

of **Trescal Livingston Calibration B.V.**

**Zoetermeer**

Valid from: **24-05-2006** till **01-03-2010**

Replaces appendix dated: **05-10-2004**

Measured quantity, range		Frequency	Best measurement capabilities ( $k=2$ )	Remarks	
1	ELECTRICITY				
1.1	DC/LF Quantities				
1.1.1	Voltage				
1.1.1.1	DC Voltage				
	10 $\mu$ V - 100 $\mu$ V		$5 \cdot 10^{-3} \cdot U$	Measuring	
	100 $\mu$ V - 1 mV		$5 \cdot 10^{-4} \cdot U$		
	1 mV - 10 mV		$1 \cdot 10^{-4} \cdot U$		
	10 mV - 100 mV		$2 \cdot 10^{-5} \cdot U$		
	100 mV - 2 V		$7 \cdot 10^{-6} \cdot U$		
	2 V - 20 V		$3 \cdot 10^{-6} \cdot U$		
	20 V - 1 kV		$6 \cdot 10^{-6} \cdot U$		
	0,1 V		$1,2 \cdot 10^{-6} \cdot U$		Measuring, generating
	1 V		$9 \cdot 10^{-7} \cdot U$		
	1,018 V		$1 \cdot 10^{-6} \cdot U$		
	10 V		$7 \cdot 10^{-7} \cdot U$		
	100 V		$7 \cdot 10^{-7} \cdot U$		
	1000 V		$1,2 \cdot 10^{-6} \cdot U$	Generating	
	10 mV - 100 mV		$6 \cdot 10^{-5} \cdot U$		
	100 mV - 2,2 V		$1,5 \cdot 10^{-5} \cdot U$		
	2,2 V - 22 V		$7 \cdot 10^{-6} \cdot U$		
	22 V - 1 kV		$1 \cdot 10^{-5} \cdot U$		
1.1.1.2	AC Voltage			Measuring, generating Generating >200V at 50 Hz - 1 kHz	
	60 mV	10 Hz - 20 Hz	$3 \cdot 10^{-4} \cdot U$		
		20 Hz - 40 Hz	$1,5 \cdot 10^{-4} \cdot U$		
		40 Hz - 20 kHz	$1 \cdot 10^{-4} \cdot U$		
		20 kHz - 50 kHz	$2 \cdot 10^{-4} \cdot U$		
		50 kHz - 100 kHz	$3,5 \cdot 10^{-4} \cdot U$		
		100 kHz - 300 kHz	$6 \cdot 10^{-4} \cdot U$		
		300 kHz - 500 kHz	$8,5 \cdot 10^{-4} \cdot U$		
		500 kHz - 1 MHz	$1,5 \cdot 10^{-3} \cdot U$		

This annex has been approved by:

