ANNEX 1

Individual Motor Compensation
6,3 kV – 800 kvar (MAC)
6,3 kV – 1600 kvar (BAC)
6,3 kV – 215 kvar (GAN)

Technical Description

1 Voltage Design of Capacitor Units

The peaks of overvoltage, that my be tolerated without significant deterioration of the capacitor, depends on its duration, its total number and of the capacitor temperature. The design of the capacitor unit according to IEC 871-1 from 1987 will be performed by multiplying the design-voltage (at design-power rating) with the factor of 1.10 (+10 %). The obtained „upper voltage limit" is permitted as the network voltage variation for maximum 12 hours within a 24 hour's day. The factor of 1.15 (+15 %) is allowed for maximum 30 minutes within a 24 hour's day. All above statements are valid only for the fundamental network frequency without considering any harmonics.

2 Current Design of Capacitor Units

Overcurrents could occur due to increased voltage (at fundamental wave frequency) or due to Harmonics or due to both.

Capacitors should not be operated with currents which exceed the as follows described maximum values – except those ones with operating times less than 5 minutes in combination with increased voltage due to low-load conditions.

Capacitors have to be designed to operate continously at 1,3 p.u. of the nominal current (at nominal voltage, without any harmonics). Dependet on the actual capacitance of the capacitors (which is alowed to be maximum 1,15 C_{nom}) the maximum current can be up to 1,5 I_{nom}.

Those values should consider the summarised effect of harmonics and increased voltage up to 1,1 U_{nom}.

Transient overcurrents with a high amplitude and frequency can occur during switching in capacitor units, especially if one part of the whole compensation plant (i.e. one capacitor step) will be switched in to another already energised part of the compensation plant.

The peak value of those transient overcurrents due to switching operations has to be limited to 100 I_{nom} (RMS-value).

3 Harmonics

The offer is based on an assumed negligible harmonic pre-load at the connecting points of the compensation units. As there isn't available any information about harmonic current sources this assumption has to be seen as preliminary. Furthermore it is possible that converters or rectifiers (with small to medium load) will be in service at the connecting point of the capacitor banks.

4 Switching Conditions of Capacitors

Capacitor banks have to be switched only with circuit breakers or vacuum contactors, which are capable and also tested for capacitive switching duty. If a restrike-free switching cannot be guaranteed, an early failure and a short service life of the capacitor units may be result. Vacuum circuit breaker or vacuum contactors of Siemens meet these requirements without any restrictions.

5 Use of water-endangering Materials

Capacitors contain an impregnating fluid (JARYLEC C101 / FARADOL). The total amount of that used fluid can be taken from the technical data sheets.

The used fluid has to be seen as dangerous for any water contamination. If any water protective measures are necessary and required by local law the owner or operator of the compensation plant shall provide those ones.

6 Discharging and Earthing

Within the casing the whole capacitor element assembly is equipped with a discharge resistor which discharges the capacitance within 10 minutes down to 75 Volts after disconnection from power source. But a re-energising of the capacitor bank can be executed already after 5 minutes after disconnection when the actual voltage decreased down to 10 % of the nominal voltage.

7 Capacitor Unbalance Monitoring Relays ESTAsym 3C (*Medium Voltage Application*)

The Relay type ESTAsym 3C is designed to monitor large capacitor equipment in double star circuit or bridge circuit. Two trip values can be adjusted each serving as reference criterion for three different voltage inputpoints. Only the effective value of the measurement signal is used for the control impulses to the display panel. All actuell values having initiated the switch-off of the capacitor equipment are memorized. This allows the operater, even after the equipment has been switched off, to find out to which degree the set trip value has been exceeded.

