Hunt Country Vineyards

Branchport, New York

G&D 5x5 Refrigeration Chiller Units

Electrical “AS BUILT” Drawings per Information gathered by Tom Brady during the Troubleshooting and “REVERSE ENGINEERING” procedures performed September 2012

Documents library

A FINAL SERVICE MANUAL

Name	Date modified	Size	Date created
#1 Cover Page Hunt Country Vineyards	9/24/2012 6:22 PM	57 KB	9/19/2012 3:14 PM
#1 Index Page	9/25/2012 6:47 AM	190 KB	9/24/2012 8:36 PM
#1 Operations Instructions Placard	10/1/2012 5:32 AM	176 KB	10/1/2012 5:32 AM
#2 GD 5x5 Chiller Unit Service Log	9/24/2012 7:45 PM	134 KB	9/24/2012 7:43 PM
#3 Chillers Flow one line diagram	9/14/2012 10:42 AM	290 KB	9/20/2012 12:36 AM
#4 Schematics with Components 10x17	9/14/2012 10:42 AM	438 KB	9/20/2012 12:32 AM
Components #1 Capacitors Spare Parts List	9/25/2012 5:41 AM	32 KB	9/24/2012 8:45 PM
Components #2 Capacitor Bleed Down Resistors Explained	8/21/2012 5:49 PM	38 KB	8/21/2012 5:49 PM
Components #3 GE Potential Relay Mounting Positions	9/8/2012 6:03 AM	107 KB	9/8/2012 6:03 AM
Components #3 GE Potential Relay Mounting Positions-1	9/25/2012 7:11 PM	337 KB	9/25/2012 7:11 PM
Components #3 GE Potential RelayVoltage Data Sheet	9/8/2012 6:02 AM	625 KB	9/8/2012 6:02 AM
Components #3 PR-APPLICATION	9/25/2012 6:38 AM	201 KB	9/25/2012 6:38 AM
Components #4 Duplexing Alternating Relay SSAC ARP63S 2 page	9/25/2012 6:30 AM	161 KB	9/8/2012 5:28 AM
Components #5 ETC Two Stage Temp Control	9/5/2012 10:32 PM	4,982 KB	9/5/2012 10:32 PM
Components #6 ICM-492C-LM Digital Line Voltage Monitor voltage range	9/25/2012 6:12 AM	97 KB	9/25/2012 6:12 AM
Components #6 ICM-492C-LM Digital Line Voltage Monitor	9/25/2012 6:33 AM	706 KB	9/17/2012 12:54 PM
Components #7 (6)- page KP Dual Pressure Switch Manual	9/7/2012 11:54 AM	3,636 KB	9/7/2012 10:45 AM
Components #8 Relay Base Layout	10/1/2012 6:44 AM	84 KB	10/1/2012 6:44 AM
Components #9 Johnson Controls Freeze Stat Interlock	9/28/2012 9:21 AM	179 KB	9/28/2012 9:21 AM
Maneurop 36-page reciprocating compressors	1/5/2012 3:26 PM	1,616 KB	1/5/2012 3:07 PM
Summary 1 Hey Dave	9/13/2012 9:45 PM	97 KB	9/13/2012 9:45 PM
Summary 2 of Findings Hunt Country	9/14/2012 10:05 AM	201 KB	9/20/2012 12:33 AM
Z Hunts Original 5x5 Manual	9/28/2012 4:35 PM	4,352 KB	9/28/2012 4:35 PM

Electronic Temperature Control
ETC

STAGE #1

STAGE#2

Toggle Switch "B" Compressor - Leave on 24/7/365 - Turn off for service only!

Toggle Switch "A" Compressor - Leave on 24-7-365 - Turn off for service only!

Toggle Switch - Coolant Circulation Pump is the:

MAIN ON / OFF SWITCH for the unit.

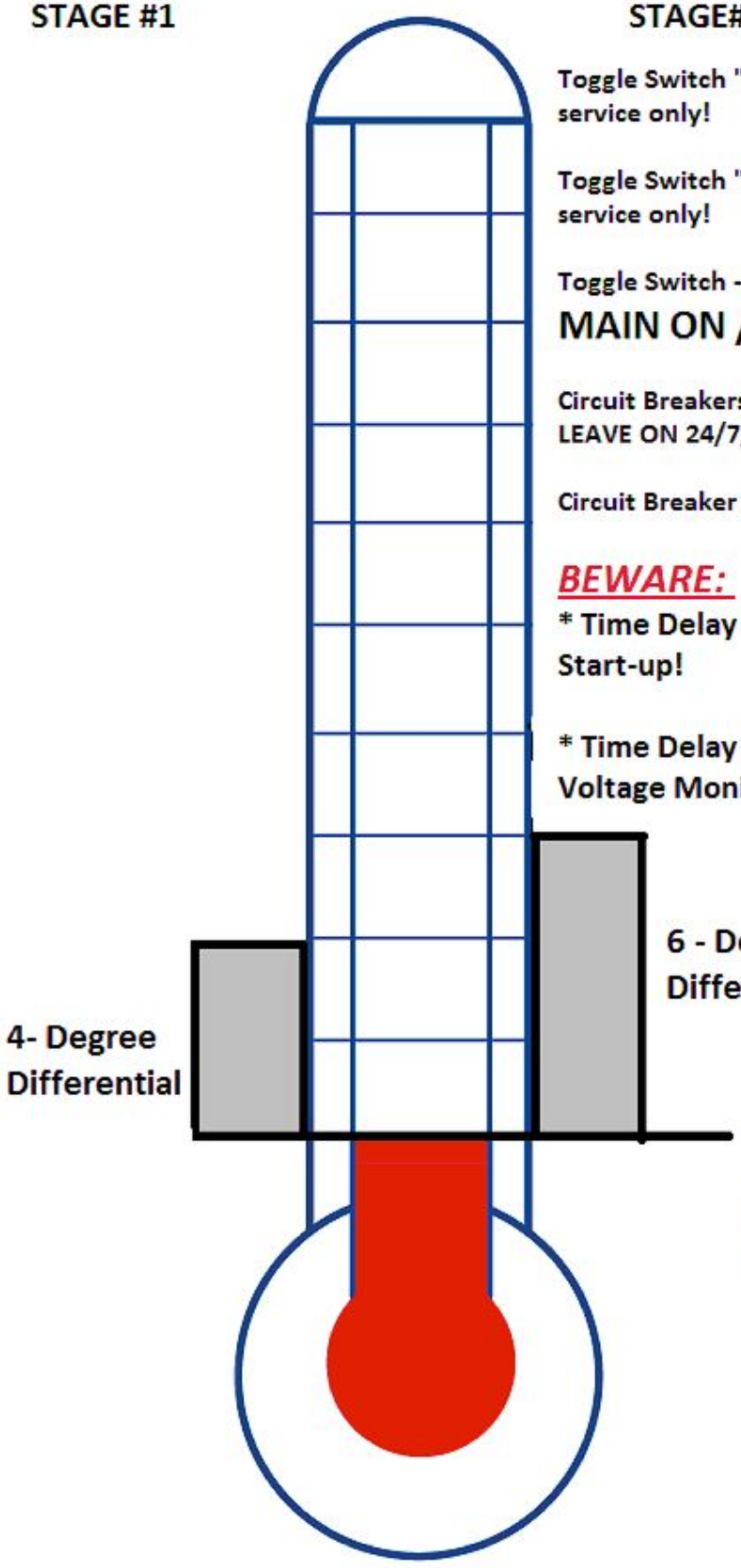
Circuit Breakers #4 - Crankcase Heaters -
LEAVE ON 24/7/364

Circuit Breaker #1, #2, #3 can be turned off during "NON-USE"

BEWARE:

*** Time Delay of 2-minutes for Stage #2 Compressor Start-up!**

*** Time Delay of (6) -Minutes for Automatic Restart after Voltage Monitor records FAULT!**



Per TMB
9/28/2012

Per Dave Mortensen -
Hunt Country Vineyards

BradyElectric@hotmail.com

Maintenance Log for Hunt Country Vinyards 5x5 Chiller Unit

	A	B	C	D
1	Addendum/Changes/Alterations/Repairs Description	Date	Company	Repairman
2				
3	Install proper sized Start/Run Capacitors and Potential Start Relay	Jul-05	FL Troubleshooter	Tom Brady
4	Check Voltage Reading at the motor terminals upon compressor startup - ok!			
5	Check amperage reading at the compressor and pump controls - ok!			
6	Perform Preventive Maintenance on control panel and controls			
7	Color Code leg "A" and "B" on the 240 volt control circuit to allow easier troubleshooting			
8	Rewire Control Panel for easier flow (left to right - top to bottom) point to point troubleshooting.			
9	Replace faulty flow switch on the liquid chiller loop (Flow Indication)			
10	Reprogram 2-stage temperature (ETC) for proper operation (21/4 -stage1) (41/4 - stage2) Degrees F			
11	Reverse Engineer System controls and provide documentation with recommended changes			
12	Move Compressor Switches "A" and "B" Wiring per revised electrical drawing.			
13				
14				
15				
16				
17				
18				

Maintenance Log for Hunt Country Vinyards 5x5 Chiller Unit

	A	B	C	D
1	Addendum/Changes/Alterations/Repairs Description	Date	Company	Repairman
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Maintenance Log for Hunt Country Vinyards 5x5 Chiller Unit

	A	B	C	D
1	Addendum/Changes/Alterations/Repairs Description	Date	Company	Repairman
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Maintenance Log for Hunt Country Vinyards 5x5 Chiller Unit

	A	B	C	D
1	Addendum/Changes/Alterations/Repairs Description	Date	Company	Repairman
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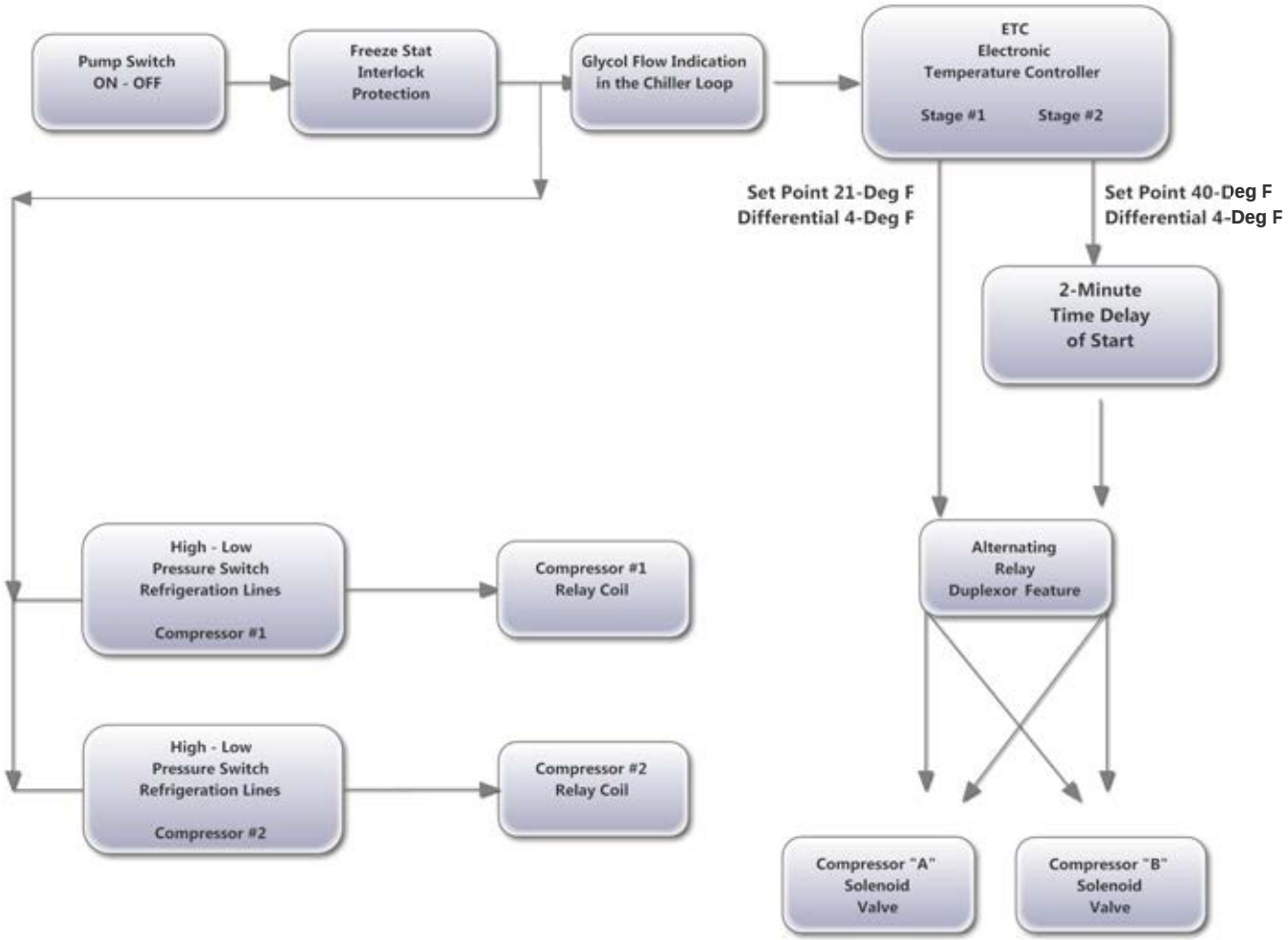
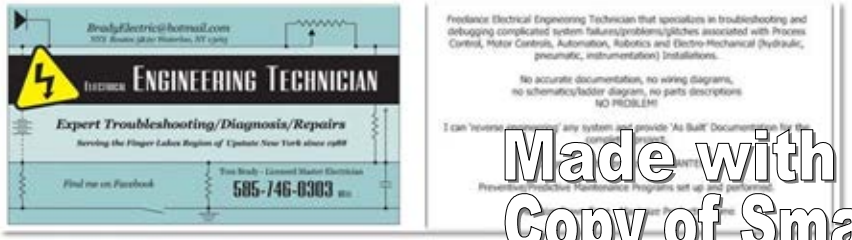




Electrical Flow Chart of G&D 5x5 Chiller For Hunt Country Vineyards

240 VAC - Single Phase

Circuit Breaker #4 (Proposed)

WARNING:
Crank Case Heaters Should be Turned on 4-12 hours before Start Up of the Compressors!

FU-3

Circulating Pump Relay Coil

PUMP Toggle On-Off Switch

Low High

Compressor "A" High-Low Pressure Switch

"C" Terminal

"A" Terminal

The compressor is cut in and out on the low-pressure side of the combined high and low pressure control type KP 15 (5) depending on the suction pressure. In addition, the high-pressure side of this control gives protection against too-high a condensing pressure by cutting out the compressor if it becomes necessary (e.g. when the ventilator is defected or the airflow is blocked (dirt)).

