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Data Sheet 8.81-1/1

High-Voltage Capacitive Compensation Unit for Transformer and Shunt Reactor Testing, Type HVCC

Application

The High-Voltage Capacitive Compensation Unit (HVCC) is an extension to the test systems type WV. It can be used for:

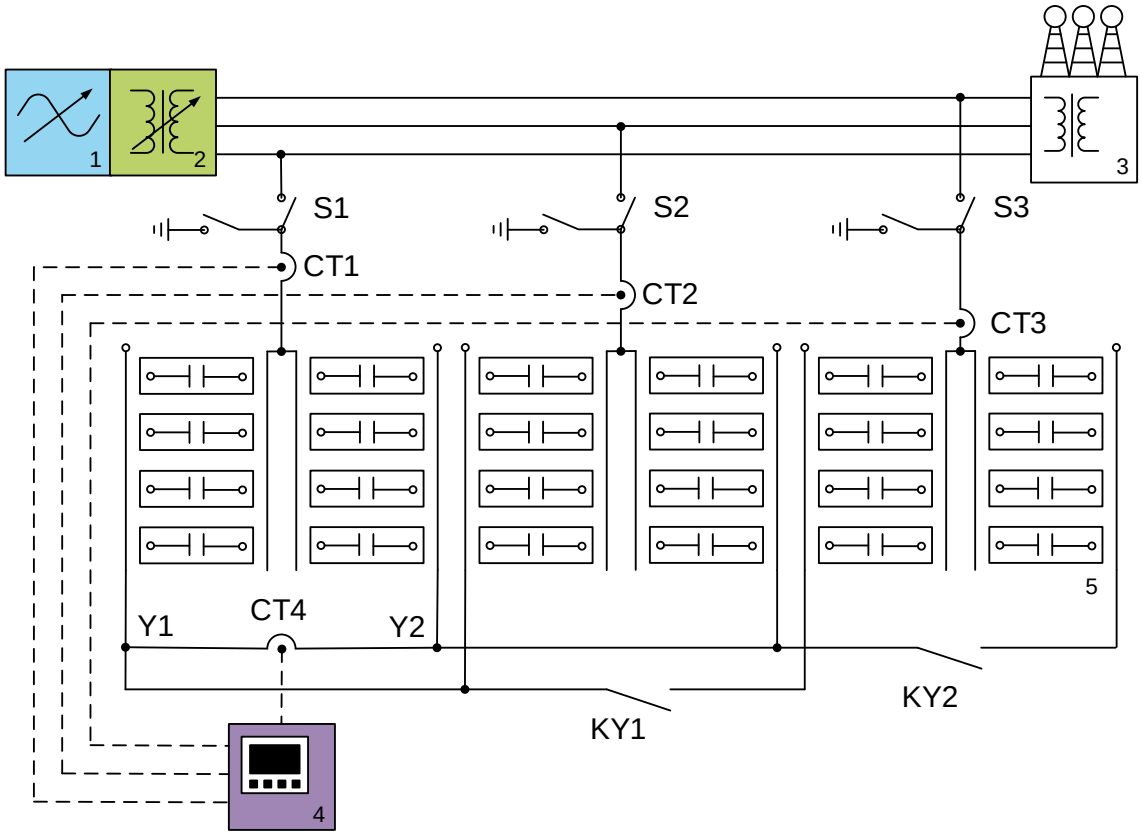
- Measurements of short-circuit impedance on transformers,
- Measurements of load loss on transformers and shunt reactors,
- Temperature-rise tests on transformers and shunt reactors,
- Test on on-load tap changers (OLTC) on transformers and shunt reactors,
- Determination of reactance and linearity of reactance on shunt reactors,
- Induced-voltage tests on shunt reactors.

These tests require a very high capacitive reactive power up to 200~400 Mvar. Since the power capacity of the control and feeding converter (type CFI) is limited (Data Sheet 8.73), a HV Capacitive Compensation Unit is necessary. It covers most of the capacitive reactive power requirements. The CFI converter needs only to supply the necessary active power and a small part of reactive power, which is not compensated by the HV capacitive compensation unit. To comply with the power capacity of the CFI converter, the HV capacitive compensation unit is designed with fine power graduation.

