

MOTORS FOR DWM COPELAND SEMI-HERMETIC COMPRESSORS

1 Built in Motors for Semi-hermetic Refrigerant Compressors

The electric motors integrated in the compressor housing have been designed especially for use in refrigerant compressors. As they are subject to various loads in the application area of the compressor and come into contact with refrigerant and refrigerant machine oil, high grade and highly resistant insulation materials have been used. The insulation material of the motor windings of the compressors are in accordance with heat resistances grade "B" to VDE 0530. The associated temperature limit of 130°C is not fully utilized.

All motors are adapted to each specific optimum application area so that the compressor is highly effective when using full or part load.

2 Motor Code

Semi-hermetic refrigerant compressors are available in various motor versions depending upon requirements. The motor versions differ in operating voltage, type of switching, number of phases, frequency and type of motor protection. Due to the vast number of variations available a code for the motor is included in the model nomenclature to ensure correct designation. An example for a compressor model is given below .

DKSL - 15X - C A G
D6SH - 3500 - E W L
D8DJ - 600X - B W M / D

Motor Type		Motor Protection		Motor Voltages			
					V	Ph	Hz
C	Single-phase motor, one main and one auxiliary winding with start and run capacitor and potential relay	A	Over current thermal protection switch in the terminal box for single-phase motors	G	220-230	1	50
				S	220	1	50
				Z	220-240	1	50
T	Three-phase motor, one voltage D.O.L. only, connections only to terminals U, V, W	W	For three-phase motors, electronic motor protection with thermistors and release module KRIWAN in the terminal box	L	220-240/380-420	3	50
E	Three-phase motor, interchangeable for Y or Δ operation. Can be used D.O.L.			M	380-420	3	50
A	Three-phase part-winding or D.O.L. start motor, not interchangeable. For part-winding start the winding is divided 2/3 – 1/3.			R	220-240	3	50
				Y	500-550	3	50
B	Three-phase part-winding or D.O.L. start motor, not interchangeable. For part-winding start the winding is divided 3/5 – 2/3.			N	250-280/440-480	3	60
				D	440-480	3	60
F	Three-phase part-winding or D.O.L. start motor, not interchangeable. For part-winding start the winding is divided 1/2 – 1/2.			C	208-230	3	60
				K	220-240/380-420	3	60
		X	380-420	3	60		

Tab.1: Key to motor code

3 Motor Voltages and Frequencies

3.1 Nominal voltage range

A nominal voltage range appertaining to the motor is stated in Select software and on compressor nameplates as opposed to one single nominal voltage. DWM Copeland additionally ensures a voltage tolerance of + 10% with a few exceptions see Select software.

Example: Compressor model D4SH*-250X EWL

Nominal voltage range according to the nameplate 220-240V Δ / 380-420V Y

Motors connectable in Y or Δ

Voltage tolerance of + 10%

Voltage range

- | | | | |
|----|------------------------|----|------------------------|
| a) | From 220V - 10% = 198V | to | 240V + 10% = 264V in Δ |
| b) | From 380V - 10% = 342V | to | 420V + 10% = 462V in Y |

The compressor can be put into full operation within the specified load limits throughout this voltage range.

3.2 Frequency

DWM Copeland semi-hermetic compressors are available for 50 Hz and / or 60 Hz voltage supply. The use of a 50 Hz three-phase motor with 60 Hz and vice-versa is possible. There are exceptions such as DLL-401(-40X) and DSLG-401(-40X). The following calculation factors need to be considered.

	50Hz → 60 Hz	60 Hz → 50 Hz
Refrigeration Capacity	1.2	0.83
Power Input	1.2	0.83
Speed	1.2	0.83

Motor codes and current (Amps) factors at 50 Hz				
Code	Power supply	Nominal voltage	Connnection	Amps factor
AWM	380-420 / 3 / 50	400	YY/Y	1
EWL	380-420 / 3 / 50	400	Y	1
EWL	220-240 / 3 / 50	230	Δ	1.73
EWM	380-420 / 3 / 50	400	Δ/Y	1
AWR	220-240 / 3 / 50	230	YY/Y	1.73
AWY	500-550 / 3 / 50	525	YY/Y	0.76
TWY	500-550 / 3 / 50	525	Δ	0.76
BWR	220-240 / 3 / 50	230	YY/Y	1.73
BWM	380-420 / 3 / 50	400	Δ / Δ	1
BWY	500-550 / 3 / 50	525	Δ / Δ	0.76

