

Deutsche Akkreditierungsstelle

Annex to the Partial Accreditation Certificate D-K-17616-01-02 according to DIN EN ISO/IEC 17025:2018

Valid from: 07.11.2022

Date of issue: 14.02.2023

This annex is a part of the accreditation certificate D-K-17616-01-00.

Holder of partial accreditation certificate:

Thermo Electron LED GmbH
Robert-Bosch-Straße 1, 63505 Langenselbold

The calibration laboratory meets the minimal requirements of DIN EN ISO/IEC 17025:2018 and, if applicable, additional legal and normative requirements, including those in relevant sectoral schemes, in order to carry out the conformity assessment activities listed below.

The management system requirements of DIN EN ISO/IEC 17025 are written in the language relevant to the operations of calibration laboratories and confirm generally with the principles of DIN EN ISO 9001.

Calibration in the fields:

Electrical quantities

DC and low frequency quantities

- **DC resistance**
- **DC current**
- **DC voltage**
- **AC current**
- **AC voltage**

This certificate annex is only valid together with the written accreditation certificate and reflects the status as indicated by the date of issue. The current status of any given scope of accreditation can be found in the directory of accredited bodies maintained by Deutsche Akkreditierungsstelle GmbH at <https://www.dakks.de>.

Abbreviations used: see last page

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Permanent Laboratory

Calibration and Measurement Capabilities (CMC)

Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
DC voltage Measuring instruments	0V		2 μ V	U = set value
	0,001 V to < 0,33 V		$37 \cdot 10^{-6} \cdot U + 2 \mu$ V	
	0,33 V to < 3,3 V		$15 \cdot 10^{-6} \cdot U + 3 \mu$ V	
	3,3 V to < 33 V		$17 \cdot 10^{-6} \cdot U + 25 \mu$ V	
	33 V to < 330 V		$20 \cdot 10^{-6} \cdot U + 0,2$ mV	
	330 V to 1000 V		$22 \cdot 10^{-6} \cdot U + 1,7$ mV	