Ir. J.C. van der Poel  
Chief Executive

of **Trescal Livingston Calibration B.V.**

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Measured quantity, range	Frequency	Best measurement capabilities ( $k=2$ )	Remarks
100 mV – 200 mV	10 Hz – 20 Hz	$2,5 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$1 \cdot 10^{-4} \cdot U$	
	20 kHz – 50 kHz	$1 \cdot 10^{-4} \cdot U$	
	50 kHz – 100 kHz	$2 \cdot 10^{-4} \cdot U$	
	100 kHz – 300 kHz	$3 \cdot 10^{-4} \cdot U$	
	300 kHz – 500 kHz	$5,5 \cdot 10^{-4} \cdot U$	
200 mV – 600 mV	500 kHz – 1 MHz	$1,4 \cdot 10^{-3} \cdot U$	
	10 Hz – 20 Hz	$2,5 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$1 \cdot 10^{-4} \cdot U$	
	20 kHz – 50 kHz	$1 \cdot 10^{-4} \cdot U$	
	50 kHz – 100 kHz	$2 \cdot 10^{-4} \cdot U$	
	100 kHz – 300 kHz	$2,5 \cdot 10^{-4} \cdot U$	
600 mV – 2 V	300 kHz – 500 kHz	$4 \cdot 10^{-4} \cdot U$	
	500 kHz – 1 MHz	$1,3 \cdot 10^{-3} \cdot U$	
	10 Hz – 20 Hz	$2 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$5 \cdot 10^{-5} \cdot U$	
	20 kHz – 50 kHz	$1 \cdot 10^{-4} \cdot U$	
	50 kHz – 100 kHz	$1 \cdot 10^{-4} \cdot U$	
2 V – 20 V	100 kHz – 300 kHz	$2 \cdot 10^{-4} \cdot U$	
	300 kHz – 500 kHz	$3,5 \cdot 10^{-4} \cdot U$	
	500 kHz – 1 MHz	$1,3 \cdot 10^{-3} \cdot U$	
	10 Hz – 20 Hz	$2 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$5 \cdot 10^{-5} \cdot U$	
	20 kHz – 50 kHz	$1 \cdot 10^{-4} \cdot U$	
20 V – 200	50 kHz – 100 kHz	$1 \cdot 10^{-4} \cdot U$	
	100 kHz – 200 kHz	$3 \cdot 10^{-4} \cdot U$	
	300 kHz – 500 kHz	$4,5 \cdot 10^{-4} \cdot U$	
	500 kHz – 1 MHz	$1,5 \cdot 10^{-3} \cdot U$	
	10 Hz – 20 Hz	$2 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$5 \cdot 10^{-5} \cdot U$	
200 V – 1000 V	20 kHz – 50 kHz	$1 \cdot 10^{-4} \cdot U$	
	10 Hz – 20 Hz	$2 \cdot 10^{-4} \cdot U$	
	20 Hz – 40 Hz	$1 \cdot 10^{-4} \cdot U$	
	40 Hz – 20 kHz	$5 \cdot 10^{-5} \cdot U$	
	20 kHz – 50 kHz	$1,5 \cdot 10^{-4} \cdot U$	



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Measured quantity, range	Frequency	Best measurement capabilities ( $k=2$ )	Remarks
1 $\Omega$ - 2 $\Omega$		$3 \cdot 10^{-5} \cdot R$	Measuring
2 $\Omega$ - 20 $\Omega$		$2 \cdot 10^{-5} \cdot R$	
20 $\Omega$ - 200 k $\Omega$		$1 \cdot 10^{-5} \cdot R$	
200 k $\Omega$ - 2 M $\Omega$		$2 \cdot 10^{-5} \cdot R$	
2 M $\Omega$ - 20 M $\Omega$		$7 \cdot 10^{-5} \cdot R$	
20 M $\Omega$ - 200 M $\Omega$		$7 \cdot 10^{-4} \cdot R$	
1.1.7 Capacitance			Generating
1 pF	1 kHz	$1,5 \cdot 10^{-4} \cdot C$	
10 pF	1 kHz	$3 \cdot 10^{-5} \cdot C$	
100 pF; 1000 pF	1 kHz	$1 \cdot 10^{-5} \cdot C$	
10 nF	1 kHz	$1 \cdot 10^{-4} \cdot C$	
100 nF	1 kHz	$1 \cdot 10^{-4} \cdot C$	
1 $\mu$ F	1 kHz	$2,5 \cdot 10^{-4} \cdot C$	Measuring, D<0,01
1 pF – 10 pF	1 kHz	$1,5 \cdot 10^{-5} \cdot C$	
10 pF – 1 nF	1 kHz	$1 \cdot 10^{-5} \cdot C$	
1 nF – 10 nF	1 kHz	$3 \cdot 10^{-5} \cdot C$	
10 nF - 100 nF	1 kHz	$7 \cdot 10^{-5} \cdot C$	
100 nF - 1 $\mu$ F	1 kHz	$2,5 \cdot 10^{-4} \cdot C$	
Inductance			Measuring, generating
100 $\mu$ H	1 kHz	$1,5 \cdot 10^{-3} \cdot L$	
1 mH	1 kHz	$5 \cdot 10^{-4} \cdot L$	
10 mH	1 kHz	$1 \cdot 10^{-3} \cdot L$	
100 mH	1 kHz	$5 \cdot 10^{-4} \cdot L$	
1 H	1 kHz	$1 \cdot 10^{-3} \cdot L$	
1 H	400 Hz	$5 \cdot 10^{-4} \cdot L$	