FU-4

Chiller Loop Circulating Pump

Freeze-Stat Interlock

Circuit Breaker #3

Circuit Breaker #2

FU-2

FAN 1 Orange

FAN 2 Pink

Compressor "B"

Correct Parts List for your Dual 5 ½ H.P. Refrigeration Compressors
(2) 220 k-ohm 1-watt resistors for the Run Capacitors
(2) 15 k-ohm 1-watt Resistors for the Start Capacitors
(2) 55 micro farad capacitors - 440 Volt AC - Run Capacitors
(2) 235 micro-farad capacitors - 330 Volt AC - Start Capacitors
(2) 3ARR1AA4 Start Relays for taking the start capacitor off line as the compressor comes up to about 3/4 speed.

Low High

Compressor "B" High-Low Pressure Switch

"C" Terminal "A" Terminal

Circuit Breaker #1

FU-1

FAN 1 Orange

FAN 2 Pink

Compressor "A"

TROUBLESHOOTING ERROR MESSAGES

Pump Down Cycle

Chiller Loop Flow Interlock

Flashing LED Annunciate Safety During Time Down Cycle

Proposed

Time Delay for Stage #2 Compressor Cycle (2)-Minute Delay

Hunt Vineyards - Condensing Unit Parts Required

From: bradyelectric@hotmail.com
Saved: Thu 1/05/12 12:47 PM
To:

Dave, we need the following components for the Chiller Condensing Units:

1. (2) 220 k-ohm 1-watt resistors for the Run Capacitors
2. (2) 15 k-ohm 1-watt Resisters for the Start Capacitors
3. (2) 55 micro-farad capacitors - 440 Volt AC - Run Capacitors
4. (2) 235 micro-farad capacitors - 330 Volt AC - Start Capacitors
5. (2) 3ARR3J4A4 Start Relays for taking the start capacitor off line as the compressor comes up to about 3/4 speed.

All parts are from the Danfoss/Maneurop Service Manual I found online.

I would double the order so that you have replacements just in case something else is wrong that we are not aware of!

Tom Brady

0666 Waterloo-Geneva Road

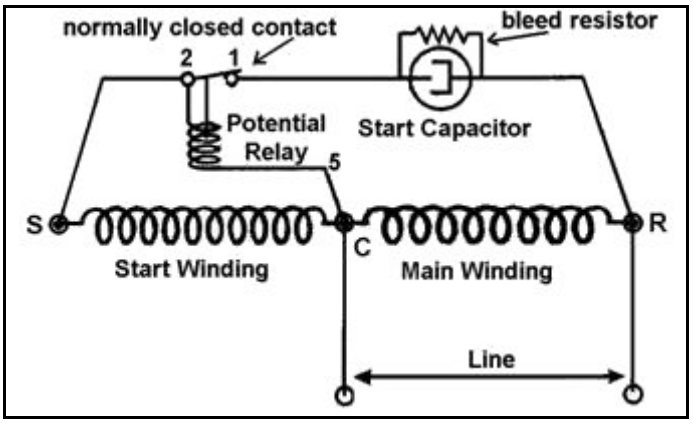
Waterloo, New York 13165

585-746-0303

Bleed Resistors and Potential Relays

A Start Capacitor, when used with a Potential Relay requires a bleed resistor. The drawing shows that the discharge path* of the start capacitor is directly across the normally closed relay's points. If the charge in the capacitor exceeds 60% of it's rated voltage, the points will be damaged. That possibility can happen at anytime.
**on compressor shut down*

Current relays are normally open so they don't need bleed resistors as a discharging capacitor does not affect the points.

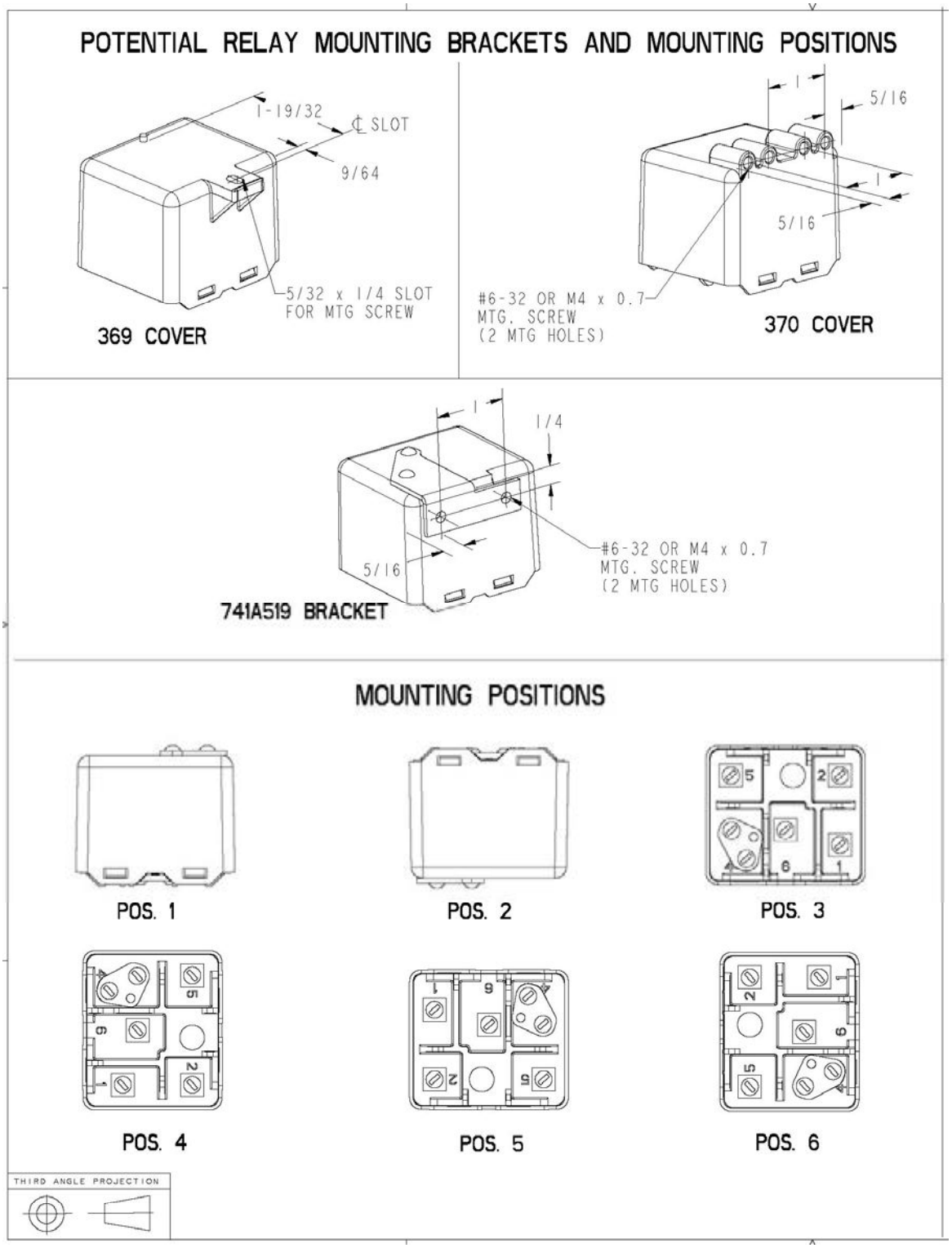


Excerpts from Electrical Handbooks to Ponder

Copeland Electrical Handbook	Tecumseh Service Handbook
Start Capacitor Bleeder Resistors All standard Copeland start capacitors are supplied with bleed-resistors securely attached and soldered to their terminals. **The use of capacitors without these resistors will result in sticking relay contacts and/or erratic relay operation especially where short cycling is likely to occur**. This is due to the start capacitor discharging through the relay contacts as they close, following a very short running cycle. The resistor permits the capacitor charge to bleed down at a much faster rate, preventing arcing and overheating of the relay contacts. The use of capacitors supplied by Copeland is recommended. In case of an emergency exchange, a 15,000-18,000 ohm, two watt resistor should be soldered across the terminals of each start capacitor. Care should be taken to prevent their shorting to the case or other nearby metallic objects. If sticking contacts are encountered on any start relay, the first item to check is the start capacitor resistor. If damaged, or not provided, install a new resistor and clean or replace the relay.	**A. Start Capacitor Bleeder Resistors** Modern high power factor, low current single phase compressor motors which require start and run capacitors used with potential type relays can create electrical circuits which could cause starting relay damage resulting in compressor failure. The high voltage stored in the start capacitor could discharge across the contacts of the starting relay thus welding them and preventing the relay from functioning. Capacitor failure and/or start winding failure could result. To eliminate this, Tecumseh Products Company start capacitors are equipped with bleeder resistors wired across the capacitor terminals**. No start capacitor used in conjunction with a potential relay and run capacitor should be installed without such a bleeder resistor.** In an emergency where no bleeder resistor equipped capacitors are available, then a two watt 15,000 ohm resistor can be obtained and soldered across the capacitor terminals.

APPENDIX C.

Potential Relay Mounting Brackets and Mounting Positions



Potential Type Relay Supplier Code Designations

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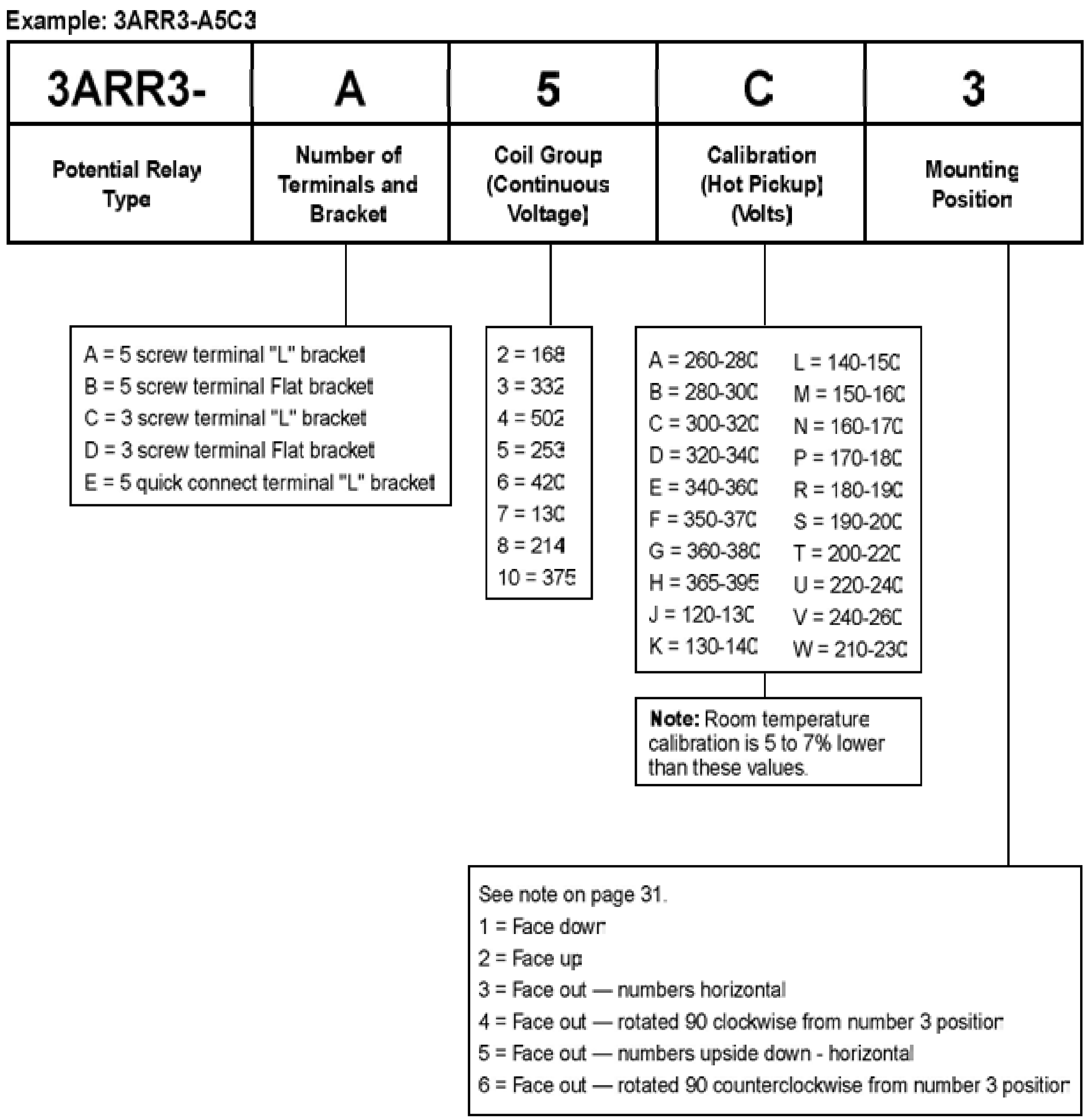

Figure 3-20. Explanation of GE Potential Relay Code.

TITLE POTENTIAL RELAY APPLICATION
SELECTION OF THE PROPER
COIL VOLTAGE RATING

FIRST MADE FOR 5AR22, 5AR22

74-407791 SHEET NO. 1

THE CONTINUOUS DUTY VOLTAGE OF THE RELAY COIL MUST BE EQUAL TO OR GREATER THAN THE MAXIMUM VOLTAGE TO WHICH IT WILL BE EXPOSED. THIS VOLTAGE WILL BE THE VOLTAGE INDUCED IN THE MOTOR START WINDING WHEN THE MOTOR IS RUNNING AFTER THE START WINDING HAS BEEN DISCONNECTED. IT WILL BE THE GREATEST WHEN THE THE LINE VOLTAGE IS AT ITS MAXIMUM, WHEN THE MOTOR IS RUNNING AT ITS MAXIMUM SPEED (LIGHTLY LOADED), AND WHEN THE RUN CAPACITOR SIZE IS LARGEST.

THE EFFECT OF THE "EFFECTIVE AMBIENT TEMPERATURE" SURROUNDING THE RELAY MUST ALSO BE TAKEN INTO ACCOUNT.

THE EFFECTIVE AMBIENT TEMPERATURE IS NOT THE AMBIENT TEMPERATURE IN WHICH THE APPLIANCE OR EQUIPMENT IS INSTALLED, BUT IS THE AMBIENT TEMPERATURE SURROUNDING THE RELAY WHILE THE APPLIANCE IS OPERATING. OFTEN THE ENCLOSED CONTROL COMPARTMENT WILL BE SUBSTANTIALLY HIGHER IN TEMPERATURE THAN THE AREA AROUND THE APPLIANCE. IN SOME CASES OTHER HEAT SOURCES OR RADIANT EFFECTS ARE CONTRIBUTING TO ITS TEMPERATURE.

THE MAXIMUM ALLOWABLE TEMPERATURE OF THE COIL WINDING IS 130°C. WHEN MEASURED BY CHANGE IN RESISTANCE METHOD.

THIS MEANS THAT THE COIL GROUP NUMBER SELECTED MUST NOT PRODUCE A HEAT RISE, WHICH WHEN ADDED TO THE EFFECTIVE AMBIENT TEMPERATURE, WILL RESULT IN THE COIL TEMPERATURE EXCEEDING THE MAXIMUM ALLOWABLE FOR THE SPECIFIC INSULATION CLASS.