Design

Fig. 1 shows a schematic circuit diagram of the HV Capacitive Compensation Unit. The capacitor or capacitor groups can be selected and connected manually with plug-in contacts or automatically with off-load disconnectors. According to the test voltage, the number of capacitors to be connected in series will be defined. According to the test power, the number of capacitors to be connected in parallel can be selected. A three-phase disconnector with earthing switch is used to connect the HV capacitor unit to the output terminals of the transformer test system.

For the purpose of safety and protection, each capacitor is equipped with a discharge resistor. Most of the capacitors are equipped with internal fuses. The unit consists of three phase banks. Each phase bank consists of two subbanks of capacitors. The whole three-phase capacitor bank is configured as a double-star circuit for three-phase application. In case of single-phase operation, the two phase banks (U and V) build up an H-bridge circuit. Three phase-current instrument transformers (CT1, CT2 and CT3 in Fig. 1), an unbalance current instrument transformer (CT4 in Fig. 1) and a capacitor protection relay are used to detect the unbalance, which occurs in case of wrong connections or defect capacitors.



1	CFI converter (Data Sheet 8.73)
2	Tapped transformer (Data Sheet 8.75)
3	Test object
4	HVCC protection box
5	Capacitor
CT1, CT2, CT3	Phase current instrument transformers
CT4	Unbalance current instrument transformer
KY1, KY2	Star-point disconnectors
S1, S2, S3	HVCC disconnector with earthing switch

Fig. 1: Schematic circuit diagram of the HV Capacitive Compensation Unit

Technical Data of Manual HV Capacitive Compensation Unit

Type designation

HVCC a/b

a = maximum compensation power in kvar at maximum operation voltage and a frequency of 50 Hz
b = maximum operation in kV

Table 1: Technical data of manual HV Capacitive Compensation Unit (1)

Type	**HVCC 9700/12**	**HVCC 13000/24**	**HVCC 54000/36**
Operation voltage (rms) (kV)	12	24	36
Test voltage at power frequency (kV)	28	50	70
Max. operation current (A)	1000	1000	2000
Operation frequency (Hz)	50 / 60	50 / 60	50 / 60
Max. compensation power at 50 Hz (kvar)	9700	13000	54000
Max. compensation power at 60 Hz (kvar)	11640	15600	65152
Max. power graduation at 60 Hz (kvar)	270	543	977
Losses (kW)	2.1	5.5	10
Quantity of oil (l)	370	950	1800
Leakable oil (l)	160	410	700
Compensation power dependent on test voltage	See Fig. 2	See Fig. 3	See Fig. 4
Standard	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410
Interfaces for Control			
Operation voltage (V AC)	230/400	230/400	230/400
Operation current (A)	max. 5	max. 5	max. 5
Dimensions, Environment			
Dimensions (LxWxH) (m)	5.5 x 5.25 x 1.87	6.5 x 5.25 x 1.87	11.43 X 5.2 x 2.4
Weight (t)	4.5	7	10
Installation	Indoor, stationary	Indoor, stationary	Indoor, stationary
Ambient temperature (°C)	+5…+40	+5…+40	+5…+40
Height above sea level (m)	1000	1000	1000
Humidity (%)	90 (no condensation)	90 (no condensation)	90 (no condensation)

Type designation

HVCC a/b

a = maximum compensation power in kvar at maximum operation voltage and a frequency of 50 Hz
b = maximum operation voltage in kV

Table 2: Technical data of manual HV Capacitive Compensation Unit (2)