Measurement principle

Each measurement cycle of 100 ms duration comprises:

- Registering all values of current and all set desired values
- Computing all unbalance values
- Controlling display
- Tripping alarm

Hardware

The hardware consists of following components:

- Measurement circuits
- Desired value adjustment key
- Analogue / digital C.T
- Microprocessor
- Display panel

Measurement circuits

In the measurement circuit, the unbalance current is converted into a proportional voltage by a current-to-voltage transformer that also serves for the galvanic separation of the measuring circuits against each other and against the voltage supply circuit. The voltage thus generated is led through a 50 Hz or 60 Hz band-pass filter to make sure that only the fundamental wave is used for the measurement. Harmonic currents and starting currents of transformers thus do not affect the measurement.

Desired value adjustment

The user can set two trip values and one trip delay time by means of three trimmer potentiometers. The desired trip values can be selected within the whole range of current measurement (0-1 A or, 0-5 A). The delay time can be in the range of 0,1 to 6,5 seconds.

The set values apply to all measurement channels alike.

8 Internal Fuses

High-voltage power capacitors possess a number of series groups with parallel winding elements; the number of series groups in a capacitor unit depends on its rated voltage and rated output. In case of a failure in a winding element, the energy stored in the other parallel elements will cause the blowing of the element fuse. This stored energy should, however, be still high enough to ensure the actuation of the fuse. The rated voltage of single-phase components should, therefore, not exceed 10 kV with a casing output of approximately 300 kvar. With significantly smaller components, the rated voltaqe used should be lower. Due to the large number of winding elements, a capacitance change of only about 2 % is produced when a winding element fuse is actuated. In principle, every winding element is fitted with fuses at each pole. Even if these fuses do not blow in case of winding defects during operation, they provide complete protection against rupture of the casing in the event of phase to earth short circuits.

The functioning of winding fuses can extend the service life of power capacitors and thus avoid interruption of operation. The safety mechanism only remains intact, however, provided a sufficient number of winding elements connected in parallel still remains faultless. With the progressive ageing of capacitors, however, a point will eventually be reached after which the fuses of the remaining winding elements will no longer respond. It is advisable to check the capacitance at intervals of 1 to 2 years. For this reason, an unbalance protection or a phase comparison protection system should monitor every capacitor installation. External fuses are also regarded as protection devices; but they will not prevent possible formation of gas and subsequent rupture of casing, because they cannot operate following insidious defects which entail only a slightly increased capacitor current.

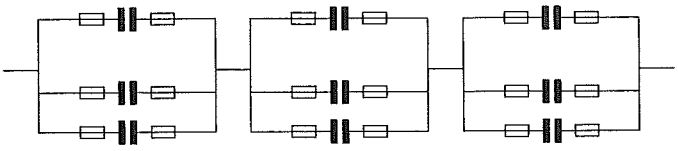


Fig. 1-1 principle scheme of internal fuses connection

9 Tests

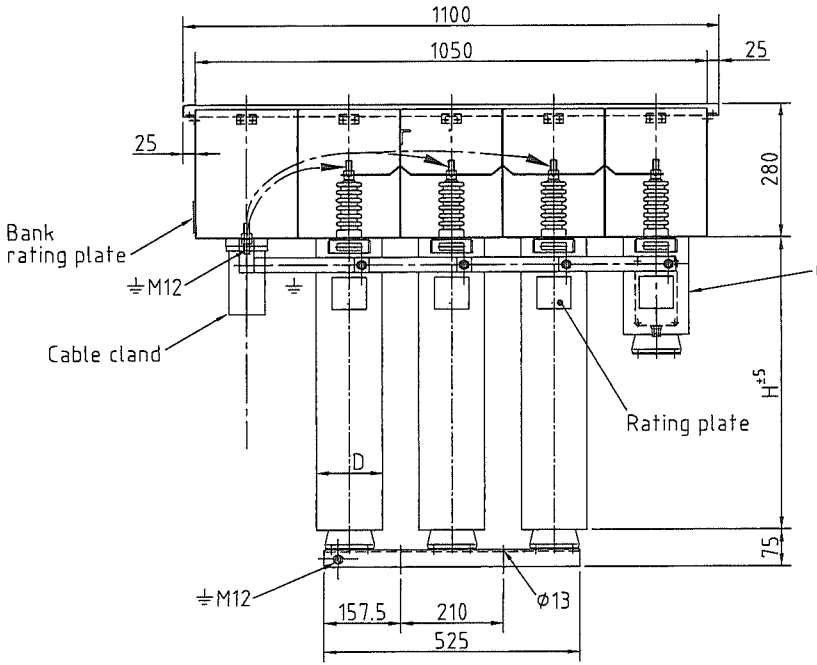
Routine tests of the capacitor units are included in our price. The relevant test certificates will be send free of charge immediately after the tests have been finalised. Type tests only can be executed if our expenses for these will be reimbursed. Already existing type test certificates for equipment with similar ratings can be supplied free of charge.

