LT6
Protection and Intelligence Combined

File 9110

CONTENTS

Telemecanique

SQUARE D
GROUPE SCHNEIDER

Operating conditions

There are many possible causes of electric motor failure. One of the most common, and which is often accidental, is the utilization of motors beyond the operating limits defined by the manufacturer or in abnormal ambient conditions.

A statistical survey covering 9000 incidents of motor failure, gave the following results :

Overloads (1)	30 %
Operating conditions (example: corrosive atmosphere)	19 %
Phase failure	14 %
Bearing failure	13 %
Aging (example: ambient temperature too high) (1)	10 %
Rotor faults	5 %
Miscellaneous	9 %

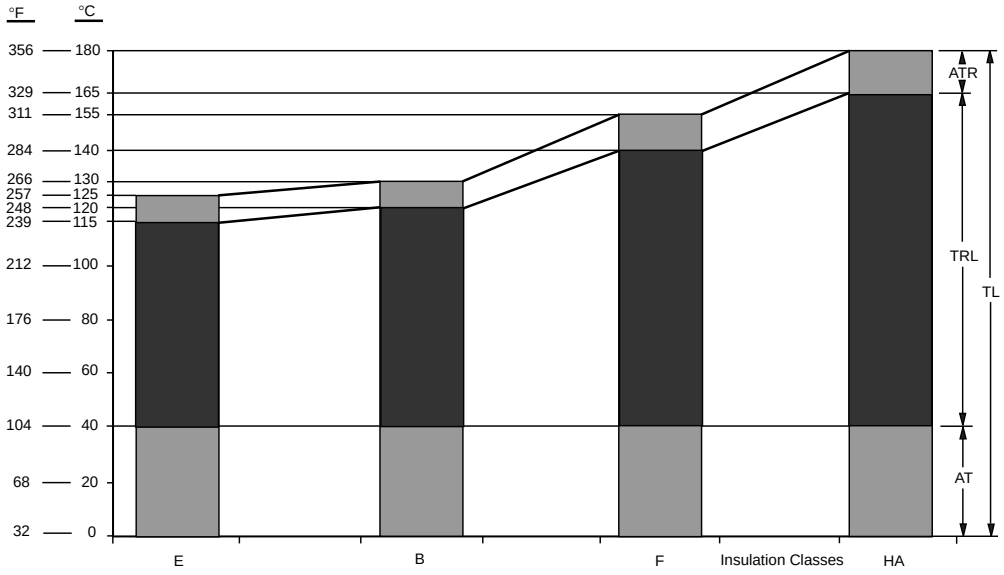
These faults are related to motors with a power rating of 37 kW (50 hp) or more.

(1) An examination of the above results shows that, in more than 40 % of cases, the fault is due to the effects of heating.

Leaving aside the replacement of wearing parts, such as bearings, slip rings, brushes, etc., the life of an electric motor is linked to that of its insulation. Provided that the temperature rise limit is not exceeded, the life expectancy of insulating materials is extremely long. It is decreased by approximately one half for an excess temperature rise of 10 °C (18 °F).

The operating temperature limit TL of an insulating material depends on the type of material and is the sum of the ambient air temperature AT (cooling air), the temperature rise limit TRL and an additional temperature rise value ATR considered necessary because the measurement of winding resistance variation does not determine the temperature of the hottest part of the motor winding, but only gives an average value for temperature rise.

The diagram below defines the standardized limits for different classes of insulation. In all cases, the normal ambient cooling air temperature is fixed at 40 °C (104 °F).



The rated power of a motor corresponds to its temperature rise limit for an ambient temperature of 40 °C (104 °F). The temperature rise limits for the different parts of a machine are given in the following table, which is an extract from IEC publication 34-1.

Temperature rise limit

		Insulation class		
		B	F	H
Insulated winding (measurement by resistance)	°C/°F	80/176	100/212	125/257
Commutators and slip-rings	°C/°F	80/176	90/194 (1)	100/212 (1)
Bearings	°C/°F	60/140	60/140 (2)	60/140 (2)

When a motor is used at an ambient air temperature other than the normal value, its temperature rise limit should be modified in order to maintain the same maximum temperature limit. The result is that the motor operational power is no longer the same as its rated power.
Also, the altitude of the installation, if this is above 1000 m (3281 ft), affects the cooling and increases the temperature rise.
The following table gives the ratio between operational power and rated power, according to the operating conditions, for a given ambient temperature. It corresponds to insulation class B.

Operational power / Rated power in watts

Altitude		Ambient air temperature (AT)						
		30 °C	35 °C	40 °C	45 °C	50 °C	55 °C	60 °C
m	ft	(86 °F)	(95 °F)	(104 °F)	(113 °F)	(122 °F)	(131 °F)	(140 °F)
1000	3281	1.07	1.04	1.00	0.96	0.92	0.87	0.82
1500	4922	1.04	1.01	0.97	0.93	0.89	0.84	0.79
2000	6562	1.01	0.98	0.94	0.90	0.86	0.82	0.77
2500	8203	0.97	0.95	0.91	0.87	0.84	0.79	0.75
3000	9843	0.93	0.91	0.87	0.84	0.80	0.76	0.71
3500	11,484	0.89	0.86	0.83	0.80	0.76	0.72	0.68
4000	13,124	0.83	0.81	0.78	0.75	0.72	0.68	0.64

The values shown in the above table are for guidance only. In effect, the derating of a motor depends on its size, insulation class, method of construction (self-ventilated or forced ventilation, enclosure type), and varies according to the manufacturer.

Also, in addition to the normal ambient conditions, the rated power of a motor is defined by the manufacturer for continuous duty S1. This covers continuous operation of sufficient duration to enable the motor to reach a steady temperature. It is this value of rated power that is normally shown on the motor plate.

There are other standardized types of duty, such as temporary duty S2, or intermittent periodic duty type S3, S4 and S5, for which the motor manufacturer defines an operational power appropriate to each and different from the rated power.

(1) For temperature rise limits of 90 °C (194 °F) and 100 °C (212 °F) the brushes must be selected with the agreement of the motor manufacturer.
(2) These limit values may be exceeded depending on the quality of the grease used and the applied loads.

LT6-P0M005FM

The LT6 is designed for the control, monitoring, and protection of AC motors.

Product functions not using serial link communication

The LT6 protects against
- thermal overloads by monitoring motor currents: up to 25 full load amps with internal current transformers; greater than 25 full load amps with external current transformers,
- overheating of motors with embedded PTC thermistor probes,
- phase unbalance and phase loss,
- earth (ground) fault.

It provides
- control of up to two power contactors for non-reversing, reversing, two-speed, and star-delta motor starting,
- fault signalling via an internal output relay and a 7-segment LED display.

Using serial link communication

The LT6 may be set to protect against
- thermal overloads by monitoring motor currents: up to 25 full load amps with internal current transformers; greater than 25 full load amps with external current transformers,
- overheating of motors with embedded PTC thermistor probes,
- phase unbalance and phase loss,
- earth (ground) fault,
- underload,
- prolonged starting time,
- overtorque and locked rotor,
- phase reversal,
- low power factor.

It provides
- control of one or two power contactors for non-reversing, reversing, two-speed, and star-delta motor starting,
- fault signalling via an output relay and a 7-segment LED display,
- voltage limitation by monitoring voltage between phases,
- signalling in the event of exceeding the short-circuit current,
- thermal alarm,

Bus communication
- provides information exchange between the LT6 and PLC or personal computer:
  - instantaneous values (voltage, current per phase, frequency, power factor, thermal state of motor stator and copper windings),
  - data log of 5 previous trip incidents (causes and remedies),
  - maintenance statistics, cause of trip statistics,
  - operating and alarm states.

