	
MAS-3	J	non-invasive mA & mAs	mA and mAs	0,10-2000 mA r1: 0,1-20 r2: 3-200 r3: 25-2000	

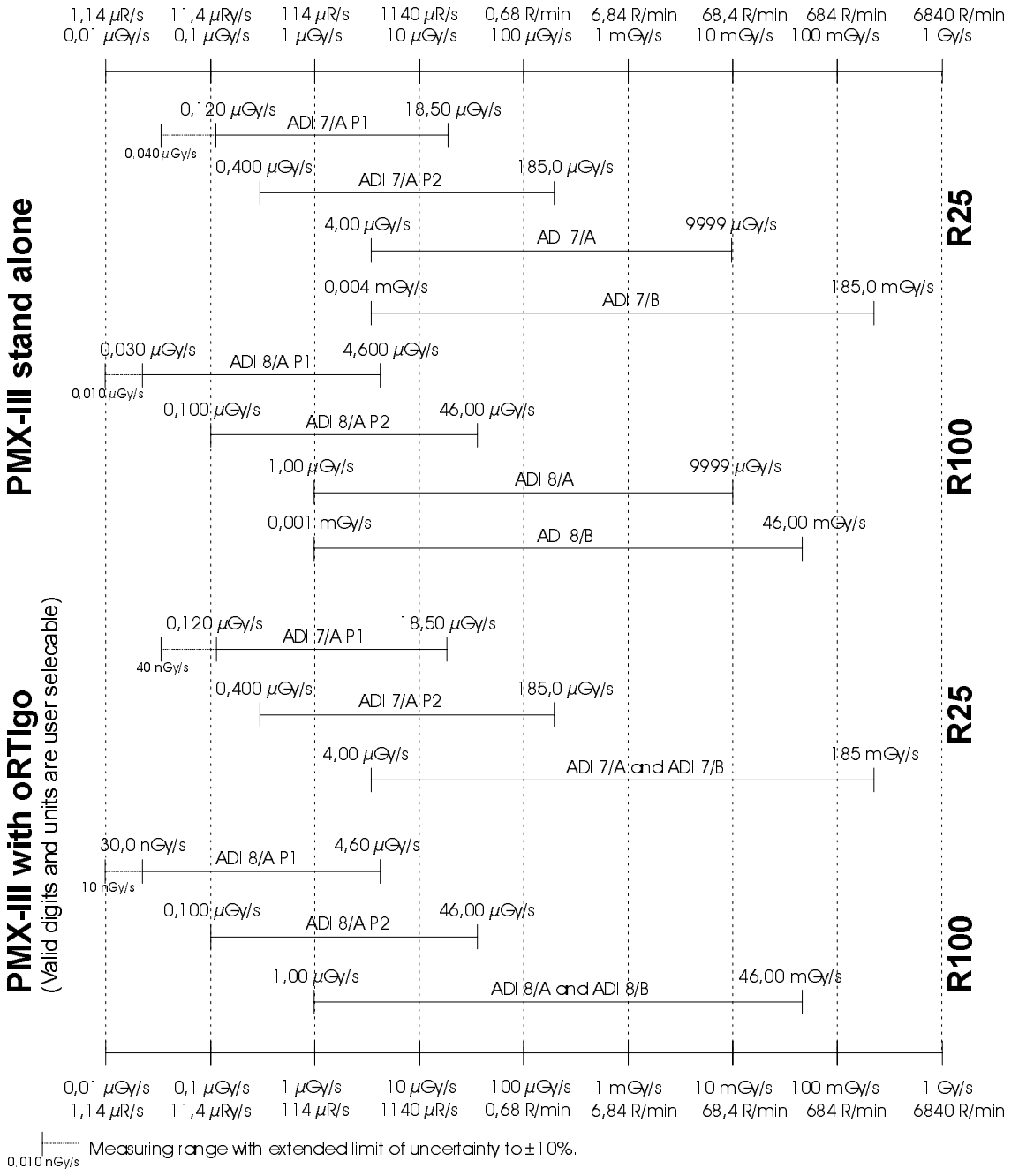
Special mammographic calibrations

R25	7/(E)	22-40 kV, Mo/25 µm Rh	Skin dose & dose rate	Same as for 7/D
R25	7/(F)	25-46 kV, Rh/25µm Rh	Skin dose & dose rate	Same as for 7/D
R25	7/(I)	25-40 kV, Rh/1,0 mm Al	Skin dose & dose rate	Same as for 7/D
R25	7/(J)	23-35 kV, W/50 µm Rh	Skin dose & dose rate	Same as for 7/D
R100	8/(E)	22-40 kV, Mo/25 µm Rh	Skin dose & dose rate	Same as for 7/D
R100	8/(F)	25-46 kV, Rh/25µm Rh	Skin dose & dose rate	Same as for 7/D
R100	8/(I)	25-40 kV, Rh/1,0 mm Al	Skin dose & dose rate	Same as for 7/D
R100	8/(J)	23-35 kV, W/50 µm Rh	Skin dose & dose rate	Same as for 7/D

[A] Note that the PMX-III display can not show higher values than 9999. With oRTIgo also higher rate values can be shown.
[B] When measuring on CRTs, the measuring range depends on the frequency and the after glowing time in the phosphors. The table shows a typical range.

The dose detectors R25 and R100 used with the PMX-III electrometer

The figure below shows the measuring ranges for PMX-III used together with the dose detectors R25 and R100. Ranges with the ADI modules 7-8/AP1, 7-8/AP2, 7-8/A, and 7-8/B are shown. For PMX-III stand alone measurements the shown units are the same as the PMX-III uses. Also the values are shown with the PMX-III display resolution. Note that when oRTIgo is used, the ranges and the resolution are increased for some ADI modules. That depends on that the PMX-III display can not show higher values than 9999, and no more digits than four. With oRTIgo the resolution, unit, and number of digits can be selected by user.



R100 — Typical Energy Correction — 8/A

kV	Cq
50	0,929
55	0,956
60	0,977
65	0,991
70	1,00
75	1,005
80	1,007
85	1,007
90	1,005
95	1,002
100	0,999
105	0,996
110	0,993
115	0,991
120	0,990
125	0,990
130	0,991
135	0,992
140	0,994
145	0,997
150	0,999

Application: Image Intensifier and Low Dose/Rate Measurements
kV range: 50-150 kV
Reference point: 70 kV
Anode: W
Filtration: 3 mm Al + 20 mm Al
3 mm Al + 1,5 and 2,0 mm Cu

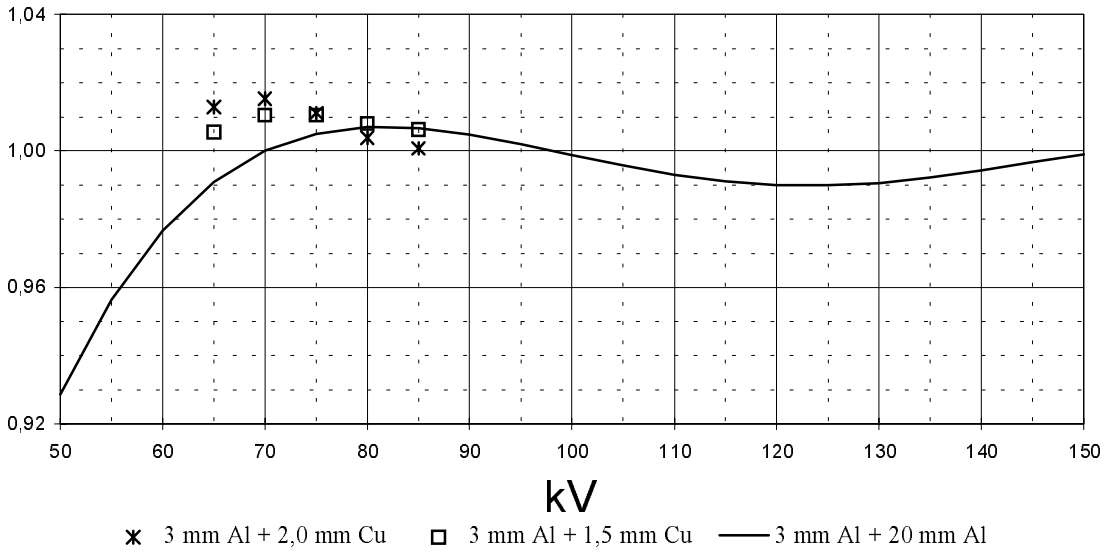
3 mm Al + 1,5 mm Cu	
65	1,006
70	1,010
75	1,011
80	1,008
85	1,006
3 mm Al + 2,0 mm Cu	
65	1,013
70	1,015
75	1,011
80	1,004
85	1,001

Example:
Measured or set kVp = 60 kV
Measured dose = 0,50 mGy
Correction factor Cq = 0,977 for 60 kV
Corrected dose = 0,977 x 0,50 = 0,49 mGy

Inaccuracy:
The inaccuracy of the typical correction factor is less than ±4 %.