Type	**HVCC 100000/42**	**HVCC 75000/54**	**HVCC 132000/72**
Operation voltage (rms) (kV)	42	54	72
Test voltage at power frequency (kV)	95	115	140
Max. operation current (A)	2000	2000	3000
Operation frequency (Hz)	50 / 60	50 / 60	50 / 60
Max. compensation power at 50 Hz (kvar)	100000	75000	132000
Max. compensation power at 60 Hz (kvar)	120000	90000	158000
Max. power graduation at 60 Hz (kvar)	2524	1924	1440
Losses (kW)	22	14	20
Quantity of oil (l)	3100	2500	3700
Leakable oil (l)	1100	800	1500
Compensation power dependent on test voltage	See Fig. 5	See Fig. 6	See Fig. 7
Standard	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410
Interfaces for Control			
Operation voltage (V AC)	230/400	230/400	230/400
Operation current (A)	max. 5	max. 5	max. 5
Dimensions, Environment			
Dimensions (LxWxH) (m)	14.0 x 6.41 x 2.76	14.0 x 5.5 x 3.0	14.0 x 6.5 x 3.26
Weight (t)	18	13	19
Installation	Indoor, stationary	Indoor, stationary	Indoor, stationary
Ambient temperature (°C)	+5…+40	+5…+40	+5…+40
Height above sea level (m)	1000	1000	1000
Humidity (%)	90 (no condensation)	90 (no condensation)	90 (no condensation)

Type designation

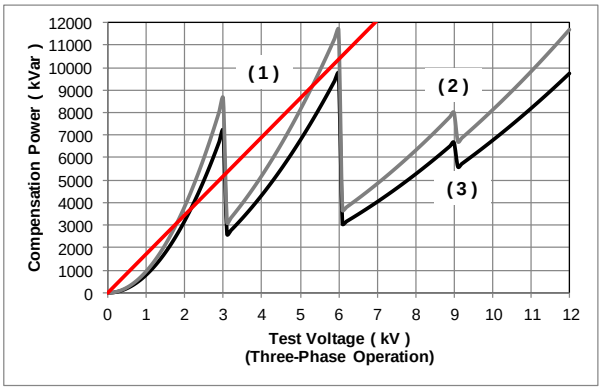
HVCC a/b

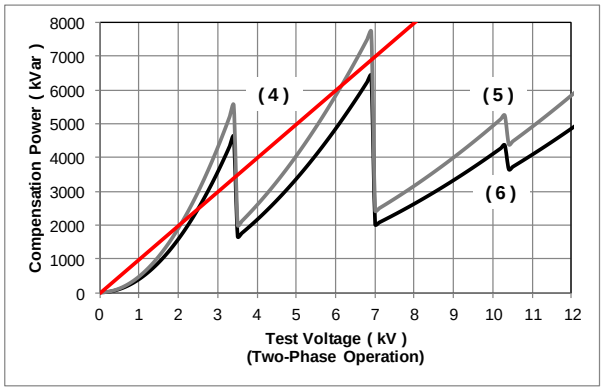
a = maximum compensation power in kvar at maximum operation voltage and a frequency of 50 Hz
b = maximum operation voltage in kV

Table 3: Technical data of manual HV Capacitive Compensation Unit (3)

Type	**HVCC 140000/90**	**HVCC 190000/90**	**HVCC 200000/100**
Operation voltage (rms) (kV)	90	90	100
Test voltage at power frequency (kV)	185	185	185
Max. operation current (A)	3000	3000	4000
Operation frequency (Hz)	50 / 60	50 / 60	50 / 60 / 200*1)
Max. compensation power at 50 Hz (kvar)	140000	190000	200000
Max. compensation power at 60 Hz (kvar)	168000	228000	240000
Max. power graduation at 60 Hz (kvar)	1794	1794	1080
Losses (kW)	27	27	27.8
Quantity of oil (l)	4600	4600	6152
Leakable oil (l)	1800	1800	2742
Compensation power dependent on test voltage	See Fig. 8	See Fig. 9	See Fig. 10
Standard	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410
Interfaces for Control			
Operation voltage (V AC)	230/400	230/400	230/400
Operation current (A)	max. 5	max. 5	max. 5
Dimensions, Environment			
Dimensions (LxWxH) (m)	20.0 x 8.0 x 3.34	20.0 x 8.0 x 3.34	20.0 x 6.45 x 3.76
Weight (t)	26	26	33
Installation	Indoor, stationary	Indoor, stationary	Indoor, stationary
Ambient temperature (°C)	+5…+40	+5…+40	+5…+40
Height above sea level (m)	1000	1000	1000
Humidity (%)	90 (no condensation)	90 (no condensation)	90 (no condensation)

*1) In case of operation frequency of 200 Hz, the HV capacitive compensation unit can be used only at up to 55 % of the rated operation voltage.

