INTRODUCTION

The standard describes the contactor as an electromechanical manoeuvring device, generally designed for a high number of operations, with just one idle position which is non-manually activated, capable of making carrying and breaking currents under normal circuit conditions, including overloading and operating conditions. The force required to close the main contacts which are normally open or to open contacts which are normally closed is supplied by an electromagnet. On the following pages you will find a series of useful information for choosing the best contactor for your specific requirements

HOW TO DIMENSION A CONTACTOR

In order to correctly dimension a contactor, several factors have to be considered:
- the categories of use which identify the type of load
- the electrical life
- the number of operations per hour

CONTACTORS UTILIZATION CATEGORIES

The standard establishes several categories of use referred to precise uses of contactors. These categories are listed in the following table.

	ALTERNATING CURRENT		DIRECT CURRENT
CATEGORIES	TYPICAL APPLICATIONS	CATEGORIES	TYPICAL APPLICATIONS
AC-1	Non inductive or slightly inductive loads, resistance furnaces	**DC-1**	Non inductive or slightly inductive loads, resistance furnaces
AC-2	Slip-ring motors: starting and switching off		
AC-3	Squirrel cage motors: starting switching off motors during running	**DC-3**	Shunt-motors: starting - plugging inching. Dynamic breaking of D.C. motors
AC-4	Squirrel cage motors: starting plugging - inching		
AC-5a	Switching of electric discharge lamp controls	**DC-5**	Series motors: starting - plugging - inching Dynamic braking of D.C. motors
AC-5b	Switching of incandescent lamps		
AC-6a	Switching of transformers		
AC-6b	Switching of capacitors banks		

SWITCHING ELEMENTS UTILIZATION CATEGORIES

AC-12	Control of resistive loadsand solid state loads with isolation by opto couples	**DC-12**	Control of resistive loads isolation by opto couples
AC-13	Control of solid state loads with transformer isolation	**DC-13**	Electromagnet control
AC-14	Control of small electromagnetic loads (< 72 VA)	**DC-14**	Control of electromagnetic loads having economic resistors in circuit
AC-15	Control of electromagnetic loads (> 72 VA)		

UTILIZATION CATEGORIES

MAKE AND BREAK CONDITIONS				
Category	Minimum (50 cycles)		Standard (6000 cycles)	
	Making	Breaking	Making	Breaking
AC-1	1,5 x In	1,5 x In	1 x In	1 x In
AC-2	4 x In	4 x In	2 x In	2 x In
AC-3	10 x In	8 x In	2 x In	2 x In
AC-4	12 x In	10 x In	6 x In	6 x In
AC-5a	3 x In	3 x In	2 x In	2 x In
AC-5b	1,5 x In	1,5 x In	1 x In	1 x In
AC-6a	-	-	-	-
AC-6b	-	-	-	-
DC-1	1,5 x In	1,5 x In	1 x In	1 x In
DC-3	4 x In	4 x In	2,5 x In	2,5 x In
DC-5	4 x In	4 x In	2,5 x In	2,5 x In

AC-1

This category provides for make, maintenance and break of a given nominal current. Therefore, in addition to the control of resistive loads, this category can be used for electrically equivalent loads, such as softstarters and inverters (no-load operation for line contactor) and to distribute power.

AC-2 - AC-3

AC-3 Contactors classified in AC-3 can be used for occasional inching manoeuvres and/or plugging for short periods of time (max. 5 op./min. and less than 10 op./in 10 min.).

AC-4

This is the most stressful category of all. The contactor undergoes tremendous stress as it is used both to make the initial current and to break it.