Note:
Check your manual to verify when you have to do the correction manually.

Typical Correction Graph



• **End** •

Introduction

The PMX-III electrometer has an upper limit when measuring dose rate. For the dose value, the limitation is the upper display limit for the PMX-III. For example the upper limit for the rate is 2300 nA, which corresponds to around 180 mGy/s (1200 R/min) for R25, and around 45 mGy/s (300 R/min) for R100. The limitation for the display of the dose value is 9999 mGy (9999 R) for both R25 and R100. While the dose in most applications is not that high, the dose rate sets the limitation when measuring with the PMX-III.

When selecting between an R100 and an R25, one also has to have in mind that the R100 is about four times more sensitive than R25. That means that one can measure lower dose rates, which can be of advantage, for instance when measuring image intensifyer entrance dose rate. In most cases the sensititvity of R25 will be enough. Table 1 shows the dose rate ranges for PMX-III version 5.2 with the preamplifier AMP-1, and R25 or R100.

Table 1. Dose rate ranges for PMX-III version 5.2. The lower limits are valid for AMP-1 (P1) and free run mode.

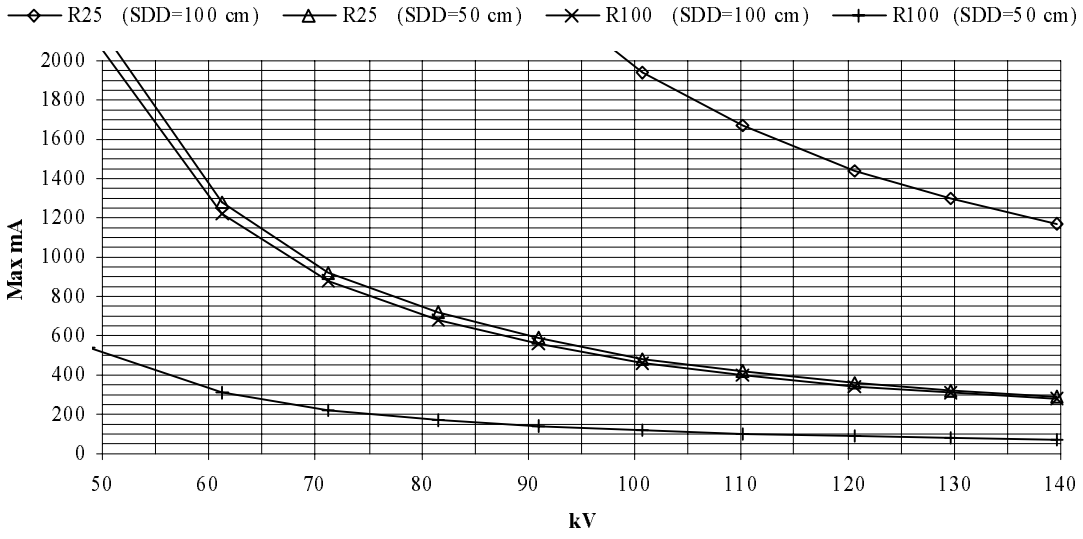
R25	R100
40 nGy/s - 180 mGy/s	10 nGy/s - 45 mGy/s
4.5 μR/s - 1200 R/min	1.1 μR/s - 300 R/min

Maximum mA and kV for different source to detector distance

The dose rates mentioned above is corresponding to a mA and kV value, under conditions that no other changes are made in the measuring geometry. The table and figure below show typical values for a 3-phase, 12-pulse generator, operating under normal conditions. The values are valid for a total filtration of 3 mm Al.

Table 2 and Figure 1. Upper limit for set tube current at different kV and SDD, when measuring with PMX-III and the dose detector R25 or R100. The values are valid for a 3 phase, 12 pulse generator, tungsten target, and a total filtration of 3 mm Al.

Tube Potential	Typical mA limit for overflow in the PMX-III electrometer			
	R100 (SDD=50 cm)	R100 (SDD=100 cm)	R25 (SDD=50 cm)	R25 (SDD=100 cm)
50 kV	540 mA	2100 mA	2300 mA	9000 mA
60 kV	310 mA	1200 mA	1300 mA	5100 mA
70 kV	220 mA	880 mA	920 mA	3700 mA
80 kV	170 mA	680 mA	720 mA	2900 mA
90 kV	140 mA	560 mA	590 mA	2400 mA
100 kV	120 mA	460 mA	480 mA	1900 mA
110 kV	100 mA	400 mA	420 mA	1700 mA
120 kV	90 mA	340 mA	360 mA	1400 mA
130 kV	80 mA	310 mA	320 mA	1300 mA
140 kV	70 mA	280 mA	290 mA	1200 mA



9.2 Problem report

Issued by: _____ Date: _____
Name:_____
Company/Hospital: _____
Address: _____
Country: _____
Phone: _____ Telefax: _____
E-mail: _____

---

oRTIgo software version: _____ PMX-III version: _____
Instrument type: _____ Serial No: _____
Trig detector type: _____ Serial No: _____

Generator settings

Generator type: _____
kVp: _____ mA: _____ exposure time: _____

Describe the type of problem as thoroughly as possible. Also describe mode and settings of the instrument and program when the problem occurred.

_____
_____
_____
_____
_____
_____
_____
_____
_____

For RTI use only

Date received: _____

Handled by: _____ Date: _____

Description:

_____
_____
_____
_____

10 HINTS AND TROUBLESHOOTING

10.1 Hints

10.1.1 General Info

Where can I find general Information about QC measurements?

RTI has published the "MANUAL FOR X-RAY NON-INVASIVE ROUTINE CONSTANCY TESTS" The manual should be used as a guide for how practical Quality Control should be made. Contact your local dealer or contact RTI directly to order your own copy.

How do I insert and remove the detector and extension cables?

Carefully insert the probe plug into the PMX III meter to avoid damage of the measuring pin. Also, when removing, do not pull the cable but pull the plug housing .

10.1.2 oRTIgo Measurement

General hints:

A) Always use the power adapter when communicating with a PC. The PMX-III drains much more power and sooner or later the battery level starts to be to low during communication otherwise.

B) Low power battery mode and other programs that runs simultaneously on the PC are typical sources for communication errors. PMX-III use a special designed high speed communication protocol optimized to read waveform data quickly and are therefore more sensitive to have full access to the communication port all time.

C) In general Windows 95 works to run oRTIgo in a DOS windows,Windows 3.11 not.

I did not see any way of recording dose rate information (apart from kV measurement). Can oRTIgo do that?

Yes, oRTIgo can read dose rate information continuously, you have to use a template based on the use PMX-III in dosimeter mode.You have to press "INS" to start/stop the transfer to the oRTIgo template.

Please also observe that it is possible to store the whole dose rate waveform using the R25/R100 alone in the field by using the waveform analyzer and select to measure with the electrometer alone.

It is difficult to use the PMX- III by the end user, the user-interface software requires a redesign (for each measuring parameter one button).

It already exists: F2 to F7. The user can select the title for each template. Version 3.0 is more user friendly than ever. Take a look in chapter 6 for the new features.

Is it possible to build a template without the PMX- III connected?

Yes, you should not have communication on during building new or modify old templates (press ctrl-R to toggle on/off) if you want to have maximum speed. oRTIgo accept inputs from the keyboard so the templates can be tested that way in many cases. We recommend making changes to existing templates before building new ones. Please observe that is possible to add measurement values or check list in oRTIgo templates that not only are uploaded from PMX-III by the serial port. These values can be input directly from the keyboard.

10.2.1 Dose Measurements

How to correct for filtration when I measure standalone with ADI 8/A, or 8/A(P1) or 8/A(P2) what is the correction factor to measuring with filtrations: Could you supply me with an application note for different filtrations?

The detector calibration record that have been delivered with each PMX-III system have basic energy corrections for different beam qualities. In general R25/R100 have very little energy dependence in the radiographic range 60-150 kV Application note for other filtration are available as application note. Please find the most relevant notes list as today, the note 03-10, 03-17 should address the question regarding R100. You can find these
application notes on the RTI web page. (http://www.rti-e.se)

Can I perform HVL measurements with 8B and 2,5/5,0 and 7,5 mm Al. How do I make correction in this case?

