

*SRC-XS and SRC-S series compressors*

*Electrical devices*

*(SA-05-07-E)*

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## 5. Electrical motor

### 5.1 General

The electric motors are three-phase asynchronous two-pole motors (2900 rpm at 50 Hz). To reduce the peak current, they are available in the part-winding (PW) or star/delta (Y/ $\Delta$ ) version; for the standard supply see Table C in paragraph 5.6: Electrical specifications.

Depending on the compressor model there are two different types of PW motors which differ from each other for the connection of the three phases: star or delta type. In any case at the compressor starting only a part of the windings is powered, while in normal operation all are powered. The PW versions can be:

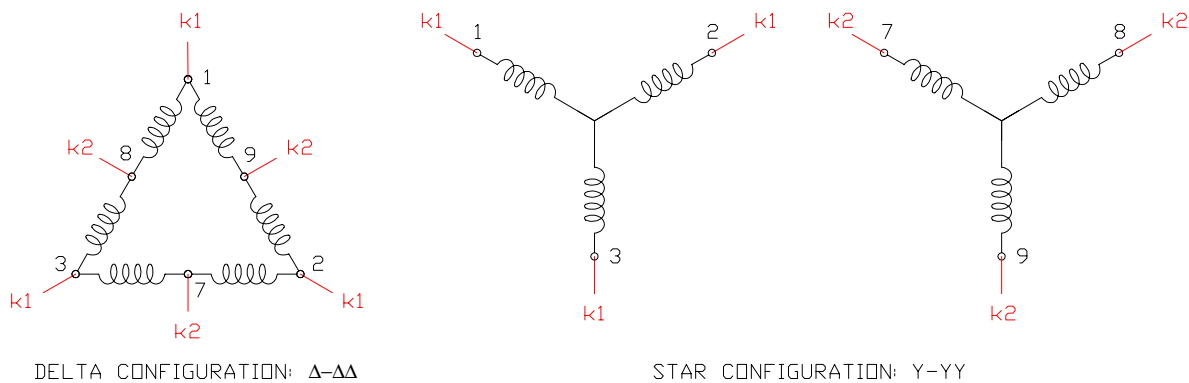
- ✓ Double star (Y-YY);
- ✓ Double delta ( $\Delta$ - $\Delta\Delta$ ).

As regards the mains connections, there is no difference between the two PW motor configurations. Pictures 5-A and 5-B below show the internal connections of the phases, depending on the configuration of the electrical motor.

• **PART-WINDING CONFIGURATION**

	<p><b>Important note:</b></p> <p>The two above-mentioned part-winding types of motors can be distinguished by measuring the electrical resistance between terminals 1-2-3 and 7-8-9.</p> <p>With reference to picture 5-A:</p> <ul style="list-style-type: none"> <li>✓ in the Y-YY configuration there is continuity between terminals 1 and 2, 1 and 3, 2 and 3, 7 and 8, 7 and 9, 8 and 9; while there is insulation between terminals 1 and 7/8/9, 2 and 7/8/9, 3 and 7/8/9.</li> <li>✓ in the <math>\Delta</math>-<math>\Delta\Delta</math> configuration there is continuity between each pair of terminals and there is not reciprocal insulation between any of them.</li> </ul>
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### PART-WINDING CONFIGURATION