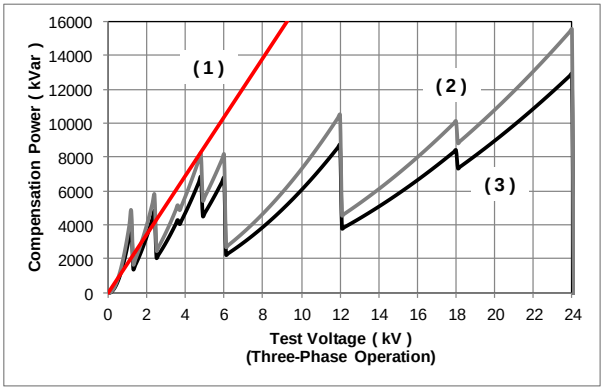


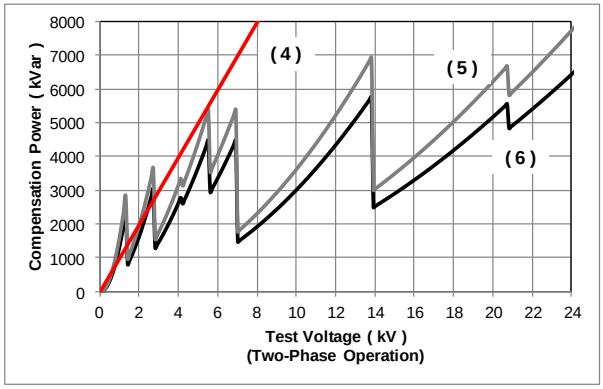


(1) Current limit:1000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 1000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 2: Compensation power dependent on the test voltage for type HVCC 9700/12

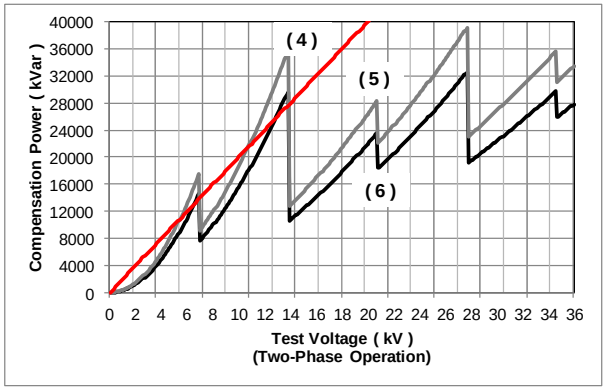




(1) Current limit: 1000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 1000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

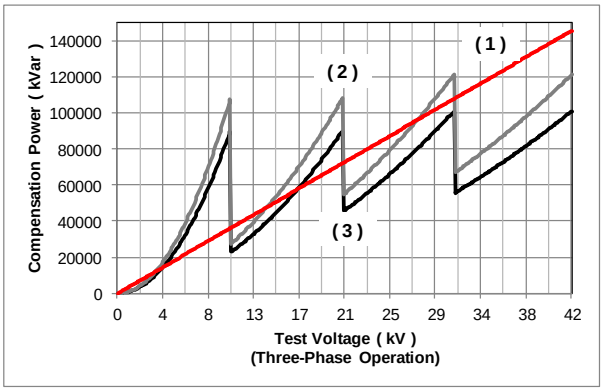
Fig. 3: Compensation power dependent on the test voltage for type Mobile-HVCC 13000/24