See leaflet “DETECTOR DATA R100 ver 9602” and your detector calibration record that have been delivered with each PMX-III system. For some kV setting up to 8 mm Al can be measured.

If no ADI is connected the valid choices for dose measurements are: Ch.Cu or User". What does it mean?

Ch.Cu indication: See page 5-12 and 5.13 in the reference manual Without ADI PMX-III indicates that it measures charge Ch (in nC) or Current Cu (in nA) in the display instead of dose and dose rate. This can be very handy if the user wants to know the real charge and current value from the detector.”User” means that the instrument is using a “User” conversion factor for the dosimeter reading, see 5.72 page 5-41 in the reference manual.

When measuring doserate level of 2 µGy/s with ADI-8A/P1, what’s the total inaccuracy of the measurement, do I have to add the inaccuracy of the AMP-1 to the tolerances mentioned in reference manual page 7-10, dosimeter specifications?

First of all the inaccuracy mentioned in the reference manual addendum includes the PMX-III and the R100 inaccuracy. Secondly our inaccuracy definition includes the random error see PMX-III reference manual page 7-2, 7.1 .

Without the indication of units of measurement, it is difficult to tell what you are measuring. The decimal point is especially a problem (in concert with the colon that indicates dose rate).

After the measurements the correct dose and dose rate unit is shown for a while with alternating display. You can always press the dose or rate knob to read the correct unit.
In dosimeter mode, the user can also press the DOSE or RATE knob during the exposure to see the unit without disturbing the measurement. Both dose rate and dose are “hold in the display after the measurements so it is easy to read afterwards Please note that unit µGy/s have been selected for all three ADIs 8/A(P1),8/A(P2) and 8/A (compared before the unit could be nGy/s, µGy/s and mGy/s). An alternative is to use oRTIgo where we have better user interface. In oRTIgo the user can select whatever dose unit he wants presented.

Because of the lead backing, the R25/R100 is less sensitive to backscatter and consequently will read doses 10-15% lower (10 mm distance from probe to II). This may cause a problem with VA inspectors. Do we now calibrate to 10% lower doses as opposed to those measured via ionchambers?

The R25/R100 is correctly calibrated free in air (Air-Kerma (see calibration record) and measures without the risk that different scattering material can affect the reading in an uncontrolled way (due to its built in lead backing feature). The back-scattering from the I.I. to an Ion chamber gets therefore an incorrectly higher dose value than measured with R25/R100. If instead the detector types are compared free in air far away from scattering material you should see that they show the same reading. RTI believes that the correct value that should be measured is the value without back scattering. The user has to decide if they should correct the readings with ion chambers or add approximately 10 % to the R100/ R25 value. The RTI method has the advantage that it is insensitive to position, distance, and material variations.

ADIs included in the kit are three ADIs marked 8A. Two of which are marked 8A(P1) and 8A(P2). Since the differentiation is in parenthesis and these two are not attached to the chain, there is a possibility to use the 8A on the chain and as a result, get no fluoro dose readings.

Correct, but the PMX-III system checks and alert you the detector code in the display when you press Reset so you can verify if you put the correct ADI in. And furthermore for the AMP-1 ADI´s you can very easily determine that you have one by reading directly on the ADI´itself and knowing that a AMP-1 ADI always have extra small tags on it to activate AMP-1.Furthermore, in oRTIgo the program automatically checks if you have selected the correct ADI comparing the old data in the measurement template. If this is the case you get a warning and you can then change the ADI to get the correct one. It is also possible in the oRTIgo to read out the detector and calibration information from the ADI.

The use of the different ADIs is confusing and not user-friendly when a lot of ADIs must be used. Is it possible to use one ADI for most of our measurements?

Yes, a ADI-Multi module exist as an option that stores up to six detector calibration data. See the picture below .Comparing to have several instruments and dose detectors with different detector calibration factors stored all over the place is an even worse situation. The reason we introduced he ADI was after we had tried the other alternatives. Furthermore to avoid user mistakes with wrong units the ADI is actually a very good approach. An extra bonus is that the instrument or detectors can be exchanged out in the field as long the ADIs and detectors are exchanged at the same time.

The range switches by using the ADIs are not always working correctly.

Listen to a “click” when mounted and use the two screws to fix the ADI to AMP-1 to secure it, so it cannot fall of. The ADI Multi box eliminates the problem of mounting the ADI incorrectly.

10.2.2 Questions on kV Measurements

kV measurements cannot be made if any filtration (other than intrinsic X-ray tube filtration) is in the beam. We had a 1.5 mm copper plate in the beam and the PMX refused to do any measurement until kV set reached 75 kV set reached and then the PMX measured 91,4 kV.

Not true, see The kV corrections for total filtration can be found both in chapter 7 and in PMX-III refernce manual chapter 4.8 page 4-43 to 4-48. If oRTIgo is used it is possible to automatically correct for the correction graph on page 4-47 (CA-1) in the program itself. For other filtration's a special calibration can technically be done but not a part in the PMX-III basic package. No kV meter can measure with an extra 1.5 mm Cu added (approx 25 mm Al) without use of corrections.

Setting the PMX upside down with the dose probe attached is awkward, invariably the kV detectors are at a slight angle to beam. Is this a problem?

We have a commercial solution which is the HVL stand and use the bottom plate for this. This stand can be used to hold the R 100 detector as well during the II measurements. The probe holder extension supplied can also be used to make space for the dose detector.

10.2.3 Light Measurements

Supply the lightprobe with a protection cap, which will also secure the screw.

Yes, it is now included. Now the dose detector has a protection bag as well

We like to use the light measuring probe also for measurements on the monitor and on light boxes

Please study the "Short form Detection Guide" in the first chapter of this manual. RTI has several light meter probes. The existing L100 can be used, only a monitor tube and rubber ring in two

sizes and an extra ADI 6/U most be ordered to be able to measure CRT monitors and film viewing boxes correctly. A special monitor adapter with built in shutter have been made for very easy measurement of monitor luminance frequency, and light waveform.

10.2.4 General Questions

The inversion of the display for an inverted (turned over) PMX is flaky. Spontaneously it will flip over again leaving the display to read the data upside down again. Additionally, if you take care and gently turn the unit over, it will not detect the inversion and flip the display over. When unit auto powers off when upside down, when turned on again, display does not invert.

Little training helps. It is possible to change a wrong reading by quickly flip the PMX-III little back and forward. It is also possible to disable the “position detection”, see page 4-52 4.9.4 in the reference manual.

Is it possible to switch off the power saver of the PMX-III in dosimer mode?

For version 6.0 the power saver is disabled.
For earlier versions the PMX-III goes to power down mode after 2 minutes of inactivity (no value above trig level) and “0000” is displayed. Press any key to wake up PMX-III.
Selecting “Free” running mode makes the instrument to be ON until the user Power down the instrument.

Do not connect ADIs on the cable chain of the detectors, use the storage room in the foam.

Agree, select only the ADI you normally use. If the EXT-1 extension cable should be used then the best way is to have the ADI stored separately or buy the ADI Multi box.

10.2 Troubleshooting

The kVp value measured with PMX-III seems to be wrong

A)
The total filtration in front of the PMX-III is considerably larger than 2-5 mm Al. If this is the case, the kVp-value will be higher than expected. You must make a kVp correction (Chapter 7)
B)
The PMX-III kV sensor area is not fully radiated.
C)
The PMX-III kV sensor area is not uniform radiated

When measuring kVp always get the display code Sh.E (Short exposure time). Why?

The exposure time is to short (normally less than 50 ms) for the PMX-III to automatically select kV and filter range within the time. Increase the exposure time or change to manual LOCK mode to take control of settings of PMX-III. KV values can then be measured down to a few ms.

The exposure time seems to be wrong.

A)
The radiation exceeds the trig level only a short peidod of the total exposure time. Most frequently also display code **Sh.E** is shown. To avoid that select manual LOCK mode
B)
Use the BNC ouput to check how the radiation waveform look like to be sure
C)
The exposure is pulsed with periodic time longer than 25 ms. PMX-III interprets this as a series of exposures. To be able to measure the total exposure time use the oRTIgo waveform analyzer in this case.
D)
Low tube current, A low tube current often results in a long fall time of the kV-curve, if there are long high voltage cables between the generator and the tube, This is normal.
E)
For very short exposure times, (shorter than 5 ms) use the oRTIgo waveform analyzer to study the radiation and kVp waveform and determine the exposure time from the waveform itself.

It seems that the light value measured with L100 is wrong.

Make sure that the reset have been made with no signal on the detector.

I get HI.SI. in the display when I connect the ADI.'s for the pre amplifier.