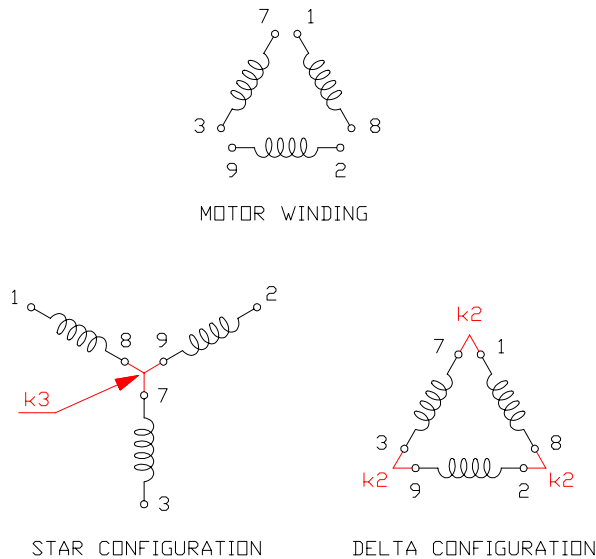


**Picture 5-A: internal winding connections for the motors with part-winding configuration;**

- STAR-DELTA CONFIGURATION**

	<p><b>Important note:</b></p> <p>With reference to picture 5-B, measuring the electrical resistance between terminals 1-2-3 and 7-8-9, the star-delta version has the following values: continuity between terminals 1 and 8, 3 and 7, 2 and 9, and insulation between terminals 1 and 2/3/7/9, 2 and 1/3/7/8, 3 and 1/2/8/9, 7 and 1/2/8/9, 8 and 2/3/7/9, 9 and 1/3/7/8.</p>
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## STAR-DELTA CONFIGURATION



**Picture 5- B: internal winding connections for the motors with star-delta configuration;**

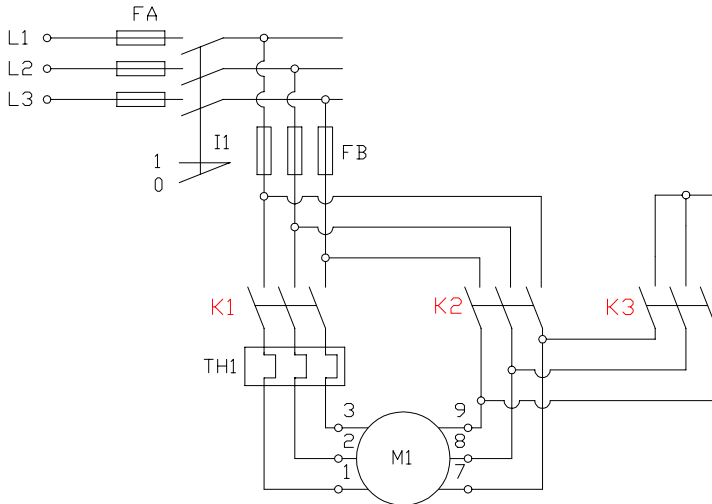
By starting the electrical motor either in part-winding configuration or with the windings in star connection for the electrical motor in star-delta configuration there is a reduction in the starting current LRA and starting torque. To achieve a reduction in the resisting torque and consequently start the motor without overloading it, the compressor needs to be started at the minimum capacity step, see chapters SA-03: “Capacity control” and SA-13: “Operating instructions”.