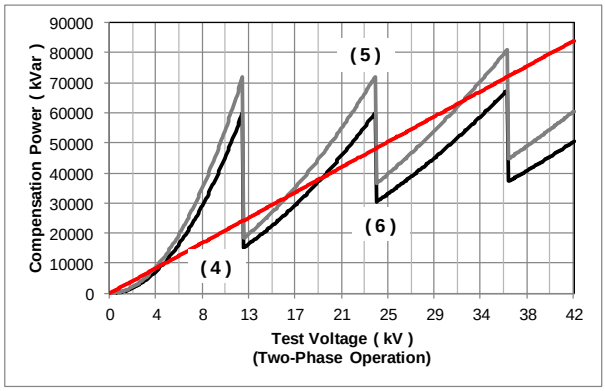


(1) Current limit: 2000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 2000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 4: Compensation power dependent on the test voltage for type HVCC 54000/36

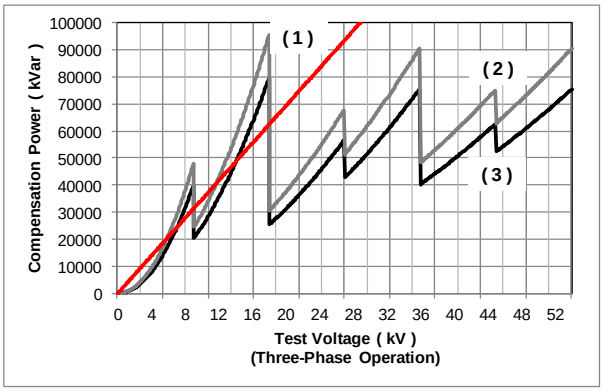


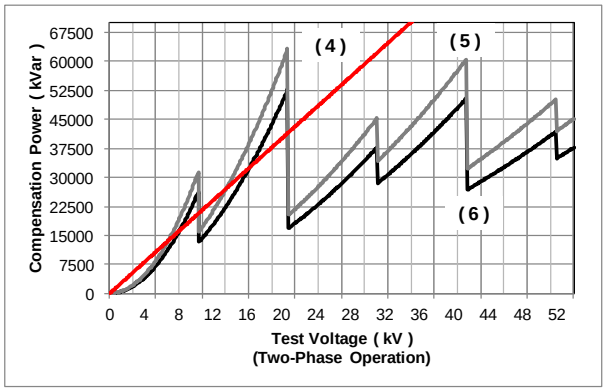


(1) Current limit: 2000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 2000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 5: Compensation power dependent on the test voltage for type HVCC 100000/42

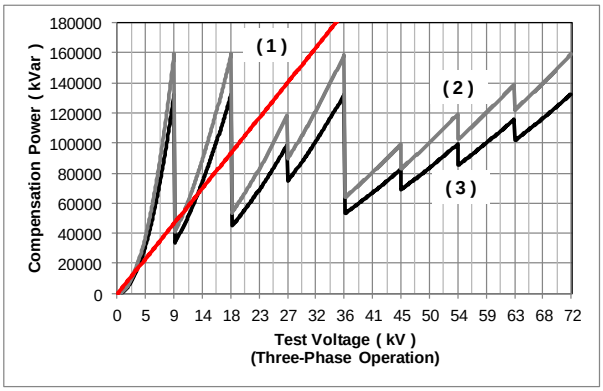


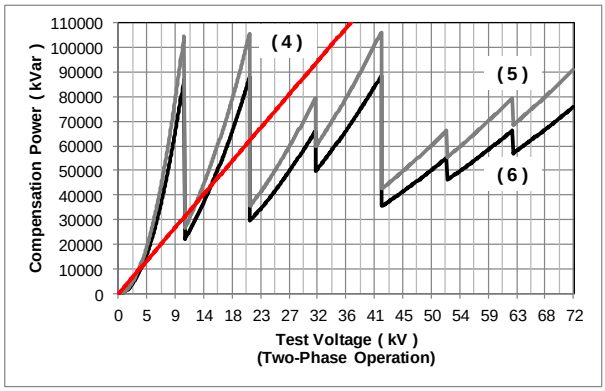


(1) Current limit: 2000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 2000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 6: Compensation power dependent on the test voltage for type HVCC 75000/54

