

Control Panel Technical Guide

How to select the appropriate
motor starters for your
HVAC & R* equipment



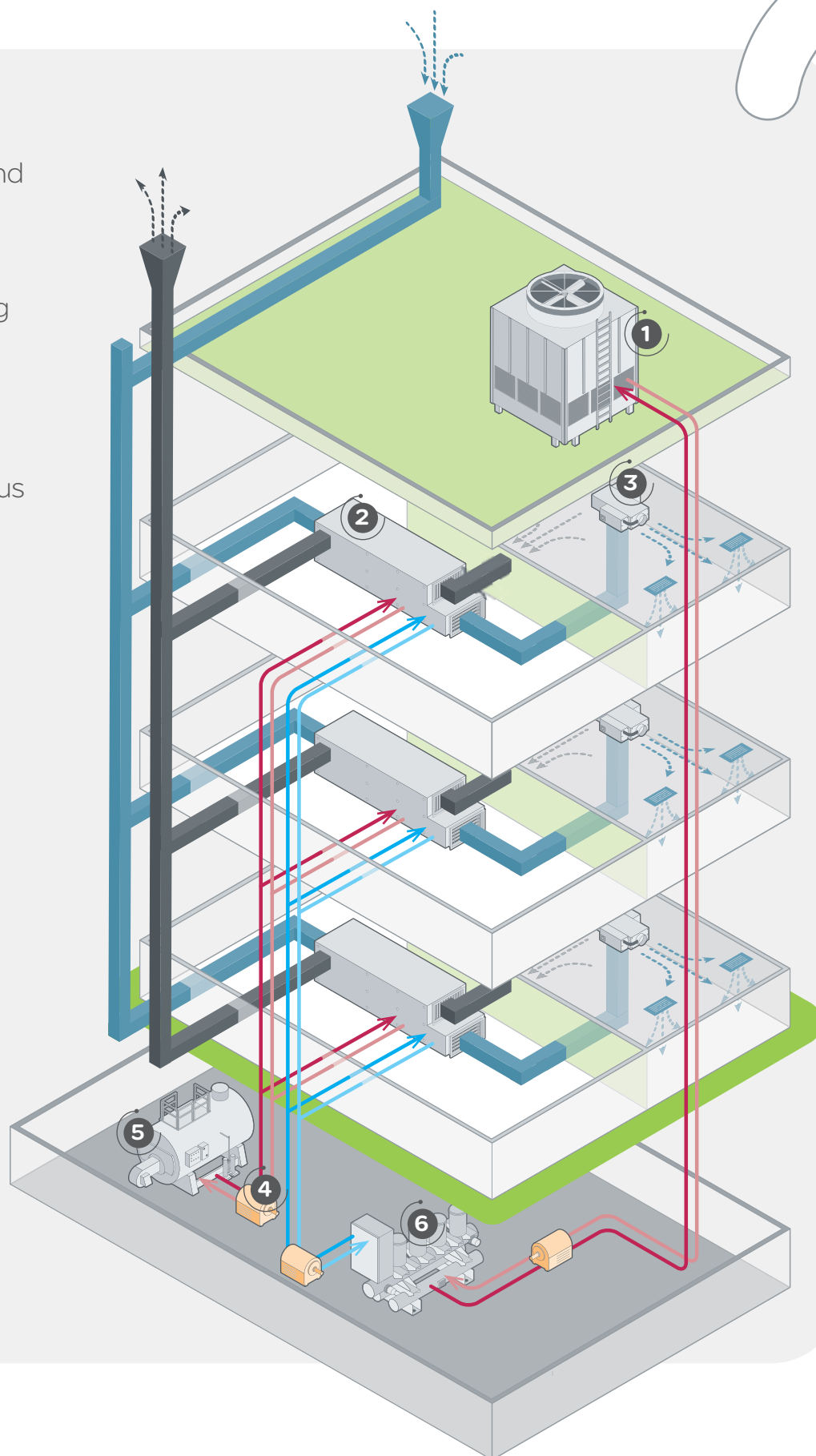
* Heating, Ventilation,
Air conditioning &
Refrigeration

Schneider
Electric

Many machines can be used in a HVAC&R installation

As an example, heating, cooling and ventilation of buildings may require, depending on the selected solution, the association of machines as various as chillers, boilers, cooling towers, air handling units, terminal units, etc.

- ❶ Cooling tower
- ❷ Air handler
- ❸ Terminal unit
- ❹ Pump
- ❺ Boiler
- ❻ Water cooled chiller





All these machines embed electric motors for three kind of applications



Compressor



Fan



Pump

These motors must be protected and controled by motor starters



Protection is usually provided by a motor circuit breaker.



Control is usually provided by a contactor, a soft starter or a Variable Speed Drive (VSD).



? Why this guide?

A guide to choose the **right contactor-based motor starter solution** for your 3 phase alternative motors:



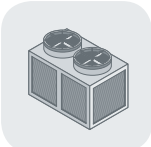
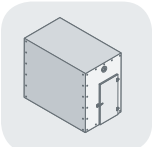
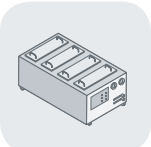
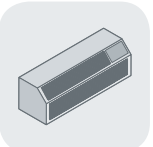
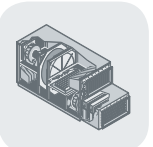
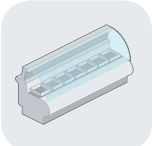
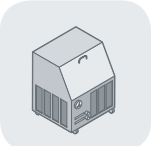
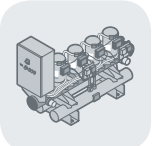
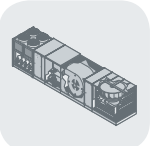
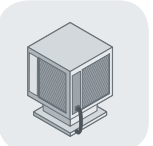
A "**Standard**" solution for general purpose application



An "**HVAC&R adapted**" solution to definite purpose application

Each solution of this guide combines **thermal-magnetic protection + control by contactors.**

Contents

							
	Condensing unit						
							
	Air cooled chiller	Cold room	Ice bank			Packaged terminal air conditioner	Air handler
							
	Heat pump	Showcase	Ice maker	Water cooled chiller	Cooling tower	Packaged unit / rooftop	Evaporative cooler
Composed of:							
	Compressors	Compressors	Compressors	Compressors		Compressors	
	Condenser and/or evaporator fans	Condenser and/or evaporator fans	Condenser and/or evaporator fans		Condenser fans	Exhaust, supply blower, condenser fans	Exhaust/ supply blower
	Recirculating pumps	Recirculating pumps	Recirculating pumps	Recirculating pumps	Recirculating pumps	Recirculating pumps	



How to read the table?