Physical features

- Power input terminals from the contactor and power output terminals to the motor.
- 16-pin plug-in connector for monitoring protection inputs.
- 11-pin plug-in connector for outputs for contactor coil, thermal alarm, and fault signalling.
- 5-pin plug-in connector for ground fault current transformer and PTC thermistor probes.
- Two rotary dials for selection of motor full load current from 20% to 109% of the maximum rated current (1 A, 5 A, or 25 A) of the LT6 relay.
- Rotary dial for selection of Class 5 (10 A), 10, 15, 20, 25, or 30 thermal overload protection.
- DIP switch for selection of:
  Bus communication address
  UNI-TELWAY™ or JBUS/MODBUS® protocol
  Manual or automatic thermal overload reset
  Enable local (front face) or line (serial communication link) thermal overload settings
- Sealable transparent cover eliminates tampering with local front cover settings.
- 7-segment display for fault indication.
- "Test" button (opens N/C overload trip contact and closes N/O fault signal contact).
- Manual "Reset" button.
- SUB-D Serial interface port for bus communication.
  For use with personal computer running Microsoft Windows 3.1 or Windows 95 with Configuration Software Kit LA9P620 (includes RS232 cable and software)
  For use with PLC or MAGELIS™ XBT terminal with XBT-L100 programming software

LT6 configuration table

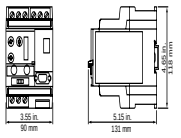
	Functions		Parameters		
Protection	**Parameters preset and function enabled at factory**	**Ability to enable or disable by serial link**	**Description**	**Factory settings**	**Adjustment range accessible via serial link communication**
Thermal overload	**YES**		Ir (% rating) Overload class Overload alarm	20 % 5 100 %	20 to 109 % (1) 5,10,15,20,25,30 (1) 0 to 100 %
Overheating via PTC thermistors	**YES**		—	Factory installed 1 kΩ resistor to disable function	Enable or disable
Phase unbalance and phase failure	**YES**		Id (% I rms average (2)) Start inhibit Time before tripping	30 % I average 0.7 sec. 5 sec.	10 to 30 % 0 to 10 sec. 0 to 10 sec.
Earth (ground) fault	**YES**	**YES**	IΔr Time before tripping	30 A 5 sec.	0.3 to 30 A 0 to 5 sec.
Prolonged starting time		**YES**	I_{SD} (% Ir) Starting time	150 % Ir 10 sec.	100 to 500 % Ir 0 to 30 sec.
Undercurrent		**YES**	I_V (% Ir) Time before tripping	30 % Ir 10 sec.	30 to 90 % Ir 0 to 30 sec.
Torque limitation		**YES**	I_{LC} (% Ir) Time before tripping	200 % Ir 10 sec.	150 to 800 % Ir 0 to 30 sec.
Cos φ (power factor)		**YES**	Cos φ Time before tripping	0.1 10 sec.	-1 to 1 0 to 10 sec.
Phase rotation direction monitoring		**YES**	—	Disabled	Enable or disable

(1) These values can be activated and adjusted from the front face of the relay when set to “Local adjust”.
(2) The average rms current is equal to the average current value of the 3 phases.

Complementary functions	**Parameters preset and function enabled at factory**	**Ability to enable or disable by serial link**	**Description**	**Factory setting**	**Adjustment range accessible via serial link communication**
Voltage threshold detection		**YES**	Trip voltage Time before tripping Reset voltage Time before resetting	70 % Un 10,000 sec. 90 % Un 10,000 sec.	68 to 120 % Un 0 to 100,000 sec. 68 to 120 % Un 0 to 100,000 sec.
Short-circuit detection	**YES**		Isc	15 x Ir peak	–
Automatic reset	**YES**		Time before reset Iron θ °C before reset	0 sec. 100 % θn	0 to 1000 sec. 0 to 100 % θn
Motor control	**YES**		Control of outputs A and B	Reversing	Reversing Independent 2-stage
Motor cooling	**YES**		Cooling method for motor	Self-cooled (3)	Self-cooled or external-cooled (3)

(3) Thermal overload reset time is based on calculated cooling time. Cooling time of a self-cooled motor at standstill is four times longer than the cooling time of an external-cooled motor.

Environment

Conforming to standards			IEC 947-4-1, IEC 34-11, IEC 755, VDE 0106, VDE 0660
European community directives			CE marking Meets the essential requirements of Low Voltage equipment (LV) & Electromagnetic Compatibility (EMC).
Approvals			UL 508, CSA, PTB
Protective treatment			"TH" (Tropical Finish)
Degree of protection	Conforming to IEC 947-1		IP 20 (1)
Pollution degree	Conforming to IEC 664		3
Shock resistance	Conforming to IEC 68-2-27		15 gn, 11 milliseconds
Vibration resistance	Conforming to IEC 68-2-6		2 gn (3 to 100 Hz)
Ambient air temperature around the device	Storage	**°C** **°F**	- 35 to + 85 - 31 to + 185
	Operation	**°C** **°F**	- 20 to + 70 - 4 to + 158
Flame resistance	Conforming to UL 94		V0
Maximum operating altitude		**m** **ft**	2000 6562
Operating position	In relation to normal vertical mounting plane		
Resistance to electrostatic discharge	Conforming to IEC 1000-4-2 level 3	**kV**	8
Resistance to electromagnetic interference	Conforming to IEC 1000-4-3 level 3	**V/m**	10
Resistance to fast transient currents	Conforming to IEC 1000-4-4 level 4	**kV**	2
Resistance to conducted radio-frequency disturbances			Conforming to IEC 1000-4-6 level 3
Rated undissipated pulse withstand (U imp)	Conforming to IEC 947-1	**kV**	6
Rated dissipated pulse withstand			Conforming to IEC 1000-4-5 level 3
Resistance to low frequency disturbances - supply harmonics			Conforming to IEC 947-2 Appendix F Clause F4.1
Resistance to micro-breaks			Conforming to IEC 1000-4-11

(1) Only applicable when power cabling to relay exceeds the following sizes:
1.5 mm^2 (16 AWG) fitted with cable end or 2.5 mm^2 (14 AWG) not fitted with cable end.

Power circuit characteristics—terminals L11, L21, L31, L15, L25, L35, 2T1, 4T2, 6T3

Relay type			**LT6-P0M005FM**	**LT6-P0M025FM**
Operating voltage range		**V**	110 to 600 VAC	110 to 600 VAC
Rated insulation voltage (Ui)	Conforming to IEC 947-1	**V**	690 VAC	690 VAC
Operating frequency		**Hz**	50/60 (1)	50/60 (1)
Rated operational current		**A**	0.2 to 5 (2)	5 to 25
Cabling				
Solid cable	1 or 2 conductors	**mm²** **AWG**	1.5 to 6 16 to 10	
Stranded cable w/out cable end	1 or 2 conductors	**mm²** **AWG**	1.5 to 6 16 to 10	
Stranded cable with cable end	1 or 2 conductors	**mm²** **AWG**	1.5 to 4 16 to 12	
Terminal tightening torque		**N.m** **lb-in**	1.7 15	
Short-circuit protection By circuit breaker			Select in accordance with National Electrical Code	Select in accordance with National Electrical Code
By fuses	≤ 1 A 1 to 5 A > 5 A		RK5 - 4 Amp. max. RK5 - 20 Amp. max. Max. 400 % of motor FLA	Max. 400 % of motor FLA