IF THIS SHOULD OCCUR, A COIL GROUP SHOULD BE SELECTED WHICH WILL PRODUCE A LOWER HEAT RISE WITH THE MAXIMUM VOLTAGE APPLIED TO THE COIL. A GROUP WITH A HIGHER COIL RATING WILL PRODUCE A LOWER HEAT RISE AT A SPECIFIC APPLIED VOLTAGE.

IF THE COMPRESSOR/MOTOR MANUFACTURER IS NOT SURE OF THE ACTUAL EFFECTIVE AMBIENT IN THE APPLIANCE IN WHICH THE RELAY IS INSTALLED, A WORST CONDITION OF 40°C OR HIGHER SHOULD BE USED IN SELECTING THE PROPER COIL GROUP. FOR EXAMPLE, UNITS INSTALLED OUTDOORS OR IN TIGHTLY CONFINED SPACES.

TO PREDICT A HEAT RISE AT A NEW VOLTAGE, MULTIPLY THE KNOWN RISE AT A SPECIFIC VOLTAGE BY THE SQUARE OF THE RATIO OF THE NEW VOLTAGE OVER THE OLD.

TABLES OF COILS BY GROUP, ALONG WITH CALIBRATION IDENTIFICATION FOLLOW ON SHEETS 1 THRU 4. THE COIL RATINGS FOR SPECIFIC GROUPS FOR 50 HZ OPERATION ARE ON SEPARATE SHEETS. IT SHOULD BE NOTED THAT FOR A GIVEN COIL GROUP, THE VOLTAGE RATING AT 60 HZ IS HIGHER THAN FOR 50 HZ.

		REVISIONS		PRINTS TO
		1	98-4-3 GENE SPENNY ET-52182	AE
		2	98-7-11 GENE SPENNY ET-53701	
		3	2005-10-24 K. REYNES ET-55512	SP
				F

MADE BY: GENE SPENNY OCT. 24, 1995

ISSUED: NOVEMBER 28, 1988 ON ET-55487

APPROVAL: SPV

APPLIANCE CONTROLS
HOPKINSVILLE, KY 42240

74-407791 SHEET NO. 1

GE MOTOR STARTING RELAY (3ARR3, 3ARR22) DATA

74-407791
SH. 1

CALIBRATION VALUES ARE BASED ON AVERAGE COIL COPPER TEMPERATURES OF: COLD 25°C HOT 95°C.

CUSTOMER COLD PICK-UP AND DROP-OUT FOR EACH COIL GROUP

COIL GROUPS ARE U.L. CLASS B RATING AND VDE RECOGNIZED (U.L. FILE E4659 AND VDE LICENSE 40014098)

MAXIMUM COIL VOLTAGES FOR SPECIFIED MAXIMUM TEMPERATURE RISE

CALIBRATION IDENTIFICATION	FREQUENCY (HERTZ)	"O" PICK-UP VOLTS		GROUP 2, 12: 168V-Δ 80°C, 147V-Δ 50°C				GROUP 3, 13: 352V-Δ 80°C, 290V-Δ 60°C				GROUP 4, 14: 500V-Δ 80°C, 459V-Δ 60°C				GROUP 5, 15: 253V-Δ 80°C, 221V-Δ 60°C				GROUP 6, 16: 420V-Δ 80°C, 376V-Δ 60°C				GROUP 7, 17: 130V-Δ 80°C, 114V-Δ 60°C				GROUP 8, 18: 214V-Δ 80°C, 187V-Δ 50°C				GROUP 9, 19: 317V-Δ 80°C, 277V-Δ 60°C				GROUP 10, 20: 375V-Δ 80°C, 329V-Δ 60°C			
				PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	60	260	280					243	271	40	90	239	269	60	135	240	269	35	77	242	272	60	121					236	266	25	65	243	271	40	90	239	270	50	110
B	60	280	300					261	290	50	100	259	287	60	135	258	286	35	77	262	290	60	121					256	285	25	65	261	290	50	100	250	289	50	110
C	60	300	320					280	309	55	100	277	305	60	135	275	306	35	77	280	310	60	121					275	305	25	65	280	309	55	100	268	300	50	110
D	60	320	340					299	327	50	100	295	324	60	135	296	325	35	77	300	328	60	121					293	324	25	65	299	327	50	100	288	326	50	110
E	60	340	360					317	345	50	100	314	342	60	135	315	343	35	77	318	347	60	121									317	345	50	100	306	344	50	110
F	60	360	380					336	364	50	100	333	362	60	135	333	362	35	77	338	366	60	121									336	364	50	100	325	354	50	110
G	60	380	400					355	384	50	100	352	381	60	135	353	383	35	77	357	386	60	121									355	384	50	100	334	363	50	110
H	60	395	415									368	398	70	150					340	370	75	161																
J	60	120	130	111	124	20	45																	111	125	15	40												
K	60	130	140	120	134	20	45									120	134	35	77					121	134	15	40	120	134	25	57								
L	60	140	150	130	144	20	45	132	148	40	90					130	145	35	77					130	143	15	40	129	142	25	57								
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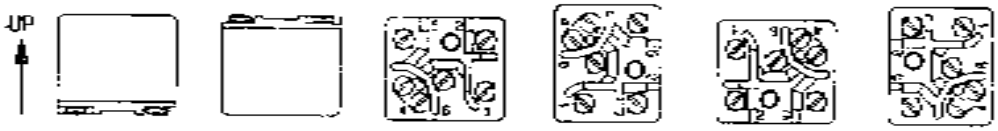
T	60	200	220					199	215	40	90					188	213	35	77	189	211	60	121									198	215	40	90	190	215	40	105
U	60	220	240					205	234	40	90					203	234	35	77	204	233	60	121									205	234	40	90	203	239	50	110
V	60	240	260					224	252	40	90					221	253	35	77	223	252	60	121									224	252	40	105	224	252	60	121
W	60	210	230	198	225	20	45													195	224	60	125													159	227	50	110
60	60																							85	99	15	40												
Y	60	70	90																					82	96	15	40												
BE	50																							90	104	15	40												
BX	60	290	310					268	298	50	100																					268	298	50	100				
BE	60	110	120																					101	115	15	40												
TY	60	240	260																	218	243	60	121																
TN	60	250	230																	195	224	60	121																
TP	60	170	180					164	175	70	100																					162	175	70	100				
COIL RESISTANCE @ 25°C (OHMS) REFERENCE				1,620				6,350				14,920				4,080				11,500				930				2,500				5,550				9,400			

MOUNTING POSITIONS



ISSUED MARCH 1, 1968
REVISED APRIL 17, 1991
REV. ET-92162 96-4-9
REV. ET-93701 96-9-11
REV. ET-96912 2005-10-24
REV. ET-97023 2006-02-15
REV. ET-97056 2006-04-19

74-407791
SHEET 1

SE MOTOR STARTING RELAY (3AAA3, 3AAA22) DATA

74-407791
SH.2

CALIBRATION VALUES ARE BASED ON AVERAGE COIL COPPER TEMPERATURES OF COLD 25°C HOT 95°C.

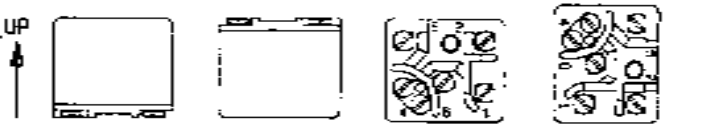
CUSTOMER COLD PICK-UP AND DROP-OUT FOR EACH COIL GROUP

COIL GROUPS ARE U.L. CLASS B RATING AND VDE RECOGNIZED. U.L. FILE S4839 AND VDE LICENSE 40014095

MAXIMUM COIL VOLTAGE FOR SPECIFIED MAXIMUM TEMPERATURE RISE

CALIBRATION IDENTIFICATION	FREQUENCY (HERTZ)	HOT PICK-UP VOLTS		GROUP 2, 12 (159V-Δ 80°C, 132V-Δ 60°C)				GROUP 3, 13 (299V-Δ 80°C, 261V-Δ 60°C)				GROUP 4, 14 (452V-Δ 80°C, 395V-Δ 60°C)				GROUP 5, 15 (229V-Δ 80°C, 199V-Δ 60°C)				GROUP 6, 16 (379V-Δ 80°C, 343V-Δ 60°C)				GROUP 7, 17 (117V-Δ 80°C, 102V-Δ 60°C)				GROUP 8, 18 (183V-Δ 80°C, 159V-Δ 60°C)				GROUP 9, 19 (270V-Δ 80°C, 234V-Δ 60°C)				GROUP 10, 20 (338V-Δ 80°C, 296V-Δ 60°C)			
				PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
AA	50	250	280					243	271	40	90	239	269	60	135	240	269	35	77	242	272	60	121					239	266	25	64	243	271	40	90	239	270	50	110
AB	50	280	300					251	280	50	100	259	287	60	135	259	289	35	77	262	290	60	121					255	285	25	65	261	290	50	100	259	289	50	110
AC	50	300	320					280	309	55	100	277	305	60	135	278	306	35	77	280	310	60	121					275	303	25	65	280	309	55	100	279	309	50	110
AD	50	320	340					295	327	50	100	295	324	60	135	296	325	35	77	300	328	60	121					293	324	25	65	299	327	50	100	299	329	50	110
AE	50	340	360					317	345	50	100	314	342	60	135	315	343	35	77	318	347	60	121									317	345	50	100	315	344	50	110
AF	50	350	370					326	354	50	100	323	352	60	135	323	352	35	77	328	358	60	121									326	354	50	100	325	354	50	110
AG	50	360	380					335	364	50	100	332	361	60	135	333	363	35	77	337	368	60	121									335	364	50	100	334	363	50	110
AH	50	385	395									338	376	70	150																								
AJ	50	120	130	115	124	20	45																	111	126	15	40												
AK	50	130	140	120	134	20	45									123	134	35	77					121	134	15	40	123	134	35	57								
AL	50	140	150	130	144	20	45	132	148	40	90					130	143	35	77					130	143	15	40	128	142	25	57								
AM	50	152	160	140	153	20	45	142	157	40	90					140	152	35	77					139	153	15	45	138	152	25	57								
AN	50	160	170	149	163	20	45	152	166	40	90					150	163	35	77					149	153	15	40	148	162	25	57								
AP	50	171	180	159	172	20	45	162	175	40	90					159	172	35	77									158	171	25	57	162	175	40	90				
AR	50	180	190	168	182	20	45	171	184	40	90					168	182	35	77									167	180	25	57	171	184	40	90				
AS	50	191	200	178	192	20	45	180	193	40	90					178	192	35	77	180	196	50	121					175	189	25	57	180	193	40	90	180	195	40	105
AT	50	200	220					185	215	40	90					193	213	35	77	186	214	50	121									186	215	40	90	190	215	40	105
AU	50	220	240					205	234	40	90					203	231	35	77	204	233	50	121									205	234	40	90	208	235	50	110
AV	50	240	260					224	252	40	90					221	250	35	77	229	252	50	121									224	252	40	90				
AW	50	219	230	198	225	20	45													195	224	50	125																
CC	50																							85	99	15	40												
AY	50	70	80																					62	76	15	40												
CE	50																							90	104	15	40												
CA	50	290	310					288	298	50	100																					286	298	50	100				
CB	50	110	120																					101	115	15	40												
COIL RESISTANCE @ 25°C (OHMS) REFERENCE				5,620				6,650				14,620				4,080				11,600				830				2,600				5,350				9,400			

MOUNTING POSITIONS



ISSUED MARCH 1, 1989	
REVISED APRIL 17, 1991	
REV. ET-92182	96-4-3
REV. ET-93701	98-3-11
REV. ET-96918	2005-12-14
REV. ET-97023	2006-02-15
REV. ET-97084	2006-04-25

74-407791
SHEET 2

GE MOTOR STARTING RELAY (3ARR3, 3ARR22) DATA

CALIBRATION VALUES ARE BASED ON AVERAGE COIL COPPER TEMPERATURES OF: COLD 35°C HOT 35°C.

CUSTOMER COLD PICK-UP AND DROP-OUT FOR EACH COIL GROUP

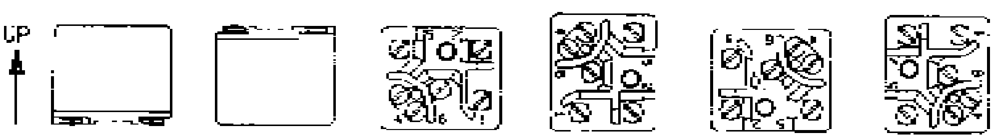
COIL GROUPS ARE U.L. CLASS B RATING AND VDE RECOGNIZED U.L. FILE SA535 AND VDE LICENSE 40C1409E

MAXIMUM COIL VOLTAGES FOR SPECIFIED MAXIMUM TEMPERATURE RISE

CALIBRATION IDENTIFICATION	FREQUENCY (HERTZ)	HOT PICK-UP VOLTS		GROUP 21, 41 148V-Δ 80°C 130V-Δ 60°C				GROUP 22, 42 194V-Δ 80°C 170V-Δ 60°C				GROUP 23, 43 292V-Δ 80°C 256V-Δ 60°C				GROUP 24, 44 363V-Δ 80°C 336V-Δ 60°C			
				PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	60	260	290									240	269	45	95	243	271	55	125
B	60	280	300									259	286	45	95	261	290	55	125
C	60	300	320									276	305	45	115	280	309	55	125
D	60	320	340									296	325	45	115	298	327	55	125
E	60	340	360									315	343	45	115	317	345	55	125
F	60	350	370									323	352	45	115	326	354	55	125
G	60	350	380									333	353	45	115	335	364	55	125
H	60	365	395													340	370	55	125
J	60	120	130	111	123	20	50	111	124	30	65								
K	60	130	140	121	134	20	50	120	134	30	65								
L	60	140	150	130	143	20	55	130	144	30	65								
M	60	150	160	139	153	20	55	140	153	30	65	139	150	45	90				
N	60	160	170	149	162	20	55	149	163	30	65	152	163	45	90	153	165	55	115
P	60	170	180					159	172	30	65	158	172	45	90	162	175	55	115
R	60	180	190					166	182	30	65	168	182	45	95	171	185	55	115
S	60	190	200					176	192	30	75	176	192	45	95	180	193	55	115
T	60	200	220									186	213	45	95	188	215	55	115
U	60	220	240									203	231	45	95	205	234	55	115
V	60	240	260									221	250	45	95	224	252	55	125
W	60	210	230																
X	60																		
Y	60	70	80	62	76	20	45												
Z	60																		
E4	60	290	310													267	257	55	125
E5	60	110	120	101	115	20	45												
EC	60			85	99	20	45												
EE	50			90	104	20	45												
COIL RESISTANCE @ 25°C (OHMS) REFERENCE				1,350				2,200				5,220				8,000			

CALIBRATION IDENTIFICATION	GROUP 25, 45 450V-Δ 80°C 395V-Δ 60°C				GROUP 26, 46 475V-Δ 80°C 420V-Δ 60°C				GROUP 27, 47 534V-Δ 80°C 455V-Δ 60°C				GROUP 28 530V-Δ 80°C 455V-Δ 60°C							
	PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT	
	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
A	242	272	60	140	242	272	75	150	239	268	75	170	239	258	75	170				
B	262	290	60	140	262	290	75	150	258	267	75	170	258	287	75	170				
C	279	310	60	140	280	310	75	150	277	305	75	170	277	305	75	170				
D	300	328	60	140	300	328	75	160	295	324	75	170	295	324	75	170				
E	319	347	60	140	318	347	75	160	314	342	75	180	314	342	75	180				
F	328	356	60	140	328	356	75	160	323	352	75	180	323	352	75	180				
G	337	366	60	140	337	366	75	160	332	361	75	180	332	361	75	180				
H	342	370	60	140	340	370	75	160												
J																				
K																				
L																				
M																				
N																				
P																				
R																				
S	195	205	60	130																
T	189	211	60	130																
U	204	233	60	130	204	233	75	150												
V	223	252	75	150	223	252	75	150												
W					195	224	75	150												
X																				
Y																				
Z																				
E4																				
E5																				
EC																				
EE																				
COIL RESISTANCE @ 25°C (OHMS) REFERENCE	11,600				13,260				15,900				17,650							

MOUNTING POSITIONS



POS.1 POS.2 POS.3 POS.4 POS.5 POS.6

PROPRIETARY AND CONFIDENTIAL

ISSUED MARCH 1, 1989
REV. ET-59412 JUNE 4, 1993
REV. ET-92182 98-4-9
REV. ET-93701 98-5-11
REV. ET-96312 2005-10-04
REV. ET-97394 2006-04-[illegible]

GE MOTOR STARTING RELAY (3ARR3, 3ARR22) DATA

74-407791
SH. 4

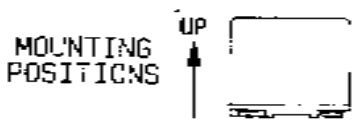
CALIBRATION VALUES ARE BASED ON AVERAGE COIL COPPER TEMPERATURES
OF: COLD 25°C
HOT 95°C.