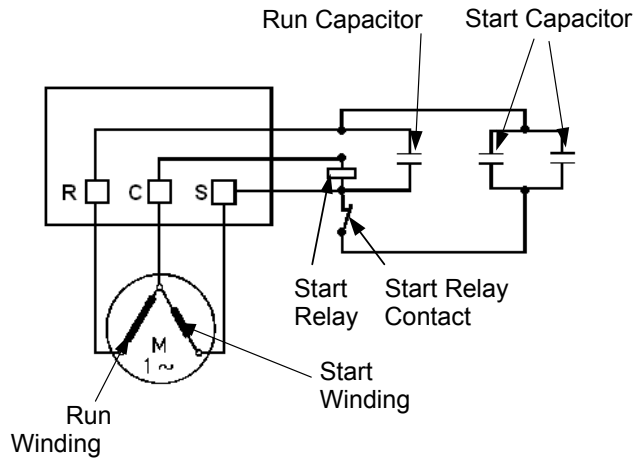
Motor codes and current (Amps) factors at 60 Hz				
Code	Power supply	Nominal voltage	Connnection	Amps factor
EWN	440-480 / 3 / 60	460	Y	1
EWK	220-240 / 3 / 60	230	Δ	2.1
EWK	380-420 / 3 / 60	400	Y	1.2
AWX	380 / 3 / 60	380	YY/Y	1.2
EWD	440-480 / 3 / 60	460	Δ/Y	1
AWC	208-230 / 3 / 60	230	YY/Y	2.19
AWD	440-480 / 3 / 60	460	YY/Y	1
EWN	250-280 / 3 / 60	265	Δ	1.73
BWX	380 / 3 / 60	380	Δ / Δ	1.2
BWC	208-230 / 3 / 60	230	Δ / Δ	2.19
BWD	440-480 / 3 / 60	460	Δ / Δ	1

Table 2: Calculation Factors

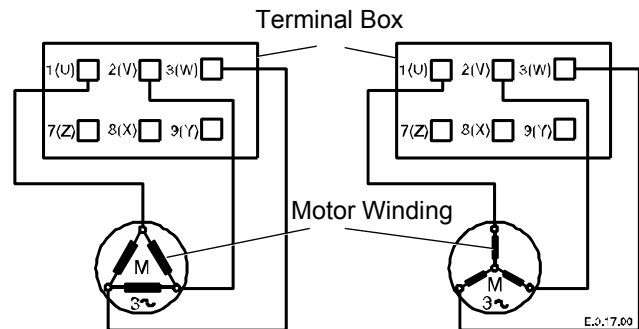
4 Internal Connection of the Motors

If the motor winding resistance needs to be measured the diagrams below show the internal connections for the motor versions C, T, E, A & B used by DWM Copeland.

Single-phase: motor code C



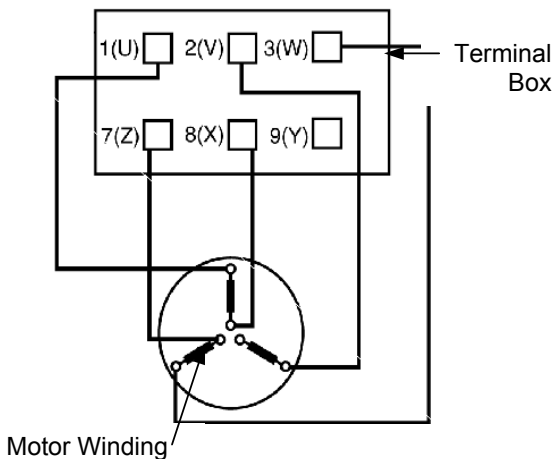
Three-phase: motor code T



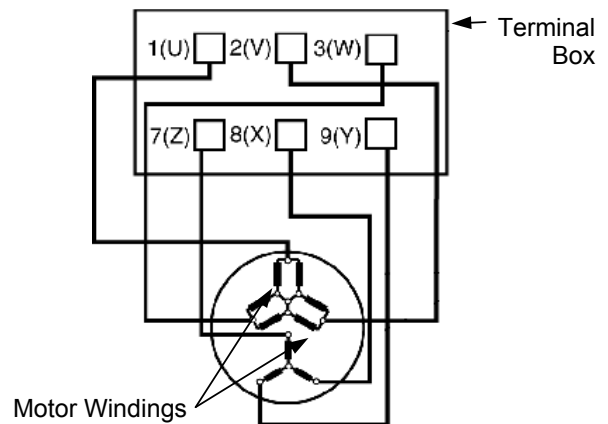
Delta connected (internally)

Star connected (internally)

Star-Delta (Y/Δ): motor code E



Part Winding 2/3:1/3: motor code A



Part Winding 3/5:2/5: motor code B

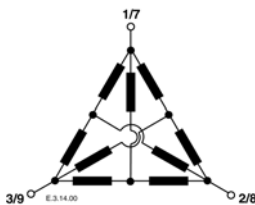


Fig.1: Direct On Line start winding arrangement with bridges

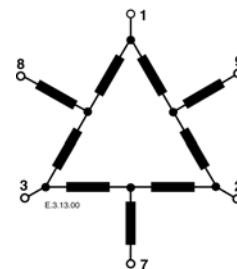


Fig.2: Part Winding Start arrangement

5 Single-phase motor: motor code C

For operation with single-phase power supply, compressors with single-phase motors are available with options up to compressor model DKSL-15X. They have one main and one auxiliary winding. In order to achieve the starting torque for automatic start and optimum operation, as in the case of three-phase motors, a capacitor and relay assembly consisting of a start and run capacitor and a potential relay will be supplied. Assembly must be in accordance with the position of the capacitors and relay shown on the wiring diagram.