Control circuit supply characteristics—terminals A1, A2

Rated insulation voltage (Ui)	Conforming to IEC 947-1	**V**	380 VAC
Operating voltage		**V**	90 to 276 VDC 90 to 276 VDC - 50/60 Hz
Cabling	Plug-in connector		
Solid cable	1 or 2 conductors	**mm²** **AWG**	0.5 to 1 20 to 18
Stranded cable w/out cable end	1 or 2 conductors	**mm²** **AWG**	0.5 to 1 20 to 18
Stranded cable with cable end	1 conductor	**mm²** **AWG**	0.5 to 1 20 to 18
	2 conductors	**mm²** **AWG**	0.5 to 0.75 20
Terminal tightening torque		**N.m** **lb-in**	0.7 6.5

Discrete input characteristics—terminals I1, I2, I3, I4, I5, I6, I7, I8, C1, C2 (see "Control circuit supply characteristics" for cabling and tightening torques)

Rated insulation voltage (Ui)	Conforming to IEC 947-1	**V**	250 VAC
Operating voltage		**V**	90 to 15 VDC; 90 to 276 VAC - 50/60 Hz
Current consumption	Minimum transient value	**mA**	≥ 1 (changing from 0 state to 1 state in t ≥ 4 ms)
Input impedance		**kΩ**	56

(1) For use with 110 to 690 V - 50/60 Hz AC motors only. Not approved for use with DC motors or variable speed drives.
(2) For motor full load currents > 25 A, use LT6P0M005FM with customer-provided external current transformers with 1 A or 5 A secondary outputs.

Discrete output characteristics—terminals 95, 96, 01, 02 (see "Control circuit supply characteristics" for cabling and tightening torques)

Rated insulation voltage (Ui)		Conforming to IEC 947-1	**V**	380 VAC
Type of output		Relay		1 N/O per channel
Associated fuse protection		Conforming to IEC 947-5	**A**	6 A max. type RK5
AC loads	Rated voltage		**V**	250 VAC
	Permissible power for category AC-15 Associated with contactor		**VA**	500 (Ie = 0.5 A, Ue = 250 VAC, Ith = 5 A, cos φ = 0.4, for 100,000 operations) **LC1-K, LC2-K, LC7-K, LC8-K LC1-D09 to D95, LC1-F115 to F150**
DC loads	Rated voltage		**V**	30 VDC
	Permissible power for category DC-15 Associated with contactor		**VA**	50 (Ie = 0.5 A, Ue = 30 VDC, Ith = 5 A, L/R ≤ 25 ms for 100,000 operations) **LP1-K, LP2-K, LP1-D09 and D12 LP1-D18 to D32 (with LA4-DC1U or DC2U) LP1-D40 to D80 (with LA4-DC3U)**

Signalling output characteristics—terminals 97, 98, 93, 94 (see "Control circuit supply characteristics" for cabling and tightening torques)

Rated insulation voltage (Ui)		Conforming to IEC 947-1	**V**	380 VAC
Type of output		Relay		1 N/O per channel
Associated fuse protection		Conforming to IEC 947-5	**A**	4 A max. Type RK5
Current limit		At U = 5 VDC	**mA**	10
AC loads	Rated voltage		**V**	250 VAC
	Permissible power for category AC-15 Associated with contactor		**W**	250 (Ie = 0.2 A, Ue = 250 VAC, Ith = 2 A, 300,000 operations for resistive load) **LC1-K, LC2-K, LC7-K, LC8-K with suppressor block LA4-KE**
DC loads	Rated voltage		**V**	30 VDC
	Permissible power for category DC-15 Associated with contactor		**W**	50 (Ie = 0.2 A, Ue = 30 VDC, Ith = 2 A, 300,000 operations for resistive load) **LP1-K, LP2-K with suppressor block LA4-KC**

External current transformer characteristics (Customer provided. Must have 1 A or 5 A secondary output)

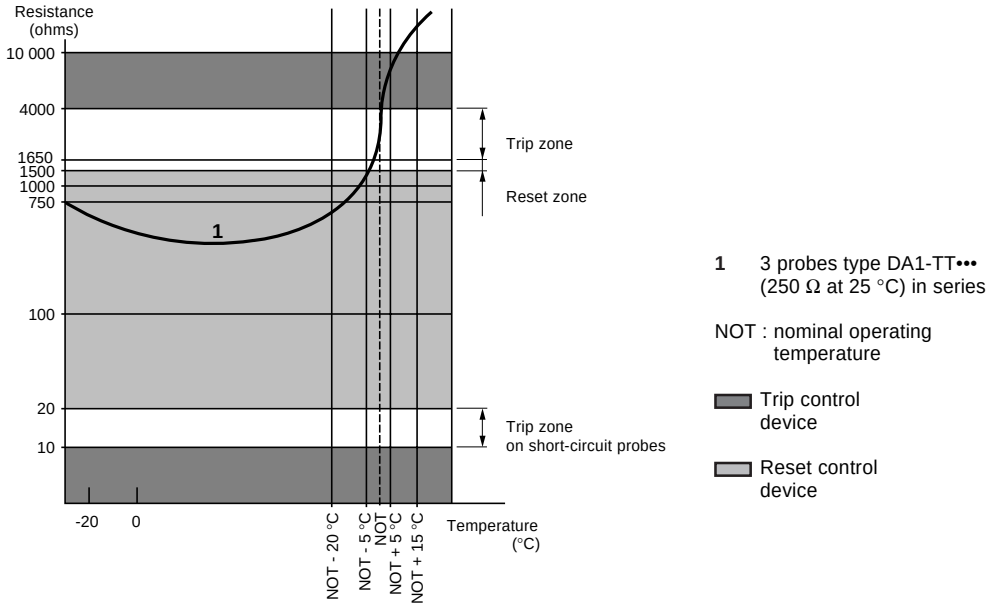
Conforming to standards			IEC 185, IEC 71
Accuracy class			5P
Accuracy limit factor			15

PTC thermistor probes			**DA1-TT•••**

Probe characteristics—terminals T1, T2 (see "Control circuit supply characteristics" for cabling and tightening torques)

