INDEPENDENT X-RAY
QUALITY ASSURANCE



RTI Mako | Specifications

Unparelleled performance and versatility.

New sensor technology

Experience the groundbreaking new sensor technology with best-ever accuracy, unrivalled in the market (± 1.5% kVP uncertainty across entire measurement range). Place RTI Mako Probes in any orientation in the X-ray beam, for the most efficient measurements of kVp, time, HVL, total filtration, dose and dose rate, while revelling in the captivation presentation of waveform data. Offering the broadest application range, across all diagnostic X-ray modalities (Radiography, Fluoroscopy, Mammography, CT and Dental). Now also integrating the RTI Scatter Probe for seamless scatter and leakage measurements.

Mako adapts to your needs with plug-and-play simplicity, boosting your entire workflow. It's the world's most efficient meter, with the highest practical accuracy and the broadest application range.

All-in-one X-ray testing solution

Mako is designed for modern X-ray equipment and tailored to your needs. The complete solution includes the Mako meter, Mako Display, Ocean Next™ software, and our full probe line-up.

Future-proof by design, Mako evolves with new functions, probes, and an ever-expanding application range.
The Mako Display gives you fast, wireless touchscreen access to QA data – no laptop required. With quick-access buttons, and easy export, testing is simpler than ever.

If you prefer to use your own mobile device, download the **RTI Mako Display App** to connect wirelessly and get instant results directly on your Apple or Android display.

Download on the App Store GET IT ON Google Play



RTI Mako Base Unit with Ion Chamber Module docked, and CT Ion Chamber attached. Instant measurments with the Mako Display.



RTI Mako Base Unit with R/F Probe docked, mAs Module connected and mAs cable.



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RTI Mako System

Live Measurement Display	App-powered display device (mobile phone/tablet), on Android or iOS
Software	Ocean Next Windows Application
Operating System	Windows 10, 11
Simultaneous Air Kerma Measure	Yes
Exposures needed	One
Min. Exposure Time	0.1 ms
Warranty	2-year
Extended Warranty	Up to 10 years
Calibration Cycle	2 years
X-ray dosimeter Standards	According to IEC 61674 and IEC 61676
PTB Approval	DE-26-M-PTB-0034
Conforms with the provisions of the following EC Directive(s):	2014/30/EU Electromagnetic Compatibility (EMC) Directive, 2014/35/EU Low Voltage Directive (LVD), 2014/53/EU Radio Equipment Directive (RED), 2015/863/EU Restriction of Hazardous Substances in EEE Directive (RoHS 3)

*Specifications in this document may be changed without notice

RTI Mako Base Unit

Size	117.3 x 73 x 23.2 mm (4.62 x 2.87 x 0.91 in)
Weight	250 g (8.82 oz)
Interface to Mako Display	Wireless (Bluetooth) or via USB cable
Interface to Probes	USB-C connection
Bluetooth Range	100 m (free-in-air)
Power Source	Rechargeable Li ion battery
Battery Life	20 hours (practical measurement time)
Battery Tested	According to UN 38.3
Memory	Unlimited (via Mako Display)
Operating Temperature	15 – 35°C
Storage Temperature	-10 – 50°C







Mako Probes (R/F, Mammo, Dental)

Size	122.5 x 27.7 x 14.5 mm (4.82 x 1.1 x 0.57 in)
Weight	55 g (1.94 oz)
Detector active areas	Smallest 0.9 x 0.9 mm^2, Largest 7 x 7 mm^2
Detector position check	Orientation independent, no check required
Backscatter Protection	Yes

Mako Ion Chamber Module

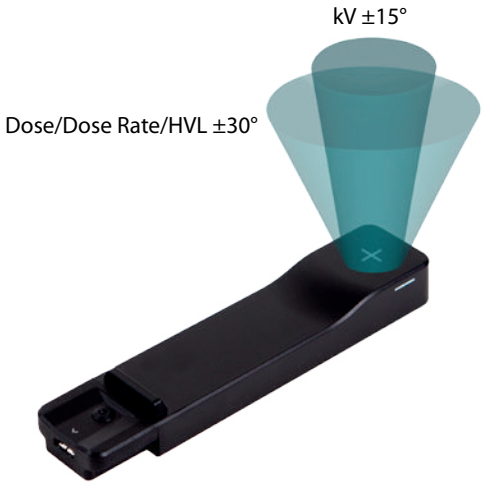
Size	80.2 x 27 x 16.5 mm (3.16" x 1.06” x 0.65”)
Weight	32 g (1.3 oz)
Compatible probes which can be connected to module:	RTI CT Ion Chamber (10 cm and 30 cm) RTI DAP Chamber (86 x 86 mm and 147 x 147 mm), Ion Chamber Magna 1cc, and other Ion Chambers using Triaxial-to-Lemo adapter