	<p><b>Note:</b></p> <p>Then with the screw compressors no by-pass system between the high and low pressure is required for reducing the resisting torque on starting.</p>
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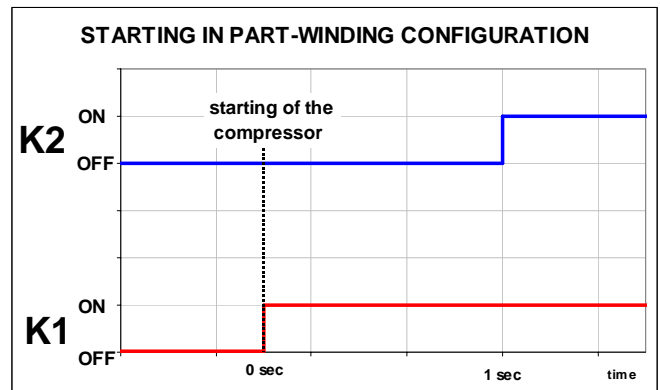
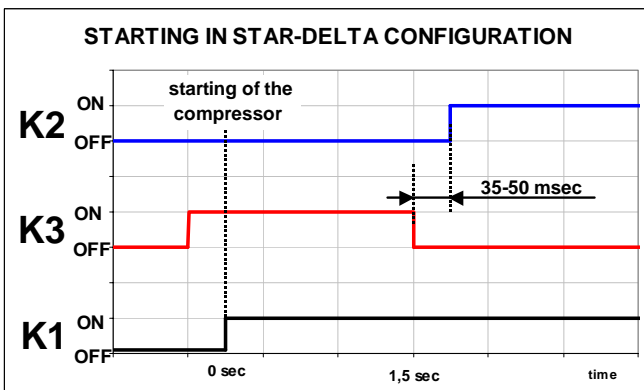
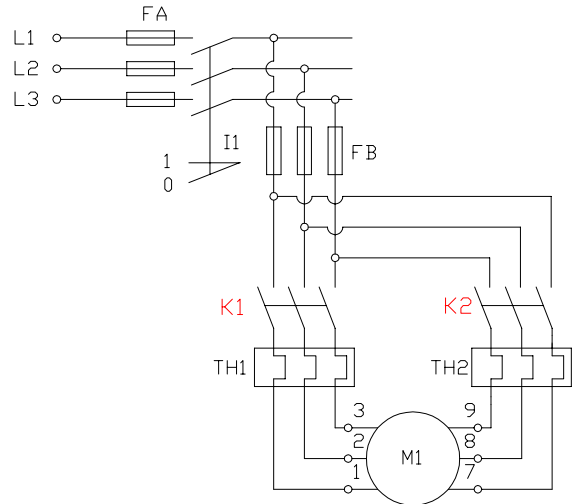
Picture 5-C shows how to connect the electrical motor to the three-phase line, both for the star-delta configuration and the part-winding one. It also gives the time sequence for the contactors. The compressor therefore starts as follows:

- ✓ In the PW motors, the delay in closing the run contactor K2 from when the starting contactor K1 closes must be 1 second maximum (recommended value 0.6 sec), see picture 5-C.
- ✓ In the star-delta configuration, on the other hand, the starting duration in star configuration (closing of contactors K1-K3) must not exceed 1.5 sec (recommended value 0.8/1 sec); while when switching to delta configuration (closing of contactors K1-K2), contactor K2 must be closed with a delay of 35-50 msec from the instant when contactor K3 is opened, see picture 5-C again.

STAR-DELTA  
CONFIGURATION



PART-WINDING  
CONFIGURATION



**Picture 5- C: connection diagrams to the three-phase network and time charts for the activation of contactors K1, K2 and K3 in the two compressor starting modes: star-delta and part-winding;  
FA, FB: main fuses and compressor’s fuses  
I1: main switch;  
M1: electrical motor;  
TH1, TH2: overload relay;**


The motor stator is secured to the compressor casing by using a screw and a key. Hence no special tools are required to replace the motor. The electrical motors are designed and tested in compliance with the European standard EN 60335-2-34.

## 5.2 Protection devices

### 5.2.1 Motor thermistors

To protect the motor against high temperatures six PTC thermistors connected in series are inserted in the motor windings. Three thermistors are positioned on the intake side of the motor (suction side) and have an activation temperature of 100°C, while the other three are positioned on the opposite side of the motor (discharge side) and have an activation temperature of 120°C.

The resistance of the chain of thermistors when cold (temperature less than 40°C) must be less than 1800 Ohm; but even if just one of the thermistors reaches the critical temperature, the resistance of the chain will increase exponentially, with the consequent activation of the INT 69 VS electronic module (INT 69 RCY as an option), which cut off the power supply to the motor. The resistance can be measured between terminals T1 and T2 on the terminal block.