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Measured quantity, range		Frequency	Best measurement capabilities ( $k=2$ )	Remarks
1.2	High Frequency quantities High frequency Power Calibration factor	(0,1 - 18) GHz	(1,3 – 2,8) %	Measuring nom. 1 mW HP8481 A 1), 2), 4), 5)
1.2.4	Attenuation (10 – 30) dB	0,05 - < 1 GHz (1 - 14) GHz (> 14 - 18) GHz	0,05 dB 0,10 dB 0,15 dB	Measuring 2), 3), 5), 6)
	(> 30 – 60) dB dB	0,05 - < 1 GHz (1 - 16) GHz (> 16 - 18) GHz	0,07 dB 0,10 dB 0,15 dB	Measuring 2), 3), 5), 6)
3	Time and Frequency			
3.1	Time			
3.1.1	Time interval 0,1 $\mu$ s - 1 s		$2 \cdot 10^{-6} \cdot t + 0,1 \mu$ s	Measuring
3.2	Frequency			Generating
	0,1/ 1/ 5/ 10 MHz 10 Hz - 30 MHz 30 MHz - 6 GHz (6 - 26) GHz		$3 \cdot 10^{-11} \cdot f$ $(1 \cdot 10^{-7} - 1 \cdot 10^{-10}) \cdot f$ $(1 \cdot 10^{-9} - 1 \cdot 10^{-10}) \cdot f$ $2 \cdot 10^{-7} \cdot f$	
	1/ 5/ 10 MHz (0 - 200) MHz 200 MHz - 26,5 GHz		$3 \cdot 10^{-11} \cdot f$ $2 \cdot 10^{-10} \cdot f$ $2 \cdot 10^{-9} \cdot f$	Measuring
8	Optical quantities			
8.3	Optical system properties			
8.3.2	Optical Power			
	(Calibrationfactor)			
	-23 till -55 dBm (5uW - 3,16nW)	850 nm	0,09 dB (2,0%)	FC/PC multi mode
	- 5 till -55 dBm (316uW - 3,16nW)	1300 nm	0,13 dB (3,0%)	FC/PC multi mode
	+ 3 till -55 dBm (2mW - 3,16nW)	1310 nm	0,09 dB (2,0%)	FC/PC single mode
	+ 3 till -55 dBm (2mW - 3,16nW)	1550 nm	0,10 dB (2,2%)	FC/PC single mode
	- 5 till -55 dBm (316uW - 3,16nW)	1625 nm	0,11 dB (2,5%)	FC/PC single mode
	Incremental loss			
	(0 tot 30) dB	850 nm	0,065 dB	FC/PC multi mode
	(0 tot 45) dB	1300 nm	0,065 dB	FC/PC multi mode
	(0 tot 55) dB	1310 nm	0,065 dB	FC/PC single mode
	(0 tot 55) dB	1550 nm	0,065 dB	FC/PC single mode
	(0 tot 50) dB	1625 nm	0,065 dB	FC/PC single mode

Annex to accreditation-certificate  
Number: **K 052**

of **Trescal Livingston Calibration B.V.**  
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Remarks:

Temperature conditions for calibrations performed in the basement (DC/LF calibrations)  $(23\pm 1)$  °C; temperature conditions for calibrations performed on the 1st floor (RF/uW and Optical calibrations)  $(23\pm 3)$  °C.

Best Measurement Capabilities: at a given measurement point or measurement range, uncertainty of measurement is expressed as total uncertainty, plus and minus.

The BMC in RF and Microwave measurements are applicable to transmission lines with a characteristic impedance of nominal 50 Ohm

- 1) Measurements are performed at a fixed set of measurement frequencies;
- 2) Measurements using N-type connectors;
- 3) Measurements using type APC-7 connectors;
- 4) Calibration factor is applicable to measurements relative to 50 MHz;
- 5) Best accuracy is calculated for a test object VSWR of 1.01;
- 6) The maximal VSWR for the uncertainty calculation is 1.35

Measurement uncertainty is calculated according to EA-4/02 "Expression of the Uncertainty of Measurement in Calibration";

The measurements are carried out inside Trescal Livingston Calibration BV 's laboratory.