Impulse-Calibration-System KAL 1000 Calibration-Software TRAS-KAL

according to IEC 61083-1, IEEE 1122 and IEC 60060-2, IEEE 4

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Application

For the calibration and for performance tests and checks according to IEC 1083-1 und IEC-60-2 several calibration generators with high accuracy are required which are optimally adapted to the digital impulse voltage measuring system to be tested.

For this purpose a new family of precise calibration generators became developed including the necessary software to perform the required calibrations and tests in the high-voltage test-field in accordance with IEC 61083-1 and IEC 60060-2 in an easy manner and in short time to save costs.

The impulse calibration system KAL 1000 is a modular system to perform tests on complete impulse voltage measuring systems and on digital recorders for the measurement of high impulse voltages and impulse currents. Its modular design allows an optimal KAL configuration depending on the actual application.

Additional, this modularity allows to upgrade or modify an existing KAL 1000 system in case of changing or additional requirements.

The technical design of the impulse calibration system KAL 1000 was done considering the international standards IEC 61083-1, Digital recorders for measurements in high-voltage impulse tests and the revision of IEC 60060-2, at this time under consideration, the requirements for calibration generators in IEC61083-1, Table 3 are fulfilled.

Calibration of Digital-Recorders according to IEC 61083-1

the calibration, performance check or performance test of the measuring ranges of the digital impulse voltage measuring systems TR-AS® according to IEC 61083-1 may be performed either by the method pulse calibration or alternatively by a separate calibration of voltage and time with a step voltage calibration and a time calibration.



Pulse Calibration

The pulse calibration is performed with help of the impulse calibration generators KAL-LI 0.84/60 (optional KAL-LI 1.56/60) for full and chopped lightning impulse voltage or with help of the impulse calibration generator KAL-SI 20/4000 for full or chopped switching impulse voltage.

The time-to-chopping can be set to any value from 0.1 μ s to 10 000 μ s including the standard chopping time of 0.5 μ s.

Step Voltage Calibration

The step voltage calibration is performed with help of the impulse calibration generator KAL-STEP.

Time Calibration

The time calibration is performed with help of the time mark generator KAL-TIME.

Calibration-Software TRAS-KAL

The impulse calibration system KAL 1000 is controlled automatically by the digital impulse voltage measuring system TR-AS® with help of an built-in or complementary relay.

The channels under calibration were connected separate or parallel to the respective output of the calibrator. After setting the d.c. charging voltage the calibration is done simultaneously on all channels for the selected measuring

range.

With help of the control relay in the measuring system automatically the selected number of e.g. 20 measurements are performed and evaluated according to IEC 61083-1.

The mean value of the selected number of records and the largest deviation detected is stored into a protocol file for generation of the calibration certificate subsequently.

The basic system includes the electronically controlled d.c. voltage source with a precise tunable output voltage, available on a coaxial output and additional two measuring taps for control measuring with an calibrated external d.c. voltmeter.

In this way the calibration may be referenced to a National Standard, e.g. to an approved DKD-testlab or the PTB.

At the start of the automatic calibration procedur the value of this d.c. charge voltage must be input to the measuring system as reference level for the calculations.

Calibration Record

The calibration results of a KAL 1000 impulse calibrator with shapes STEP, ZEIT, LI, LIC und SI performed with an high-resolution digital impulse voltage measuring system TR-AS® 200-12 is documented in parts in the following calibration record:

Impulse-Calibration-System RIG 1000 Calibration-Software TRAS-TEIL

according to IEC 61083-1, IEEE 1122 and IEC 60060-2, IEEE 4

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Ch	Uo	Un	Usm	Fi	δm	StA	Max	MaxU	tmin	tmax
	V	V	V	Un/Usm	%	%	%	%	μs	μs
1	16	-15.89	-15.86	1.002	-0.16	0.06	0.62	0.10	0.25	1
1	50	-49.65	-49.48	1.003	-0.34	0.02	0.55	0.05	0.25	1
1	100	-99.3	-99.04	1.003	-0.26	0.02	0.60	0.03	0.25	1
1	500	-496.5	-495.5	1.002	-0.20	0.01	0.55	0.02	0.25	1
1	1000	-993	-986.9	1.006	-0.61	0.07	0.55	0.11	0.25	1
1	16	-16	-15.96	1.002	-0.22	0.07	0.23	0.13	0.42	8000
1	50	-50	-49.87	1.003	-0.27	0.02	0.24	0.04	0.42	8000
1	100	-100	-99.74	1.003	-0.26	0.02	0.24	0.03	0.42	8000
1	500	-500	-499.2	1.002	-0.17	0.01	0.24	0.02	0.42	8000
1	1000	-1000	-995.5	1.004	-0.45	0.02	0.29	0.05	0.42	8000