CUSTOMER COLD PICK-UP AND DROP-OUT FOR EACH COIL GROUP

COIL GROUPS ARE U.L. CLASS B RATING AND VDE RECOGNIZED.
U.L. FILE SA339 AND VDE LICENSE 40014098.

CALIBRATION IDENTIFICATION	FREQUENCY (HERTZ)	HOT PICK-UP VOLTS		MAXIMUM COIL VOLTAGES FOR SPECIFIED MAXIMUM TEMPERATURE RISE																															
				GROUP 21, 41				GROUP 22, 42				GROUP 23, 43				GROUP 24, 44				GROUP 25, 45				GROUP 26 4E				GROUP 27, 47				GROUP 28			
				133V-Δ 80°C 117V-Δ 60°C				174V-Δ 80°C 153V-Δ 60°C				262V-Δ 80°C 230V-Δ 60°C				344V-Δ 80°C 302V-Δ 60°C				406V-Δ 80°C 356V-Δ 60°C				415V-Δ 80°C 359V-Δ 60°C				470V-Δ 80°C 407V-Δ 60°C				530V-Δ 80°C 455V-Δ 60°C			
				PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT		PICK-UP		DROP-OUT	
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
AA	50	260	280									240	259	45	109	243	271	55	159	242	272	60	133	242	272	75	152	239	268	75	170	239	268	75	170
AB	50	280	300									259	280	45	109	281	299	55	159	262	290	60	133	262	290	75	152	258	287	75	170	256	287	75	170
AC	50	300	320									278	296	45	129	280	305	55	138	279	310	60	133	280	310	75	152	277	305	75	170	277	305	75	170
AD	50	320	340													299	327	55	138	300	328	60	154	300	328	75	152	295	324	75	170	295	324	75	170
AE	50	340	360													319	340	75	140	318	347	60	154	318	347	75	152	314	342	75	180	314	342	75	180
AF	50	350	370																	328	355	60	154	328	356	75	152	323	352	75	180	323	352	75	180
AG	50	360	380																	337	365	60	154	337	366	75	181	332	361	75	180	332	361	75	180
AH	50	365	385																	342	370	60	154	343	370	82	154								
AJ	50	120	130	111	125	20	52	111	124	30	62																								
AK	50	130	140	121	134	20	52	123	134	30	62																								
AL	50	140	150	130	143	20	59	135	144	30	62																								
AM	50	150	160					145	153	30	75	138	159	45	90																				
AN	50	160	170					149	163	30	75	159	169	45	90																				
AP	50	170	180					159	172	30	75	159	172	45	90	162	175	55	118																
AR	50	180	190									169	182	45	90	171	184	55	115																
AS	50	190	200									178	192	45	90	180	193	55	119	180	195	60	133												
AT	50	200	220									195	213	45	90	196	215	55	119	196	214	60	133												
AU	50	220	240									203	221	45	109	205	224	55	119	204	223	60	133	204	223	75	170								
AV	50	240	260									221	250	45	109	224	252	55	119	223	252	60	133	223	252	75	152								
AW	50	210	230																					195	224	75	152								
AX	50																																		
AY	50	70	80	62	78	20	48																												
AZ	50																																		
COIL RESISTANCE @ 25°C (OHMS) REFERENCE				1,350				2,200				5,220				9,000				11,600				13,200				15,900				17,550			

MOUNTING POSITIONS



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REV. ET-92182 96-4-3
REV. ET-93701 96-3-11
REV. ET-96912 2005-10-04
REV. ET-97084 2006-04-19

74-407791
SHEET 4

GE Consumer & Industrial
GE Appliance Controls

GENERAL INFORMATION

3ARR3 & 3ARR22 Potential Type Motor Starting Relays

General Description

GE Potential Relays are used for assisting in the initial function of capacitor start, induction run and capacitor start, capacitor run motors. The motors are the larger sized compressor motors for residential central air conditioning systems and larger pump motors (over 1/3 hp at 120 VAC and 3/4 hp at 240 VAC). Smaller motors used on residential refrigeration systems generally use current type starting relays or thermal/resistance devices such as PTCR's. In order to use a potential type starting relay, the motor must have a start capacitor, but it may or may not also have a run capacitor.

Operation

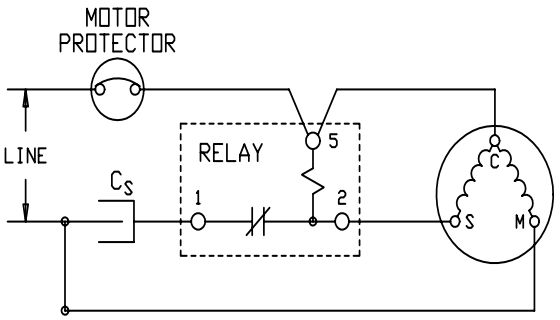
In a capacitor start, induction run or capacitor start, capacitor run motor, a voltage is generated in the start winding when the motor is running. This voltage results from the induced magnetic flux lines in the rotor cutting through the turns of the start winding. The voltage induced in the start winding is a function of the speed of the motor at any time and the number of turns in the start winding. The higher the speed of the rotor, for a given start winding, the higher the induced voltage in that start winding. When a motor is first energized, the voltage across the start winding is less than the supply voltage since the start winding is in series with the start capacitor. As the motor increases speed, the voltage across the start winding increases, and continues to increase until full motor speed is reached. At that point, the value of start winding voltage is called the continuous voltage rating required for relay coil design considerations. The start winding voltage can be significantly higher than the supply voltage.

Since the coil of the relay is connected across the start winding of the motor, the relay responds to the increase in start winding voltage as the motor increases speed *(See Figs 1 & 2).* The normally closed relay contacts, in series with the start capacitor, are designed to open at a specific motor speed as the start winding voltage increases.

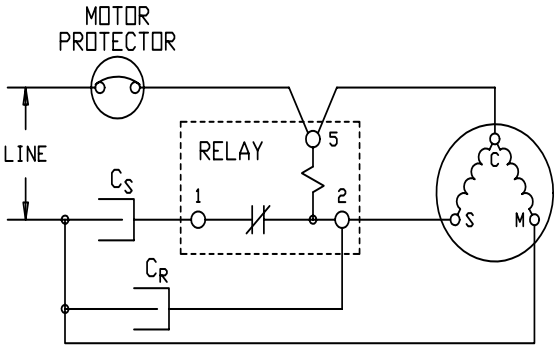
Note: The relay responds to the start winding voltage and not the supply voltage to the equipment.

For a specific motor and load conditions, there is a correlation between the start winding voltage and the speed of the motor. The relay utilizes this correlation to "pick up" and open the relay contacts at a voltage which will ensure that the motor will pull up to normal running speed after the start capacitor is disconnected. The relay pickup voltage is determined from the voltage/ speed/torque characteristics of the specific motor in the application.

CIRCUIT FOR POTENTIAL RELAY APPLICATIONS



CAPACITOR START - INDUCTION RUN
FIG 1



CAPACITOR START - CAPACITOR RUN
FIG 2

After disconnecting the start capacitor, the relay remains "picked up" during the run cycle of the motor. Therefore, the coil of the relay must be designed to be continuously energized at the value of the start winding voltage after the start capacitor is disconnected.

When the motor is de-energized, the relay "drops out", closing the contacts, and the relay is ready for the next motor start function.

Note: The start capacitor must be discharged during the run cycle by a bleed resistor across the terminals to prevent a charged start capacitor from discharging through the relay contacts and welding them as the motor is de-energized and the relay contacts re-close. The equipment manufacturer should determine the required value and wattage rating based on the specific application. Normally, a start capacitor bleed resistor has a resistance value of approximately 15,000 ohms and 2 watt capacity.

Design Features

The 3ARR3 and 3ARR22 potential type starting relays are enclosed relays designed for remote mounting from the equipment it is controlling.

The design is an iron core, armature actuated, electro-magnetic relay with a single-pole, single-throw normally closed contact structure. The armature engages the contact structure at a specific coil voltage value to open the relay contacts during the motor starting function.

The relay is designed for "clean" pick up within the calibration range. The mechanical load curve of the armature and contact structure action, and the magnetic pull curve from the coil are optimized such that once the armature begins its pick-up action, there is no "stalling" of the armature as it picks up the load of the contact spring. This ensures that there is always "clean" action of the contacts.

Materials

Materials are corrosion resistant or plated for long life in typical applications.

Base and cover materials are selected based on the application requirements. General Purpose Phenolic is the standard plastic. Melamine Phenolic material is available for more severe application conditions.

The large electrical contacts are (Ag CdO) silver/cadmium oxide composition for reliable disconnection of the start capacitor.

Terminal Options

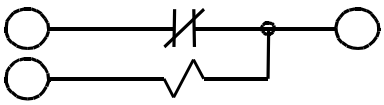
The design affords easy access to the wiring terminals.

- Quick Connect Tabs
  0.032" x 0.250" (0.8 mm x 6.3 mm)
  Tin-plated Brass
- Screw Type Terminals
  #8-32 Tin-plated Brass
- Spare Terminals
  Spare Terminals are available for interconnections

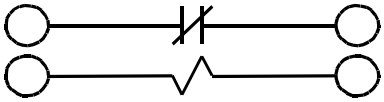
Note: If there is a wiring terminal in position 6 on 3ARR3 relays, it must be the same polarity as #1, #2, and #4 to prevent possible "flashover". If there is no terminal in position 6, then position 4 can be either polarity.

Circuits

Circuits are available for a three-terminal, common coil and contact circuit; or a four-terminal, isolated coil and contact configuration.



Common Coil Circuit



Isolated Coil Circuit

Coils

All coils have Class B insulation with a maximum allowed winding temperature of 120° C (by change in resistance method).

There are (16) standard coil groups, with ratings from 130 to 500 volts AC, 60 Hz. 50 Hz coil ratings range from 117 to 470 volts AC. The ratings are based on an 80° C temperature rise above a 40° C effective ambient temperature at the relay.

Contact Ratings

3ARR3 35 amperes (max), 50/60 Hz, break only.
3ARR22 50 amperes (max), 50/60 Hz, break only.

Mounting

A variety of standard mounting types are available which provide suitable mounting means for specific applications. The relay may be mounted in any position, but the calibration is position sensitive; therefore, the relay is calibrated for the specific mounting position in the application. The plastic cover permits mounting to metal without additional insulation.

Approvals

U.L.	File #	SA639	3ARR3/3ARR22
CSA	File #	11746-15 3ARR3	
CSA	File #	11746-115 3ARR22	
VDE		License No. 97252	3ARR3/3ARR22
		Ref. No. 4376.15-4510-8007/A1F	

General Application Considerations

The parameters and characteristics which must be evaluated for a satisfactory application are:

1. Motor Curves.
   (Max, Nom, Min Supply Volts)
   Motor Speed vs. Torque
   (Starting and Running)
   Motor Speed vs. Start Winding Volts
   (Start Capacitor In/Out)
2. Ratings in Amperes.
   Required Electrical Rating of the Contacts in Amperes. Determines the relay design required. (3ARR3/3ARR22)
3. Mechanical Form
   - Number and types of terminals (quick connect or screw)
   - Circuitry
     Common coil or isolated coil
   - Mounting Bracket Type
     Select from standard designs
     Other special features which may be required
4. Coil Voltage Rating.
   Follow Application Procedure.
5. Calibration.
   Follow Application Procedure.
6. Mounting Position.
   Customer specification for calibrating the relay in the position in which it will be mounted.

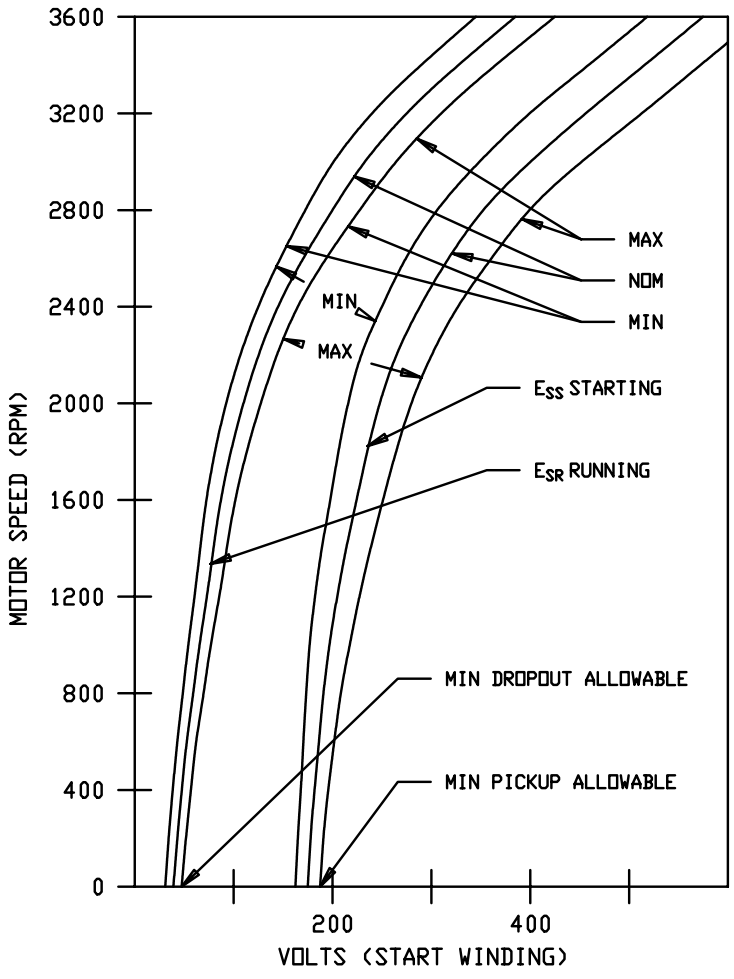
Endurance

100,000 to 500,000 operations depending on load.