10 Standards

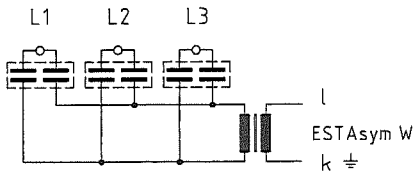
All materials comply with IEC recommendation and codes or with national standards of practice.

Capacitor units	IEC 871-1/1987	Shunt capacitors for a.c. power systems having a rated voltage above 660 V

A - A



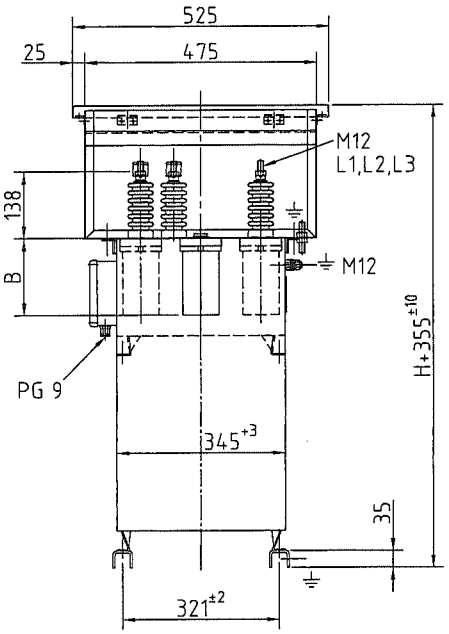
Circuit diagram

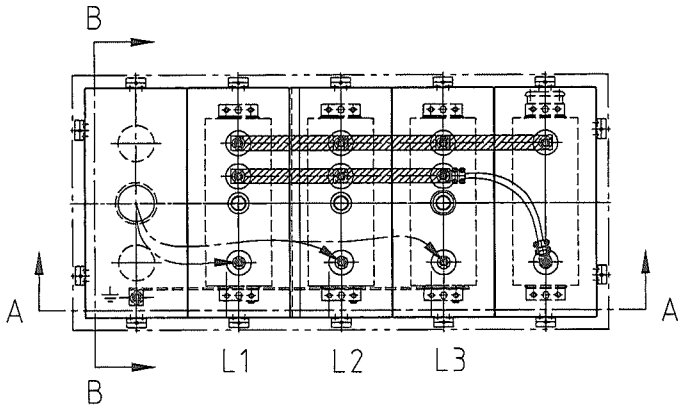


PRELIMINARY DRAWING
FOR INFORMATION ONLY

Ang.-Nr.	Datum	Unterschrift

B - B





Shown without cover!

Type: C/6.6/1.764/50 *Bank-no.: 4233*

Data:

Q	1.764	Mvar
U	6.6	kV
f	50	Hz
U_i	20 kV/60	kVp

Bushing-type	:	D- 199/M12
Capacitor-type	:	Phao 3.82/294+294/1
Drawing-no.	:	ME-723-422-003
Erection	:	indoor
Cable ø		18-42mm / KV-PG48
~~Cable ø~~		~~25-68mm / KV-PG68~~

Dimensions:

H	905	mm
D	175	mm
B	134	mm
m		kg

PERMISSIBLE TOLERANCES: ISO 2768		Tag	Name				
☐ FINE ☐ MEAN ☒ COARSE ☐ VERY COARSE	DRAWN	17.10.00	MAYER				
	CHECKED			1.2	3 cable cland; PG48	24.10.05	Stones
DIMENSIONS IN mm	DRAWN			1.1	quoted data added	13.10.05	Stones
ORIGINAL DRAWING: MH-113-331-001E-A1	CHECKED			INDEX	REVISION	DATE	NAME

APPLICATION FOR:	SCALE:	DESIGNATION:	MATERIAL:
200404066	1:10	CAPACITOR BANK TYPE OF ENCLOSURE IP 55	- -
			SUBST. FOR: / SUBST. BY:

VISHAY ELECTRONIC GMBH
Division Roederstein/ESTA

VISHAY

DWG NO.: 200404066P60A02 RA

EDV Nr. Objprojekte_

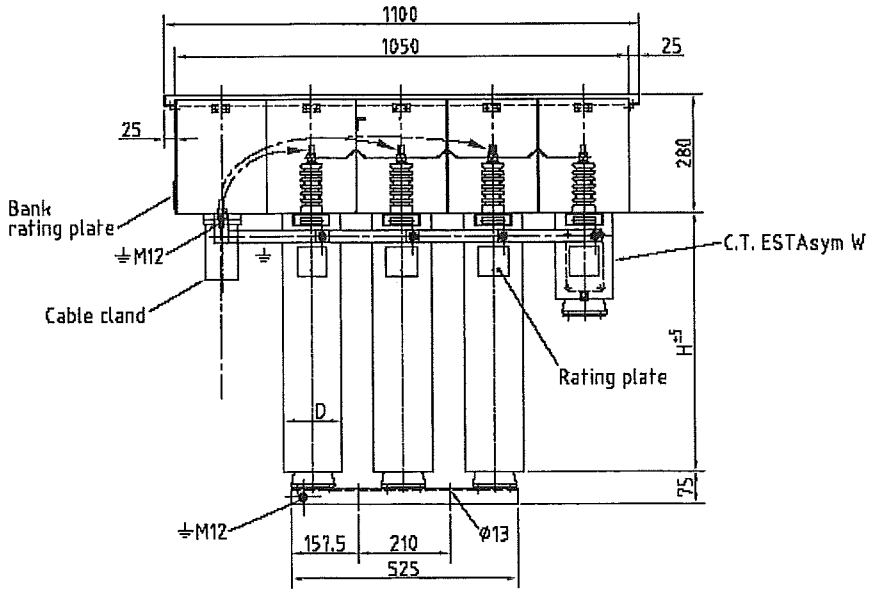
ANNEX 2

Individual Motor Compensation
6,3 kV – 800 kvar
6,3 kV – 1600 kvar
6,3 kV – 215 kvar

