

— Contactors for DC switching applications

DC-1, DC-3, DC-5 applications according to IEC 60947-4-1

The circuit switching on DC is more difficult than on AC, as alternating current goes to zero according to the frequency of the supply source while DC current has a continuous value.

The main parameters to be considered for selecting a contactor are the current, the voltage and the L/R time constant of the controlled load.

Time constant and utilization categories

In DC applications, the nature of load to switch (resistor, inductance or a combination) is characterized by the ratio of the inductance to the resistance (L (inductance of operated circuit) / R (resistance of operated circuit) = $\text{mH}/\Omega = \text{ms}$)

This ratio L/R is called the time constant of the circuit.

DC current utilization categories are defined according to IEC 60947-4-1:

- DC-1 non inductive or slightly inductive loads, resistance furnaces ($L/R \leq 1 \text{ ms}$)
- DC-3 shunt motors: starting, plugging, inching, dynamic breaking of DC motors ($L/R \leq 2 \text{ ms}$)
- DC-5 series motors: starting, plugging, inching, dynamic breaking of DC motors ($L/R \leq 7.5 \text{ ms}$).

The higher the time constant value is, the more difficult it is to break the arc.

The addition of a resistor in parallel with an inductive winding helps in the elimination of the arcs, by reducing the time constant.

Operational voltage

- The higher the operational voltage value is, the more difficult it is to break the arc.
- The use of main poles connected in series will allow to increase the value of switched voltage.

However, the maximum switched voltage must be within the max operational voltage of the contactor.

All the poles required for breaking must be connected in series between the load and the source polarity not linked to earth (or chassis) (see recommended connection diagrams).

ABB offer a large choice of possibilities for DC switching applications (see selection tables):

- Standard 3-pole or 4-pole contactors with either 1-pole breaking or breaking with poles connected in series.
- Special contactors designed for DC breaking with permanent magnets fitted on the main poles for use with the 3 poles connected in series and considered as 1-pole devices:
GAF460 ... GAF2050 contactors: the 3 poles must be connected in series by the user according to conductor cross-sectional area (refer to main pole technical data) or by using LP connection bars to be ordered separately.

Selection tables

The enclosed selection tables will guide your choice through all contactor variants according to utilization category, for operational voltage up to 1000 V DC-1 and operational current up to 2050 A in ambient temperatures from -25 °C up to 40 °C.

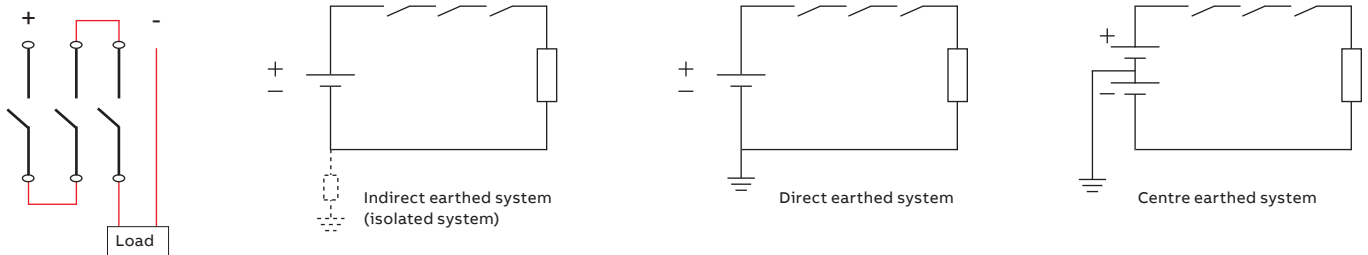
For higher values of current or voltage or heavy DC switching applications see bar mounted R contactors.

Connection diagrams

Connection diagrams

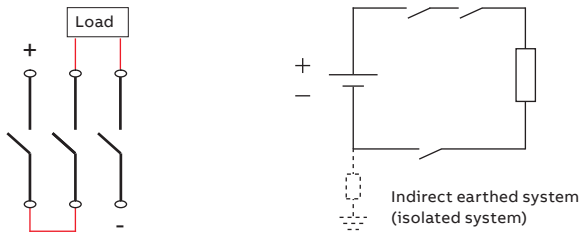
Recommended connection

In the example below, the 3 poles are connected in series without the load in between. This connection is recommended in systems according to the following configurations.



