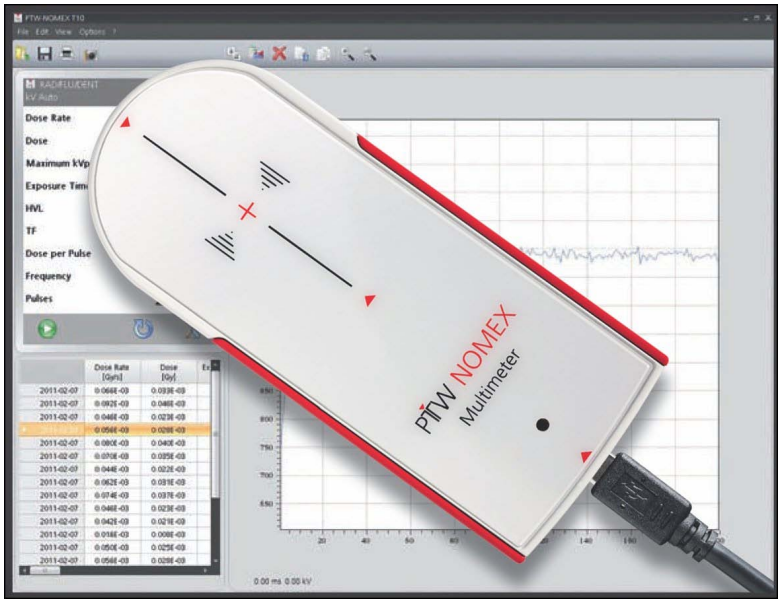
User Manual

NOMEX

NOMEX Multimeter T11049 Firmware Version 1.1 or higher

NOMEX Software S030008 Version 1.1 or higher



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General Information

- The product bears the CE-mark "CE-0124" in accordance with the Council Directive 93/42/EEC about Medical Devices and fulfills the essential requirements of Annex I of this directive. The product is a class IIb device (MDD).

- **Product standard**
  The product fully complies with the requirements of the following standards:
  - IEC 61674

- **Electrical safety**
  The product fully complies with the requirements of the following standards:
  - IEC 61010-1

- **Electromagnetic immunity**
  The product fully complies with the requirements of the following standards:
  - IEC 61326-1
  - CISPR11/EN 55011 class B

- The user manual is an integral part of the product. It should always be kept near the product. Observance of the manual is a prerequisite for proper product performance and correct operation.

- Operator safety, specified measuring accuracy, and interference-free operation can only be guaranteed if original products and parts are used. Furthermore, only the accessories listed in this manual are approved by PTW-Freiburg and only they or other accessories whose use has been expressly permitted by PTW-Freiburg may be used in conjunction with the product. Safe operation and proper product performance are not guaranteed if accessories or consumables from other manufacturers are used.

- PTW-Freiburg cannot be held liable for damage resulting from the use of accessories or consumables from other manufacturers or when the user ignores the instructions and information given in this manual.

- The warranty period is 1 (one) year and begins on the day of delivery. It is unaffected by repairs covered by the warranty regulations.

- PTW-Freiburg only considers itself responsible for the safety, reliability, and performance of the product if the assembly, extension, readjustment, modification, or repair is carried out by PTW-Freiburg or by persons authorized by PTW-Freiburg, and if the product is used in compliance with the technical documentation.

- In case of any questions concerning the service, support, or warranty, please contact your supplier.

- This manual is in conformity with the product specifications, all applicable safety standards, and with the **NOMEX** software (version as indicated on the front page) that are valid as at the printing date. All rights are reserved for devices, circuits, techniques, software, and names as referred to in the manual.

- PTW-Freiburg reserves the right of modifications.
  Please contact PTW or your local representative for the most current information.

- No part of the technical documentation may be reproduced without written permission from PTW-Freiburg.

- PTW-Freiburg is a registered manufacturer according to the ElektroG (Elektro- und Elektronikgeräte-Gesetz).
  Elektro-Altgeräte-Register (EAR), Registration number DE15599992

– PTW-Freiburg works in strict accordance with a quality management system that is continuously updated according to the national and international standards.

CE 0124

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Intended Use

The NOMEX multimeter is a diagnostic dosimetry system according to IEC 61674 for absolute dosimetry and quality control measurements in diagnostic radiology. It can be used for acceptance testing and constancy checks in radiography, fluoroscopy, dental X-ray, mammography, and computed tomography (CT) applications.

The NOMEX multimeter set includes the NOMEX multimeter, a miniaturized dosemeter consisting of the electronic system and the semiconductor detectors and the NOMEX software.

The NOMEX multimeter measures the dose, dose rate, dose per pulse, pulses, pulse frequency, exposure time, tube voltage, total filtration, and half value layer as well as kV and dose rate waveforms.

System Components

The NOMEX multimeter set L981815 includes these components:

- NOMEX multimeter T11049
- NOMEX software S030008
- USB 2.0 cable with a length of 2 m L178089
- USB 2.0 active extension cable with a length of 5 m L178088
- NOMEX transport case L522056

Accessories

The following accessories are available for the NOMEX multimeter:

- NOMEX multimeter holder T20016
  Mechanical holder allowing the NOMEX multimeter to be attached to a dental X-ray unit or to a tripod
- NOMEX multimeter cassette adapter T20017
  Mechanical holder allowing the NOMEX multimeter to be mounted in the cassette compartment of an X-ray unit.

For more information about using the accessories, refer to section 13 "NOMEX Multimeter Accessories".

Safety Information

This is the safety alert symbol. It is used to alert the user to potential hazards. Obey all safety messages that follow this symbol to avoid any possible bodily injury or equipment damage.

All safety messages consist of the following components:
- Safety alert symbol and signal word
- Type of danger
- Source of danger
- Consequence
- Measures to prevent hazards.

Signal Words

DANGER

Indicates an imminent hazard. If not avoided, the hazard will result in death or serious injury.

WARNING

Indicates a hazard. If not avoided, the hazard can result in death or serious injury.

CAUTION

Indicates a potential hazard. If not avoided, the hazard could result in minor injury or product/property damage.

NOTE

Provides application tips or other useful information to ensure that you get the most from your equipment.

Safety Information for the NOMEX System

Strictly observe the following safety information concerning the signal words DANGER and WARNING. Failure to do so may endanger the lives of the patient, user, and other persons involved.

DANGER

Operation in areas where an explosion may occur or in oxygen-enriched atmospheres.

Explosion Hazard!

The product is not suitable for operation in areas of risk where an **explosion** may occur. Explosion hazards may be caused, for example, by the use of combustible anesthetics, skin-cleansing agents, and disinfectants.

Furthermore, the product is not suitable for application in **oxygen-enriched atmospheres**. The atmosphere is considered to be oxygen-enriched when more than 25 % of oxygen or nitrous oxide is added to the ambient air.

⚠ WARNING

Improper handling.

Hazards to Persons!

The product is a medical device and must only be handled by persons who are trained in the use of such equipment and are capable of applying it properly. The operator must be trained in the use and operation of the product.

⚠ WARNING

Electricity is a source of risk, particularly when the product is not in perfect operating condition or when it is operated inappropriately.

Shock Hazard!

– Before using the product, the user must first ascertain that it is in correct working order and operating condition.

– Before putting the product into operation, visually inspect all connection cables, connectors, housing, and covers for signs of damage. Damaged cables and connectors must be replaced immediately.

⚠ WARNING

Electricity is a source of risk, particularly when the product is not in perfect operating condition or when it is operated inappropriately.

Shock Hazard!

– Products on which moisture condensation has developed as a result of temperature changes must not be switched on unless completely dry.

– Liquids must not enter the product. If liquids have entered the product, you have to dry it or wait for it to dry completely, and it must be thoroughly inspected before being used again.

– Extension cords must not be used.

⚠ WARNING

Electricity is a source of risk, particularly when the product is operated inappropriately.

Shock Hazard!

Exclusion of operation in the patient environment:
Neither the product nor any peripheral devices may be operated in the patient environment (see Figure 1).

Exclusion of operation with patient contact:
The product is not intended for use in direct contact with the patient. Neither the product nor any peripheral device may have contact with the patient.

Exclusion of operation as a controlling instrument:
The product is only designed for use as a measuring device. Measuring results must not be used to control radiodiagnostic equipment or radiotherapy units.

⚠ WARNING

Electricity is a source of risk, particularly when the product is operated inappropriately.

Shock Hazard!

Use of peripheral devices:

Peripheral devices (PC, printer) may only be connected if they meet the requirements of standard UL 60950-1 or IEC 60950-1 or of standard IEC 61010-1.

Devices may be connected to other devices or to parts of systems only if it has been ascertained that this connection does not impair the safety of the patient, the operator, or the environment.

If the device specifications do not contain information regarding the connecting of the device to other equipment, you must consult the manufacturer of the other equipment or an expert about the effects of the connection on the patient, operator, or environment. Always observe standard IEC 61010-1.

⚠ WARNING

Magnetic and electrical fields are capable of interfering with the proper performance of the product.

Equipment Failure!

– For this reason, make sure that all external devices operated in the vicinity of the product comply with the relevant EMC requirements. X-ray equipment, MRI devices, and radio systems are possible sources of interference as they may emit higher levels of electromagnetic radiation. Keep the product away from these devices and verify its performance before use.

– The use of cables longer than specified may impair the electromagnetic compatibility characteristics of the product.

– The product should not be used in the immediate vicinity of, or placed on top of or below, other equipment. However, if the application requires an arrangement of devices as described above, the product should be monitored in order to ensure its proper functioning in the specific arrangement.

– The customer or user of the product should assure that it is used in an electromagnetic environment as described in IEC 61326-1.

⚠ WARNING

Hazards originating from other system components.

Hazards to Persons! Equipment Damage!

Observe the safety information provided in the user manuals of the system components.

⚠ CAUTION

Use of the product without observing the user manual.

Bodily Injury! Equipment Damage!

Always use the product in compliance with the user manual. Otherwise, the intended protection can be reduced.

Handle the product with care to avoid equipment damage.

⚠ CAUTION

Operation under inadequate ambient conditions.

Equipment Damage!

Always observe the ambient conditions as indicated in the section "Technical Specifications".

⚠ CAUTION

Operation under unsuitable ambient conditions or when the NOMEX multimeter is moved.

Erroneous Measurements!

The NOMEX multimeter is a highly sensitive multi-channel semiconductor detector. For this reason, cosmic radiation as well as moving the NOMEX multimeter are capable of starting a measurement.

⚠ CAUTION

Improper handling of cables and connectors.

Equipment Damage!

To avoid damage to the cables and connectors, observe the following points.

– Do not kink the cables. Observe the minimum bend radius of the cables. Never exert pressure on the cables. Do not step on the cables. Do not roll trolleys over the cables. Do not pull or twist the cables.

– Disconnect the cables from the devices during transport and when the devices are not in use. Do not let the cables hang down unrestrained.

– The connectors must always be clean. Do not allow connectors to lie on the floor. Always protect connectors when pulling them through cable conduits.

NOTE

Please observe the user manuals of all connected devices!

NOTE

Set up the product so that the operator has a clear, unobstructed view of the control panel.

NOTE

In order to separate the product from the power supply, unplug the USB cable from the product. Position the device so that it is not difficult to unplug the USB plug.

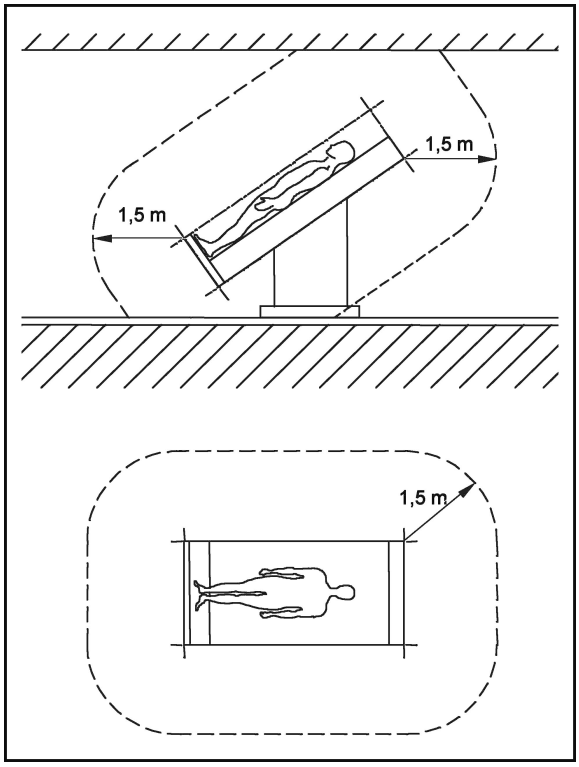
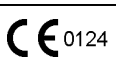


Figure 1: Definition of the patient environment

Symbols on the Product and Nameplate

Symbol	Description
	Please refer to the user manual!
	The product bears the CE-mark.
	The device is only suitable for use with direct current.
	USB port
	Manufacturer and date of manufacture
	Reference number
	Serial number
	Separate collection for electrical and electronic equipment! (refer also to the section "Disposal of the Product")
	Labeling according to "Administration on the Control of the Pollution caused by Electronic Information Products (ACPEIP)" (China RoHS) (refer also to the "Appendix")

Safety Information Concerning the Software

⚠ WARNING

Hazards originating from other system components.

Incorrect Operation!

Observe the safety information provided in the user manuals of the system components

⚠ WARNING

Use of the NOMEX software by persons with inadequate qualifications.

Incorrect Operation!

The use of the NOMEX software is limited to persons who are familiar with the software and who are adequately trained or experienced in the use of such programs and who own the necessary decision-making competence to ensure proper use. This includes the following activities:

- determination of the measuring and analysis parameters
- determination of the tolerance levels
- selection of correction protocols according to different standards
- selection or generation of the correction tables according to different standards
- evaluation and plausibility check of measuring and analysis data provided by the software
- introduction of the software in the department
- as well as the instruction provided to the personnel on how to perform measurements.

⚠ CAUTION

Influences by other software.

Malfunction!

If software programs other than the NOMEX software or programs approved by PTW-Freiburg are installed on the PC, PTW-Freiburg cannot be held liable for computer malfunctions resulting from this fact. Furthermore, PTW-Freiburg cannot guarantee the proper functioning if third-party software programs were previously installed on the PC and were not entirely removed.

For the proper functioning of the NOMEX software, ensure that only **one** version of this software is installed on the PC.

⚠ CAUTION

Use in combination with unsuitable system components.

Incorrect Operation!

Only install the NOMEX software on PCs that meet the requirements of the standard UL 60950-1 or IEC 60950-1.

Do not operate the PC in the patient environment.

NOTE

It is recommended to secure the NOMEX data at regular intervals.
The data are located, for example, in the directory '<PTW documents>\Nomex\Data' (refer to section 2.5 "Storage of Data").

NOTE

Please observe the user manuals of all connected devices!

Disclaimer

The NOMEX software has been developed and tested with all due care. However, PTW-Freiburg is not in a position to guarantee that the program is completely free of errors.

PTW-Freiburg is not responsible in any way for the consequences resulting from the use of the NOMEX software. Any conclusions drawn from these measurements are the sole responsibility of the user.

The user automatically accepts this agreement by their using the NOMEX software.

Agreement about Updates and Licenses

PTW-Freiburg is not obliged to keep the software up to date. When you contact us for advice, please let us know the software revision, the serial numbers of the peripheral devices, and the date of purchase.

