HOMA
Hochstromtechnik

Capacitor contactors

for on-load switching

List 507E

Edition from 01. August 2001

General

Induction furnaces for the heating and melting of metals possess a deleterious power factor. In order to charge the supply mains only with active power, static capacitors are used to compensate for the reactive current which arises in the furnaces coil. In order to adjust to the varying requirements of the furnaces coil for the reactive current, a number of the capacitors are made switchable via the contactor.

Switching-on of capacitors

Due the low actual resistance of the capacitor connection lead, the switching-on of a capacitor directly to a live parallel capacitor bank is effected by means of an equalizing current with a natural frequency of

$$\omega_e = \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2}$$

which corresponds very nearly to the resonant frequency.

The highest current peaks are caused when switching at the maximum of the steady capacitor voltage occurs and thus at the zero-axis crossing of the current precipitation at 90°. Under normal conditions this is always the case, because shortly before the switching-on contactor touches the contact piece, a sparking-over occurs and initiates the switching-on process.

The initial amplitude of the equalising current must not exceed a value of 50 times the rated current of the contactor in order not to over-exert the welding strength of the capacitor contactor contacts nor the dynamic loading capacity of the capacitors. A simplified calculation of the overcurrent factor (o.f.) for 50 Hz capacitors is made possible by the following formula:

$$\ddot{u}f = \frac{1}{\sqrt{\omega L \cdot \omega C}}$$

o.f. = in this o.f. represents many times the rated capacitor current

$$\omega L = 2\pi f \cdot L$$

$$\omega C = \frac{P_c}{U^2}$$

P_c = output of the switched capacitor (Var)

U = operating voltage (V)

L = effective inductivity of the circuit

F = frequency of the supply mains

It can be seen from the above formula that with the switching-on of capacitors of smaller output and higher voltage, the overcurrent factor increases and can even reach 100 times the rated current. In these cases a capacitor contactor must be selected that is of sufficient thermal design with regard to its making and/or breaking capacity.

With higher operating frequencies, the overcurrent factors become smaller as a function of the square root of the frequency ratio. A reduction of the starting current will be achieved by the application of series resistances which a bridged by a lagging contact from the same contactor. This series resistors (see List 506) are so designed that during the first and the second stage of the switch-on process, maximum overcurrent factors of 6 to 8 times the rated current of the capacitor occur.

Switching-off of capacitors

With the switching-off of one capacitor the quenching of the arc will follow at the slightest opening of the contactor. The dielectric consolidation of the switching path must, however, follow so quickly that the returning voltage will not cause arcing-through or arcing back. With higher operating voltages, 2 or 3 switching contacts are therefore connected in series.

Discharge

The capacitor, after having been switching off, must be discharged as quickly as possible, so that when it is switched on again , it is not subjected to even higher overcurrents. The discharging provided by us via resistors (see List 506) with discharge contactors makes an exact calculation possible in accordance with the following formula of the remaining residual voltage at the time "t":

$$U_{Rest} = U_n \cdot 1{,}1 \cdot \sqrt{2} \cdot \varepsilon^{-\frac{t}{T}}$$

in this the following means :

U_N = rated voltage (+ 10% overvoltage)

t = time (s)

T = time contacts = R C

R = value of the discharge resistor (Ohm)

C = capacity of the capacitor (F)