DC voltage Sources	0 V		2 μ V	U = measuring value
	0,001 V to < 0,2 V		$5 \cdot 10^{-6} \cdot U + 2 \mu$ V	
	0,2 V to < 2 V		$5 \cdot 10^{-6} \cdot U + 1 \mu$ V	
	2 V to < 20 V		$5 \cdot 10^{-6} \cdot U + 5 \mu$ V	
	20 V to < 200 V		$7 \cdot 10^{-6} \cdot U + 50 \mu$ V	
	200 V to 1000 V		$7 \cdot 10^{-6} \cdot U + 0,6$ mV	
DC current Measuring instruments	0 A		2 μ A	I = set value
	100 μ A to < 330 μ A		$10 \cdot 10^{-6} \cdot I + 2 \mu$ A	
	330 μ A to < 3,3 mA		$30 \cdot 10^{-6} \cdot I + 2 \mu$ A	
	3,3 mA to < 33 mA		$0,10 \cdot 10^{-3} \cdot I + 2 \mu$ A	
	33 mA to < 330 mA		$0,12 \cdot 10^{-3} \cdot I + 5 \mu$ A	
	330 mA to < 1,1 A		$0,25 \cdot 10^{-3} \cdot I + 50 \mu$ A	
	1,1 A to < 3 A		$0,45 \cdot 10^{-3} \cdot I + 50 \mu$ A	
3 A to < 11 A		$0,6 \cdot 10^{-3} \cdot I + 0,6$ mA		
	11 A to 20,5 A		$1,2 \cdot 10^{-3} \cdot I + 1,7$ mA	
DC current Sources	0 A		2 μ A	I = measuring value
	0,1m A to < 2 mA		$1 \cdot 10^{-6} \cdot I + 2 \mu$ A	
	2 mA to < 20 mA		$4 \cdot 10^{-6} \cdot I + 2 \mu$ A	
	20 mA to < 200 mA		$45 \cdot 10^{-6} \cdot I + 2 \mu$ A	
	0,2A to < 2 A		$0,21 \cdot 10^{-3} \cdot I + 20 \mu$ A	
	2A to 20 A		$0,47 \cdot 10^{-3} \cdot I + 0,47$ mA	
DC resistance Measuring instruments	0 Ω		0,5 m Ω	R = set value
	0,01 Ω to < 11 Ω		$35 \cdot 10^{-6} \cdot R + 1,6$ m Ω	
	11 Ω to < 110 Ω		$30 \cdot 10^{-6} \cdot R + 2,3$ m Ω	
	110 Ω to < 1,1 k Ω		$30 \cdot 10^{-6} \cdot R + 2,7$ m Ω	
	1,1 k Ω to < 11 k Ω		$35 \cdot 10^{-6} \cdot R + 25$ m Ω	
	11 k Ω to < 110 k Ω		$35 \cdot 10^{-6} \cdot R + 0,25$ Ω	
	110 k Ω to < 1,1 M Ω		$40 \cdot 10^{-6} \cdot R + 2,5$ Ω	
	1,1 M Ω to < 3,3 M Ω		$70 \cdot 10^{-6} \cdot R + 35$ Ω	
	3,3 M Ω to < 11 M Ω		$0,16 \cdot 10^{-3} \cdot R + 60$ Ω	
	11 M Ω to < 33 M Ω		$0,3 \cdot 10^{-3} \cdot R + 3$ k Ω	
	33 M Ω to < 110 M Ω		$0,6 \cdot 10^{-3} \cdot R + 3,5$ k Ω	
	110 M Ω to < 330 M Ω		$3,5 \cdot 10^{-3} \cdot R + 0,15$ M Ω	
	330 M Ω to 1,1 G Ω		$17 \cdot 10^{-3} \cdot R + 0,6$ M Ω	