Mako PI Dongle

Size	33.3 x 14.3 x 10 mm (1.31" x 0.56" x 0.39")
Weight	5.2 g (0.18 oz)

Broadest angular range

Unique detector design provides unbeaten angular sensitivity, offering the broadest range of use and best accuracy in practice.



Mako mAs Module

Size	67.5 x 27 x 14.5 mm (2.65” x 1.06” x 0.57”)
Weight	16 g (0.6 oz)
Compatible probes which can be connected to module:	Mako mAs Cable, RTI MAS-2, Mako Test Point Cables

Mako Legacy Module

Size	68 x 27 x 14.5 mm (2.68” x 1.06” x 0.57”)
Weight	20 g (0.7 oz)
Compatible probes which can be connected to module:	RTI CT Dose Profiler, RTI Light Probe, RTI Dose Probe, T20, MAS-1, and MAS-2





Mako R/F (R/F Probe)

Tube Potential	
Range	35 – 155 kV
Min Air Kerma rate	2 µGy/s
PPV and kVp	Yes
Uncertainty	±1.5%
Air Kerma	
Range	1 nGy – 9999 Gy
Uncertainty	±5% or 5 nGy
Air Kerma Rate	
Range	1 nGy/s – 500 mGy/s
Resolution	0.1 nGy/s
Trigg level	25 nGy/s @ exp. time >200 ms 3 µGy/s @ 1 ms 300 nGy/s @ 10 ms
Uncertainty	±5% or 1 nGy/s
Time	
Range	0.33 ms – 48 h
Resolution	0.33 ms
Bandwidth	Up to 1 kHz
Uncertainty	±0.5% or 0.33 ms
HVL	
Range	1 – 15 mm Al
Min Air Kerma Rate	500 nGy/s
Uncertainty	±5% or 0.2 mm Al
Total Filtration	
Range	1 – 90 mm Al equivalent
Min Air Kerma Rate	2 µGy/s
Uncertainty	±10% or 0.2 mm Al
Pulses	
Range	1 – 5 000 000
Min peak Air Kerma rate	250 nGy/s
Min pulse width	0.33 ms
Pulse Rate	
Range	0.2 – 260 Hz
Min peak Air Kerma Rate	250 nGy/s
Min pulse width	0.33 ms
Waveforms	
Range	0 – 240 s
Resolution	0.33 ms at exposures <15 s
Bandwidth kV	1 kHz
Bandwidth Air Kerma Rate	1 kHz

Mako Mammography (Mammo Probe)

Tube Potential	
Range	18 – 49 kV
Min Air Kerma rate	2 µGy/s
PPV and kVp	Yes
Uncertainty	±1.5% or 0.5 kV
Air Kerma	(in kV range 18 – 49 kVp)
Range	1 nGy – 9999 Gy
Uncertainty	±5% or 5 nGy
Air Kerma Rate	
Range	2 nGy/s – 1 Gy/s
Resolution	0.1 nGy/s
Trigg level	50 nGy/s @ exp. time >200 ms 6 µGy/s @ 1 ms 600 nGy/s @ 10 ms
Uncertainty	±5% or 2 nGy/s
Time	
Range	0.33 ms – 48 h
Resolution	0.33 ms
Bandwidth	Up to 1 kHz
Uncertainty	±0.5% or 0.33 ms
HVL	
Range	0.2 – 4.0 mm Al
Min Air Kerma Rate	1 µGy/s
Uncertainty	±5% or 0.025 mm Al
Waveforms	
Range	0 – 240 s
Resolution	0.33 ms at exposures <15 s
Bandwidth kV	1 kHz
Bandwidth Air Kerma Rate	1 kHz

Supported Radiation Qualities for kV

Every mammography radiation quality also covers use of compression paddle, and use of PMMA and Aluminum phantoms up to 2.5 mm Al equivalent.