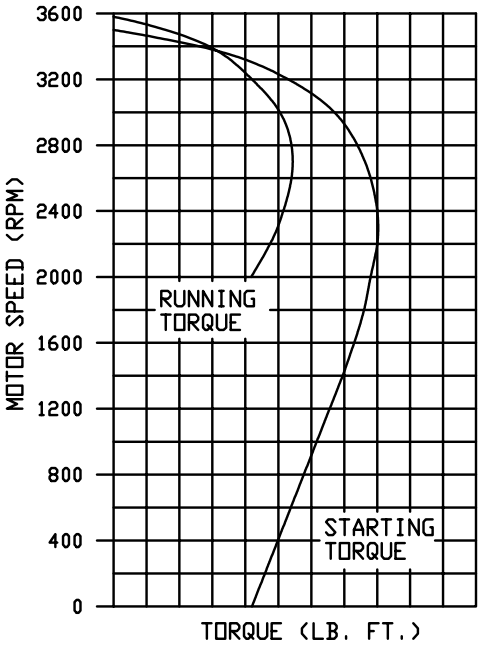
Motor Curves

Prior to beginning the procedure for determining the functional characteristics of the relay, the motor curves for start winding voltage vs. motor speed should be examined to see if the shapes of the curves lend themselves to a good application.

These curves should be obtained from the motor suppliers who generally are aware of motor curve characteristics which facilitate the application of potential type starting relays. See Figures 3 and 4 for typical start winding voltage and torque curves. Other basic electrical measurements on the motor/compressor will also assist in the application.



START WINDING VOLTAGE VS. MOTOR SPEED
TYPICAL CAPACITOR START MOTOR
(NOM, MIN, MAX SUPPLY VOLTAGE)
TWO-POLE, 60 Hz MOTOR
FIG.3



OUTPUT TORQUE VS. MOTOR SPEED
TYPICAL CAPACITOR START MOTOR
(NOMINAL SUPPLY VOLTAGE)
TWO-POLE, 60 Hz MOTOR
FIG.4

NOTE:
FOR A TWO-POLE, 50 Hz MOTOR,
SYNCHRONOUS SPEED IS 3000 RPM.

From the specified motor data, GE Application Data Work Sheets *(Appendix A)* and Coil Group/Calibration Tables *(74-407791 Appendix B)* are used to select the proper coil group and calibration for either 60 or 50 Hz applications. Appropriate suffix numbers and letters are identified and made part of the full model number.

To make a good application, the curves should exhibit a significant change in start winding voltage with a change in speed. If the curves are "unusually straight", it is difficult to make a good application. Since the relay responds to changes in voltage, a significant difference in voltage is required for a specific change in speed. However, excessive changes in start winding voltage with speed can result in high disconnect voltage and current on the start capacitor. It may also require a relay with a very high differential to prevent the relay from dropping out while the motor is running.

Definitions

Supply (Line) Voltage
Value of voltage at the input terminals of the motor. Specified as "Nominal", "High"(+10%), or "Low" (-15%).

Ess
Voltage across the start winding with start capacitor in the circuit.

Esr
Voltage across the start winding with start capacitor out of the circuit.

Ecs
Voltage across the start capacitor with the capacitor in the circuit during starting.

Transfer Speed
Selected RPM of the motor at which the start capacitor is disconnected and motor will pull up to normal running speed.

Crossover Speed
Motor speed above which the running torque exceeds the starting torque.

Coil Voltage Rating
Continuous voltage which can be applied to the relay coil without exceeding the maximum allowable coil winding temperature.

Pickup Voltage
Determines the "transfer speed" at which the start capacitor is disconnected. Allowance is made in the specified pickup voltage to compensate for the response time of the relay.

Cold Pickup Voltage
Value of pickup voltage when the relay coil is "cold". This is the condition when the coil has not been energized and is the lowest expected pickup voltage. (Coil temp approx 40° C.)

Hot Pickup Voltage
Value of pickup voltage after the coil has been energized during a run cycle and has not cooled down to the ambient temperature during the off cycle. (Coil temp approx 95° C.)

When a coil is energized continuously, the resistance value of the coil wire increases; therefore, a higher voltage is required to produce enough current to actuate the relay.

Dropout Voltage
Value of voltage at which the relay will dropout, allowing the contacts to reclose after the compressor or motor is de-energized.

Dropout voltage is related to the rating of the relay coil. The higher the coil rating, the higher the range of dropout voltage.

The minimum dropout voltage must be greater than the maximum value of Esr at zero speed with maximum supply voltage.

Load Current
Maximum expected current which the relay contacts will break to disconnect the start capacitor. It can be calculated using the maximum capacitor voltage, the capacitance value of the capacitor, and the frequency. This value must be within the rating of the relay contacts.

Application Procedures

General

There are various procedures used to select the correct functional elements and characteristics of the relay to be applied, depending on the amount of information available. The more operating information available, the better the application.

Aside from general information pertaining to terminals, circuits, and mounting position, the primary decisions concern relay type (3ARR3 or 22), coil group, and calibration.

The Application Data Work Sheets *(Appendix A)* are step-by-step procedures and should be followed for each application.

It is recommended that the characteristics be measured on the motor/compressor at the expected supply voltage and frequency for the best applications. There are some approximations which may be used to convert coil performance and calibration from one frequency to another, but they should be used with caution.

Potential relay applications involve compromises to ensure specific performance requirements are not violated. This means reviewing data and preliminary calculations and refining them to provide the optimum relay characteristics.

Mounting Location

The relay should not be mounted in a location where there is close proximity to large pieces of magnetic material which may link the magnetic flux of the relay and change the calibration. If another location is not possible, the calibration of the relay may be modified to compensate for the effect.

The relay also should not be mounted in a location where it will be subject to substantial vibration or shock which may alter the calibration or cause the contacts to open prematurely.

The relay may be mounted in any one of the six possible positions *(Appendix B and C)*; however, position #6 should be avoided. In position #6, the return spring may not properly seat the armature in its pivots especially on low calibration models. This can cause a first-cycle error in calibration.

Mounting Brackets

The standard mounting types are shown in Appendix C.

Coil Group Selection Procedure

1. Determine the maximum continuous start winding voltage which the relay coil will see during the normal running of the motor/ compressor.

   Measure Esr at synchronous speed (no load) with the maximum expected supply voltage (nominal + 10%) and at the frequency of the application (60 or 50 Hz).

   If voltage data is not available at synchronous speed, use 110% of Esr at approximately 3500 RPM for two-pole 60 Hz motors or 1750 RPM for four-pole motors at maximum supply voltage. For 50 Hz motors, use 110% Esr at approximately 2900 PM. (1450 RPM for four-pole.)

2. Select appropriate coil group from Application Data Sheets *(74-407791 Appendix B)* for the applicable voltage and frequency.

Because the coil designs have a very large number of turns, there is a significant inductive reactance which has an effect on the heat rise of the coil, depending on whether the coil voltage frequency is 60 or 50 Hz. Sheets 1 and 3 are ratings for 60 Hz and Sheets 2 and 4 are for 50 Hz applications.

The Data Sheets contain (16) standard coil groups for which the voltage rating for continuous coil operation is listed for two specific temperature rise values (80° C and 60° C). The maximum start winding voltage in the application must not exceed the maximum coil voltage rating for an 80° C temperature rise.

All coils have a 120° C total temperature rating, based on IEC 730-1 (EN 60730-1). Therefore, in an application where the effective ambient is 40° C, an allowable rise of 80° C is within the 120° C temperature rating of the coil. The effective ambient temperature at the relay plus the heat rise of the coil must not exceed 120° C.

If the effective ambient temperature at the relay is expected to exceed 40° C, then a coil group with a higher voltage rating should be selected.

The tables show voltage ratings for 60° C temperature rise as a guide for selecting coils where the effective relay ambient may exceed 40° C.

Note: Be sure that the effective ambient at the relay is checked in the worst conditions for highest expected ambient temperature. Some applications may have unusually high effective ambients due to small space constraints, tighter enclosures, and/or insulation around the motor/compressor compartment for noise damping.

Calibration Specification Procedure

Calibration values can be approached from two directions. One is starting at the optimum transfer speed and working down from a value of maximum hot relay pickup volts which will disconnect the start capacitor at the optimum transfer speed. The most common procedure is to start with a calculation of the minimum cold pickup volts which will not be less than a voltage surge at Ess at zero speed when the circuit is energized. The calculation includes a safety factor. From this minimum cold pickup value, along with the speed change during the response time of the relay, it can be observed whether or not the transfer speed is appropriate for proper pull-in up to normal running speed.

In either approach, both maximum and minimum operating parameters and the relay functional tolerances must be evaluated prior to final selections. To determine the correct value of pickup voltage, there must be compensation for the response time of the relay. The motor will typically accelerate approximately 700 RPM for two-pole 60 Hz motors (400 RPM four-pole motors) from the time the relay pickup action is started until the relay contacts open and disconnect the start capacitor. For 50 Hz motors, an approximate value is 500 RPM for two-pole and 300 RPM for four-pole.

The minimum cold pickup voltage should be no less than 130% of the start winding voltage under starting conditions, at locked rotor (zero speed), and at high supply line voltage (nominal + 10%). This will prevent premature operation of the relay in response to a transient surge of voltage which occurs when the motor is initially energized. Maximum start winding voltage at zero speed occurs with maximum supply voltage, and maximum values of start and run capacitors connected.

The minimum cold pickup voltage must also be high enough that when the start capacitor is disconnected, there is enough running torque to pull the motor up to normal running speed.

The maximum hot pickup voltage value should be low enough that the motor will always get to a speed high enough under load conditions to pick up the relay and disconnect the start capacitor.

It is advisable to disconnect the capacitor at the lowest speed which will start the motor. This will assure the capacitor voltage and disconnect current of the relay contacts are kept as low as possible.

In all cases, the minimum relay dropout voltage must be greater than the maximum Esr at zero speed with maximum supply line voltage to assure that the relay drops out when the motor is de-energized.

The current which the relay contacts must break to disconnect the start capacitor can be calculated by formulas in Appendix A. This value of current must be less than the contact rating of the relay. If it is not, the capacitor must be disconnected at a lower speed to reduce Ecs to a value which will be within the relay contact rating or a higher rated relay (3ARR22) should be used.

After the approximate value of hot (or cold) pickup has been determined, refer to the previously selected coil group table in the Application Calibration Tables *(74-407791 Appendix B*) for the appropriate calibration letters which best fit the speed-torque-voltage values of the motor curves.

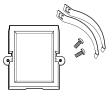
Note: Once values are determined, they must be rechecked for the effects of all maximum and minimum tolerances, capacitance of the start capacitor, and capacitor voltage and current.

Alternating Relay
ARP Series
Motor Duplexor

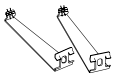
- Provides Equal Run Time for Two Motors
- Alternating or Electrically Locked Operation
- Low Profile Selection Switch
- 10 A Relay Contacts
- LED Status Indication
- Industry Standard Base Connection

Approvals:

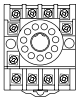
Accessories



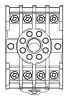
Panel mount kit
P/N: **BZ1**



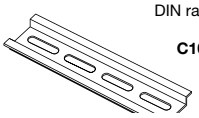
Hold down clips
P/Ns: **PSC8** (NDS-8)
PSC11 (NDS-11)



11 pin socket
P/N: **NDS-11**



Octal
8 pin socket
P/N: **NDS-8**



DIN rail P/Ns:
C103PM (Al)

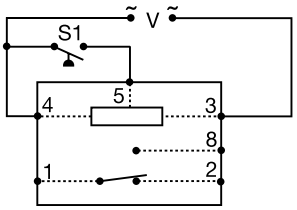
See accessory pages for specifications.

Description
The ARP Series is used in systems where equal run time for two motors is desirable. The selector switch allows selection of alternation or either load for continuous operation. LED's indicate the status of the output relay. This versatile series may be front panel mounted (BZ1 accessory required) or 35 mm DIN rail mounted with an accessory socket.

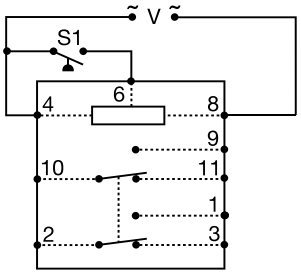
Operation
Alternating: When the rotary switch is in the "alternate" position, alternating operation of Load A and Load B occurs upon the opening of the control switch S1. To terminate alternating operation and cause only the selected load to operate, rotate the switch to position "A" to lock Load A or position "B" to lock Load B. The LEDs indicate the status of the internal relay and which load is selected to operate.

Note: Input voltage must be applied at all times for proper alternation. The use of a solid state control switch for S1 may not initiate alternation correctly. S1 voltage must be from the same supply as the unit's input voltage (see connection diagrams). Loss of input voltage resets the unit; Load A becomes the lead load for the next operation.

Connection

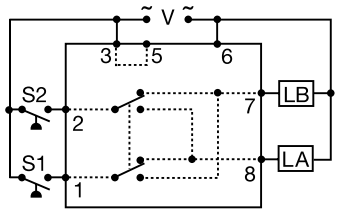


1.
SPDT 8 Pin



2.
DPDT 11 Pin

Relay contacts in above are isolated.



3.
DPDT 8 Pin Cross Wired

Duplexing (Cross Wired): Duplexing models operate the same as alternating relays and when both the Control (S1) and Lag Load (S2) Switches are closed, Load A and Load B energize simultaneously.

The DPDT 8-pin, cross wired option, allows extra system load capacity through simultaneous operation of both motors when needed. Relay contacts are not isolated.

Dashed lines are internal connections.

V = Voltage LA = Load A LB = Load B
S1 = Primary Control Switch S2 = Lag Load Switch

Available Models-

ARP22
•ARP41S
•ARP43
•ARP63S
•ARP23S
•ARP42
•ARP43S
•ARP41
•ARP42S
ARP62S

Don't see what you need? Call us for a minimum quantity and price quote!