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Measurement quantity / Calibration item	Range	Measurement conditions / procedure	Expanded uncertainty of measurement	Remarks
DC resistance Sources	0 Ω 0,1 mΩ to < 2 Ω 2 Ω to < 20 Ω 20 Ω to < 200 Ω 200 Ω to < 2 kΩ 2 kΩ to < 20 kΩ 20 kΩ to < 200 kΩ 200 kΩ to < 2 MΩ 2 MΩ to < 20 MΩ 20 MΩ to < 200 MΩ 200 MΩ to < 2 GΩ 2 GΩ to 20 GΩ		0,5 mΩ $20 \cdot 10^{-6} \cdot R + 0,015 \text{ m}\Omega$ $15 \cdot 10^{-6} \cdot R + 0,02 \text{ m}\Omega$ $10 \cdot 10^{-6} \cdot R + 0,06 \text{ m}\Omega$ $10 \cdot 10^{-6} \cdot R + 0,6 \text{ m}\Omega$ $10 \cdot 10^{-6} \cdot R + 6 \text{ m}\Omega$ $10 \cdot 10^{-6} \cdot R + 60 \text{ m}\Omega$ $12 \cdot 10^{-6} \cdot R + 1,2 \Omega$ $25 \cdot 10^{-6} \cdot R + 0,12 \text{ k}\Omega$ $0,15 \cdot 10^{-3} \cdot R + 12 \text{ k}\Omega$ $1,7 \cdot 10^{-3} \cdot R + 1,2 \text{ M}\Omega$ $1,7 \cdot 10^{-3} \cdot R + 15 \text{ M}\Omega$	R = measuring value
AC voltage Measuring instruments	0,001 V to < 0,033 V 0,033 V to < 0,33 V 0,33 V to < 3,3 V 3,3 V to < 33 V 33 V to < 330 V 330 V to 1000 V	10 Hz to 45 Hz > 45 Hz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz > 100 kHz to 500 kHz 10 Hz to 45 Hz > 45 Hz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz > 100 kHz to 500 kHz 10 Hz to 45 Hz > 45 Hz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz 45 Hz to 1 kHz > 1 kHz to 10 kHz > 10 kHz to 20 kHz > 20 kHz to 50 kHz > 50 kHz to 100 kHz 45 Hz to 1 kHz > 1 kHz to 5 kHz > 5 kHz to 10 kHz	$0,75 \cdot 10^{-3} \cdot U + 10 \mu\text{V}$ $0,13 \cdot 10^{-3} \cdot U + 10 \mu\text{V}$ $0,18 \cdot 10^{-3} \cdot U + 10 \mu\text{V}$ $1,0 \cdot 10^{-3} \cdot U + 9 \mu\text{V}$ $3,5 \cdot 10^{-3} \cdot U + 18 \mu\text{V}$ $7,5 \cdot 10^{-3} \cdot U + 75 \mu\text{V}$ $0,40 \cdot 10^{-3} \cdot U + 10 \mu\text{V}$ $0,15 \cdot 10^{-3} \cdot U + 12 \mu\text{V}$ $0,20 \cdot 10^{-3} \cdot U + 12 \mu\text{V}$ $0,40 \cdot 10^{-3} \cdot U + 12 \mu\text{V}$ $0,80 \cdot 10^{-3} \cdot U + 45 \mu\text{V}$ $2,0 \cdot 10^{-3} \cdot U + 100 \mu\text{V}$ $0,37 \cdot 10^{-3} \cdot U + 60 \mu\text{V}$ $0,15 \cdot 10^{-3} \cdot U + 85 \mu\text{V}$ $0,20 \cdot 10^{-3} \cdot U + 85 \mu\text{V}$ $0,30 \cdot 10^{-3} \cdot U + 70 \mu\text{V}$ $0,70 \cdot 10^{-3} \cdot U + 0,16 \text{ mV}$ $2,5 \cdot 10^{-3} \cdot U + 0,80 \text{ mV}$ $0,35 \cdot 10^{-3} \cdot U + 0,80 \text{ mV}$ $0,15 \cdot 10^{-3} \cdot U + 0,85 \text{ mV}$ $0,25 \cdot 10^{-3} \cdot U + 0,80 \text{ mV}$ $0,35 \cdot 10^{-3} \cdot U + 0,75 \text{ mV}$ $1,0 \cdot 10^{-3} \cdot U + 2,0 \text{ mV}$ $0,20 \cdot 10^{-3} \cdot U + 2,5 \text{ mV}$ $0,25 \cdot 10^{-3} \cdot U + 8 \text{ mV}$ $0,30 \cdot 10^{-3} \cdot U + 8 \text{ mV}$ $0,35 \cdot 10^{-3} \cdot U + 7,5 \text{ mV}$ $2,0 \cdot 10^{-3} \cdot U + 65 \text{ mV}$ $0,35 \cdot 10^{-3} \cdot U + 12 \text{ mV}$ $0,30 \cdot 10^{-6} \cdot U + 12 \text{ mV}$ $0,35 \cdot 10^{-3} \cdot U + 12 \text{ mV}$	U = set value