W / 0.70 m Al	(18-49 kV)	0.5 – 3.5 mm Al
W / 50 µm Rh	(18-49 kV)	45 – 55 µm Rh
W / 60 µm Rh	(18-49 kV)	55 – 65 µm Rh
W / 50 µm Ag	(18-49 kV)	45 – 55 µm Ag
W / 75 µm Ag	(18-49 kV)	70 – 80 µm Ag
W / 0.30 mm Cu	(40-49 kV)	0.25 – 0.35 mm Cu
W / 1 mm Ti	(40-49 kV	1 – 1.5 mm Ti
Mo / 30 µm Mo	(18-49 kV)	25 – 35 µm Mo
Mo / 25 µm Rh	(18-49 kV)	20 – 30 µm Rh
Mo / 1.0 mm Al	(18-49 kV)	0.8 – 1.2 mm Al
Mo / 0.25 mm Cu	(40-49 kV)	0.25 – 0.35 mm Cu
Rh / 25 µm Rh	(25-49 kV)	20 – 30 µm Rh
Rh / 1.0 mm Al	(25-49 kV)	0.8 – 1.2 mm Al
Rh / 30 µm Ag	(25-49 kV)	25 – 35 µm Ag
Rh / 0.25 mm Cu	(25-49 kV)	0.25 – 0.35 mm Cu





Mako Dental (Dental Probe)

Tube Potential	
Range	35 – 125 kV
Min Air Kerma rate	2 µGy/s
PPV and kVp	Yes
Uncertainty	±1.5%
Air Kerma	
Range	1 nGy – 9999 Gy
Uncertainty	±5% or 5 nGy
Air Kerma Rate	
Range	1 nGy/s – 500 mGy/s
Resolution	0.1 nGy/s
Trigg level	25 nGy/s @ exp. time >200 ms 3 µGy/s @ 1 ms 300 nGy/s @ 10 ms
Uncertainty	±5% or 1 nGy/s
Time	
Range	0.33 ms – 48 h
Resolution	0.33 ms
Bandwidth	Up to 1 kHz
Uncertainty	±0.5% or 0.33 ms
HVL	
Range	1 – 15 mm Al
Min Air Kerma rate	500 nGy/s
Uncertainty	±5% or 0.2 mm Al
Total Filtration	
Range	1 – 25 mm Al equivalent
Min Air Kerma rate	2 µGy/s
Uncertainty	±10% or 0.2 mm Al
Pulses	
Range	1 – 5 000 000
Min peak Air Kerma rate	250 nGy/s
Min pulse width	0.33 ms
Pulse Rate	
Range	0.2 – 260 Hz
Min peak Air Kerma rate	0.25 µGy/s
Min pulse width	0.33 ms
Waveforms	
Range	0 – 240 s
Resolution	0.33 ms at exposures <15 s
Bandwidth kV	1 kHz
Bandwidth Air Kerma rate	1 kHz

Invasive mA and mAs
(Mako mAs Module with Mako mAs Cable)

mAs	
Range	0.001–9999 mAs
Resolution	0.001 mAs
Uncertainty	±1% or 0.001 mAs
mA	
Range	0.1 - 2000 mA
Resolution	0.01 mA
Uncertainty	±1% or 0.01 mA
Time	
Range	0.5 ms - 48 h
Resolution	0.5 ms
Bandwidth	0.7 kHz
Uncertainty	±0.5% or 0.5 ms
Pulses	
Range	1 – 5 000 000
Min pulse width	0.5 ms
Uncertainty	±0.5 pulses
Pulse Rate	
Range	0.2 – 260 Hz
Min pulse width	0.5 ms
Uncertainty	±0.5 pulses/s
mAs/Pulse	
Range	0.001 - 9999
Resolution	0.001 mAs
Uncertainty	±1%
Waveforms	
Range	0 – 120 s
Resolution	0.5 ms at exposures <15 s
Bandwidth	0.7 kHz
Mako mAs Cable:	3 m length (9.9 ft)