① Select your HVAC&R machine

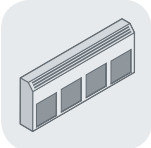
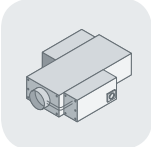
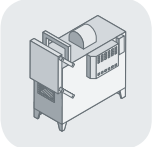
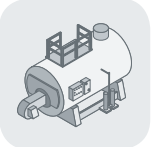
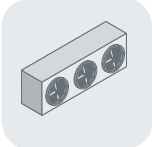
Eg.: Water Cooled Chiller

② Find the motors that should be embedded

Eg.: Compressors +
recirculating pumps

③ Go to correspondent motor starter selection pages

Eg.: page 6 for compressors and
page 12 for pumps

				
Fan coil unit			Condenser	
				
Terminal unit	Furnace	Boiler	Evaporator	
Select your starter:				
				 Starter for Compressors P. 6
Fan	Blower		Evaporator or condenser fans	 Starter for Fans P. 10
		Recirculating pumps		 Starter for Pumps P. 12

- Glossary for HVAC&R machines
- Method for selection of circuit breakers and contactors
- Electrical diagrams for DOL and star-delta starters
- Products and catalogues that could also interest you



Appendix

P. 14



Compressor: Starter type selection

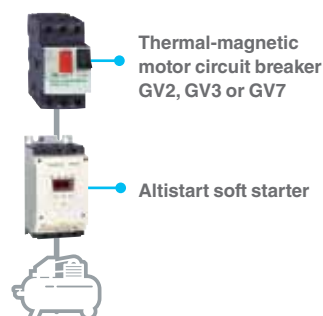
Other starting modes & Special applications

More information on page 22

- Constant speed
- ON-OFF control
- Inrush current limitation
- Soft start and/or stop

→ Soft starter

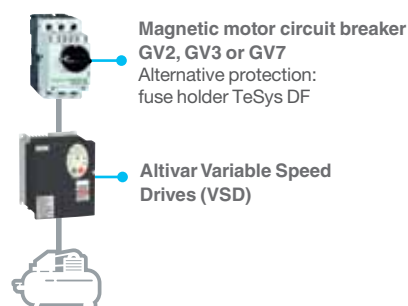
Products to be chosen in the product ranges:



- Variable speed
- Inrush current limitation
- Soft start and/or stop
- Fine control

→ Variable Speed Drive (VSD)

Products to be chosen in the product ranges:



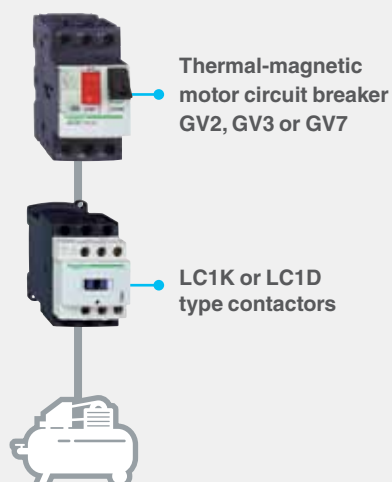
Select your starter regarding your application



- Constant speed
- ON-OFF control

→ Direct-On-Line (DOL) starter

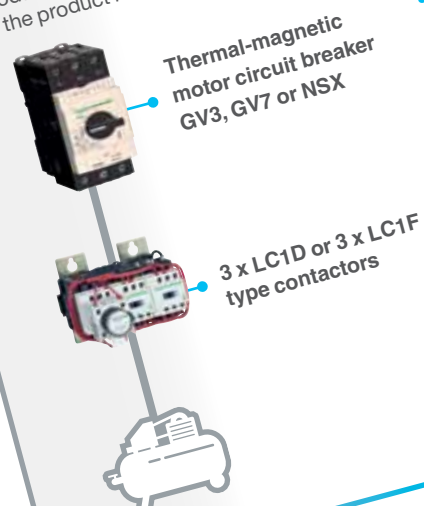
Products to be chosen
in the product ranges:



- Constant speed
- ON-OFF control
- Inrush current limitation

→ Star-delta starter

Products to be chosen
in the product ranges:



See page 8
to select your
star-delta starter
regarding your
application

→ Compressor: Direct-On-Line starter

① Your need: select the type of solution for your DOL starter regarding your constraints

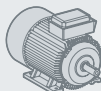
Operating specifications						> Solution
Ambient temp. in the panel	Motor inrush current	Starting time	Electrical durability (cycles)	Mini. interval between motor stop & start	Compacity requirements between devices	Type
≤ 60°C	≤ 6 x RLA*	≤ 5 s (RLA ≤ 40 A) ≤ 10 s (RLA > 40 A)	≈ 1 million	≥ 1 s	Close or separate mounting	Standard
≤ 45°C	≤ 4 x RLA*	≤ 1 s (RLA ≤ 40 A) ≤ 5 s (RLA > 40 A)	≤ 300,000	≥ 15 min	Separate mounting	HVAC&R Adapted

For other specifications, contact Schneider Electric support.

*RLA = Rated Load Amperage (A)

② Our TeSys solution: find references for a Standard or Adapted solution

The main input for selection is the current which will go through the circuit breaker (Rated Load Amperage).
Corresponding nominal power (Pn) is given as information for 400 V – 50 Hz.

Motor		Thermal-magnetic CB	Contactor	
	Rated Load Amperage (RLA), up to 440 V (A ~)			
	or Corresponding average nominal power (Pn) under 400 V (kW)			
0.2	0.06	GV2ME02	LC1D09••	LC1K06•• (2)
0.3	0.09	GV2ME03	LC1D09••	LC1K06•• (2)
0.4	0.12	GV2ME04	LC1D09••	LC1K06•• (2)
0.6	0.18	GV2ME04	LC1D09••	LC1K06•• (2)
0.9	0.25	GV2ME05	LC1D09••	LC1K06•• (2)
1.1	0.37	GV2ME06	LC1D09••	LC1K06•• (2)
1.5	0.55	GV2ME06	LC1D09••	LC1K06•• (2)
1.9	0.75	GV2ME07	LC1D09••	LC1K06•• (2)
2.7	1.1	GV2ME08	LC1D09••	LC1K06•• (2)
3.6	1.5	GV2ME08	LC1D09••	LC1K06•• (2)
4.9	2.2	GV2ME10	LC1D09••	LC1K06•• (2)
6.5	3	GV2ME14	LC1D09••	LC1K09•• (2)
8.5	4	GV2ME14	LC1D09••	LC1K09•• (2)
11.5	5.5	GV2ME16	LC1D12••	LC1K12•• (2)
15.5	7.5	GV2ME20	LC1D18••	LC1D12•• (2)
22	11	GV2ME22	LC1D25••	LC1D18•• (2)
29	15	GV2ME32	LC1D32••	LC1D25•• (2)
35	18.5	GV3P40	LC1D40A••	LC1D32•• (2)
41	22	GV3P50	LC1D50A••	LC1D40A•• (2)
55	30	GV3P65	LC1D65A••	LC1D50A•• (2)
66	37	GV7RE100	LC1D80••	LC1D65A•• (2)
80	45	GV7RE150	LC1D95••	LC1D80•• (2)
97	55	GV7RE150	LC1D95••	LC1D95•• (2)
132	75	GV7RS150	LC1D150••	LC1D115•• (2)

(1) Check circuit breaker breaking capacity (Icu) in catalogue defined page 14

(2) For DC control voltage, replace LC1K by LP1K

Note: Dots in the contactors' reference should be replaced by the coil code. Example: 0.55kW motor - 230 Vac / 50-60 Hz control voltage > GV2ME14 circuit breaker + LC1K06P7 contactor

Coil codes	12 V	24 V	230 V	400 V	415 V
AC (50 – 60 Hz)	-	B7	P7	V7	N7
DC	JD	BD	-	-	-
DC low consumption	JL	BL	-	-	-

Those coil references correspond to most common contactors. Please, refer to catalogue for more details.

Warning:

Contactors references selected for the HVAC&R solution **have been optimized for this application** and should not be used for another application.

