

WHEN QUALITY IS AN ISSUE, THE CHOICE IS HAEFELY



KIT

## HIGH VOLTAGE CONSTRUCTION KIT

**HAEFELY**   
HIGH VOLTAGE TEST

# HIGH VOLTAGE CONSTRUCTION KIT

## APPLICATION

The High Voltage Construction KIT is a system of components for applications in high voltage technology. All components have the same length and mechanical interconnections. They can be combined to form a test configuration and are extremely versatile. Test configurations are available which allow the generation of AC voltages up to 300 kV, DC voltages up to 400 kV and impulse voltages up to 400 kV with different output power ratings.

Such test configurations are extremely compact and their flexibility allows the test system to be matched to the prevailing conditions in the test room (dimensions, height etc.).

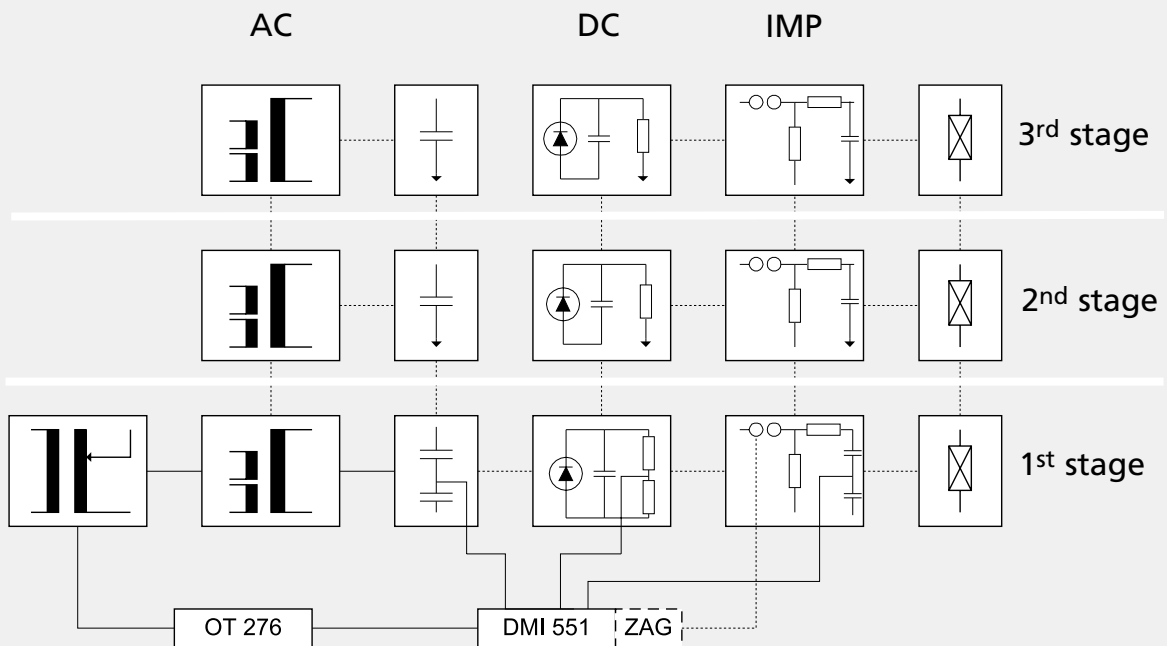
The application range for the high voltage KIT covers not only use in high voltage laboratories of technical universities, but also as an industrial test system for routine and type tests on electrical equipment up to 30 kV.

A complete test system requires a volume of 30 m<sup>3</sup> and a floor surface of three by four meters.

The configuration is built up, as its name suggests, by simply inserting the various elements to form a self-supporting structure. No tools are required. In spite of its striking simplicity, the KIT is equipped with all the components of comparable large industrial test systems.

The accuracy of the measuring instruments is such that they compare favourably with larger test systems and are used by calibration laboratories.

Numerous accessories are available for the basic KIT elements. The high voltage KIT has very compact dimensions and a wide range of application. It is portable and truly represents a complete high voltage test system.



KIT

## GENERAL SPECIFICATION

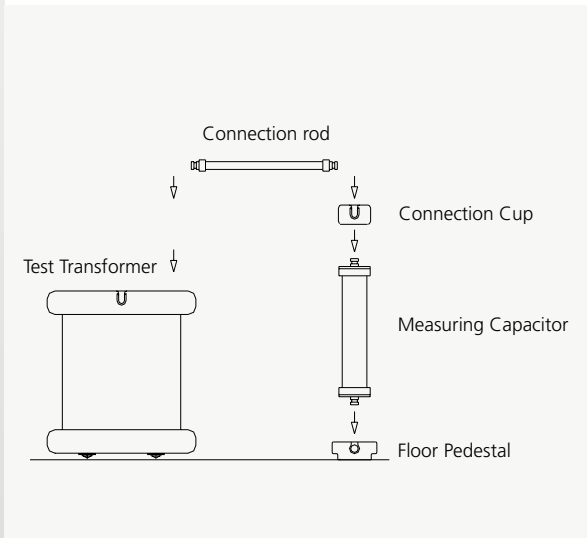
Design of the high voltage KIT follows nine major factors. These are:

- A clear structure is required to ensure that the assembled circuits can be easily checked both by students and their instructors.
- Rapid set up of the circuit in order to have as much time for active experiments as possible. The assembly of a circuit should not take longer than the connection of a previously equipped high voltage test system.
- As few elements as possible should be used in order to maintain the simplicity of the system and reduce replacement parts. A minimum of hardware also makes sound economic sense.
- Lightest possible weight of the individual components. This allows circuits to be built up by one person only, without danger.
- All components can be used in all possible circuits from the mechanical, thermal and electrical point of view.
- Design for low Corona-effects  
Special attention must be paid to this requirement due to the ever increasing demand placed on modern high voltage equipment to achieve the lowest possible partial discharge level.
- As few oil-filled components as possible should be used. A leak-proof construction for the oil-filled components is required.
- Highest reliability.  
Potential rough handling of the components during experimentation means that the components should be virtually maintenance free. The recommended constructions should be extremely simple.
- KIT should look good!



*Various elements joined together by a connection cup*

## GENERAL REMARKS FOR SETUP



The assembly of high voltage circuits using the high voltage construction KIT is quick and easy.

An example is the structure of an AC circuit 100 kV (without matching transformer or control unit).

The configuration is built up by inserting elements to form a self-supporting arrangement. No additional tools are required.

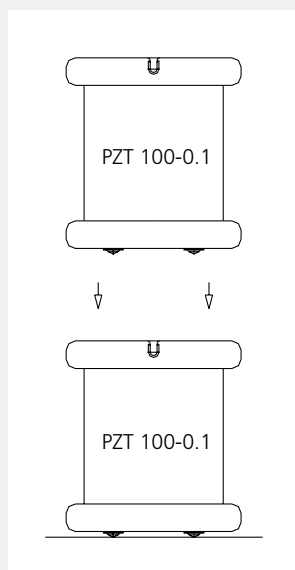
Thanks of this simple, but sophisticated design the user can make changes in the circuit quickly and efficiently. That's especially an advantage, for combined systems. Every connection cup has six possible combinations. Two vertical and four horizontal.

Every floor pedestal has two threads on opposite sides for ground connection. This way the grounding can be made at the end of the assembly simply by screwing the copper foil to the floor pedestals without need to rearrange them.

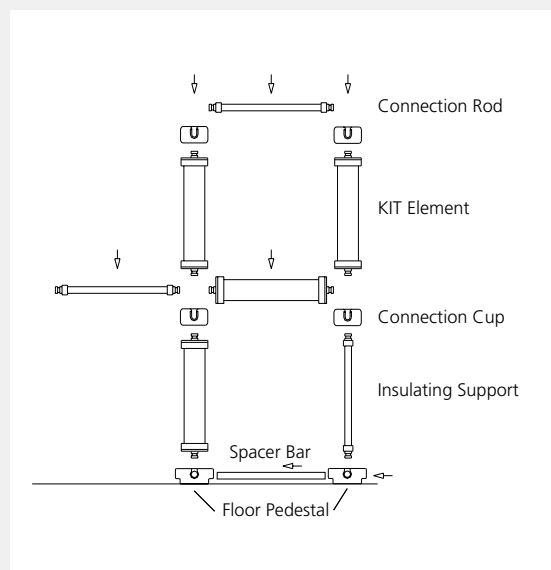
## Multistage Configuration, extension or raise

Configurations with more than just one stage can be build as in the following examples.

