



**Calibration Laboratory No. 2202 Accredited by Czech Accreditation Institute  
according to ISO/IEC 17025:2017**

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## **CERTIFICATE OF CALIBRATION**

**1013-KL-80077-24**

**Date of issue:** December 11<sup>th</sup>, 2024

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**User:** State Unitary Enterprise  
Uzbek Center of Scientific Testing and Quality Control (STE UzTest)  
St. Farabi 333A  
100169 Tashkent city - Alzamar District

**Measuring instrument:** Combined test generator

**Manufacturer:** EM Test

**Type:** NX5

**Serial number:** P2018240626

**Accessories:** none

The results of the calibration have been obtained following the procedures reported in this Certificate and are related only to the calibrated measuring instrument, the date, place and conditions of the calibration.

**Date of calibration:** November 25<sup>th</sup> – 27<sup>th</sup>, 2024

**Calibrated by:**

**Director of Regional inspectorate:**

Martin Hudlička, Ph.D.



Radek Strnad, PhD.

<b>Metrological traceability:</b>	Measurements are traceable to (inter)national standards.  GPS receiver GPS EC 20S Rb, SPECTRACOM, ser. no. LX1100760556, calibrated at ČFE, calibration certificate 10/2024
	Oscilloscope DPO 7354C, TEKTRONIX, ser. no. C130911, calibrated at ČMI, calibration certificate 1011-KL-50018-24
	Counter 53132A, HEWLETT PACKARD, ser. no. 3736A05287, calibrated at ČMI, calibration certificate 1013-KL-40015-24
	50 Ω load resistor PVF50, AMETEK, ser. no. P1609175825, calibrated at ČMI, calibration certificate 1013-KL-70078-23
	1000 Ω load resistor PVF1000, AMETEK, ser. no. P1609175892, calibrated at ČMI, calibration certificate 1013-KL-70038-24
<b>Calibration procedure:</b>	Calibration was performed in accordance with the internal procedure ČMI 113-MP-C017 and standards ČSN EN 61000-4-4 ed. 3 (Electrical fast transients/burst immunity test) and ČSN EN 61000-4-5 ed. 3 (Surge immunity test). Measurement of time parameters was performed in accordance with internal procedure ČMI 113-MP-C007.
<b>Place of calibration:</b>	Czech Metrology Institute, Regional Inspectorate Praha, Radiová 1136/3, 102 00 Praha 10
<b>Ambient conditions:</b>	Ambient temperature $(23 \pm 2)^\circ\text{C}$ Relative humidity $(40 \pm 10)\%$
<b>Results of calibration:</b>	Measured values are listed in the following tables. Measurements of the generator effective output impedance in tables 19 and 39 are not covered by the accreditation.

### Electrical fast transients/burst immunity test

Following symbols are used in the tables:

$U_{A0}$	test level setting (open circuit voltage)
$U_{Anom}$	nominal peak voltage
$U_{Alk}$	measured peak voltage into 1 kΩ load
$U_{A50}$	measured peak voltage into 50 Ω load
$t_{rn}$	nominal rise time (time interval between the instants when the pulse amplitude is 10 % and then 90 % of the peak value on the leading edge)
$t_r$	measured rise time
$t_{wn}$	nominal pulse width (time interval between the instants when the pulse amplitude is 50 % of the peak value on the leading edge and then 50 % of the peak value on the trailing edge)
$t_w$	measured pulse width

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{A50}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
Impulse Output	0.2	0.10	0.103	0.004	+10 / -10	3.0
	0.5	0.25	0.255	0.009	+10 / -10	2.2
	1	0.50	0.518	0.018	+10 / -10	3.6
	2	1.0	1.011	0.035	+10 / -10	1.1
	4	2.0	2.028	0.071	+10 / -10	1.4
	5.5	2.75	2.83	0.12	+10 / -10	2.8
	-0.2	-0.10	-0.108	0.004	+10 / -10	7.8
	-0.5	-0.25	-0.250	0.009	+10 / -10	0.1
	-1	-0.50	-0.513	0.018	+10 / -10	2.6
	-2	-1.0	-1.009	0.035	+10 / -10	0.9
	-4	-2.0	-2.038	0.071	+10 / -10	1.9
	-5.5	-2.75	-2.82	0.12	+10 / -10	2.4