References given relatively to power diagram A page 21

Compressor: Star-delta starter

① Your need: select the type of solution for your Star-delta starter regarding your constraints

Operating specifications						> Solution
Ambient temperature in the panel	Motor inrush current	Starting time	Electrical durability (cycles)	Minimum interval between motor stop & start	Compacity requirements between devices	Type
≤ 60°C	≤ 8 x RLA*	≤ 30 s (RLA ≤ 230 A) ≤ 20 s (RLA ≤ 280 A)	≈ 1 million	≥ 2 min D range ≥ 5 min F range	Close or separate mounting	Standard
≤ 45°C	≤ 6 x RLA*	≤ 5 s (RLA ≤ 97 A) ≤ 10 s (RLA > 97 A)	≤ 300,000	≥ 15 min D range ≥ 60 min F range	Separate mounting	HVAC&R Adapted

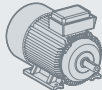
For other specifications, contact Schneider Electric support.

*RLA = Rated Load Amperage (A)

② Our TeSys solution: find references for a Standard solution

The main input for selection is the current which will go through the circuit breaker (Rated Load Amperage).

Corresponding nominal power (Pn) is given as information for 400 V – 50 Hz.

Motor		Thermal-magnetic CB	Contactors	Interlock
 Rated Load Amperage (RLA), up to 440 V (A ~) or Corresponding average nominal power (Pn) under 400 V (kW)		 (Q1)	 (KM2) Line Contactor > (KM3) Delta Contactor > (KM1) Star Contactor Standard solution	 > Electrical interlock > Mechanical interlock Standard solution
55	30	GV3P65	LC1D40A** LC1D40A** LC1D40A**	Customer cabling LAD4CM
66	37	GV3ME80	LC1D40A** LC1D40A** LC1D40A**	Customer cabling LAD4CM
80	45	GV7RE100	LC1D50A** LC1D50A** LC1D40A**	Customer cabling LAD4CM
97	55	GV7RE150	LC1D50A** LC1D50A** LC1D40A**	Customer cabling LAD4CM
132	75	GV7RE150	LC1D80** LC1D80** LC1D80**(3)	LA9D4002
160	90	GV7RE220	LC1D115** LC1D115** LC1D115**(4)	LA9D11502
195	110	GV7RE220	LC1D115** LC1D115** LC1D115**(4)	LA9D11502
230	132	NSX400N(2)	LC1D150** LC1D150** LC1D115**	LA9D11502
280	160	NSX400N(2)	LC1F185** LC1F185** LC1F150**	Customer cabling LA9FG4F

(1) Check circuit breaker breaking capacity (Icu) in catalogue defined page 14

(2) With Micrologi 2.3-M or Micrologic 6.3M for advanced motor protection

(3) LC1D50A OK but with no available mechanical interlock

(4) LC1D80 OK but with no available mechanical interlock.

Nota: Dots in the contactors' reference should be replaced by the coil code. Example: 30 kW motor under 400 V - 230 Vac / 50-60 Hz control voltage

> GV3P65 circuit breaker + 3 x LC1D32P7 contactor

Coil codes	12 V	24 V	230 V	400 V	415 V
AC (50 – 60 Hz)	-	B7	P7	V7	N7
DC	JD	BD	-	-	-
DC low consumption	JL	BL	-	-	-

Those coil references correspond to most common contactors. Please, refer to catalogue for more details.

↓
References given relatively to power diagram B1 page 21

Warning:**Electrical and mechanical interlocking**

between star and delta contactor should always be recommended for improved reliability.

Warning:

Contactors references selected for the HVAC&R solution **have been optimized for this application** and should not be used for another application.

2 Our TeSys solution: find references for an HVAC&R adapted solution

The main input for selection is the current which will go through the circuit breaker (Rated Load Amperage).
Corresponding nominal power (Pn) is given as information for 400 V – 50 Hz.

Motor			Thermal-magnetic CB or Fuse + Thermal relay		Contactors			Interlock	
	Rated or Load Amps (RLA), up to 440 V (A ~)	Corresp. average nom. power (Pn) under 400 V (kW)	 (Q1)	 (F1)	 (KM2) +  (KM3) +  (KM1)				
				Thermal protection ref. + Independent mounting accessory	Line Contactor	> Delta Contactor	> Star Contactor	> Electrical interlock	> Mechanical interlock
				Delta contactor current (A) (informative)			HVAC&R Adapted solution		HVAC&R Adapted solution
55	30	31.8	GV3P65	LRD35 + LAD7B106	LC1D32**	LC1D32**	LC1D25**	LAD9V1	LAD9V2
66	37	38.1	GV3ME80	LRD350 + LAD96560	LC1D38**	LC1D38**	LC1D32**	LAD9V1	LAD9V2
80	45	46.2	GV7RE100	LRD350 + LAD96560	LC1D40A**	LC1D40A**	LC1D40A** ⁽³⁾	Customer cabling	LAD4CM
97	55	56	GV7RE150	LRD365 + LAD96560	LC1D40A**	LC1D40A**	LC1D40A** ⁽³⁾	Customer cabling	LAD4CM
132	75	76.2	GV7RE150	LRD3363 +LA7D3064	LC1D65A**	LC1D65A**	LC1D40A**	Customer cabling	LAD4CM
160	90	92.4	GV7RE220	LRD3365 +LA7D3064	LC1D95**	LC1D95**	LC1D80**	LA9D4002 ⁽⁴⁾	
195	110	112.6	GV7RE220	LRD4369 + A7D3064	LC1D95**	LC1D95**	LC1D80**	LA9D4002 ⁽⁴⁾	
230	132	132.8	NSX400N ⁽²⁾	LRD4369 +LA7D3064	LC1D115**	LC1D115**	LC1D115**	LA9D11502	
280	160	161.7	NSX400N ⁽²⁾	LR9F5371	LC1D150**	LC1D150**	LC1D115**	LA9D11502	

(1) Check circuit breaker breaking capacity (Icu) in catalogue defined page 14

(2) With Micrologic 1.3-M or Micrologic 6.3M, for advanced motor protection

(3) LC1D32 OK but with no mechanical interlock

(5) LA9D50978 for mechanical interlock only.

Nota: Dots in the contactors' reference should be replaced by the coil code. Example: 30 kW motor under 400 V - 230 Vac / 50-60 Hz control voltage

> GV3P65 circuit breaker + 2 x LC1D32P7 + LC1D25P7 contactor

Coil codes	12 V	24 V	230 V	400 V	415 V
AC (50 – 60 Hz)	-	B7	P7	V7	N7
DC	JD	BD	-	-	-
DC low consumption	JL	BL	-	-	-

Those coil references correspond to most common contactors.
Please, refer to catalogue for more details.