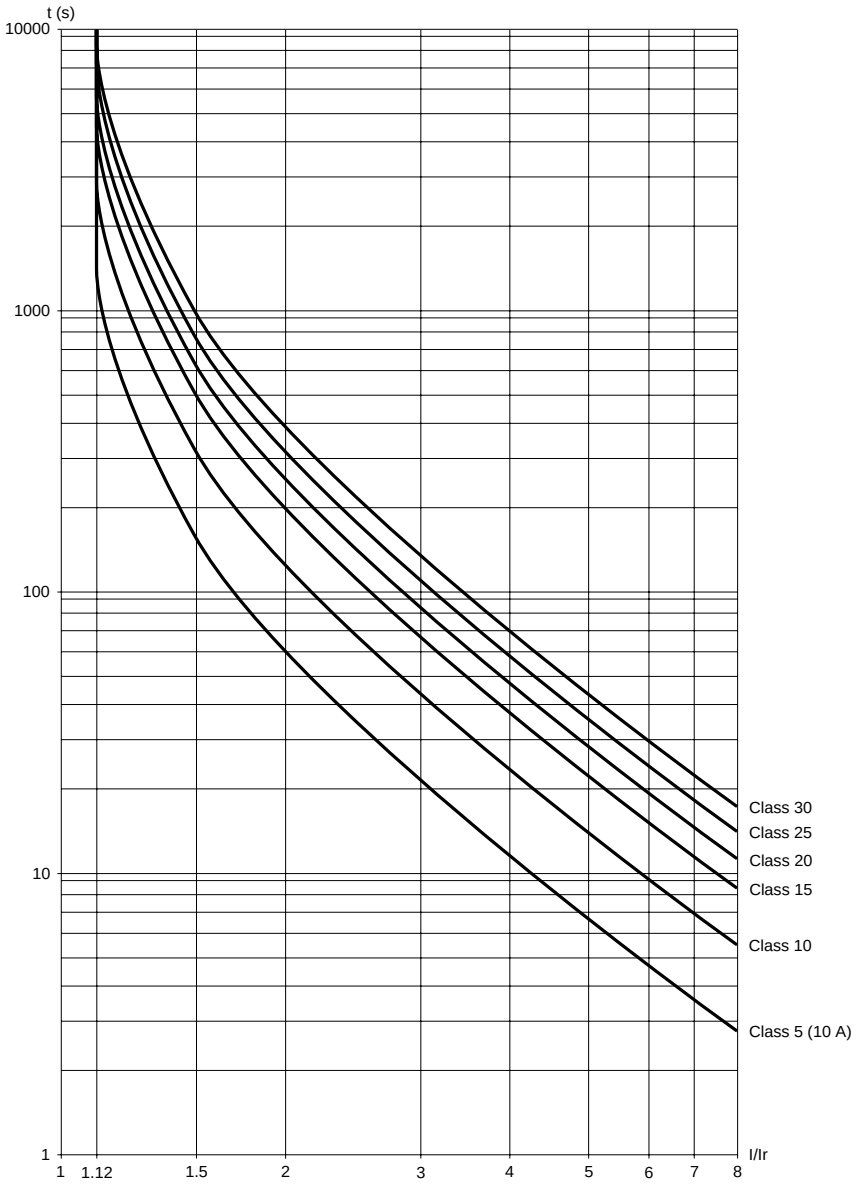
Conforming to standards			IEC 34-11, mark A
Resistance	At 25 °C	Ω	3 x 250 in series
Rated operational voltage (Ue)	Per probe	**V**	2.5 VDC max.
Rated insulation voltage (Ui)		**kV**	2.5
Insulation			Reinforced
Cable lengths	Between probes	**mm** **in**	250 10
	Between probe and motor terminal block	**m** **ft**	1 3

Guaranteed operating zones : examples with 3 probes type DA1-TT••• (250 Ω at 25 °C) connected in series, conforming to IEC 34-11, mark A.



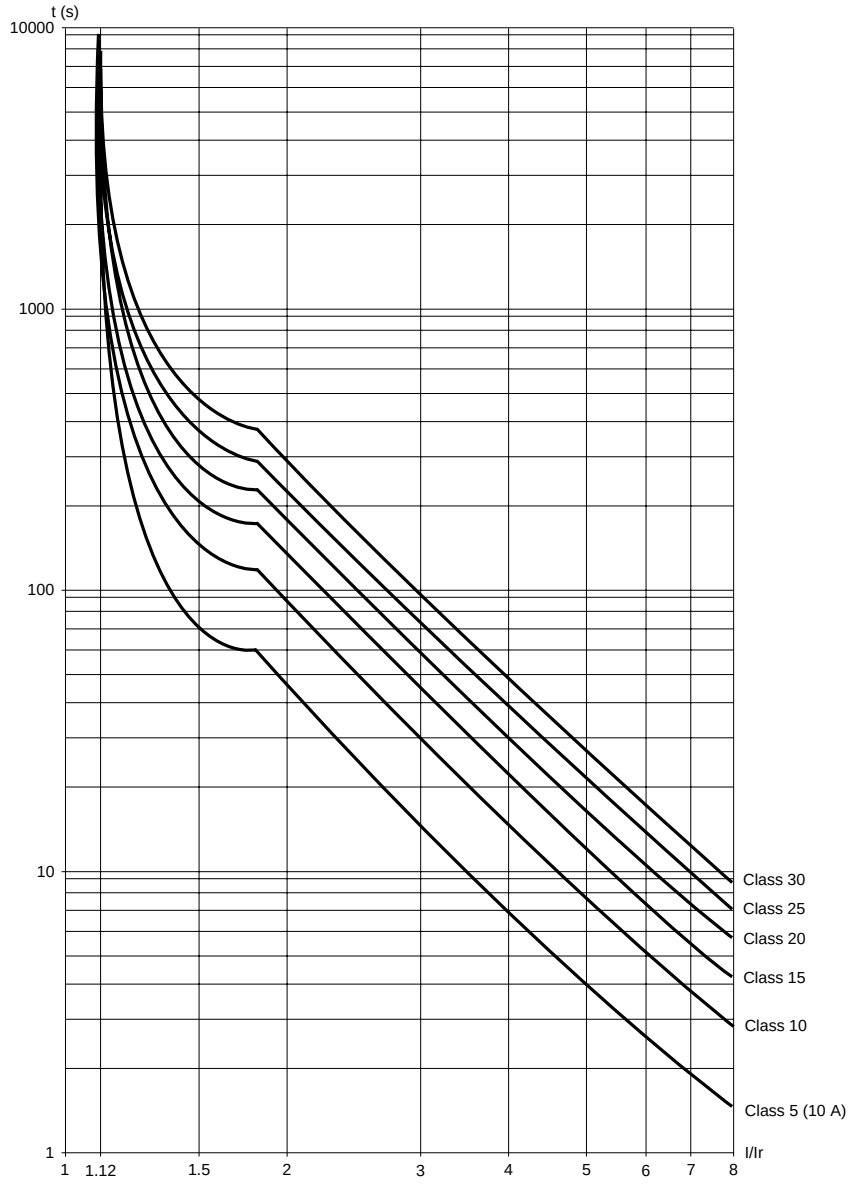
Tripping Curves

Cold state curves (1)



(1) Tripping time accuracy : ± 8 % to 7.2 x I/Ir.

Hot state curves (1)



(1) Tripping time accuracy : ± 8 % to 7.2 x I/Ir.

LT6-P0M005FM

3-pole multifunction protection relays

Operational current **A**	Catalog Number
0.2 to 1 (use terminals L11-L21-L31)	**LT6-P0M005FM**
1 to 5 (use terminals L15-L25-L35)	**LT6-P0M005FM**
5 to 25	**LT6-P0M025FM**

For AC motor full load currents > 25 A, use LT6P0M005FM with customer provided external current transformers with 1 A or 5 A secondary outputs.

Configuration software and user's manual

Description	For use with	Catalog Number
Configuration software kit: - 3"1/2 diskette, - 2 meter RS232 cable	All ratings of relay PC minimum requirements: 386 SX with Windows 3.1	**LA9-P620**
User's manual — USA Edition		**9110IM9701**

Earth fault toroids (ground fault current transformers)

Products marketed under the Merlin Gerin brandname. For ordering references, please refer to our Merlin Gerin "Low voltage distribution 95/96" catalog, pages D72 to D74

Sensitivity	Internal Ø of toroid **mm**	Type	Catalog Number
0.3 to 30 A	30	TA30	**50437**
	50	PA50	**50438**
	80	IA80	**50439**
	120	MA120	**50440**
	200	SA200	**50441**
	300	GA300	**50442**
	46	POA	**50485**
	110	GOA	**50486**

Note: Merlin Gerin earth fault toroids may be substituted with GFCT with 1000:1 ratio.