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AC voltage Sources	0,001 V to < 0,2 V	10 Hz to 40 Hz	$0,18 \cdot 10^{-3} \cdot U + 6 \mu\text{V}$	$U =$ measuring value
		> 40 Hz to 100 Hz	$0,13 \cdot 10^{-3} \cdot U + 6 \mu\text{V}$	
		> 100 Hz to 2 kHz	$0,13 \cdot 10^{-3} \cdot U + 6 \mu\text{V}$	
		> 2 kHz to 10 kHz	$0,15 \cdot 10^{-3} \cdot U + 6 \mu\text{V}$	
		> 10 kHz to 30 kHz	$0,37 \cdot 10^{-3} \cdot U + 12 \mu\text{V}$	
		> 30 kHz to 100 kHz	$0,85 \cdot 10^{-3} \cdot U + 30 \mu\text{V}$	
	0,2 V to < 2 V	10 Hz to 40 Hz	$0,14 \cdot 10^{-3} \cdot U + 25 \mu\text{V}$	
		> 40 Hz to 100 Hz	$0,11 \cdot 10^{-3} \cdot U + 25 \mu\text{V}$	
		> 100 Hz to 2 kHz	$90 \cdot 10^{-6} \cdot U + 25 \mu\text{V}$	
		> 2 kHz to 10 kHz	$0,13 \cdot 10^{-3} \cdot U + 25 \mu\text{V}$	
		> 10 kHz to 30 kHz	$0,26 \cdot 10^{-3} \cdot U + 50 \mu\text{V}$	
		> 30 kHz to 100 kHz	$0,66 \cdot 10^{-3} \cdot U + 0,25 \text{ mV}$	
		> 100 kHz to 300 kHz	$3,5 \cdot 10^{-3} \cdot U + 2,9 \text{ mV}$	
	2 V to < 20 V	10 Hz to 40 Hz	$0,14 \cdot 10^{-3} \cdot U + 0,25 \text{ mV}$	
		> 40 Hz to 100 Hz	$0,11 \cdot 10^{-3} \cdot U + 0,25 \text{ mV}$	
		> 100 Hz to 2 kHz	$90 \cdot 10^{-6} \cdot U + 0,25 \text{ mV}$	
		> 2 kHz to 10 kHz	$0,13 \cdot 10^{-3} \cdot U + 0,25 \text{ mV}$	
		> 10 kHz to 30 kHz	$0,26 \cdot 10^{-3} \cdot U + 0,50 \text{ mV}$	
		> 30 kHz to 100 kHz	$0,66 \cdot 10^{-3} \cdot U + 2,5 \text{ mV}$	
	20 V to < 200 V	> 100 kHz to 300 kHz	$3,5 \cdot 10^{-3} \cdot U + 29 \text{ mV}$	
> 300 kHz to 1 MHz		$12 \cdot 10^{-3} \cdot U + 0,30 \text{ V}$		
10 Hz to 40 Hz		$0,14 \cdot 10^{-3} \cdot U + 2,3 \text{ mV}$		
> 40 Hz to 100 Hz		$0,11 \cdot 10^{-3} \cdot U + 2,3 \text{ mV}$		
> 100 Hz to 2 kHz		$95 \cdot 10^{-6} \cdot U + 2,3 \text{ mV}$		
200 V to 1000 V	> 2 kHz to 10 kHz	$0,13 \cdot 10^{-3} \cdot U + 2,3 \text{ mV}$		
	> 10 kHz to 30 kHz	$0,26 \cdot 10^{-3} \cdot U + 5,0 \text{ mV}$		
	> 30 kHz to 100 kHz	$0,67 \cdot 10^{-3} \cdot U + 25 \text{ mV}$		
	> 40 Hz to 10 kHz	$0,15 \cdot 10^{-3} \cdot U + 25 \text{ mV}$		
	> 10 kHz to 30 kHz	$0,25 \cdot 10^{-3} \cdot U + 50 \text{ mV}$		