Transformers



Other elements



## BASIC CONFIGURATION

Type	Description	AC voltage			DC voltage			IMP voltage		
		1	2	3	1	2	3	1	2	3
	Stages	1	2	3	1	2	3	1	2	3
PZT 100-0.1	Test Transformer 100 kV, 10 kVA	1	2	3	1	1	1	1	1	1
KDL 1)	Compensating Reactor		2	3						
Top EL	Top Electrode for PZT 100-0.1		1	1						
STL 2)	Regulating Transformer	1	1	1	1	1	1	1	1	1
OT 276	Control Unit	1	1	1	1	1	1	1	1	1
DMI 551	Digital Measuring Instrument	1	1	1	1	1	1	1	1	1
HSV 200	High Voltage Connection		1							
HSV 300	High Voltage Connection			1						
GS	HV Rectifier				2	4	6	2	2	2
RE 2.5	Discharge Resistor, 2.5 kΩ				1	1	1	1	1	1
CS	Smoothing Capacitor				1	3	5	1	2	3
CB	Load Capacitor							1	2	3
RL	Charging Resistor								1	2
RD	Wave Front Resistor							1	2	3
RE	Wave Tail Resistor							1	2	3
CM	Measuring Capacitor	1	2	3				1	1	1
RM	Measuring Resistor				1	2	3	1	1	1
ES	Grounding Switch				1	1	1	1	1	1
EST	Discharge Rod	1	1	1	1	1	1	1	1	1
EL	Top Electrode		1	1	2	7	5	2	2	2
IS	Insulating Support				2	9	12	2	5	12
KF	Sphere Gap							1	2	3
AKF	Drive for Sphere Gap							1	1	1
V	Connection Rod	1			1	3	3	1	4	6
K	Connection Cup	1	2	3	4	11	14	6	13	21
F(s)	Floor Pedestal	1	1	1	4	6	7	6	8	8
D	Spacer Bar				2	5	7	4	7	8
NTZ	Secondary Part for CB (Impulse)							1	1	1
SEK AC	Secondary Part for CM (AC)	1	1	1	1	1	1	1	1	1
SEK DC	Secondary Part for RM (DC)				1	1	1	1	1	1
MK BNC	Coaxial Measuring Cable	1	1	1	1	1	1	1	1	1
DMI ZAG	Triggering Device							1	1	1
EZK	Electronic Trigger Sphere, incl. cable							1	1	1

1) For AC voltage test system with more than 1 stage compensating reactors are highly recommended.

2) STL 5 (5 kVA) is standard. For test objects with higher capacitive load regulating transformers with 7.5 kVA or 10 kVA are also available.

# AC - VOLTAGE

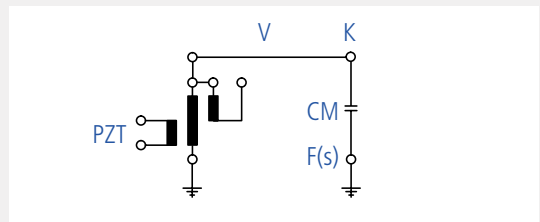
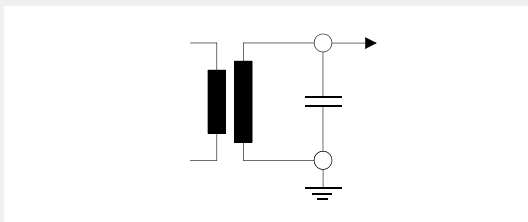
## AC - SINGLE STAGE



without compensating reactor

Regulating transformer		continuous			1 h ON, 1 h OFF
		STL 5	STL 7.5	STL 10	4 x day STL 10
Rated voltage	[kV rms]	100	100	100	100
Base load (CM)	[pF]	100	100	100	100
<b>Frequency</b>	<b>[Hz]</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>50</b>
Rated current	[mA]	50	75	90	100
Output	[kVA]	5	7.5	9	10
Impedance voltage (approx.)	[%]	2.6	3.9	4.6	-
Max. capacitive load, $C_{load}$	[nF]	1.4	2.3	2.7	3.1
<b>Frequency</b>	<b>[Hz]</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>
Rated current	[mA]	50	75	90	100
Output	[kVA]	5	7.5	9	10
Impedance voltage (approx.)	[%]	3.1	4.7	5.6	-
Max. capacitive load, $C_{load}$	[nF]	1.2	1.9	2.3	2.5

remark: Impedance voltage relates to rated power continuous and rated frequency.  
Technical data is subject to alterations.



## AC - TWO STAGES

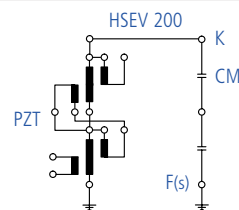
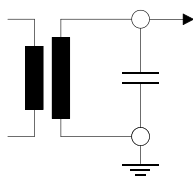


### without compensating reactor

		continuous		
Regulating transformer		STL 5	STL 7.5	STL 10
Rated voltage	[kV rms]	200	200	200
Base load (2 x CM)	[pF]	50	50	50
<b>Frequency</b>	<b>[Hz]</b>	<b>50</b>	<b>50</b>	<b>50</b>
Rated current	[mA]	15	30	38
Output	[kVA]	3	6	7.6
Impedance voltage (approx.)	[%]	4	7	8
Max. capacitive load, $C_{load}$	[pF]	180	420	550
<b>Frequency</b>	<b>[Hz]</b>	<b>60</b>	<b>60</b>	<b>60</b>
Rated current	[mA]	15	28	36
Output	[kVA]	3	5.6	7.2
Impedance voltage (approx.)	[%]	5	8	10
Max. capacitive load, $C_{load}$	[pF]	150	320	420

### with compensating reactor

		continuous			1h ON, 1h OFF, 4 x day	
Regulating transformer		STL 5	STL 7.5	STL 10	STL 7.5	STL 10
Rated voltage	[kV rms]	200	200	200	200	200
Base load (2 x CM)	[pF]	50	50	50	50	50
<b>Frequency</b>	<b>[Hz]</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>50</b>
Rated current	[mA]	39	75	80	95	100
Output	[kVA]	7.8	15	16	19	20
Max. capacitive load, $C_{load}$	[nF]	0.57	1.15	1.2	1.45	1.55
<b>Frequency</b>	<b>[Hz]</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>
Rated current	[mA]	36	65	80	85	100
Output	[kVA]	7.2	13	16	17	20
Max. capacitive load, $C_{load}$	[nF]	0.4	0.75	0.95	1.05	1.25



# AC - VOLTAGE

## AC - THREE STAGES

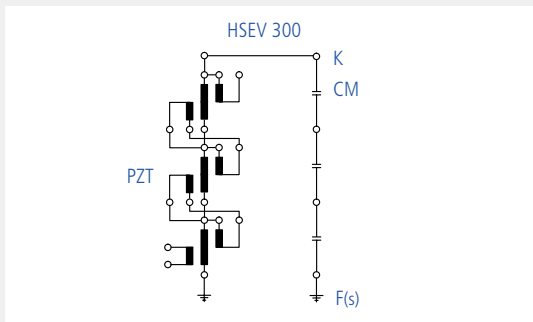
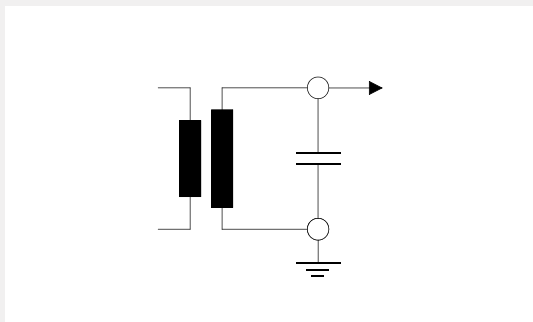


### without compensating reactor

		continuous	
Regulating transformer		STL 7.5	STL 10
Rated voltage	[kV rms]	300	300
Base load (3 x CM)	[pF]	33	33
<b>Frequency</b>	<b>[Hz]</b>	<b>50</b>	<b>50</b>
Rated current	[mA]	10	10
Output	[kVA]	3	3
Impedance voltage (approx.)	[%]	8	9
Max. capacitive load, $C_{load}$	[pF]	70	70
<b>Frequency</b>	<b>[Hz]</b>	<b>60</b>	<b>60</b>
Rated current	[mA]	5	5
Output	[kVA]	1.5	1.5
Impedance voltage (approx.)	[%]	8	9
Max. capacitive load, $C_{load}$	[pF]	10	10

### with compensating reactor

		continuous		1h ON, 1h OFF, 4 x day	
Regulating transformer		STL 5	STL 7.5	STL 10	STL 10
Rated voltage	[kV rms]	300	300	300	300
Base load (3 x CM)	[pF]	33	33	33	33
<b>Frequency</b>	<b>[Hz]</b>	<b>50</b>	<b>50</b>	<b>50</b>	<b>50</b>
Rated current	[mA]	20	60	80	
Output	[kVA]	6	18	24	
Max. capacitive load, $C_{load}$	[pF]	175	595	815	
<b>Frequency</b>	<b>[Hz]</b>	<b>60</b>	<b>60</b>	<b>60</b>	<b>60</b>
Rated current	[mA]	17	50	60	80
Output	[kVA]	5.1	15	18	24
Max. capacitive load, $C_{load}$	[nF]	115	405	495	675