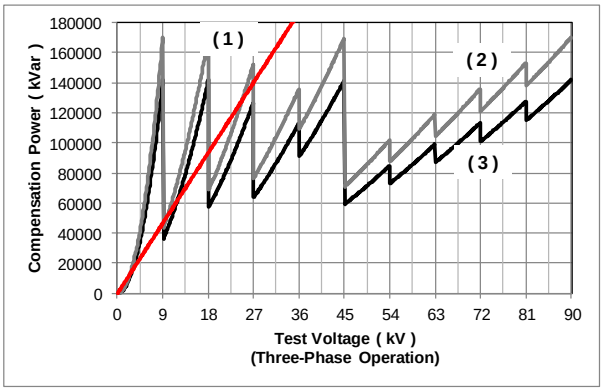


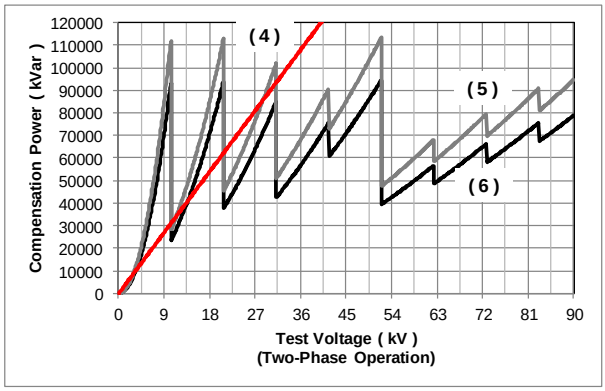


(1) Current limit:2000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 3000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 7: Compensation power dependent on the test voltage for type HVCC 132000/72

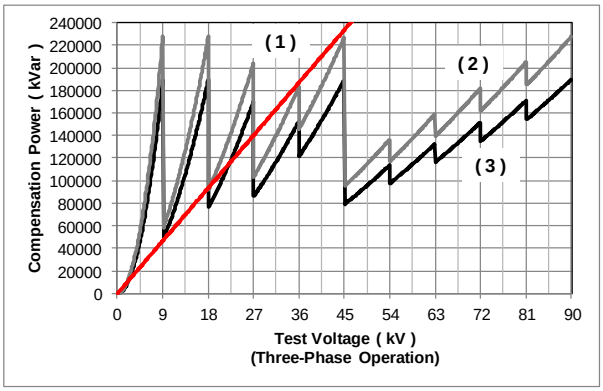


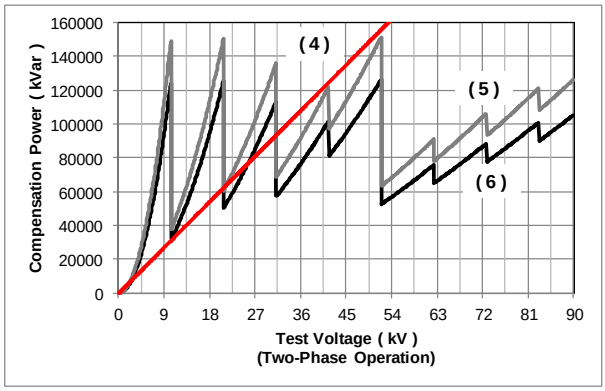


(1) Current limit: 3000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 3000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 8: Compensation power dependent on the test voltage for type HVCC 140000/90