A few picoAmpere current spike can create a doserate overflow that set the dose display indication to show HI.SI.This situation can typical happen when the user connect or change to detector & ADI with power on and the preamplifer circuitry at the same time is activated. Press **RESET** to clear.

PMX-III is not indicating any value when measuring kVp, howcome?

A)
The PMX-III is not placed in the X-ray beam
B)
No radiation from the X-ray tube, e.g the collimator complety closed or wrong tube selected.
C)
Too low intensity, check the kVp sensitivity graph (Chapter 7)
D)
Wrong TUBE/FILTER combination. Press F4 to select CA:5 (mammo Mo/Mo 30 µm , 23- 35 kV) or CA 1 (rad W/Al 3.0 mm 45-155 kV) or press the TUBE/FILTER button to select manually.

Why is PMX-III sometimes measuring dose-rate and sometimes measure dose as default when power up in dosimeter mode. Also the default unit sometimes changes.

This is normal. This is controlled by the ADI, to best suit the application situation.

**When I select "Free Run" in dosimeter mode to be able to measure very low dose-rate levels I get a "-" indication sometimes in the display to the left.
I have pressed the "RESET" several times but it is still there.
Is this normal?**

Yes, this is just an indication of that the dose rate level is very near zero or little negative. When using oRTIgo the "-" sign is not displayed.

10.3 Save EEPROM and ADI data

10.3.1 Backup of internal EEPROM and ADI Modules

Prepare an empty formatted diskette. Insert the diskette in drive A. Make the oRTIgo directory to active directory. Power on PMX and wait until the start-up procedure is completed. Connect the interface cable between PMX and the computer.

1. Click on the icon Save EEPROM if you use Windows.

Or, if you use DOS,

To start the backup program, type

SAVEEPR5 <Enter>

2. If the communication is OFF LINE, move cursor to “Init Com” and press <Enter>.

3. If necessary change the path (should be “A:\”). Move cursor to “Path” and press <Enter>. Choose “Path for EEPROM data files” and enter “A:\”.

4. Move cursor to “EEPROM” and press <Enter>.

5. Move cursor to “Save EEPROM data on disk” and press <Enter> again.

The data in the internal EEPROM is saved in a file. The file is stored on the diskette in drive A. The filename will be generated automatically. The format is “0XXXX.EEP”, where “XXXX” is the serial number of the PMX. If the file exists, the old file will be overwritten.

Note that backup of the non-volatile memory must be repeated after a re-calibration of kVp.

Now continue with the ADI modules. If the communication is OFF LINE, move cursor to “Init Com” and press <Enter>. To store the data in the ADI module:

6. Connect the ADI module.

7. If necessary change the path. Move cursor to “Path” and press <Enter>. Choose “Path for ADI data files” and enter “A:\”.

8. Move cursor to “ADI” and press <Enter>.

9. Move cursor to “Save ADI data on disk” and press <Enter>.

10. Repeat from Step 6 for all ADI modules.

The data in the ADI module is saved in a file. The file is stored in the directory specified by current ADI data path. The filename will be generated automatically. The format is “XYYYYZQQ.ADI”.

Where

X	is the detector code (see Detector Data)
YYYY	The serial number of the detector
Z	Beam quality code (see Detector Data)
QQ	Version number

If the file exists, the old file will be overwritten.

Remove the diskette and put it in a safe place. The installation procedure is now completed. Leave the backup program with “Quit”. Read section 1.4 and 1.8 in the oRTIgo User’s Manual.

Note that backup of the ADI must be repeated after a re-calibration of the corresponding beam quality.

10.4 Restoring data from backup

Under unpredictable conditions it may occur an “Er. 30" message on the PMX-III display. If that occur PMX-III has encountered a problem with the content of either the internal EEPROM or the connected ADI. To determine the source of error power of PMX-III after an ”Er. 30" message and restart without any ADI module connected. If the “Er. 30" message remains the problem is in the PMX-III internal EEPROM.

The software allows you to restore the content in a file after an “Er. 30” in the PMX-III or an ADI module or loss of an ADI module.

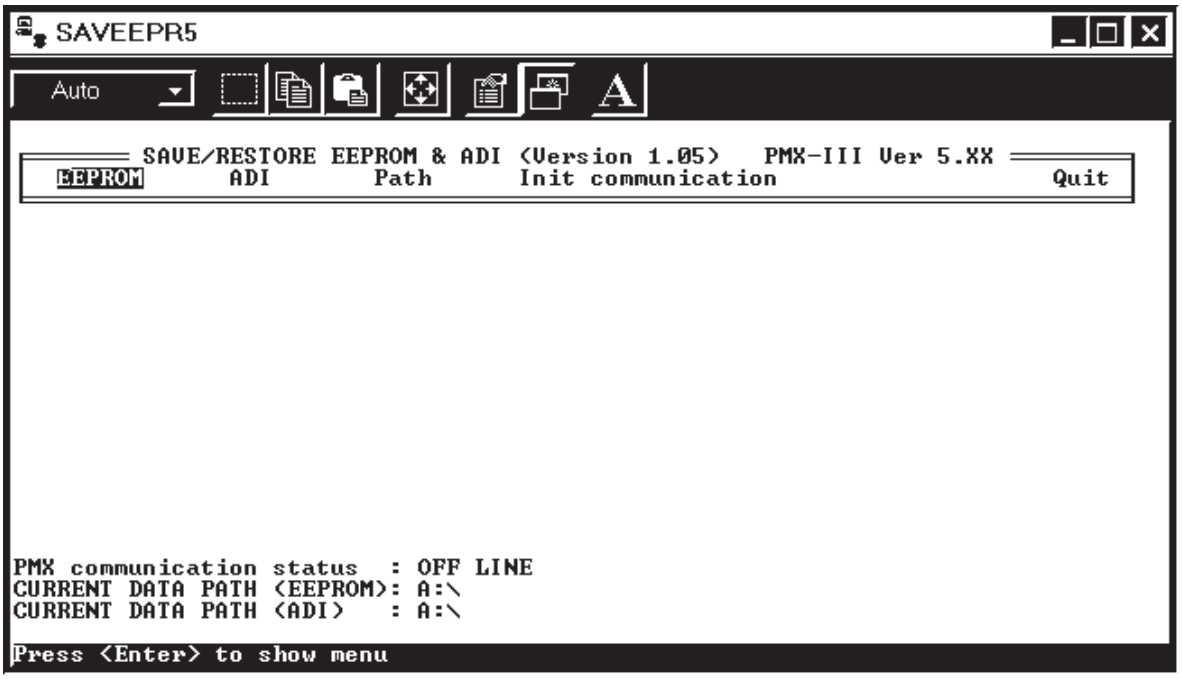
10.4.1 Restore the content of PMX-III internal EEPROM

Power on the PMX and wait for the start-up procedure to finish or until “Er. 30” is displayed. Connect the interface cable between PMX and the computer. Do not connect any ADI module. Insert your diskette with backup data in drive A.

To restore the content of the internal EEPROM:

1. Click on the icon Save EEPROM if you use Windows.

Or, if your use DOS,
Make the oRTIgo directory to the active directory and type
SAVEEPR5 <Enter>



If necessary change the path. Move cursor to “Path” and press <Enter>. Set “Path for EEPROM data files” to “A:\”.

2. Move cursor to “EEPROM” and press <Enter>. Use the arrow keys (not mouse).

3. Move cursor to “Restore EEPROM data” and press <Enter>.

4. You will be asked if you want to continue. If you are sure answer “Y”

or “y”.

5. You are now asked to enter the serial number of the PMX. Note that you must enter four digits. If the serial number for example is 355 enter “0355”.

6. The data will be read from the directory specified by the EEPROM data path. When the data is read it will be programmed into the PMX. That will take approximately 100 seconds. When the EEPROM is programmed it will be verified.

7. If data is correctly programmed the message “Data is OK” is displayed. Press any key...” will be displayed. Press any key.

The EEPROM in the PMX-III is now programmed. Disconnect the interface cable and restart the PMX to verify that the “Er. 30” message is removed.

You can also choose “Reset PMX” from the menu to restart the PMX.

Restore the content an ADI module

Power on the PMX and wait for the start-up procedure to finish. Connect the interface cable between PMX and the computer. Connect the ADI module. Insert your diskette with backup data in drive A.

1. Connect the ADI module with “Er. 30” problem.

2. If necessary change the path. Move cursor to “Path” and press <Enter>. Set “Path for EEPROM data files” to “A:\”.

3. Move cursor to “ADI” and press <Enter>.

4. Move cursor to “Restore ADI data” and press <Enter>.

5. You will be asked if you want to continue. If you are sure answer “Y” or “y”.

6. You are now asked to enter the filename. Enter the filename including the extension and finish with <Enter>.

7. The data will be read from the directory specified by the ADI data path. When the data is read it will be programmed into the ADI.