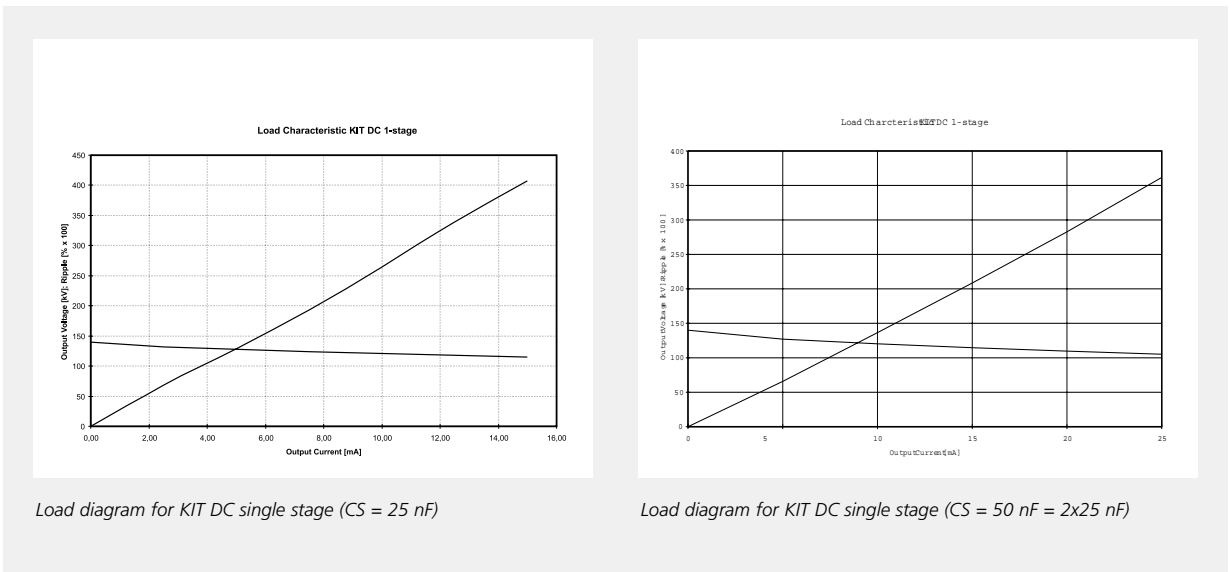
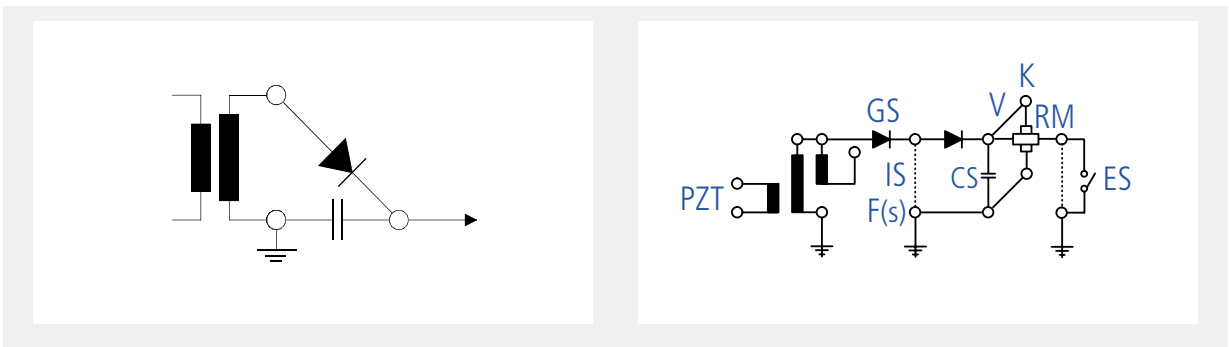
# DC - VOLTAGE

## DC - SINGLE STAGE



Regulating transformer		continuous STL 5	
Smoothing capacitor CS		25 nF	50 nF (2 x 25 nF)
Rated no-load voltage	[kV]	140	140
Rated output	[kVA]	5	5
Rated current	[mA]	11.2	21.5
Ripple	[%]	3	3
Voltage drop at rated current	[kV]	20	30

Rated current is limited by the ripple of 3% according IEC 600060-1.  
 Technical data is subject to alterations



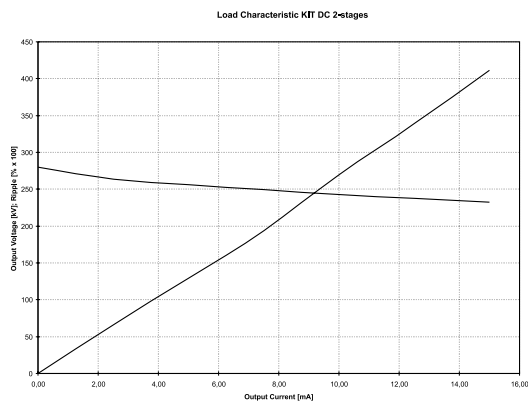
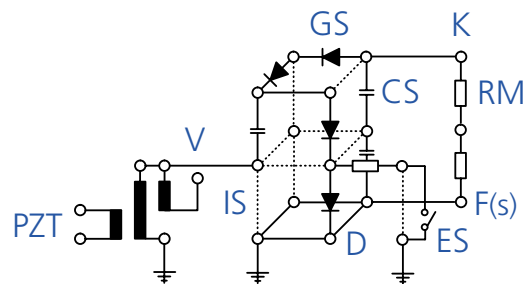
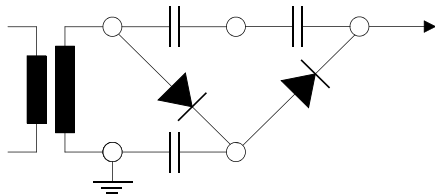
## DC - TWO STAGES



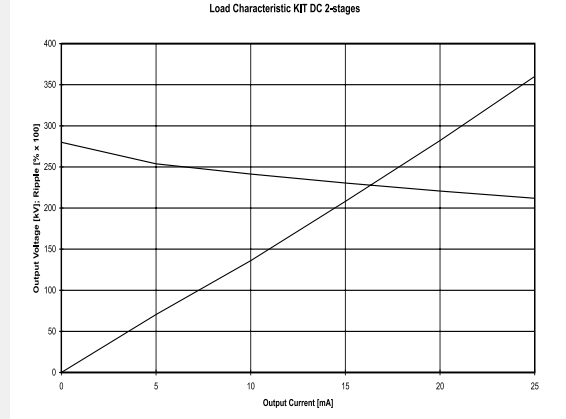
### Regulating transformer

		continuous	STL 5
Smoothing capacitor CS		25 nF	50 nF (2//25)
Rated no-load voltage	[kV]	280	280
Rated output	[kVA]	5	5
Rated current	[mA]	11.0	21,5
Ripple	[%]	3	3
Voltage drop at rated current	[kV]	40	60

Rated current is limited by the ripple of 3% according IEC 600060-1.  
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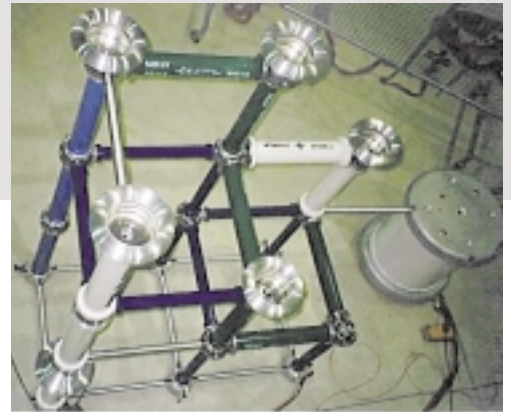


Load diagram for KIT DC two stages (CS = 25 nF)



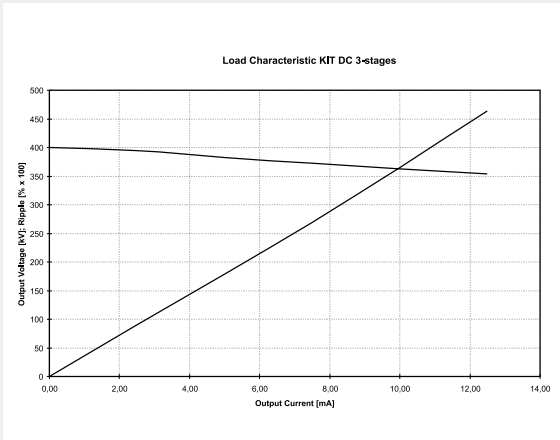
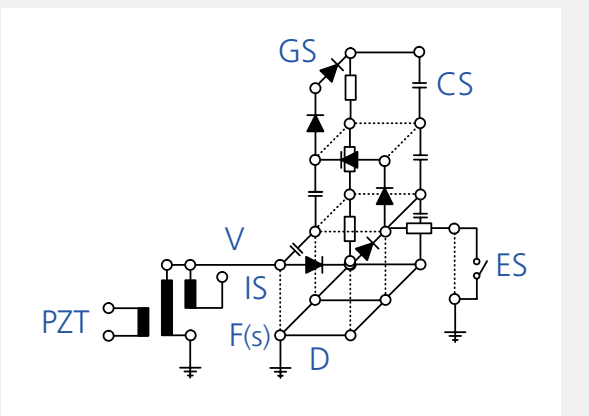
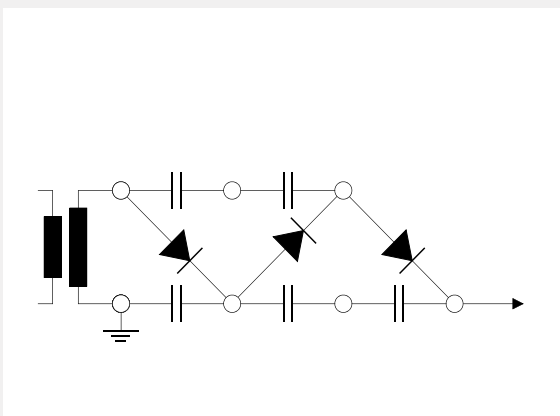
Load diagram for KIT DC two stages (CS = 50 nF = 2x25 nF)