Non-invasive mA and mAs
(Mako mAs Module with MAS-2)

mAs	
Range	0.1–9999 mAs
Resolution	0.1 mAs
Uncertainty	±5%
mA	
Range	10 - 4000 mA
Resolution	1 mA
Uncertainty	±5% or 2 mA
Time	
Range	0.5 ms – 48 h
Resolution	0.5 ms
Bandwidth	0.7 kHz
Uncertainty	±0.5% or 0.5 ms
Pulses	
Range	1 – 5 000 000
Min pulse width	0.5 ms
Uncertainty	±0.5 pulses
Pulse Rate	
Range	0.2 – 260 Hz
Min pulse width	0.5 ms
Uncertainty	±0.5 pulses/s
mAs/Pulse	
Range	0.1– 9999
Resolution	1 mAs
Uncertainty	±5%
Waveforms	
Range	0 – 120 s
Resolution	0.5 ms at exposures <15 s
Bandwidth	0.7 kHz



RTI CT Ion Chamber 10 & 30 cm
(with Mako Ion Chamber Module)

Connector type	LEMO triaxial
Cable length	2 m (6.6 ft), low noise triaxial
Active volume	5.3 cm^3 (16 cm^3)
Effective length	100 mm (300 mm)
Diameter	12 mm, 12.6 incl O-rings
Typical leakage	±20 fA
Radiation quality	70 – 150 kV
Sensitivity	30 mGycm/nC
Energy dependence	±1%
Air Kerma Length Product	
Range	10 µGycm - 9999 Gycm
Uncertainty	±5% or 10 µGycm
Air Kerma Length Product Rate	
Range	300 µGycm/s – 3 Gycm/s
Resolution	10 µGycm/s
Uncertainty	±5% or 30 µGycm/s
Time	
Range	3.3 ms – 48 h
Resolution	3.3 ms
Bandwidth	100 Hz
Uncertainty	±0.5% or 3.3 ms
Waveforms	
Range	0 – 120 s
Resolution	3.3 ms at exposure <15 s
Bandwidth kV	100 Hz
Bandwidth Air Kerma rate	100 Hz
Air Kerma*	
Range	1 µGy - 9999 Gy (300 nGy - 9999 Gy)
Uncertainty	±5% or 1 µGy
Air Kerma Rate*	
Range	30 µGy/s – 300 mGy/s (10 µGy/s – 100 mGy/s)
Resolution	1 µGy/s
Uncertainty	±5% or 3 µGy/s

* Specifications for Air Kerma and Air Kerma rate are valid for full irradiation of the sensitive volume of the ion chamber.

Notice: Information within brackets ( ) are valid for the 30 cm chamber.



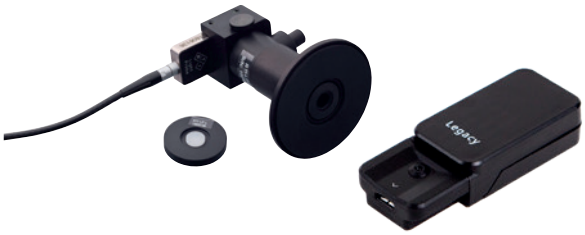


RTI DAP Chamber 86x86 & 147x147 mm (with Mako Ion Chamber Module)

Connector type	LEMO triaxial
Cable lenght	2 m (6.6 ft), low noise triaxial
Quality equivalent filtration (70 kV)	0.2 mm Al
Radiation quality	70 - 150 kV
Sensitivity	15 mGycm^2/nC
Energy Dependence	±10% RQR 2 to RQR 10
Air Kerma Area Product	
Range	30 µGycm^2 – 9999 Gycm^2
Uncertainty	±5% or ±30 µGycm^2
DAP Rate	
Range	300 µGycm^2/s – 1.5 Gycm^2
Uncertainty	±5% or 30 µGy cm^2/s
Time	
Range	3.3 ms – 48 h
Resolution	3.3 ms
Bandwidth	100 Hz
Uncertainty	±0.5% or 3.3 ms
Waveforms	
Range	0 – 120 s
Resolution	3.3 ms at exposure <15 s
Bandwidth	100 Hz
Bandwidth Air Kerma rate	100 Hz

Ion Chamber Magna 1cc (with Mako Ion Chamber Module)

