eoProbe™

DESCRIPTION

Kapteos electro-optic probes eoProbe™ give you access to a complete measurement of the electric (E) field, in both frequency and time domains for single-shot or repetitive signals, whatever the environmental conditions and the measurement constraints: > 1 MV, > 40 kA, > 5 T, reactive near field area, vacuum, ultra confined space, in biological tissues measurements, < 1 kHz and > 10 GHz, coupled physical effects like 1 kW CW at 100 MHz with 3T static magnetic field…

Any E field probe or receiving electric antenna can be substituted by an electro-optic probe associated with its optoelectronic converter eoSense™. This converter is used to feed the probe with a laser beam and then to convert the optical information carried by the laser beam into an electric signal. This electric signal gives you the true temporal evolution of a single component of the measured E field. Owing to its fully dielectric composition based on ultra low loss tangent materials, eoProbe™ do not interfere at all with the E field to be measured.

With this new line of electro-optic transducers, the permanent power handling has been enhanced by a factor of 10 and a cubic base has been added for a better usability. Based on quartz and ceramics, electro-optic probes have to be handled with care and mechanical shocks must be avoided.

APPLICATIONS

When not in the far field conditions, the key point for achieving a true value of the E field is to use a field probe with no galvanic link and a permittivity close to the one of the medium of measurement. This is the reason for which we offer three lines of probe:

- **vac** line for measurements in vacuum (down to 10^{-5} mbar),
- **air** line for measurements at atmospheric pressure in low permittivity media like air or oils,
- **bio** line for measurements in high permittivity media like aqueous liquids and biological tissues.

Depending on your setup and on the E field component you are interested in, you can use two different types of probe leading to a specific component of the E field to be measured:

- **longitudinal** probes (**EL** type) for an E field component parallel to the probe axis,
- **transverse** probes (**ET** type) for an E field component perpendicular to the probe axis.

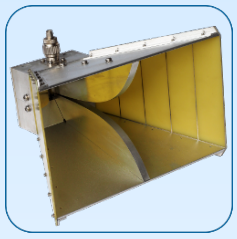
Depending on what you seek, either sensitivity, spatial resolution or high frequency, two different lengths of transducer can be used:

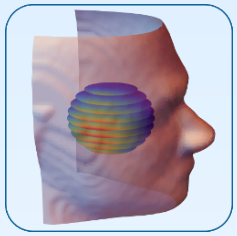
- short transducer (**1** mm long) leading to high spatial resolution and high frequency probes,
- long transducer (**5** mm long) leading to high sensitivity probes with lower spatial resolution.

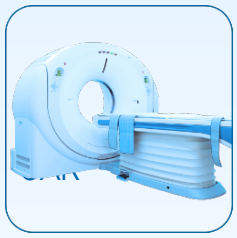
Depending on your need, you have finally the choice among 12 different configurations of probe manufactured with 5 metres of optical fibre length.

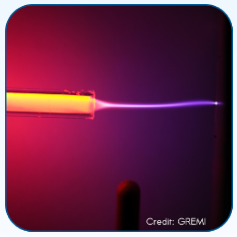
SERVICES

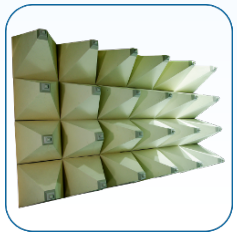
Kapteos offers a recalibration service of your probes and associated optoelectronic converters. Specific calibration in different liquids are also possible on request. Each probe is delivered with a routine test report.











Your **key partner** for **electromagnetism** in **harsh environment**

COMMON FEATURES

Dynamic range	> 130 dB.Hz
Selectivity (orthogonal components rejection)	> 50 dB
Insertion Loss	< 9 dB
Connector durability	500 matings
Connector repeatability	< 0.2 dB
Damage threshold	E > 10 MV/m **or** permanent PD[1] > 10 W/cm²
Transducer composition (probe head)	Fully dielectric, low loss materials, **no metal part**

[1] Power Density

	air and **bio** lines	**vac** line
Fibre length	5 m	according to customer spec. (1 to 10m)
Optical connector	Souriau Duplex LC/APC	FC/APC x 2
Overall weight (w/ 5 m fibre link & optical connector)	110 ± 10 g (probe: ~ 2 g)	< 200 g (probe: ~ 2 g)