# DC - THREE STAGES

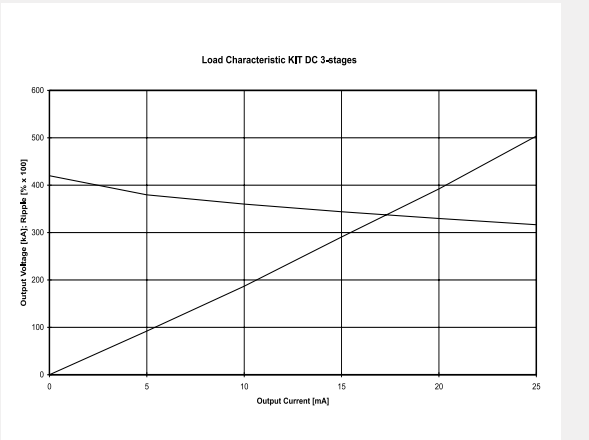


Regulating transformer		continuous STL 5	
Smoothing capacitor CS		25 nF	50 nF (2//25)
Rated no-load voltage	[kV]	400	400
Rated output	[kVA]	5	5
Rated current	[mA]	8,2	17
Ripple	[%]	3	3
Voltage drop at rated current	[kV]	30	60

Rated current is limited by the ripple of 3% according IEC 600060-1.  
 Technical data is subject to alterations



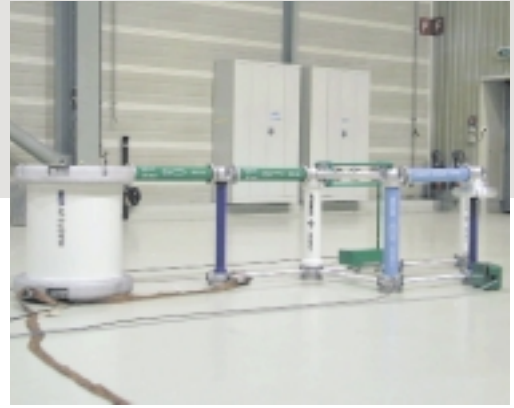
Load diagram for KIT DC three stages (CS = 25 nF)



Load diagram for KIT DC three stages (CS = 50 nF = 2x25nF)

# IMPULSE VOLTAGE

## SINGLE STAGE



### IMP - Single Stage

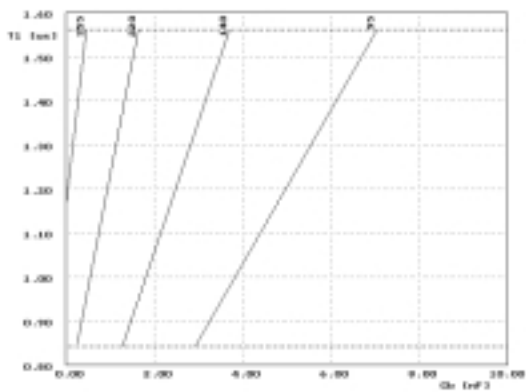
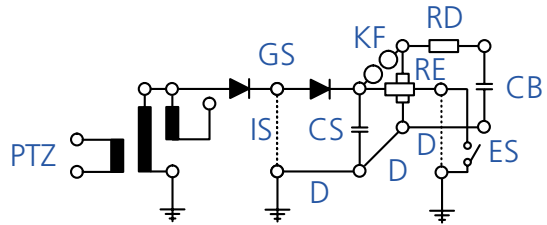
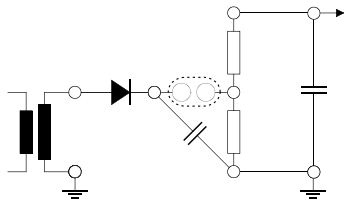
		Impulse Capacitance	
		25 nF (1 x CS25)	50 nF (2 x CS25)
Max. total charging voltage	[kV]	140	140
Max. energy at max. charging voltage	[J]	250	490
Max. output voltage LI no load	[kV]	125	130
Max. output voltage LI max. load	[kV]	98	115
Max. capacitive load for LI	[pF]	7000	5800
Max. output voltage SI no load	[kV]	118	123
Max. output voltage SI max. load	[kV]	99	112
Max. capacitive load for SI	[pF]	5000	4500

### Load Range

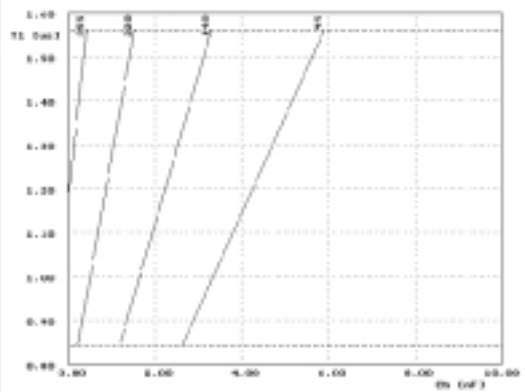
Basic configuration per stage:		LI (IEC 60-1)		SI (IEC 60-1)	
Smoothing capacitor, CS	[nF]	25	50	25	50
Load capacitor, CB (divider)	[nF]	1.2	1.2	1.2	1.2
Wave tail resistor, RE	[kΩ]	2.4	2.4/2.4	120	120//120
<b>Wave front resistor RD<sub>A</sub></b>	[Ω]	355	355	55000	55000
Load range with RDA, C <sub>load</sub>	[pF]	0...400	0...400	0...300	0...290
Output voltage at min. load with RD <sub>A</sub>	[kV]	125	130	118	123
Output voltage at max. load with RD <sub>A</sub>	[kV]	122	127	115	120
<b>Wave front resistor RD<sub>B</sub></b>	[Ω]	220	220	35000	35000
Load range with RDB, C <sub>load</sub>	[pF]	250...1600	250...1500	220...1200	220...1150
Output voltage at min. load with RD <sub>B</sub>	[kV]	124	130	119	124
Output voltage at max. load with RD <sub>B</sub>	[kV]	116	125	112	119
<b>Wave front resistor RD<sub>C</sub></b>	[Ω]	140	140	22000	22000
Load range with RDC, C <sub>load</sub>	[pF]	1300...3700	1200...3200	1100...2800	1100...2600
Output voltage at min. load with RD <sub>C</sub>	[kV]	120	128	115	122
Output voltage at max. load with RD <sub>C</sub>	[kV]	108	120	106	116
<b>Wave front resistor RD<sub>D</sub></b>	[Ω]	95	95	15000	15000
Load range with RDD, C <sub>load</sub>	[pF]	3000...7000	2700-5800	2300...5000	2200...4500
Output voltage at min. load with RD <sub>D</sub>	[kV]	112	124	111	120
Output voltage at max. load with RD <sub>D</sub>	[kV]	98	115	99	112

The best suitable wave front resistor can be chosen according to the expected load. One resistor is included in the basic configuration but can be selected.