	<p><b>Warning!</b> When measuring the resistance of the thermistors' chain, never apply a voltage higher than 3V.</p>
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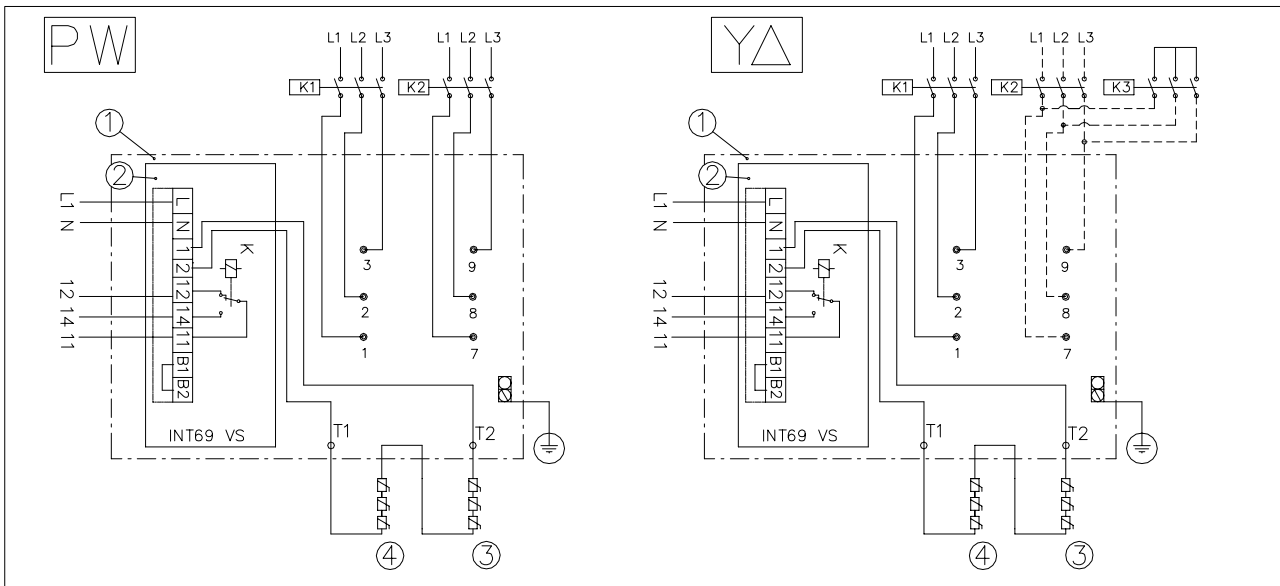
### 5.2.2 INT 69 VS

This electronic protection module is supplied as standard with the compressor and in combination with the thermistors it carries out the function of monitoring the temperature of the electrical motor windings. The thermistors in the motor can be connected in series to a further PTC probe for monitoring the temperature of the oil (set point 120°C; picture 5-F shows the position of the temperature sensor in the compressor; see also chapter SA-11: “Additional cooling”).

The protection device is electrically connected by the manufacturer as shown in picture 5-D. For the technical specifications of the module, see Table A.

<b>Activation threshold</b>	12500 Ohm;
<b>Reset threshold</b>	2400 Ohm;
<b>Power supply</b>	230 V ±10%, 50/60 Hz, 3VA;
<b>Switching relay</b>	250 V AC, continuous current max 5 A, switch capacity 300 VA
<b>Ambient temperature</b>	-30° C...+60° C
<b>Fuse required</b>	4 A quick blow

**TableA: INT 69 VS technical specifications;**




**Picture 5-D: electrical connections to the INT 69 VS module (part-winding and star delta);**

- |                                       |   |
|---------------------------------------|---|
| 1: Terminal plate;                    | L1/N: Phase + neutral;                          |
| 2: Motor protection device INT 69 VS; | 11/14: Control circuit;                         |
| 3, 4: Motor thermistors PTC;          | 1/2 : Connection cables to thermistor (orange); |
| L1, L2, L3: Supply voltage;           | 12: alarm;                                      |
| PW: K1 Contactor 1st PW (PW 50%);     | B1, B2: Link for automatic reset;               |
| K2 Cont. 2nd PW (PW 50%);             | K: Relay (supplied fitted);                     |
| Y/Δ: K1 and K3 Start contactors (Y);  |   |
| K1 and K2 Run contactors (Δ);         |   |

To protect the electronic module, it is recommended to install a 4A fast-blow fuse to prevent the contacts from melting in the event of short-circuits.