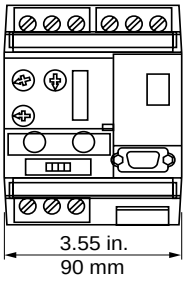
DA1-TT•••

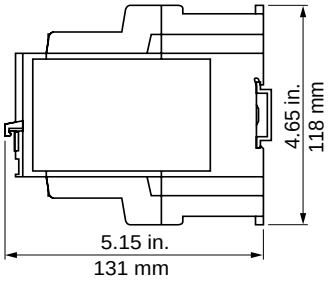
PTC thermistor probes

Description	Nominal operating temperature (NOT) °C	Sold in lots of	Catalog Number
Triple probes	90	10	**DA1-TT090**
	110	10	**DA1-TT110**
	120	10	**DA1-TT120**
	130	10	**DA1-TT130**
	140	10	**DA1-TT140**
	150	10	**DA1-TT150**
	160	10	**DA1-TT160**
	170	10	**DA1-TT170**

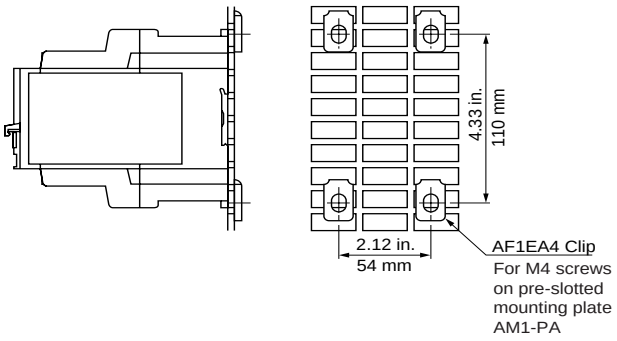
Mounting Dimensions

Protection relays LT6-P
LT6-P0M•••FM
on 35 mm " DIN rail



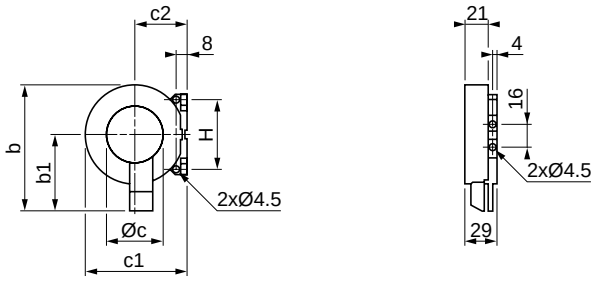


Drilling pattern for panel mounting with M4 or ANSI #8 machine screws



LT6-P0M•••FM weight: 1.03 kg (2.3 lbs).

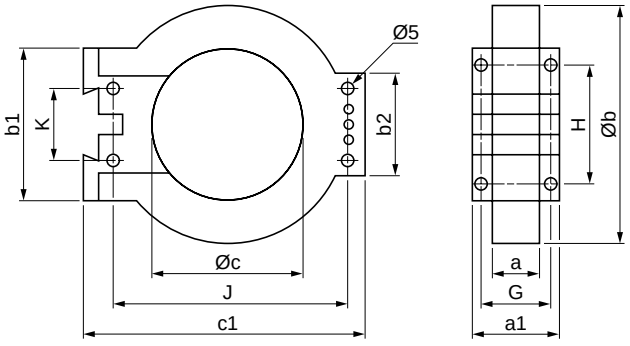
Earth fault toroids
TA30, PA50



Dimensions in millimeters

Type	b	b1	Øc	c1	c2	H
TA30	83	53	30	60	31	50
PA50	109	66	50	87	45	60

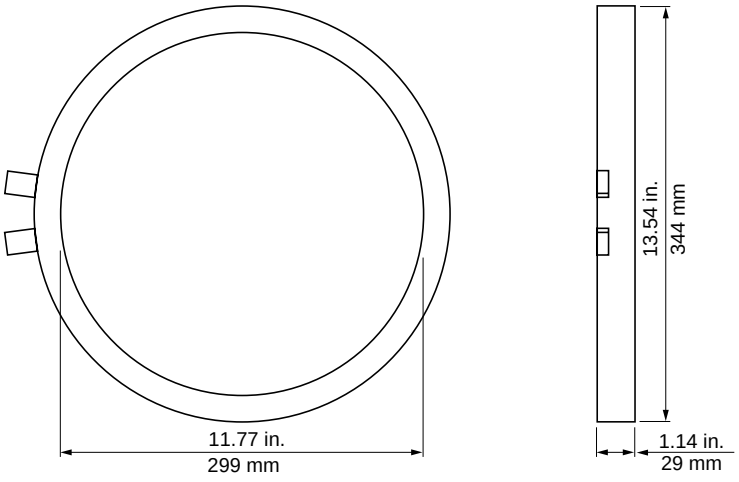
IA80, MA120, SA200



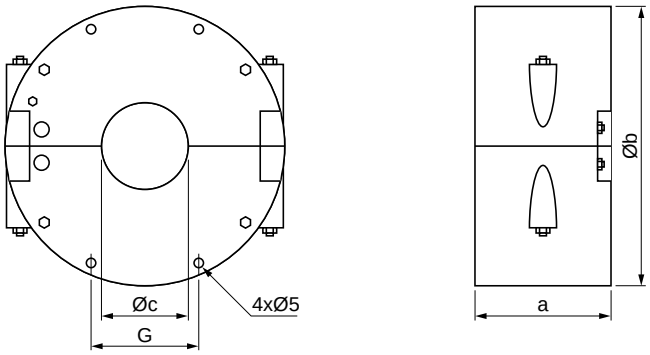
Dimensions in millimeters

Type	a	a1	Øb	b1	b2	Øc	c1	G	H	J	K
IA80	26.5	44	122	80	55	80	150	35	65	126	40
MA120	26.5	44	164	80	55	120	190	35	65	166	40
SA200	29	46	256	120	90	196	274	37	104	254	60