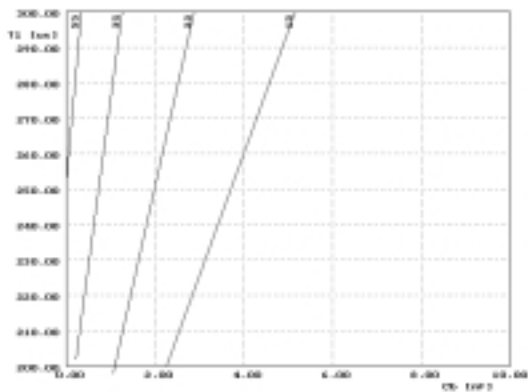
Technical data is subject to alterations



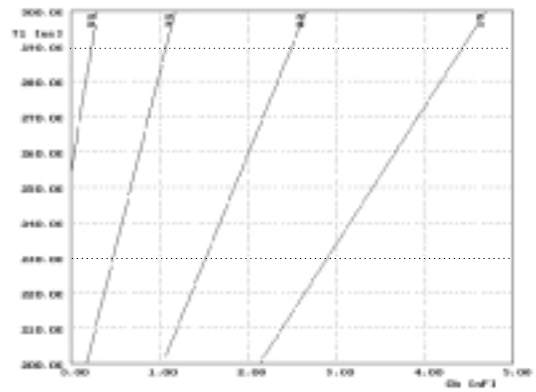
Load range for lightning impulse single stage ( $CS = 25 \text{ nF}$ )



Load range for lightning impulse single stage ( $CS = 50 \text{ nF} = 2 \times 25 \text{ nF}$ )



Load range for switching impulse single stage ( $CS = 25 \text{ nF}$ )



Load range for switching impulse single stage ( $CS = 50 \text{ nF} = 2 \times 25 \text{ nF}$ )

# IMPULSE VOLTAGE

## TWO STAGES



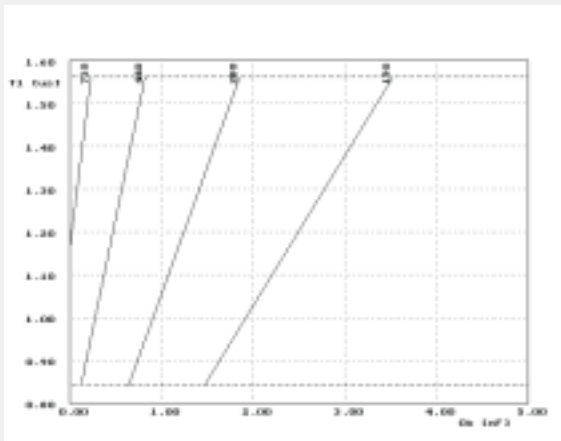
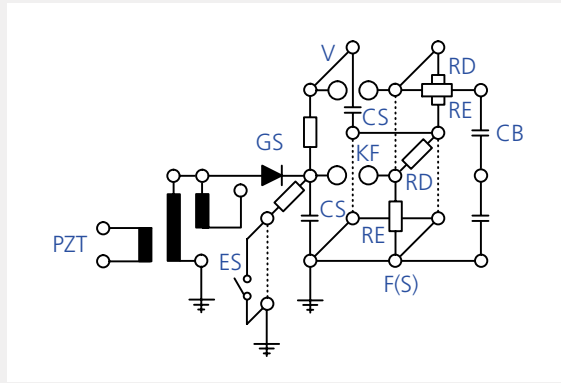
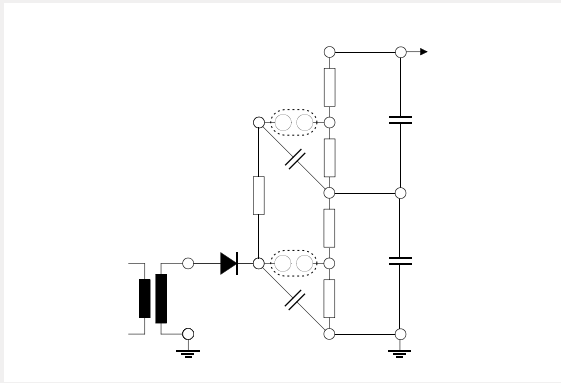
		Impulse Capacitance	
		25 nF (1 x CS25)	50 nF (2xCS 25)
Max. total charging voltage	[kV]	280	280
Max. energy at max. charging voltage	[J]	490	960
Max. output voltage LI no load	[kV]	243	258
Max. output voltage LI max. load	[kV]	196	233
Max. capacitive load for LI	[pF]	2500	2600
Max. output voltage SI no load	[kV]	229	244
Max. output voltage SI max. load	[kV]	198	223
Max. capacitive load for SI	[pF]	3500	2300

### Load Range

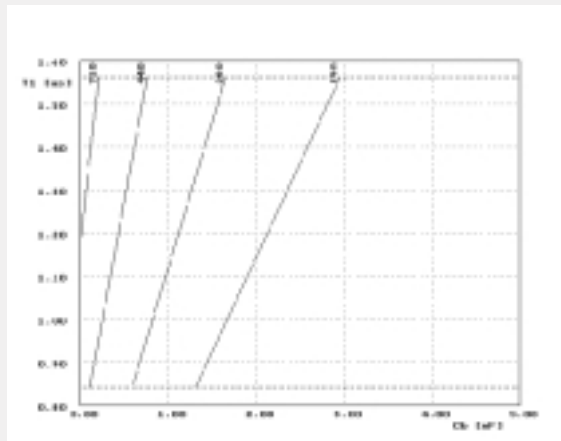
Basic configuration per stage:		LI (IEC 60-1)		SI (IEC 60-1)	
Smoothing capacitor, CS	[nF]	25	50	25	50
Load capacitor, CB (divider)	[nF]	1.2	1.2	1.2	1.2
Charging resistor, RL	[MΩ]	2.5	2.5	2.5	2.5
Wave tail resistor, RE	[kΩ]	2.4	2.4/2.4	120	120/120
<b>Wave front resistor RD<sub>A</sub></b>	[Ω]	355	355	55000	55000
Load range with RDA, C <sub>load</sub>	[pF]	0...200	0...200	0...150	0...150
Output voltage at min. load with RD <sub>A</sub>	[kV]	249	258	234	244
Output voltage at max. load with RD <sub>A</sub>	[kV]	243	255	229	239
<b>Wave front resistor RD<sub>B</sub></b>	[Ω]	220	220	35000	35000
Load range with RDB, C <sub>load</sub>	[pF]	150...800	100...720	120...600	120...580
Output voltage at min. load with RD <sub>B</sub>	[kV]	248	260	237	247
Output voltage at max. load with RD <sub>B</sub>	[kV]	233	250	222	236
<b>Wave front resistor RD<sub>C</sub></b>	[W]	140	140	22000	22000
Load range with RDC, C <sub>load</sub>	[pF]	650...1800	460...1450	550...1400	530...1300
Output voltage at min. load with RD <sub>C</sub>	[kV]	239	256	230	244
Output voltage at max. load with RD <sub>C</sub>	[kV]	218	243	212	230
<b>Wave front resistor RD<sub>D</sub></b>	[Ω]	95	95	15000	15000
Load range with RDD, C <sub>load</sub>	[pF]	1500...3500	1000...2600	1200...2500	1100...2300
Output voltage at min. load with RD <sub>D</sub>	[kV]	225	251	220	240
Output voltage at max. load with RD <sub>D</sub>	[kV]	196	233	198	223

The best suitable wave front resistor can be chosen according to the expected load. One resistor is included in the basic configuration but can be selected.

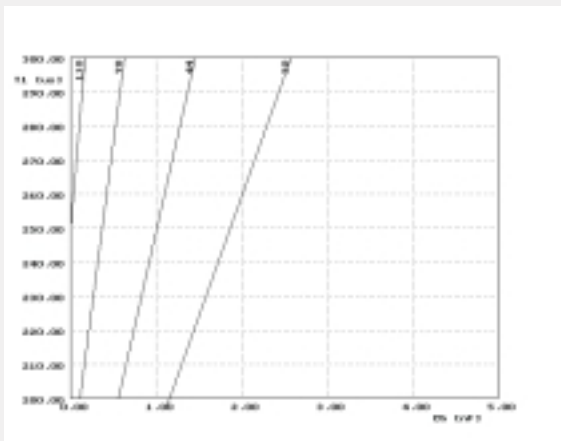
Technical data is subject to alterations



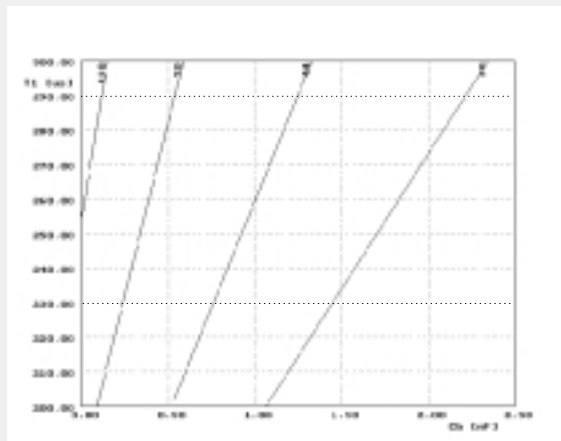
Load range for lightning impulse two stages (CS = 25 nF)



Load range for lightning impulse two stages (CS = 50 nF = 2x25 nF)



Load range for switching impulse two stages (CS = 25 nF)



Load range for switching impulse two stages (CS = 50 nF = 2x25 nF)