The correct operation of the module must be checked when testing the installation and after any fault occurred in the auxiliary circuit. For this purpose, remove one of the connection wires from terminals T1 and T2 on the terminal block (not powered). When supplying power to the auxiliary control circuit, the power runs between terminals 12 and N, signalling an alarm.

In the event where the thermal protector on the electric motor is activated, this must be reset by specialist personnel. The device can only be reset after the causes of activation have been identified and removed.

	<p><b>Warning!</b></p> <ul style="list-style-type: none"> <li>✓ Following an alarm and after the motor has cooled down, an internal lockout prevents the compressor from starting again. Reset the INT 69 VS module by briefly disconnecting the power supply through the main switch or by pressing a specific button that can be installed for this purpose in the power supply line.</li> <li>✓ Never apply power to the module terminals 1-2, B1-B2, nor to terminals T1 and T2 of the terminal plate.</li> </ul>
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A phase monitor must be installed to check the correct direction of the electrical motor rotation.

## 5.2.3 INT 69 RCY

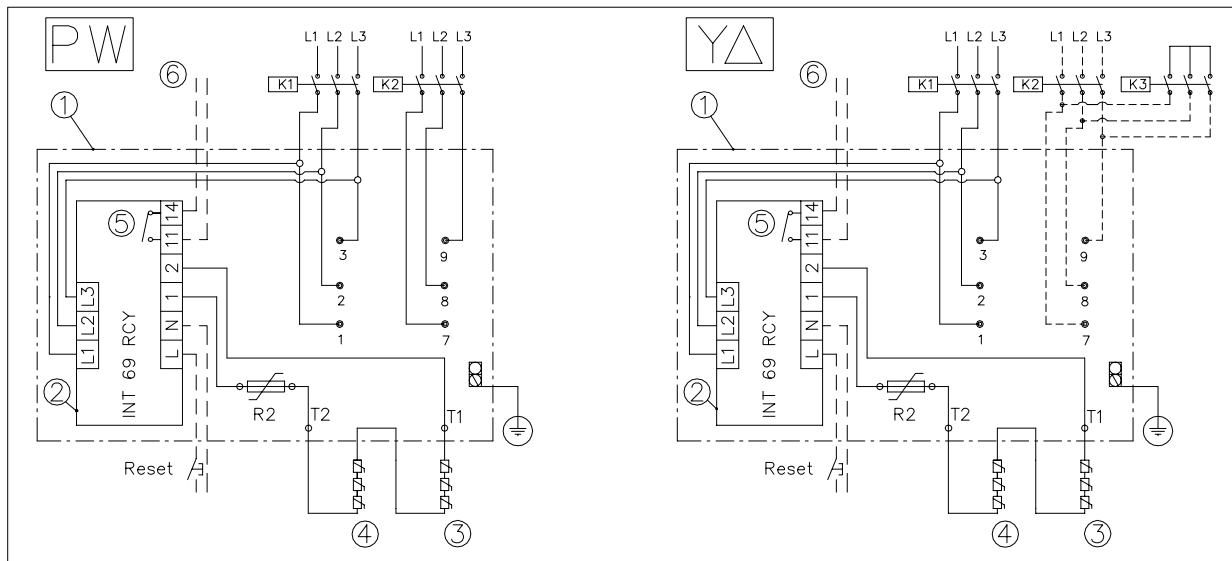
The INT 69 RCY module is available as an optional. This module carries out the following functions:

- ✓ monitors the temperature of the electrical motor and the oil;
- ✓ monitors the direction of rotation of the motor;
- ✓ monitors for a missing phase.

The electrical connections on the INT 69 RCY protection module are shown in pictures 5-E (PW and Star/Delta). For the technical specifications of the module see Table B.