Coil power consumption

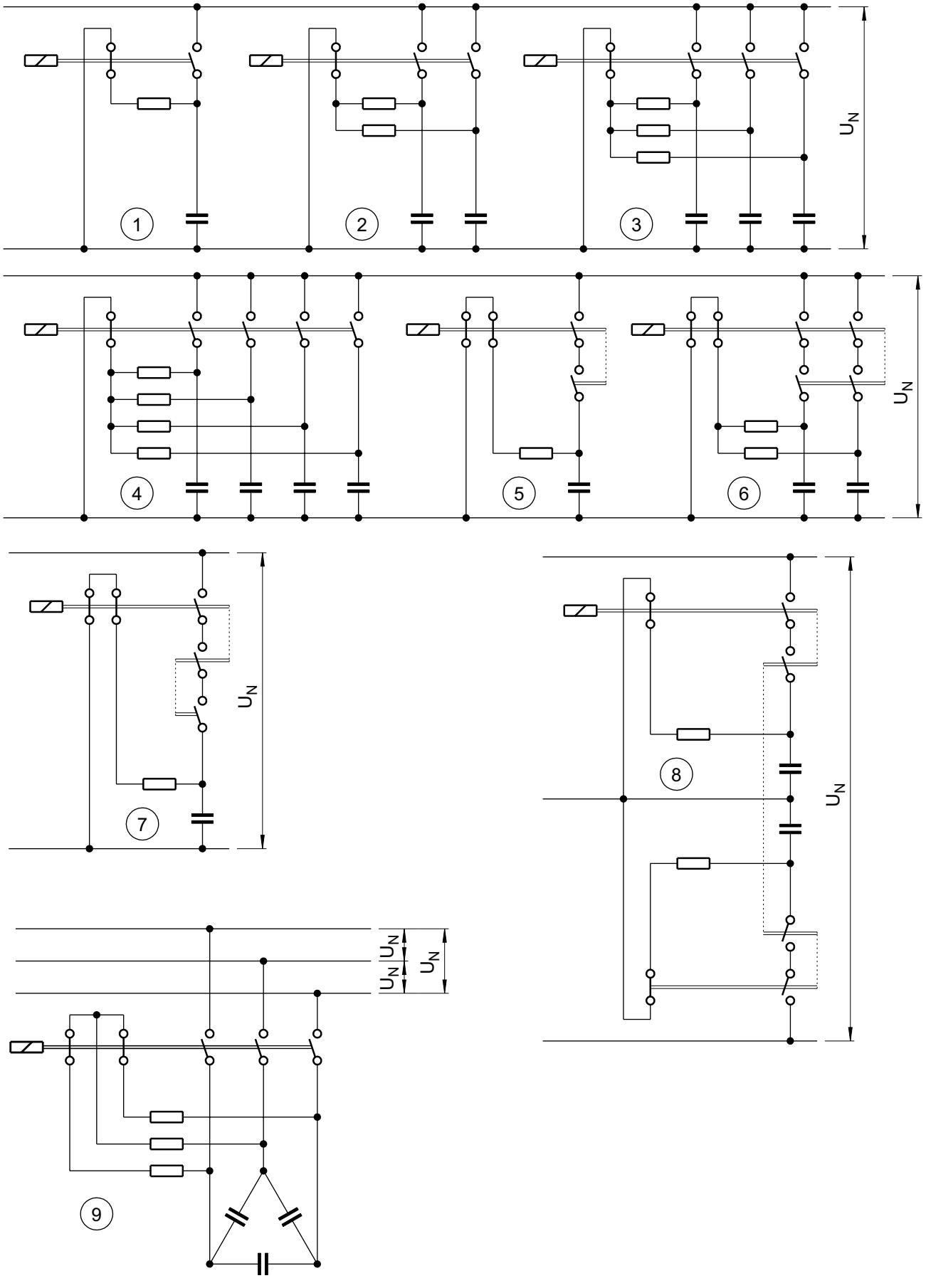
contactor type	power consumption at alternating voltage [VA] closing / holding			
	110V 50Hz	110V 60Hz	220V 50Hz	220V 60Hz
G 125/... G 200/... G 320/...	800 / 140	800 / 140	800 / 70	800 / 80