Ordering Table

ARP	X	X	X
Series	**Input**	**Output Form**	**Switch Option**
	2 - 24 V AC	**1** - SPDT, 8 Pin	**S** - Rotary Switch
	4 - 120 V AC	**2** - DPDT, 11 Pin	Blank - No Switch
	6 - 230 V AC	**3** - DPDT, 8 Pin Cross Wired	

Example P/N: **ARP41S, ARP63**

ARP02B01 09.10

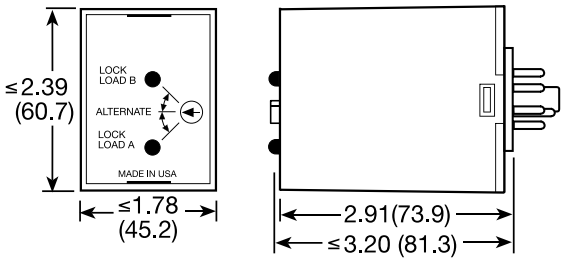
Alternating Relay
ARP Series
Motor Duplexor

Liquid level controls

Technical Data

Input		
Voltage		24, 120, or 230 V AC
Tolerance	24 V AC	-15% ... +20%
	120 & 230 V AC	-20% ... +10%
Line Frequency		50 ... 60 Hz
Output		
Type		Electromechanical relay
Form		SPDT, or DPDT, or cross wired DPDT
Rating		10 A resistive at 120/240 V AC & 28 V DC; 1/3 hp at 120/240 V AC
Maximum Voltage		250 V AC
Life		Mechanical -- 1 x 10^7
		Electrical -- 1 x 10^6
Protection		
Isolation Voltage		≥ 1500 V RMS input to output
Mechanical		
Mounting		Plug-in socket
Package		3.2 x 2.39 x 1.78 in. (81.3 x 60.7 x 45.2 mm)
Termination		8 Pin octal or 11 Pin magnal
Environmental		
Operating Temperature		-20°C ... +60°C
Storage Temperature		-30°C ... +85°C
Weight		≅ 5.6 oz (159 g)

Mechanical View



Inches (Millimeters)

9

ARP02B01 09.10

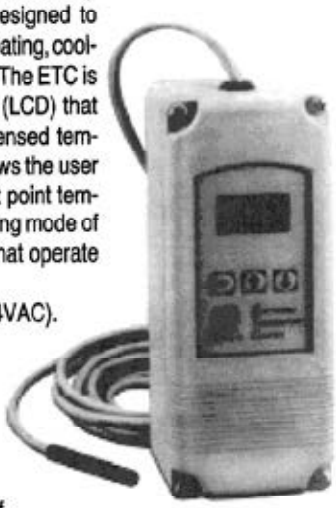
• denotes a preferred product

Form No. 7515004-001 Rev. B

ETC TWO STAGE ELECTRONIC TEMPERATURE CONTROL

PRODUCT DESCRIPTION

The Ranco ETC is a microprocessor-based family of electronic temperature controls, designed to provide on/off control for commercial heating, cooling, air conditioning and refrigeration. The ETC is equipped with a liquid crystal display (LCD) that provides a constant readout of the sensed temperature, and a touch keypad that allows the user to easily and accurately select the set point temperature, differential and heating/cooling mode of the operation. Models are available that operate on either line voltage (120/208/240 VAC) or low voltage (24VAC).



APPLICATIONS

With its wide temperature setpoint range and selectable heating or cooling modes, the ETC can be used for a wide variety of applications including multiple compressor control, two stage heating, ventilation control, automatic changeover, condenser fan cycling, space and return air temperature control, water cooled condensers and control with alarm funtion.

FEATURES

- Wide setpoint temperature range (-30°F to 220°F) and differential adjustment (1°F to 30°F).
- Simple keypad programming of setpoint temperature, differential and cooling/heating modes.
- Two individually programmable stages for heating and/or cooling.
- LCD readout of sensor temperature, control settings, relay status and onboard diagnostics.
- Remote temperature sensing up to 400 feet.
- Two SPDT output relays.
- User-selectable Fahrenheit/Celsius scales.
- Lockout switch to prevent tampering by unauthorized personnel.
- Choice of line voltage and low voltage models available.
- Optional 0 to 10 volt analog output available for remote temperature indication.

SPECIFICATIONS

Input Voltage	120 or 208/240 VAC (24 VAC optional), 50/60 Hz
Temperature Range	-30°F to 220°F
Differential Range	1°F to 30°F
Switch Action	SPDT
Sensor	Thermistor, 1.94 in. long x 0.25 in. diameter with 8 ft. cable
Power Consumption	120/208/240 VAC : 100 milliamps 24 VAC : 2-6 VAC

Relay Electrical Ratings

	120V	208/240V
NO Contact		
Full-load amps	9.8 A	4.9 A
Locked rotor amps	58.8 A	29.4 A
Resistive amps	9.8 A	4.9 A
Horsepower	1/2 hp	1/2 hp
NC Contact		
Full-load amps	5.8 A	2.9 A
Locked rotor amps	34.8 A	17.4 A
Resistive amps	5.8 A	2.9 A
Horsepower	1/4 hp	1/4 hp

Pilot Duty: 125 VA at 120/208/240 VAC

Control Ambient Temperature	
Operating	-20°F to 140°F (-29°C to 60°C)
Storage	-40°F to 176°F (-40°C to 80°C)
Ambient Humidity	0 to 95%, RH, Non-condensing
0 to 10 V Output Impedance	1K
Enclosure	NEMA 1, Plastic
Agency Approvals	UL Listed, File E94419, Guide XAPX CSA Certified, File LR68340, Class 4813 02

ETC ORDERING INFORMATION

Code Number	Input Voltage	No. of Stages	0 - 10 V Output
ETC-211000-000	120/240	2	No
ETC-211100-000	120/240	2	Yes
ETC-212000-000	24	2	No
ETC-212100-000	24	2	Yes

OPERATION

Liquid Crystal Display (LCD)

The LCD display provides a constant readout of the sensor temperature and indicates if either of the two output relays is energized. When the **S1** annunciator is constantly illuminated during operation, the Stage 1 relay is energized. Likewise, when the **S2** annunciator is constantly illuminated during operation, the Stage 2 relay is energized. The display is also used in conjunction with the keypad to allow the user to adjust the setpoint temperatures, differentials and heating/cooling modes for each stage.

Control Setup

The temperature setpoint refers to the temperature at which the normally open (NO) contacts of the output relay will open. Determine the loads to be controlled and the operating modes required for each stage, cooling or heating.

- When the cooling mode is chosen, the differential is above the setpoint. The relay will de-energize as the temperature falls to the setpoint.
- When the heating mode is chosen, the differential is below the setpoint. The relay will de-energize as the temperature rises to the setpoint.

The ETC two stage control can be set up for two stages of heating, two stages of cooling or one stage cooling plus one stage heating. Refer to Figures 1, 2 and 3 for a visual representations of different control setups.

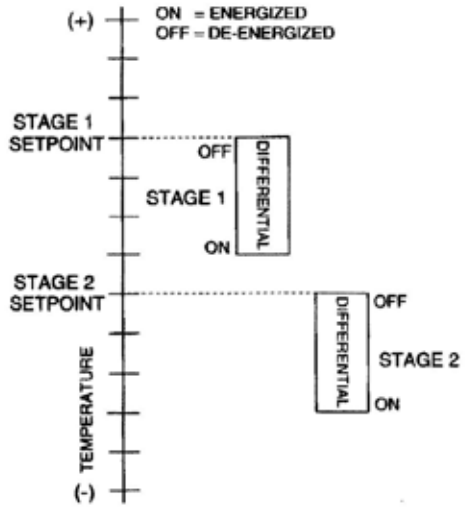


Figure 1: Two Stage Heating Example

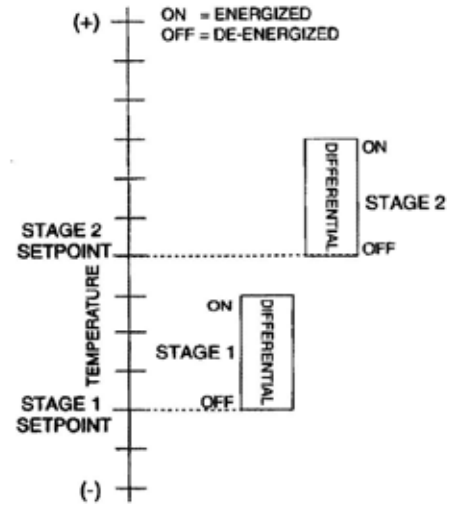


Figure 2: Two Stage Cooling Example

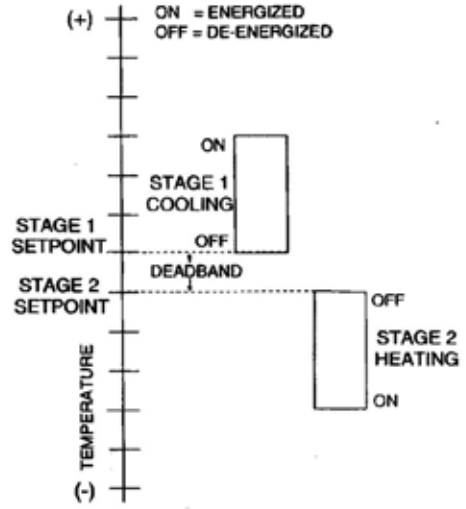


Figure 3: One Stage Cooling and One Stage Heating Example

Programming Steps and Display

The ETC two stage can be programmed in seven simple steps using the LCD display and the three keys on the face of the control.

Step 1- To start programming, press the **SET** key once to access the Fahrenheit/Celsius mode. The display will show the current status, either **F** for degrees Fahrenheit or **C** for degrees Celsius. Then press either the up ⬆ or down ⬇ arrow key to toggle between the **F** or **C** designation.

Stage 1

Step 2- Press the **SET** key again to access the stage 1 setpoint. The LCD will display the current setpoint and the **S1** annunciator will be blinking on and off to indicate that the control is in the setpoint mode. Then press either the up ⬆ key to increase or the down ⬇ key to decrease the setpoint to the desired temperature.

Step 3- Press the **SET** key again to access the stage 1 differential. The LCD will display the current differential and the **DIF 1** annunciator will be blinking on and off to indicate that the control is in the differential mode. Then press either the up ⬆ key to increase or the down ⬇ key to decrease the differential to the desired setting.

Step 4- Press the **SET** key again to access the stage 1 cooling or heating mode. The LCD will display the current mode, either **C1** for cooling or **H1** for heating. Then press either the up ⬆ or down ⬇ key to toggle between the **C1** or **H1** designation.

Stage 2

Step 5- Press the **SET** key again to access the stage 2 setpoint. The LCD will display the current setpoint and the **S2** annunciator will be blinking on and off to indicate that the control is in the setpoint mode. Then press either the up ⬆ key to increase or the down ⬇ key to decrease the setpoint to the desired temperature.

Step 6- Press the **SET** key again to access the stage 2 differential. The LCD will display the current differential and the **DIF 2** annunciator will be blinking on and off to indicate that the control is in the differential mode. Then press either the up ⬆ key to increase or the down ⬇ key to decrease the differential to the desired setting.

Step 7- Press the **SET** key again to access the stage 2 cooling or heating mode. The LCD will display the current mode, either **C2** for cooling or **H2** for heating. Then press either the up ⬆ or down ⬇ key to toggle between the **C2** or **H2** designation. Press the **SET** key once more and programming is complete.

Refer to Page 3 for an illustrated guide to programming the ETC.

NOTE: The ETC will automatically end programming if no keys are depressed for a period of thirty seconds. Any settings that have been input to the control will be accepted at that point.

All control settings are retained in non-volatile memory if power to ETC is interrupted for any reason. Re-programming is not necessary after power outages or disconnects unless different control settings are required.

Step	Annunciator	Description	Display
1	**F** or **C**	Fahrenheit or Celsius Scale	F
2	**S1** (blinking)	Stage 1 Setpoint Temperature	S1 70
3	**DIF 1** (blinking)	Stage 1 Differential Temperature	DIF 5
4	**C1/H1**	Stage 1 Cooling or Heating Mode	C1
5	**S2** (blinking)	Stage 2 Setpoint Temperature	S2 65
6	**DIF 2** (blinking)	Stage 2 Differential Temperature	DIF2 10
7	**C2/H2**	Stage 2 Cooling or Heating Mode	C2

TROUBLESHOOTING ERROR MESSAGES

Display Messages

E1- Appears when either the up ⬆ or down ⬇ key is pressed when not in the programming mode.
To correct: If the **E1** message appears even when no keys are being pressed, replace the control.

E2- Appears if the control settings are not properly stored in memory.
To correct: Check all settings and correct if necessary.

EP- Appears when the probe is open, shorted or sensing a temperature that is out of range.
To correct: Check to see if the sensed temperature is out of range. If not, check for probe damage by comparing it to a known ambient temperature between -30°F and 220°F. Replace the probe if necessary.

EE- Appears if the EEPROM data has been corrupted.
To correct: This condition cannot be field repaired. Replace the control.

CL- Appears if calibration mode has been entered.
To correct: Remove power to the control for at least five seconds. Reapply power. If the **CL** message still appears, replace the control.

Lockout Switch

The ETC is provided with a lockout switch to prevent tampering by unauthorized personnel. When placed in the **LOCK** position, the keypad is disabled and no changes to the settings can be made. When placed in the **UNLOCK** position, the keypad will function normally.

To access the lockout switch, disconnect the power supply and open the control. The switch is located on the inside cover about 2 inches above the bottom. (see Figure 4). To disable the keypad, slide the switch to the left **LOCK** position. To enable the keypad, slide the switch to the right **UNLOCK** position. All ETC controls are shipped with this switch in the **UNLOCK** position.

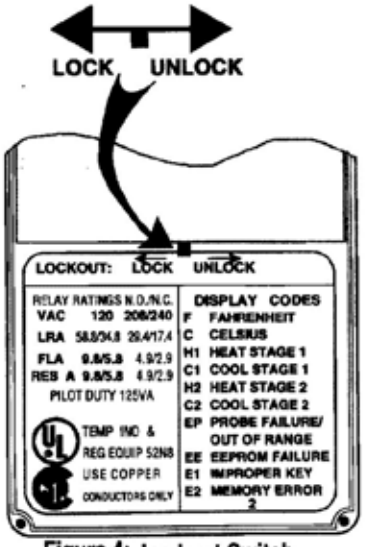


Figure 4: Lockout Switch

INSTALLATION INSTRUCTIONS

IMPORTANT

1. All ETC series controls are designed as operating controls only. If an operating control failure could result in personal injury or loss of property, a separate safety control and/or alarm should be installed.

2. The schematic drawings and other information included in these installation instructions are for the purpose of illustration and general reference only.

3. These instructions do not expand, reduce, modify or alter the Ranco Terms in any way; and no warranty or remedy in favor of the customer or any other person arises out of these instructions.

4. Ranco ETC controls have been approved by Underwriters' Laboratories as UL Listed; however, approval does not extend to their use for any other purpose. Ranco assumes no responsibility for any unconventional application of its control unless such application has been approved in writing by Ranco.

5. It is the responsibility of the installer and the user to assure that his or its application and use of all Ranco products are in compliance with all federal, state and local requirements, including, without any limitation, all requirements imposed under the National Electric Code and any applicable building codes.