Connector type	LEMO triaxial
Active volume	1 cm^3
Height	25.4 mm
Diameter	41.3 mm
Inner plate separation	8 mm
Weight	200 g
Cable length	2 m (6.6 ft)
Materials	Air equivalent plastic, acrylic
Entrance window	Kapton conductive film
Typical leakage	±5 fA
Radiation quality	20 – 150 kV
Energy dependence	±2%
Typical sensitivity	20 mGy/nC
Air Kerma	
Range	2 µGy - 9999 Gy
Uncertainty	±5% or ±2 µGy
Air Kerma Rate	
Range	20 µGy/s - 2 Gy/s
Uncertainty	±5% or ±20 µGy/s
Time	
Range	3.3 ms – 48 h
Resolution	3.3 ms
Bandwidth	100 Hz
Uncertainty	±0.5% or 3.3 ms
Waveforms	
Range	0 – 120 s
Resolution	3.3 ms at exposure <15 s
Bandwidth	100 Hz



RTI Light Probe
(with Mako Legacy Module)

Spectral Response	CIE V(λ) (Photopic)
Field of view	
Lux adapter	180° (Cosine)
Monitor adapter	Ø 7 mm
Luminance	
Range	0.04 cd/m² – 128 kcd/m²
Uncertainty	±5% or ±0.008 cd/m²
Illuminance	
Range	0.014 lx – 48 klx
Uncertainty	±5% or 0.003 lx



RTI CT Dose Profiler
(with Mako Legacy Module)

General specifications	
Length	210 mm
Diameter	12.5 mm
Weight	50 g
Sensor width	250 µm
Cable length	4.0 m (13.1 ft)
Air Kerma	
Range	50 nGy – 9999 Gy
Uncertainty	±5%
Air Kerma Rate	
Range	500 nGy/s – 3 Gy/s
Uncertainty	±5% or 1 nGy/s



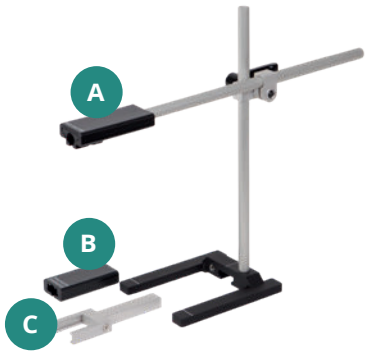


RTI Dose Probe (with Mako Legacy Module)

Dimensions	20 x 45 x 7.4 mm (0.79" x 1.8" x 0.29")
Weight	85 g (3 oz)
Cable length	2.0 m (6.6 ft)
Backscatter protected	Yes
Angular dependence	Near cosine (flat sensor)
Temperature and air pressure	Insensitive, no correction needed
Air Kerma	
Range	0.1 nGy – 9999 Gy 0.012 µR – 999 R
Uncertainty	±5%
Air Kerma Rate	
Range	4 nGy/s – 150 mGy/s 0.46 µR/s – 16 R/s
Uncertainty	±5% or ±10 nGy/s ±5% or ±1 µR/s
Time	
Range	0.33 ms – 34000 s
Uncertainty	±1% or ±0.33 ms
Pulses	
Range	1 – 65535 pulses
Uncertainty	±1 pulse
Air Kerma per pulse	
Range	1 nGy/pulse – 300 mGy/pulse
Pulse rate/frequency	
Range	0.5 – 100 Hz
Pulse width	
Range	4 ms – 2000 s

RTI T20 (with Mako Legacy Module)

Dimensions	35 × 320 × 6.0 mm (metal 23,5 × 5,6 mm)
Weight approx.	75 g (2.6 oz)
Cable length	2.0 m (6.6 ft)
Backscatter protection	Yes
Angular dependence	Near cosine (flat sensor)
Temperate and air pressure	Insensitive, no correction needed
Air Kerma	
Range	0.7 nGy – 999 Gy 0.8 µR – 999 R
Uncertainty	±5%
Air Kerma Rate	
Range	27 nGy/s – 500 mGy/s 3 µR/s – 57 R/s
Uncertainty	±5%
Time	
Range	0.33 ms – 9999 s
Uncertainty	±1% or ±0.33 ms
Pulses	
Range	1 – 65535 pulses
Uncertainty	±1 pulse
Pulse rate/frequency	
Range	0.5 – 100 Hz
Typical energy dependence	±2% (radiation quality RQR 2 to RQR 10)



Mako Stand with Holders

Stand with holders for Mako R/F, Mammo and Dental Probes as well as RTI Dose Probe, RTI CT Ion Chamber, and RTI CT Dose Profiler. A filter holder designed to fit 33 x 33 mm Aluminum Filters is also included. (Aluminum Filters are sold separately).