Operating Manual

1 Equipment Description

1.1 Features

- multi-channel semiconductor detector
- measurement of dose, dose rate, dose per pulse, pulses, pulse frequency, exposure time, tube voltage, total filtration, and half value layer as well as of the tube voltage and dose rate waveforms
- fully automatic dose and tube voltage ranging
- fully automatic total filtration compensation
- measurement of very heavily filtered radiation qualities
- measurement of the half value layer in all applications
- adjustable sampling with an appropriately sized log memory for several seconds
- adjustable timer functions
- message if the accuracy of the measured value is inadequate
- auto-start/auto-stop mode with auto-reset
- USB interface
- powered via USB interface
- NOMEX software for the display and evaluation of the measured values
- NOMEX software for equipment setup
- selectable display language for the NOMEX software

⚠ CAUTION

Improper handling.

Equipment Damage!

The NOMEX multimeter is a sensitive measuring device that requires regular inspection and calibration.

- Ensure that the NOMEX multimeter is serviced at regular intervals as outlined in section 17 "Preventive Maintenance".
- Have the NOMEX multimeter calibrated periodically by an authorized laboratory (also refer to section 17 "Preventive Maintenance").

Legally Calibrated NOMEX Multimeters

The calibration authority has placed a calibration mark on the back of the device. Damaging or removing the calibration mark automatically invalidates the calibration.

1.2 Indicators and Interfaces of the NOMEX Multimeter

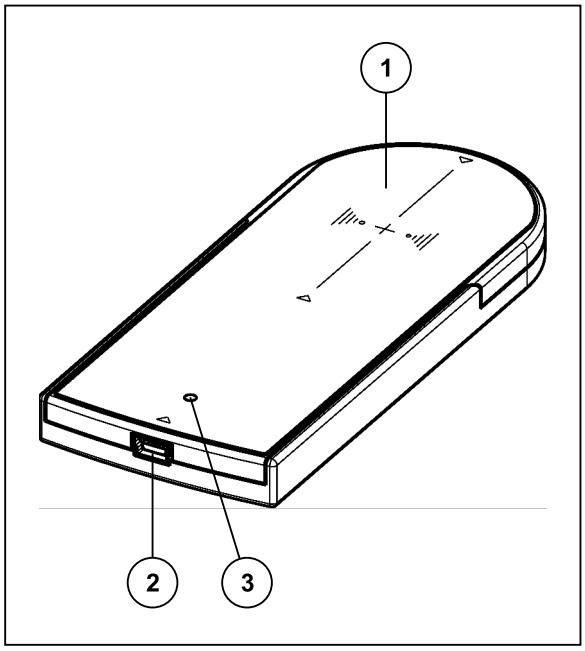


Figure 2: NOMEX multimeter, top view

1 *Radiation measurement area (refer to Figure 4)*

2 *USB port*

3 *Status LED*

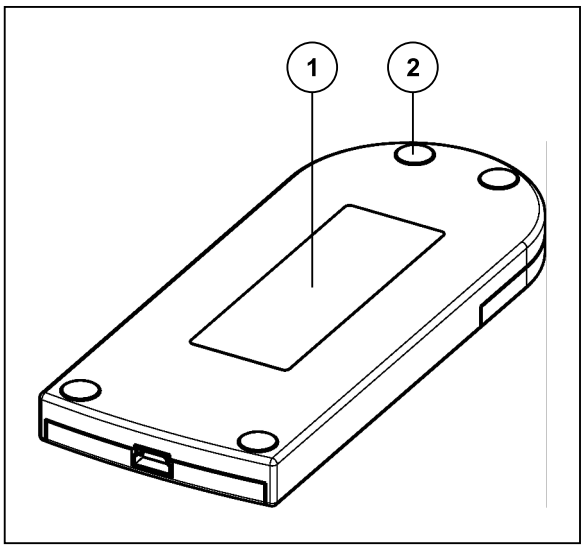


Figure 3: NOMEX multimeter, bottom view

1 *Nameplate*

2 *Rubber pad (4)*

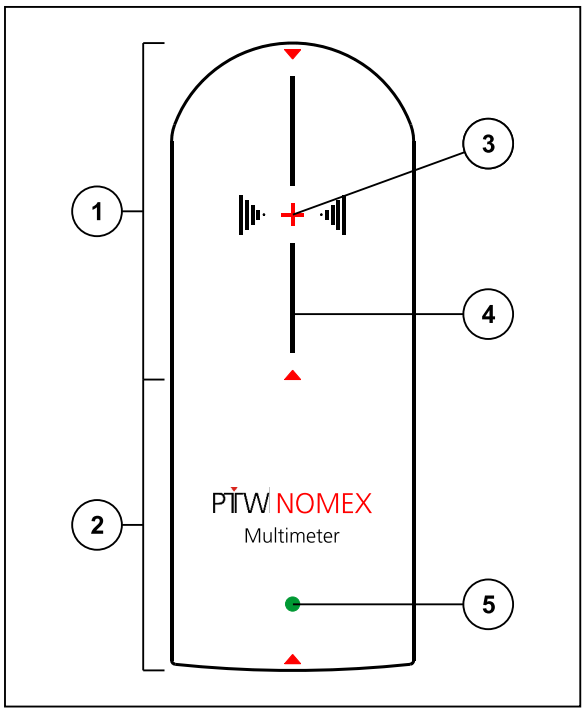


Figure 4: NOMEX multimeter, measurement area

1 *Detector area*

2 *Electronics area*

3 *Mark for alignment with the central axis*

4 *Mark for alignment in CT and dental panoramic applications*

5 *Status LED*

1.3 Status LED on the NOMEX Multimeter

(refer to Status LED **5**, Figure 4)

Function	**LED indication**
The NOMEX multimeter is inactive, i.e., it is not connected to the PC and, therefore, is not powered.	none
Establishing a communication link via USB	illuminated blue
The NOMEX multimeter is ready for measurement.	illuminated green
Measurement in progress	blinking green
Measured values are being determined.	blinking blue
The NOMEX multimeter is not ready for measurement because the device is being set up via the NOMEX software.	illuminated red
Error condition of the NOMEX multimeter Exception error, refer to section 11.1.2 "Other Error Messages"	blinking red

2 Installing, Starting, and Exiting the NOMEX Software

2.1 Minimum Hardware Requirements

Operation systems:	– Windows XP Professional or – Windows Vista Business x32/x64 or – Windows 7 Professional x32/x64 with recent Service Packs and Updates
Processor:	Pentium IV processor, 2 GHz or compatible processor recommended Pentium IV processor, 3 GHz or better
RAM:	min. 2 GB RAM
Hard disk:	min. 100 MB of free space for NOMEX and min. 300 MB of free space for .NET Framework 2.0 and 3.5
Graphics:	XGA (1024 x 768 pixel) or higher resolution recommended SXGA (1280 x 1024 pixel) default font size enabled
Software:	– MS Internet Explorer 8.0 or higher – Adobe Reader 7.0 or higher – Microsoft Excel

Alternatively, you can also use a tablet PC with the following configuration:

Operation systems:	Windows 7 Professional x32/x64
RAM:	2 GB RAM
Hard disk:	32 GB recommended SSD
Graphics:	WSVGA (1024 x 600 Pixel)

2.2 Installation

⚠ CAUTION

Working with an incomplete version of the NOMEX software.

Malfunction!

If a restart of the system is required during or after the installation of the software, it is essential to restart the PC before the first use of the software in order to ensure a correct installation of the software.

NOTE

Switch off antivirus software, energy saving modes, and screen savers in order to avoid problems during installation or measurements.

The installation program is delivered on CD-ROM.

- Log in as the administrator.
- Start Windows on your PC and close all running applications.
- Insert the installation CD into the CD-ROM drive (e.g. drive D:\).

If you have configured your CD-ROM drive to 'Autorun', the installation process will be started automatically. Otherwise, follow the instructions below:

- In Windows Explorer, open the directory of the CD-ROM drive.
- Start the installation with the "setup.exe" file.

➔ The installation program will be executed and the software will be installed on the hard disk of your PC.

- Please follow the prompts on the screen.

➔ The *Customer Information* window will be displayed.

Figure 5: Customer Information window

If the operation system on your PC is set for several users, you can choose between installation for all users with *Anyone who uses this computer* or for the current user with *Only for me*.

- Click the *Next* button.

➔ The *Setup Type* window will be displayed.

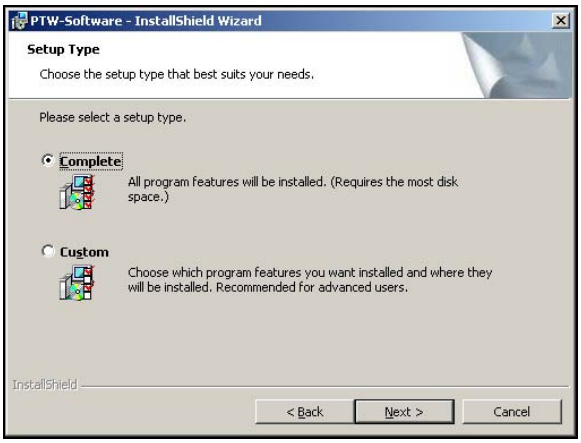


Figure 6: Setup Type window

- In the *Setup Type* window, select the setup type *Custom* or *Complete*.

PTW-Freiburg recommends selecting the setup type *Complete*, especially if you are using the software for the first time.
With the setup type *Complete* all available program features will be installed in the directory 'C:\Program Files\'.

If you want to choose another directory you have to select the setup type *Custom*. The installation program recommends the default directory 'C:\Program Files\'.
Click the *Change* button to select another directory.
Confirm with *OK*. The target directory will be created if it does not exist yet.

- Click the *Next* button and in the following window the *Install* button to start the installation.

➔ The NOMEX software will be installed.

2.3 Repairing and Uninstalling

You can uninstall the NOMEX software or repair installation errors.

- Click *Start* → *Settings* → *Control panel*.
- Double-click *Add/Remove programs*.
- Select the NOMEX software and click the *Change* button.

➔ The *Program Maintenance* window will be displayed.

Figure 7: Program Maintenance window

The *Program Maintenance* window offers the following options.

Modify	not needed with this software
Repair	to check and repair the installation
Remove	to uninstall the software

2.4 Data Backup and Restoring a Backup

To avoid loss of data, e.g. in case of a computer crash, it is recommended to make data backups at regular intervals.

The data are located, for example, in the directory '<PTW documents>\Nomex\Data'.

NOTE

To avoid loss of data when moving data to another directory, it is recommended to do so using the *Copy*/*Paste* and *Delete* functions rather than *Cut* and *Paste*.

2.5 Storage of Data

When you store data, please keep in mind that you write them only to completely accessible directories. Otherwise, Windows Vista and Windows 7 will store the data in a virtual directory ("virtualization"). These data in the selected storage path will no longer be visible to other users or Windows Explorer.

Depending on the operating system of your PC, the PTW specific files will be stored in the following directories:

- <PTW documents>
  e.g. demo data, measurement data, or evaluation data
  - Windows XP:
    'C:\Documents and Settings\
    All Users\Shared Documents\PTW'
  - Windows Vista / Windows 7:
    'C:\Users\Public\Public
    Documents\PTW'

2.6 Starting

- Click the Windows *Start* button
  → *Program Files*
  → *PTW*
  → *NOMEX*
  → *NOMEX* icon.

➔ The main screen of the software (see section 5 "Main Screen") will be displayed.

2.7 Exiting

Exiting the NOMEX software can be done in several different ways:

- Click menu *File* → *Exit* or
- Press the standard Windows hot-key sequence *Alt+F4* or
- Double-click the program icon in the title bar of the main screen or
- Click the Windows button [X] in the title bar of the main screen.

If the software contains data that have not yet been saved, an appropriate message will be displayed and you will be given the option to save these data.

3 Putting the NOMEX Multimeter into Service

3.1 Connecting the NOMEX Multimeter

⚠ CAUTION

Use of USB cables not approved by PTW.

Malfunction!

Only use the USB cables (USB cable L178089 or USB active extension cable L178088) supplied with the NOMEX multimeter to connect it to the PC. Otherwise, correct communication, which is the basis for proper operation, cannot be guaranteed. Do not use more than 4 of the USB active extension cables with a length of 5 m each.

NOTE

Do not connect more than one NOMEX multimeter to the PC because the NOMEX software can only communicate with the first device it detects.

Furthermore, the NOMEX software does not offer the possibility to search for multiple, connected devices and to select the appropriate device.

- Connect the NOMEX multimeter (USB port **4**, Figure 2) to a USB port of the PC where the NOMEX software has been installed. To do so, use one of the supplied USB cables (USB cable L178089 or USB active extension cable L178088).

NOTE

The PTW info file "NOMEX_Multimeter.inf" for the USB driver of the NOMEX multimeter is part of the NOMEX software. The file is copied to the folder 'C:\WINDOWS\inf' during the installation of the NOMEX software.

When you first connect the NOMEX multimeter to the PC, the corresponding USB driver is automatically configured by means of this info file.

PTW recommends configuring the USB driver only the first time and selecting automatic configuration.

➔ The USB driver configuration starts.

➔ The Windows logo test is running first and this test fails. PTW guarantees that the NOMEX multimeter does not impair the functioning of your PC.

- Acknowledge the warning by clicking the *Continue installation* button.

➔ The USB driver configuration continues.

- Follow the prompts displayed on the screen to perform the configuration.

➔ The USB driver will be configured.

➔ The NOMEX multimeter will automatically be activated and initialized.

➔ The NOMEX multimeter is then ready for measurement. Once the NOMEX software has started, the status LED (**3**, Figure 2) is illuminated green.

NOTE

If you connect the NOMEX multimeter via two, three, or four USB active extension cables L178088 while the NOMEX software is started, this can lead to communication problems between the NOMEX software and the NOMEX multimeter.
In this case, exit and restart the NOMEX software so that the USB connection will be detected again and the communication between the NOMEX software and the NOMEX multimeter will be re-established.

3.2 Positioning the NOMEX Multimeter

3.2.1 Radiography, Fluoroscopy, Dental X-Ray, and Mammography

For a measurement, the measurement area of the NOMEX multimeter must be located in the radiation beam of the X-ray unit and the detector area must be **fully irradiated** (gray area in Figure 8).

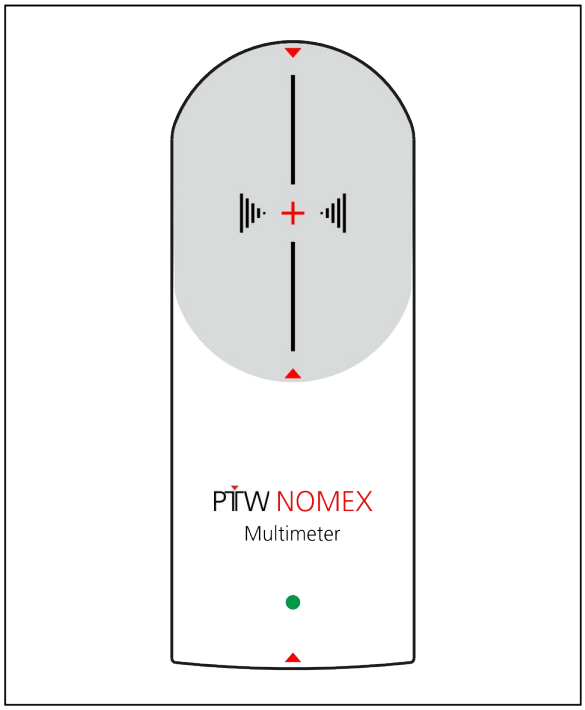


Figure 8: Measurement area for RAD/FLU/ DENT and MAM applications

3.2.2 Computed Tomography and Dental Panoramic X-Ray

For CT and DENT-PAN applications, the bar with a width of approx. 1 mm is used (**4**, Figure 4) that identifies the center of the 3 mm wide measurement area. The measurement area must be **fully irradiated** (gray area in Figure 9).