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AC current Measuring instruments	0,029 mA to < 0,33 mA	10 Hz to 20 Hz	$1 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	I = measuring value
		> 20 Hz to 45 Hz	$0,6 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	
		> 45 Hz to 1 kHz	$0,45 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	
		> 1 kHz to 5 kHz	$1,9 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	
		> 5 kHz to 10 kHz	$7,5 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	
	0,33 mA to < 3,3 mA	10 Hz to 20 Hz	$2,2 \cdot 10^{-3} \cdot I + 1 \mu\text{A}$	
		> 20 Hz to 45 Hz	$1,3 \cdot 10^{-3} \cdot I + 1 \mu\text{A}$	
		> 45 Hz to 1 kHz	$1 \cdot 10^{-3} \cdot I + 1 \mu\text{A}$	
> 1 kHz to 5 kHz		$2,2 \cdot 10^{-3} \cdot I + 1 \mu\text{A}$		
> 5 kHz to 10 kHz		$6 \cdot 10^{-3} \cdot I + 1 \mu\text{A}$		
3,3 mA to < 33 mA	10 Hz to 20 Hz	$2,1 \cdot 10^{-3} \cdot I + 2,5 \mu\text{A}$		
	> 20 Hz to 45 Hz	$1,1 \cdot 10^{-3} \cdot I + 2,5 \mu\text{A}$		
	> 45 Hz to 1 kHz	$0,5 \cdot 10^{-3} \cdot I + 2,5 \mu\text{A}$		
	> 1 kHz to 5 kHz	$1,0 \cdot 10^{-3} \cdot I + 2,4 \mu\text{A}$		
	> 5 kHz to 10 kHz	$2,5 \cdot 10^{-3} \cdot I + 3,5 \mu\text{A}$		
33 mA to < 330 mA	10 Hz to 20 Hz	$2,1 \cdot 10^{-3} \cdot I + 25 \mu\text{A}$		
	> 20 Hz to 45 Hz	$1,1 \cdot 10^{-3} \cdot I + 25 \mu\text{A}$		
	> 45 Hz to 1 kHz	$0,5 \cdot 10^{-3} \cdot I + 25 \mu\text{A}$		
	> 1 kHz to 5 kHz	$1,2 \cdot 10^{-3} \cdot I + 60 \mu\text{A}$		
	> 5 kHz to 10 kHz	$2,4 \cdot 10^{-3} \cdot I + 0,12 \text{ mA}$		
0,33 A to < 1,1 A	10 Hz to 45 Hz	$2,1 \cdot 10^{-3} \cdot I + 0,12 \text{ mA}$		
	> 45 Hz to 1 kHz	$0,6 \cdot 10^{-3} \cdot I + 0,12 \text{ mA}$		
	> 1 kHz to 5 kHz	$7 \cdot 10^{-3} \cdot I + 1,2 \text{ mA}$		
	> 5 kHz to 10 kHz	$30 \cdot 10^{-3} \cdot I + 6 \text{ mA}$		
	1,1 A to < 3 A	10 Hz to 45 Hz	$2,1 \cdot 10^{-3} \cdot I + 0,12 \text{ mA}$	
> 45 Hz to 1 kHz		$0,7 \cdot 10^{-3} \cdot I + 0,13 \text{ mA}$		
> 1 kHz to 5 kHz		$7 \cdot 10^{-3} \cdot I + 1,2 \text{ mA}$		
> 5 kHz to 10 kHz		$29 \cdot 10^{-3} \cdot I + 5,9 \text{ mA}$		
3 A to < 11 A		45 Hz to 100 Hz	$0,72 \cdot 10^{-3} \cdot I + 2,5 \text{ mA}$	
	> 100 Hz to 1 kHz	$1,2 \cdot 10^{-3} \cdot I + 2,5 \text{ mA}$		
	> 1 kHz to 5 kHz	$35 \cdot 10^{-3} \cdot I + 2,5 \text{ mA}$		
11 A to 20,5 A	45 Hz to 100 Hz	$1,5 \cdot 10^{-3} \cdot I + 6 \text{ mA}$		
	> 100 Hz to 1 kHz	$1,8 \cdot 10^{-3} \cdot I + 6 \text{ mA}$		
	> 1 kHz to 5 kHz	$35 \cdot 10^{-3} \cdot I + 6 \text{ mA}$		
AC current Sources	0,1 mA to < 0,2 mA	10 Hz to 10 kHz	$55 \cdot 10^{-6} \cdot I + 1,5 \mu\text{A}$	I = measuring value
	0,2 mA to < 2 mA	10 Hz to 10 kHz	$0,2 \cdot 10^{-3} \cdot I + 1,5 \mu\text{A}$	
	2 mA to < 20 mA	10 Hz to 10 kHz	$0,4 \cdot 10^{-3} \cdot I + 3,0 \mu\text{A}$	
	20 mA to < 200 mA	10 Hz to 10 kHz	$0,4 \cdot 10^{-3} \cdot I + 30 \mu\text{A}$	
	200 mA to < 2 A	10 Hz to 10 kHz	$0,9 \cdot 10^{-3} \cdot I + 0,25 \text{ mA}$	
	2 A to 20 A	10 Hz to 2 kHz	$3 \cdot 10^{-3} \cdot I + 2,5 \text{ mA}$	

Abbreviations used:

CMC Calibration and measurement capabilities

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