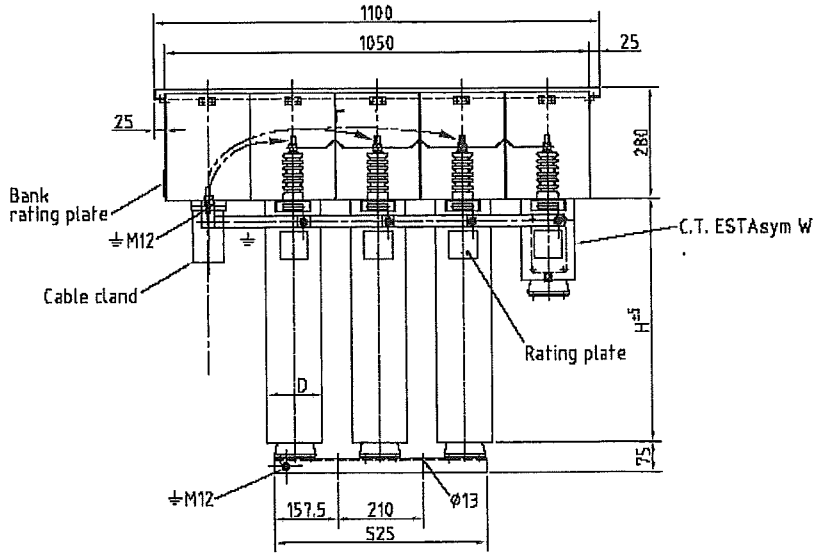
Technical Data

Capacitor step 800 kVAr

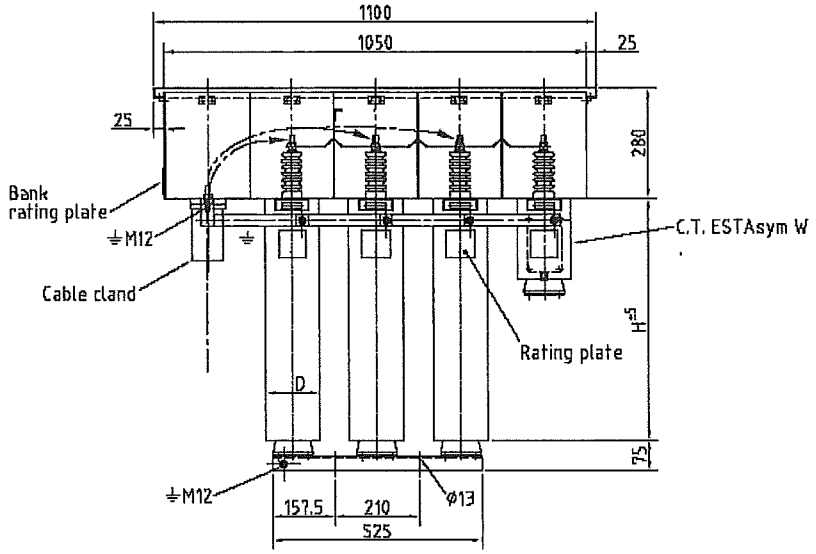
Data of the capacitor bank	
nominal reactive power at nominal voltage	800 kvar
nominal voltage (phase-to-phase)	6,3 kV (+/- 5%)
rated reactive power	882 kvar
rated voltage (phase-to-phase)	6,6 kV
capacitance	64,5 µF
number of capacitor units	3
nominal frequency	☒ 50 Hz ☐ 60 Hz
Lightning Impulse withstand voltage between terminals	☒ 60 kV ☐ 95 kV ☐ 125 kV
Lightning Impulse withstand voltage between terminals and earth	☒ 60 kV ☐ 95 kV ☐ 125 kV
Power frequency withstand voltage	☒ 20 kV ☐ 38 kV ☐ 50 kV
Connection scheme	☐ Y ☒ Y-Y ☐ H
protection scheme	unbalance monitoring with relays
protection class	☐ IP 00 ☒ IP 55
installation	☐ outdoor ☒ indoor
dimensions of the capacitor bank (length x width x height)	1100 x 525 x 830 mm
Data of the capacitor units	
rated voltage	3,82 kV
rated reactive power output	147 + 147 kvar
capacitance	64,13 µF
nominal current	77,0 A
number of bushings	3
weight	~ 55 kg
internal discharging resistors	☐ without ☒ included
losses after 500 operating hours	0,2 W/kVAr
protection class	IP 00
material of casing	stainless steel
pre-treatment of the casing	Washprimer
color of the casing	RAL 7033
maximum temperature	+45 °C
dielektric material	All-Film
dielectric fluid (non-PCB)	Jarylec C101