8. When the ADI module is programmed the message “The ADI module is now programmed. Press any key...” will be displayed. Press any key.

The ADI module is now re-programmed. Disconnect the interface cable. Connect the ADI module to the PMX-III and restart to verify that the “Er. 30” message is removed.

You can also choose “Reset PMX” from the menu to restart the PMX.

INDEX

!

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

Q

R

S

T

U

W

Addendum to PMX-III Reference Manual PMX-III

Introduction

Primary goal for the new version

Improvements have been done since PMX-III version 5.2 to simplify routine measurements and make PMX-III user-friendlier. The main objective with the new version of PMX-III firmware is to simplify some measurements done manually. An automatic hold-function is now included. This means that both dose and rate can be read on the display after the exposure has finished until next exposure.

Better supports of low level dose rate measurements and light measurement have been added.
PMX-III ver 6.0 is adapted to the new field applications as monitor test and checking pulsed fluoro units,

A change in the waveform analyser have made the oRTIgo very powerful to collect low level dose-rate waveforms and monitor light output. Dose/frame, number of frames/s and monitor frequency can be calculated automatically

This PMX-III version 6.0 should be used with oRTIgo version 3.0 and PMX-III firmware 6.0.

New documentation strategy

PMX-III user manual change name to PMX-III reference manual . The reference manual is the place to consult where information can be found that is seldom needed in the daily use of the instrument.

Instead a new updated PMX-III User Manual, version 6.0, that includes the basics of the description of the instrument should be used. The manual includes the description of the preamplifier and have new information about light measurements as well as low dose rate measurements. An introduction to the use of oRTIgo software is also included. A separate short form manual is not needed anymore.

Latest information about PMX-III and oRTIgo can be found on RTI's web page: www.rti-e.se

This addendum describes the most important changes and improvements in PMX-III version 6.0 compared to the reference manual information. Please add this information to the existing reference manual.

New functions in version 6.0

PMX-III starts up as dosimeter independent of earlier use of the instrument

The default function of PMX-III was earlier to start up with Multimeter or Dosimeter mode, depending on the mode used when it was powered off. This is sometimes inconvenient, especially when having specific written instructions for certain measurements.

You can now program the PMX-III to start up in either Multimeter or Dosimeter mode. You activate this function by pressing the MODE and ENTER key when choosing the measuring mode you want to be default after power on. It is done in the following way:

1. Activate the measuring mode, Multimeter or Dosimeter, you **don't** want to have as default. Use the MODE menu if you have to change measuring mode.
2. Press MODE to activate the MODE menu.
3. Move to the entry corresponding to the mode you want to have as default, i.e. "Mult" or "dOSI".
4. While keeping the MODE key pressed, press the ENTER key.
5. Release both keys.

The PMX-III will now start up with the measuring mode you selected.

To disable the above described function:

1. Press the MODE key.
2. Move to the entry End.
3. While pressing the MODE key, press Enter.

Display "hold-function" for all rate related signals in dosimeter mode

The function of the electrometer has been improved with regards to current related parameters (dose rate, mA, cd/m^2). An automatic hold-function is now included. This means that both dose and rate can be read on the display after the exposure has finished until next exposure.
This especially simplifies measurements on I.I. during fluoroscopy and when using the light detector L100.

Automatic selection of measured unit determined by information stored in the ADI

In dosimeter mode PMX-III automatically switches over to the appropriate parameter, dose or rate, depending on the currently used detector and ADI. For example, if the light detector is used and the ADI for measurement on I.I. or monitors are connected, PMX-III automatically shows the cd/m^2 value in the display (that is "rate"). If you then switch to R100 and the ADI 8/B, it is most likely that you want to measure dose measurements when making exposures. PMX-III automatically switches the display to show dose values. You can override the automatic selection by pressing the "Dose" or "Rate" key on the front panel.

This new feature make the instrument ready to start measure directly after power on without pressing any additional keys in most cases.

Dose rate unit is µGy/s for all A-qualities instead of nGy/s, µGy/s and mGy/s

For all Image intensifier measurements using 8/A(P1), 8/A(P2) and 8/A the same unit is displayed. This eliminates the need to remember the unit, it is always µGy/s for hard filtrated beams (A-quality)

No need for offset adjustment of AMP-1 preamplifier anymore

Older versions of the pre-amplifier had a knob for offset adjustment and the procedure to adjust the offset was supported in the software in version 5.2. Newer pre-amplifier doesn't have this possibility and the support for adjustment has been removed in version 6.0.
Offset is tested and a warning message is displayed if it is outside the allowed limits.

New range for selection of number of frames and frames/s

It is now possible to select frames/s in steps of 0.5 frames/s. The range is 1.5 to 63.5 frames/s. Default value is 25 frames/s. PMX-III automatically increase the number of displayed decimals to be able to read the value with enough resolution.

Set-up menu for waveform have been changed

The set-up menu for the waveform analyser has been modified. The following selections has been removed:

Compressed mode
Display part
Display time
Smooth mode

These functions are now not available when PMX-III waveform analyser is used in the manual mode. This modification does not effect the function of oRTIgo.

Manual trig with the waveform analyser (only with oRTIgo 3.0)

Support for manual trig when using oRTIgo has been added. This simplifies the measurement of low rate signals, light measurements, and when it takes a long time for the signal to stabilise. The user has full control when he wants to collect the waveform. Now for the first time it is very easy to store and automatically calculate the frame rate, the dose/frame, and frequency of the video monitor based on the collected waveform using oRTIgo.
See the oRTIgo 3.0 information for details.

Front panel knob functions now inactive when oRTIgo controls PMX-III

Only possible to press "DOSE" or "RATE" to change the display reading in dosimeter mode, all other key is disabled in dosimeter, multimeter, and waveform mode.

Summary of changes in PMX-III firmware releases and support by oRTIgo

Functions in oRTIgo 3.0	PMX-III 5.0	PMX-III 5.1	PMX-III 5.2X	PMX-III 6.0
Manual trig in Waveform				x
Fluoro mode (Multimeter)			x	x
Fluoro mode (Dosimeter)	x	x	x	x
Manual LOCK mode (Multimeter, Gain #2,#3,#4)	x	x	x	x
Manual LOCK mode (Multimeter, Gain #1)		x	x	x
Manual LOCK mode (Dosimeter)	x	x	x	x
Free run mode (Dosimeter)			x	x
Improved data communication and printing	x	x	x	x

New functions in version 5.2

A new measuring mode "FREE RUN" suitable for very low dose rate measurements

In this mode the internal trig level of the electrometer is disabled. This means that extremely low dose rate levels can be measured. This mode is useful when measuring with the pre-amplifier and R100 combination. See new user manual PMX-III 6.0.

Support for the new light detector L100

See detector selection guide and the G_x chapter in the new user manual for PMX-III.

Improved performance of "CONTINUOUS MODE" in the MULTIMETER,

In PMX-III version 5.1, kVp is displayed in CONTINUOUS MODE during an exposure. When the exposure finishes all measured values are alternated in the display. The new version of PMX-III displays any parameter during the exposure. This parameter is selected by means of the PARAMETER key. This means that it is possible to see the real-time values of dose and dose rate during the exposure in MULTIMETER mode, in the same way as in DOSIMETER mode. Se page v 4-10 in the reference manual

Better support for oRTIgo version 3.0 for measurement on fluoro in MULTIMETER mode. It will be possible to use the INS key to get data from PMX-III when MULTIMETER mode is active. This means that the user during a fluoro can choose when to make the measurement. In version 2.20 of oRTIgo data is only transferred from PMX-III to the PC when the exposure is finished. This can sometimes give erroneous results due to a slow falling edge of the waveform.

Manual reset for the electrometer is available also in MULTIMETER mode.

The function key F3 works as RESET key in MULTIMETER mode in the following cases:

The normal function is that SETUP table #1 is loaded when F3 is pressed (default function). However, when dose or dose rate is selected by means of the PARAMETER key this function is overridden and a reset of the electrometer is performed.
If no SETUP table is programmed to the F3 key, it works as RESET key in all situations both in MULTIMETER and DOSIMETER mode.

The ADIs can now control the number of displayed decimals of the measured parameter

The number of displayed decimals is specified in the ADI module and will be defined by the detector, signal level, accuracy, and the different applications. This has been a limitation especially for the use of AMP-1 in the past, where only display values without decimals were possible.