Compressor Model	Run capacitor		Start capacitor		Potential relay
	MF	Voltage	MF	Voltage	
Motor code CAG					
DKM -5X / -50	10	420	72-88	330	GE 3ARR3CE5AA1
DKM -7X / -75	16	420	2 x (72-88)	330	GE 3ARR3CE3AC1
DKJ -7X / -75	16	420	2 x (72-88)	330	GE 3ARR3CE3AC1
DKJ -10X / -100	20	420	2 x (72-88)	330	GE 3ARR3CE3AC1
DKSJ -10X / -100	20	420	2 x (72-88)	330	GE 3ARR3CE3AC1
DKSJ -15X / -150	20	420	2 x (88-108)	250	GE 3ARR3CE3AC1
DKL -15X / -150	25	420	2 x (88-108)	250	GE 3ARR3CE3AC1
DKSL -15X	25	420	2 x (88-108)	250	GE 3ARR3CE3AC1

Table 3: Single-phase compressor models

6 Electrical connections

Each compressor terminal box contains wiring diagrams. Always ensure the supply voltage, the phases and frequency match the nameplate prior to connecting the compressor to the system power supply.

7 Three-phase motors

All DWM Copeland three-phase compressors can be started Direct-On-Line (DOL). The position of bridges for Direct-On-Line start depending on type of motor and/or mains voltage are shown in the "Wiring Diagrams".

7.1 Three-phase motor (DOL): motor code T

For standardisation reasons 6 pole cable bushings are used for not interchangeable motors for three-phase supply. This motor is only suitable for one voltage and can only be started Direct-On-Line. The motor windings are internally connected into star or delta and 3 winding ends are connected to the terminals U, V, W in the terminal box. The cable bushings X, Y & Z are not connected to the motor.

Note: The motor version TWY is not to be confused with the special motor TWK which is a part-winding motor with 9 terminals and is not described here.

7.2 Three-phase motor (Star-Delta (Y/Δ)): motor code E

The 6 ends of the three windings of this three-phase motor are led into the terminal box of the compressor via cable bushings. With the help of bridges in the terminal box or via contactors this motor is interchangeable for star (Y) or delta (D) operation. The voltage versions L, N & K are suitable for two voltages (e. g. 400V in star connection, 230V in delta). The voltage versions M, D & Y of this motor shall be used for full load in delta connection. The star connection is primarily used here for the starting procedure and also for power supply with 660V / 3 / 50 Hz (only "EWM" version).

7.3 Three-phase motor (Part-Winding Start (YY/Y)): motor code A

Part-winding start motors contain two separate windings (2/3:1/3) which are internally connected in star and operated in parallel. You cannot change the voltage by changing the electrical connections, the motor is only suitable for one voltage range (see Table 1). The first part winding (2/3) on terminals 1-2-3 can be used for part winding start. After a time delay of 1 ± 0.1 seconds, the second part winding, the 1/3 winding on terminals 7-8-9 must be brought on line.

The part winding motor can be regarded as two motors if it's winding due to the part winding start is separately connected to the power supply. The winding ratio 2/3:1/3 applies, taking the tolerance into consideration for winding resistances and the magnetic flow. The partial currents flowing during operation under load, have a mutual interference and a current ratio arises which does not correspond with the geometric division. This means that the current of the first part winding drops down from 66 to 62% depending upon the load and can rise up from 34 to 38% in the second part winding. With motor code "A" part winding start the compressor must be unloaded. Therefore in order not to overload the motor unnecessarily, voltage on one part winding (except during starting with the first winding) should be avoided. The motor should be safe guarded by one common fuse group.

Attention!: In order not to endanger the motor, the connection of first terminals 1, 2 & 3 and second terminals 7, 8 & 9 part winding to the mains must be identical. The connections of the first and second part winding must be equiphase.