Contactor type	1) Admissible rated current of capacitor [A]	Rated insulation voltage Ui [kV]	Rated voltage [kV]	Wiring according figure	Number of discharge contacts	Dimension A [mm]	Figure	Net weight [kg]
G 125/11	100	2	1,2	1	1	300	1	6,2
G 125/12				2		344	2	7,2
G 125/13				3		432	3	8,4
G 125/14				4		490	4	9,5
G 200/11	180	2	1,2	1	1	300	1	6,8
G 200/12				2		344	2	8,2
G 200/13				3		432	3	9,8
G 200/14				4		490	4	11,3
G 320/11	300	2	1,2	1	1	300	1	7,5
G 320/12				2		344	2	9,0
G 320/13				3		432	3	11,0
G 320/14				4		490	4	12,9
G 125/13D	100	2	1,2	9	2	490	7	8,6
G 200/13D	180							10,0
G 320/13D	300							11,0
G 125/21	100	2	1,5	10	1	344	2	7,5
G 125/22				11		490	4	9,8
G 200/21	180	2	1,5	10	1	344	2	8,3
G 200/22				11		490	4	11,5
G 320/21	300	2	1,5	10	1	344	2	9,3
G 320/22				11		490	4	15,8
G 125/21	100	3	3	5	2	432	5	7,5
G 125/22				6 or 8		560	7	12,0
G 200/21	180	3	3	5	2	432	5	8,5
G 200/22				6 or 8		560	7	13,6
G 320/21	300	3	3	5	2	432	5	9,5
G 320/22				6 or 8		560	7	16,0
G 125/31	100	3	3	7	2	490	6	8,6
G 200/31	180							10,0
G 320/31	300							11,2
G 125/V11	150	2	1,2	12	1	344	2	7,5
G 200/V11	250							9,8
G 320/V11	400							8,3
G 125/V12	150	2	1,2	13	1	490	4	11,5
G 200/V12	250							9,3
G 320/V12	400							15,8
G 125/V21	150	2	2	14	2	490	6	8,6
G 200/V21	250							10,0
G 320/V21	400							11,2
G 125/V31	150	3	3	15	2	560	8	12,0
G 200/V31	250							13,6
G 320/V31	400							16,0

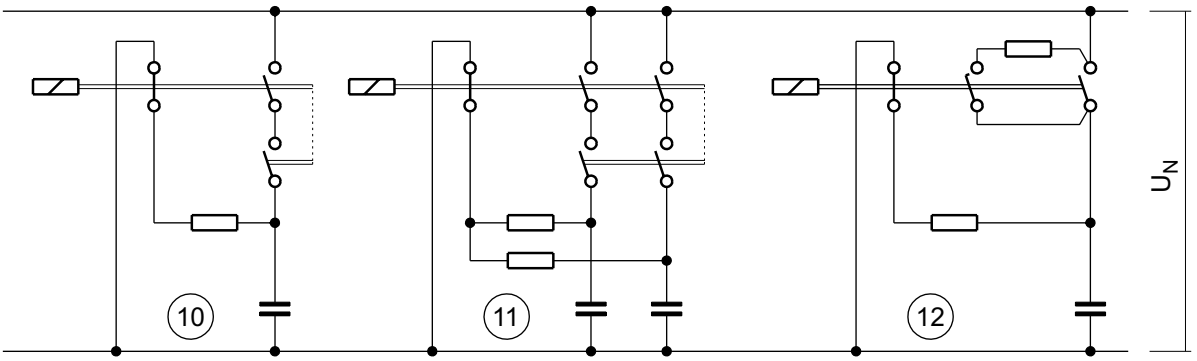
1) Admissible rated current of the capacitor with different frequencies

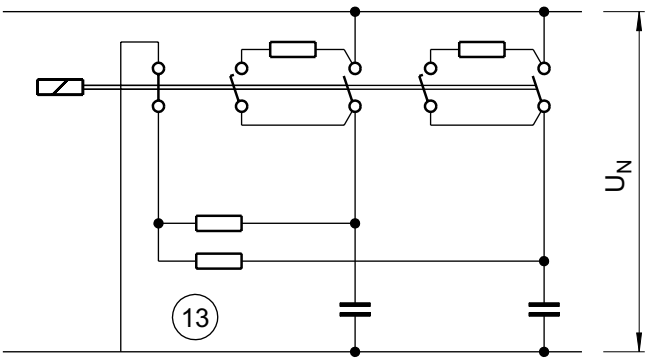
Contactor type	Rated current [A] at	
	1200V, 150 Hz	1100V, 250 Hz
G 125/...	100	100
G 200/...	180	170
G 320/...	250	225