_													
_	oration	LI 0.84/60											
Ch	Uo	Un	Usm	δm	StA	T1n	T1	δm	StA	T2n	T2	δm	StA
	V	V	V	%	%	μs	μs	%	%	μs	μs	%	%
1	50	48.84	48.6	-0.48	0.02	0.839	0.832	-0.88	0.11	60.2	60.4	0.32	0.0
1	55	53.71	53.43	-0.52	0.04	0.836	0.829	-0.88	0.10	60.0	60.3	0.56	0.04
1	75	73.36	73	-0.49	0.02	0.834	0.824	-1.20	0.10	60.1	60.3	0.29	0.0
1	110	107.3	107.1	-0.22	0.02	0.835	0.828	-0.82	0.10	60.0	60.3	0.55	0.02
1	150	146.4	145.9	-0.33	0.02	0.836	0.828	-0.95	0.09	60.2	60.3	0.20	0.05
1	220	214.9	214.1	-0.35	0.03	0.839	0.830	-1.11	0.09	60.0	60.3	0.54	0.04
1	300	292.8	292.1	-0.24	0.01	0.841	0.831	-1.20	0.07	60.2	60.4	0.38	0.06
1	440	429.2	428.7	-0.11	0.03	0.840	0.832	-0.90	0.12	60.1	60.4	0.44	0.03
1	600	585.5	584.6	-0.15	0.02	0.841	0.834	-0.85	0.09	60.3	60.4	0.14	0.05
1	750	731.8	730.1	-0.24	0.02	0.843	0.836	-0.81	0.10	60.4	60.5	0.17	0.06
1	900	877.9	875.4	-0.29	0.03	0.843	0.836	-0.78	0.13	60.5	60.6	0.09	0.05
1	1000	976	972.7	-0.33	0.02	0.846	0.838	-0.95	0.07	60.1	60.6	0.88	0.03
1	50	-48.78	-48.58	-0.41	0.03	0.835	0.830	-0.64	0.10	60.0	60.1	0.19	0.02
1	55	-53.66	-53.43	-0.44	0.02	0.833	0.825	-0.94	0.07	59.9	60.2	0.44	0.03
1	75	-73.25	-72.98	-0.36	0.02	0.828	0.819	-1.07	0.09	59.9	60.1	0.27	0.04
1	110	-107.2	-106.9	-0.24	0.03	0.827	0.821	-0.71	0.13	59.9	60.1	0.34	0.05
1	150	-146.3	-145.8	-0.32	0.02	0.831	0.824	-0.81	0.11	60.0	60.2	0.36	0.05
1	220	-214.6	-214.1	-0.22	0.03	0.834	0.828	-0.75	0.11	59.9	60.1	0.41	0.04
1	300	-292.4	-292.1	-0.10	0.03	0.835	0.829	-0.72	0.12	60.1	60.2	0.22	0.04
1	440	-428.8	-428.7	-0.02	0.01	0.837	0.829	-0.96	0.08	60.0	60.2	0.41	0.04
1	600	-584.9	-584.3	-0.10	0.02	0.838	0.830	-0.98	0.07	60.2	60.2	0.07	0.03
1	750	-730.8	-729.7	-0.16	0.04	0.839	0.832	-0.85	0.15	60.2	60.4	0.33	0.06
1	900	-876.8	-875	-0.21	0.02	0.840	0.834	-0.71	0.08	60.2	60.4	0.28	0.04
1	1000	-973.9	-971.7	-0.23	0.02	0.841	0.834	-0.79	0.13	60.0	60.5	0.91	0.10