# IMPULSE VOLTAGE

## THREE STAGES



### IMP - Three Stages

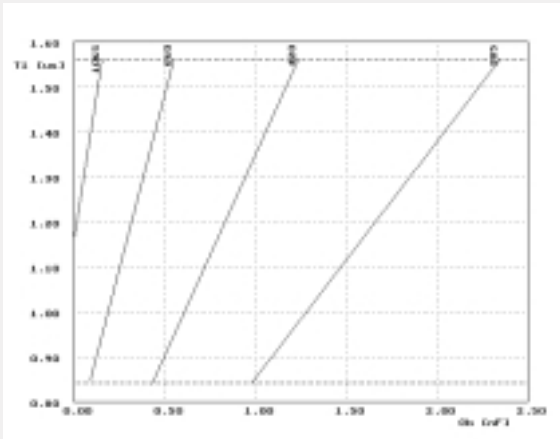
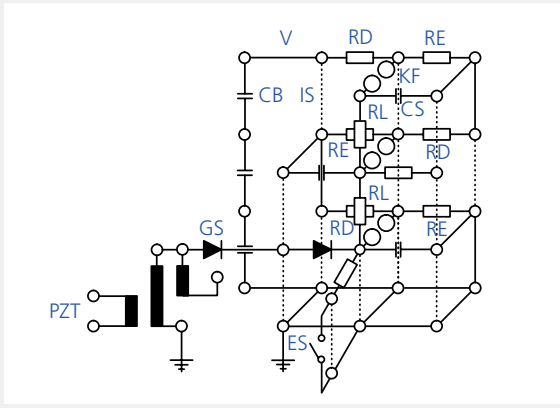
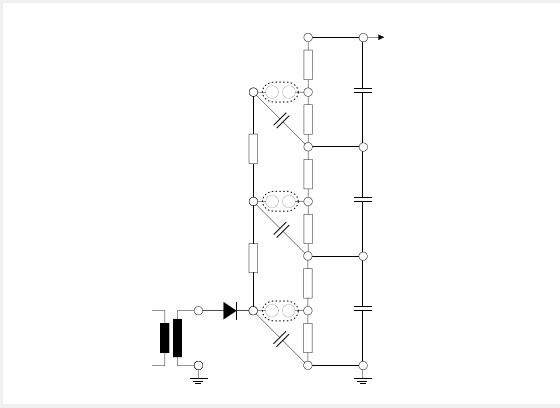
		Impulse Capacitance	
		25 nF (1 x CS25)	50 nF (2xCS25)
Max. total charging voltage	[kV]	420	420
Max. energy at max. charging voltage	[J]	740	1440
Max. output voltage LI no load	[kV]	365	388
Max. output voltage LI max. load	[kV]	295	348
Max. capacitive load for LI	[pF]	2300	1900
Max. output voltage SI no load	[kV]	341	364
Max. output voltage SI max. load	[kV]	295	335
Max. capacitive load for SI	[pF]	1700	1500

### Load Range

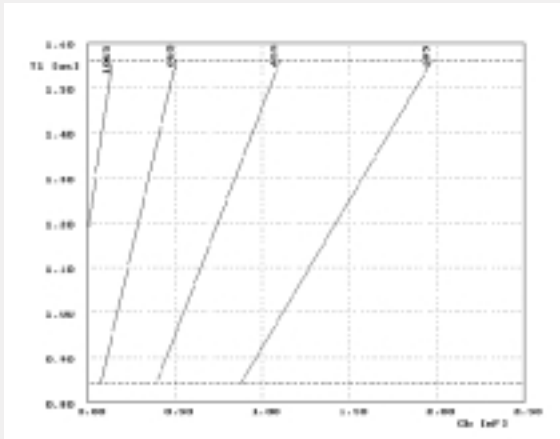
#### Basic configuration per stage:

		LI (IEC 60-1)		SI (IEC 60-1)	
Smoothing capacitor, CS	[nF]	25	50	25	50
Load capacitor, CB (divider)	[nF]	1.2	1.2	1.2	1.2
Charging resistor, RL	[MΩ]	2.5	2.5	2.5	2.5
Wave tail resistor, RE	[kΩ]	2.4	2.4/2.4	120	120/120
<b>Wave front resistor RD<sub>A</sub></b>	[W]	355	355	55000	55000
Load range with RDA, C <sub>load</sub>	[pF]	0...130	0...130	0...100	0...100
Output voltage at min. load with RD <sub>A</sub>	[kV]	373	388	350	364
Output voltage at max. load with RD <sub>A</sub>	[kV]	365	382	341	357
<b>Wave front resistor RD<sub>B</sub></b>	[Ω]	220	220	35000	35000
Load range with RDB, C <sub>load</sub>	[pF]	80...500	80...480	70...400	70...400
Output voltage at min. load with RD <sub>B</sub>	[kV]	373	390	355	370
Output voltage at max. load with RD <sub>B</sub>	[kV]	350	375	332	352
<b>Wave front resistor RD<sub>C</sub></b>	[Ω]	140	140	22000	22000
Load range with RDC, C <sub>load</sub>	[pF]	430...1200	400...1050	360...950	360...880
Output voltage at min. load with RD <sub>C</sub>	[kV]	359	382	345	366
Output voltage at max. load with RD <sub>C</sub>	[kV]	326	363	316	345
<b>Wave front resistor RD<sub>D</sub></b>	[Ω]	95	95	15000	15000
Load range with RDD, C <sub>load</sub>	[pF]	1000...2300	900...1900	750...1700	730...1500
Output voltage at min. load with RD <sub>D</sub>	[kV]	338	372	333	360
Output voltage at max. load with RD <sub>D</sub>	[kV]	295	348	295	335

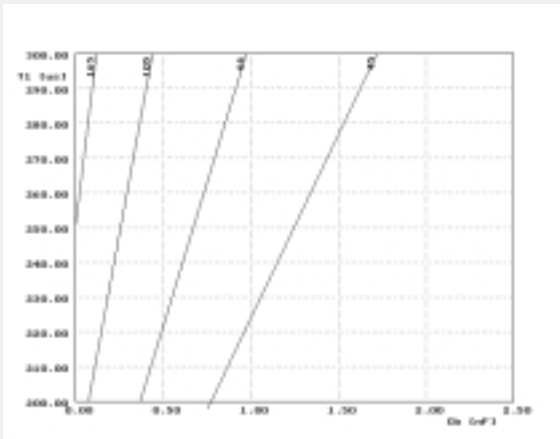
The best suitable wave front resistor can be chosen according to the expected load. One resistor is included in the basic configuration but can be selected.  
Technical data is subject to alterations



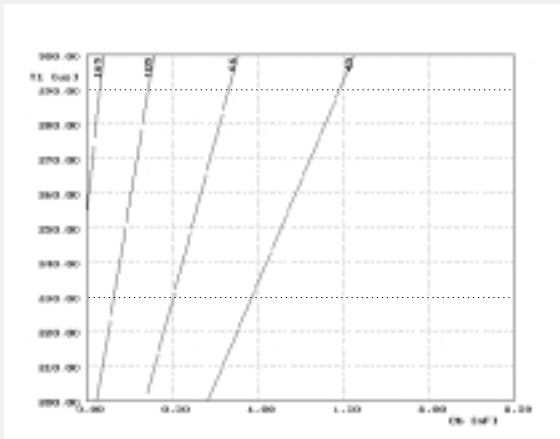
Load range for lightning impulse three stages (CS = 25 nF)



Load range for lightning impulse three stages (CS = 50 nF = 2x25 nF)



Load range for switching impulse three stages (CS = 25 nF)



Load range for switching impulse three stages (CS = 50 nF = 2x25 nF)

# CONTROL AND MEASURING

The high voltage KIT is supplied with two separate instruments:

The OT 276 control unit and the DMI 551 AC, DC and impulse measurement unit.

Both instruments are available as desktop or rack versions.

## OT 276

OT 276 controls the regulating transformer. It is based on conventional relay technology and is built into a 19" standard housing of 3 units. Operation is by means of push buttons. The state of contactors as well as the current and voltage on the secondary side of the regulating transformer are clearly indicated on the front plate by means of LED displays.

The OT 276 is equipped with required safety functions by laboratories large test and also those required by the standards.



## DMI 551

With the KIT it is often required to measure AC, DC and impulse voltages at the same time.

Therefore the DMI 551 is equipped with three independent measuring channels (AC, DC, IMP) and can display all three values simultaneously.

The DMI 551 is a microprocessor controlled instrument. Input is via the numeric keypad. A large LCD-Display indicates measured values and the function options.

With its optional triggering function, firing of the impulse configuration or a chopping gap is possible. An interface (RS-232 or IEEE-488) is also available for connection to a host computer.

The DMI 551 is designed in accordance with the international standard IEC 60.



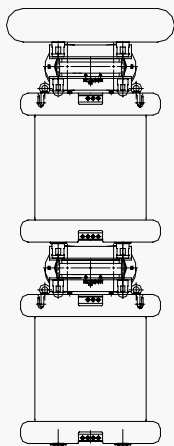
# COMPONENTS



## PZT 100-0.1 Single phase AC voltage test transformer

Test transformer which can be used for AC-, DC- and impulse voltage generation. The output power can be extended by cascading the transformers.