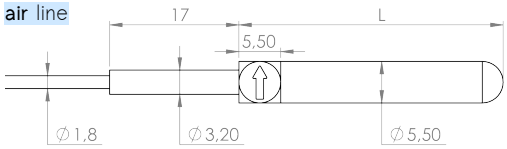
SPECIFIC CHARACTERISTICS		EL5-air|vac	ET5-air|vac	EL1-air|vac	ET1-air|vac	EL5-bio	ET5-bio	EL1-bio	ET1-bio
FD[2] Sensitivity (mV/m.√Hz)	**Typ.**	**40**	**200**	**160**	**400**	**40**	**64**	**160**	**250**
	Max.	50	250	200	500	50	80	200	320
TD[3] Sensitivity (mV/m.√Hz)	**Typ.**	**16**	**80**	**64**	**160**	**16**	**25**	**64**	**100**
	Max.	20	100	80	200	20	32	80	125
P1dB[4] (kV_{rms}/m)		> 50	> 250	> 200	> 500	> 50	> 80	> 200	> 320
Transducer length (mm)		5		1		5		1	
Measurement voxel		Ø ≲ 1mm, length 5 mm		Ø ≲ 1mm, length 1 mm		Ø ≲ 1mm, length 5 mm		Ø ≲ 1mm, length 1 mm	
Frequency range (Hz)		10 → 10G[5]		10 → 50G		30k → 1G		30k → 1G	
Probe sheath permittivity[6]		4				23			
Recommended use		Gases, Non-Polar Liquids (e.g. oils) | Vacuum				Polar Liquids (e.g. water & biological media)			

[2] Frequency-Domain - Sensitivity is given in air for **air|vac** lines and in pure water (deionized) for **bio** line
[3] Time-Domain (on µs time window) - Sensitivity is given in air for **air|vac** lines and in pure water (deionized) for **bio** line
[4] 1-dB compression Point (in case of use of moderate gain -G30- for the optoelectronic converter eoSense)
[5] For narrower bandwidths (*e.g.* 500 MHz), EL5 and ET5 probes could sometime be used even if the operating frequency is higher than 10 GHz (please ask Kapteos for details)
[6] @1MHz - For electromagnetic simulation purpose, contact Kapteos for details

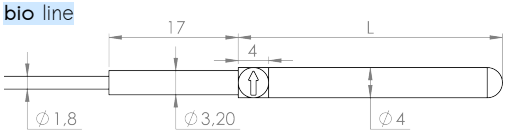
TRANSDUCER DESCRIPTION

Drawings at scale 1:1 - Dimensions in mm (± 0.1 mm on diameters unless otherwise noted) - Arrow indicating the measured E field component

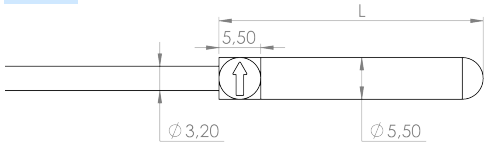
air line



bio line



vac line

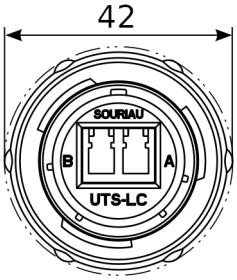


Transducer length (mm)	1	5
Overall length L ± 0.25 (mm)	31.75	34.75

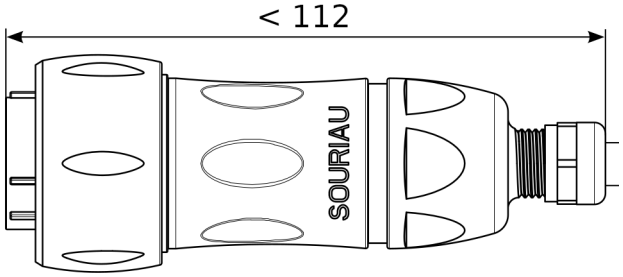
CONNECTOR DESCRIPTION

Drawings at scale 1:1 - Dimensions in mm (± 0.25 mm on diameters unless otherwise noted)

connector-to-eoSense™ front view



connector-to-eoSense™ side view



OPERATING CONDITIONS ([8] Max. 8h per day in case operating conditions are harsher than storage conditions | [9] Max. 4h in a row in pure water and 1h in salty water)