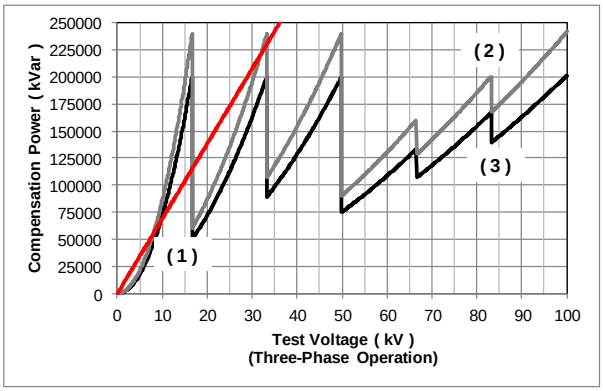


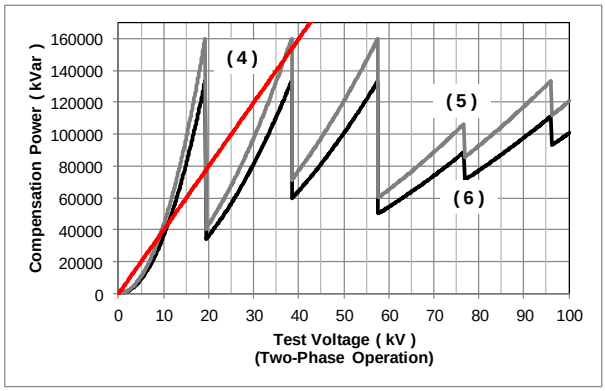


(1) Current limit: 3000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 3000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 9: Compensation power dependent on the test voltage for type HVCC 190000/90





(1) Current limit:4000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 4000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 10: Compensation power dependent on the test voltage for type HVCC 200000/100

Technical Data of Automatic HV Capacitive Compensation Unit

Type designation

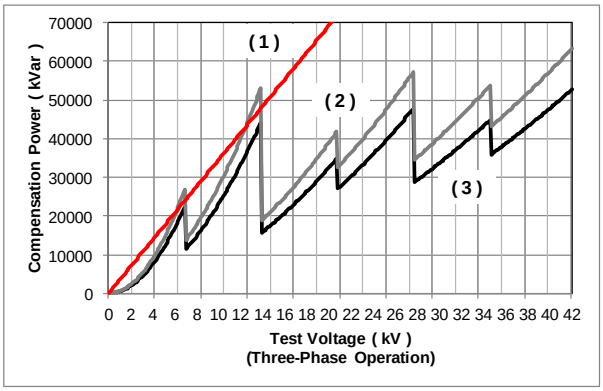
HVCC a/b

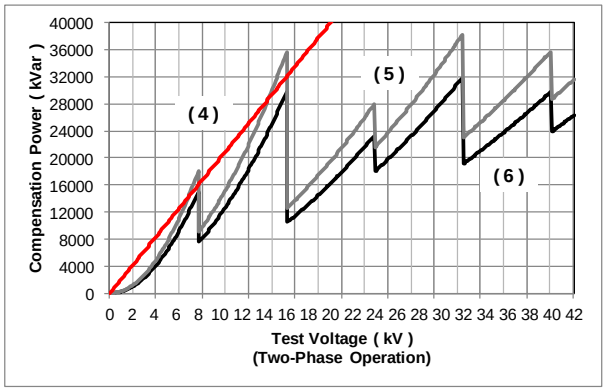
a = maximum compensation power in kvar at maximum operation voltage and a frequency of 50 Hz
b = maximum operation voltage in kV

Table 4: Technical data of automatic HV Capacitive Compensation Unit

Type	**Auto-HVCC 54000/42**	**Auto-HVCC 130000/72**	**Auto-HVCC 200000/100**
Operation voltage (rms) (kV)	42	72	100
Test voltage at power frequency (kV)	70	140	185
Max. operation current (A)	2000	3000	4000
Operation frequency (Hz)	50 / 60	50 / 60 / 200*2)	50 / 60 / 200*2)
Max. compensation power at 50 Hz (kvar)	54000	130000	200000
Max. compensation power at 60 Hz (kvar)	64800	156000	240000
Max. power graduation at 60 Hz (kvar)	665	1440	2160
Losses (kW)	18	48	73
Quantity of oil (l)	3700	9150	13864
Leakable oil (l)	900	2895	4387
Compensation power dependent on test voltage	See Fig. 11	See Fig. 12	See Fig. 13
Standard	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410	IEC 60871; ANSI/IEEE 18 VDE Part 410
Interfaces for Control			
Operation voltage (V AC)	230/400	230/400	230/400
Operation current (A)	max. 5	max. 5	max. 5
Air supply			
Rated air pressure (bar)	6	8	8
Rated air flow rate (l/min)	400	400	400
Dimensions, Environment			
Dimensions (LxWxH) (m)	14.45 X 5.5 x 3.2	30.0 x 15.0 x 4.85	37.0 x 15.0 x 4.85
Weight (t)	25	125	125
Installation	Indoor, stationary	Indoor, stationary	Indoor, stationary
Ambient temperature (°C)	+5…+40	+5…+40	+5…+40
Height above sea level (m)	1000	1000	1000
Humidity (%)	90 (no condensation)	90 (no condensation)	90 (no condensation)

*2) In case of operation frequency of 200 Hz, the HV capacitive compensation unit can be used only at up to 55 % of the rated operation voltage.