References given relatively to power diagram page 21:

B1 for Thermal-magnetic circuit breaker solution
B2 for fuse + relay solution



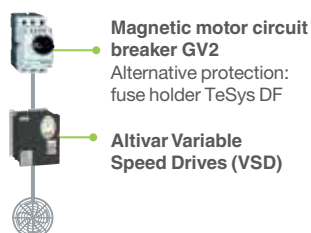
Fan: Starter type selection

Other starting modes & Special applications

More information on page 22

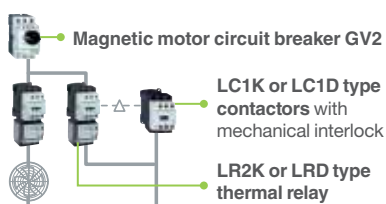
- Variable speed
 - Inrush current limitation
 - Soft start and/or stop
 - Fine control
- **Variable Speed Drive (VSD)**

Products to be chosen in the product ranges:



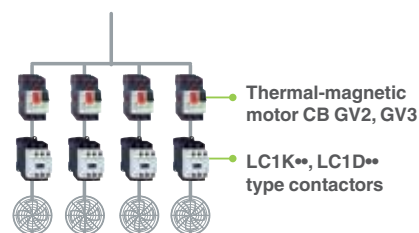
- Two-speed air flow adjustment
- **Dahlander motor with Dahlander coupling**

Products to be chosen in the product ranges:

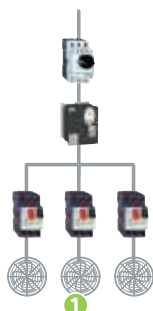


- Incremental air flow adjustment
- **Cascading control with contactors**

Products to be chosen in the product ranges:



- Fine air flow adjustment
- **Variable control with Variable Speed Drive**



Products to be chosen in the product ranges:

- > GV2 or GV3 motor circuit breakers
- > LC1K or LC1D contactors
- > LR2K or LRD type thermal relays
- > Altivar variable speed drives

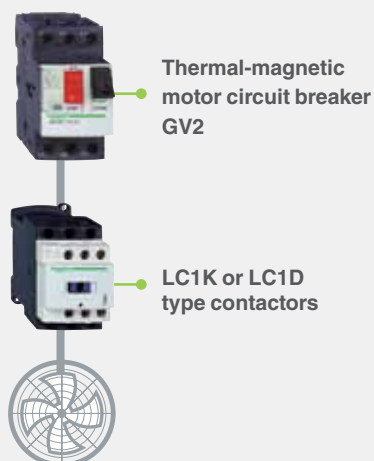
- 1 Identical variable speed for all the fans in operation simultaneously.
- 2 Identical variable speed for all the motors, with possibility of starting and stopping the fans according to the load.
- 3 Separate variable speed for each motor, with possibility of starting and stopping the fans according to the load.

Select your starter
regarding your application



- Constant speed
 - ON-OFF control
- **Direct-On-Line (DOL) starter**

Products to be chosen in the product ranges:



→ Fan: Direct-On-Line starter

① Your need: select the type of solution for your Star-delta starter regarding your constraints

Operating specifications						> Solution
Ambient temperature in the panel	Motor inrush current	Starting time	Electrical durability (cycles)	Mini. interval between motor stop & start	Compacity requirements between devices	Type
≤ 60°C	≤ 6 x RLA*	≤ 10 s	≈ 1.5 million	≥ 1 s	Close or separate mounting	Standard
≤ 45°C	≤ 6 x RLA*	≤ 1 s	≤ 500,000	≥ 5 min	Separate mounting	HVAC&R Adapted

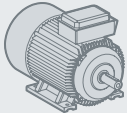
For other specifications, contact Schneider Electric support.

*RLA = Rated Load Amperage (A ~)

② Our TeSys solution: find references for a Standard or Adapted solution

The main input for selection is the current which will go through the circuit breaker (Rated Load Amperage).

Corresponding nominal power (Pn) is given as information for 400 V – 50 Hz.

Motor		Thermal-magnetic CB	Contactor	
	Rated Load Amperage (RLA), up to 440 V (A ~)	 (Q1)	 (KM1)	 (KM1)
or	Corresponding average nominal power (Pn) under 400 V (kW)		Standard solution	HVAC&R Adapted solution
0.2	0.06	GV2ME02	LC1D09••	LC1K06•• (2)
0.3	0.09	GV2ME03	LC1D09••	LC1K06•• (2)
0.4	0.12	GV2ME04	LC1D09••	LC1K06•• (2)
0.6	0.18	GV2ME04	LC1D09••	LC1K06•• (2)
0.9	0.25	GV2ME05	LC1D09••	LC1K06•• (2)
1.1	0.37	GV2ME06	LC1D09••	LC1K06•• (2)
1.5	0.55	GV2ME06	LC1D09••	LC1K06•• (2)
1.9	0.75	GV2ME07	LC1D09••	LC1K06•• (2)
2.7	1.1	GV2ME08	LC1D09••	LC1K06•• (2)
3.6	1.5	GV2ME08	LC1D09••	LC1K06•• (2)
4.9	2.2	GV2ME10	LC1D09••	LC1K06•• (2)
6.5	3	GV2ME14	LC1D09••	LC1K09•• (2)
8.5	4	GV2ME14	LC1D09••	LC1K09•• (2)

(1) Check circuit breaker breaking capacity (Icu) in catalogue defined page 14

(2) For DC control voltage, replace LC1K by LP1K

Nota: Dots in the contactors' reference should be replaced by the coil code. Example: 0.55kW motor - 230 Vac / 50-60 Hz control voltage > GV2ME14 circuit breaker + LC1K06P7 contactor

Coil codes	12 V	24 V	230 V	400 V	415 V
AC (50 – 60 Hz)	-	B7	P7	V7	N7
DC	JD	BD	-	-	-
DC low consumption	JL	BL	-	-	-

Those coil references correspond to most common contactors. Please, refer to catalogue for more details.

References given relatively to power diagram A page 21

Warning:

Contactors references selected for the HVAC&R solution **have been optimized for this application** and should not be used for another application.



Pumps: Starter type selection

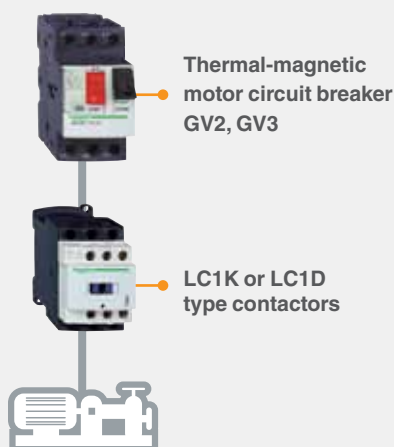
Select your starter
regarding your application



- Constant speed
- ON-OFF control

→ Direct-On-Line (DOL) starter

Products to be chosen in the product ranges:



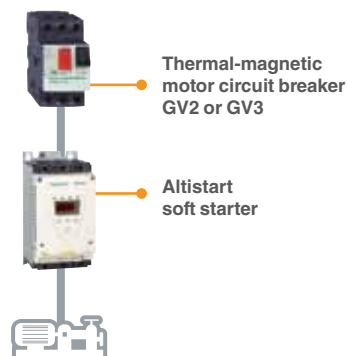
Other starting modes & Special applications

More information on page 22

- Constant speed
- ON-OFF control
- Inrush current limitation
- Soft start and/or stop

→ Soft starter starter

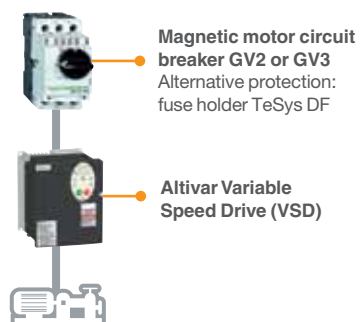
Products to be chosen in the product ranges:



- Variable speed
- Inrush current limitation
- Soft start and/or stop
- Fine control