Table 1: Measured peak voltage, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$t_{rnom}$ (ns)	$t_r$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	0.2	5.0	5.18	0.31	+1.5 / -1.5	0.18
	0.5	5.0	5.58	0.33	+1.5 / -1.5	0.58
	1	5.0	5.50	0.33	+1.5 / -1.5	0.50
	2	5.0	5.45	0.33	+1.5 / -1.5	0.45
	4	5.0	5.18	0.31	+1.5 / -1.5	0.18
	5.5	5.0	5.40	0.32	+1.5 / -1.5	0.40
	-0.2	5.0	5.20	0.31	+1.5 / -1.5	0.20
	-0.5	5.0	5.05	0.30	+1.5 / -1.5	0.05
	-1	5.0	4.88	0.29	+1.5 / -1.5	-0.13
	-2	5.0	4.80	0.29	+1.5 / -1.5	-0.20
	-4	5.0	4.58	0.27	+1.5 / -1.5	-0.43
	-5.5	5.0	4.75	0.29	+1.5 / -1.5	-0.25

Table 2: Measured rise time, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$t_{wnom}$ (ns)	$t_w$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	0.2	50.0	44.0	2.6	+15 / -15	-6.0
	0.5	50.0	44.9	2.7	+15 / -15	-5.1
	1	50.0	45.4	2.7	+15 / -15	-4.7
	2	50.0	46.1	2.8	+15 / -15	-3.9
	4	50.0	47.0	2.8	+15 / -15	-3.1
	5.5	50.0	46.5	2.8	+15 / -15	-3.5
	-0.2	50.0	42.5	2.5	+15 / -15	-7.6
	-0.5	50.0	43.1	2.6	+15 / -15	-6.9
	-1	50.0	43.9	2.6	+15 / -15	-6.1
	-2	50.0	44.8	2.7	+15 / -15	-5.3
	-4	50.0	45.6	2.7	+15 / -15	-4.4
	-5.5	50.0	46.1	2.8	+15 / -15	-3.9

Table 3: Measured pulse width, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{A50}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
Impulse Output	2	1.0	1.013	0.035	+10 / -10	1.3
	-2	-1.0	-1.010	0.035	+10 / -10	1.0

Table 4: Measured peak voltage, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$t_{rnom}$ (ns)	$t_r$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	2	5.0	5.45	0.33	+1.5 / -1.5	0.45
	-2	5.0	4.80	0.29	+1.5 / -1.5	-0.20

Table 5: Measured rise time, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$t_{wnom}$ (ns)	$t_w$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	2	50.0	46.0	2.8	+15 / -15	-4.0
	-2	50.0	42.8	2.6	+15 / -15	-7.2

Table 6: Measured pulse width, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{AIk}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
Impulse Output	0.2	0.19	0.178	0.006	+20 / -20	-6.4
	0.5	0.48	0.450	0.016	+20 / -20	-5.4
	1	0.95	0.908	0.032	+20 / -20	-4.6
	2	1.90	1.815	0.064	+20 / -20	-4.7
	4	3.81	3.74	0.13	+20 / -20	-1.9
	5.5	5.24	5.01	0.18	+20 / -20	-4.3
	-0.2	-0.19	-0.190	0.007	+20 / -20	-0.2
	-0.5	-0.48	-0.421	0.015	+20 / -20	-11.6
	-1	-0.95	-0.857	0.030	+20 / -20	-10.0
	-2	-1.90	-1.722	0.060	+20 / -20	-9.6
	-4	-3.81	-3.54	0.12	+20 / -20	-7.0
	-5.5	-5.24	-4.76	0.17	+20 / -20	-9.0

Table 7: Measured peak voltage, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$t_{rnom}$ (ns)	$t_r$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	0.2	5.0	5.15	0.31	+1.5 / -1.5	0.15
	0.5	5.0	5.33	0.32	+1.5 / -1.5	0.33
	1	5.0	5.28	0.32	+1.5 / -1.5	0.28
	2	5.0	5.30	0.32	+1.5 / -1.5	0.30
	4	5.0	5.23	0.31	+1.5 / -1.5	0.23
	5.5	5.0	5.23	0.31	+1.5 / -1.5	0.23
	-0.2	5.0	4.33	0.26	+1.5 / -1.5	-0.68
	-0.5	5.0	4.55	0.27	+1.5 / -1.5	-0.45
	-1	5.0	4.40	0.26	+1.5 / -1.5	-0.60
	-2	5.0	4.38	0.26	+1.5 / -1.5	-0.63
	-4	5.0	4.25	0.26	+1.5 / -1.5	-0.75
	-5.5	5.0	4.33	0.26	+1.5 / -1.5	-0.68