Ratio:	2 x 220 V / 100 kV / 220 V
Current cont.:	2 x 20 A / 90 mA / 20 A
Current 1 h:	2 x 22 A / 100 mA / 22 A
Output power:	9 kVA continuous, 10 kVA 1h ON, 1h OFF, 4 x per day
Impedance voltage:	approx. 5%
Frequency:	50/60 Hz
Partial discharge level:	≤ 2 pC
Weight:	290 kg



## KDL Compensating reactor

Compensating reactor type KDL are used between transformers (PZT 100-0.1) in cascade circuits to reduce input power and provide uniform voltage distribution across cascade winding. Compensating reactors are recommended for AC configurations of more than 1 stage.



## Top EL Top electrode

For AC two and three stages a top electrode on the test transformer is recommended to provide corona effects.

Diameter:	820 mm
Ring diameter:	220 mm
Weight:	9 kg



## STL 5, (STL 7.5, STL 10) Regulating transformer

Power supply:	230 V / 22 A (33, 43 A)
Secondary voltage:	0 ... 230 V
Rated power:	5 kVA (7.5, 10 kVA) cont.
Frequency:	50/60 Hz
Weight:	80 kg (255 kg, 260 kg)

# COMPONENTS

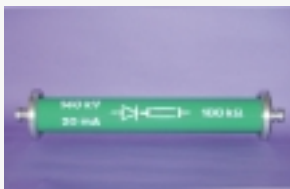


## HSEV 200

## HV Connection 200 kV

Flexible connection with suitable contacts to connect a two stage AC voltage configuration to the test transformer.

Length: approx. 1 m



## HSEV 300

## HV Connection 300 kV

Flexible connection with suitable contacts to connect a three stage AC voltage configuration to the test transformer.

Length: approx. 2 m

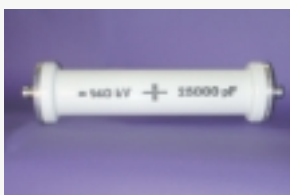


## GS

## HV rectifier

Rectifier, which can be used for impulse and DC voltage configurations.

Built-in protective resistor: 100 k $\Omega$   
 Inverse peak voltage: 140 kV  
 Rated current: 20 mA  
 Weight: 9.1 kg



## RE

## Parallel (Wave tail) resistor

Resistor, which can be used as discharge resistor for DC and impulse voltage configurations and as parallel resistor in impulse voltage configurations, determining the duration.

Resistance: different values (2.4, 2.5, 120 k $\Omega$ )  
 Max. DC and IMP voltage: 140 kV  
 Weight: 4 kg

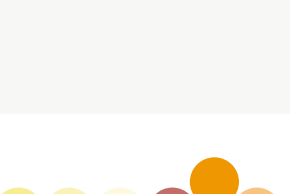


## CS 25

## Smoothing capacitor

Capacitor, which can be used as energy storage capacitor for generation of impulse voltages or as smoothing capacitor for DC generation.

Capacitance: 25 nF  
 Max. DC and IMP voltage: 140 kV  
 Weight: 15 kg



## CB

## Load capacitor

Capacitor, which can be used as HV unit for measuring of impulse voltages and as load capacitance.

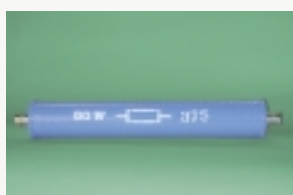
Capacitance: 1200 pF  
 Max. DC and IMP voltage: 140 kV  
 Weight: 9.5 kg



**RL Charging resistor**

Resistor, which can be used as charging resistor for multistage impulse configurations, as current limiting resistor in DC configurations and as damping resistor in connection with the grounding switch.

Resistance: 10 MΩ or 2.5 MΩ  
Max. DC and IMP voltage: 140 kV  
Weight: 4.5 kg



**RD Series (Wave front) resistor**

Resistor, which can be used as series resistor for impulse voltage configurations, determining the wave risetime.

Resistance: different values  
(95, 140, 220, 355 Ω, 15, 22, 35, 55 kΩ)  
Max. DC and IMP voltage: 140 kV  
Weight: 4.5 kg



**CM Measuring capacitor**

Capacitor, which can be used as HV unit for measuring of AC voltages.

Capacitance: 100 pF  
Max. AC voltage: 100 kV  
Weight: 10 kg



**RM Measuring resistor**

Resistor, which can be used as HV unit for measuring of DC voltages.

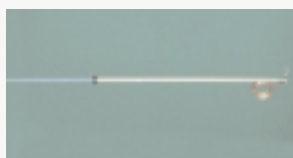
Resistance: 280 MΩ  
Rated current (continuous): 0.5 mA  
Max. DC voltage: 140 kV  
Weight: 4 kg



**ES Grounding switch**

Remote controlled switch, which can be used to ground the high voltage construction KIT.

Max. DC and IMP voltage: 140 kV  
Service voltage: 24 V, 50/60 Hz  
Weight: 6.5 kg



**EST Discharge rod**

Rod, for manual discharge of HV KIT components.

Length: 2.5 m  
Discharge resistance: 100 W  
Weight: 1.5 kg

# COMPONENTS

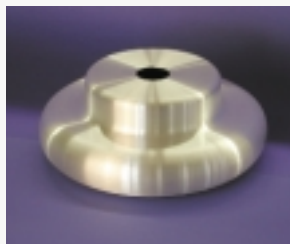


**EB**

**Ground foil**

Copper ground foil, which can be used to make ground connections between the individual high-voltage apparatus.

Copper foil  
Weight: 0.44 kg/m



**EL**

**Electrode**

Electrode, used together with grounding switch ES and for termination top elements when test set should be corona-free.

Diameter: 300 mm  
Weight: 2 kg

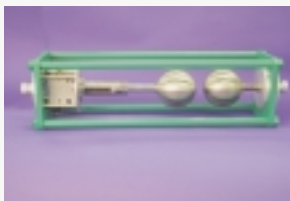


**IS**

**Insulating support**

Support insulator, which can be used as insulating component.

Max. AC voltage: 100 kV  
Max. DC and IMP voltage: 140 kV  
Weight: 1.5 kg



**KF**

**Sphere gap**

Sphere gap, for impulse voltage configuration.

Max. IMP voltage: 140 kV  
Sphere diameter: 100 mm  
Max. gap setting: 80 mm  
Weight: 6 kg



**AKF**

**Drive for sphere gap**

Remote controlled drive for sphere gap KF and MF100. Drive shaft ASA (short) for 1st Stage and ASB (long) for 2nd and 3rd Stage needed. The AKF is clamped to a spacer bar D.

With capacitor motor: 230 V  
Frequency: 50/60 Hz  
Weight: 6 kg





**V** **Connecting rod**  
Conductive connection element  
Aluminium tube  
Weight: 1 kg



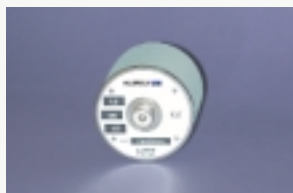
**K** **Connecting cup**  
Conductive connection element, four components can be connected horizontally and two components vertically.  
Aluminium-cast  
Weight: 2.5 kg



**F(s)** **Floor pedestal**  
Conductive element, for mounting up to four spacer bars horizontally and supporting one component vertically.  
Aluminium-cast  
Weight: 2 kg



**D** **Spacer bar**  
Spacer bar, which can be used for mechanical and electrical connection at ground level inserted into a floor pedestal F(s).  
Aluminium tube  
Weight: 1 kg



**NTZ** **Secondary part for CB (impulse)**  
Low voltage divider for impulse measurements, which incorporates the LV capacitors and a 75  $\Omega$  matching resistor. Connected between the HF-socket of the load capacitor CB and the DMI 551 by means of a coaxial cable (MK BNC).



**SEK AC** **Secondary part for CM (AC)**  
Low voltage divider for AC measurements, which incorporates the LV capacitors and a 75  $\Omega$  matching resistor. Connected between the HF-socket of the measuring capacitor CM and the DMI 551 by means of a coaxial cable (MK BNC).

# COMPONENTS



## SEK DC Secondary part for RM (DC)

Low voltage divider for DC measurements, which incorporates the LV resistors and a 75 Ω matching resistor. Connected between the HF-socket of the measuring resistor RM and the DMI 551 by means of a coaxial cable (MK BNC)



## MK BNC Coaxial measuring cable

Coaxial cable with BNC plugs can be used to connect high-voltage dividers to measuring instruments (DMI 551).

Impedance: 75 Ω  
Standard Length: 10 m  
other lengths on request



## EZK Electronic trigger sphere

Trigger sphere, which is used to generate triggered impulses in impulse voltage configurations together with sphere gap KF and triggering device DMI ZAG. Chopped impulses can be generated with an additional EZK together with the measuring spark gap MF 100. Supplied with fibre-optics cable LWL.