7.4 Three-phase motor (Part-Winding Start (Δ/Δ)): motor code B

From January 1994 DWM COPELAND semi-hermetic 8 cylinder compressors are equipped with a new part-winding motor. Compared with the motor code "A" part-winding motor used before the torque has been increased both for Direct-On-Line starting as well as for part-winding start. Additionally, in order to improve the starting characteristics, the entire motor winding has been divided in such a way that 3/5 of the entire motor current flows through terminals 1-2-3 and 2/5 through terminals 7-8-9. You cannot change the voltage by changing the electrical connections, the motor is only suitable for one voltage range. In spite of the increased torque provided the locked rotor current (full winding) and the maximum operating current remain unchanged.

a) Start-up wiring via terminals 1-2-3

If the motor is supplied with power by terminals 1-2-3 a part-winding start without unloading is put into effect. The starting current is **68%** of the value for Direct-On-Line starting, it is therefore 9% lower than in the "A" motor code series part winding motor with 2/3:1/3 winding arrangement. After a time delay of 1 ± 0.1 seconds the second part winding, the 2/5 winding on terminals 7-8-9 must be brought on line.

b) Start-up wiring via terminals 7- 8- 9

When the motor is started via terminals 7-8-9, the starting current is **54%**. With 2/5 part winding start the compressor must be unloaded.

Attention!: In order not to endanger the motor, the connection of first and second part winding to the mains L1, L2 and L3 must be identical. The connections of the first and second part winding must be equiphase.

In order to guarantee that the motor starts up properly without unloading, at least one of the following conditions must be met:

1. The terminal voltage must be within the documented voltage range - **2.5%** i.e. the lower voltage tolerance is limited.
2. It is possible to start up without limiting the voltage tolerance (+/- 10%) provided that the operating point is below the line "G" in the range of application for R22 compressors (see Fig. 3). If the operating point is above "G" and/or if the mains voltage may drop below the voltage range by **more than 2.5%**, a proper start-up cannot be guaranteed and when the other part-winding is connected, a current peak of 100% start-up current results. In this case the system should only be started via terminals 1-2-3 or, if the start-up current of 54% is not to be exceeded a start-up unloading system with auxiliary unloading (5 - 10s) should be installed.

Fig. 3: BW motors

Legend

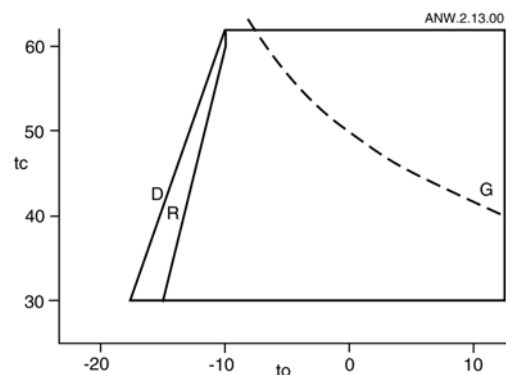
D = Discus

S = Standard

G = limit (see text)

to = evap. temp. °C

tc = cond. temp. C



In part-winding motors with a 2/3:1/3 arrangement, current distribution is dependent on the respective load. It is approximately 62-66% for the first part-winding and 38-34% for the second part-winding. Although the current distribution in the 8-cylinder motors differs only slightly, fuses, circuit breakers and cable cross-sections should be checked to ensure that the permissible values (making and breaking capacity, current load) are not exceeded. This applies in particular to installations where the fuses, circuit breakers and conductors were designed separately for each part-winding.

Option

A further reduction in the starting current to approximately 50% can be achieved, for example, with a rheostatic starter or with a gating control system. In this case it is necessary to install an unloading system and the compressor must be pre-unloaded.

8 Current Distribution

The distribution of current to both windings is **independent** of the load:

Winding on terminals 1-2-3	60%
Winding on terminals 7-8-9	40%

9 Resistance Measurements

The winding resistances must always be specified with the terminal designations between which measurements were made; further it must be stated whether the measurements were made with or without bridges.

Resistance **R_V** of the complete winding is measured **with bridges** between terminals:

1/7 - 2/8 / 1/7 - 3/9 / 2/8 - 3/9

Resistance **R₁**, **without** bridges between terminals:

1 - 2 / 1 - 3 / 2 - 3

Resistance **R₂**, **without** bridges between terminals:

7 - 8 / 7 - 9 / 8 - 9

The following designations apply:

R1 = 2,5 RV & R2 = 4,325 RV

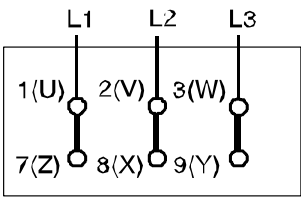
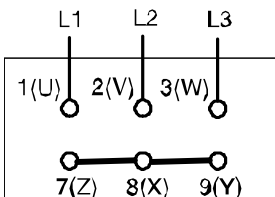
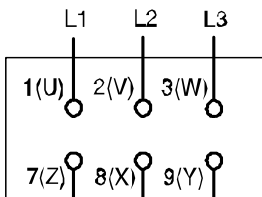
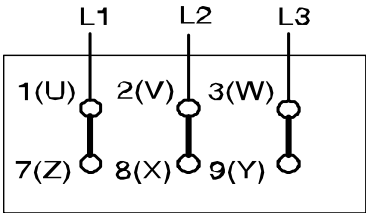
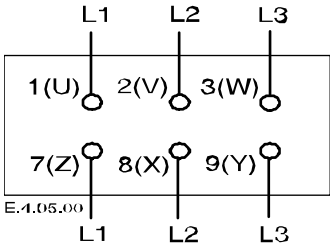
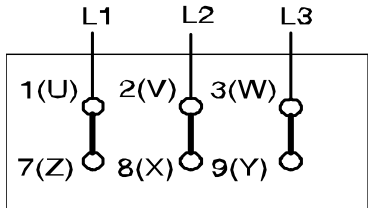
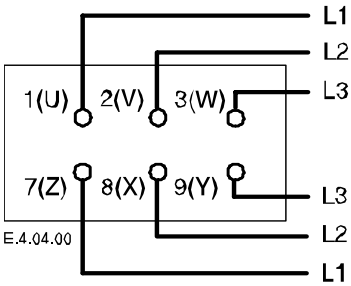
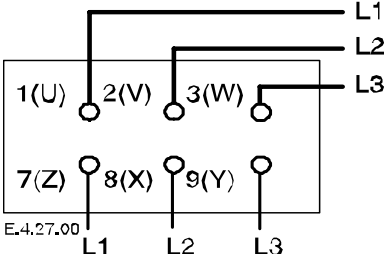
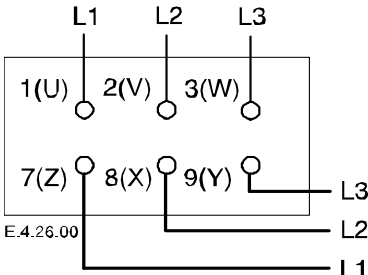
10 Circuit Diagrams

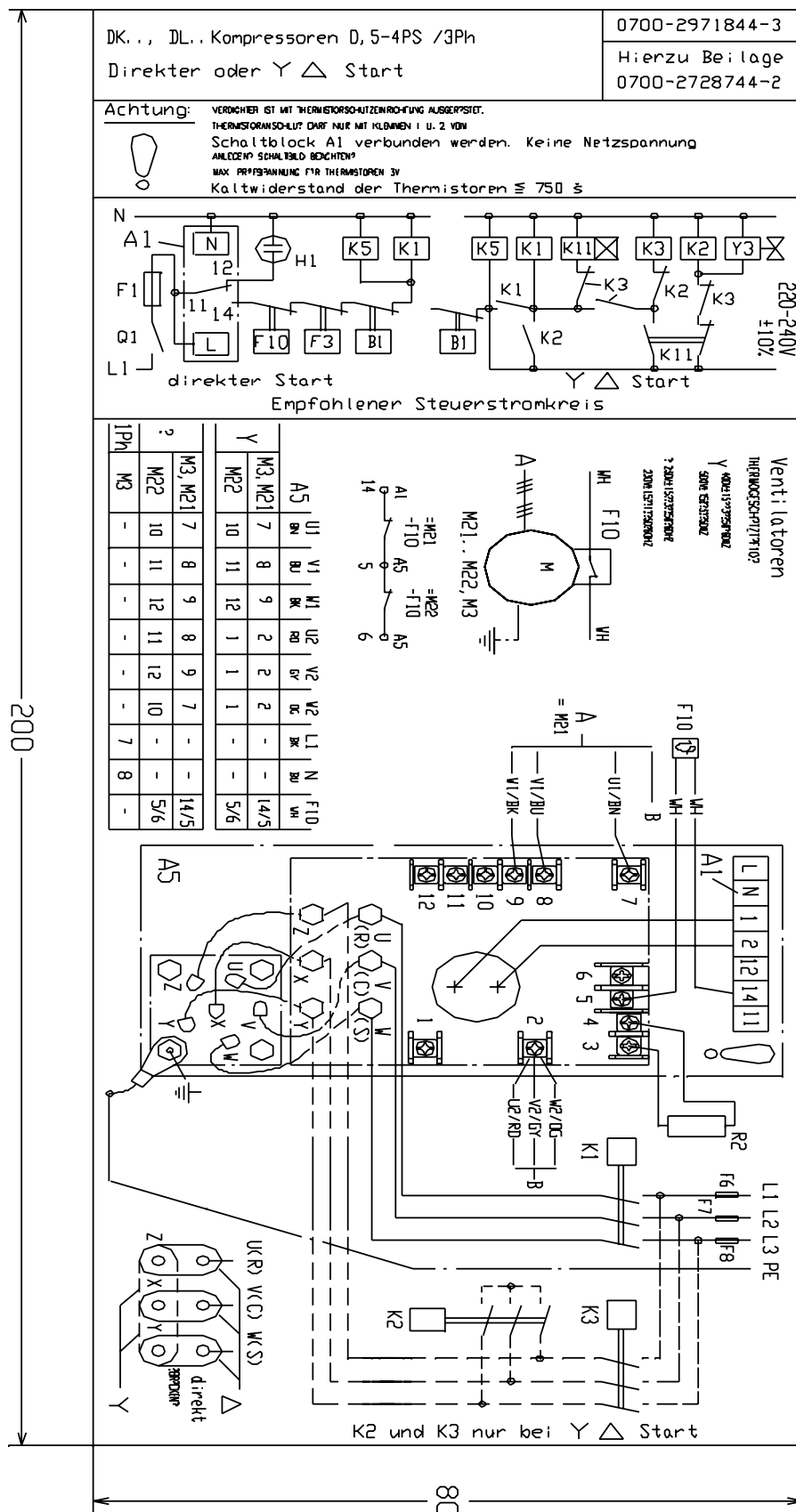
The circuit diagrams used here will be altered and will no longer take into account a timing relay for the auxiliary unloading arrangement in the control circuit. The following figures show only the altered control circuits in the new circuit diagrams (0700-2975620-2; 0700-2975619-2). For the internal circuitry, see Fig. 1 and Fig. 2. For details on the legend and the symbols, please refer to the supplement, respectively.