Temperature[8]	+10°C → +50°C (+50°F → +122°F)
Pressure[8]	0-2030 hPa (0-29.4 psi)
Bending radius[8]	40 mm min.
Ingress Protection rating[9]	IP67 (probe only)
Probe cleaning	Use cloth lightly moistened with isopropyl alcohol

STORAGE CONDITIONS

Storage	Only in its original case in a clean, dry environment
Temperature	+10°C → +40°C (+50°F → +104°F)
Relative humidity	< 90% - non-condensing
Pressure	690-1075 hPa (10-15.6 psi)
Bending radius	50 mm min.

CONTENTS LIST

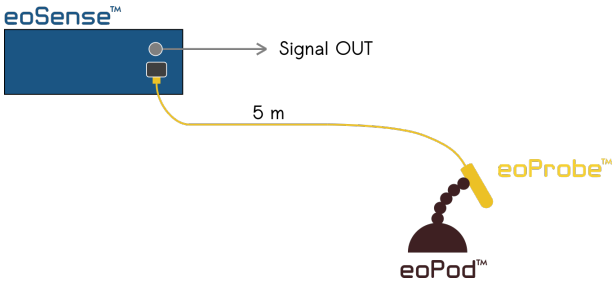
Probe	Delivered with a routine test report
Transport case (up to 4 probes)	Drip-proof and dust-proof case (W = 430 mm - D = 330 mm - H = 110 mm - Weight: 2200 g)
Protection tool used for handling	Protective foam
User guide	cf. eoSense User Guide PDF file GU-eoSense

COMPATIBLE DEVICES & ACCESSORIES

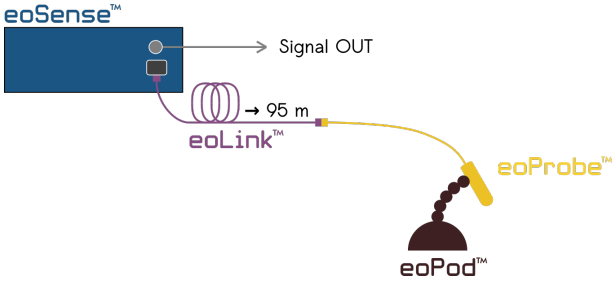
Optoelectronic converter	eoSense (cf. related data sheet FT-eoSense)
Holder	eoPod (cf. related data sheet FT-eoPod)
Calibration cell	eoCal (cf. related data sheet FT-eoCal)
Fibre extension	eoLink (cf. related data sheet FT-eoLink)

APPLICATIONS INFORMATION

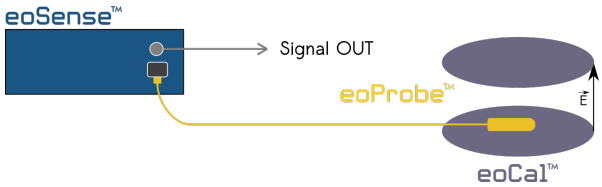
Standard setup
Recommended setup in most cases



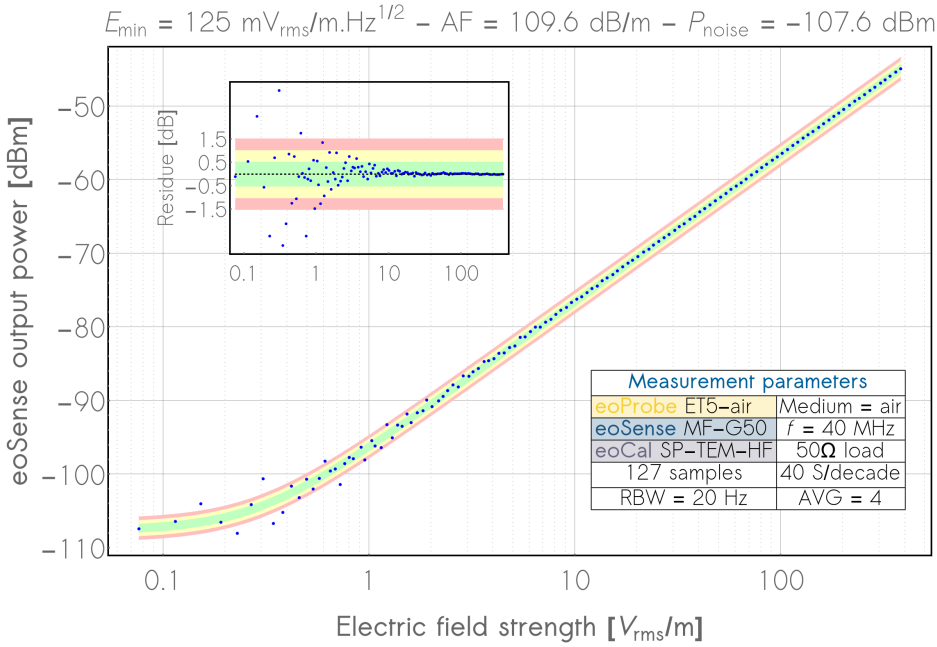
Remote setup
Required setup from a great distance, like outdoor conditions