Better measuring function for AMP-1 using P2 ADI modules (range 2)

Earlier versions of the AMP-1 ADI was not optimised for correct trig level and resolution for the type P2. It does not work very well with software version 5.1. In the new software version, an individual trig level for each detector is stored in the ADI module. This gives an opportunity to get optimal performance for each detector, both the existing and new, without having to change the software for the electrometer.

The PMX-III will have a front panel with new dose and light unit indication

nGy, nGy/s, cd/m^2, and lx, see user manual version 6.0 for picture.

Auto range scaling for the display reading of measured dose

Earlier the dose value was displayed in only one unit. That gave limited resolution for measurements where low dose was measured with high dose rate (AEC and dose per frame applications). The solution is to change to a more sensitive unit and display the unit after each exposure.

Example:
Instead of displaying 0.011 mGy, the PMX changes to µGy and displays 11.23 µGy. For an extremely short X-ray pulse with a very high dose rate, the PMX can even change to nGy if the dose value is less than 0.010 µGy.

The normalised mode, page 5-16, has been changed to be useful for ratio measurements

A change between dose and dose rate is not resetting the earlier stored scale factor anymore. The scale factor is stored both for dose and dose rate measurements until ⍁ + MODE is pressed again.

.

Example of application: calculation of ratio between two rate measurements before and after a 20 mm Al phantom with two different detectors, A and B.

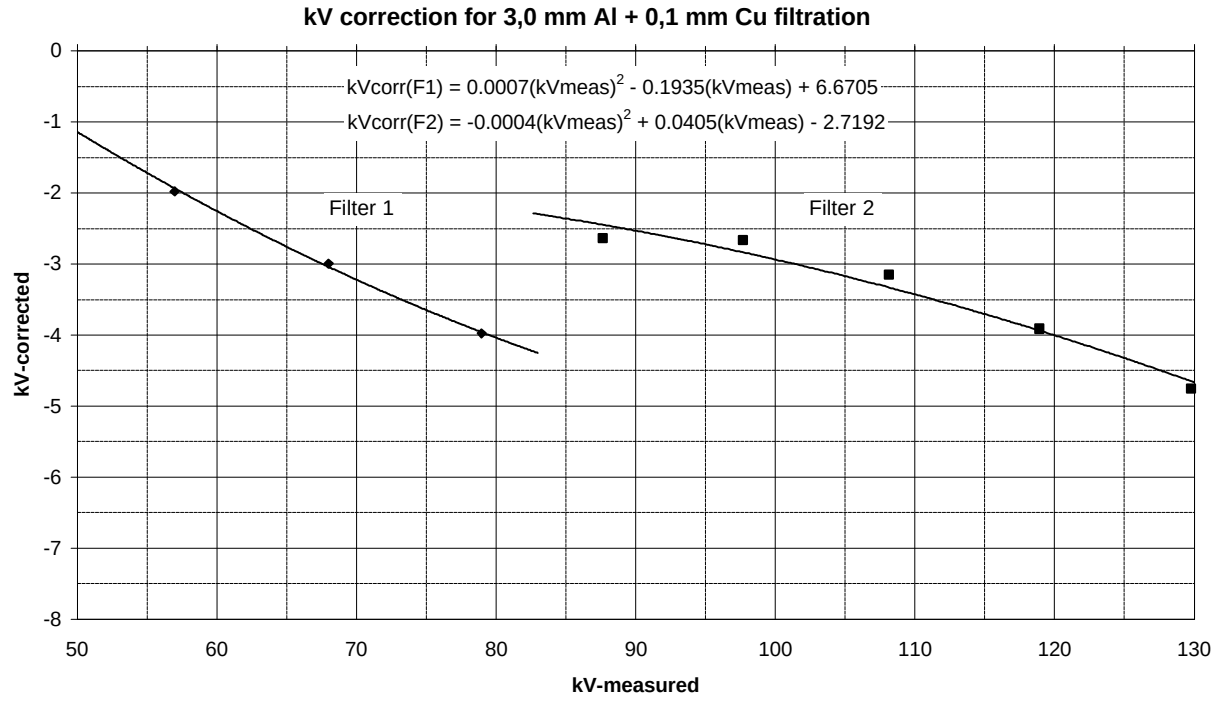
Procedure:

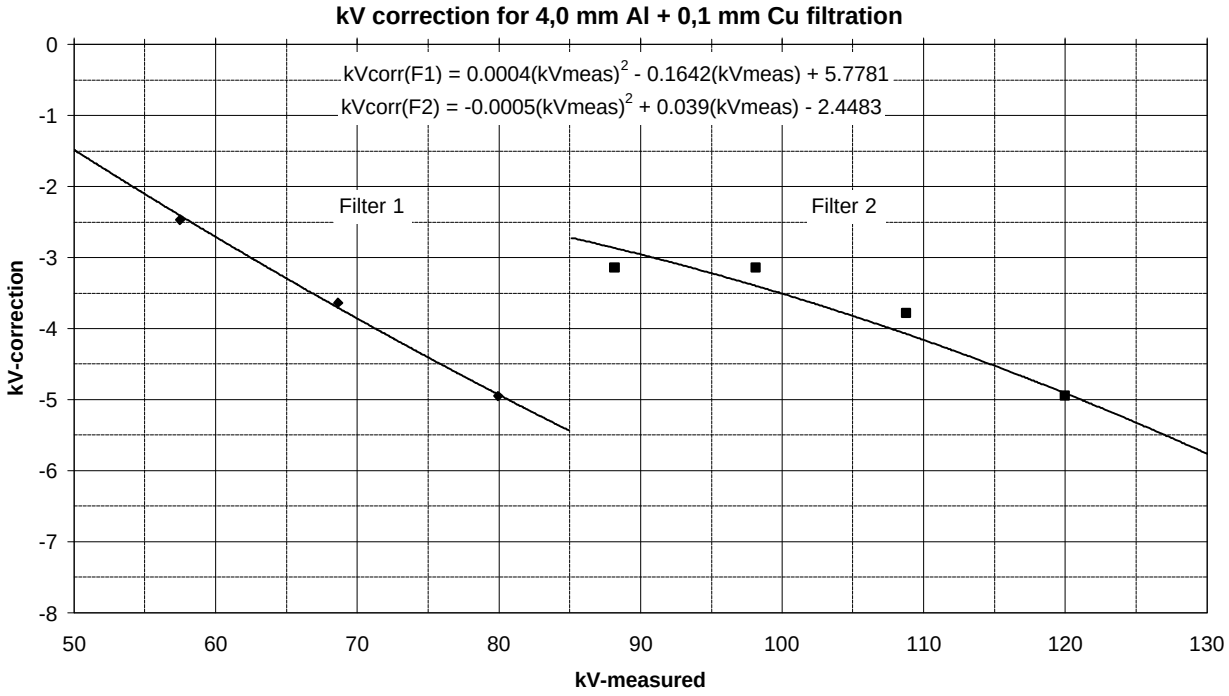
1. Select kV and mA.
2. Connect detector A, press ON/OFF.
3. If DOSIMETER LED is off, press MODE, select "Dosi" with ⍁ buttons, press ENTER
4. Press RATE and then press RESET to read the ADI.
5. Start and wait for a stable rate reading, "rate A", on the display.
6. Press ⍁+MODE. The display shall read a value near 1.
7. Change detector A to detector B, press RESET which reads the ADI and resets the electrometer. The text "norM" is displayed.
8. Start the exposure again, the ratio "rate B" / "rate A" is displayed.
9. To read the "rate B" value, press ⍁+MODE again.