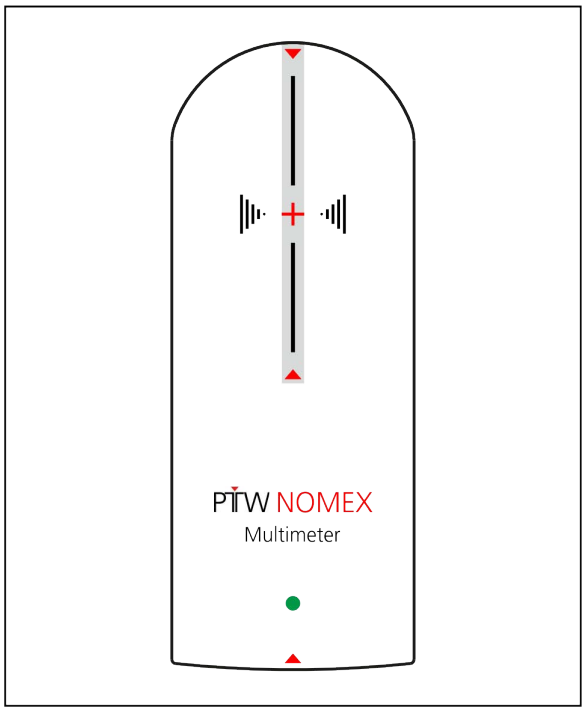


Figure 9: Measurement area for CT and DENT-PAN applications

⚠ CAUTION

NOMEX multimeter measurements in the presence of rotating radiation.

Erroneous Measurements!

Rotation of CT and DENT-PAN X-ray units is not permitted. The X-ray tube should be operated in the so-called topogram or service mode and be positioned vertically above the NOMEX multimeter.

The NOMEX multimeter always needs to be positioned in a permanently irradiated area. A rotating field of radiation will lead to erroneous measurements.

Measurement on CT Systems in the Presence of Rotating Radiation:

If the rotation of the CT tube and the treatment table cannot be deactivated (service mode), the NOMEX multimeter cannot be used to perform measurements.

Remedy:

CT systems can also be used to create two-dimensional X-ray images. For this purpose, the tube moves to 12 o'clock where it stops and the treatment table travels slowly through the gantry.

- Choose a small pitch.
- Move the treatment table out of the gantry as far as possible.
- Place the NOMEX multimeter at the bottom of the gantry.

➔ With this method, neither the NOMEX multimeter nor the X-ray tube will move and the measurement can be performed.

Measurement on Dental Panoramic Units in the Presence of Rotating Radiation:

With this type of equipment it must also be assured that the NOMEX multimeter is always fully irradiated statically when the rotation cannot be avoided, i.e., the NOMEX multimeter must follow the rotating movement. For this purpose, you can use the NOMEX multimeter holder T20016, for example (refer to section 13.1.2 "Using the NOMEX Multimeter Holder T20016").

4 Quick Start (Workflow)

1. Connect the NOMEX multimeter to the PC and set it up at the measuring site
2. Start the NOMEX software
3. Configure the basic NOMEX software settings:
   menu *Setup* → *Display and Audio*
4. Select the application:
   menu *Setup* → *Multimeter* → *Application*
5. Configure the measurement:
   menu *Setup* → *Measurement* → *Sensitivity Mode*
   menu *Setup* → *Measurement* → *Timer*
   menu *Setup* → *Measurement* → *Ranging*
6. Perform the measurement
   - Auto-start/auto-stop mode:
     measurement starts when a signal is detected
     measurement ends when no signal is detected
   - Manually start/stop measurement:
     Start measurement button
     Stop measurement button
7. Save measurement data:
   Save button
8. Archive measurement data
   - Print measurement data:
     Print measurements button
   - Export all measurement data:
     menu *File* → *Export all*
   - Export selected measurement data:
     Export selected measurements button
   - Export displayed waveform:
     Export waveform button
   - Copy selected measurement data to the clipboard:
     Copy selected values button
   - Copy displayed waveform:
     Copy waveform data button

5 Main Screen

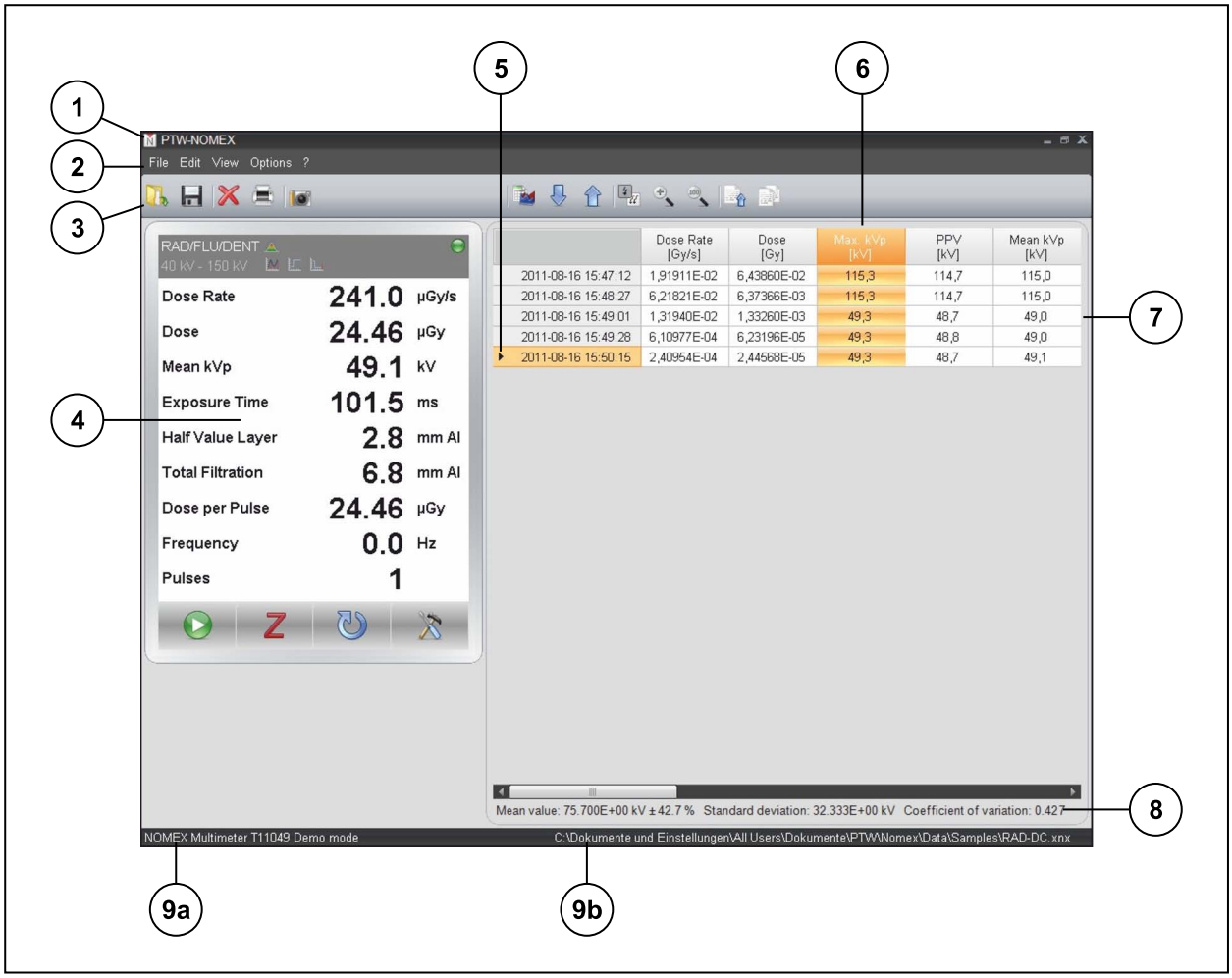


Figure 10: NOMEX software main screen with measuring table

1 *Title bar*

2 *Menu bar*

3 *Toolbar*

4 *Measuring window of the NOMEX multimeter (refer to section 5.1 "NOMEX Software Measuring Window")*

5 *Selected (highlighted) measurement in the measuring table*

6 *Selected (highlighted) column in the measuring table*

7 *Main data window with measuring table*

8 *Statistical evaluation of the column highlighted in the measuring table, indicating*
- *Mean value*
- *Standard deviation*
- *Coefficient of variation*

9 *Status bar*

a *indicating NOMEX multimeter connection status*

b *showing the path and name of the loaded file*

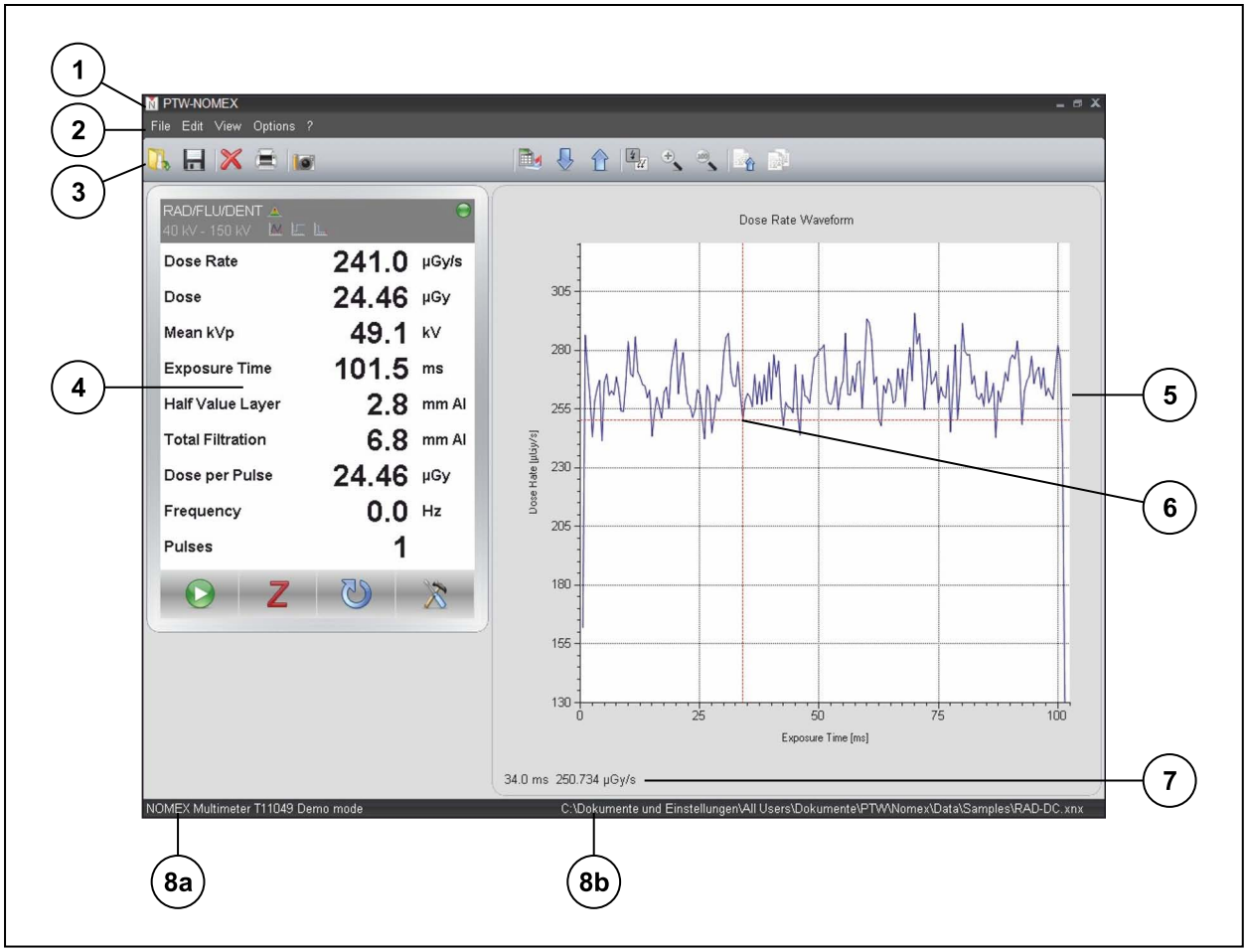


Figure 11: NOMEX software main screen with waveform

1 *Title bar*

2 *Menu bar*

3 *Toolbar*

4 *Measuring window of the NOMEX multimeter (refer to section 5.1 "NOMEX Software Measuring Window")*

5 *Main data window with waveform*

6 *Current position of the crosshairs*

7 *Measured value corresponding to the current position of the crosshairs on the waveform graph*

8 *Status bar*

- ***a*** *indicating NOMEX multimeter connection status*
- ***b*** *showing the path and name of the loaded file*

Legally Calibrated NOMEX Multimeters

NOTE

The type approval demands that the NOMEX software be displayed in the foreground at all times.

If the device is legally calibrated and the measuring window contains measured values, it is not possible to position the NOMEX software window outside the visible range or to superimpose other programs.

5.1 NOMEX Software Measuring Window

Measuring Mode

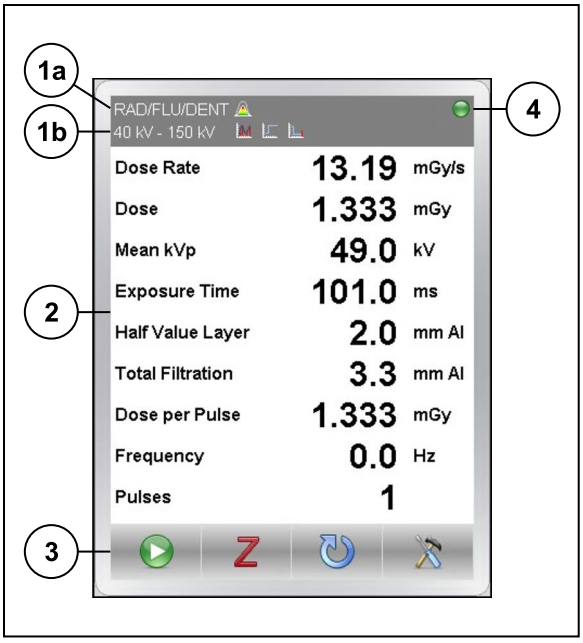


Figure 12: NOMEX multimeter measuring window in the NOMEX software

1 *Status line with*

- ***a*** *current application and current sensitivity mode*
- ***b*** *current measurement setting or menu item*
  When you move the mouse cursor over the measurement setting, the timer settings will be displayed in the form of a tooltip.

2 *Display of the measurement data or of the Setup menu*

3 *Toolbar of the measuring window*

4 *Status LED (for explanations, refer to section 5.1.1 "Status LED in the NOMEX Software Measuring Window")*

Display Mode

The NOMEX measuring window will be automatically in display mode if stored measurement data are loaded. For further information, refer to section 7.6 "Loading Stored Measurement Data".