Table 8: Measured rise time, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$t_{wnom}$ (ns)	$t_w$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	0.2	50.0	106.8	6.4	+100 / -15	56.8
	0.5	50.0	118.3	7.1	+100 / -15	68.3
	1	50.0	117.1	7.0	+100 / -15	67.1
	2	50.0	115.8	6.9	+100 / -15	65.8
	4	50.0	109.8	6.6	+100 / -15	59.8
	5.5	50.0	115.1	6.9	+100 / -15	65.1
	-0.2	50.0	120.5	7.2	+100 / -15	70.5
	-0.5	50.0	121.3	7.3	+100 / -15	71.3
	-1	50.0	120.5	7.2	+100 / -15	70.5
	-2	50.0	121.4	7.3	+100 / -15	71.4
	-4	50.0	118.9	7.1	+100 / -15	68.9
	-5.5	50.0	124.4	7.5	+100 / -15	74.4

Table 9: Measured pulse width, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{A50}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
Impulse Output	2	1.90	1.811	0.076	+20 / -20	-4.9
	-2	-1.90	-1.713	0.077	+20 / -20	-10.1

Table 10: Measured peak voltage, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$t_{rnom}$ (ns)	$t_r$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	2	5.0	5.30	0.32	+1.5 / -1.5	0.30
	-2	5.0	4.35	0.26	+1.5 / -1.5	-0.65

Table 11: Measured rise time, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 100 kHz; burst duration 0.75 ms*

coupling	$U_{A0}$ (kV)	$t_{wnom}$ (ns)	$t_w$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
Impulse Output	2	50.0	115.7	6.9	+100 / -15	65.7
	-2	50.0	109.6	6.6	+100 / -15	59.6

Table 12: Measured pulse width, 1 kΩ load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{A50}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
L+N+PE (load on L)	0.2	0.10	0.103	0.004	+10 / -10	2.8
	0.5	0.25	0.249	0.009	+10 / -10	-0.4
	1	0.50	0.514	0.018	+10 / -10	2.8
	2	1.0	1.007	0.035	+10 / -10	0.7
	4	2.0	2.036	0.071	+10 / -10	1.8
	5.5	2.75	2.90	0.12	+10 / -10	5.6
	-0.2	-0.10	-0.103	0.004	+10 / -10	3.4
	-0.5	-0.25	-0.250	0.009	+10 / -10	0.1
	-1	-0.50	-0.517	0.018	+10 / -10	3.4
	-2	-1.0	-1.009	0.035	+10 / -10	0.9
	-4	-2.0	-2.038	0.071	+10 / -10	1.9
	-5.5	-2.75	-2.88	0.12	+10 / -10	4.6

Table 13: Measured peak voltage, 50 Ω load

*burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms*

coupling	$U_{A0}$ (kV)	$t_{rnom}$ (ns)	$t_r$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
L+N+PE (load on L)	0.2	5.5	5.18	0.31	+1.5 / -1.5	-0.32
	0.5	5.5	5.55	0.33	+1.5 / -1.5	0.05
	1	5.5	5.45	0.33	+1.5 / -1.5	-0.05
	2	5.5	5.45	0.33	+1.5 / -1.5	-0.05
	4	5.5	5.28	0.32	+1.5 / -1.5	-0.22
	5.5	5.5	5.40	0.32	+1.5 / -1.5	-0.10
	-0.2	5.5	5.18	0.31	+1.5 / -1.5	-0.32
	-0.5	5.5	5.35	0.32	+1.5 / -1.5	-0.15
	-1	5.5	5.20	0.31	+1.5 / -1.5	-0.30
	-2	5.5	5.05	0.30	+1.5 / -1.5	-0.45
	-4	5.5	4.77	0.29	+1.5 / -1.5	-0.73
	-5.5	5.5	4.90	0.29	+1.5 / -1.5	-0.60

Table 14: Measured rise time, 50 Ω load

burst period 300 ms; repetition frequency of the pulses 5 kHz; burst duration 15 ms

coupling	$U_{A0}$ (kV)	$t_{wnom}$ (ns)	$t_w$ (ns)	uncertainty (ns)	tolerance (ns)	deviation (ns)
L+N+PE (load on L)	0.2	45.0	42.0	2.5	+15 / -15	-3.0
	0.5	45.0	42.0	2.5	+15 / -15	-3.0
	1	45.0	41.9	2.5	+15 / -15	-3.1
	2	45.0	43.0	2.6	+15 / -15	-2.1
	4	45.0	43.3	2.6	+15 / -15	-1.7
	5.5	45.0	41.8	2.5	+15 / -15	-3.2
	-0.2	45.0	40.8	2.4	+15 / -15	-4.2
	-0.5	45.0	40.2	2.4	+15 / -15	-4.8
	-1	45.0	39.8	2.4	+15 / -15	-5.2
	-2	45.0	41.3	2.5	+15 / -15	-3.7
	-4	45.0	42.5	2.5	+15 / -15	-2.6
	-5.5	45.0	40.2	2.4	+15 / -15	-4.8