GA300



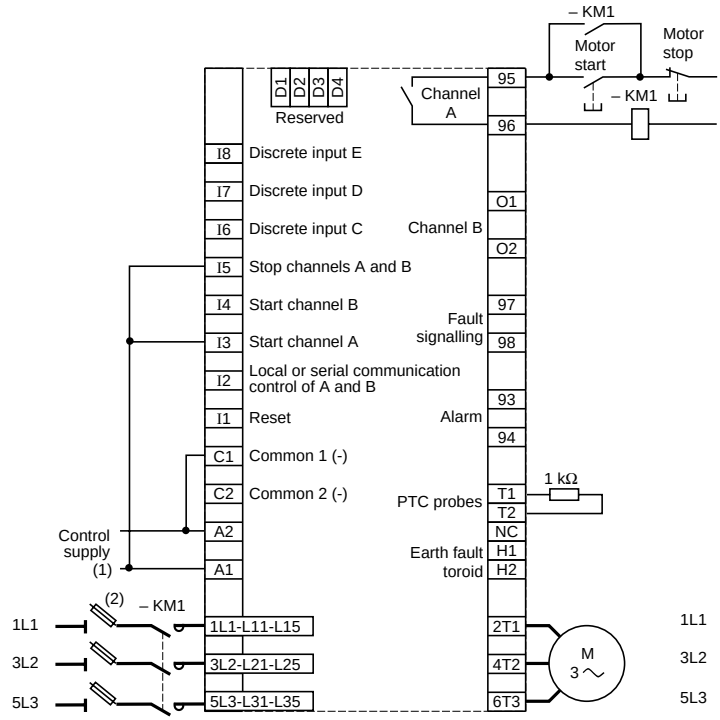
POA, GOA



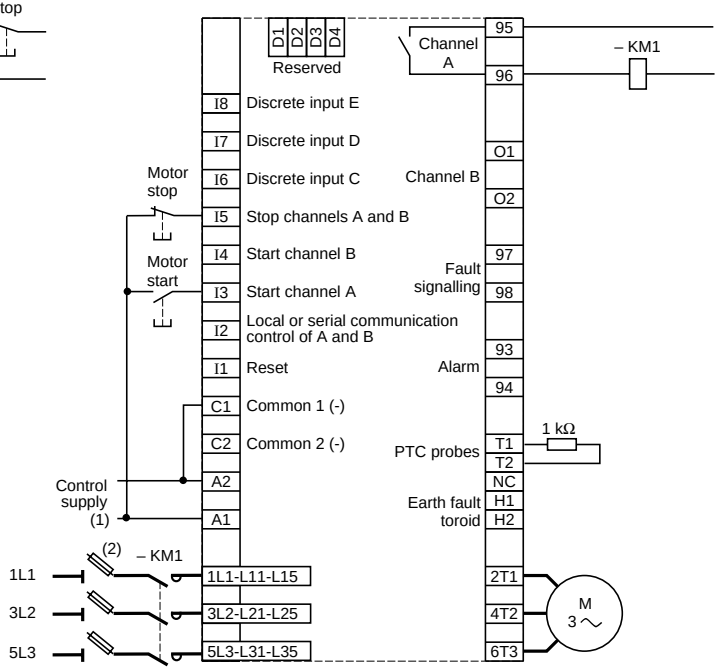
	Dimensions in millimeters			
Type	a	Øb	Øc	G
POA	72	148	46	57
GOA	78	224	110	76

Motor control: full-voltage non-reversing starting (channels A and B set for reversing or independent control)

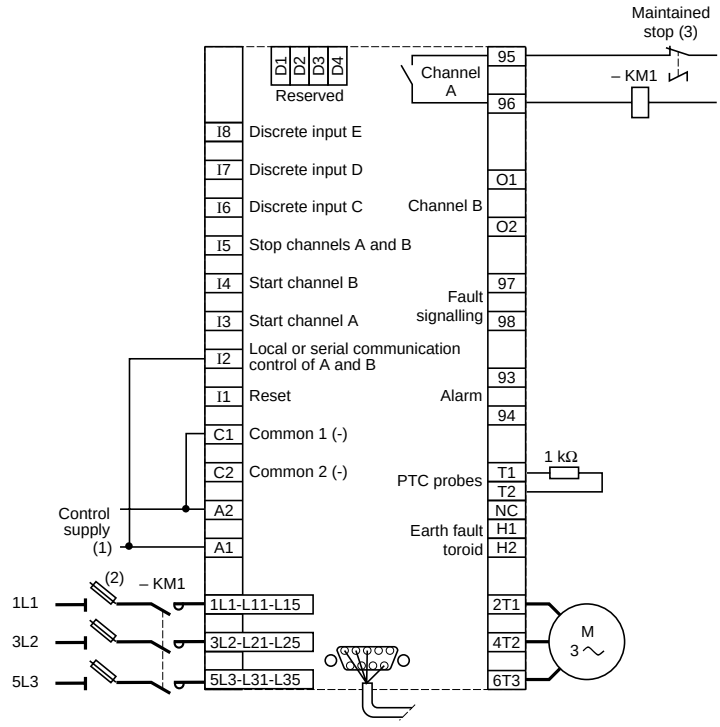
Control from front face of relay



Control via discrete inputs of relay



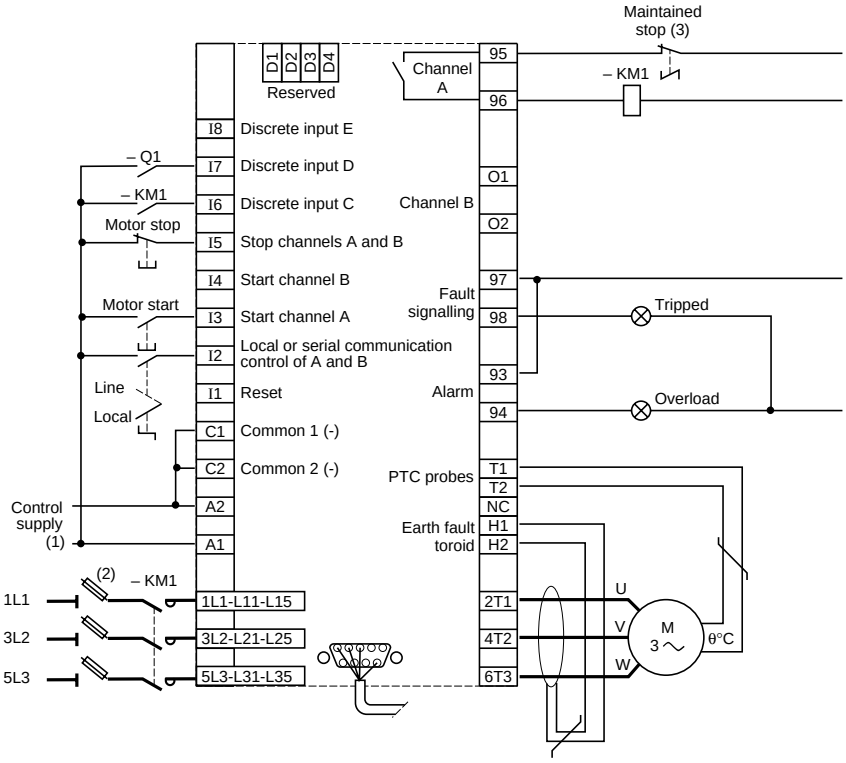
Control via serial link communication (UNI-TELWAY, Jbus/Modbus)



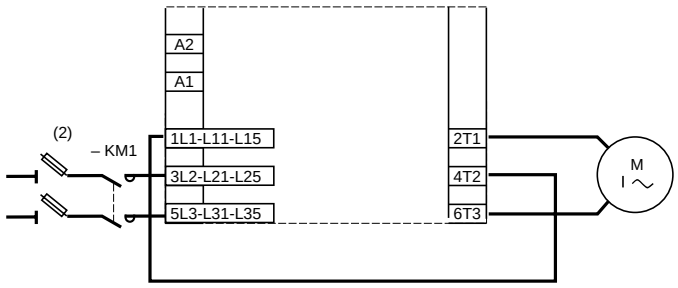
(1) For DC control supplies inputs I1 to I8 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

Motor control: full-voltage non-reversing starting

Control via serial link communication with signalling, earth fault toroid, PTC probes, state of power components
Channels A and B set for reversing or independent control
Possible to control the motor via discrete input (“local” position) or by serial link communication



Power terminal connections for single-phase motor applications

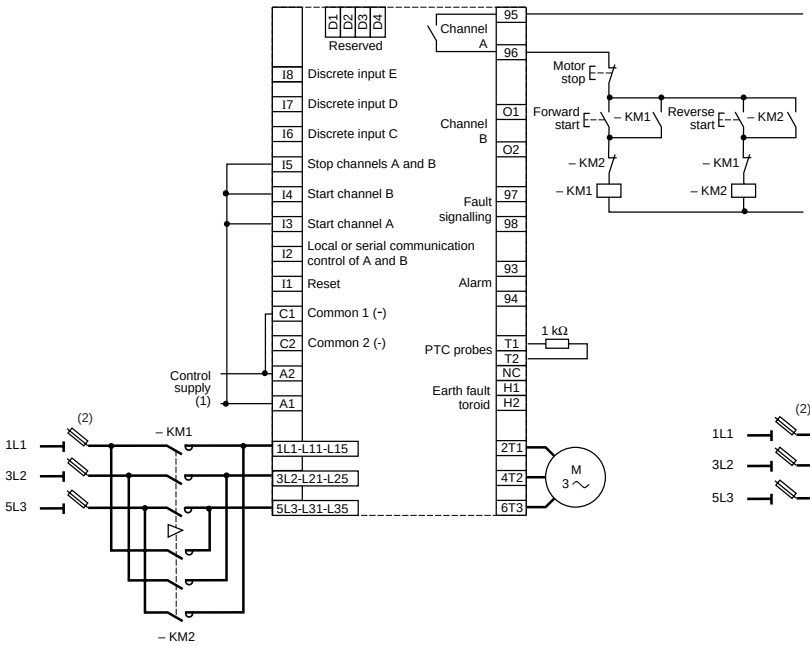


(1) For DC control supplies the inputs I1 to I8 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with the National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