5.1.1 Status LED in the NOMEX Software Measuring Window

(refer to Status LED **4**, Figure 12)

Function	**LED indication**
The NOMEX multimeter is inactive, i.e., it is not connected to the PC and, therefore, is not powered.	none
Establishing a communication link via USB	illuminated blue
The NOMEX multimeter is ready for measurement.	illuminated green
Measurement in progress	blinking green
Measured values are being determined.	blinking blue
The NOMEX multimeter is not ready for measurement because the device is being set up via the NOMEX software.	illuminated red
Error condition of the NOMEX multimeter Exception error, refer to section 11.1.2 "Other Error Messages"	blinking red

5.2 Icons

5.2.1 Explanation of the Main Screen Toolbar Icons


Open file


Save data


Delete all currently displayed measurement data


Print measurements or waveform graph


Copy measuring window to clipboard


Display waveform graph


Display measuring table


Display next measurement


Display previous measurement


Display tube voltage waveform graph


Display dose rate waveform graph


Enlarge a section of the waveform graph


Resize waveform graph to standard size


Export waveform data or selected measured values


Copy waveform data or selected measured values to clipboard

5.2.2 Explanation of the Measuring Window Status Bar Icons


Sensitivity Mode *Normal* is activated


Sensitivity Mode *High* is activated


Sensitivity Mode *Heavily Filtered* is activated


Measurement sampling


Start delay is activated


Stop delay is activated

5.2.3 Explanation of the Measuring Window Toolbar Icons


Start measurement manually


Stop measurement manually


Zeroing


Cancel measurement and reset measured values to zero


Display *Setup* menu


Display measuring window with measurement data


Display previous menu


Display calibration and detector information

5.2.4 Explanation of the Setup Menu Icons


Submenu exists


Menu item selected and submenu exists


Parameter or option selected


Parameter or option not selected


Application configuration menu


RAD/FLU/DENT application


CT application


DENT-PAN application


MAM application


A compression paddle is used for MAM applications


No compression paddle is used for MAM applications


Measurement configuration menu


Sensitivity mode configuration menu


Sensitivity mode - Normal


Sensitivity mode - High


Sensitivity mode - Heavily filtered


Measurement timer configuration menu


Measurement sampling


Start delay (delay before measurement starts)


Stop delay (delay before measurement stops)


Measuring range configuration menu

kV measuring range


TF measuring range


Buttons to start/stop a measurement manually


Display and audio menu


Language


Introduction (Intro)


Beep

Icons on Legally Calibrated Devices:


NOMEX multimeter is legally calibrated


RAD/FLU/DENT application is legally calibrated


RAD/FLU/DENT application is not legally calibrated


CT application is legally calibrated


CT application is not legally calibrated


DENT-PAN application is legally calibrated


DENT-PAN application is not legally calibrated


MAM application is legally calibrated


MAM application is not legally calibrated

5.2.5 Explanation of Warning and Error Icons

Warning
Measured value with reduced accuracy
The measuring error is ≥ 5 %.

or

Error
The system is not able to determine the measured value.
This icon is always accompanied by an error message. For further information, refer to section 11.1.1 "Error Messages of the Measured Quantities".

Severe error
This icon is always displayed in an error window. For further information, refer to section 11.1.2 "Other Error Messages".

5.3 Context Menu

Context menus are available for important and special functions. Context menus are activated with a right mouse click. The program offers different context menus for the different windows.

5.4 Changing the Presentation of Measurement Data

5.4.1 Measuring Table and Waveform Positions

- To display the measuring table, select menu *View* → *Table* or click the following button.

- To display the waveform, select menu *View* → *Waveform* or click the following button.

- To display the tube voltage waveform, select menu *View* → *Waveform* → *Tube Voltage* or click the following button.

- To display the dose rate waveform, select menu *View* → *Waveform* → *Dose Rate* or click the following button.

5.4.2 Determining the Dose Unit

The dose or dose rate can be displayed in Gray [Gy] or Roentgen [R] units.

- To display the units [Gy] or [Gy/s], select menu *View → Dose unit → [Gy]*.

- To display the units [R] or [R/s], select menu *View → Dose unit → [R]*.

NOTE
The units [R] and [R/s] are not available on legally calibrated devices.

5.4.3 Determining the Type of Tube Voltage Displayed

After the measurement, the following values are determined for the tube voltage:

– mean peak voltage (mean kVp)
  The mean kVp corresponds to the mean value of the upper 10 % of the highest measured tube voltages.
– maximum peak voltage (maximum kVp)
  The maximum kVp corresponds to the highest measured tube voltage that has been recorded 5 times.
– practical peak voltage (PPV)
  The PPV is calculated according to the algorithm of IEC 61676.

One of these values can be selected for display:

- To display the mean peak voltage, select menu *View → Tube Voltage → Mean kVp*.

- To display the maximum peak voltage, select menu *View → Tube Voltage → Max. kVp*.

- To display the practical peak voltage, select menu *View → Tube Voltage → PPV*.

or

- Continue clicking the appropriate row in the measuring window until the desired value is displayed.

5.4.4 Changing the Display Format of the Measuring Table

Hiding Columns

- In the measuring table, click the header(s) of the column(s) to hide.

➔ The columns will be highlighted.

- Select the *Hide columns* context menu.

➔ The highlighted columns will be hidden.

This function can be applied repeatedly.

Showing All Columns

- Select the *Show all columns* context menu.

➔ All columns will be displayed.

Determining the Value Presentation

The measured values can be displayed in two ways:

- Presentation in technical notation:
  To choose this presentation, select context menu *Value presentation → Technical notation*.

- Presentation with unit prefix:
  To choose this presentation, select context menu *Value presentation → Value with unit*.

The type of presentation can also be selected on the *Table* tab of the *Options* menu (refer to section 10.4 "Measuring Table Options").

Determining the Row Header

The following titles can be used as row headers of the measuring table:

- Number of the measurement:
  To choose this title, select context menu *Row header → Measurement number*.

- Date of the measurement:
  To choose this title, select context menu *Row header → Measurement date*.

The row header can also be selected on the *Table* tab of the *Options* menu (refer to section 10.4 "Measuring Table Options").

6 NOMEX Multimeter Setup

6.1 General Information

The following settings can be selected in the Setup menu of the NOMEX software:

– device and detector settings

– measurement settings

– user interface settings (e.g. the language).

All these settings are stored in the non-volatile memory of the NOMEX multimeter, which means they are retained even when the device is switched off.

Upon the connection of a NOMEX multimeter, its settings will automatically be loaded.

- In the measuring window, click the *Setup* button. 

➔ The *Setup* menu will be displayed:

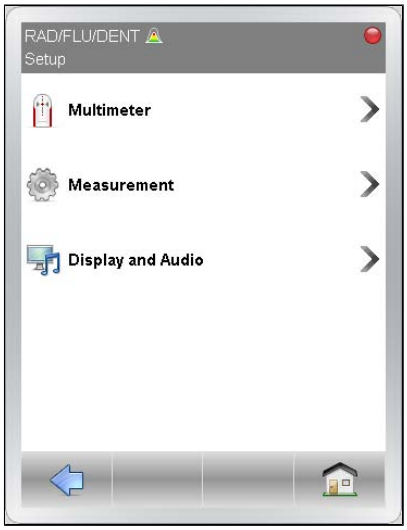


Figure 13: Setup menu

- Select a menu item by clicking the corresponding line.

6.1.1 Changing the Setup

We distinguish between three kinds of settings:

– editing numeric values
– selecting a value from a dropdown list
– enabling and disabling an option.

6.1.1.1 Editing Numeric Values

- Click the setting you want to change.
- Delete the numbers that are not needed with the backspace key or with the *Del* key.
- Enter the new value.

or

- Doubleclick the setting you want to change.

➔ The background of the value turns **blue**.

- Enter the new value.

6.1.1.2 Selecting Values from a Dropdown List

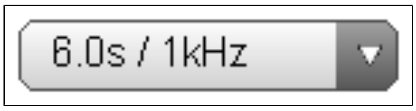


Figure 14: Example showing the sampling time dropdown list

- Click the dropdown list.

➔ The dropdown list opens.

- Click the desired value.

6.1.1.3 Enabling and Disabling Options

A red cross identifies the options that are disabled.

- Click the option you want to enable.

➔ The option will be enabled and is identified with a green check mark.

- Click the option again to disable it.

➔ The option will be disabled and is identified with a red cross again.

6.2 Detector Menu

- In the *Setup* menu, click the *Multimeter* line. 

➔ The *Multimeter - Application* menu for the NOMEX multimeter will be displayed:

Figure 15: Multimeter - Application menu

The following settings can be performed in the *Multimeter - Application* menu:

– selection of the NOMEX multimeter application

– display of the NOMEX multimeter calibration and detector information.

6.2.1 Selecting the Application

The *Multimeter - Application* menu will be displayed.

- Click the application that you want to select:
  – RAD/FLU/DENT
  – CT
  – DENT-PAN
  – MAM

➔ The selected application will be identified with a green check mark. 

- The MAM application requires further settings to be performed. To access these settings, click the *MAM* line.
  - Select or deselect the *Compression Paddle* function.
    This setting ensures that the values obtained by a measurement with a compression paddle are corrected.
  - Click the beam quality you want to use:
    – Mo / 30 µm Mo
    – Mo / 0.5 mm Al
    – Mo / 25 µm Rh
    – W / 50 µm Rh
    – Rh / 25 µm Rh
    – W / 50 µm Ag
    – W / 0.7 mm Al

6.2.2 Display of the Calibration and Detector Information

The *Multimeter - Application* menu will be displayed.

- To view the NOMEX multimeter calibration and detector information, click the *Calibration and detector information* button.

The following calibration and detector information will be displayed:

– device manufacturer

– device name

– type number of the device

– serial number of the device

– device model

– calibration data

  The following calibration conditions are displayed separately for each application:

  – tube voltage

  – anode material

  – total filtration

  – half value layer (HVL)

  – calibration factor (Nk)

– date of the next device calibration

– hardware version

– firmware version

– bootloader version

6.3 Measurement Setup

- In the *Setup* menu, click the *Measurement* line. 

➔ The *Measurement* menu will be displayed:

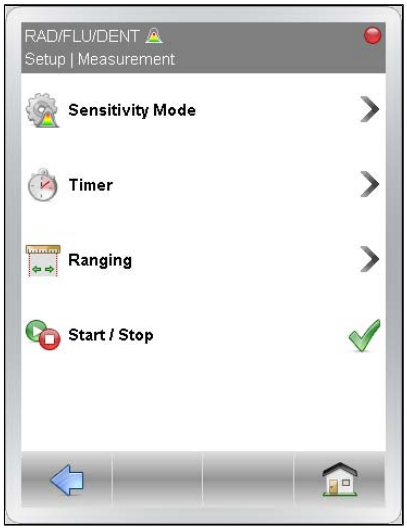


Figure 16: Measurement menu

- Select the desired menu item by clicking the corresponding line.

The following settings can be performed in the *Measurement* menu:

– Selection of the sensitivity mode in the corresponding submenu:
  – Normal
  – High
  – Heavily Filtered.

– Timer settings in the corresponding submenu:
  – Measurement sampling
  – Start delay (delay before measurement starts)
  – Stop delay (delay before measurement stops).

– Selection of the measuring ranges in the corresponding submenu:
  – kV range (measuring range of the tube voltage)
  – TF range (measuring range of the total filtration).

– Show/hide button to start/stop a measurement manually.
  In sensitivity mode *Normal*, the button for performing the zero adjustment manually will also be shown or hidden hereby.

6.3.1 Sensitivity Mode

The following settings are available in the *Sensitivity Mode* menu:

Normal

The sensitivity mode *Normal* is the standard measuring mode of the NOMEX multimeter.

High

The sensitivity mode *High* is intended for measuring low dose rates (< 5 µGy/s) at direct current/high frequency tube voltages (DC/HF). The recommended minimum measuring time is 5 seconds.

In this mode the measurement sampling and the start delay in submenu *Timer* cannot be configured.

In addition, the following measuring quantities are not available:
– Mean dose rate after the measurement [1)]
– Dose per pulse
– Frequency
– Pulses.

In the sensitivity mode *High* the measured values of kVp_{max}, kVp_{mean} and PPV are identical. The time resolution is 0.5 sec.

Heavily Filtered

The sensitivity mode *Heavily Filtered* is intended for measuring low dose rates (< 5 µGy/s) at direct current/high frequency tube voltages (DC/HF) and heavily filtered radiation qualities (TF > 1 mm Cu). The recommended minimum measuring time is 5 seconds.

In this mode, the following measurement settings in the submenus *Timer* and *Ranging* cannot be configured:
– Measurement sampling
– Start delay
– kV range
– TF range.

In the sensitivity mode *Heavily Filtered* only the following measuring quantities are available:
– Dose rate during the measurement [1)]
– Dose
– Exposure time.

In this mode, the time resolution is 0.5 sec.

The sensitivity mode *Heavily Filtered* makes sense if you intend, for instance, to measure the dose rate in fluoroscopy behind an absorber with 1.5 mm Cu + 25 mm Al.

For MAM applications, it is not possible to select the sensitivity modes *High* and *Heavily Filtered*.

[1)] In both sensitivity modes "High" and "Heavily Filtered", the current dose rate will be displayed during the measurement
After the measurement, **"---"** will be displayed instead of the mean dose rate because of the reduced time resolution of 0.5 seconds.

6.3.2 Measurement Sampling

The following settings can be made for measurement sampling:

– Measuring time of 3 s at a sampling rate of 2 kHz
– Measuring time of 6 s at a sampling rate of 1 kHz
– Measuring time of 12 s at a sampling rate of 500 Hz
– Measuring time of 24 s at a sampling rate of 250 Hz
– Measuring time of 60 s at a sampling rate of 100 Hz.

In the sensitivity modes *High* and *Heavily Filtered*, you cannot adjust the measurement sampling. It is set to a measuring time of 3000 s at a sampling rate of 2 Hz.

For the storage of the entire exposure time, the sampling time must be longer than the exposure time. Select a sampling rate that results in an exposure time shorter than the sampling time.

6.3.3 Start Delay

A start delay (delay before the measurement starts) in a range from 0 ms to 9999 ms can be adjusted.

The start delay is the period of time between the radiation start and data logging start.

Setting a start delay allows you to eliminate the power-up effects of the installation (excessive tube current or tube voltage) from the kV measurement result.

The set start delay does not affect the measured dose. It only controls the time when the storage of the dose rate waveform starts.

6.3.4 Stop Delay

If a stop delay (delay before the measurement stops) has been set, the NOMEX multimeter waits for this time to elapse after the detection of the automatic end of the measurement. The measurement is then considered completed and is terminated.

The following settings are available for the stop delay:

– *Off*,
  i.e., the stop delay is automatically set to 100 ms
– *1 s*,
  i.e., the stop delay is 1 s
– …
– *5 s*,
  i.e., the stop delay is 5 s.

Periods of more than 1 second may be useful if, for example, radiation intervals longer than 1 second are expected. This allows the total dose of multiple radiation pulses with long intervals to be measured.

6.3.5 kV Range

The following settings are available for the kV range (tube voltage range):

– automatic adjustment of the kV range *Auto*
– manual adjustment of the kV range

The automatic adjustment of the kV range is the easiest and most accurate method for the measurement of an unknown signal. The NOMEX multimeter automatically determines the correct measuring range. As a general rule, PTW recommends performing measurements with the automatic kV range setting.

The following kV ranges can be set manually:

RAD/FLU/ DENT [kV]	**CT DENT-PAN [kV]**	**MAM [kV]**
40 … 75 60 … 115 90 … 150	60 … 115 90 … 150	23 … 35

NOTE

At power-up or when the application is changed, the kV range is automatically set to *Auto*.

For MAM applications, it is **not** possible to select the kV range.

The measurable tube voltage (kV) depends on the total filtration and vice versa. For measurable combinations of tube voltage and total filtration, refer to Figure 17. The gray area is the range that is defined by PTW for measuring the tube voltage, dose, and half value layer. It is also possible to perform measurements in the hatched areas. In this case, however, the measurement results may be less accurate.