1	100	76.4	76.68	0.36	0.06					0.502	0.506	0.84	0.06
1	200	150.5	150.9	0.28	0.08					0.498	0.501	0.52	0.05
1	300	225.3	226.1	0.35	0.08				'	0.500	0.501	0.36	0.04
1	400	300.2	301.4	0.40	0.06				'	0.501	0.503	0.41	0.03
1	600	450.7	453.5	0.61	0.07					0.503	0.505	0.45	0.05
1	800	600.8	603.8	0.50	0.05					0.503	0.506	0.51	0.02
1	1000	750.6	751.9	0.17	0.05			•	•	0.503	0.504	0.28	0.03
1	100	-76.48	-76.88	0.53	0.10			•	•	0.501	0.505	0.82	0.06
1	200	-150.7	-151.2	0.36	0.07					0.495	0.498	0.69	0.13
1	300	-225.8	-226.9	0.49	0.05			•	•	0.498	0.501	0.67	0.04
1	400	-300.8	-302.5	0.58	0.06					0.501	0.503	0.47	0.03
1	600	-451.7	-454.8	0.69	0.06			•	•	0.502	0.505	0.57	0.03
1	800	-600.3	-605	0.78	0.08			•	'	0.500	0.503	0.65	0.05
1	1000	-747.6	-750	0.32	0.06			•	•	0.497	0.498	0.20	0.04
Calit	oration	SI 250/2500	-										
Ch	Uo	Un	Usm	δm	StA	T1pn	T1p	δm	StA	T2n	T2	δm	StA
	V	l v	V	%	%	μs	μs	%	%	μs	μs	%	%
1	50	42.33	42.56	0.54	0.03	247.60	249.00	0.58	0.16	2524.0	2530.0	0.24	0.09
1	100	84.71	85.11	0.47	0.02	247.40	248.80	0.55	0.10	2526.0	2532.0	0.22	0.03
1	500	422.9	426	0.74	0.04	247.70	248.40	0.28	0.11	2529.0	2532.0	0.13	0.06
1	1000	845.6	851.3	0.67	0.03	246.90	248.70	0.75	0.09	2537.0	2532.0	-0.19	0.09
1	50	-42.26	-42.42	0.38	0.04	247.20	248.40	0.47	0.07	2504.0	2502.0	-0.09	0.05

Ch	Range Time interval		δ	m			StA		M as	<			
1	25 20000		0.0008 0.0		.0001		0.000)1					
	V		μs				%		%		%		
Ch	Rang	ge	Time interval			δm			StA			Max	
Calit	Calibration TIME												
1	1000	-843.8	-848.6	0.57	0.02	246.90	248.00	0.44	0.13	2512.0	2508.0	-0.16	0.05
1	500	-421.6	-425	0.80	0.02	247.00	248.10	0.43	0.06	2503.0	2505.0	0.10	0.06
1	100	-84.46	-84.85	0.47	0.02	247.00	248.00	0.39	0.11	2499.0	2504.0	0.18	0.06
		-42.20	72.72	0.00	0.04	247.20	240.40	0.47	0.07	2004.0	2002.0	-0.00	0.00

Calibration of Impulse-Measuring-Systems according to IEC 60060-2

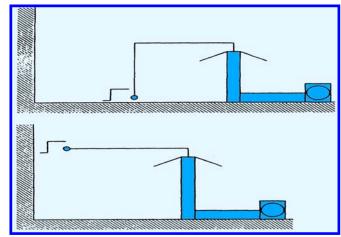
The automatic controlled calibration of complete measuring systems comprising an impulse voltage divider, necessary leads / measuring cable and the digital impulse voltage measuring system TR-AS®, follows by parameter method with help of the unit-step-voltage-generator RIG 1000 and the calibration software TRAS-TEIL.



Unit-Step-Voltage-Generator RIG 1000

At the parameter method, applicable for performance check or test, the impulse scale factor and the time parameters of the measuring system are determined by measuring and evaluating the step response of the measuring system. The result can be compared with the manufacturers specification or with performance tests or checks performed in the past.

For automatically calibration and generation of an calibration report the powerful software TRAS-TEIL with menu-oriented operations is available.