	AC1	AC2						AC3								AC4			
	(Ith)	200-220V		380-440V		500-550V		200-220V		380-440V		500-550V		690V		200-22OV		380-440V	
	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]	[kW]	[A]
9	20	2.5	11	4	9	4	7	2.5	11	4	9	4	7	4	5	1.5	8	2.2	6
12	20	3.5	13	5.5	12	7.5	12	3.5	13	5.5	12	7.5	12	7.5	9	2.2	11	4	9
18	25	4.5	18	75	18	7.5	13	4.5	18	7.5	18	7.5	13	7.5	9	3.7	18	4	9
22	32	5.5	22	11	22	15	22	5.5	22	11	22	15	22	15	18	3.7	18	5.5	13
32	50	7.5	32	15	32	18.5	28	7.5	32	15	32	18.5	28	18.5	20	4.5	20	7.5	17
40	60	11	40	18.5	40	22	32	11	40	18.5	40	22	32	22	23	5.5	25	11	24
50	80	15	55	22	50	30	43	15	55	22	50	30	43	30	28	7.5	35	15	32
65	100	18.5	65	30	65	37	60	18.5	65	30	65	33	60	33	35	11	50	22	47
75	110	22	75	37	75	45	64	22	75	37	75	37	64	37	42	13	55	25	52
85	135	25	85	45	85	45	75	25	85	45	85	45	75	45	45	15	65	30	62
105	150	30	105	55	105	55	85	30	105	55	105	55	85	55	65	19	80	37	75
120	150	37	125	60	120	60	90	37	125	60	120	60	90	60	70	22	93	45	90
150	200	45	150	75	150	90	140	45	150	75	150	90	140	90	100	30	125	55	110
180	230	55	180	90	180	110	180	55	180	90	180	110	180	110	120	37	150	75	150
250	260	75	220	132	220	132	200	75	250	132	250	132	200	132	150	45	180	90	180
300	350	90	300	160	300	160	250	90	300	160	300	160	250	200	220	55	220	110	220
400	420	125	400	220	400	225	350	125	400	220	400	225	350	250	300	75	300	150	300
630	660	190	630	330	630	330	500	190	630	330	630	330	500	330	420	110	400	200	400
800	800	220	800	440	800	500	720	220	800	440	800	500	720	500	630	160	630	300	630

UTILIZATION CATEGORIES

AC-5a

FLUORESCENT LAMP CONTROL

With fluorescent lamps where the power factor has not been corrected, the making current is about twice the nominal current of the circuit with starting times up to 10s. The contactor must be chosen with inom. in AC 1, multiplied by a factor of 1.3 or 1.4.
With fluorescent lamps where the power factor has been corrected the presence of the capacitors reduces the starting time to a few seconds but has a making current which is 20 times the nominal current of the circuit due to the charge of the capacitors. The contactor must be < than 20xinom circuit. If the lamp has an electronic feeder for starting up, the start current is 10 times the nominal current of the circuit with starting times of a few seconds. The contactor must be chosen with inom. in AC 1, multiplied by a factor of 1.2 or 1.3.

Nominal current		100V							200V							
Power [W]		40		60	80	110		220	40		60	80	110		220	
No. of lamp		1	2	1	1	1	2	1	1	2	1	1	1	2	1	1
Start current (A)		0.95(1.2)	0.96(1)	0.92	1.17	1.55	2.5	2.7	0.29(0.6)	0.48(0.55)	0.46	0.58	0.78	1.3	1.38	2.5
9		18(9)	11(10)	12	9	7	4	4	37(18)	22(20)	23	19	14	8	8	4
12		22(10)	13(11)	14	11	8	5	4	44(21)	27(23)	28	22	16	10	9	5
18		30(15)	18(16)	19	15	11	7	6	62(30)	37(32)	39	31	23	13	13	7
22		32(15)	19(17)	20	16	12	7	7	65(31)	39(34)	41	32	24	14	14	7
32		44(21)	27(23)	28	22	16	10	9	89(43)	54(47)	56	44	33	20	19	10
40		59(29)	36(31)	38	29	22	14	13	120(58)	72(63)	76	60	44	26	25	14
50		84(41)	52(45)	54	42	32	20	18	172(83)	104(90)	108	86	64	38	37	20
65		110(54)	67(59)	70	55	41	26	24	224(108)	135(118)	141	112	83	50	48	26

AC-5a

MERCURY VAPOUR LAMP CONTROL

With lamps where the power factor has not been corrected, the making current is about twice the nominal current of the circuit with starting times up to 5 minutes. The contactor must be chosen with inom. in AC 1, equal to the making current. With lamps where the power factor has been corrected, the start current is 20 times the nominal current of the circuit with reduced starting times. The contactor must be chosen with inom. in AC 1 considering that the closing power must be < than 20xinom circuit.