Calibration setup
Required setup for probe (re)calibration in air or in any fluid - refer to eoCal™ data sheet



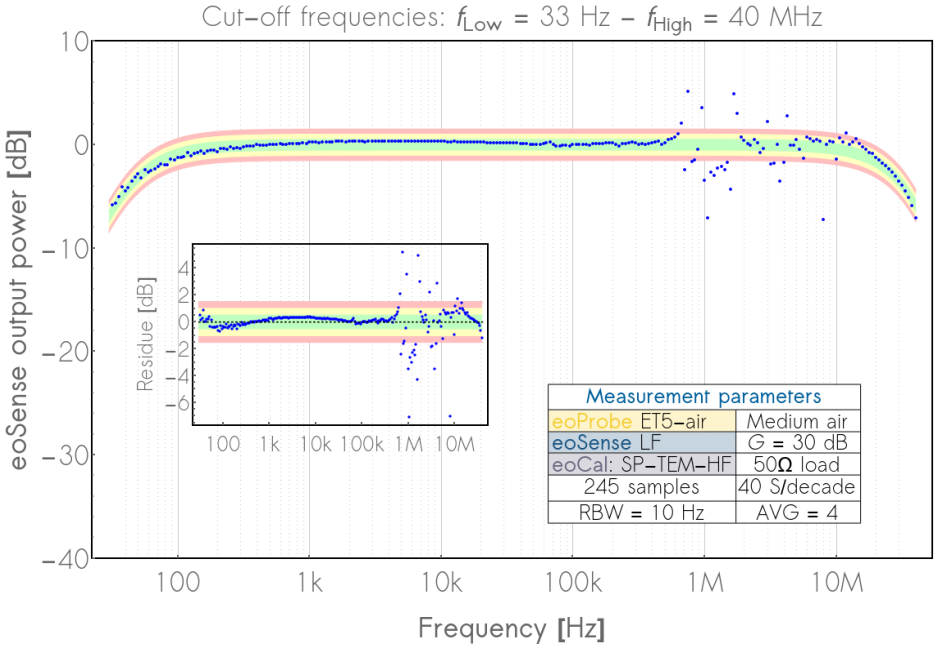
Probe response vs E field strength



- Dynamic range lower bound → eoSense noise floor (-107.6 dBm)
- Min. measurable E field E_{min} → E field strength at intersection of noise floor and eoProbe linear response given in a 1-Hz RBW[1] (irrespective of frequency)
- Deviation from linearity → < 0.1 dB for E field strength > 10 V_{rms}/m (see graph inset showing the residue[2])