CAUTION

To prevent possible electrical shock or equipment damage, disconnect electrical power to the unit before and during installation. **DO NOT** restore electrical power to unit until the control is properly installed and the cover is assembled. **DO NOT** locate the control in an explosive atmosphere as a safety hazard can result due to possible spark generation in the control. Controls are not to be located in areas of significant moisture, dirt or dust, or in a corrosive explosive atmosphere. Use of control in such environments may result in injury or damage to the persons or property (or both) and are likely to shorten the control life;
Ranco assumes no responsibility for any such use.

CONTROL MOUNTING

Mount the ETC to a wall or any flat surface using a combination of any two or more of the slotted holes located on the back of the control case. The control's components are not position sensitive, but should be mounted so that they can be easily wired and adjusted. Avoid excessive conditions of moisture, dirt, dust and corrosive atmosphere.

The ETC has provisions for 1/2 inch conduit connections. The conduit hub should be secured to the conduit before securing the hub to the plastic housing of the control. When using the conduit entry in the rear of the case, a standard plug should be inserted into the conduit hole in the bottom. Caution should be exercised not to damage the control circuit board or wiring when installing a conduit connector.

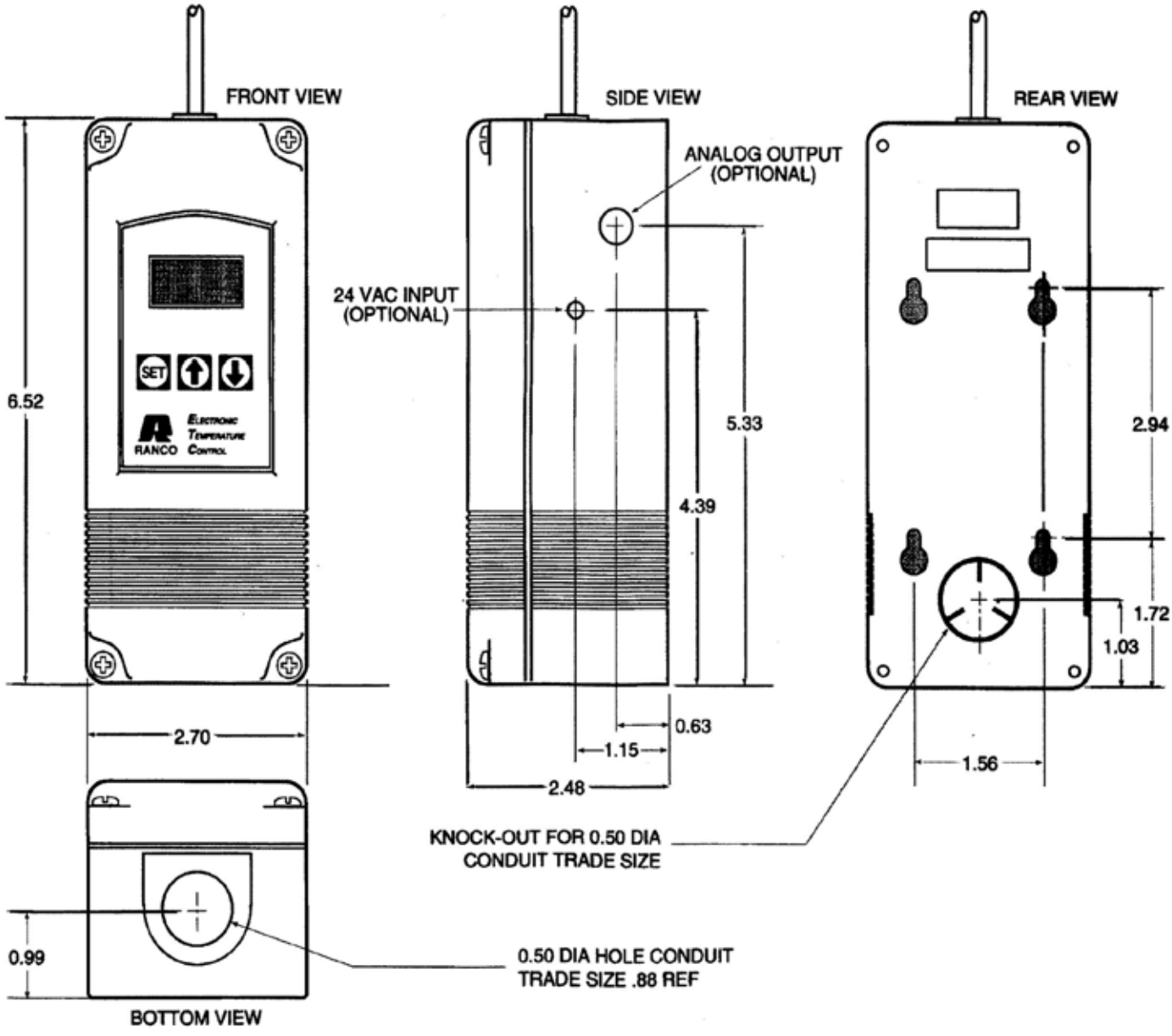


Figure 5: Dimensions (Inches)

CONTROL WIRING

General

- All wiring should conform to the National Electric Code and local regulations.
- The total electrical load must not exceed the maximum rating of the control (see Specifications).
- Use copper conductors only.
- Electrical leads should not be taut; allow slack for temperature change and vibration.

Input and Output Wiring

For typical wiring diagrams, refer to Figures 6 and 7.
All connections are made to the power (lower) circuit board. When using the 24 VAC powered models, the 24 VAC input lines must enter through the sidewall of the case. Refer to Figure 5 for location of the entry hole.

Analog Output

ETC models are available with an optional 0 to 10 volt analog output. This signal is a linear representation of the sensor temperature with 0 volts = -30°F and 10 volts = 220°F. See figure 8 for wiring information and Figure 5 for location of the entry hole. The reference for this output is designated by the "-" symbol on the wiring diagram. The output signal is designated by the "+" symbol.

Sensor Wiring

The temperature sensor leads are soldered to the circuit board so no additional connections are necessary. However, splicing is required when extending the sensor cable length beyond the standard 8 foot length supplied with the ETC. The sensor cable can be extended up to 400 feet.

A damaged sensor can be replaced by splicing a new Ranco sensor onto the sensor leads from the circuit board. The sensor is not polarity sensitive.

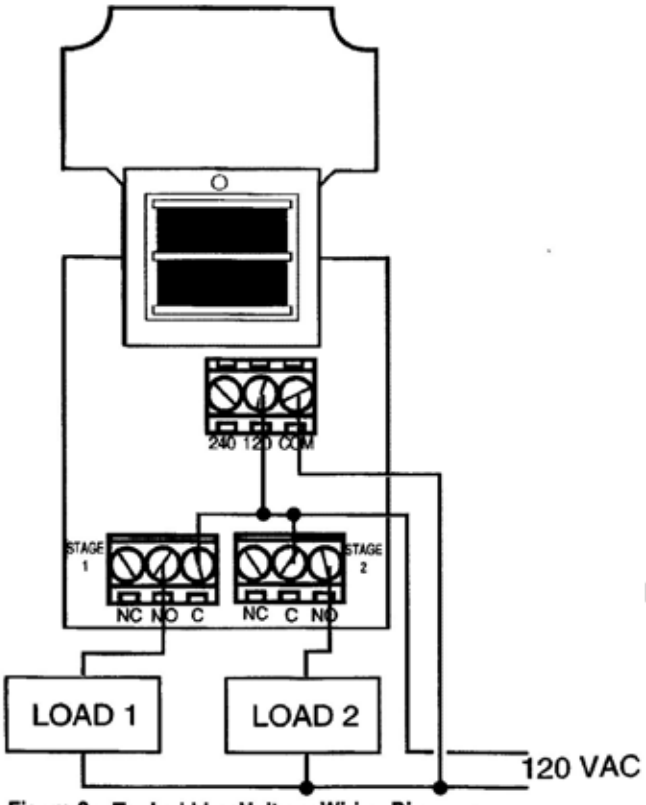


Figure 6: Typical Line Voltage Wiring Diagram.

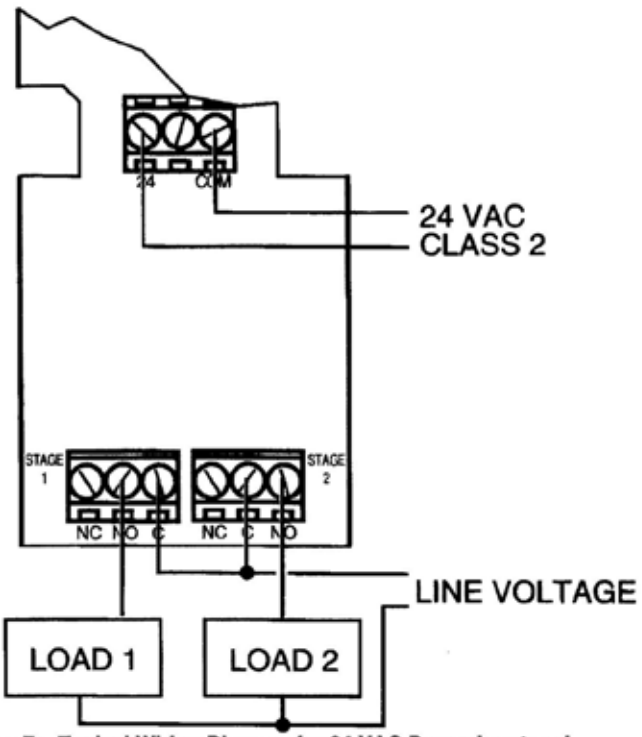


Figure 7: Typical Wiring Diagram for 24 VAC Power Input and Line Voltage Switching.

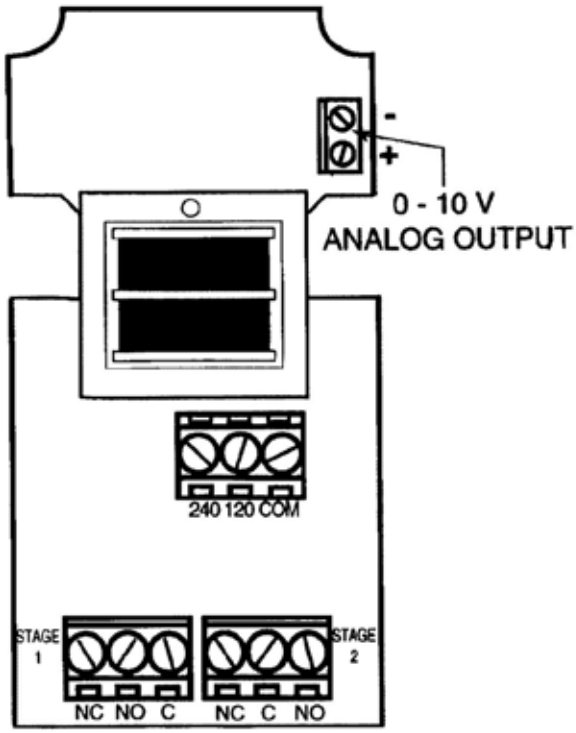


Figure 8: 0-10 V Analog Output Located on Power (Lower) Circuit Board.

FIELD REPAIRS

Field calibrating or repairs to the ETC control must not be attempted. Sensors and replacement controls are available through Ranco wholesalers

SENSOR MOUNTING

For space sensing, mount the sensor where it will be unaffected by heat/cool discharge or radiated heat sources. Spot sensing requires the sensor to be in good contact with the surface being sensed. The sensor can be inserted in a bulb well for immersion sensing.

EXTENDING SENSOR

CAUTION: Sensor wiring splices may be made external from the control. **DO NOT** attempt tyo unsolder the sensor at the control circuit board!

CAUTION: Disconnect power to control before wiring to avoid possible electrical shock or damage to the controller.

Additional cable can be spliced to the sensor cable to increase the length beyond the standard 8 feet. It can be extended up to 400 feet. The cable should be at least 22 AWG or larger to keep additional resistance to a minimum.

All splices and wire lengths added to the sensor cable should be made according to acceptable wiring practices and should conform to the National Electrical Code and local regulations. Use copper conductors only. Shielded cable is not required.

Checkout Procedure

1. Before applying power, make sure installation and wiring connections are correct.
2. Apply power to the control and observe one or more cycles of operation.
3. If performance indicates a problem, check sensor resistance to determine if sensor or control is at fault.
4. To check sensor resistance, disconnect sensor and measure the resistance across the leads while measuring temperature at the sensor.

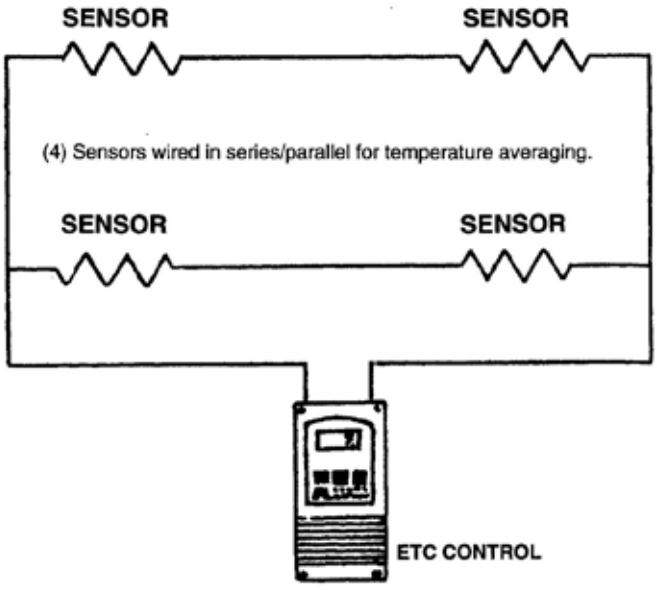


Figure 9

Replacement Sensor - Order Part No. 1309007-044

SPECIFICATIONS

The 1309007-044 sensor is a negative temperature coefficient (NTC) thermistor sensor. The sensor resistance decreases with temperature increase. It is .25 x 1.94 long with 8 feet #22 AWG cable. The termistor has a reference resistance of 30,000 ohms at 77°F (25°C).

IMPORTANT

The schematic drawings and other information included in these instructions are for the purpose of illustration and general reference only. Ranco assumes no responsiblity for any unconventional application of this control, unless such application has been approved in writing by Ranco.

Deg. C.	Deg. F.	RES. Nom.
-40	-40	1,010,000
-30	-22	531,000
-20	-4	291,200
-10	14	166,000
0	32	97,960
10	50	59,700
20	68	37,470
25	77	30,000
30	86	24,170
40	104	15,980
50	122	10,810
60	140	7,464
70	158	5,200
80	176	3,774
90	194	2,753
100	212	2,036
110	230	1,531

Figure 10:
Resistance vs Temperature of 1309007-044. Sensor including 8 foot cable.

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ICM492
Single Phase, Digital Line Voltage Monitor

The ICM492 constantly monitors line voltage and protects single-phase equipment against low and high voltage conditions, and rapid short cycling due to voltage fault or power interruption. Its easy-view, backlit digital display makes it user friendly to read and monitor voltage conditions, and adjust parameters to meet specific needs.