Nominal current	100 V Lamp with low/high cosφ								200 V Lamp with low/high cosφ							
Power [W]	40	100	200	250	300	400	700	1000	40	100	200	250	300	400	700	1000
Start current	1.25 (0.55)	2.6 (1.4)	4.6 (2.6)	5.1 (3.0)	6.0 (3.7)	8.0 (4.9)	14.5 (8.5)	21 (12)	0.53 (-)	1.0 (0.65)	1.9 (1.2)	2.1 (1.5)	2.5 (1.8)	3.3 (2.3)	5.9 (4.1)	8.5 (5.8)
9	8(20)	4(7)	2(4)	2(3)	1(2)	1(1)	-(-)	-(-)	20(-)	11(16)	5(9)	5(7)	4(6)	3(4)	1(2)	1(1)
12	10(23)	5(9)	2(5)	2(4)	2(3)	1(1)	-(1)	-(1)	24(-)	13(20)	6(10)	6(8)	5(7)	3(5)	2(3)	1(2)
18	14(32)	6(12)	3(6)	3(6)	3(4)	2(3)	1(2)	-(1)	33(-)	18(27)	9(15)	8(12)	7(10)	5(7)	3(3)	2(3)
22	15(34)	7(13)	4(7)	3(6)	3(5)	2(3)	1(2)	-(1)	35(-)	19(29)	10(15)	9(12)	7(10)	5(8)	3(4)	2(3)
32	20(47)	10(18)	5(10)	5(8)	4(7)	3(5)	1(3)	1(2)	49(-)	26(40)	13(21)	12(17)	10(14)	7(11)	4(6)	3(4)
40	28(63)	13(25)	7(13)	6(11)	5(9)	4(7)	2(4)	1(2)	66(-)	35(53)	18(29)	16(23)	14(19)	10(15)	5(8)	4(6)
50	40(90)	19(35)	10(19)	9(16)	8(13)	6(10)	3(5)	2(4)	94(-)	50(76)	26(41)	23(33)	20(27)	15(21)	8(12)	6(8)
65	52(118)	25(46)	14(25)	12(21)	10(17)	8(13)	4(7)	3(5)	122(-)	65(100)	34(54)	30(43)	26(36)	19(28)	11(15)	7(11)

AC-5a

SODIUM VAPOUR LAMP CONTROL

These are lamps with starting times f up to 5 minutes with a start current of 1.7 - 2.2 times the nominal current of the circuit. The contactor must be chosen with inom. in AC 1, equal to the start current.
Es.: Im circ. = 20A
I contactor = 20A * 2.2 = 44A
090C32 with 50A AC-1

UTILIZATIONCATEGORIES

AC-5b

INCANDESCENT LAMP CONTROL

These lamps have a making current which is about 15 times the nominal current of the circuit and which is cancelled after a few milliseconds. The peak is due to the sharp passage of the filament from cold with very high resistance to hot with very low resistance. The contactor must be chosen with inom. in AC 1 and taking into account that the breaking capacity must be ≥ than the making current.

	Rated operational current Ie [A]															
	100V(n. of lamps)								200V(n. of lamps)							
Potenza [W]	100	150	200	250	300	500	1000	1500	100	150	200	250	300	500	1000	1500
9	11	7	5	4	3	2	1	-	22	14	11	8	7	4	2	1
12	13	8	6	5	4	2	1	-	26	17	13	10	8	5	2	1
18	18	12	9	7	6	3	1	1	36	24	18	14	12	7	3	2
22	19	12	9	7	6	3	1	1	38	25	19	15	12	7	3	2
32	26	17	13	10	8	5	2	1	52	34	26	20	17	10	5	3
40	35	23	17	14	11	7	3	2	70	46	35	28	23	14	7	4
50	50	33	25	20	15	10	5	3	100	66	50	40	33	20	10	6
65	65	42	32	26	19	13	6	4	130	85	65	52	42	26	13	8

AC-6a

TRANSFORMER CONTROL

The connection of transformers is distinguished by a start peak which can reach 30 x In. due to high absorption of magnetising current. Obviously when dimensioning the contactor it is necessary for the breaking capacity to be ≥ than the making current.

	Mono phase				Tri phase			
	220V		440V		220V		440V	
	[kVA]	[A]	[kVA]	[A]	[kVA]	[A]	[kVA]	[A]
9	1	5	1.5	3	2	5	2.5	3
12	1.5	7.5	2	5	3	7.5	4	5
18	2	9	3	7	3.5	9	5	7
22	2.5	10	4	9.5	4	10	7.5	9.5
32	3	13	5	12	5	13	10	12
40	4	17	7.5	16	6.5	17	12	16
50	5	25	10	24	10	25	18	24
65	7	32	15	32	12	32	25	32
75	8	35	17	35	13	35	27	35
85	9	40	18	40	15	40	30	40
100	10	46	20	45	18	46	35	45
125	15	62	25	55	25	62	42	55
150	17	75	33	75	30	75	60	75
180	20	90	40	90	35	90	70	90
220	25	110	50	110	42	110	85	110
300	33	150	57	130	57	150	100	130
400	44	200	90	200	75	200	150	200
600	65	300	130	300	110	300	250	300
800	90	400	175	400	150	400	300	400