→ Variable Speed Drive (VSD)

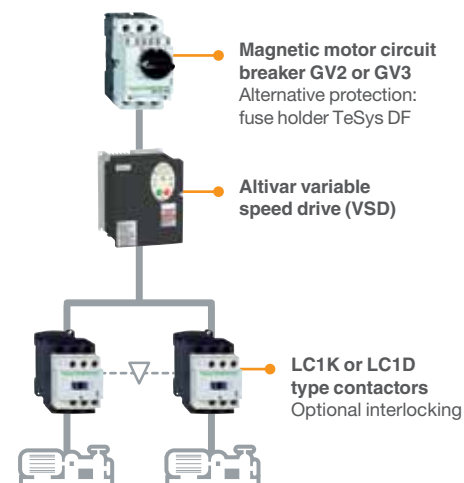
Products to be chosen in the product ranges:



- Motor redundancy (eg.: twin pumps)

→ 2 mechanically locked contactors alternately driven by a Variable Speed Drive

Products to be chosen in the product ranges:



→ Pumps: Direct-On-Line starter

① Your need: select the type of solution for your DOL starter regarding your constraints

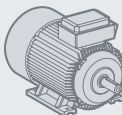
Operating specifications						> Solution
Ambient temperature in the panel	Motor inrush current	Starting time	Electrical durability (cycles)	Mini. interval between motor stop & start	Compacity requirements between devices	Type
≤ 60°C	≤ 6 x RLA*	≤ 5 s	≈ 1 million	≥ 1 s	Close or separate mounting	Standard
≤ 45°C	≤ 6 x RLA*	≤ 1 s	≤ 300,000	≥ 5 min	Separate mounting	HVAC&R Adapted

For other specifications, contact Schneider Electric support.

*RLA = Rated Load Amperage (A)

② Our TeSys solution: find references for a Standard or Adapted solution

The main input for selection is the current which will go through the circuit breaker (Rated Load Amperage).
Corresponding nominal power (Pn) is given as information for 400 V – 50 Hz.

Motor		Thermal-magnetic CB	Contactor	
	or			
Rated Load Amperage (RLA), up to 440 V (A ~)	Corresponding average nominal power (Pn) under 400 V (kW)		Standard solution	HVAC&R Adapted solution
2.7	1.1	GV2ME08	LC1D09••	LC1K06•• (2)
3.6	1.5	GV2ME08	LC1D09••	LC1K06•• (2)
4.9	2.2	GV2ME10	LC1D09••	LC1K06•• (2)
6.5	3	GV2ME14	LC1D09••	LC1K09•• (2)
8.5	4	GV2ME14	LC1D09••	LC1K09•• (2)
11.5	5.5	GV2ME16	LC1D12••	LC1K12•• (2)
15.5	7.5	GV2ME20	LC1D18••	LC1D12•• (2)
22	11	GV2ME22	LC1D25••	LC1D18•• (2)
29	15	GV2ME32	LC1D32••	LC1D25•• (2)
35	19	GV3P40	LC1D40A••	LC1D32•• (2)
41	22	GV3P50	LC1D50A••	LC1D40A•• (2)
55	30	GV3P65	LC1D65A••	LC1D50A•• (2)

(1) Check circuit breaker breaking capacity (Icu) in catalogue defined page 14

(2) For DC control voltage, replace LC1K by LP1K

Nota: Dots in the contactors' reference should be replaced by the coil code. Example: 0.55kW motor - 230 Vac / 50-60 Hz control voltage > GV2ME14 circuit breaker + LC1K06P7 contactor

Coil codes	12 V	24 V	230 V	400 V	415 V
AC (50 – 60 Hz)	-	B7	P7	V7	N7
DC	JD	BD	-	-	-
DC low consumption	JL	BL	-	-	-

Those coil references correspond to most common contactors. Please, refer to catalogue for more details.

References given relatively to power diagram A page 21

Warning:

Contactors references selected for the HVAC&R solution **have been optimized for this application** and should not be used for another application.

For detailed electrical characteristics and dimensions, please consult:

> To discover the TeSys range, connect on:
www.schneider-electric.com/tesys



Flexible
Safety M
Smart Connected
Protection
Compliant
Energy efficiency
Reliable
Available
Let TeSys®
be your drive

> Control and Protection
Components Catalogue
(Ref. MKTED210011EN)



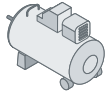
TeSys range: TeSys GV, TeSys GK, TeSys GS, TeSys DF, TeSys K, TeSys D, TeSys F, TeSys B, TeSys LR, TeSys LT, TeSys M, TeSys T, TeSys Vario, TeSys U, TeSys LE, TeSys LG

Appendix



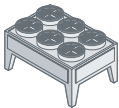
HVAC&R machine definitions

Spare parts for refrigeration



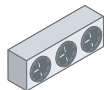
Compressor

In a refrigeration cycle, a compressor is a device which pumps the refrigerant gas up to a high pressure and temperature.



Condenser

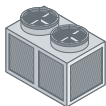
A condenser or condensing coil is a heat exchanger incorporated in a refrigeration cycle. It is designed to enable the liquid refrigerant to lose energy (heat) to the outside in order to cool, while it condenses into its liquid phase.



Evaporator

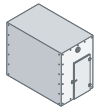
An evaporator or evaporating coil is a heat exchanger incorporated in a refrigeration cycle. It is designed to enable the liquid refrigerant to absorb energy (heat) from the outside in order to warm up, while it evaporates into its gas phase.

Commercial and industrial refrigeration



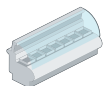
Condensing unit

The function of a condensing unit is to cool down the incoming refrigerant vapour and condense it into liquid. A condensing unit embeds a compressor and a condenser fan.



Cold room

A cold room is a sealed box which is used to store goods in a fresh or frozen ambient atmosphere. It contains an evaporator. Either an integrated or remote condensing unit is connected to the evaporator.



Refrigerated/low-temperature showcase

A refrigerated (or low-temperature) showcase/display cabinet is used for sale of chilled (or frozen) foodstuffs. It can be self-refrigerated or connected to a remote condensing unit.



Ice-maker machine

An ice-maker machine produces ice for industrial processes. It can be self-refrigerated or connected to a remote condensing unit.



Ice bank

An ice bank produces and stores ice in order to increase cooling power for peak loads. This device has three benefits:

- 1- Generation of ice at low night tariffs
- 2- Limitation of max. electricity peaks
- 3- Use of smaller refrigeration machines, designed for average demand only.

It can be self-refrigerated or connected to a remote condensing unit.

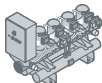
Cooling



Chiller

A chiller is a device forming part of an air conditioning system, that removes heat from a liquid via a vapour-compression or absorption refrigeration cycle. The cooled liquid usually supplies coils in air handlers, fan-coil units, or other systems. Chillers are of two types:

- > **Air-cooled chillers** are usually outdoors and consist of a condenser coil cooled by fan-driven air.
- > **Water-cooled chillers** are usually located inside a building, and heat from these chillers is carried by recirculating water to a heat sink such as an outdoor cooling tower.



Cooling tower

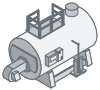
A cooling tower is a heat discharge device installed outside of the building envelope. It is used to cool water that has been heated in the condenser of a water-cooled chiller (in a refrigerant/water fluid exchanger).