Alternative connection

The load could be placed in between the contacts in a indirect earthed system. If not connected according to the configuration below, a fault to earth could result in one or two contacts breaking the full load which the contactor is not approved for.



Points to consider

The above relates to power circuit switching. The SCPD (Short Circuit Protection Device) must comply with applicable protection rules.

Polarity:

For all GAF types, connection polarities must be respected.

(See instruction leaflet and see markings on the main terminals or the contactor front)

AF09 ... AF96 contactors

DC circuit switching

General

The arc switching on DC is more difficult than on AC.

- For selecting a contactor it is essential to determine the current, the voltage and the L/R time constant of the controlled load
- For information, typical time constant values are quoted hereafter: non inductive loads such as resistance furnaces (L/R $\approx$ 1 ms), inductive loads such as shunt motors (L/R $\approx$ 2 ms) or series motors (L/R $\approx$ 7.5 ms)
- The addition of a resistor in parallel with an inductive winding helps in the elimination of the arcs
- All the poles required for breaking must be connected in series between the load and the source polarity not linked to earth (or chassis).

Technical data

- The tables indicate for the standard contactors the I_e max. operating currents depending on: the utilization category (i.e. L/R) DC-1, DC-3, DC-5 as defined in the IEC 60947-4-1 publication, the operating voltage U_e and the pole coupling details.
Ampere values quoted in these tables are valid for a -25...+70 °C temperature close to the contactors, as long as these values do not exceed the AC-1 Ampere values for the corresponding ambient temperature
- Max. switching frequency: 300 cycles/h.

Selection table

Contactor types	AF09	AF12	AF16	AF26		AF30	AF38		AF40	AF52	AF65	AF80	AF96
	3 or 4-pole			3-pole	4-pole	3-pole	3-pole	4-pole	3 or 4-pole	3 or 4-pole	3-pole	3 or 4-pole	3-pole

Utilization category DC-1, L/R $\leq$ 1 ms

	≤ 72 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	110 V	10 A	15 A	20 A	-	-	-	-	-	-	-	-	-	-
	220 V	-	-	-	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	110 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	220 V	10 A	15 A	20 A	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	110 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	220 V	25 A	27 A	30 A	45 A	45 A	50 A	50 A	55 A	70 A	100 A	105 A	125 A	130 A
	≤ 72 V	25 A	-	30 A	-	45 A	-	-	55 A	70 A	100 A	-	125 A	-
	110 V	25 A	-	30 A	-	45 A	-	-	55 A	70 A	100 A	-	125 A	-
	220 V	25 A	-	30 A	-	45 A	-	-	55 A	70 A	100 A	-	125 A	-
	440 V	10 A	-	20 A	-	-	-	-	-	-	-	-	-	-

Utilization category DC-3, L/R $\leq$ 2 ms

	≤ 72 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	6 A	7 A	8 A	-	-	-	-	-	-	-	-	-	-
	220 V	-	-	-	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	220 V	6 A	7 A	8 A	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	220 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	≤ 72 V	25 A	-	30 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	110 V	25 A	-	30 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	220 V	25 A	-	30 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	440 V	6 A	-	8 A	-	-	-	-	-	-	-	-	-	-

Utilization category DC-5, L/R $\leq$ 7.5 ms

	≤ 72 V	9 A	12 A	16 A	20 A	-	25 A	25 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	4 A	4 A	4 A	-	-	-	-	-	-	-	-	-	-
	220 V	-	-	-	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	10 A	15 A	20 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	220 V	4 A	4 A	4 A	-	-	-	-	-	-	-	-	-	-
	≤ 72 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	110 V	25 A	27 A	30 A	45 A	-	50 A	50 A	-	70 A	100 A	105 A	125 A	130 A
	220 V	9 A	12 A	16 A	20 A	-	25 A	25 A	-	70 A	100 A	105 A	125 A	130 A
	≤ 72 V	25 A	-	30 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	110 V	25 A	-	30 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	220 V	10 A	-	20 A	-	-	-	-	-	70 A	100 A	-	125 A	-
	440 V	4 A	-	4 A	-	-	-	-	-	-	-	-	-	-

For additional ratings $\geq$ 440 V, please consult us.