Table 15: Measured pulse width, 50 Ω load

$U_{A0} = +1.0 \text{ kV}$

nominal repetition frequency (kHz)	measured repetition frequency (kHz)	uncertainty (kHz)	tolerance (%)	deviation (%)
5	5.000	0.001	+2 / -2	-0.006
100	99.892	0.027	+2 / -2	-0.118

Table 16: Burst repetition frequency

$U_{A0} = +1.0 \text{ kV}$

burst repetition frequency (kHz)	burst duration (ms)	burst period (ms)	measured burst period (ms)	uncertainty (ms)	tolerance (%)	deviation (%)
5	15	300	300.002	0.015	+20 / -20	0.002
100	0.75	300	300.002	0.013	+20 / -20	0.002

Table 17: Burst period

$U_{A0} = +1.0 \text{ kV}$

burst repetition frequency (kHz)	burst period (ms)	burst duration (ms)	measured burst duration (ms)	uncertainty (ms)	tolerance (ms)	deviation (ms)
5	300	15	14.801	0.002	+3 / -3	-0.199
100	300	0.75	0.741	0.001	+0.15 / -0.15	-0.009

Table 18: Burst duration

$U_{A0}$ (kV)	nominal output impedance ( $\Omega$ )	measured output impedance ( $\Omega$ )	uncertainty ( $\Omega$ )
0.2	50	40	6
0.5	50	42	6
1	50	41	6
2	50	44	6
4	50	46	6
5.5	50	42	6
-0.2	50	42	6
-0.5	50	37	6
-1	50	37	6
-2	50	39	6
-4	50	40	6
-5.5	50	38	6

Table 19: Effective output impedance of the generator (coaxial impulse output).

**Surge immunity test, Open-circuit voltage**

Following symbols are used in the tables:

$U_{A0}$	test level setting (open circuit voltage)
$U_{Anom}$	nominal peak voltage, open circuit
$U_{Ameas}$	measured peak voltage
$t_{fnom,U}$	nominal front time (virtual parameter; measured time interval between the instants when the pulse amplitude is 30 % and then 90 % of the peak value on the leading edge multiplied by 1.67)
$t_{f,U}$	measured front time
$t_{wnom,U}$	nominal pulse width (time interval between the instants when the pulse amplitude is 50 % of the peak value on the leading edge and then 50 % of the peak value on the trailing edge)
$t_{w,U}$	measured pulse width

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{Ameas}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
L-N (2 $\Omega$ )	0.2	0.2	0.200	0.007	+10 / -10	0.2
	0.5	0.5	0.502	0.018	+10 / -10	0.4
	1	1	1.015	0.036	+10 / -10	1.5
	2	2	2.033	0.071	+10 / -10	1.6
	4	4	4.08	0.14	+10 / -10	2.1
	5	5	5.11	0.18	+10 / -10	2.2
	-0.2	-0.2	-0.202	0.007	+10 / -10	0.8
	-0.5	-0.5	-0.505	0.018	+10 / -10	1.0
	-1	-1	-1.019	0.036	+10 / -10	1.9
	-2	-2	-2.049	0.072	+10 / -10	2.5
	-4	-4	-4.09	0.14	+10 / -10	2.1
	-5	-5	-5.12	0.18	+10 / -10	2.3

Table 20: Measured peak voltage

coupling	$U_{A0}$ (kV)	$t_{fnom,U}$ (μs)	$t_{f,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-N (2 Ω)	0.2	1.2	1.42	0.08	+30 / -30	18.0
	0.5	1.2	1.33	0.08	+30 / -30	10.8
	1	1.2	1.30	0.08	+30 / -30	8.0
	2	1.2	1.23	0.07	+30 / -30	2.4
	4	1.2	1.25	0.07	+30 / -30	4.1
	5	1.2	1.25	0.07	+30 / -30	4.1
	-0.2	1.2	1.40	0.08	+30 / -30	16.9
	-0.5	1.2	1.35	0.08	+30 / -30	12.4
	-1	1.2	1.28	0.08	+30 / -30	6.9
	-2	1.2	1.25	0.07	+30 / -30	4.1
	-4	1.2	1.26	0.08	+30 / -30	4.7
	-5	1.2	1.28	0.08	+30 / -30	6.3