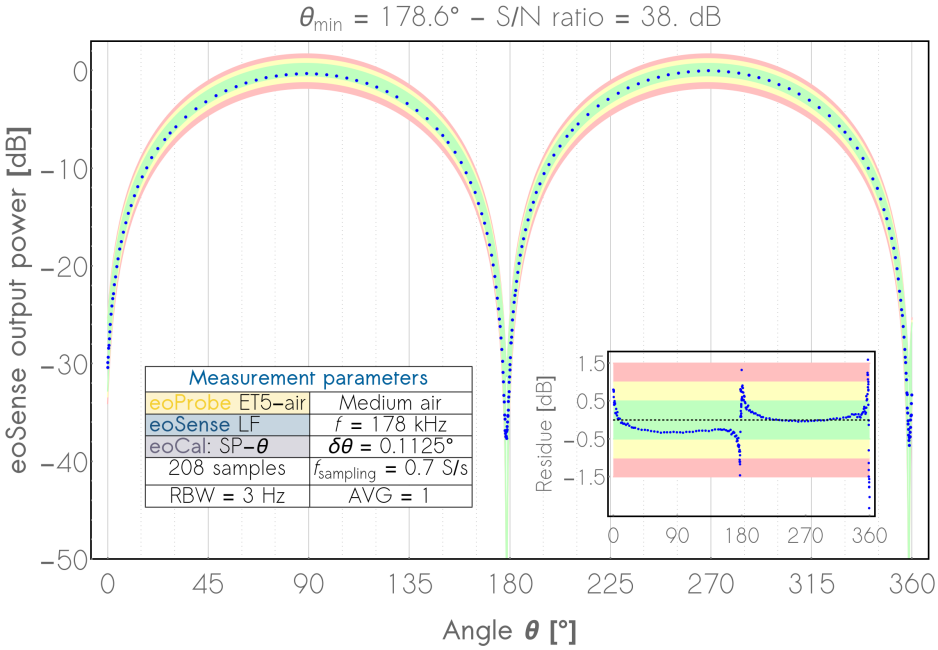
[1] Resolution Band Width
[2] Difference between measurement and theoretical fit

Probe response vs frequency



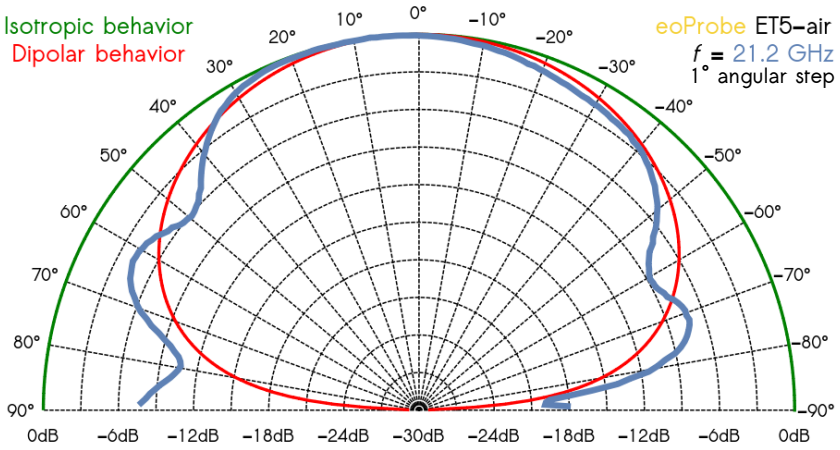
- Composite frequency response → eoProbe™ + eoSense™
- Cut-off (-3dB) frequencies (33 Hz & 40 MHz) → linked only to converter eoSense™ (specified bandwidth of 40 Hz - 30 MHz)
- Flat frequency response (± 1.5 dB) except some (< 20) narrow (< 20 kHz) resonances and antiresonances in the 600 kHz - 15 MHz band width → stationary piezoelectric resonances of the electro-optic transducer

Probe response vs E field angle

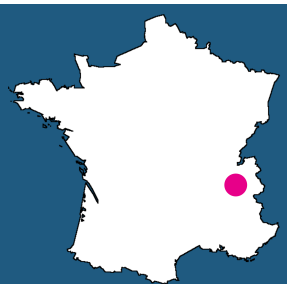


- Single E field component transducer → purely sinusoidal scalar response
- High rejection ratio of the orthogonal E field components → 38 dB (limited by noise floor of production setup)
- Precise orientation of probe sensitivity axis → misalignment of 1.4°

Probe response vs wave incidence angle



- Low frequency behaviour → receiving pattern close to that of isotropic antenna
- High frequency behaviour → receiving pattern in between that of isotropic antenna and dipolar antenna (case for RF signal wavelength comparable to eoProbe size - for f > 5 GHz)
- High -3 dB acceptance angle → 80° at 21.2 GHz (see Fig. above)



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