Holder A is compatible with the Mako R/F Probe, the Mako Mammo Probe and the Mako Dental Probe.

Holder B is compatible with the RTI Dose Probe and RTI CT Ion Chamber (10 cm & 30 cm).

Holder C is compatible with HVL filters provided with the Mako kits (dimensions 33 x 33 mm).

The base of the Stand can also hold the Mako R/F, Mammo & Dental Probes.



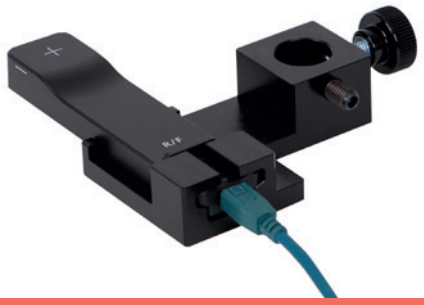
Mako Mammo Holder

Holder for simple positioning of Mako Mammo Probe to give reference heights of 40 mm or 45 mm (dual-sided).



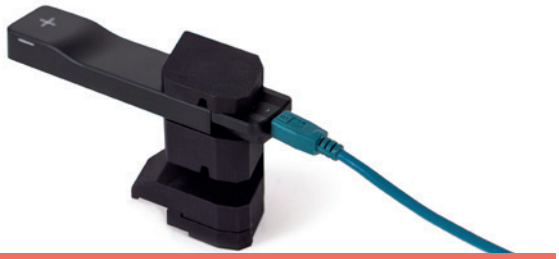
Mako Panoramic Dental Holder

The Mako Panoramic Dental Holder is designed to hold the Mako R/F or Dental Probe in position during panoramic dental measurements.



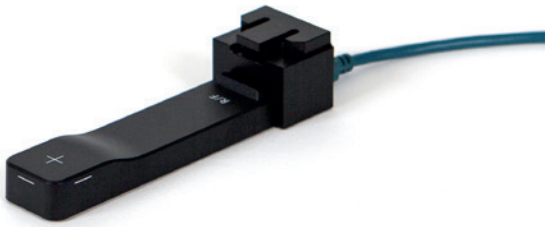
Philips Mako Holder

Holder for simple positioning of Mako R/F Probe on the Philips EDL-stand. The Philips stand has a cylindrical part to which this holder attaches, to place the Mako Probe in Philips reference dose measurement position.



GE Mako Mammo holder

To place the Mako Mammo Probe in the reference positions in the IQST jig for GE Pristina as well as the Seno 2000D/DS/Essential/DMR.



GE Mako Rad holder

For accurate positioning of the Mako R/F Probe on the GE Rad Jig.

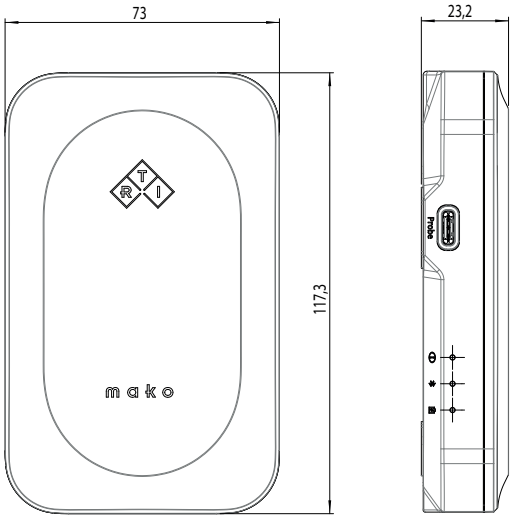


GE Mako Vascular holder

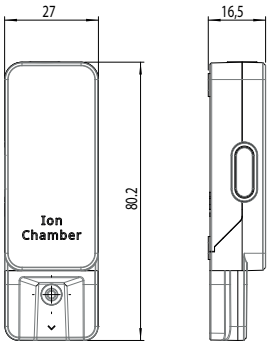
For accurate positioning of the Mako R/F Probe on the GE Vascular system.