Heating



Heat pump

A heat pump is a device that warms or cools a building by transferring heat from a relatively low-temperature reservoir to one at a higher temperature (air to water or water to water or direct expansion circuit).



Boiler

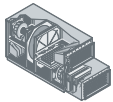
A boiler is a closed vessel in which water or another fluid is heated. The heated or vaporized fluid leaves the boiler for use in various processes or heating applications, including central heating in a hydronic system.



Furnace

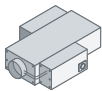
A furnace is a heating system component designed to heat air for distribution in a building.

Ventilation and air conditioning



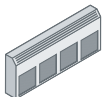
Air handler / Air Handling Unit (AHU)

An air handler is a device used to condition and circulate air as part of a Heating, Ventilation and Air Conditioning (HVAC) system, to meet environmental requirements. It includes cooling coils and possibly heating coils to cool and/or warm air. Cold/warm water is supplied by a remote chiller and/or heater.



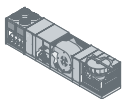
Terminal Unit (TU)

A Terminal Unit is an outlet in ductwork to allow air delivery to an environment such as a room. Terminal units may have built-in heating and cooling coils connected to central heating and/or cooling systems.



Fan Coil Unit (FCU)

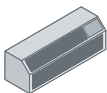
A Fan Coil Unit is a Terminal Unit which is not connected to air ductwork but to a hydronic system.



Packaged Unit (PU)

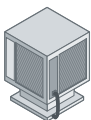
A Packaged Unit is an AHU equipped with its own heating and cooling sources. It can be classified according to the place of installation:

- > **Roof Top Unit (RTU)**, installed on the roof and completely weatherproof
 - > **Indoor Packaged Unit**, installed indoors, usually connected to a cooling tower
-



Packaged Terminal Air Conditioner (PTAC)

A Packaged Terminal Air Conditioner is a Packaged Unit dedicated to a single room. It consists of a wall sleeve and a separate encased combination of heating units (by hot water, steam, or electric resistance) and cooling units (includes refrigeration components) for mounting through the wall.



Evaporative cooler

An evaporative cooler (also called swamp cooler, desert cooler, and wet air cooler) is a device that cools air through the evaporation of water. This method uses far less energy than refrigeration, but once evaporated, the water is lost. In extremely dry climates, evaporative cooling of air has the added benefit of conditioning the air with more moisture for the comfort of building occupants.

Method for selection of the circuit breaker and contactor

The selection of control and protection components requires a good knowledge of the application data but, above all, a knowledge of the components' characteristics.



These characteristics are available in the Schneider Electric "Control and protection components" catalogue.

① Choice of the contactor-base motor starter

Examples of project data

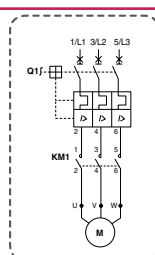
Wound-rotor asynchronous motor.

Starting must be **gradual** to avoid peak currents.

Starting torque is lower than one-third of nominal torque.

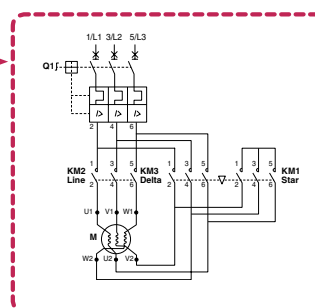
Selection criteria

Standard layouts



Direct starting:

The motor starts quickly, with its natural characteristics creating a current peak on the network.



Star-delta starting:

Condition: starting torque must be lower than one-third of nominal torque.

The motor starts gradually, at reduced voltage. Low current peak (one-third) at starting. 3 contactors are used, 2 of which are mechanically interlocked.

② Choice of motor circuit breaker

Examples of project data

Data concerning the electrical network:

50 kA ① short-circuit current at the motor level

Data concerning the motor:

DNI102

BRAND

MOT. 3 ~ XYZ100

N° 8945/79

22 kg

Code :

T

IP 55

I cl. F

40°C

S1

%

c/h

Hz

min⁻¹

kW

cos φ

A

Δ 380

50

1415

3

0.83

7.1

Δ 400

50

1420

3

0.78

7.2

Δ 415

50

1430

3

0.74

7.3

DE

NDE

g

h

N°1000000

IEC XXXXX

The inrush current is 6 times the Rated Load Amperage (or nominal current): $6 \times 7.2 = 43.2 \text{ A}$ ④

Selection criteria

To select your motor protection properly, you must check that:

Motor circuit-breakers from 0.06 to 15 kW / 400 V, with screw clamp terminals									
GV2 ME with pushbutton control									
Standard power ratings of 3-phase motors 50/60 Hz category AC-3									
400/415 V ②		500 V		690 V		Setting range of thermal trips (2)		Magnetic tripping current (4)	
P	Icu	Ics (%)	P	Icu	Ics (%)	P	Icu	Ics (%)	A
kW	kA	%	kW	kA	%	kW	kA	%	A
2.2	3	50	100	4	3	75	4...6.3	78	GV2 ME10
3	>100 ①	100	4	10	100	5.5	3	75	6...10 ③
4	>100	>100	5.5	10	100	7.5	3	75	138 ④

- > The maximum operating voltage of the CB is greater than the motor nominal voltage;
- > The short-circuit current does not exceed the circuit breaker's breaking capacity (Icu);
- > The inrush current does not exceed the magnetic tripping current;
- > The motor's nominal current is within the thermal trip setting range of the overload protection system.

③ Choice of contactor

Examples of project data

The max. temperature of the panel in operation must not exceed **35°C**

MOT. 3 ~ XYZ100						
N° 8945/79 22 kg						
Code : T						
IP 55	I cl. F	40°C	S1	%	c/h	
Δ 380	50	1415	3	0.83	7.1	
Δ 400	50	1420	3	0.78	7.2	
Δ 415	50	1430	3	0.74	7.3	

Nominal voltage (Un) in delta cabling= **400 V** ①

Rated Load Amperage (RLA) for this voltage = **7.2 A** ②

Maximum starting current: **6 x 7.2 A**

Contactor characteristics

To select your contactor properly, you must check that:

Contactor type	LC1	D09...D18 DT20 and DT25	D25...D38 DT32 and DT40	D40A...D65A DT60A and DT80A	D80...D95	D115 and D150
Environment						
Ambient air temperature around the device	Storage	°C	-60...+80			
	Operation	°C	-5...+60			
	Permissible	°C	-40...+70, for operation at Uc			

The panel temperature acceptable by the selected contactor must be compatible with the project data.

Contactor type	LC1	D09 (3P)	DT20 D098	D12 (3P)	DT25 D128	D18 (3P)	DT32 D188	D25 (3P)	DT40 D258
Pole characteristics									
Rated operational current (Ie) (Ue y 440 V)	In AC-3, θ ≤ 60 °C	A	9	12	18	25			
	In AC-1, θ ≤ 60 °C	A	25 (1)	25 (1)	32 (1)	32	40 (1)	40	
Rated operational voltage (Ue)	Up to	V	690	690	690	690			
Frequency limits	Of the operational current	Hz	25...400	25...400	25...400	25...400			

The maximum voltage (Ue) that can be withstood by each pole of the contactor must be greater than the motor's working voltage Un.