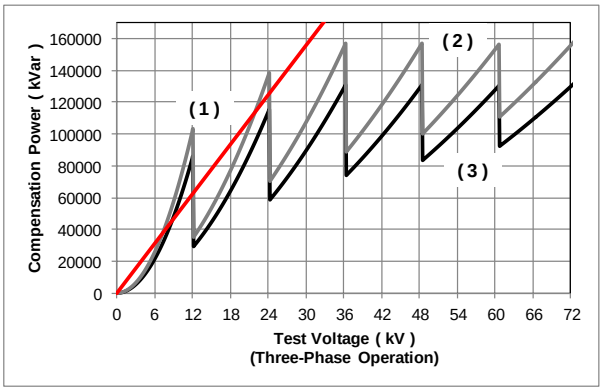


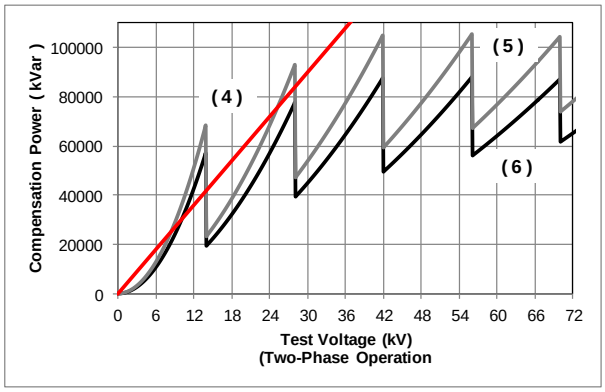


(1) Current limit: 2000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 2000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 11: Compensation power dependent on the test voltage for type Auto-HVCC 54000/42

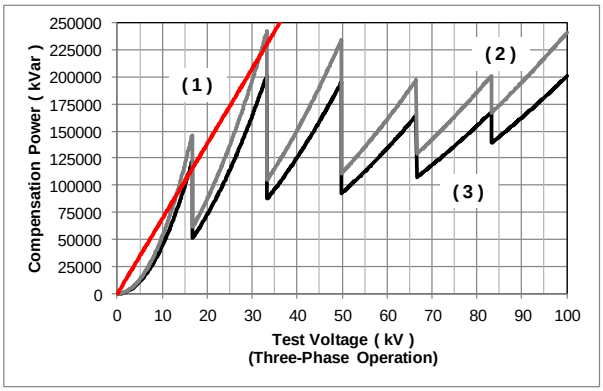


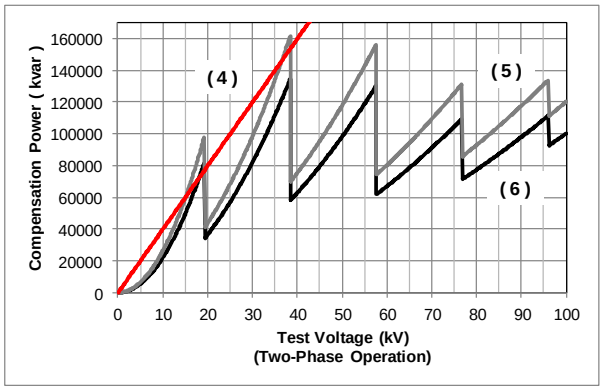


(1) Current limit: 3000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 3000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 12: Compensation power dependent on the test voltage for type Auto-HVCC 130000/72





(1) Current limit: 4000 A
(2) Operation frequency: 60 Hz
(3) Operation frequency: 50 Hz

(4) Current limit: 4000 A
(5) Operation frequency: 60 Hz
(6) Operation frequency: 50 Hz

Fig. 13: Compensation power dependent on the test voltage for type Auto-HVCC 200000/100