Capacitor step 1600 kVAr			
Data of the capacitor bank			
nominal reactive power at nominal voltage	1600 kvar		
nominal voltage (phase-to-phase)	6,3 kV (+/- 5%)		
Rated reactive power	1764 kvar		
rated voltage (phase-to-phase)	6,6 kV		
capacitance	128,3 µF		
number of capacitor units	3		
nominal frequency	☒ 50 Hz	☐ 60 Hz	
Lightning Impulse withstand voltage between terminals	☒ 60 kV	☐ 95 kV	☐ 125 kV
Lightning Impulse withstand voltage between terminals and earth	☒ 60 kV	☐ 95 kV	☐ 125 kV
Power frequency withstand voltage	☒ 20 kV	☐ 38 kV	☐ 50 kV
Connection scheme	☐ Y	☒ Y-Y	☐ H
protection scheme	unbalance monitoring with relays		
protection class	☐ IP 00	☒ IP 55	
installation	☐ outdoor	☒ indoor	
dimensions of the capacitor bank (length x width x height)	1100 x 525 x 12600 mm		
Data of the capacitor units			
rated voltage	3,82 kV		
rated reactive power output	294,0 + 294,0 kvar		
capacitance	128,3 µF		
nominal current	154,0 A		
number of bushings	3		
weight	~ 65 kg		
internal discharging resistors	☐ without	☒ included	
losses after 500 operating hours	0,2 W/kVAr		
protection class	IP 00		
material of casing	stainless steel		
pre-treatment of the casing	Washprimer		
color of the casing	RAL 7033		
maximum temperature	+45 °C		
dielektric material	All-Film		
dielectric fluid (non-PCB)	Jarylec C101		



Capacitor step 215 kVAr			
Data of the capacitor bank			
nominal reactive power at nominal voltage	215 kvar		
nominal voltage (phase-to-phase)	6,3 kV (+/- 5%)		
Rated reactive power	237 kvar		
rated voltage (phase-to-phase)	6,61 kV		
capacitance	17,24 µF		
number of capacitor units	3		
nominal frequency	☒ 50 Hz	☐ 60 Hz	
Lightning Impulse withstand voltage between terminals	☒ 60 kV	☐ 95 kV	☐ 125 kV
Lightning Impulse withstand voltage between terminals and earth	☒ 60 kV	☐ 95 kV	☐ 125 kV
Power frequency withstand voltage	☒ 20 kV	☐ 38 kV	☐ 50 kV
Connection scheme	☐ Y	☒ Y-Y	☐ H
protection scheme	unbalance monitoring with relays		
protection class	☐ IP 00	☒ IP 55	
installation	☐ outdoor	☒ indoor	
dimensions of the capacitor bank (length x width x height)	1100 x 525 x 625 mm		
Data of the capacitor units			
rated voltage	3,82 kV		
rated reactive power output	39,5 + 39,5 kvar		
capacitance	17,24 µF		
nominal current	20,6 A		
number of bushings	3		
weight	~ 45 kg		
internal discharging resistors	☐ without	☒ included	
losses after 500 operating hours	0,2 W/kVAr		
protection class	IP 00		
material of casing	stainless steel		
pre-treatment of the casing	Washprimer		
color of the casing	RAL 7033		
maximum temperature	+45 °C		
dielektric material	All-Film		
dielectric fluid (non-PCB)	Jarylec C101		



Capacitor Unbalance Monitoring Relays ESTAsym 3C	
measurement circuit	
permissible c.t. types	x/1 or x/5 A
measuring range	0-999 mA or 0-5 A
power consuption per circuit	1 VA
measurement input filter	50/60 Hz band-pass filter (a=10 dB)
measuring accuracy	class 1
electrical overloading capacity	2500 A at 0.1 ms
control circuit	
adjustment range for trip 1 and 2	0-1000 mA or 0-5 A
trip delay	0.1 - 6.5 seconds
display	3-digit, red
display resolution	5 mA or 25 mA
watchdog	monitors functioning of microprecessor
electric power supply	
operating voltages	-110 V AC or 220 V AC - 110 V DC – 350 V DC - 24 V DC
fuses	160 mA slow-acting on rear
power comsumption	approx. 10 VA
mechanical construction	
front panel	144 x 144 mm
switch panel cut-out	138 x 138 mm
depth	138 mm
weight	1,0 kg
connections	16-pin and 15-pin terminal strips
protection class	IP 41 if installed
operating/ambient temperature	-10 to +60°C
drawing