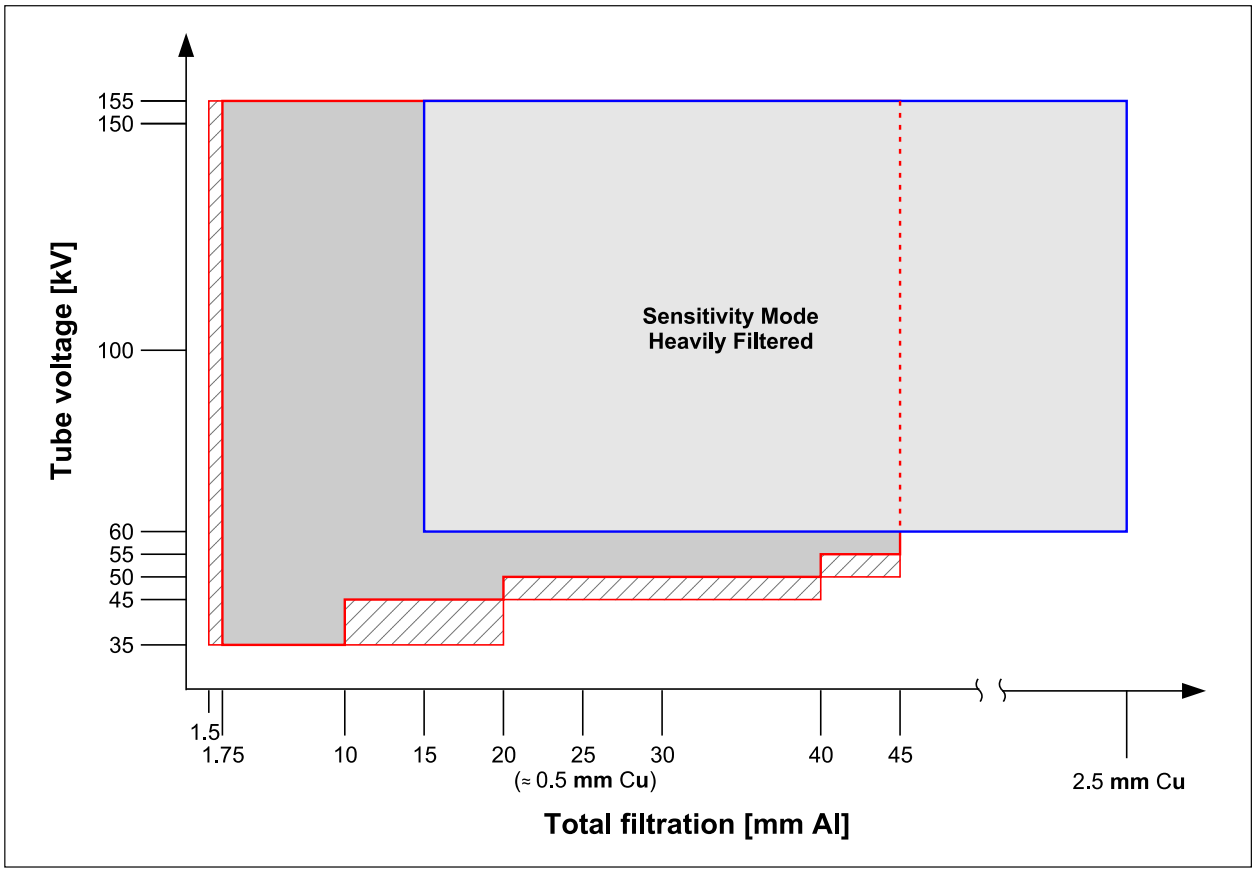


Figure 17: Measurable combinations of kV and TF for measuring the tube voltage, dose, and half value layer in sensitivity mode "Normal" or for measuring the dose in sensitivity mode "Heavily Filtered"

6.3.6 TF Range

The following settings are available for the TF range (total filtration range):

– *Auto*,
  i.e., automatic detection of the total filtration during a measurement

– *Manual*,
  i.e., manual entry of the total filtration

NOTE

At power-up or when the application is changed, the TF range is automatically set to *Auto*.

NOTE

When the TF range is set to *Manual*, the total filtration is displayed in gray in the measuring table and on the measuring window. The color gray indicates that the total filtration is not a measured value but rather a set value. The set total filtration value is also displayed in the status line of the measuring window.

For MAM applications, it is **not** possible to select the TF range.

The measurable total filtration depends on the tube voltage (kV) and vice versa. For measurable combinations of tube voltage and total filtration, refer to Figure 18. The gray area is the range that is defined by PTW for measuring the total filtration. It is also possible to perform measurements in the hatched areas. In this case, however, the measurement results may be less accurate.

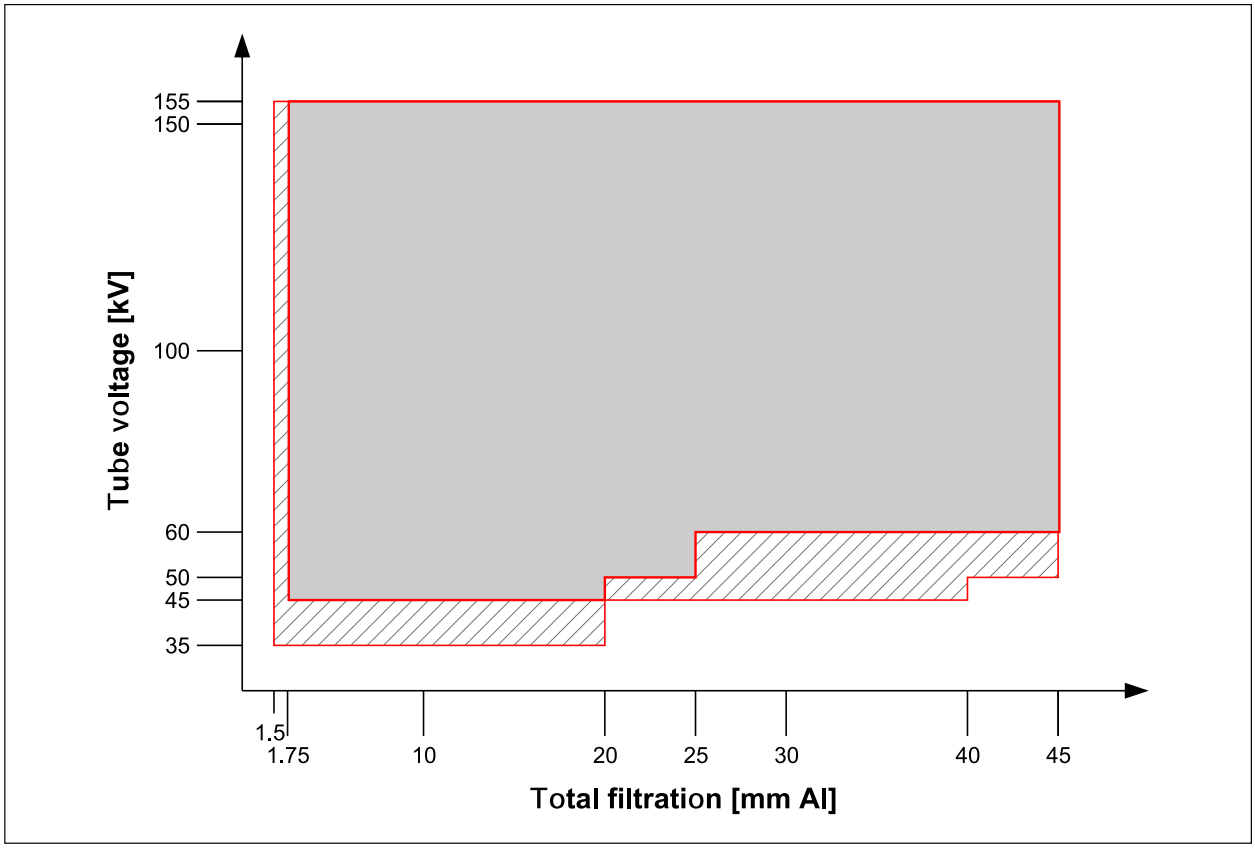


Figure 18: Measurable combinations of kV and TF for measuring the total filtration

6.3.7 Start/Stop

The NOMEX multimeter is normally used in the auto-start/auto-stop mode. If needed, a measurement can be manually started and stopped when the button for the manual start and manual termination of the measurement is visible on the measuring window.

You can show and hide this button by enabling and disabling the *Start / Stop* option.

NOTE

If you have disabled the *Start / Stop* option, the *Zeroing* button will be hidden in sensitivity mode *Normal*. Thus, zeroing manually is no longer possible in this mode. For further information, refer to section 7.3.4 "Zero Adjustment".

Auto-Start/Auto-Stop:

The NOMEX multimeter is permanently in auto-start mode. This means that a measurement starts automatically when a signal is detected.
For dose measurements, the dose and time values are first set to zero (auto reset).

Manual Start/Stop:

When the *Start / Stop* option is enabled, the button for the manual start and manual termination of the measurement is visible on the measuring window.

Start measurement manually

Stop measurement manually

6.4 Display and Audio Setup

- In the *Setup* menu, click the *Display and Audio* line. 

➔ The *Display and Audio* menu will be displayed:

Figure 19: Display and Audio menu

- Select the desired menu item by clicking the corresponding line.

The following settings can be performed in the *Display and Audio* menu:

– selection of the language

– enabling or disabling the introduction

– enabling or disabling the audio signal (beep)

6.4.1 Language

The menus, dialogs, and messages can be displayed in different languages. 

The following languages can be selected:

– German

– English

– French

– Spanish

– Portuguese

– Italian

– Russian

– Chinese

– Japanese.

6.4.2 Introduction (Intro)

If the Intro option is enabled, an intro will be displayed on the start screen during initialization and during the automatic selftest. 

6.4.3 Beep

If the Beep option is enabled, the system will emit an audio signal to acknowledge the activation of buttons or the end of a measurement (when new measured values are available). 

7 Measurements with the NOMEX Multimeter

7.1 Preparing Measurements

RAD/FLU/DENT and MAM Applications

The measurement area of the NOMEX multimeter must be located in the radiation beam of the X-ray unit and the detector area must be **fully irradiated** (refer to Figure 8).

CT or DENT-PAN Application

The measurement area with a width of 3 mm must be **fully irradiated** (gray area in Figure 9). The bar with a width of approx. 1 mm (**4**, Figure 4) indicates the center of the measurement area.

NOTE

To obtain the most accurate kV measurement results possible, the dose rate selected on the X-ray unit should not be too small. The NOMEX software does not require any special settings, because the NOMEX multimeter automatically selects the optimal dose rate measuring range.

NOTE

Rotation of the CT and DENT-PAN X-ray units is not permitted. The X-ray tube must be positioned vertically above the NOMEX multimeter.

During irradiation, the tube voltage value in kV is determined for an exposure time corresponding to the maximum storage time. The maximum storage time depends on the selected sampling rate, e.g. maximum storage time of 3.2 s at a sampling rate of 2 kHz.
Only the values stored in the log memory are taken into account in the calculation of the kV measured value.
Dose and time are measured continuously.
All readings are updated at 0.5 s intervals.

7.2 Verifying the Settings Before a Measurement

1. The application selected in the NOMEX software is appropriate for the X-ray unit used (RAD, FLU, DENT, MAM, CT, DENT-PAN).

2. In the NOMEX software, the total filtration is set to *Auto* or to a filtration value which corresponds to the filtration of the X-ray unit (e.g. 3 mm Al).

3. The detector area of the NOMEX multimeter is located at the center of the irradiated field and is fully irradiated.

4. The dose rate is within the measuring range of the NOMEX multimeter.

5. The sensitivity mode set in the NOMEX software matches the dose rate to check.

6. The sampling rate set in the NOMEX software matches the desired storage time.

7. In case of excessive voltage or current, a start delay has been set at the NOMEX multimeter.

8. The exposure time set on the X-ray unit is sufficient for an accurate measurement.

NOTE

As a matter of course, the measuring time should be proportionately longer with a higher ripple and smaller ripple frequency of the tube voltage waveform. Experience has shown that optimal results are obtained with measuring times ≥ 100 ms. If in doubt it is recommended to verify the measurement results for shorter measuring times at approx. 100 ms.

NOTE

Please refer to section 6 "NOMEX Multimeter Setup" for information about the required settings for the intended measurement.

7.3 Performing the Measurement

7.3.1 Starting the Measurement

⚠ CAUTION

Operation under unsuitable ambient conditions or when the NOMEX multimeter is moved.

Erroneous Measurements!

The NOMEX multimeter is a highly sensitive multi-channel semiconductor detector. For this reason, cosmic radiation as well as moving the NOMEX multimeter are capable of starting a measurement.

Auto-Start:

The NOMEX multimeter is permanently in auto-start mode. This means that a measurement begins as soon as a signal is detected. Before, however, all parameter readings will be set to zero (auto-reset).

Manual Start:

If the *Start / Stop* option in the *Measurement* menu is enabled, a measurement can also be started by clicking the *Start measurement* button on the measuring window.

7.3.2 Readouts During the Measurement

The display is updated at 0.5 s intervals.

NOTE

The displayed *Dose per Pulse* result is a value averaged over all pulses of the sequence. Therefore, a change of the dose rate during the measurement will cause erroneous readouts.

7.3.3 Stopping the Measurement

Auto-Stop:

A measurement initiated with auto-start ends automatically when no measuring signal is detected for a period longer than the stop delay. It is not possible to stop the measurement manually.

By clicking the *Reset measurement* button on the measuring window, you can abort the measurement and reset the measured values to zero.

Manual Stop:

A measurement started manually must be stopped with the *Stop measurement* button on the measuring window.

7.3.4 Zero Adjustment

In sensitivity mode *Normal*, an automatic zero adjustment is performed after each automatically triggered measurement (auto-start/auto-stop mode).

No zero adjustment is performed after having manually started and stopped measurements and the measured values are corrected with the values of the previous zero adjustment.

If a successful zero adjustment is not possible after a measurement, a corresponding message will be displayed and the subsequent measured values are corrected with the values of the previous zero adjustment.

As an alternative, initiate the zero adjustment manually by clicking the *Zeroing* button. Do not move the NOMEX multimeter during the zero adjustment.
You can also initiate the zero adjustment during a running measurement. This, however, will abort the measurement.

7.3.5 Readouts at End of Measurement

After the termination of the measurement, the measured values are stored. Storing a large number of measured values may take a few seconds. During this period, the LED at the NOMEX multimeter and on the measuring window blinks blue (refer to sections 1.3 "Status LED on the NOMEX Multimeter" and 5.1.1 "Status LED in the NOMEX Software Measuring Window").

Upon completion of the measurement, the measurement data will be displayed depending on the selected application according to Table 1.

In both sensitivity modes *High* and *Heavily Filtered*, the current dose rate will be displayed during the measurement.
After the measurement, the mean dose rate display can vary because of the reduced time resolution of 0.5 seconds.

The measurement data to be displayed can be selected on the *Displayed values* tab of the *Options* menu.

	Application			
	RAD/FLU/DENT	**CT**	**DENT-PAN**	**MAM** [1]
Dose rate [2] [3]	**X**	**X**	**X**	**X**
Dose [2] [3]	**X**	**X**	**X**	**X**
Mean kVp, maximum kVp or PPV (selectable) [2]	**X**	**X**	**X**	**X**
Exposure time [2] [3]	**X**	**X**	**X**	**X**
Half value layer (HVL) [2]	**X**	**X**	**X**	**X**
Total filtration (TF) [2]	**X**	**X**	**X**	
Dose per pulse	**X**		**X**	**X**
Pulse frequency	**X**		**X**	**X**
Pulses	**X**		**X**	**X**
Tube voltage waveform [2] [3]	**X**	**X**	**X**	**X**
Dose rate waveform [3]	**X**	**X**	**X**	**X**

Table 1: Available measurement data in sensitivity mode Normal depending on the application

[1] For MAM applications, the sensitivity modes "High" and "Heavily Filtered" are not possible.
[2] Possible measurement data in sensitivity mode "High"
[3] Possible measurement data in sensitivity mode "Heavily Filtered"

7.3.5.1 Measurements with Very Short Exposure Times

The measuring amplifiers of the NOMEX multimeter are always set to autoranging for the sensitivity of all channels. During the measurement, the measuring amplifiers will switch to a higher range if needed. A short exposure time combined with the required adaptation of the measuring range for dose measurements may thus lead to results with reduced accuracy. In this case, repeat the measurement.

When evaluating the measured data at the end of the measurement, the NOMEX multimeter is able to discern whether the exposure time was too short and whether longer exposure times are required due to the dead times resulting from range switching. In this case, the measuring amplifier range that was used last will be retained for subsequent measurements because NOMEX assumes constant signal levels. Thus, measuring with very short exposure times is possible.