Table 21: Measured front time

coupling	$U_{A0}$ (kV)	$t_{wnom,U}$ (μs)	$t_{w,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-N (2 Ω)	0.2	50.0	48.4	2.9	+20 / -20	-3.2
	0.5	50.0	48.7	2.9	+20 / -20	-2.7
	1	50.0	47.0	2.8	+20 / -20	-6.0
	2	50.0	46.1	2.8	+20 / -20	-7.9
	4	50.0	45.5	2.7	+20 / -20	-9.0
	5	50.0	45.1	2.7	+20 / -20	-9.8
	-0.2	50.0	48.7	2.9	+20 / -20	-2.6
	-0.5	50.0	48.8	2.9	+20 / -20	-2.4
	-1	50.0	47.1	2.8	+20 / -20	-5.8
	-2	50.0	46.0	2.8	+20 / -20	-8.0
	-4	50.0	45.6	2.7	+20 / -20	-8.8
	-5	50.0	45.4	2.7	+20 / -20	-9.3

Table 22: Measured pulse width

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{Ameas}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	0.2	0.198	0.007	+10 / -10	-1.1
	0.5	0.5	0.499	0.017	+10 / -10	-0.1
	1	1	1.009	0.035	+10 / -10	0.9
	2	2	2.035	0.071	+10 / -10	1.7
	4	4	4.07	0.14	+10 / -10	1.7
	5	5	5.08	0.18	+10 / -10	1.6
	-0.2	-0.2	-0.200	0.007	+10 / -10	0.2
	-0.5	-0.5	-0.502	0.018	+10 / -10	0.4
	-1	-1	-1.013	0.035	+10 / -10	1.3
	-2	-2	-2.042	0.071	+10 / -10	2.1
	-4	-4	-4.07	0.14	+10 / -10	1.8
	-5	-5	-5.10	0.18	+10 / -10	2.1

Table 23: Measured peak voltage

coupling	$U_{A0}$ (kV)	$t_{fnom,U}$ (μs)	$t_{f,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	1.2	1.40	0.08	+30 / -30	16.3
	0.5	1.2	1.31	0.08	+30 / -30	9.1
	1	1.2	1.27	0.08	+30 / -30	5.8
	2	1.2	1.24	0.07	+30 / -30	3.5
	4	1.2	1.20	0.07	+30 / -30	-0.1
	5	1.2	1.19	0.07	+30 / -30	-1.2
	-0.2	1.2	1.34	0.08	+30 / -30	11.9
	-0.5	1.2	1.30	0.08	+30 / -30	8.5
	-1	1.2	1.20	0.07	+30 / -30	0.2
	-2	1.2	1.24	0.07	+30 / -30	3.0
	-4	1.2	1.18	0.07	+30 / -30	-2.0
	-5	1.2	1.19	0.07	+30 / -30	-1.2

Table 24: Measured front time

coupling	$U_{A0}$ (kV)	$t_{wnom,U}$ (μs)	$t_{w,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	50.0	52.5	3.1	+20 / -50	5.0
	0.5	50.0	51.7	3.1	+20 / -50	3.4
	1	50.0	41.6	2.5	+20 / -50	-16.8
	2	50.0	33.7	2.0	+20 / -50	-32.5
	4	50.0	30.5	1.8	+20 / -50	-39.0
	5	50.0	28.9	1.7	+20 / -50	-42.2
	-0.2	50.0	52.6	3.2	+20 / -50	5.1
	-0.5	50.0	52.1	3.1	+20 / -50	4.1
	-1	50.0	41.8	2.5	+20 / -50	-16.4
	-2	50.0	33.8	2.0	+20 / -50	-32.5
	-4	50.0	30.5	1.8	+20 / -50	-38.9
	-5	50.0	28.9	1.7	+20 / -50	-42.2

Table 25: Measured pulse width

coupling	$U_{A0}$ (kV)	$U_{Anom}$ (kV)	$U_{Ameas}$ (kV)	uncertainty (kV)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	0.2	0.198	0.007	+10 / -10	-1.0
	0.5	0.5	0.500	0.018	+10 / -10	0.0
	1	1	1.010	0.035	+10 / -10	1.0
	2	2	2.036	0.071	+10 / -10	1.8
	4	4	4.07	0.14	+10 / -10	1.8
	5	5	5.08	0.18	+10 / -10	1.6
	-0.2	-0.2	-0.202	0.007	+10 / -10	0.8
	-0.5	-0.5	-0.501	0.018	+10 / -10	0.2
	-1	-1	-1.011	0.035	+10 / -10	1.1
	-2	-2	-2.043	0.072	+10 / -10	2.2
	-4	-4	-4.08	0.14	+10 / -10	2.0
	-5	-5	-5.10	0.18	+10 / -10	2.1