UTILIZATION CATEGORIES

AC-6b

CAPACITORS CONTROL

The use of capacitors in power factor correction systems is characterised by peaks of current which the capacitive charge imposes on the network when power is started. It is possible to control single capacitors or batteries of capacitors. In the case of more than one battery of capacitors to be connected separately, an additional source of power is created due to the transfer of power from the empowered battery to the one placed into service.
This represents a supplementary charge for the contactor, and it is therefore necessary to provide for the use of impedances and resistances to increase the contactor's admissible charge.
The impedances reduce the stress generated when condensers are connected parallel to others already connected to the network and charges (connected in steps). The resistances protect the contactor's power contacts during connection of the condenser, guaranteeing the electrical life of the circuits.

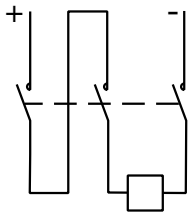
	Capacitors control									
	mono phase				tri phase					
	200~220V		400~440V		200~220V		400~440V		500~550V	
	[Kvar]	[A]	[Kvar]	[A]	[Kvar]	[A]	[Kvar]	[A]	[Kvar]	[A]
9	1,2	6	1,7	4,3	2	6	3	4,3	3	3,5
12	1,8	9	2,4	6	3	9	4	6	5	6
18	2,4	12	3,6	9	4	12	6	9	7	10
22	3	15	6	15	5	15	10	15	10	16
32	5	25	9,6	24	9	25	16	24	15	22
40	6,4	32	12	30	11	32	20	30	20	25
50	9	45	16	40	15	45	27	40	25	37
65	10	50	20	50	17	50	34	50	30	46
75	13	58	24	58	20	58	40	58	40	52
85	15	60	30	60	22	60	45	60	45	56
100					24	64	48	64		
125					29	76	58	76		
150					35	91	70	92		
180					42	109	84	110		
220					58	152	115	152		
300					69	182	139	182		
400					92	242	185	242		
600					145	382	291	382		
800					185	485	369	485		

UTILIZATION CATEGORIES

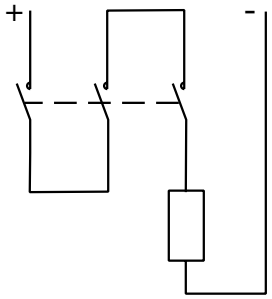
DC-1

DC-3 - DC-5

2 POLES IN SERIES



3 POLES IN SERIES



		Rated operational current Ie [A] DC-1				Rated operational current Ie [A] DC-3 / DC-5			
	N. poles in series	24V	48V	110V	220V	24V	48V	110V	220V
9	2	10	10	6	3	8	4	2.5	0.8
9	3	10	10	8	8	8	6	4	2
12	2	12	12	10	7	12	6	4	1.2
12	3	12	12	12	12	12	10	8	4
18	2	18	18	13	8	12	6	4	1.2
18	3	18	18	18	18	12	10	8	4
22	2	20	20	15	10	20	15	8	2
22	3	20	20	20	20	20	20	15	8
32	2	25	25	25	12	25	20	10	3
32	3	25	25	25	22	25	25	20	10
40	2	35	35	25	12	35	20	10	3
40	3	35	35	35	30	35	30	20	10
50	2	50	40	35	15	45	25	15	3.5
50	3	50	50	50	40	50	35	30	12
65	2	50	40	35	15	45	25	15	3.5
65	3	65	65	65	50	50	35	30	12
75	2	75	65	50	20	65	40	20	5
75	3	75	75	75	55	80	60	50	20
85	2	80	65	50	20	65	40	20	5
85	3	80	80	80	60	80	60	50	20
100	2	100	100	80	50	100	60	40	30
100	3	100	100	100	80	100	90	80	50
125	2	120	100	80	50	120	60	40	30
125	3	120	120	100	80	120	90	80	50
150	2	150	150	150	150	150	130	120	80
150	3	80	80	80	60	80	60	50	20
180	2	180	180	150	150	180	150	120	80
180	3	180	180	180	180	180	180	150	100
220	2	220	180	150	150	220	150	120	80
220	3	220	220	220	220	220	220	150	100
300	2	300	240	200	200	300	200	150	90
300	3	300	300	300	300	300	280	200	150
400	2	400	240	200	200	400	200	150	90
400	3	400	400	400	300	400	280	200	150
600	2	630	630	630	630	630	630	630	630
600	3	630	630	630	630	630	630	630	630
800	2	800	800	630	630	800	630	630	630
800	3	800	800	800	800	800	630	630	630