Note: For AFS09 ... AFS96 safety contactors, DC switching rating are the same as AF09 ... AF96 3-pole contactors.

AF116 ... AF2650 contactors

DC circuit switching

Selection table

Contactor types	AF116	AF140	AF146	AF190	AF205	AF265	AF305	AF370	AF400	AF460	AF580	AF750	AF1250	AF1350	AF1650	AF2050	AF2650
	3 or 4-pole		3-pole	3 or 4-pole					3-pole								

Utilization category DC-1, L/R ≤ 1 ms

	≤ 72 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	90 V	160	200	200	250	350	400	500	520	-	-	-	-	-	-	-	-	-
	100 V	-	-	-	250	350	400	500	520	-	-	-	-	-	-	-	-	-
	110 V	-	-	-	-	-	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	≤ 72 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	110 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	175 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	-	-	-	-	-
	200 V	-	-	-	250	350	400	500	520	600 A	700 A	800 A	1050 A	-	-	-	-	-
	220 V	-	-	-	-	-	400	500	520	600 A	700 A	800 A	1050 A	-	-	-	-	-
	≤ 72 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	110 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	220 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	260 V	160	200	200	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	300 V	-	-	-	250	350	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	340 V	-	-	-	-	-	400	500	520	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	440 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	600 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	780 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	850 V	-	-	-	-	-	-	-	-	-	-	800 A	1050 A	1250 A	1350 A	1650 A	2050 A	2650 A
	< 350 V	200	200	-	250	350	400	500	520	-	-	-	-	-	-	-	-	-
	400 V	-	-	-	250	350	400	500	520	-	-	-	-	-	-	-	-	-
	440 V	-	-	-	-	-	400	500	520	-	-	-	-	-	-	-	-	-
	440 V	-	-	-	-	-	400	500	520	-	-	-	-	-	-	-	-	-

(1) AF2650 at 780 V DC = 2650 A

Utilization category DC-3, L/R ≤ 2 ms

	≤ 72 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	≤ 72 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	220 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	-	-	-	-	-
	≤ 72 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	220 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	440 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	600 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	320 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	-	-	-	-	-	-	-	-	-

Utilization category DC-5, L/R ≤ 7.5 ms

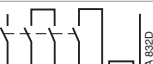
	≤ 72 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	≤ 72 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	220 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	-	-	-	-	-
	≤ 72 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	110 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	220 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	440 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	600 V	-	-	-	-	-	-	-	-	600 A	700 A	800 A	1050 A	1250 A	1350 A	-	-	-
	320 V	145 A	160 A	-	250 A	275 A	350 A	400 A	450 A	-	-	-	-	-	-	-	-	-

For additional ratings ≥ 440 V, please consult us.

EK550, EK1000 contactors

DC circuit switching

Selection table

Contactor types	EK550		EK1000	
Utilization category DC-1, L/R ≤ 1 ms				
	≤ 72 V	A	550	–
	110 V	A	550	–
	≤ 72 V	A	800	–
	110 V	A	800	–
	220 V	A	800	–
	≤ 72 V	A	800	–
	110 V	A	800	–
	220 V	A	800	–
	440 V	A	650	–
	600 V	A	650	–
	≤ 72 V	A	800	–
	110 V	A	800	–
	220 V	A	800	–
	440 V	A	650	–
	600 V	A	650	–
	Utilization category DC-3, L/R ≤ 2 ms			
				
	≤ 72 V	A	550	–
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	440 V	A	650	–
	600 V	A	650	–
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	440 V	A	650	–
600 V	A	650	–	
Utilization category DC-5, L/R ≤ 7.5 ms				
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	440 V	A	650	–
	600 V	A	650	–
	≤ 72 V	A	650	–
	110 V	A	650	–
	220 V	A	650	–
	440 V	A	650	–
	600 V	A	650	–