Important Notice: Replacement Compressors

Prior to 1984 part winding motors with a winding division of 1/2:1/2 were used marked with a motor code "F". If in a service situation the part-winding motor version "F" is replaced by a part-winding motor motor code "A" (2/3:1/3) then it is **vitaly important to check whether the electrical installation is suitable or not**.

11 Wiring diagram

	Direct-On-Line Start Δ	Direct-On-Line Start Y	Star-Delta-Start $Y - \Delta$
	Star-Delta-Motor $Y - \Delta$ Code E  E.4.01.00	 E.4.02.00	 E.4.03.00
	Direct-On-Line Start $Y - Y$	Part-Winding Start, first Start Step1-2-3 $Y - Y$	
	Part-Winding motor: $Y - Y$ Code A  E.4.01.00	 E.4.05.00	
	Direct-On-Line Start $\Delta - \Delta$	Direct-On-Line Start $\Delta - \Delta$	
	Part-Winding motor: $\Delta - \Delta$ Code B  E.4.01.00 Feed through one Contactor	 E.4.04.00 D8SH*-5000 BWC, D8SJ*-6000 BWC Feed through two Contactors	
	Part-Winding Start, Starting Wiring via Terminals 1-2-3	Part-Winding Start, Starting Wiring via Terminals 7-8-9	
	Part-Winding motor: $\Delta - \Delta$ Code B  E.4.27.00	 E.4.26.00	