7.3.6 Warning and Error Messages

If the measurement accuracy is reduced (measuring error ≥ 5 %), the information icon and the following warning will be displayed in the status line of the measuring window:

Figure 20: Status line with warning of reduced accuracy

If the measured values cannot be determined, the information icon and one or several error messages will be displayed in the status line of the measuring window. The measured values will be replaced by "**---**".

Figure 21: Staus line with an error message when the measured values cannot be determined

For further information, refer to section 11.1.1 "Error Messages of the Measured Quantities".

7.3.7 Session Comment

By default, the NOMEX multimeter settings are saved as comments with each measurement.

- If you want to enter another comment, click the appropriate measurement data set in the measuring table and select the *Edit comment* context menu.

➔ The *Edit comment* dialog will be displayed.

- Enter the desired comment and click *OK*.

7.4 Determining the Measured Values

Sensitivity Mode *Normal*

During the measurement, the measured values are stored in the internal log memory.

From the values stored in the memory, the program determines the measurement results for the following parameters:

– mean peak voltage (mean kVp)

– maximum peak voltage (maximum kVp)

– practical peak voltage (PPV)

– half value layer (HVL)

– tube voltage waveform

– dose rate waveform.

With the maximum sampling rate of 2 kHz, the memory depth (maximum measuring time) is 3.2 seconds. When the memory is full, the subsequent measured values will not be included in the determination of the measured value.

NOTE

If all values measured over a long exposure time are to be included in the determination of the measured value, make sure to set a matching sampling rate.

Example:
measurement over a total exposure time of 10 seconds, with a radiation of 100 kV in the first 5 seconds and a radiation of 150 kV in the last 5 seconds.
At a sampling rate of 2 kHz, only the first 3.2 seconds would be included in the measured value and the kVp result would be 100 kV.

Determination of the measured dose quantities is independent of the memory. The measured dose quantities are determined over the entire exposure time.

Sensitivity Modes *High* and *Heavily Filtered*

In the sensitivity modes *High* and *Heavily Filtered*, the determination of the measured values is independent of the memory. The measured values are determined over the entire exposure time.

The values of mean peak voltage (mean kVp), maximum peak voltage (maximum kVp), and practical peak voltage (PPV) are identical.

7.5 Saving Measurement Data

- To save measurement data, click the *Save* button or select menu *File* → *Save* or → *Save as.*

➔ With menu *File* → *Save*, you overwrite the open file.

➔ With menu *File* → *Save as*, you create a new file.

- When creating a new file, enter a file name and directory in the standard *Save* dialog. You can overwrite existing files or create new files.

7.6 Loading Stored Measurement Data

- To load stored measurement data, click the *Open* button or select menu *File* → *Open*.

- Select the file to open from the standard *Open* dialog.

➔ NOMEX will check whether the application and the measurement settings of the data to load match the current settings.

- If the application does not match, an appropriate message will appear. Confirm the message with *OK*.

➔ The file will be loaded, overwriting the currently displayed measurement data. If the currently displayed data were not yet saved, a message will appear and you can save them, if required.

➔ In the main data window, either the current measurement will be highlighted in the measuring table or the waveform graph of the current message will be displayed.

➔ The measuring window will show the measured values of the current measurement.

- By clicking the *Next* button

  – the next measurement will be highlighted in the measuring table or the waveform graph of the next message will be displayed in the main data window

  – the measuring window will show the measured values of the next measurement.

- By clicking the *Previous* button

  – the previous measurement will be highlighted in the measuring table or the waveform graph of the previous message will be displayed in the main data window

  – the measuring window will show the measured values of the previous measurement.

- By clicking the *Reset measurement* or by changes in the menu *Setup* (*Setup* button) all measured values will be set to 0.

Operational Readiness of the NOMEX System when Data are Loaded

1. If the application of the loaded data does not match the current settings, the application shown in the status line of the measuring window will be grayed out.

   ➔ The current settings will be preserved and you can still perform measurements with these settings.

   ➔ When you perform a new measurement, the currently displayed measurements will be discarded and a new data set will be created. If the currently displayed measurements were not yet saved, a message will appear and you can save them, if required.

2. If the measurement settings of the loaded data do not completely match the current settings, the settings shown in the status line of the measuring window will be grayed out.

   ➔ The current settings will be preserved and you can still perform measurements with these settings.

   ➔ When you perform a new measurement, it will be appended to the currently displayed measurements.

7.7 Deleting Measurement Data

7.7.1 Deleting All Measurement Data

- To remove all measurement data from the display, click the *Delete measurements and reset display* button. 

➔ The measurement data will be deleted right away without any further confirmation.

➔ If the existing data are not yet saved, a warning will appear and you can save them, if required.

7.7.2 Deleting Individual Measurement Data

- In the measuring table, click the measurement data set(s) to delete.

- Select menu *Edit* → *Delete selected measurements* or context menu *Delete selected measurements* or press the *Del* key.

➔ After confirmation of the prompt, the selected data will be removed from the measurement table.

- Save the changes as described in section 7.5 "Saving Measurement Data".

8 Exporting and Copying Measurement Data

8.1 Exporting Measurement Data

The NOMEX software allows you to export the measurement data in the CSV or XML format. A CSV file can be opened directly with a spreadsheet program, such as Microsoft Excel.

NOTE

When importing CSV files in Microsoft Excel, you may encounter the following problems:

– The data are not properly left or right-justified.
  Cause:
  Justification depends on the setting in Microsoft Excel.

– The decimal point or comma representation of decimal numbers is not correct.
  Cause:
  NOMEX exports the decimal point or comma format as required by the selected NOMEX language. Microsoft Excel, however, uses the language of the operating system.
  If possible, set NOMEX to the language of the operating system.

8.1.1 Exporting All Measurement Data

- Select menu *File* → *Export all*.
- In the standard *Save as* dialog, enter a file name and the directory and select the file format. You can overwrite existing files or create new files.

➔ All measurement data are exported in the CSV or XML format.

8.1.2 Exporting Individual Measurement Data sets

Condition:
The measuring table is displayed in the main data window.

- In the measuring table, click the measurement data sets to export.
- To export the selected measurement data sets, click the *Export selected measurements* button.

- In the standard *Save as* dialog, enter a file name and the directory and select the file format. You can overwrite existing files or create new files.

➔ The selected measurement data sets are exported in the CSV or XML format.

8.1.3 Exporting the Displayed Waveform

Condition:
The waveform to export is displayed in the main data window.

- To export the selected waveform, click the *Export waveform* button or select menu *File* → *Export all*.

- In the standard *Save as* dialog, enter a file name and the directory and select the data format. You can overwrite existing files or create new files.

- The measured values of the selected waveform are exported in the CSV or XML format.

8.2 Copying Measurement Data

The NOMEX software allows you to copy measurement data to the clipboard. From the clipboard, the data can be pasted to another program (e.g., a spreadsheet program or an editor).

NOTE

When pasting data from the clipboard to Microsoft Excel, you may encounter the following problems:

– The data are not properly left or right-justified.
  Cause:
  Justification depends on the setting in Microsoft Excel.

– The decimal point or comma representation of decimal numbers is not correct.
  Cause:
  NOMEX exports the decimal point or comma format as required by the selected NOMEX language. Microsoft Excel, however, uses the language of the operating system.
  If possible, set NOMEX to the language of the operating system.

8.2.1 Copying Individual Measured Values

Condition:
The measuring table is displayed in the main data window.

- In the measuring table, click the measured values to copy.
- To copy the selected measurement data sets, click the *Copy selected values* button  or select menu *Edit → Copy selected values*.

➔ The selected measured values are copied to the clipboard.

8.2.2 Copying the Measured Values of the Displayed Waveform

Condition:
The waveform to copy is displayed in the main data window.

- To copy the selected waveform, click the *Copy waveform data* button  or select menu *Edit → Copy waveform data*.

➔ The measured values of the selected waveform are copied to the clipboard.

8.2.3 Copying the Measuring Window

- Click the *Copy measuring window* button  .

➔ The content of the measuring window (measurement data or menu) is copied to the clipboard.

9 Printing Measurement Data

NOTE

To ensure that Japanese, Chinese, and Russian characters are properly printed, Microsoft Excel must be installed on the PC (see section 2.1 "Minimum Hardware Requirements").

- To print the measurement data, select menu *File → Print*.
- To obtain a preview of the measurement data, select menu *File → Print preview*.

➔ The *Print* dialog will be displayed:

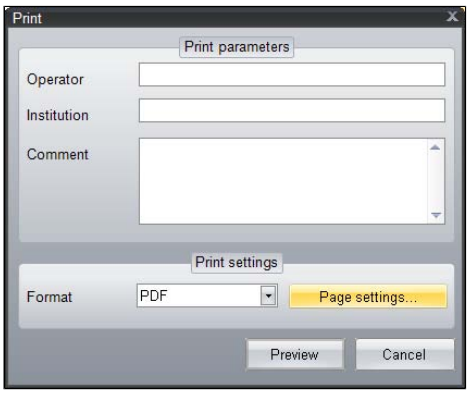


Figure 22: Print dialog (e.g., for the print preview)

- Enter the administrative data for the printout or the print preview.
- Select the output format for the printout or the preview from the list box.

NOTE

If you select an output format for which no application is installed on the PC (e. g., output format PDF and Adobe Reader is not installed), the print preview will not be shown.

NOTE

After viewing the print preview with Adobe Reader, you must close Adobe Reader or the document. Otherwise, an error message will be displayed when you are trying to view the next print preview because the document that is to be displayed is already open.

- To define the page layout, click the *Page settings...* button.
- Click the *Print* button to print the data or click the *Print preview* button to display the print preview.

10 NOMEX Software Options

Select the *Options* menu to display the *Options* dialog.

The *Options* dialog comprises four tabs for the following topics:

– *Displayed values*:
selection of the values to be displayed in the measuring window for the currently selected application

– *Demo mode:*
selection of the simulation mode

– *Graphic*:
options for the storage of the waveforms

– *Table*:
options for the measuring table

With the *Reset* button you restore the default settings of the currently displayed tab.

10.1 Selecting the Displayed Values

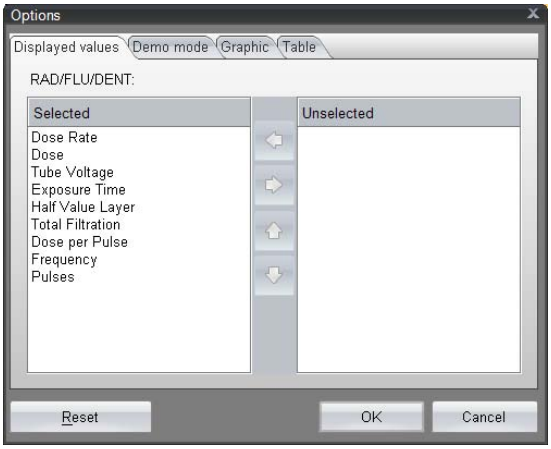


Figure 23: Options dialog - Displayed values tab

On the *Displayed values* tab, you can select the values to be displayed on the measuring window.

The choices depend on the selected application.

The window on the left shows the currently displayed values, the window on the right shows the values not currently displayed.

Use the buttons between the two windows to move the values and to determine their order.


Click to move the value selected in the right window to the left window.


Click to move the value selected in the left window to the right window.


Click to move the selected value up.


Click to move the selected value down.

10.2 Demo Mode

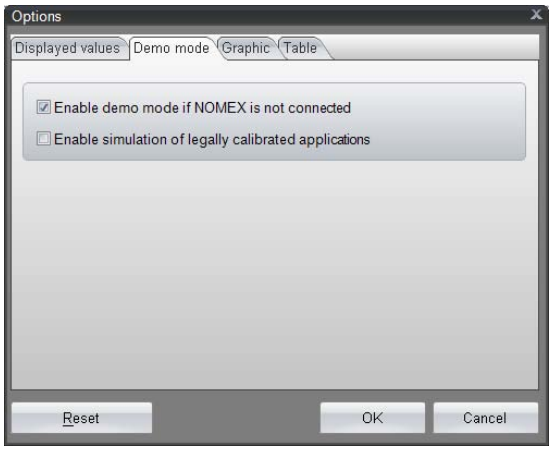


Figure 24: Options dialog - Demo mode tab

On the *Demo mode* tab, you will find the following options:

You can choose to activate the demo mode when no NOMEX multimeter is connected. In demo mode, there is no communication with the NOMEX multimeter. The NOMEX software simulates the measurement.

You can choose to simulate a legally calibrated application of the NOMEX multimeter.

10.3 Waveform Storage Options

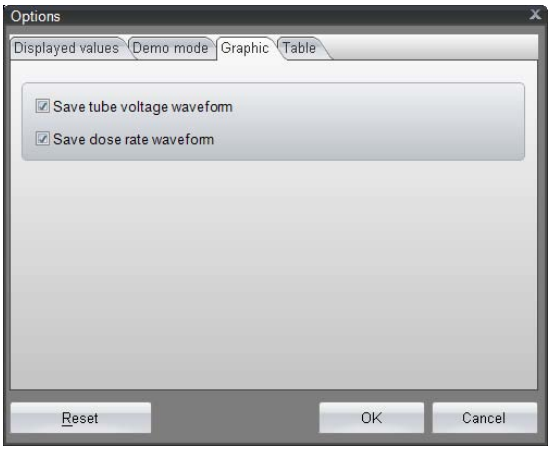


Figure 25: Options dialog - Graphic tab

On the *Graphic* tab, you can choose the waveform data to be stored: tube voltage waveform or dose rate waveform or both waveforms.

10.4 Measuring Table Options

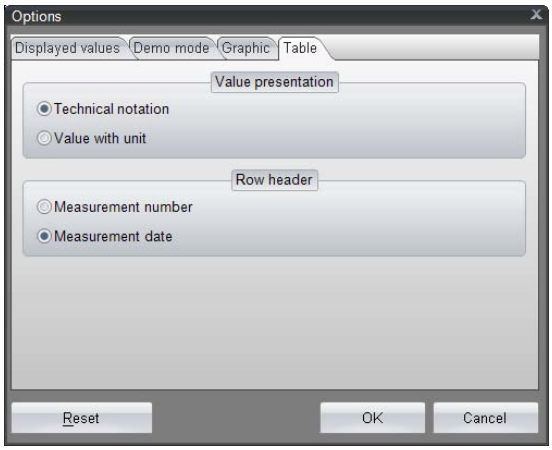


Figure 26: Options dialog - Table tab

On the *Table* tab, you will find the following options:

In the *Value presentation* pane, you determine the display format of values as they are shown in the measuring table:

– Presentation in technical notation
– Presentation with unit prefix

In the *Row header* pane, you determine the row header format that is used in the measuring table:

– Number of the measurement
– Date of the measurement.

11 Error Messages and Erroneous Measurements

11.1 Error Messages

11.1.1 Error Messages of the Measured Quantities

If an error occurs during the measurement or evaluation of the measurement data, the information icon and one or several appropriate error messages will be displayed in the status line of the measuring window. If required, the error messages will be abbreviated.

If the determination of the measured values is not possible for specific measured quantities, the measured values of the quantities concerned will be replaced by **"---"**.

Example:
The exposure time is too short.

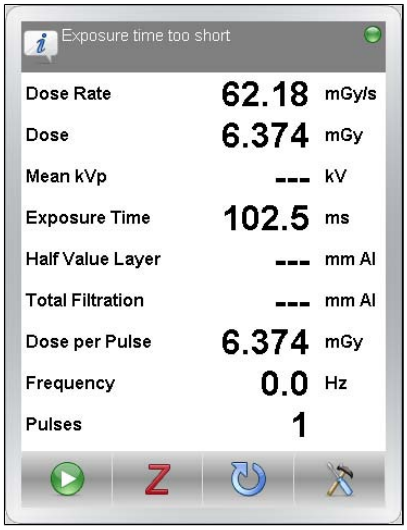


Figure 27: Measuring window with an error message when the measured values cannot be determined

By clicking the status line, a dialog will be displayed showing the complete error messages and troubleshooting tips:

Figure 28: Dialog with error message and troubleshooting tip

The dialog will be removed when

- you click the *OK* button
- you click the *Reset* button
- radiation is detected

The table below lists all the measured quantities affected by an error.