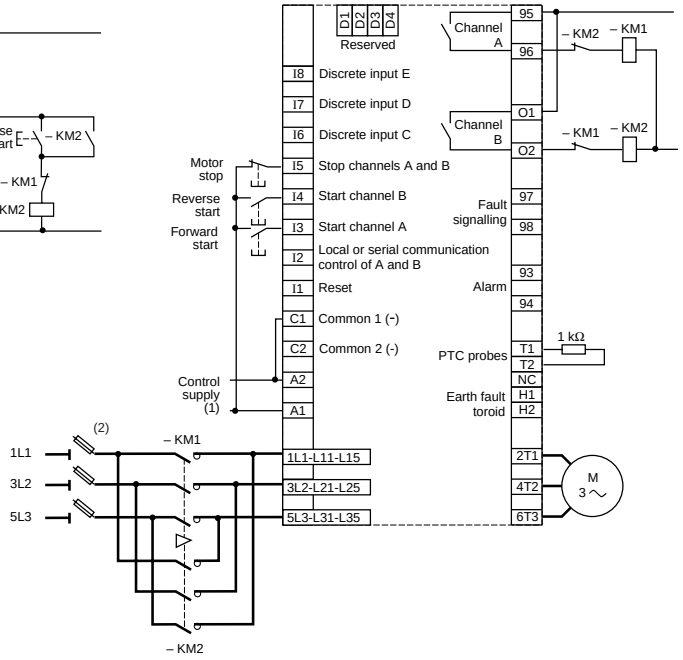
Application Diagrams

Motor control: full-voltage reversing starting

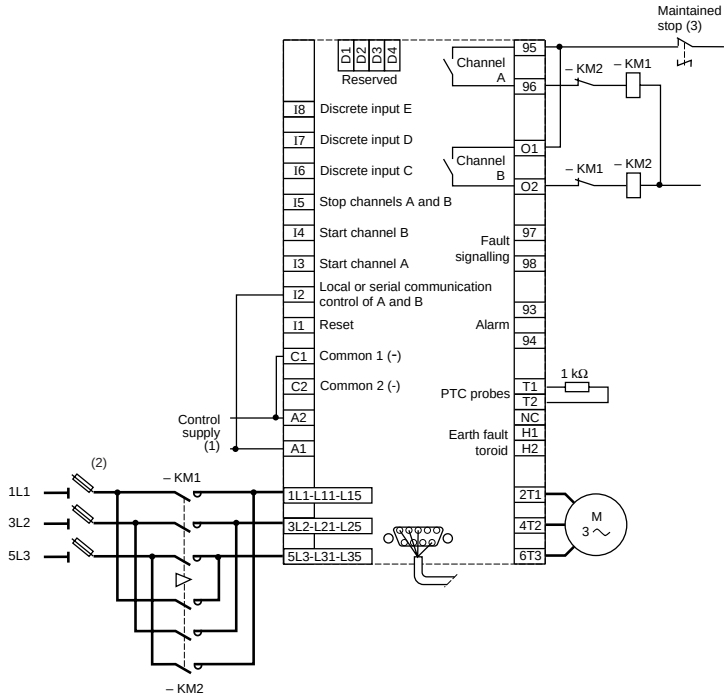
Control via front face of relay
Channels A and B set for reversing control



Control via discrete inputs of relay
Channels A and B set for reversing control



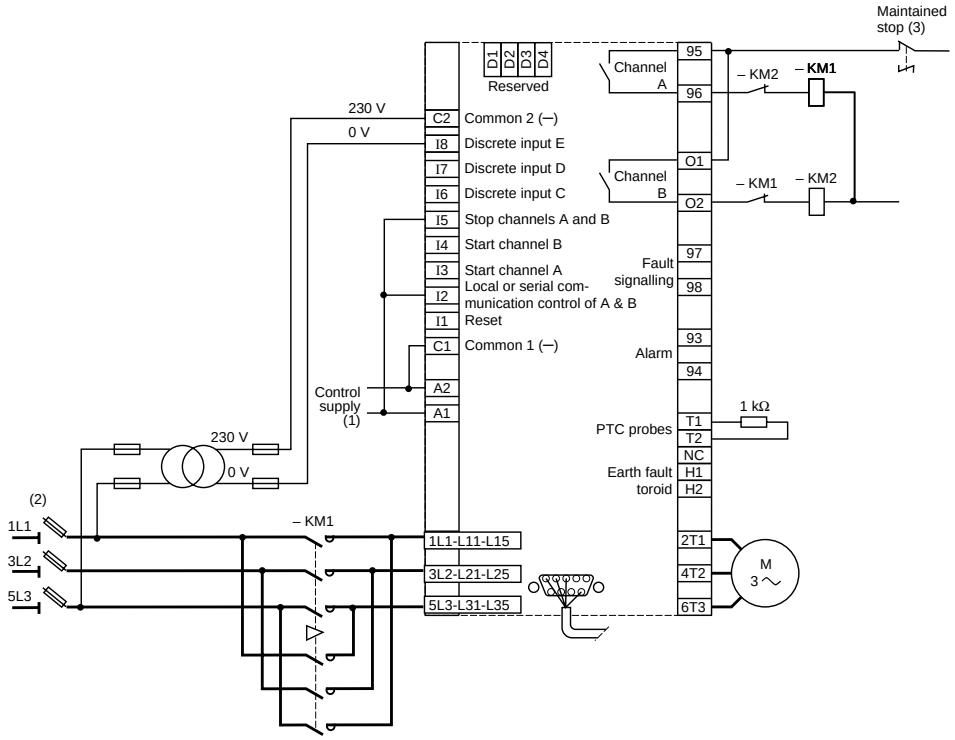
Control via serial link communication
Channels A and B set for independent control



(1) For DC control supplies the inputs I1 to I8 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

Motor control: full-voltage reversing starting with measurement of cos φ and voltage

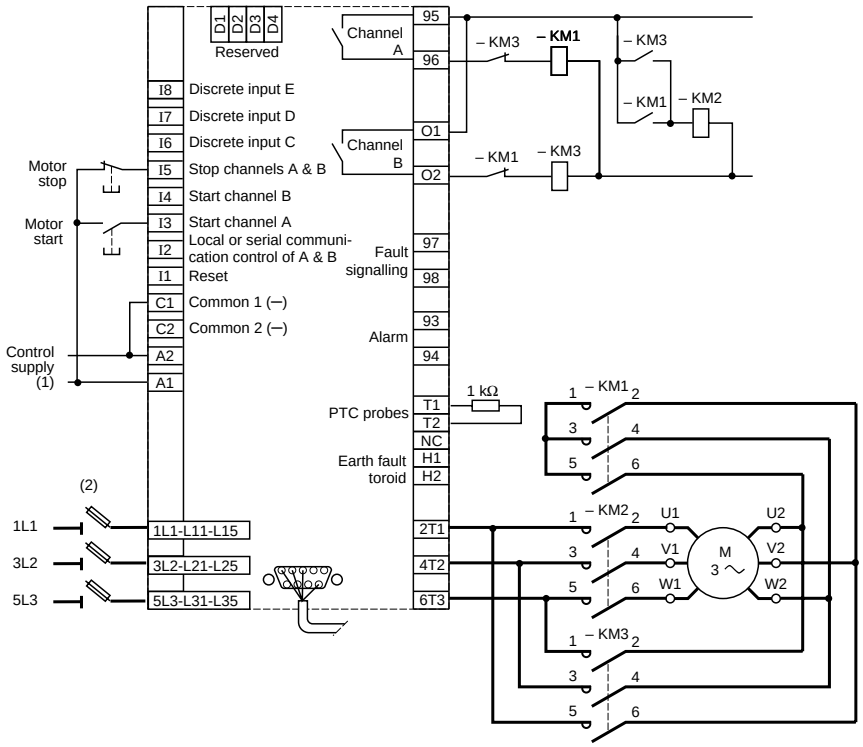
Control via serial link communication
Channels A and B set for reversing control