Table 26: Measured peak voltage

coupling	$U_{A0}$ (kV)	$t_{fnom,U}$ (μs)	$t_{f,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	1.2	1.38	0.08	+30 / -30	14.7
	0.5	1.2	1.30	0.08	+30 / -30	8.5
	1	1.2	1.26	0.08	+30 / -30	4.7
	2	1.2	1.26	0.08	+30 / -30	5.2
	4	1.2	1.20	0.07	+30 / -30	0.2
	5	1.2	1.20	0.07	+30 / -30	-0.4
	-0.2	1.2	1.38	0.08	+30 / -30	15.2
	-0.5	1.2	1.29	0.08	+30 / -30	7.4
	-1	1.2	1.24	0.07	+30 / -30	3.5
	-2	1.2	1.23	0.07	+30 / -30	2.4
	-4	1.2	1.18	0.07	+30 / -30	-1.5
	-5	1.2	1.19	0.07	+30 / -30	-0.9

Table 27: Measured front time

coupling	$U_{A0}$ (kV)	$t_{wnom,U}$ (μs)	$t_{w,U}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	50.0	52.2	3.1	+20 / -50	4.4
	0.5	50.0	52.1	3.1	+20 / -50	4.2
	1	50.0	42.0	2.5	+20 / -50	-16.0
	2	50.0	33.9	2.0	+20 / -50	-32.2
	4	50.0	30.6	1.8	+20 / -50	-38.9
	5	50.0	28.9	1.7	+20 / -50	-42.2
	-0.2	50.0	52.3	3.1	+20 / -50	4.5
	-0.5	50.0	52.3	3.1	+20 / -50	4.5
	-1	50.0	42.0	2.5	+20 / -50	-16.0
	-2	50.0	33.8	2.0	+20 / -50	-32.4
	-4	50.0	30.6	1.8	+20 / -50	-38.9
	-5	50.0	28.9	1.7	+20 / -50	-42.3

Table 28: Measured pulse width

**Surge immunity test, Short-circuit current**

Following symbols are used in the tables:

$U_{A0}$	test level setting (open circuit voltage)
$I_{Anom}$	nominal peak current, short circuit
$I_{Ameas}$	measured peak current
$t_{fnom,I}$	nominal front time of the short-circuit current wave (virtual parameter; measured time interval between the instants when the pulse amplitude is 10 % and then 90 % of the peak value multiplied by 1.25)
$t_{f,I}$	measured front time
$t_{dnom,I}$	nominal pulse duration (virtual parameter; measured time interval between the instants when the pulse amplitude is 50 % of the peak value on the leading edge and then 50 % of the peak value on the trailing edge multiplied by 1.18 for the HI-LO and L-N coupling or 1.04 for the L-PE and N-PE coupling, respectively)
$t_{d,I}$	measured pulse duration
$Z_{nom}$	nominal generator output impedance, ratio of the open circuit voltage and short-circuit current
$Z_{meas}$	measured generator output impedance

coupling	$U_{A0}$ (kV)	$I_{Anom}$ (kA)	$I_{Ameas}$ (kA)	uncertainty (kA)	tolerance (%)	deviation (%)
L-N (2 Ω)	0.2	0.1	0.095	0.003	+10 / -10	-4.8
	0.5	0.25	0.250	0.009	+10 / -10	0.2
	1	0.5	0.511	0.018	+10 / -10	2.2
	2	1	1.035	0.036	+10 / -10	3.5
	4	2	2.084	0.073	+10 / -10	4.2
	5	2.5	2.612	0.091	+10 / -10	4.5
	-0.2	-0.1	-0.096	0.003	+10 / -10	-3.5
	-0.5	-0.25	-0.252	0.009	+10 / -10	0.7
	-1	-0.5	-0.512	0.018	+10 / -10	2.4
	-2	-1	-1.035	0.036	+10 / -10	3.5
	-4	-2	-2.083	0.073	+10 / -10	4.1
	-5	-2.5	-2.606	0.091	+10 / -10	4.2

Table 29: Measured peak current

coupling	$U_{A0}$ (kV)	$t_{fnom,I}$ (μs)	$t_{f,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-N (2 Ω)	0.2	8.0	8.18	0.49	+20 / -20	2.3
	0.5	8.0	8.00	0.48	+20 / -20	0.0
	1	8.0	8.03	0.48	+20 / -20	0.4
	2	8.0	8.07	0.48	+20 / -20	0.9
	4	8.0	8.04	0.48	+20 / -20	0.5
	5	8.0	8.00	0.48	+20 / -20	0.0
	-0.2	8.0	8.33	0.50	+20 / -20	4.1
	-0.5	8.0	8.20	0.49	+20 / -20	2.5
	-1	8.0	8.18	0.49	+20 / -20	2.3
	-2	8.0	8.10	0.49	+20 / -20	1.2
	-4	8.0	8.18	0.49	+20 / -20	2.2
	-5	8.0	8.17	0.49	+20 / -20	2.1