Message	Measured quantities	Cause	Remedy
Reduced dose accuracy	Dose rate Dose Dose per pulse	Reduced dose accuracy, measuring error ≥ 5 %	Repeat the measurement. Increase the dose rate on the X-ray unit. Reduce the distance. Manually set the total filtration in the *Measurement* menu.
Short exposure time detected	Dose rate Dose Dose per pulse	The exposure time is too short for the required adaptation of the measuring range (refer also to section 7.3.5.1 "Measurements with Very Short Exposure Times").	Repeat the measurement.
Low dose rate detected	Dose rate Dose Dose per pulse	NOMEX is in a high measuring range (refer also to section 7.3.5.1 "Measurements with Very Short Exposure Times"). The dose rate is too low for this measuring range.	Repeat the measurement.
Dose rate too high *Dose measuring range exceeded*	Dose rate Dose Dose per pulse	The electronic measuring system is out of range.	Reduce the dose rate on the X-ray unit. Increase the distance. Reduce the tube voltage or tube current.
Tube voltage measuring range exceeded	Tube voltage Total filtration Half value layer		
Dose rate too low	Dose rate Dose Dose per pulse	The electronic measuring system is out of range.	Increase the dose rate on the X-ray unit. Reduce the distance. Increase the tube voltage or tube current.
Insufficient kV signal	Tube voltage Total filtration Half value layer		

Message	Measured quantities	Cause	Remedy
Unknown radiation quality	Tube voltage Total filtration Half value layer	The radiation quality cannot be determined.	Manually set the total filtration in the *Measurement* menu.
Tube voltage too high		The tube voltage is too high.	Reduce the tube voltage. Select kV auto-ranging.
Tube voltage too low		The tube voltage is too small.	Increase the tube voltage. Select kV auto-ranging.
Exposure time too short		The exposure time is too short.	Reduce the start delay or increase the exposure time.
Wrong application or radiation quality	Dose rate Dose Dose per pulse Tube voltage Total filtration Half value layer	The set application does not match the present radiation quality.	Set the correct application and radiation quality in the *Measurement* menu.

11.1.2 Other Error Messages

All other error messages are displayed in a separate window as shown in the examples below:

Figure 29: Error message not requiring any confirmation

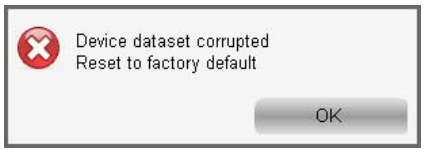


Figure 30: Error message requiring confirmation

The other error messages are composed of these components:

– Icon indicating the severity of the fault (for explanation of the icons, refer to section 5.2.5 "Explanation of Warning and Error Icons")

– Error text

– *OK* button to confirm the error message (not for all error messages)

If one of the subsequent error messages is permanently displayed or recurs after you have clicked the *OK* button, proceed as follows:

- Switch the NOMEX multimeter off and on again by removing and reconnecting the USB cable.

➔ If the error message recurs immediately or after the next measurement, please contact the PTW Customer Service.

Error text	Icon	LED	Confirmation	Remedy
Zeroing failed *Increase stop delay* *Do not irradiate NOMEX!*			no	The error message disappears automatically. Increase the stop delay. Do not irradiate NOMEX during zero adjustment.
Offset values corrupted *Recalculating offset values...*		blinking red	with *OK* button	NOMEX has identified corrupted offset values. After confirmation with the *OK* button, the offset values will be recalculated.
Device dataset corrupted *Reset to factory default*		blinking red	with *OK* button	NOMEX has identified a corrupted device data set. After confirmation with the *OK* button, the device data set will be reset to the default values.

Error text	Icon	LED	Confirmation	Remedy
Software dataset corrupted *Reset to factory default*		blinking red	with *OK* button	NOMEX has identified a corrupted software data set. After confirmation with the *OK* button, the software data set will be reset to the default values.
Communication error E;xx			no	Proceed as described above.
Fatal error:0x1 *Send NOMEX to PTW*		blinking red	no	The device cannot be used any more. Please contact PTW Customer Service.

11.2 Erroneous Measurements

Problem	Cause	Remedy
The measured tube voltage was higher than expected.	When performing measurements on systems, excessive tube voltages may occur at the beginning of the exposure. Since the NOMEX multimeter measures the peak voltage, this peak value will be indicated.	Using the start delay adjustment of the *Measurement* menu, these start-up overshoots can be excluded. The NOMEX multimeter will start saving the tube voltage values only after the start delay has elapsed.
The measured tube voltage was higher or smaller than expected.	The actual total filtration is different from the setting on the NOMEX multimeter.	Compare the NOMEX multimeter filter setting with the filtration on the X-ray unit and correct it if necessary. An X-ray tube's roughness may increase with age and utilization. This leads to additional filtration that must be taken into account when setting the total filtration at the NOMEX multimeter. The NOMEX multimeter is capable of automatically determining the total filtration. This eliminates the need for manual adjustments. **NOTE**: The parameter set on the NOMEX multimeter is total filtration, not the half value layer.
	The wrong calculation is being analyzed. For example, a peak voltage is compared with a PPV calculation.	Using three different computation methods, the NOMEX multimeter determines three kV results: kVp_{max}, kVp_{mean} and PPV. (After a measurement, you can read them on the measuring window by repeatedly clicking the measured quantity.)
	Compared with the start delay, the exposure time is too short. A falling edge is being analyzed.	Reduce the start delay or set it to zero to allow the entire exposure time to be analyzed.

Problem	Cause	Remedy
The measured tube voltage was smaller than expected.	The sensitivity mode *High* is set. Thus, a mean tube voltage will be determined that is lower than kV_{max}. The measured values for kVp_{max}, kVp_{mean} and PPV are identical.	Set the sensitivity mode *Normal*. The sensitivity mode *High* is intended for measuring low dose rates at DC/HF tube voltages. The recommended minimum measuring time is 5 seconds.
– The measurement exhibits an extreme field size dependence. – The measured tube voltage was higher or smaller than expected. – The measured values shown are completely wrong.	The measurement area of the NOMEX multimeter is not fully irradiated.	Enlarge the radiation field to the required measurement area at minimum (refer to section 3.2 "Positioning the NOMEX Multimeter").

12 Troubleshooting

What can I do if…

… the display of the NOMEX software shows artifacts (e.g. text color and background color are similar or identical)?	Check the settings for the display in the control panel: **1. Windows XP:** • Select *Start* → *Settings* → *Control Panel* → *Display*. • Select the *Appearance* tab. • Select one of the following color schemes. These schemes are recommended by PTW: – Windows Classic – Windows Standard. **2. Windows Vista Business:** • Select *Start* → *Control Panel* → *Appearance and Personalization* → *Personalization* → *Window Color and Appearance*. • Select one of the following color schemes. These schemes are recommended by PTW: – Windows Vista - Basic – Windows Classic – Windows Standard. **3. Windows 7:** • Select *Start* → *Control Panel* → *Appearance and Personalization* → *Personalization*. • Select one of the following color schemes. These schemes are recommended by PTW: – Windows 7 - Basic – Windows Classic.

13 NOMEX Multimeter Accessories

13.1 NOMEX Multimeter Holder T20016

13.1.1 Description of the NOMEX Multimeter Holder T20016

The NOMEX Multimeter Holder T20016 includes these components:

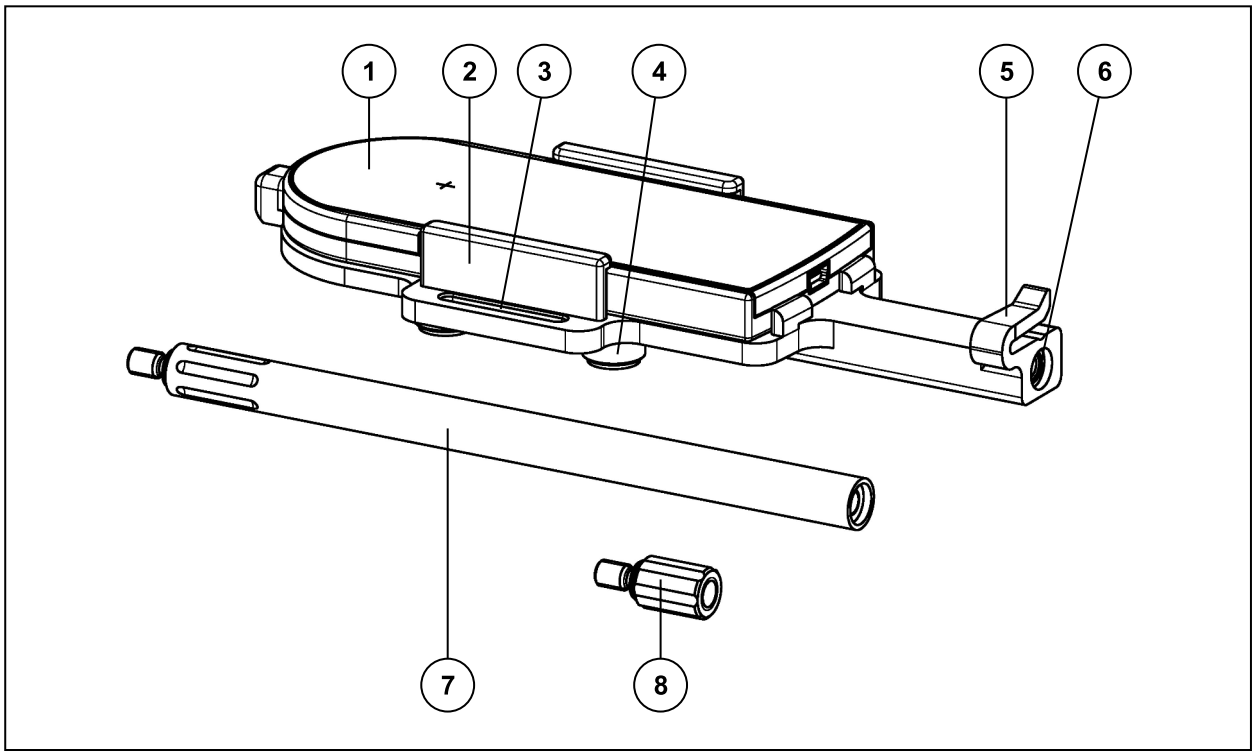


Figure 31: NOMEX multimeter holder T20016 with NOMEX multimeter

1 *NOMEX multimeter*

2 *Holder*

3 *Slot for Velcro fasteners (2 pieces)*

4 *Pad (4 pieces)*

5 *Strain relief for the USB cable*

6 *Thread for fixing the supporting bar or thread adapter*

7 *Supporting bar*

8 *Thread adapter*

9 *Velcro fastener (5 pieces), not shown*

13.1.2 Using the NOMEX Multimeter Holder T20016

Inserting the NOMEX Multimeter into the Holder

- Place the NOMEX multimeter (**1**) into the holder (**2**) as shown in Figure 31. The measurement area must face up. Check that the NOMEX multimeter properly locks into place in the holder.
- Connect the USB cable to the NOMEX multimeter.
- Slip the USB cable into the strain relief (**5**).

Installing the Holder at the Image Receptor of the Dental Panoramic Unit

- Guide a Velcro fastener (**9**) through the slots (**3**) at the holder (**2**).
- Adapt the length of the Velcro fastener to the dental panoramic system by using several fasteners.
- Close the Velcro fastener to secure the holder with the NOMEX multimeter at the image receptor.

Installing the Holder on the Tripod

- Screw the thread adapter (**8**) into the thread (**6**).
- To extend the length of the holder you can screw the supporting bar (**7**) between thread (**6**) and thread adapter (**8**).
- Screw the complete holder onto the tripod.

13.2 NOMEX Multimeter Cassette Adapter T20017

13.2.1 Description of the NOMEX Multimeter Cassette Adapter T20017

The NOMEX Multimeter Cassette Adapter T20017 includes these components:

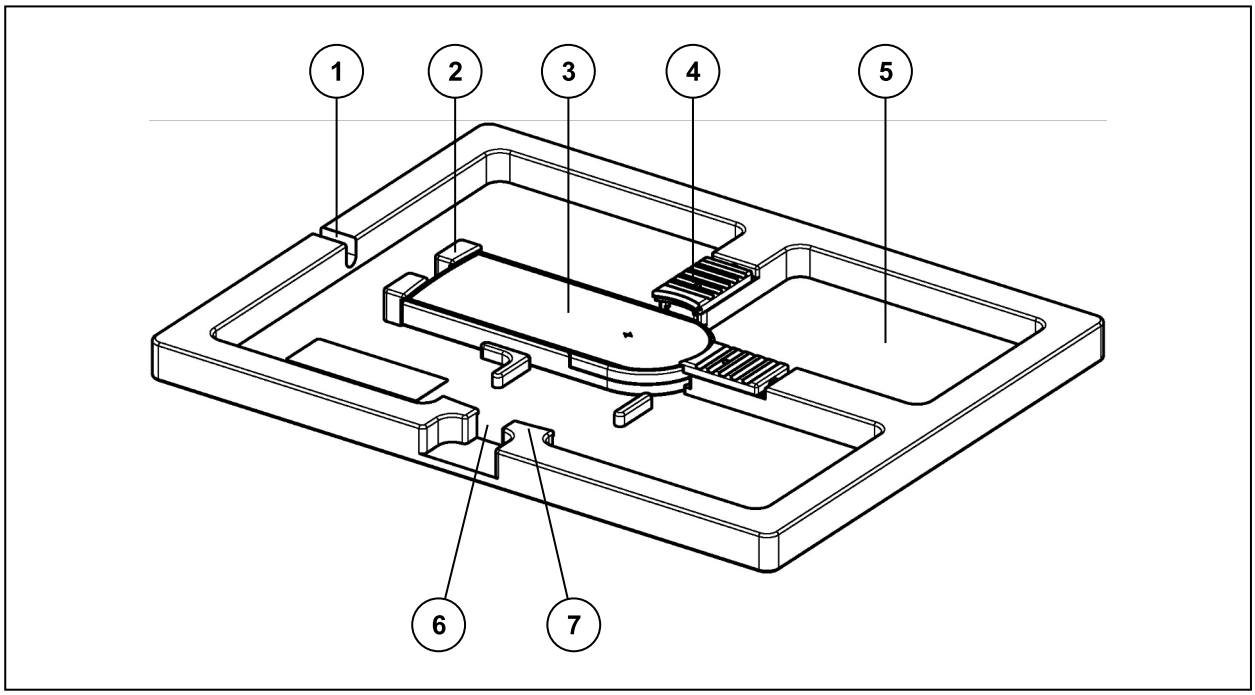


Figure 32: NOMEX multimeter cassette adapter T20017 with NOMEX multimeter

1 *Cutout for USB cable from NOMEX multimeter*

2 *Stop for NOMEX multimeter*

3 *NOMEX multimeter*

4 *Spring-loaded locking bar (2 pieces)*

5 *Frame*

6 *Cutout for USB cable from NOMEX multimeter*

7 *Stop for NOMEX multimeter*

13.2.2 Using the NOMEX Multimeter Cassette Adapter T20017

Inserting the NOMEX Multimeter into the Cassette Adapter

There are two ways of placing the NOMEX multimeter into the cassette adapter. The orientation depends on the X-ray unit to test.