Test setup according to IEC 60060-2

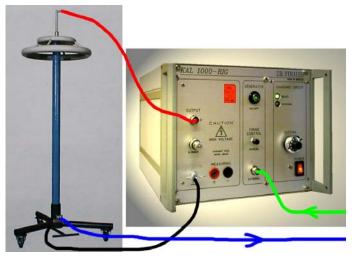
Impulse-Calibration-System RIG 1000

Calibration-Software TRAS-TEIL according to IEC 1083-1, IEEE 1122 and IEC 60-2, IEEE 4

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The determination of the impulse scale factor and the response parameters of the complete measuring system according to IEC 60060-2 is done with the unit step voltage generator RIG 1000 using a repetitive sampling methode included in the software TRAS-TEIL, which allows sampling rates of 1 to 5 GHz corresponding to sampling intevals of 1 ns downto 200 ps with our digital recorders TR-AS®.

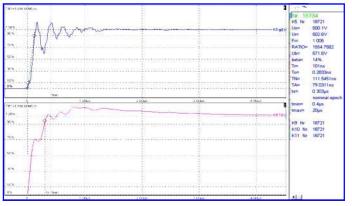


The unit step voltage generator RIG 1000 is controlled automatically by the digital impulse voltage measuring system TR-AS® with help of an inbuilt or completable relais.

For example, the performance check of an 3 MV impulse voltage divider in the h.v. testfield of an big transformer manufacturer was performed, the test results are shown in the following.

First of all the step response g(t) is measured, whereby a sampling rate of 1 GHz corresponding to 1 ns time resolution yields a satisfying accuracy within a short testing time.

The response parameter of the measured step response g(t) and the time behavior of the response time T(t) by integration of the function 1-g(t) automatically is calculated by control computer of the TR-AS® measuring system.



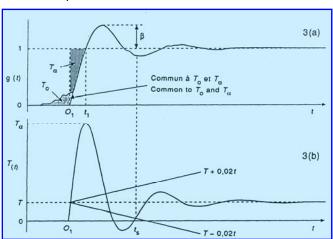
Calibration of a 3 MV impulse voltage divider in a big transformer testfield

The evaluation of the response time T(t) follows inside of an selectable time intervall tmin to tmax



The calibration report includes the test results of the reference measurement REF in the past as also the actual test results of the AMS (approved measuring system). For each individual parameter the actual difference AMS/REF-1 is calculated and then compared with an earlier specified accepted differenc. The test result "accepted" or "not accepted" automatically is written to the rightmost column.

E.g., the determination of the impulse scale factor shows in the selected time interval 0.4 - 20.0 μs negligible deviations from the specified value of the manufacturer. The scale



Definition of response parameters and settling time

The calculated results of the measurment are:

- ß overshoot
- F actual impulse scale factor
- O1 virtual origin, set to t=0
- To initial distortion time
- Ta partial response time
- TN experimental response time at t=tmax
- ts settling time
- tmin begin of evaluation
- tmax end of evaluation

For automatically determination of the settling time the limiting functions $T \pm 0.02t$ are calculated and displayed together with the response time T(t). The latest point of intersection of T(t) with the limiting functions is the wanted settling time according to IEC 60060-2.

Technical Data: KAL 1000 / RIG 1000

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± 2% / ± 0.2%

± 2% / ± 1% IEC 1083-1 table 3

KAL-ZEIT

in base device

20 ms ±0.01% 0 / 5 V, TTL-level

KAL-SI 20/4000

1)

2)

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Ca	alibrator	Basic-D	evice	KAL 1000
	and the second second	- C (I 1/A)	0	the second transfer of the section of

for supply and control of the KAL-Generators described below, rack mount with power supply, line filter, built into a 19" housing

cassette design

housing (W x H x D) or 19" rack mount

4 HF. 42 TF 500x200x320 mm

0 - +1000 V positiv

weight approx. 10 kg

according to IEC 1083-1.