Contactor type	LC1	D09 (3P)	DT20 D098	D12 (3P)	DT25 D128	D18 (3P)	DT32 D188	D25 (3P)	DT40 D258
Pole characteristics									
Rated operational current (Ie) (Ue y 440 V)	In AC-3, θ ≤ 60 °C	A	9	12	18	25			
	In AC-1, θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)
Rated operational voltage (Ue)	Up to	V	690	690	690	690			
Frequency limits	Of the operational current	Hz	25...400	25...400	25...400	25...400			
Conventional thermal current (Ith)	θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)

The maximum continuous current (Ith) that can be withstood by each pole of the contactor must be greater than the RLA of the motor.

Contactor type	LC1	D09 (3P)	DT20 D098	D12 (3P)	DT25 D128	D18 (3P)	DT32 D188	D25 (3P)	DT40 D258
Pole characteristics									
Rated operational current (Ie) (Ue y 440 V)	In AC-3, θ ≤ 60 °C	A	9	12	18	25			
	In AC-1, θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)
Rated operational voltage (Ue)	Up to	V	690	690	690	690			
Frequency limits	Of the operational current	Hz	25...400	25...400	25...400	25...400			
Conventional thermal current (Ith)	θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)
Rated making capacity (440 V)	Conforming to IEC 60947	A	250	250	300	450			
Rated breaking capacity (440 V)	Conforming to IEC 60947	A	250	250	300	450			
Permissible short time rating	For 1 s	A	210	210	240	380			
No current flowing for preceding 15 minutes with θ ≤ 40 °C	For 10 s	A	105	105	145	240			
	For 1 min	A	61	61	84	120			
	For 10 min	A	30	30	40	50			

The Rated Making Capacity (RMC) and Rated Breaking Capacity (RBC) of the contactor must be greater than the maximum starting current (expressed as a multiple of the motor's nominal current (A): coef. 6 in the example).

Maximum starting time: **5 sec** ①

Contactor type	LC1	D09 (3P)	DT20 D098	D12 (3P)	DT25 D128	D18 (3P)	DT32 D188	D25 (3P)	DT40 D258
Pole characteristics									
Rated operational current (Ie) (Ue y 440 V)	In AC-3, θ ≤ 60 °C	A	9	12	18	25			
	In AC-1, θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)
Rated operational voltage (Ue)	Up to	V	690	690	690	690			
Frequency limits	Of the operational current	Hz	25...400	25...400	25...400	25...400			
Conventional thermal current (Ith)	θ ≤ 60 °C	A	25 (1)	20	25 (1)	25	32 (1)	32	40 (1)
Rated making capacity (440 V)	Conforming to IEC 60947	A	250	250	300	450			
Rated breaking capacity (440 V)	Conforming to IEC 60947	A	250	250	300	450			
Permissible short time rating	For 1 s	A	210	210	240	380			
No current flowing for preceding 15 minutes with θ ≤ 40 °C	For 10 s	A	105	105	145	240			
	For 1 min	A	61	61	84	120			
	For 10 min	A	30	30	40	50			

Check that the starting current value and the maximum starting time are compatible with the contactor's thermal constraint.

Minimum interval between two cycles: **15 min** ②

For short times, a contactor (e.g. star contactor) can be used above its design current, provided one check that:

- > the current does not exceed the maximum permissible current for the given operating time
- > the minimum interval between two cycles is complied with.

Method for selection of the circuit breaker and contactor

③ Choice of contactor (continuation)

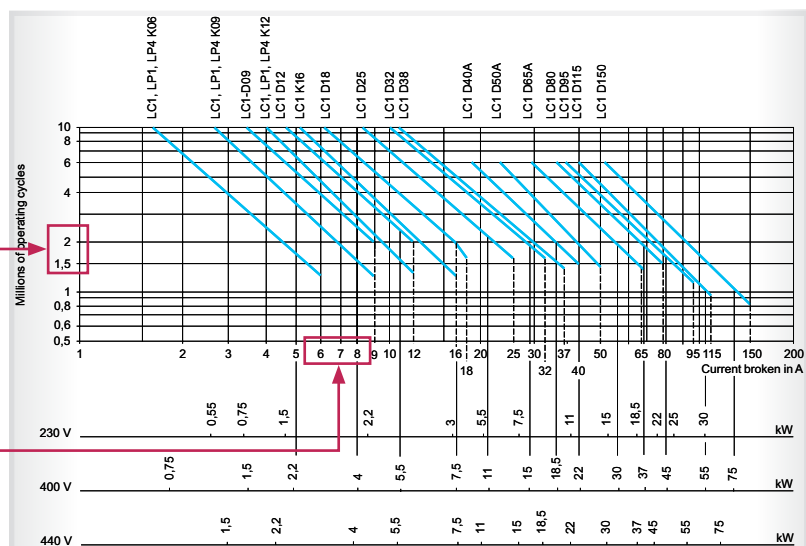
Examples of project data

The motor shall perform at most 11 starts per hour during 15 years, i.e.:

$$11 \times 24 \times 365 \times 15 = 1.5 \text{ m cycles}$$

MOT. 3 ~ XYZ100						
N° 8945/79 22 kg						
Code : T						
IP 55	I cl. F	40°C	S1	%	c/h	
Hz	min ⁻¹	kW	cos φ	A		
Δ 380	50	1415	3	0.83	7.1	
Δ 400	50	1420	3	0.78	7.2	
Δ 415	50	1430	3	0.74	7.3	

Contactor characteristics



When a contactor has been selected, you must check that its durability will be greater than or equal to the required value.

The contactor's durability depends on the current that it will have to shut off (generally the operating current).

Following thermal sizing of the cables, it was decided to use **2.5 mm² flexible cable** to connect the contactor.

Contactor type	LC1	D09	D18 and D12 DT20 and DT25	D18 (3P)	D25 (3P)	D32	D38	D18 and D25 (4P) DT32 and DT40	D40A to D65A DT60A and DT80A (1)	D80 and D95	D115 and D150
Power circuit connections											
Screw clamp terminal connections											
Tightening			Screw clamp terminals			Connector 2 inputs		Screw clamp terminals		Connector 1 input	Connector 2 inputs
Flexible cable without cable end	1 conductor	mm ²	1...4	1.5...6	2.5...10	2.5...10		1...35		4...50	10...120
	2 conductors	mm ²	1...4	1.5...6	2.5...10	2.5...10		1...25 and 1...35		4...25	10...120 + 10...50
Flexible cable with cable end	1 conductor	mm ²	1...4	1...6	1...10	2.5...10		1...35		4...50	10...120
	2 conductors	mm ²	1...2.5	1...4	1.5...6	2.5...10		1...25 and 1...35		4...16	10...120 + 10...50

The selected contactor must be able to receive the specified cables.

Star-delta starting with **mechanical** and electrical interlocking of the contactors is required.

Mechanical interlocks			
Mechanical interlock with integral electrical interlocking	LC1 D80 and D95 (∩)	LA9 D4002	0.170
	LC1 D80 and D95 (≡)	LA9 D8002	0.170
	LC1 D115 and D150	LA9 D11502	0.290
Mechanical interlock without integral electrical interlocking	LC1 D09 o D38	LAD 9V2	0.040
	LC1 D40A to D65A	LAD 4CM	0.040
	LC1 D80 and D95 (∩)	LA9 D50978	0.170
	LC1 D80 and D95 (≡)	LA9 D80978	0.170

In star-delta configuration, the selected contactor must be capable of mechanical and electrical interlocking.