<b>Activation threshold</b>	11400 Ohm;
<b>Reset threshold</b>	10900 Ohm;
<b>Power supply</b>	115/120 V or 230/240 V -15/+10%, 50/60 Hz, 3 VA;
<b>Switching relay</b>	240 V AC, continuous current max 2.5 A, switch capacity 300 VA;
<b>Ambient temperature</b>	-30° C...+60° C;
<b>Fuse required</b>	4A quick blow;
<b>Motor voltage</b>	3 AC, 50/60 Hz, 120...632 V;

**Table B: INT 69 RCY technical specifications;**



**Picture 5-E: electrical connections to the INT 69 RCY module (part-winding and star delta);**

- 1: terminal plate;
- 2: motor protection device INT 69 RCY;
- 3, 4: motor thermistors PTC;
- R2: oil temperature sensor;
- PW: K1 contactor 1st PW (PW 50%);
- K2 cont. 2nd PW (PW 50%);

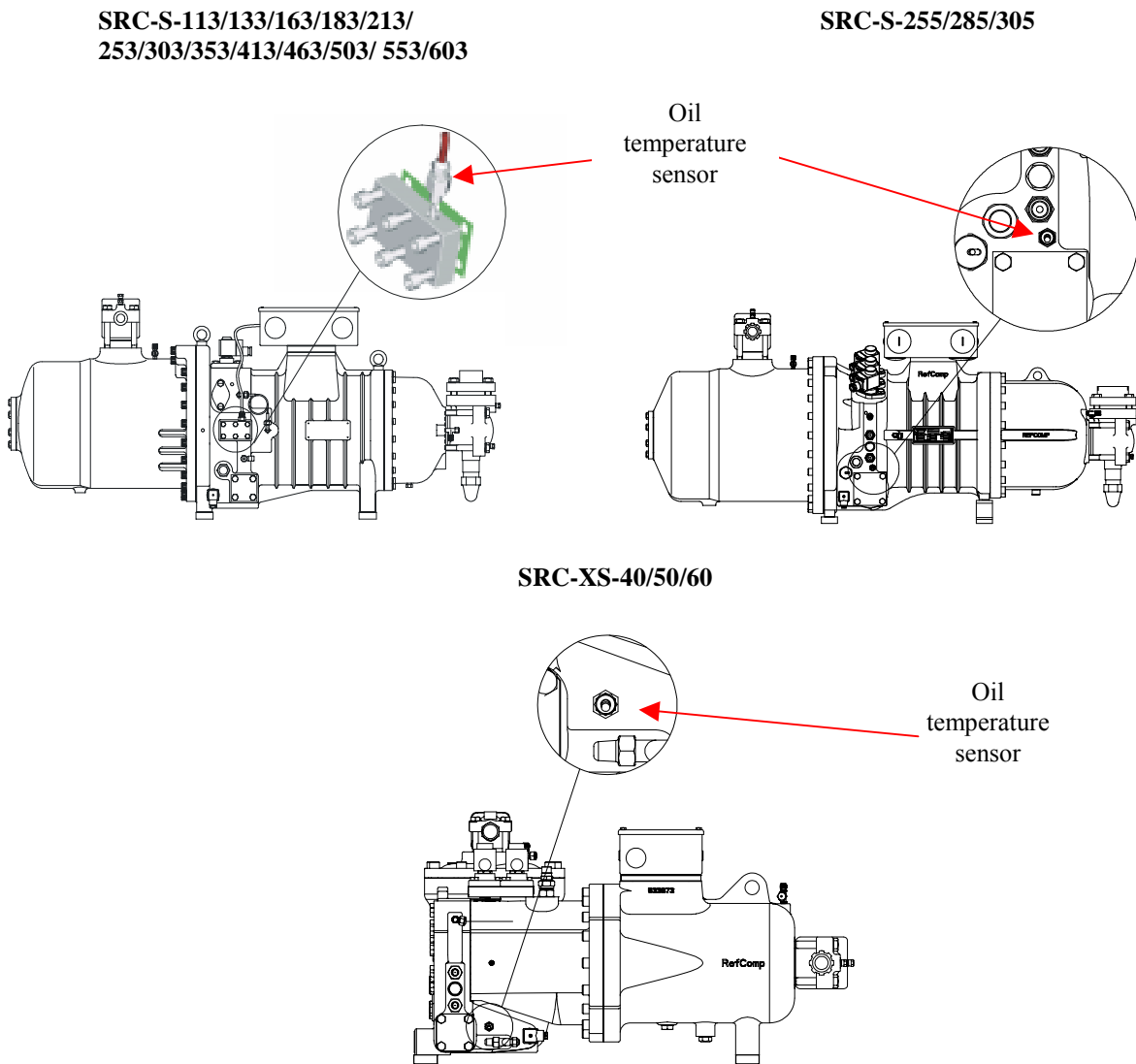
- L1/N: Phase + neutral;
- 5: Relay (supplied fitted);
- 6: Control circuit;
- L1, L2, L3: Supply voltage;
- Y/Δ: K1 and K3 Start contactor (Y);
- K1 and K2 Run contactor (Δ);