- Pull back the appropriate locking bar (**4**).
- Slip the cable side of the NOMEX multimeter (**3**) under the required stop (**2**) or (**7**) and deposit it on the frame (**5**). The measurement area must face up.
- Close the locking bar (**4**).
- Connect the USB cable to the NOMEX multimeter.
- Guide the USB cable through the appropriate cutout (**1**) or (**6**).

Inserting the Cassette Adapter in the Cassette Compartment of the X-Ray Unit

- Insert the cassette adapter in the cassette compartment of the X-ray unit.

Technical Manual

14 Technical Specifications

Only values with specified tolerances or limits are guaranteed. Values without tolerances are for informational purposes only.

14.1 NOMEX Multimeter

Device designation	**NOMEX multimeter, type T11049 with NOMEX software S030008**
Manufacturer	PTW-Freiburg
Intended use	– diagnostic dosimetry system according to IEC 61674 for absolute dosimetry and quality control measurements in X-ray diagnostic radiology – for acceptance testing and constancy checks in radiography, fluoroscopy, dental X-ray, mammography, and computed tomography (CT) applications
Operation mode	continuous operation
Measuring principle	measurement of the tube voltage of an X-ray unit, using semiconductor detectors and the dual-filter method
Measured quantities and units	dose [Gy] and dose rate [Gy/s] exposure [R] and exposure rate [R/s] dose per pulse [Gy/pulse] or [R/pulse] pulses pulse frequency [Hz] exposure time [s] mean peak voltage [kV], maximum peak voltage [kV] and practical peak voltage [kV] total filtration [mm Al] half value layer [mm Al] tube voltage waveform dose rate waveform

Device designation	**NOMEX multimeter, type T11049 with NOMEX software S030008**
Measuring ranges [1]	
Dose / dose per pulse [2]	
RAD/FLU/DENT/CT/DENT-PAN	50 nGy … 500 Gy, ± 3.5 %
MAM	500 nGy … 500 Gy, ± 2.5 %
Dose rate [2]	
RAD/FLU/DENT/CT/DENT-PAN	5 µGy/s … 500 mGy/s, ± 3.5 % 0.1 µGy/s … 500 mGy/s, typical ± 4 % or ± 5 nGy/s [4]
MAM	50 µGy/s … 500 mGy/s, ± 2.5 %
Pulses [3]	1 … 99999
Pulse frequency [3]	(0,2 ... 500) pulses/s
Exposure time [3]	1 ms … 298 h, ± 0.5 ms or ± 1 % 5 s … 298 h, ± 1 s [4]
Tube voltage	
RAD/FLU/DENT/CT/DENT-PAN	(40 … 150) kV, ± 1 kV or ± 1.5 %
MAM	(23 … 35) kV, ± 0.5 kV
Total filtration	
(40 … 45) kV	(1.5… 40) mm Al, ± 2.5 mm Al or ± 10 %
(45 … 150) kV	(1.5… 40) mm Al, ± 0.5 mm Al or ± 10 %
Half value layer	
RAD/FLU/DENT/CT/DENT-PAN	(0.95… 13.5) mm Al, ± 0.25 mm Al
MAM	(0.25… 0.75) mm Al, ± 0.01 mm Al
MAM radiation qualities	Mo / 30 µm Mo Mo / 0.5 mm Al Mo / 25 µm Rh W / 50 µm Rh W / 50 µm Ag W / 0.7 mm Al Rh / 25 µm Rh With and without compression paddle in each case
Indication of measured value	NOMEX software
Warm-up time	1 min 10 min [4]
Amplifier time constant	none
Dose resolution	1 nGy

[1] When you measure very low dose rates in the sensitivity modes "High" and "Heavily Filtered", consider the tolerances indicated here as typical tolerances. In these modes, the recommended minimum measuring time is 5 seconds.
[2] Measuring range depends on the tube voltage, total filtration, and exposure time
[4] Sensitivity modes "High" and "Heavily Filtered"
[3] Minimum pulse width 1 ms

Device designation	**NOMEX multimeter, type T11049 with NOMEX software S030008**
Memory depth referred to sampling rate	3.2 s at 2 kHz 6.4 s at 1 kHz 12.8 s at 500 Hz 25.6 s at 250 Hz 64.0 s at 100 Hz 3200 s at 2 Hz [5)]
Reference point / measurement depth	4.7 mm ± 0.5 mm below top of device
Power supply	5 VDC
Power consumption	180 mA
Interface	USB V2.0 full speed (12 Mbit/s)
Max. USB cable length	2 m (passive) + 4 x 5 m USB active extension cable = 22 m
Dimensions	approx. 115 mm x 50 mm x 9 mm
Weight	approx. 250 g

[5)] Sensitivity modes "High" and "Heavily filtered"

14.2 NOMEX Multimeter Holder T20016

Device designation	**NOMEX Multimeter Holder T20016**
Manufacturer	PTW-Freiburg
CE mark	The product bears the CE-mark "CE" in accordance with the Council Directive 93/42/EEC about Medical Devices and fulfills the essential requirements of Annex I of this directive. The product is a class I device without measuring function (MDD).
Intended use	Mechanical holder for – attachment of the NOMEX multimeter to a dental X-ray unit – attachment of the NOMEX multimeter to a tripod by means of a thread adapter The supporting bar can be used to extend the length of the holder.
Components	– Holder with 4 rubber pads – Supporting bar – Thread adapter – 5 Velcro fasteners
Material **Holder** **Thread adapter / supporting bar**	 POM natural Aluminum alloy EN AW-2007
Density **Holder** **Thread adapter / supporting bar**	 1.39 g/cm³ 2.85 g/cm³
Dimensions	171 ± 0.5 mm x 70 ± 0.5 mm x 23 ± 0.5 mm
Weight	approx. 60 g

14.3 NOMEX Multimeter Cassette Adapter T20017

Device designation	**NOMEX Multimeter Cassette Adapter T20017**
Manufacturer	PTW-Freiburg
CE mark	The product bears the CE-mark "CE" in accordance with the Council Directive 93/42/EEC about Medical Devices and fulfills the essential requirements of Annex I of this directive. The product is a class I device without a measuring function (MDD).
Intended use	Mechanical holder allowing the NOMEX multimeter to be mounted in the cassette compartment of an X-ray unit
Components	– holder frame – spring-loaded locking bar
Material **Holder frame** **Locking bar**	 POM natural POM black
Density **Holder frame** **Locking bar**	 1.39 g/cm³ 1.39 g/cm³
Dimensions	267.5 ± 0.2 mm x 207.5 ± 0.2 mm x 15 ± 0.1 mm
Weight	approx. 500 g

14.4 Nominal Useful Range and Ambient Conditions

Nominal useful range	
Temperature	(+10 ... +40) °C
Relative humidity	(10 ... 85) %, no condensation (max. 20 g/m³ absolute humidity)
Atmospheric pressure	(600 ... 1200) hPa
Maximum operating altitude	3000 m above sea level
Transport and storage conditions	
Temperature	(-20 ... +60) °C
Relative humidity	(10 ... 85) %, no condensation (max. 20 g/m³ absolute humidity)
Atmospheric pressure	(600 ... 1200) hPa

15 Accessories and Spare Parts

NOMEX Multimeter Set	**L981815**
The set includes:	
NOMEX multimeter	T11049
NOMEX software	S030008
2 m USB cable, 2.0 (miniB)	L178089
5 m USB active extension cable, 2.0	L178088
NOMEX multimeter case	L522056

Accessories	
NOMEX multimeter holder Mechanical holder for the attachment and positioning of the NOMEX multimeter	T20016
NOMEX multimeter cassette adapter Mechanical holder enabling the NOMEX multimeter to be mounted in the cassette compartment of an X-ray unit	T20017
Mobile PC	L991422
5 m USB active extension cable, 2.0	L178088
Service contract for NOMEX multimeter includes repair, calibration in factory, firmware upgrades, software updates and upgrades	E21477

Service Manual

⚠ WARNING

Improper execution of service tasks.

Hazards to Persons! Equipment Damage!

The following service tasks must only be performed by specially trained staff.

Further service tasks may only be carried out by PTW or by persons authorized by PTW.

16 Cleaning

⚠ WARNING

Liquids have entered the device.

Shock Hazard, Erroneous Measurement!

The device must be thoroughly inspected by service personnel before being used again.

⚠ CAUTION

Disinfection of the surface with disinfectants on a phenol base or peroxide compounds.

Equipment Damage!

Do **not** use disinfectants on a phenol base or peroxide compounds to disinfect the surface.

NOMEX Multimeter Surfaces

- Disconnect the NOMEX multimeter from the PC before cleaning the surface.
- Clean the NOMEX multimeter simply by wiping it down with a moist cloth. Use water or a mild soap solution. Liquids must not be allowed to enter the device. Do **not** spray liquids onto the device and connectors. The product cannot be sterilized or disinfected.

Connection Cables

Clean the cables as described below:

- Disconnect the cables from the devices (always pull on the connectors, not on the cables!).
- Clean the cables by rubbing them down with a cloth moistened with soap water or a disinfectant.
- Do not immerse the cables in liquids!

17 Preventive Maintenance

In the following, you will find a list of the maintenance measures and inspections necessary for the product.

Check before each Use

- Before each use, visually inspect the product and the cables for signs of mechanical damage.
- If damage or malfunctions are identified, the product must be repaired before it is used again.

Repair

Repairs may only be carried out by PTW Freiburg or by persons/companies authorized by PTW Freiburg.

Safety Inspections

Only regularly inspected products are fail-safe. To preserve the functional security and operational safety, a safety inspection is to be executed at regular intervals according to the national regulations.

These inspections must only be performed by independent persons with adequate training and experience.

It is recommended to execute the safety inspections annually or every 2 years.

Technical Inspections of the Measuring System

The product must be inspected at regular intervals according to the national regulations. It is recommended to perform technical inspections of the measuring system annually or every 2 years at PTW-Freiburg or a qualified calibration laboratory.

Inspections must also be performed after repairs or after each influence that may have changed the behavior of the product.

Calibration

The exact calibration factor and supplementary data are included in the calibration certificate.

The product should be recalibrated at a dose rate typical for the application.

It is recommended to have the product calibrated annually or every 2 years at PTW-Freiburg or by specially trained staff on site.

18 Repairing Legally Calibrated Dosemeters

NOTE

This section is applicable in countries where legal requirements exist demanding calibration, for example Germany and Austria.

Interventions on the part of the user that may alter the measured values determined by legally calibrated dosemeters are not permitted. For this reason, the legal calibration authority has applied stamps to those parts of the dosemeter where such interventions could take place. Devices with damaged stamps are no longer considered legally calibrated.

If a dosemeter is found to be defective, it can be sent to an officially recognized calibration laboratory for repair. After repair, the device must be legally recalibrated. However, it can be used even if not yet legally recalibrated.

If the repair is not performed at an officially recognized repair center, the device must be legally recalibrated before it can be used for applications requiring legal calibration.

19 Disposal of the Product

The typical lifetime of the product is approx. 10 years.

The cost for a potential return at the end of the product lifetime is to be borne by the customer.

At the end of the product lifetime, the components of the product must be disposed of in compliance with the applicable waste control regulations. The different materials must be separated and recycled as appropriate.

The electronic components must be recycled according to the local regulations.

The product does not contain hazardous materials.

Literature

[1] Council Directive 93/42/EEC concerning medical devices (Medical Device Directive - MDD)

[2] Council Directive 97/43/EURATOM on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure

[3] IEC 61674
Medical electrical equipment -
Dosimeters with ionization chambers and/or semi-conductor detectors as used in X-ray diagnostic imaging

[4] IEC 61676
Medical electrical equipment -
Dosimetric instruments used for non-invasive measurement of X-ray tube voltage in diagnostic radiology

[5] IEC 61010-1
Safety requirements for electrical equipment for measurement, control and laboratory use -
Part 1: General requirement

[6] IEC 61326-1
Electrical equipment for measurement, control and laboratory use - EMC requirements -
Part 1: General requirements

[7] IEC/CISPR 11
Industrial, scientific and medical equipment -
Radio-frequency disturbance characteristics - Limits and methods of measurement

[8] IEC 61140
Protection against electric shock -
Common aspects for installation and equipment

[9] IEC 60950-1
Information technology equipment - Safety -
Part 1: General requirements

Appendix: China Electronic Industry Standard Compliance
附录：中华人民共和国电子产业标准

This Supplement concerns China Electronic Industry Standard Compliance
此附录涉及中华人民共和国电子产业标准的相关规定

The following product pollution control information is provided according to SJ/T11364-2006 Marking for Control of Pollution caused by Electronic Information Products.

根据SJ/T11364-2006标准规定的《电子信息产品污染控制标识要求》特提供以下有关产品污染控制方面的信息。

1. Explanation of Pollution Control Label
   污染控制标识说明

This symbol indicates the product contains hazardous materials in excess of the limits established by the Chinese standard SJ/T11363-2006 *Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products*. The number in the symbol is the Environment-friendly Use Period (EFUP), which indicates the period during which the toxic or hazardous substances or elements contained in electronic information products will not leak or mutate under normal operating conditions so that the use of such electronic information products will not result in any severe environmental pollution, any bodily injury or damage to any assets. The unit of the period is "Year".

In order to maintain the declared EFUP, the product shall be operated normally according to the instructions and environmental conditions as defined in the product manual, and periodic maintenance schedules specified in Product Maintenance Procedures shall be followed strictly.

Consumables or certain parts may have their own label with an EFUP value less than the product. Periodic replacement of those consumables or parts to maintain the declared EFUP shall be done in accordance with the Product Maintenance Procedures.

This product must not be disposed of as unsorted municipal waste, and must be collected separately and handled properly after decommissioning.

该标识表明本产品含有的有毒有害物质超出SJ/T11363-2006标准规定的《电子信息产品中有毒有　害物质的限量要求》。标识中的数字为本产品的环保使用期限（EFUP），表明在正常使用的条件下，电子信息产品内含的有毒有害物质或元素不会发生外泄或突变，用户使用该电子信息产品不会对环境造成任何严重污染或对人身、财产造成任何严重损害的期限。单位为年。

为保证所声明的环保使用期限，应按产品手册中所规定的指示和环境条件进行正常使用，并严格遵守产品维护程序中规定的定期维护和保养日程。

产品中的耗件或某些零部件可能具有单独的标识，其环保使用期限有可能短于产品本身的环保使用期限。应按产品维护程序定期更换这些耗件或零部件，以保证所声明的整个产品的环保使用期限。

本产品在使用寿命结束后不可作为普通生活垃圾处理，必须另行收集并作妥善处理。

2. Name and Concentration of Hazardous Substances
有毒有害物质的名称及含量

Table 1 - Hazardous substances' name and concentration.
表1 - 有毒有害物质的名称及含量

Component Name 部件名称	Hazardous substances' name 有毒有害物质的名称					
	(Pb) （铅）	(Hg) （汞）	(Cd) （镉）	(Cr(VI)) （六价铬）	PBB) （多溴联苯）	(PBDE) （多溴二苯醚）
T11049	**X**	**O**	**X**	**X**	**X**	**X**

O: Indicates that this toxic or hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement in SJ/T11363-2006.
X: Indicates that this toxic or hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement in SJ/T11363-2006

- Data listed in the table represents best information available at the time of publication.
- This table shows where these substances may be found in the supply chain of PTW electronic information products, as of the date of sale of the enclosed product. Note that some of the component types listed above may or may not be a part of the enclosed product.

O: 表示该有毒有害物质在该部件所有均质材料中的含量均在SJ/T11363-2006 标准规定的限量要求以下。
X: 表示该有毒有害物质至少在该部件的某一均质材料中的含量超出SJ/T11363-2006 标准规定的限量要求。

- 此表所列数据为直至发布时所能获得的最全面信息。
- 此表表明自本产品销售之日起在PTW电子信息产品的供应链上何处可能找到以上所述有毒有害物质。请注意，以上所列的部件类型中的一些可能不属于本产品。

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