Table 30: Measured front time

coupling	$U_{A0}$ (kV)	$t_{fnom,I}$ (μs)	$t_{d,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-N (2 Ω)	0.2	20.0	20.7	1.2	+20 / -20	3.7
	0.5	20.0	20.7	1.2	+20 / -20	3.4
	1	20.0	20.6	1.2	+20 / -20	3.2
	2	20.0	20.6	1.2	+20 / -20	3.1
	4	20.0	20.6	1.2	+20 / -20	3.2
	5	20.0	21.1	1.3	+20 / -20	5.3
	-0.2	20.0	21.0	1.3	+20 / -20	5.0
	-0.5	20.0	20.9	1.3	+20 / -20	4.4
	-1	20.0	20.9	1.3	+20 / -20	4.3
	-2	20.0	20.7	1.2	+20 / -20	3.7
	-4	20.0	20.8	1.3	+20 / -20	4.2
	-5	20.0	21.3	1.3	+20 / -20	6.7

Table 31: Measured pulse duration

coupling	$U_{A0}$ (kV)	$I_{Anom}$ (A)	$I_{Ameas}$ (A)	uncertainty (A)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	16.7	16.75	0.59	+10 / -10	0.5
	0.5	41.7	43.4	1.5	+10 / -10	4.1
	1	83.3	88.1	3.1	+10 / -10	5.8
	2	166.7	177.2	6.2	+10 / -10	6.3
	4	333.3	357	12	+10 / -10	7.1
	5	416.7	445	16	+10 / -10	6.9
	-0.2	-16.7	-16.97	0.59	+10 / -10	1.8
	-0.5	-41.7	-43.4	1.5	+10 / -10	4.2
	-1	-83.3	-88.4	3.1	+10 / -10	6.0
	-2	-166.7	-177.8	6.2	+10 / -10	6.7
	-4	-333.3	-357	13	+10 / -10	7.2
	-5	-416.7	-445	16	+10 / -10	6.9

Table 32: Measured peak current

coupling	$U_{A0}$ (kV)	$t_{fnom,I}$ (μs)	$t_{f,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	2.5	3.44	0.21	+20 / -20	37.6
	0.5	2.5	2.53	0.15	+20 / -20	1.1
	1	2.5	2.38	0.14	+20 / -20	-4.8
	2	2.5	2.40	0.14	+20 / -20	-4.0
	4	2.5	2.44	0.15	+20 / -20	-2.4
	5	2.5	2.49	0.15	+20 / -20	-0.5
	-0.2	2.5	3.42	0.21	+20 / -20	36.8
	-0.5	2.5	2.56	0.15	+20 / -20	2.5
	-1	2.5	2.43	0.15	+20 / -20	-2.7
	-2	2.5	2.45	0.15	+20 / -20	-2.1
	-4	2.5	2.49	0.15	+20 / -20	-0.6
	-5	2.5	2.54	0.15	+20 / -20	1.5

Table 33: Measured front time

coupling	$U_{A0}$ (kV)	$t_{dnom,I}$ (μs)	$t_{d,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
L-PE (12 Ω)	0.2	25.0	25.4	1.5	+30 / -30	1.5
	0.5	25.0	25.2	1.5	+30 / -30	0.6
	1	25.0	25.2	1.5	+30 / -30	0.8
	2	25.0	25.4	1.5	+30 / -30	1.4
	4	25.0	25.2	1.5	+30 / -30	0.8
	5	25.0	25.1	1.5	+30 / -30	0.5
	-0.2	25.0	25.7	1.5	+30 / -30	2.6
	-0.5	25.0	25.5	1.5	+30 / -30	1.8
	-1	25.0	25.4	1.5	+30 / -30	1.5
	-2	25.0	25.4	1.5	+30 / -30	1.6
	-4	25.0	25.3	1.5	+30 / -30	1.3
	-5	25.0	25.4	1.5	+30 / -30	1.8

Table 34: Measured pulse duration

coupling	$U_{A0}$ (kV)	$I_{Anom}$ (A)	$I_{Ameas}$ (A)	uncertainty (A)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	16.7	16.75	0.59	+10 / -10	0.5
	0.5	41.7	43.4	1.5	+10 / -10	4.1
	1	83.3	88.2	3.1	+10 / -10	5.9
	2	166.7	177.4	6.2	+10 / -10	6.4
	4	333.3	357	12	+10 / -10	7.1
	5	416.7	446	16	+10 / -10	7.1
	-0.2	-16.7	-16.99	0.59	+10 / -10	1.9
	-0.5	-41.7	-43.4	1.5	+10 / -10	4.2
	-1	-83.3	-88.4	3.1	+10 / -10	6.1
	-2	-166.7	-177.6	6.2	+10 / -10	6.6
	-4	-333.3	-358	13	+10 / -10	7.3
	-5	-416.7	-445	16	+10 / -10	6.9