## Monitoring the temperature

The temperature of the motor and the oil are monitored by the PTC sensors. The oil temperature sensor is connected in series to the chain of thermistors in the electrical motor (for its position on the compressor see picture 5-F and chapter SA-11: “Additional cooling”). Following an alarm the control unit needs to be reset manually and the power supply has to be disconnected for at least 2 seconds.

N.B. Before re-starting the compressor following an alarm, the operator must check the temperature of the motor and the oil temperature, making sure that the resistance of the PTC chain is less than 3 kΩ.

As can be seen in the following figure, in compressor models SRC-S-113/133/163/183/213/253/303/353/413/463 503/553/603, the oil temperature probe should be fitted to the oil cooling plate (see chapter SA-11, paragraph 11.5) while in models SRC-XS and SRC-S-255/285/305, the probe should be inserted directly in the compressor casing, near the oil filter.



**Picture 5-F: position in the compressor of the probe for monitoring the oil temperature;**

## Monitoring the direction of rotation of the motor

The correct direction of rotation of the motor is monitored by measuring the sequence of the phases at the compressor terminals. The function has a manual reset and requires the power supply to be disconnected for at least 2s (after correcting the sequence of the phases). The check is only performed in the first 5 seconds after starting, and not during the operation of the compressor.



## Monitoring for a missing phase

The phases are monitored during the start-up and, if a missing phase is detected, the compressor is stopped. The compressor restarts automatically every 5 minutes, but after 10 consecutive restarts with a missing phase the compressor is stopped definitively. After this, it must be reset manually by disconnecting the power supply for at least 2 seconds.

The INT 69 RCY module is generally fitted in the compressor's electrical box. However it can be moved and fitted in a main control box far away from the compressor according to the following indications:

- ✓ The connection cables to the motor terminals must be connected following the specified sequence: L1 to terminal 1, L2 to terminal 2 and L3 to terminal 3; **check the direction of rotation with an indicator**;
- ✓ To connect the module to the PTC sensors, only use shielded cables or a twisted pair (danger of induction);

## 5.3 Power supply

	<p><b>Warning!</b></p> <p style="text-align: center;">  </p> <p>For the direction of rotation of the rotors see chapter SA-01: "General". If the motor turns in the opposite direction the compressor can be seriously damaged.</p>
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- Motor power supply for standard version (part-winding and star-delta):  
400 V - 3 phases - 50 Hz / 460 V - 3 phases - 60 Hz (other power supply on request);
- Permissible voltage range:  $\pm 10\%$  of rated voltage;
- Permissible voltage unbalance between L1 - L2 - L3:  $\pm 2\%$ ;
- Maximum voltage drop during the starting phase: 10 % of rated voltage;
- Permissible frequency range:  $\pm 2\%$  of rated frequency;
- Permissible current unbalance: 5 /12 % calculated as follows:

Currents on the first contactor:  $I_1 - I_2 - I_3$

Currents on the second contactor:  $I_7 - I_8 - I_9$

Currents of each supply phase

$$I_R = I_1 + I_7$$

$$I_S = I_2 + I_8$$

$$I_T = I_3 + I_9$$

Unbalance of the three R - S - T currents:

$$I_M = \frac{I_R + I_S + I_T}{3}$$

$$SB_3\% = \frac{\text{MAX}(I_R, I_S, I_T) - I_M}{I_M} \cdot 100$$

$$SB_3\% < 5\%$$

Unbalance of the six 1 - 2 - 3 - 7 - 8 - 9 currents:

$$I_M = \frac{I_1 + I_2 + I_3 + I_7 + I_8 + I_9}{6}$$

$$SB_6\% = \frac{\text{MAX}(I_1, I_2, I_3, I_7, I_8, I_9) - I_M}{I_M} \cdot 100$$

$$SB_6\% < 12\%$$

## 5.4 Selection of electrical components

The various electrical components: cables, fuses etc. must be sized considering the maximum current that can be absorbed by the electrical motor during normal operation, i.e. the FLA.

Specifically, erring on the side of safety, in Part-Winding configuration the contacts on the motor contactors must be sized for a current equal to at least 65% of the maximum operating current (FLA). On the other hand, for the star-delta configuration the contacts must be sized for a current equal to at least 75% of the FLA.

## 5.5 Size of the motor

The electric motors are available in two sizes:

- ✓ Full size (motor 1): for the refrigerants R22, R407C, R134a, R404A e R507 (see chapter SA-10 “Operating limits”);
- ✓ Size small (motor 2): for R134a refrigerant only (see chapter SA-10 “Operating limits”); Normal operating conditions with a high level of condensation require a full size motor (motor 1);

**5.6 Technical data**

SRC-S		113	133	163	183	213	253	255	285**	303	305	353	413	463	503	553	603					
SRC-XS		40	50	60																		
Nominal motor power 50 Hz [HP/kW]		motor 1 (full size)	motor 2 (small size)	40/30	50/37	60/45	70/52	80/60	100/75	100/75	110/82	120/90	120/90	140/105	160/120	180/135	200/150	220/164	240/179			
Nominal motor supply [V*/phase/Hz]		400/3/50 or 460/3/60																				
Full size	PW	LRA PW [A]	277	303	373	280	351	495	495	586	646	646	-	-	-	-	-	-	-	-		
		LRA DOL [A]	398	406	547	459	580	770	770	965	953	953	-	-	-	-	-	-	-	-	-	
		FLA [A]	80	90	96	124	140	168	168	192	196	196	-	-	-	-	-	-	-	-	-	
	YD	LRA Y [A]	131	134	182	159	193	254	254	322	318	318	354	374	453	543	595	595	595	595	595	
		LRA D [A]	398	406	547	459	580	770	770	965	953	953	1155	1155	1333	1645	1802	1802	1802	1802	1802	
		FLA [A]	80	90	96	124	140	168	168	192	196	196	225	245	270	300	334	334	334	334	334	334
Small size only for R134a	PW	LRA PW [A]	227	277	303	262	280	351	351	351	495	495	-	-	-	-	-	-	-	-	-	
		LRA DOL [A]	331	398	406	422	459	580	580	580	770	770	-	-	-	-	-	-	-	-	-	-
		FLA [A]	50	62	68	79	96	105	105	117	130	130	-	-	-	-	-	-	-	-	-	-
	YD	LRA Y [A]	109	131	134	139	159	193	193	193	254	254	276	354	374	453	543	543	543	543	543	
		LRA D [A]	331	398	406	422	459	580	580	580	770	770	876	1155	1155	1333	1645	1645	1645	1645	1645	
		FLA [A]	50	62	68	79	96	105	105	117	130	130	156	168	185	205	229	229	229	229	229	229

- \*\*** : data not final;
- \*** : tolerance ±10% around the rated voltage;
- : standard supply;
- : not available;

**Table C: electrical data of the compressors;**