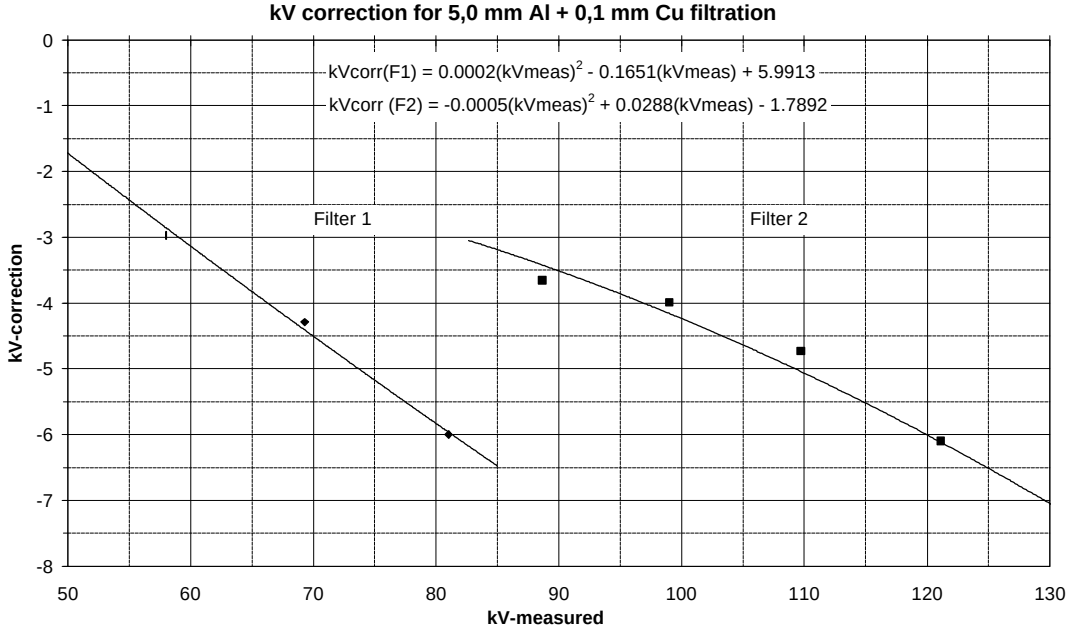
New kVp correction graphs; Chapter 4.8.4. Radiographic - CA 1

New kVp correction - 3.0, 4.0, and 5.0 mm Al + 0.1 mm Cu

The graph below shows the correction for tube/filter combination #1. The correction is valid for the RAD sensor, W target and filtration of 3.0, 4.0 and 5.0 mm Al + 0.1 mm Cu.



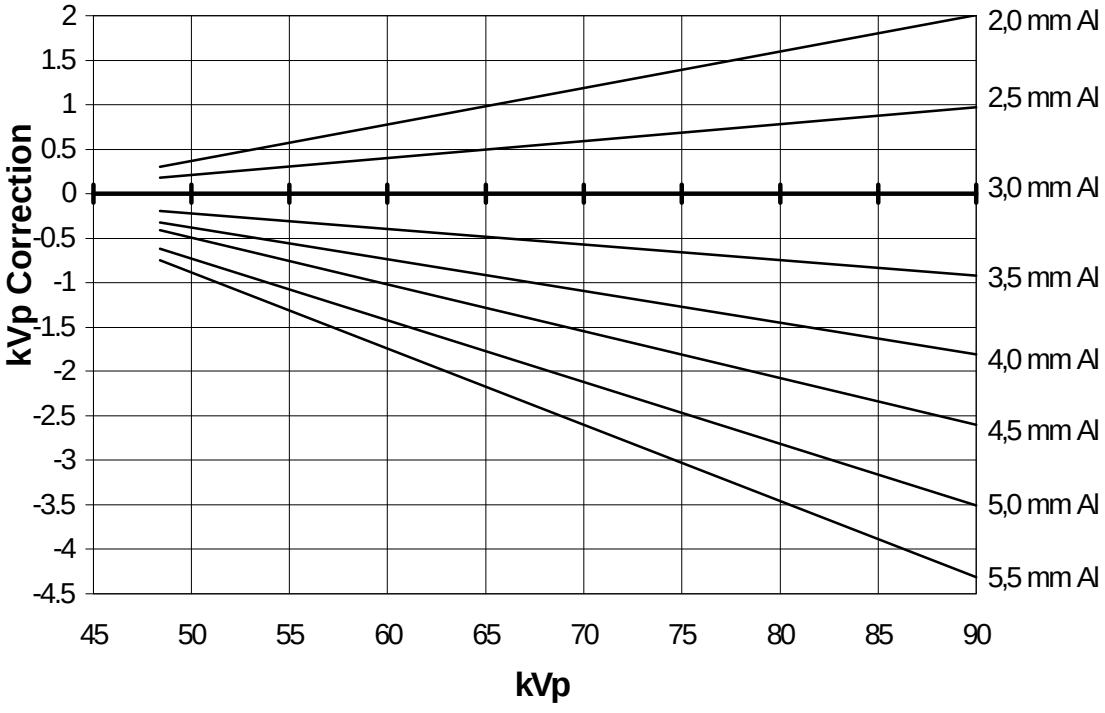




Example:

Read kVp value on the PMX-III display = 100.0 kV
Read filter pair on the PMX-III display = Fi:2
Known total filtration = 4 mm Al + 0,1 mm Cu
kVp correction from the graph or from the equation above = -3.5 kV
True kVp value = 100.0 - 3.5 = 96.5 kV

Updated kVp correction graphs; Chapter 4.8.4. Radiographic - CA 1



kVp corrections for different filtrations in the range 45-90 kVp, i.e. for Filter 1.

Example:
You are measuring on a generator with a total filtration of 4,0 mm Al and you are going to measure at kV settings between 80 and 90 kV.

1. Select setup table #13 to enable the display of filter pair used for kVp measurement, or enable it manually. See section 4.9 and page 4-53 and 4-59 in the reference manual for details.

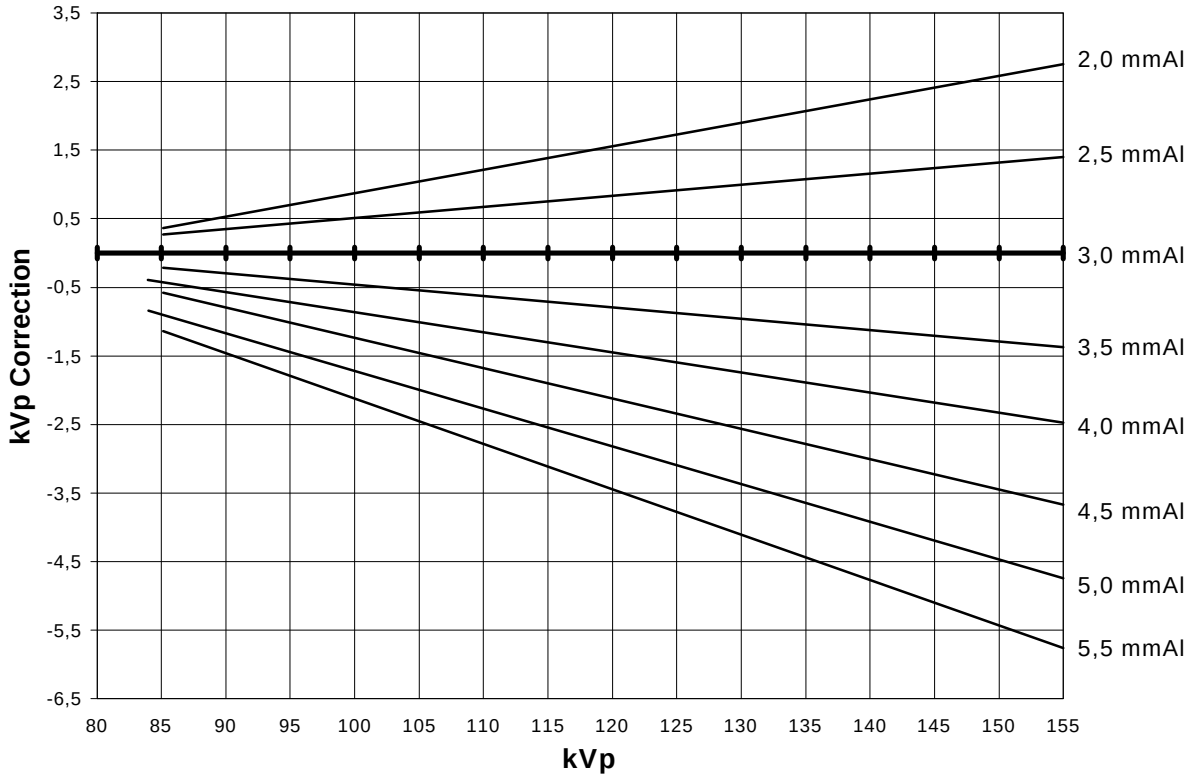
2. Make an exposure.

3. If measured kVp is between 80 and 90 kVp, information will be displayed to inform which graph to use. The display will show “Fi.1" or ”Fi.2".

Assume the following:
Read kVp value in the PMX-I R display = 83,5 kVp and “Fi.1”.
Known total filtration = 4,0 mm Al.