Table 35: Measured peak current

coupling	$U_{A0}$ (kV)	$t_{fnom,I}$ (μs)	$t_{f,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	2.5	3.36	0.20	+20 / -20	34.4
	0.5	2.5	2.49	0.15	+20 / -20	-0.3
	1	2.5	2.35	0.14	+20 / -20	-6.0
	2	2.5	2.37	0.14	+20 / -20	-5.3
	4	2.5	2.40	0.14	+20 / -20	-3.9
	5	2.5	2.48	0.15	+20 / -20	-0.9
	-0.2	2.5	3.39	0.20	+20 / -20	35.6
	-0.5	2.5	2.50	0.15	+20 / -20	-0.1
	-1	2.5	2.39	0.14	+20 / -20	-4.4
	-2	2.5	2.41	0.14	+20 / -20	-3.8
	-4	2.5	2.45	0.15	+20 / -20	-2.2
	-5	2.5	2.49	0.15	+20 / -20	-0.4

Table 36: Measured front time

coupling	$U_{A0}$ (kV)	$t_{dnom,I}$ (μs)	$t_{d,I}$ (μs)	uncertainty (μs)	tolerance (%)	deviation (%)
N-PE (12 Ω)	0.2	25.0	25.5	1.5	+30 / -30	2.0
	0.5	25.0	25.3	1.5	+30 / -30	1.2
	1	25.0	25.1	1.5	+30 / -30	0.6
	2	25.0	25.3	1.5	+30 / -30	1.2
	4	25.0	25.1	1.5	+30 / -30	0.5
	5	25.0	25.3	1.5	+30 / -30	1.1
	-0.2	25.0	25.5	1.5	+30 / -30	2.1
	-0.5	25.0	25.4	1.5	+30 / -30	1.7
	-1	25.0	25.3	1.5	+30 / -30	1.2
	-2	25.0	25.3	1.5	+30 / -30	1.4
	-4	25.0	25.3	1.5	+30 / -30	1.2
	-5	25.0	25.4	1.5	+30 / -30	1.7

Table 37: Measured pulse duration

$$U_{A0} = +1.0 \text{ kV}$$

set repetition time (s)	measured repetition time (s)	uncertainty (s)
10	10.000 0	0.000 1
30	30.000 1	0.000 5
60	60.000 3	0.001 0

Table 38: Pulse repetition time

coupling	$U_{A0}$ (kV)	$Z_{nom}$ ( $\Omega$ )	$Z_{meas}$ ( $\Omega$ )	uncertainty ( $\Omega$ )
L-N (2 $\Omega$ )	0.2	2	2.10	0.18
	0.5	2	2.01	0.18
	1	2	1.99	0.18
	2	2	1.96	0.18
	4	2	1.96	0.18
	5	2	1.96	0.18
	-0.2	2	2.09	0.18
	-0.5	2	2.01	0.18
	-1	2	1.99	0.18
	-2	2	1.98	0.18
	-4	2	1.96	0.18
	-5	2	1.96	0.18
	0.2	12	11.8	1.0
	0.5	12	11.5	1.0
	1	12	11.4	1.0
L-PE (12 $\Omega$ )	2	12	11.5	1.0
	4	12	11.4	1.1
	5	12	11.4	1.0
	-0.2	12	11.8	1.0
	-0.5	12	11.6	1.0
	-1	12	11.5	1.0
	-2	12	11.5	1.0
	-4	12	11.4	1.0
	-5	12	11.5	1.0
	0.2	12	11.8	1.0
	0.5	12	11.5	1.0
	1	12	11.4	1.0
	2	12	11.5	1.0
	4	12	11.4	1.0
N-PE (12 $\Omega$ )	5	12	11.4	1.0
	-0.2	12	11.9	1.0
	-0.5	12	11.5	1.0
	-1	12	11.4	1.0
	-2	12	11.5	1.0
	-4	12	11.4	1.0
	-5	12	11.5	1.0

Table 39: Measured effective output impedance of the generator

The standard uncertainty of measurement has been determined in accordance with EA-4/02 M:2022 document. The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor  $k$  corresponding to a coverage probability of approximately 95 %, which for normal distribution corresponds to a coverage factor  $k = 2$ .

End of calibration certificate.