Dimensions. All units in mm

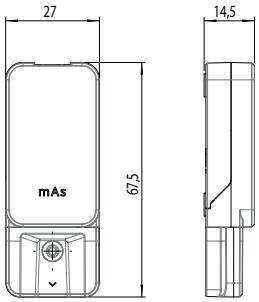
Mako Base Unit



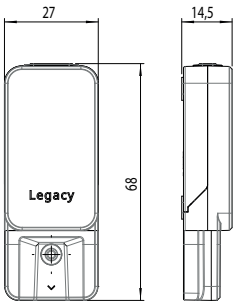
Mako Ion Chamber Module



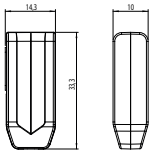
Mako mAs Module



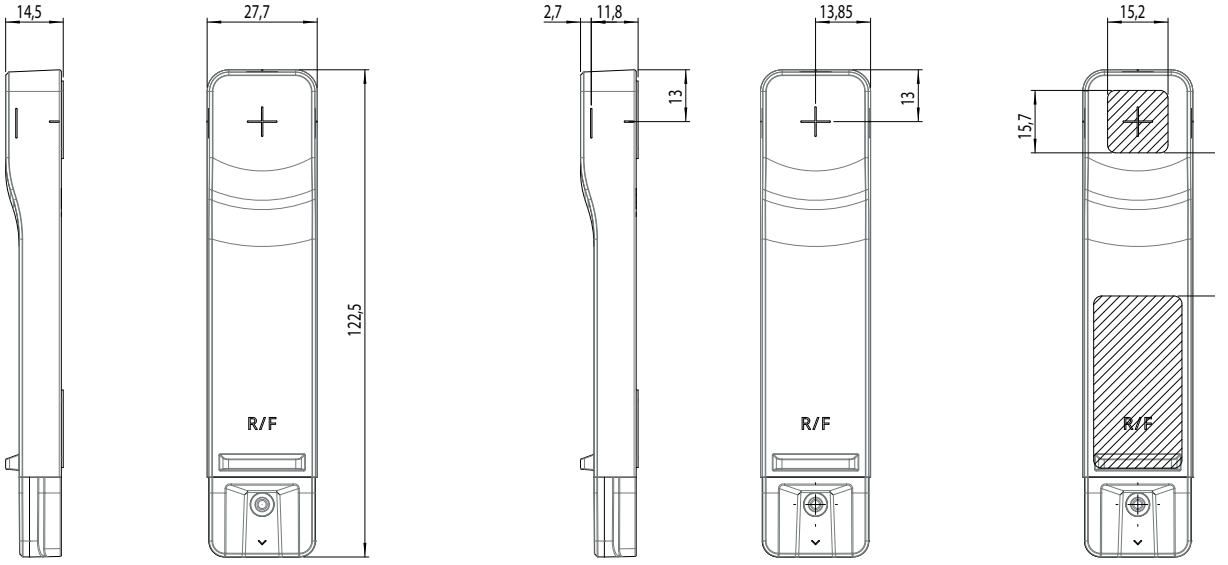
Mako Legacy Module



Mako PI Dongle



Mako Probes



Reference conditions

Specifications in this document are valid at reference conditions derived by RTI for a typical X-ray tube and HF/DC generator. Unless otherwise stated, reference conditions are at SDD 100 cm, 100 mA and 100 ms. For R/F and dental specifications, X-ray tube with tungsten (W) target, 12° anode angle, and a total filtration of 3 mm Al equivalent. For mammography specifications, X-ray tube with tungsten (W) target, 16° anode angle, and a total filtration of 0.7 mm Al.
For a parameter that is a part of the reference condition, only that parameter is changed when this specific parameter is expressed in specifications.

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to a coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EAL Publication EAL-R2.

c/o RTI

What we do matters. To patients. To professionals. To us.
It is more than algorithms, technology and design.
It is about setting the standard for quality assurance
of X-ray imaging.

INDEPENDENT X-RAY
QUALITY ASSURANCE