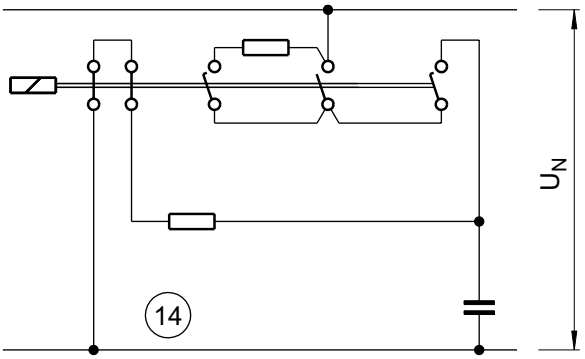
Circuit diagram

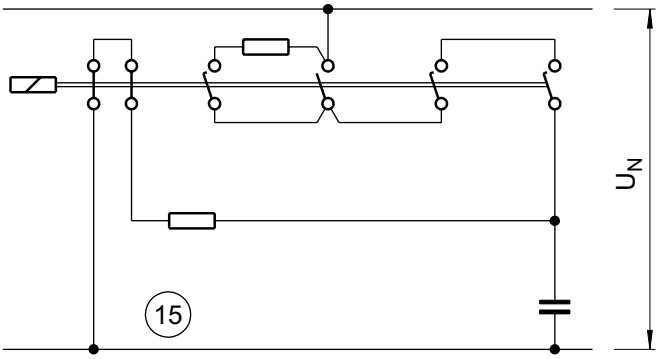


Circuit diagram

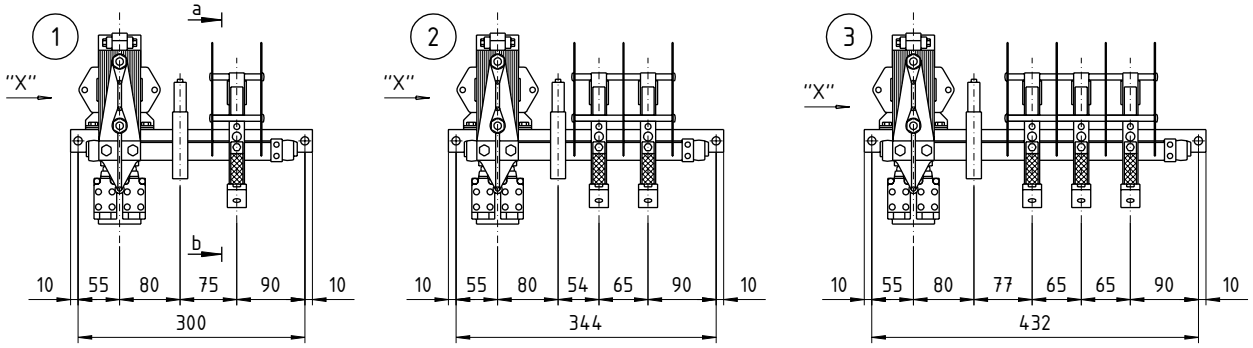


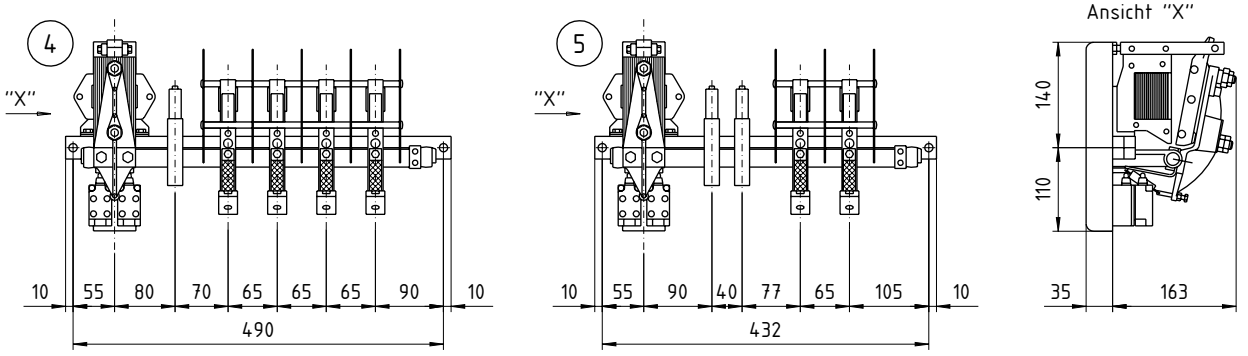


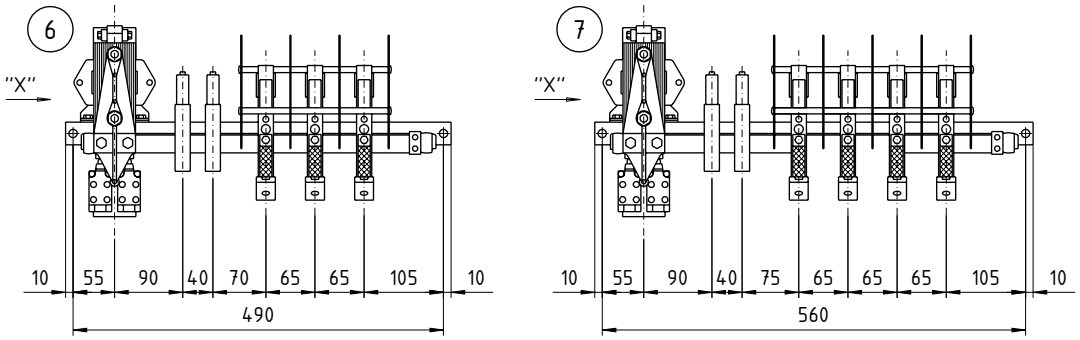




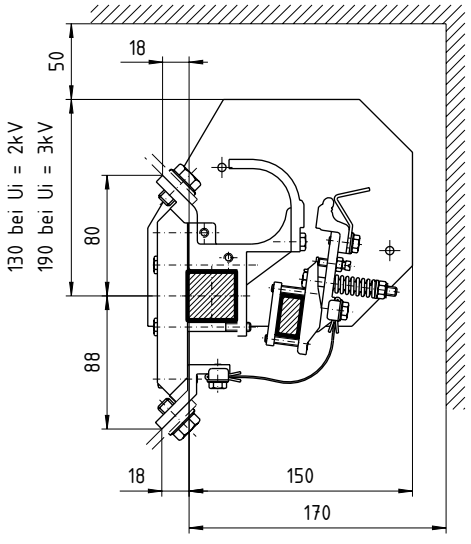
Dimension for capacity contactors





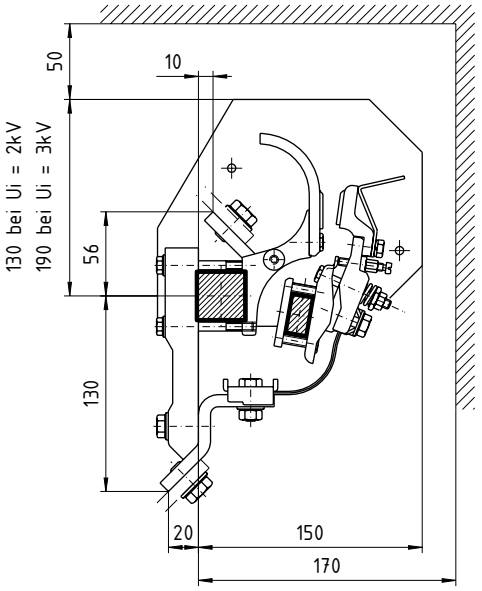


cross section a-b
type G 125/.. and G 200/..



area of connection 25x25
with thread M10

cross section a-b
type G 320/..



area of connection 30x30
with thread M10

Manufacturing-program

026/1	pole-changing switches, change over switches, circuit breakers
145	NF and MF high-current switches (air-cooled)
280	NF and MF contactors for off-load switching
282	Damping resistors
350/1	DC- and NF-contactors for on-load switching
421	Prism-contacts (air- and water-cooled)
427	NF and MF high-current switches (watercooled)
460	insulator-supports and bus-bar-supports
467	MF-contactors for on-load switching
475/1	Prism-contacts (air-cooled)
502	cable (air- and water-cooled)
506	discharge- and dropping-resistors
507	***capacitor-contactor for on-load switching***
549	contactors with NC-contacts for on-load switching
559	Prism-contacts for the electrode-position
560	spare parts
600	pole-changing switches, with motor-drive (water-cooled)
615	NF and MF high-current circuit breaker for off-load switching (water-cooled)
617	NF and MF high-current circuit breaker for off-load switching (air-cooled)
624	contactors with NC-contacts off-load switching
625	DC-contactors with brake-contacts
641	Air-cooled-current-carrying leads