Timemark-Generator

time-intervall

squarewave

according to

Switching-Impulse-Generator

for pulse calibration of the digital impulse voltage measuring system

cassette 12 TE 0 - +1000 V design charge voltage basic-device electronically switching-device chopping-device electronically

time-to-half-value

time-to-chopping

charge-capacity 1 µF ±50 .. ±1000 V 20 Ohm 1.5 m impulse output **BNC**

output-resistance cable-length standard 20/4000 µs shape optional 250/2500 µs chopping time selectable accuracy peak-voltage

250/2500 µs 0.1 ... 10 000 µs ± 1% / ± 0.2% ± 2% / ± 0.2% ± 2% / ± 0.2% ± 2% / ± 1% IEC 1083-1 table 3 time-to-peak time-to-half-value time-to-chopping 1) according to

H.V. Load Circuit, electronically controled in basic device

design charge voltage, adjustable with 10-turn-potentiometer

< 0.1 % setting-accuracy 0-1000.0 V ± 0.1 % ± 2 digit 1 .. 10 s digital display I FD measuring-accuracy modul-dependent charge time output frontside coaxial measurement 2 plugs

max. cable length unlimited load resistance >= 200 kOhm

Control Electronic

design in basic device releasing manual key TTL LO-level or BNC-input

external relais 5 Vp, BNC impulse output switching gap SG

time-to-chopping adjustable 0.1 - 10 000 µs step

0.1 μs 10 MHz, 100 ppm 5 Vp, BNC quarz-timebase chopping gap CG

Step-Voltage-Generator KAL-STEP for the step calibration of the inputs of digital impulse voltage measuring system according to IEC 1083-1

design in basic device charge voltage base-device 0 .. +1000 V

electronically switching-device output

impulse output

impulse output

impulse output

short-circuited < 10 ns (90/10%) 10 .. 1000 V falltime BNC negative step polarity

output-resistance 50 Ohm >= 200 kOhm 1,5 m load-resistance cable-length

± 0.5% / ± 0.2% accuracy step-voltage 1)

Unit-Step-Voltage-Generator RIG 1000 (H)

For time calibration of the digital impulse voltage measuring system

for determination of the impulse scale factor and the response parameters of the high voltage impulse measuring system with the unit step method according to IEC 60-2. The generator is placed on the floor or wall in the h.v. testfield and connected to the h.v. divider.

4 HE, 42 TE 260x200x320 mm design cassette housing (BxHxD) approx. 4 kg weiaht

according to IEC 1083-1.

design

output BNC

charge voltage coax-input 0 - +1000 V feeding basic device via coaxcable 20 m type H optionally inbuilt h.v. supply

Charge capacitor charge-capacity 5.3 µF

switching-device electronically output-resistance

2 Ohm < 10 ns (10/90%) TTL LO-level or risetime **BNC-input** releasing relay (meas.system) via coaxcable 20 m

chopping-device charge-capacity 0 .. ±1000 V impulse output 0.6 µF 2)

polarity positive or negative to i.v. divider >= 5 kOhm || 10 nF connection load accuracy peak value ± 0.1% stat. battery inside power supply

1) long term stability / short term stability

2) efficiency < 1

Technical data and design subject to modification without notice.

Lightning-Impulse-Generator KAL-LI 0.84/60 for pulse calibration of the digital impulse voltage measuring system

according to IEC 1083-1

cassette 12 TE design charge voltage basic-device 0 - +1000 V switching-device electronically electronically

> ±50 .. ±1000 V BNC output-resistance 20 Ohm

cable-length 1,5 m 0.84/60 µs shape standard 1.56/60 µs optional 0.1 .. 10 000 μs ± 1% / ± 0.2% chopping time selectable peak-voltage accuracy ± 2% / ± 0.5% . front-time

wave form	chopping time	output voltage range	for input range
full wave lightning impulse LI 0,84/60	100 ns—20 ms	±50 V to ±1000 V	50 V - 2500 V
front-chopped lightning impulse, Tc=500ns	500 ns	±50 V to ± 750 V	100 V - 1800 V
switching impulse SI 20/4000	100 ns—20 ms	±50 V to ±1000 V	50 V - 2500 V
switching impulse SI 250/2500	100 ns—20 ms	±50 V to ±1000 V	50 V - 2500 V
STEP Voltage		10 V to 1000 V	10 V - 2500 V