DM..., D9..., D2..., D3... Compressor

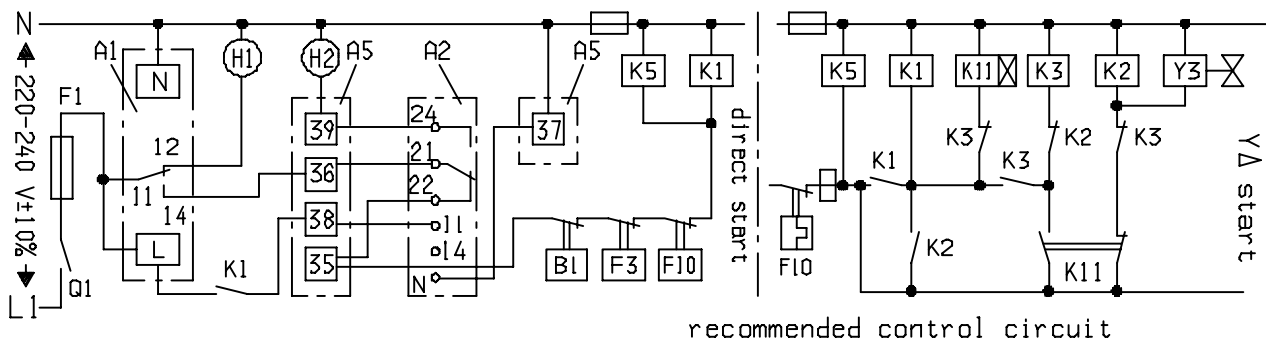
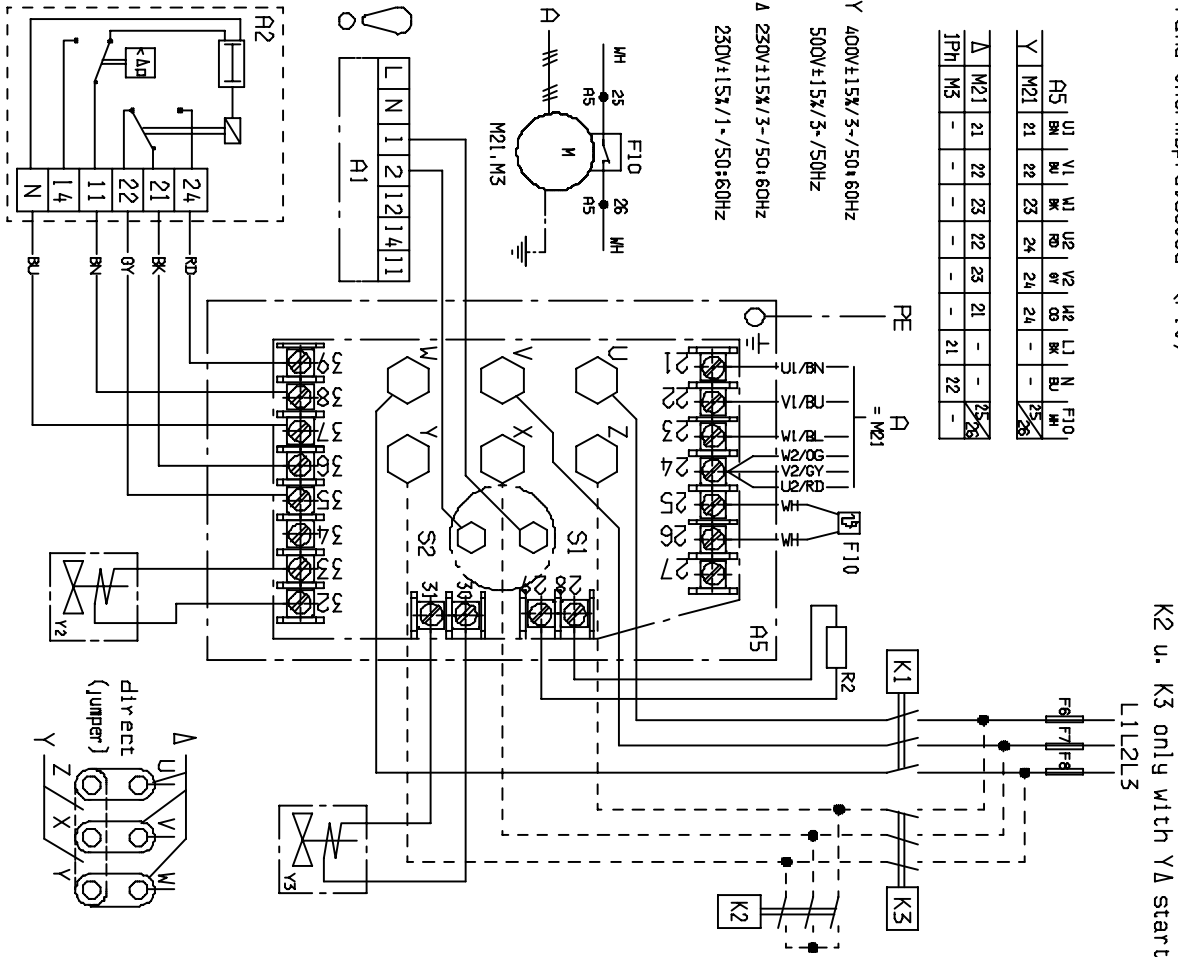
Direct or YΔ start

0700-2996998-2

See enclosure
0700-2728744-2

Fans thermoprotected (F10)

A5	U1	V1	W1	U2	V2	W2	U3	V3	W3	F10
21	21	22	23	24	24	24	24	24	24	25
21	21	22	23	24	24	24	24	24	24	25
21	21	22	23	24	24	24	24	24	24	25



Attention



Compressor equipped with protection by thermistors
Connect thermistors only at terminals I+2 of module A1.
Do not apply mains voltage. See wiring diagram.
Max. thermistor test voltage 3V.
Cold resistance of thermistors $\leq 750 \Omega$

DM..., D9..., D2..., D3... Compressor
Direct or Y-part winding start (AWM/D, AWR, AWY, AWX)