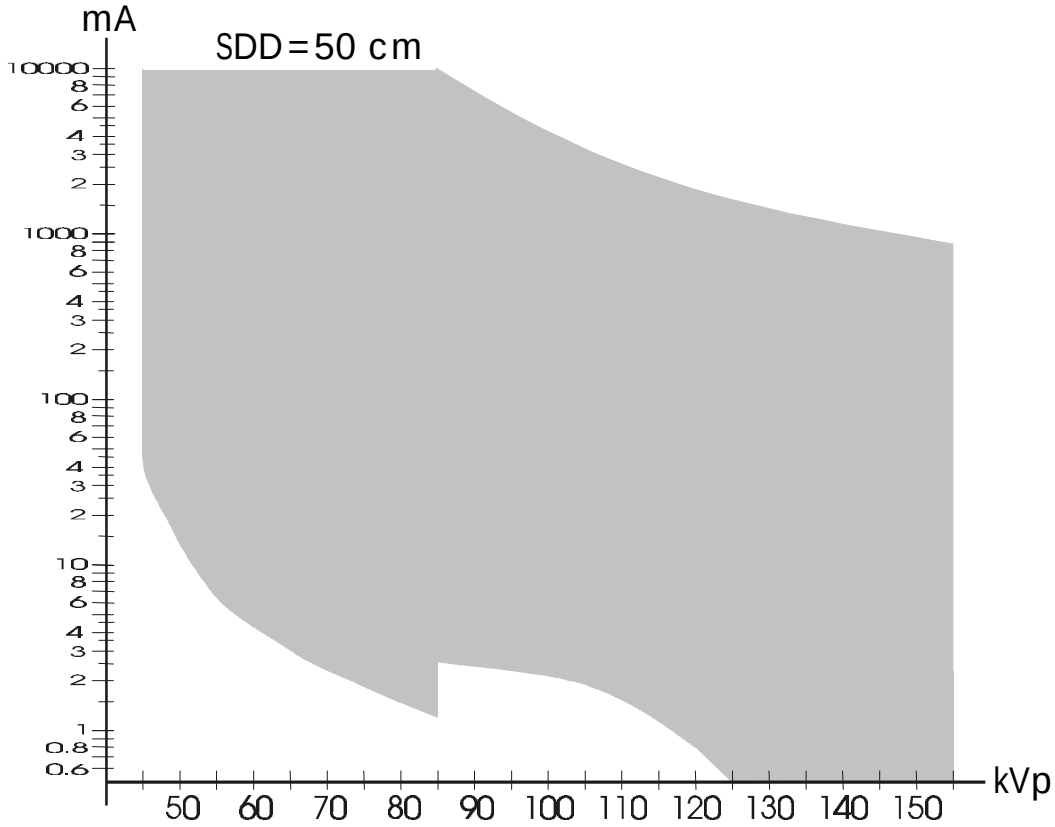
kVp correction from graph #1 = -1,6 kVp.
True kVp = 83,5 - 1,6 = 81,9 kVp.

Please note that the absolute accuracy for each instrument is stated in the kVp calibration record. The inaccuracy of the correction graph information is less than 3 %.



kVp corrections for different filtrations in the range 85-155 kVp, i.e. for Filter 2.

Typical sensitivity for PMX-III using CA 1 with a total filtration of 3.0 mm Al



Some display code names are new, a few new ones has been added

ee PMX-III reference manual page 4-39.

New Name	Old Name	Description
Lo.Si	Er.1	Low signal
Hi.Si	Er.2	High signal
Lo	Er.3	Low kVp
Hi	Er.4	High kVp
Sh.E	Er.5	Short exposure time
BAtt	Er.20	Low battery
O. FL	Er.2	Display overflow (electrometer reading > 9999)
OF.Er	New	Offset error due to negative input signal
Er. 11	New	Wrong ADI unit (Gy or R) compared to front panel text
:	:	Rate indication in the display
X.-Y-	X.-Y-	ADI defined, for detector X and beam quality Y
MAS.X	MAS.X	ADI defined, for MAS-1/MAS-2/MAS-3 probe
norM	norM	Display reading normalised to user factor
Ch.Cu	Ch.Cu	Charge/current (only without ADI)
Auto	Auto	Indicates that electrometer selects range automatically
RA:1	RA:1	This is the most sensitive range for low dose rate meas.
RA:2	RA:2	Middle dose rate range
RA:3	RA:3	High dose rate range (default for use of AMP-1)

Specifications for preamplifier AMP-1

Added specifications for the PMX-III dosimeter, page 7-10 in reference manual

Current range	0.5 - 230.0 pA (Range 1) 5 - 2300 pA (Range 2) 50 pA-2300nA (standard ADI, same as standard PMX-III)
Dose rate range (Gy version)	0.03-4.6 µGy/s (ADI=8/A(P1)) 0.10-46 µGy/s (ADI=8/A(P2))
Dose rate range (R version)	3.0-500 µR/s (ADI=8/A(P1)) 12-5000 µR/s (ADI=8/A(P2))
Frequency range	DC-1 (-3dB) ”low” or DC-30 Hz (-3dB) ”High” for P1 range DC-1 (-3dB) ”low” or DC-45 Hz (-3dB) ”High” for P2 range Second order low-pass filter
Inaccuracy	±2% or ±0,2 pA (P1,P2) ±5% or ± 4 nGy/s (8/A(P1)) ±5% (8/A(P2))
Scale factor (BNC output)	1 V/50pA (Range 1) 1 V/500pA (Range 2)
Scale factor (display)	1 nA/100 fA (Range 1) 1 nA/1 pA (Range 2)
Offset adjustment	Automatically after reset
Dimensions	82x55x28 mm
Power supply	Powered by the PMX-III
Weight	Approx. 170 g including ADI.
Operating temperature and humidity	-10 ^{o}C - +50 ^{o}C at <85 % relative humidity

Above specifications are valid for +18 ^{o}C to +23 ^{o}C at <80 % relative humidity.

All specifications can be altered without notice.

Shortform Detection Selection Guide

This information is updated compared to section 7.6 in the reference manual

Type	ADI code	Beam Quality	Typical use	Typical rate range with PMX-III	
R100	8/A(P1)	50-150 kV, W/23 mm Al	Image I. dose rate input Cont. fluoroscopy 3/6 mA	0,030-4,6 µGy/s	3,3-525 µR/s
R100	8/A(P2)	50-150 kV, W/23 mm Al	Image I. dose rate input DSI/spotfim fixed current	0,10-46 µGy/s	11-5250 µR/s
R100	8/A	50-150 kV, W/23 mm Al	Film dose & dose rate DSI/spotfim falling load	1,0-46000 [A] µGy/s r1: 1,0-460 r2: 60-4600 r3: 500-46000 [A]	0,007-315 R/min r1: 0,007-3,15 r2: 0,41-31,5 r3: 3,4-315
R100	8/B	50-150 kV, W/3 mm Al	Skin dose & dose rate	0,001-46 mGy/s r1: 0,001-0,46 r2: 0,06-4,6 r3: 0,5-46	0,007-315 R/min r1: 0,007-3,15 r2: 0,41-31,5 r3: 3,4-315
R100	8/D	25-35 kV, Mo/30 µm Mo	Skin dose & dose rate (breast)	0,002-92 mGy/s r1: 0,002-0,92 r2: 0,12-9,2 r3: 1,0-92	0,014-630 R/min r1: 0,014-6,3 r2: 0,82-63 r3: 6,85-630
L100	6/U	Luminance, MON adapter	Film viewing box CRT[B]	0,5-23000 [A] cd/m^2 r1: 0,5-230 r2: 30-2300 r3: 250-23000 [A] 0,05-1000 cd/m^2	
L100	6/Y	Illuminance, diffuser	Ambient light levels	0,25-4000 lx r1: 0,25-40 r2: 5-400 r3: 45-4000	
R25	7/B	50-150 kV, W/3 mm Al	Skin dose & dose rate	0,004-185 mGy/s r1: 0,004-1,85 r2: 0,25-18,5 r3: 2,0-185	0,027-1260 R/min r1: 0,027-12,6 r2: 1,64-126 r3: 13,7-1260
MAS-1	5	Invasive mA and mAs	mA and mAs	0,10-2000 mA r1: 0,1-20 r2: 3-200 r3: 25-2000	0.01-9999 mAs
MAS-2	4	non-invasive mA & mAs	mA and mAs	50-2000 mA	0.1-9999 mAs
MAS-3	J	non-invasive mA & mAs	mA and mAs	0,10-2000 mA r1: 0,1-20 r2: 3-200 r3: 25-2000	0.01-9999 mAs

[A] Note that the PMX-III display can not show higher values than 9999. With oRTIgo also higher rate values can be shown.

[B] When measuring on CRTs, the measuring range depends on the frequency and the after glowing time in the phosphors. The table shows a typical range for the standard monitor adapter.

For a complete list of all available detector types please read our "Short Form Detector Selection Guide" N0. 5-AN-52003-19

The top panel instructions for PMX-III