Diameter: 100 mm  
Weight: 0.7 kg  
Standard length of cable: 10 m



## DKU Vessel for vacuum and pressure

Vessel, which can be used to determine flashover voltage of electrode arrangements as a function of vacuum and over pressure.

Max. AC voltage: 100 kV  
Max. DC and IMP voltage: 140 kV  
Max. operating pressure (abs.): 0 - 6 bar  
Weight: 12 kg



## DKU ZUB Additional set of electrodes

Additional electrodes for use with the DKU.

Sphere electrodes dia. 50 mm  
Sphere electrodes dia. 20 mm  
Needles electrodes



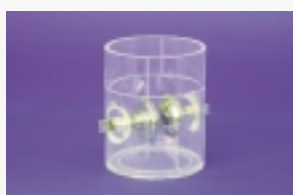
**D(D)****Spacer bar**

Spacer bar, which can be used to connect a floor pedestal F(s) with:  
-the vacuum and pressure vessel (DKU), Length: 652 mm  
Aluminium tube

**KR****Corona cage**

Corona cage, which can be used to determine glow intensity as a function of wire diameter. The corona cage is inserted into the vacuum and overpressure vessel (DKU).  
Measurements can be made at vacuum and over pressure.

Max. AC voltage: 100 kV  
Max. DC voltage: 140 kV  
Weight: 1.5 kg

**OP****Oil testing cup**

Oil testing cup, which can be used to measure flashover voltage of insulating oil. Fitted into the vacuum and pressure vessel (DKU).  
Electrodes have spherical caps acc. to VDE 370, par. 13.

Gap setting : 2.5 mm

**MF 100****Measuring sphere gap**

Sphere gap to measure flashover voltage and to generate chopped impulses together with the trigger sphere EZK. Motor-driven but also with hand-wheel for manual gap setting.

Max. AC voltage: 100 kV  
Max. DC and IMP voltage: 140 kV  
Sphere electrodes: dia. 100 mm  
Weight: 15 kg  
With motor-drive 230 V, 50/60 Hz

**MF 100 ZUB****Additional set of electrodes**

Additional electrodes available for the MF 100.

Sphere electrodes: dia. 50 mm  
Rod-type electrodes: dia. 20 mm  
Needles electrodes  
Flat electrodes (Rogowski profile)

# TEST ROOM

A suitable room is required to accommodate the high voltage construction KIT. Depending on the KIT configuration a floor surface of three by four meters is recommended, and a favourable height is 2.5 to 3 meters.

Since voltages in excess of 1000 V are to be generated, it is necessary that the respective safety regulations are carefully followed.

The most important criteria of a good test room are the screening and grounding.

## Safety Equipment

The test area should be enclosed by a metal grid fence of at least 1.8 meters height with a maximum grid spacing of 50 mm.

All doors leading to the test room must be equipped with door contacts, which close when the door is closed. All contacts should be connected in series to the interlock system provided by the control unit OT 276. This safety system will automatically turn off the high voltage if a door is opened while the test system is switched on. Red and green warning lights should be installed at all doors leading to the test room.

## Screening

The test transformer of the high voltage construction KIT can be used for partial discharge measurements. The test transformer PZT 100-0.1 with the optional top electrode is partial discharge free. In order to ensure that the partial discharge measurement is not disturbed by external interference, it is necessary that the test room is screened like a Faraday cage. Walls, ceiling and the floor of the test area have to be covered with a metallic surface. This surface can either be a wire mesh having a spacing of less than 10 mm or a 0.1 to 0.2 mm copper foil. The edges of each individual strip must be carefully joined to the next one so that the conductivity between the sheets is as high as possible. Using a wire mesh, the wires should be bound and soldered. Copper foils can be joined by folding the edges or by soldering.

Welding or soldering points are preferable to screw or clamp connections.

A steel sheet floor with non-slip surface (waffle sheeting) is recommended.

All cables leading into the shielded room should

enter the Faraday cage at a central position. Ask your Haefely Test Sales Person for assistance on how to erect shielded enclosures and for power line filters.

## Grounding

A good test field has a separate grounding. This ensures that no disturbances from surrounding machines enter the test field and - in case of a failure - the earth potential of the surrounding does not rise, causing damage to electrical equipment. It is necessary for the test field to have a lower grounding resistance than the surrounding building.

The following measures are required: Use a deep ground rod, radial ground wires below the ground surface, a lightning conductor or water mains outside the building for grounding.

If possible, the whole test room should be screened. Attention should be paid to ensure a good lasting electrical connection between all parts of the screening. The screening surfaces should be made with wide metal strips (at least 60 mm in width), since strips of this width are of lower inductivity than round wires having the same cross-sectional area.

Connections have to be made without forming loops.

The ground connection of the high voltage generator, measuring system and test object should be arranged like a star, where the central point is grounded.

To avoid ground loops between different grounding points, the KIT is grounded at only one position through a grounding rod. The rod must have a ground resistance of less than 2  $\Omega$ .

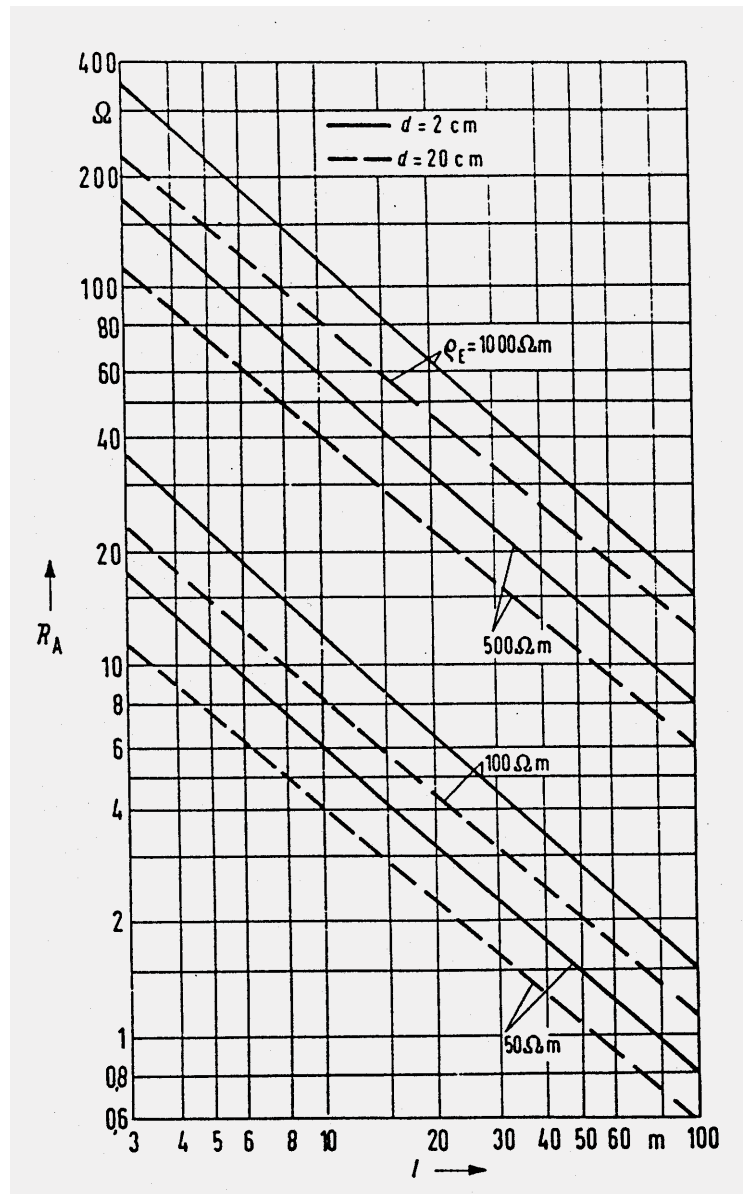
If the resistivity of the soil near the factory is not known, we recommend the following procedure: A rod with a diameter of about 20 mm is driven into the soil to a depth of approx. 30 m. The first 3 m of this rod below the soil level have to be insulated in order to avoid picking up surface currents. Then the ground resistance is measured. If the resistance is higher than 2  $\Omega$ , a second rod must be driven into the soil approx. 10 m from the first, following the same procedure. The two ground rods are then connected in parallel with a copper foil of 150 x 0.3 mm cross section for example. This procedure is repeated until the ground resistance of < 2  $\Omega$  is achieved.

The length of the grounding rod is not important but the ground resistance must be  $< 2 \Omega$  for personnel protection.

A local construction company can give you some more details about the depth of the rod.

The grounding rod(s) shall be placed close to the test area. The enclosure's ground stud will be connected to the ground rod with a strong copper band for example  $0.3 \times 100 \text{ mm}$ .

- $R_A$  = Ground resistance ( $\Omega$ )
- $\rho E$  = soil resistivity ( $\Omega\text{m}$ )
- $l$  = depth of grounding rod (m)
- $d$  = diameter of grounding rod (cm)



Ground resistance as function of length of rod and soil resistivity



E105.10  
Subject to change without  
notice 05.2001

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