0700-2997004-2

See enclosure
0700-2728744-2

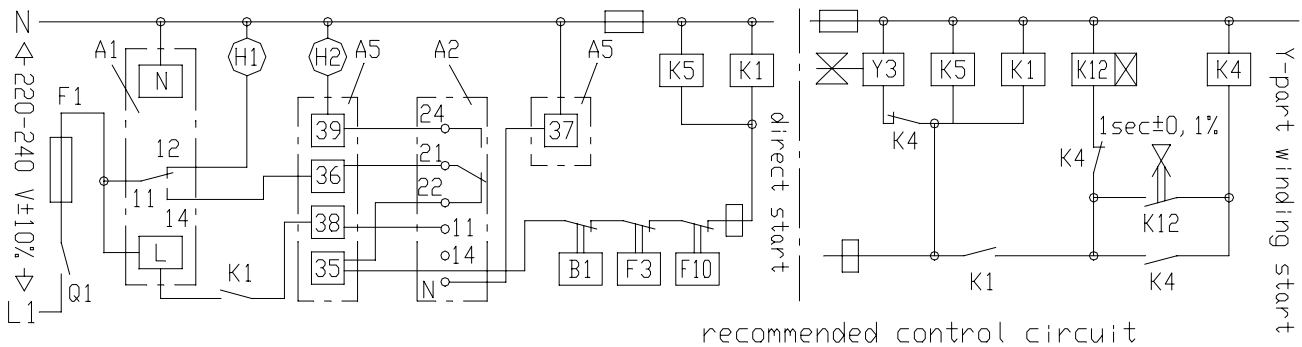
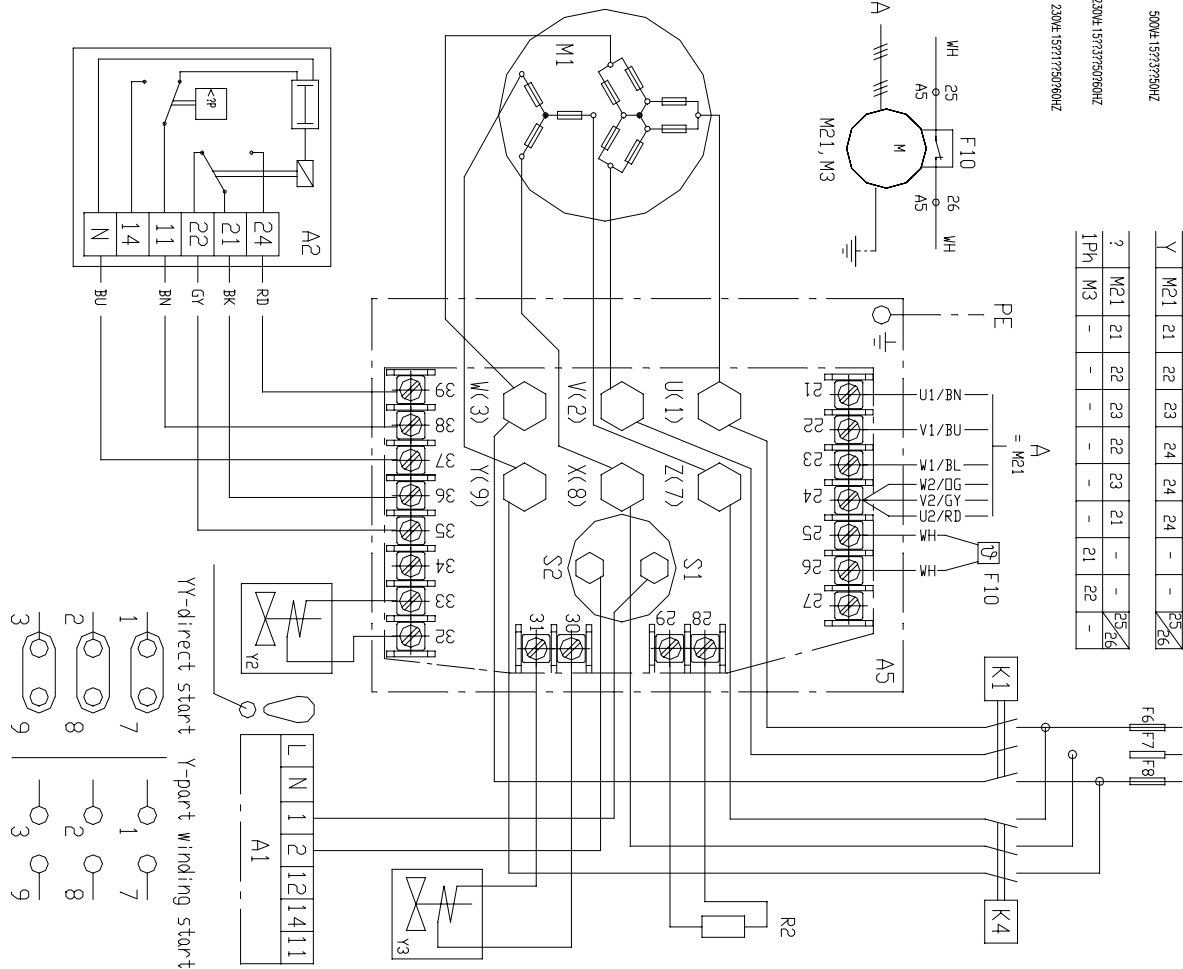
Fans thermoprotected (F10)

Y
400V 1573750/60HZ
500W 1573750/60HZ
? 230V 1573750/60HZ
230W 1573750/60HZ

	A5	U1	V1	W1	U2	V2	W2	L1	N	F10
Y	M21	21	22	23	24	24	24	-	-	25
?	M21	21	22	23	22	23	21	-	-	25
1Ph	M3	-	-	-	-	-	-	21	22	-

K4 only with
Y-part winding start

L1L2L3



Attention



Compressor equipped with protection by thermistors
Connect thermistors only at terminals 1+2 of module A1.

Do not apply mains voltage. See wiring diagram.

MAX.THERMISTOR TEST VOLTAGE 3V.

Cold resistance of thermistors ? 750 Ω