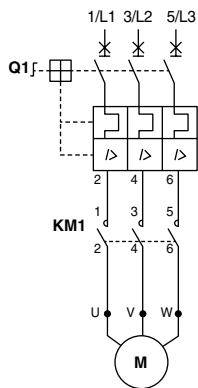
If electrical interlocking equipment does not exist for the selected contactor, the interlocking system must be cabled by the user (see next page).

Electrical diagrams

Power diagrams

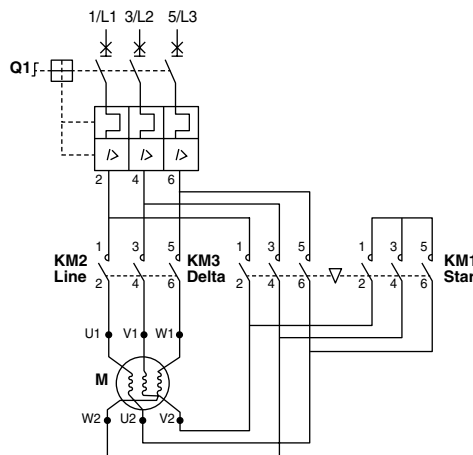
A• Direct-on-line

With thermal-magnetic motor circuit breaker.



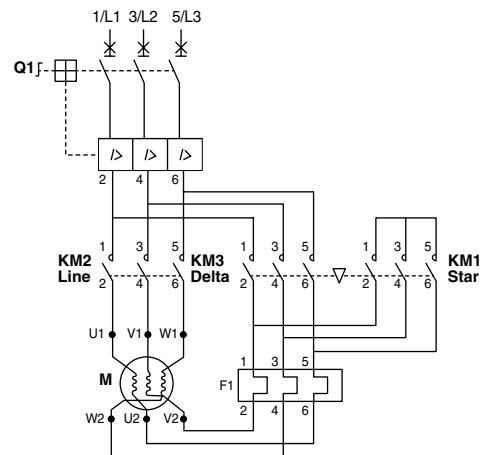
B1• Star-delta for standard solution

With thermal-magnetic motor circuit breaker.



B2• Star-delta for adapted solution

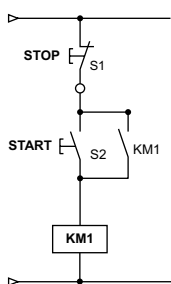
With fuse (or magnetic motor circuit breaker) and separate thermal overload relay.



The current in KM2 and KM3 contactors is $(1/\sqrt{3})$ the nominal current. Using a separate overload relay, as proposed in the "adapted solution" makes it possible to lower rating than if it was directly downstream the magnetic protection Q1.

Control diagrams

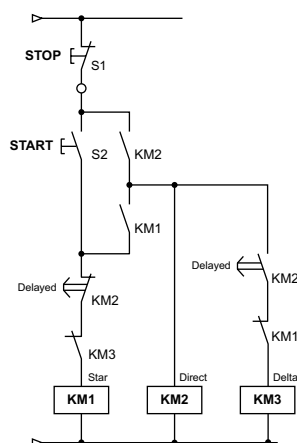
A• Direct-on-line



Push button S2 instantaneously activates contactor KM1, which is then self-maintained. When activated, push-button S1 opens the line.

B• Star-delta – Electrical interlocking

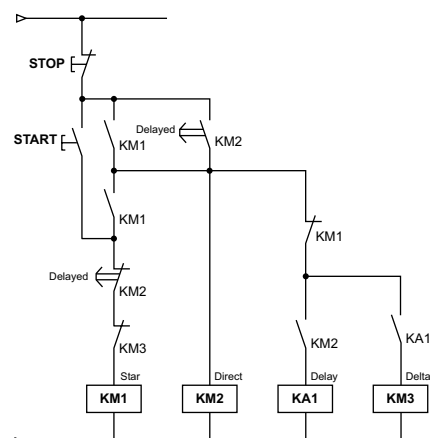
≤ 80 A



Push button S2 instantaneously activates contactor KM1 (star contactor), which is self-maintained.

- > KM1 activates KM2 (line contactor), which is self-maintained, and locks KM3 (delta contactor) open.
- > KM2 activates the time delay.
- > Once the time delay is over, KM1 is deactivated and KM3 (delta contactor) is activated.

> 80 A



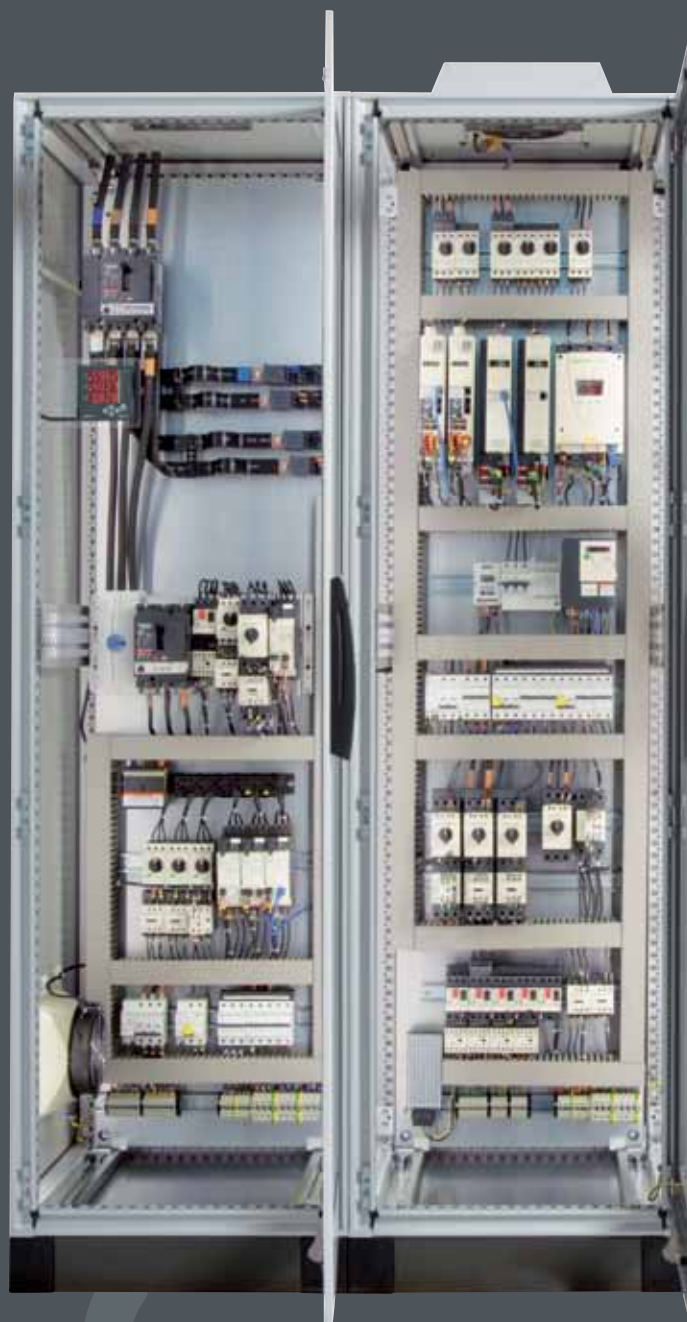
Same principle as beside, except KA1.

This relay provides a short extra delay before KM3 is closed, thereby avoiding the risk of short-circuit during the transition.

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