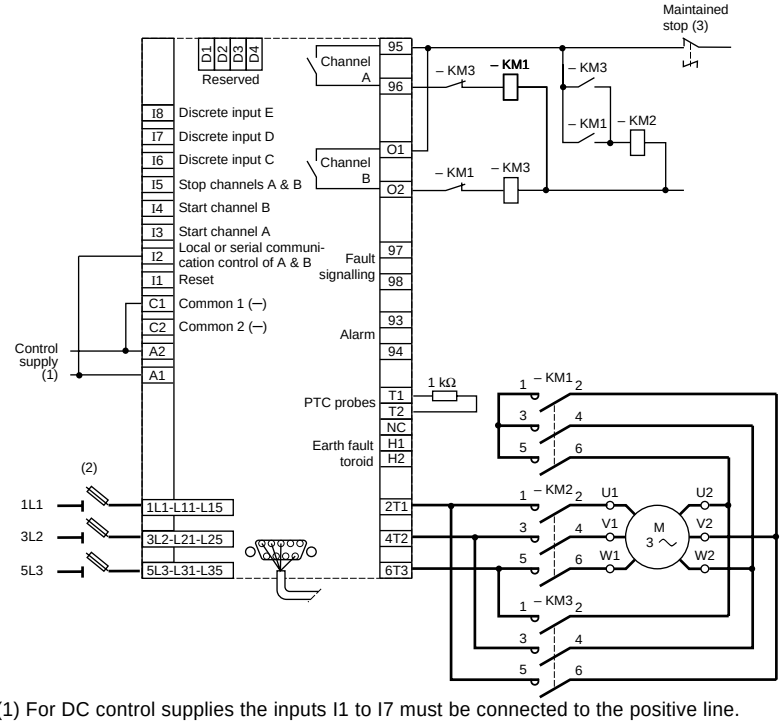
(1) For DC control supplies the inputs I1 to I7 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

Motor control: star-delta starting (channels A and B set for 2-stage control)

Control via discrete inputs of relay



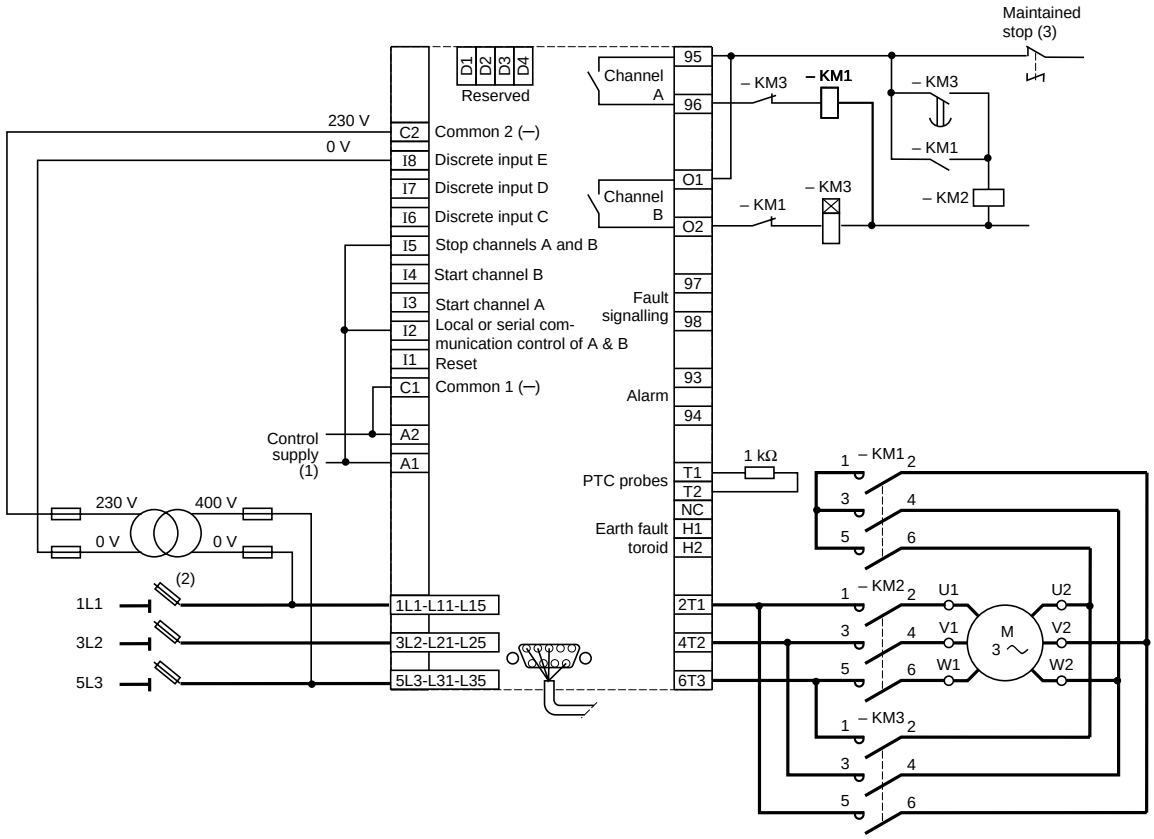
Control via serial link communication



(1) For DC control supplies the inputs I1 to I7 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

Motor control: star-delta starting with adjustable time delay

Control via serial link communication
Channels A and B set for 2-stage control



(1) For DC control supplies the inputs I1 to I7 must be connected to the positive line.
(2) Disconnecting means and short circuit protection must comply with National Electrical Code and local codes.
(3) Local maintained stop must be connected when serial link is used without local stop push button.

Glossary

PTC	Positive Temperature Coefficient. A thermistor resistor with a resistance value which increases with temperature and which increases very rapidly as the nominal operating temperature is reached.
RDF	Residual Differential Fault (earth leakage or ground fault)
rms	Root mean square value of a signal
I	Line current
Ir	Motor full load current
Id	Phase imbalance current (calculated value)
IΔ	Residual differential fault current (earth leakage current)
IΔr	Set value of the residual differential fault current (earth leakage current)
Iv	Monitoring value of the underload current, a multiple of Ir
Imax	The highest value of the three phase currents
Imini	The lowest value of the three phase currents
Iav	Average value of the three phase currents
Isd	Monitoring threshold of the starting current, a multiple of Ir
I_{LC}	Torque limitation (locked rotor) current
I_{CC}	Short-circuit current
Discrete	On/Off
Θn	Nominal temperature of the iron circuit reached with I = Ir after an infinite time
Θr	Set temperature for the thermal overload alarm
Cos φ	Power factor
Earth fault	Ground fault
Earth fault toroid	Ground fault sensor (zero sequence current transformer)
Un	Nominal voltage

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