Features

- **Protects Against Over and Under Voltage, and Rapid Short Cycling caused by Transient Faults and Power Interruptions**
- **Easy-view, Backlit Digital Display**
- **RMS Voltage Monitoring**
- **Adjustable Voltage Set Point**
- **Adjustable Over Voltage Setting**
- **Adjustable Under Voltage Setting**
- **Adjustable Anti-Short Cycle Time Delay**
- **Adjustable Response Time**
- **Control Mode**
- **Universal Line voltage Input**
- **Heavy Duty SPDT Relay Output**
- **Universal Control Voltage Input (for integrating a thermostat)**

Mode of Operation

The **ICM492** continuously monitors incoming line voltage for faults and displays RMS voltage on the digital display. When line voltage is appropriate, the **ICM492** will close COM and N.O. relay contacts. When incoming line voltage is outside of the user selected parameters, the **ICM492** will close COM and N.C. relay contacts and indicate a fault condition by flashing FAULT on display. The SELECT menu has the following user adjustable settings: voltage setpoint, time delay, over voltage, under voltage, control mode, and response time. Time delay prevents system short cycling caused by transient faults and rapid power interruptions. The response time on the fault condition can be adjusted to help reduce nuisance trips from transient faults. When Control Mode setting is selected ON, the **ICM492** will close COM and N.O. relay contacts only when control voltage is present at Control Voltage terminals. The relay contacts can be used to direct drive the load as long as current rating is not exceeded.

Specifications

User Adjustable Settings:
- **Voltage set point:** 95-280V
- **Anti-short cycle time delay:** 0-720 seconds
- **Over voltage setting:** 5-25%
- **Under voltage setting:** 5-25%
- **Control mode:** On and Off
- **Response time:** 0.1 to 10 seconds

Inputs:
- **Line Voltage:** 80 to 300 VAC
- **Frequency:** 50/60 Hz
- **Accuracy:** ±2%
- **Low Power Consumption:** **max** 50 mA @ 120V, **max** 100 mA @ 240V
- **Control Voltage:** 24 to 240 VAC

Output:
- **Type:** dry relay contacts
- **Form:** SPDT
- **Relay Contact Ratings:**
  - **N.C. Contacts:** 10A resistive @ 277 VAC
  - **N.O. Contacts:** 10A resistive @ 277 VAC
- **Connection Terminals:** 0.25" male fast-on

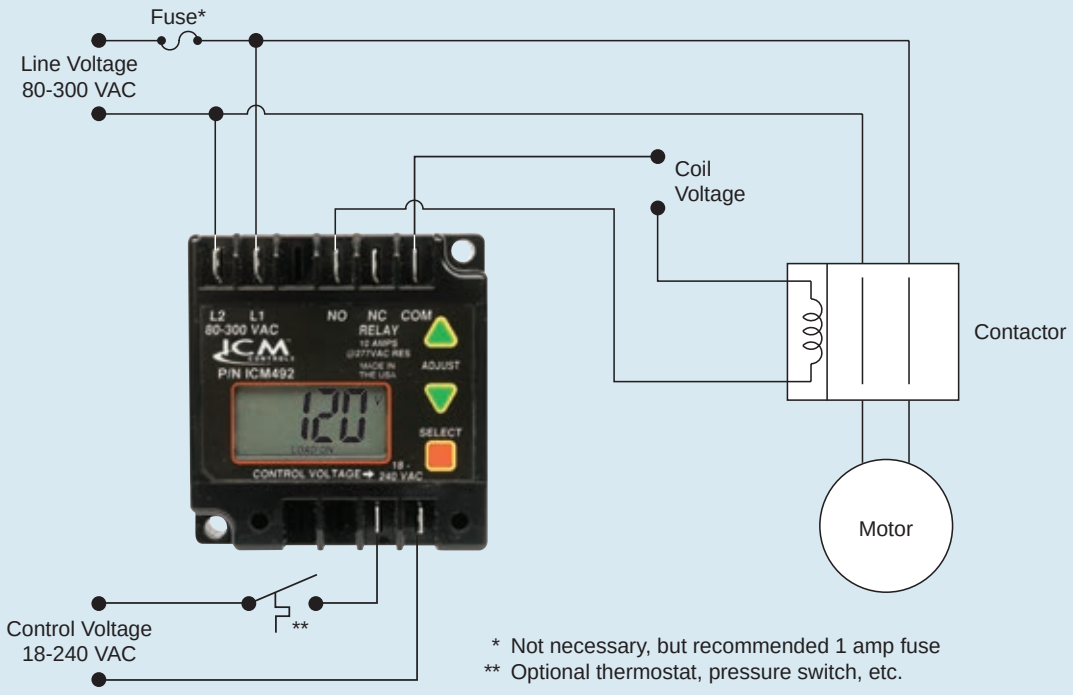
Mechanical:
- **Case Dimensions:** 3"L x 3.2"W x 1.35"H
- **Unit Weight:** 0.36 lbs.

Environmental:
- **Operating temperature range:** -40°C to +75°C
- **Storage temperature range:** -40°C to +85°C
- **Maximum Operating/Storage Relative Humidity:** 95% non-condensing

Phone 315.233.5266
Application Assistance 800.365.5525
visit us at: www.icmcontrols.com
Fax 315.233.5276
ICM CONTROLS™

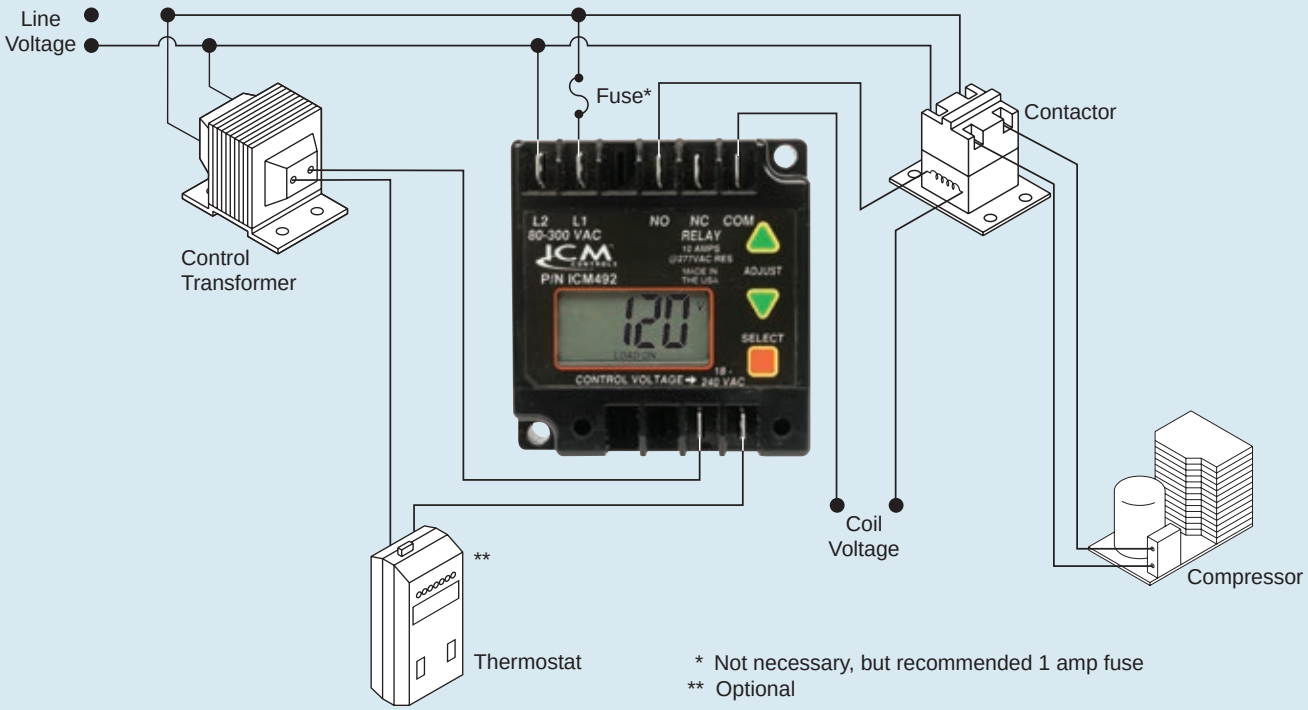
Made in USA

Wiring Diagram



* Not necessary, but recommended 1 amp fuse
** Optional thermostat, pressure switch, etc.

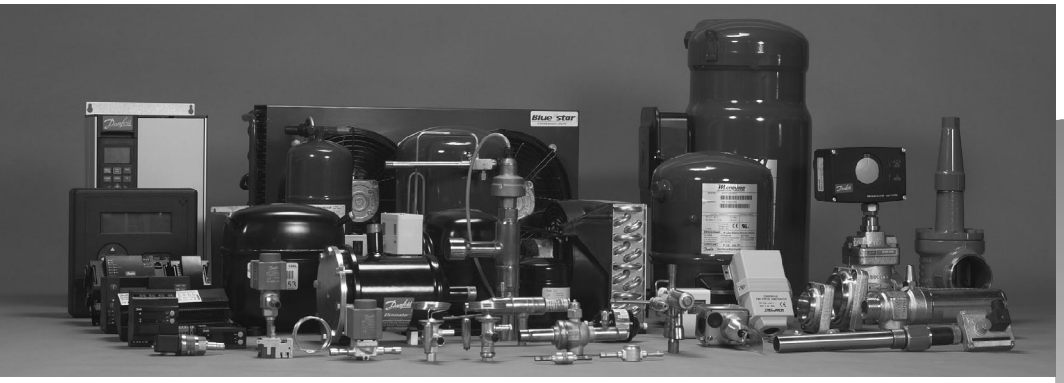
System Diagram



* Not necessary, but recommended 1 amp fuse
** Optional

Voltage application range

Motor Code	Nominal voltage	Voltage application range
1	208-230 V / 1 ph / 60 Hz	187 - 253 V
3	200-230 V / 3 ph / 60 Hz	180 - 253 V
4	400 V / 3 ph / 50 Hz	360 - 440 V
	460 V / 3 ph / 60 Hz	414 - 506 V
5	230 V / 1 ph / 50 Hz	207 - 253 V
6	230 V / 3 ph / 50 Hz	207 - 253 V
7	500 V / 3 ph / 50 Hz	450 - 550 V
	575 V / 3 ph / 60 Hz	517 - 632 V
9	380 V / 3 ph / 60 Hz	342 - 418 V



The Danfoss product range for the refrigeration and air conditioning industry

Appliance Controls
General temperature controls for the home appliance industry. The product range comprises CFC-free electromechanical and electronic thermostats for refrigerators and freezers produced to customer specifications as well as service thermostats for all refrigeration and freezing appliances.

Commercial Compressors
Large hermetic reciprocating and scroll compressor technologies for commercial air conditioning and refrigeration. The compressors and condensing units are used in a large array of applications in both businesses. This ranges from water chillers, large packaged air conditioners as well as medium and low temperature refrigeration systems for food storage and processing.

Danfoss Compressors
Hermetic compressors and fan-cooled condensing units for refrigerators, freezers and light commercial applications such as bottle coolers and display counters. Danfoss also produces compressors for heating pump systems as well as 12 and 24 volt compressors for refrigerators and freezers used in mobile applications and solar power. The division has a leading position within energy utilisation, noise filtering and know-how about environment-friendly compressors.

Refrigeration and air conditioning controls
A comprehensive and highly reputed range of self-acting valves, electronic valves and regulators as well as system protectors and line components for the refrigeration and air conditioning market. These products include thermostatic expansion valves, solenoid valves, thermostat and pressure controls, modulation pressure regulators, filter driers, shut-off valves, sight glasses, check valves, non-return valves and water valves. Decentralised electronic systems for full regulation and control of refrigeration applications are also developed and produced at Danfoss.

Industrial Controls
Products and customer specific solutions for industrial monitoring and controls systems based on the principles of pressure and temperature measurement, electrical power and fluid control. Products include a wide range of automatic controls for process control and regulation such as contactors and motor starters, electrically, pneumatically and temperature activated valves as well as temperature and pressure transmitters and switches.

~~RZ5AG207~~ → DKRCC.PF.C00.A1.02 / 520H0353

Pressure Controls

REFRIGERATION AND AIR CONDITIONING

Fitters notes

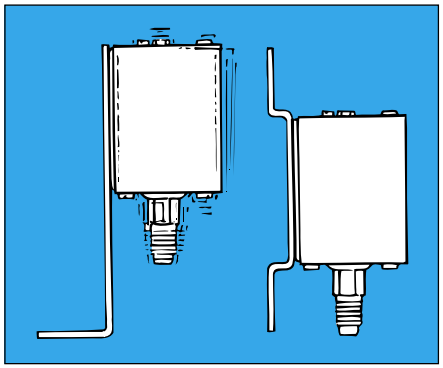
Contents

Installation

Mount the KP pressure control on a bracket or on a completely flat surface.

The pressure control can also be mounted on the compressor itself.

In unfavourable conditions, an angle bracket could amplify vibration in the mounting plane. Therefore, always use a wall bracket where strong vibration occurs.



AI0_0001

Fault location

Symptom	Possible cause	Remedy
High-pressure control disconnected. **Warning: Do not start the system before the fault has been located and rectified!**	Condensing pressure too high because: Dirty/clogged condenser surfaces. Fans stopped/water supply failure. Defective phase/fuse, fan motor. Too much refrigerant in system. Air in system.	Rectify the stated faults.
The low-pressure control fails to stop the compressor.	a) Differential setting too high so that cut-out pressure falls below –1 bar. b) Differential setting too high so that compressor cannot pull down to cut-out pressure.	Increase the range setting or reduce the differential.
Compressor running time too short.	a) Differential setting on low pressure control too low. b) High-pressure control setting too low, i.e. too close to normal operating pressure. c) Condensing pressure too high because of: Dirty/clogged condenser surfaces. Fans stopped/water supply failure. Defective phase/fuse, fan motor. Too much refrigerant in system. Air in system.	a) Increase the differential setting. b) Check the high-pressure control setting. Increase it if the system data allows. c) Rectify the stated faults.
Cut-out pressure for KP 7 or KP 17, HP side, does not match the scale value.	The fail-safe system in the bellows element is activated if the deviations have been greater than 3 bar.	Replace the pressure control.
Differential spindle on single unit is bent and the unit does not function.	Tumbler action failure arising from attempt to test wiring manually from righthand side of unit.	Replace unit and avoid manual test in any way other than that recommended by Danfoss.
High-pressure control chatters.	Liquid-filled bellows multifies the damping orifice in the inlet connection.	Install the pressure control so that liquid cannot collect in the bellows element (see instruction). Eliminate cold air flow around the pressure control. Cold air can create condensate in the bellows element. Fit a damping orifice (code no. 060-1048) in the end of the control connection furthest away from the control.
Periodic contact failure on computer-controlled regulation, with minimum voltage and current.	Transition resistance in contacts too high.	Fit KP with gold contacts.

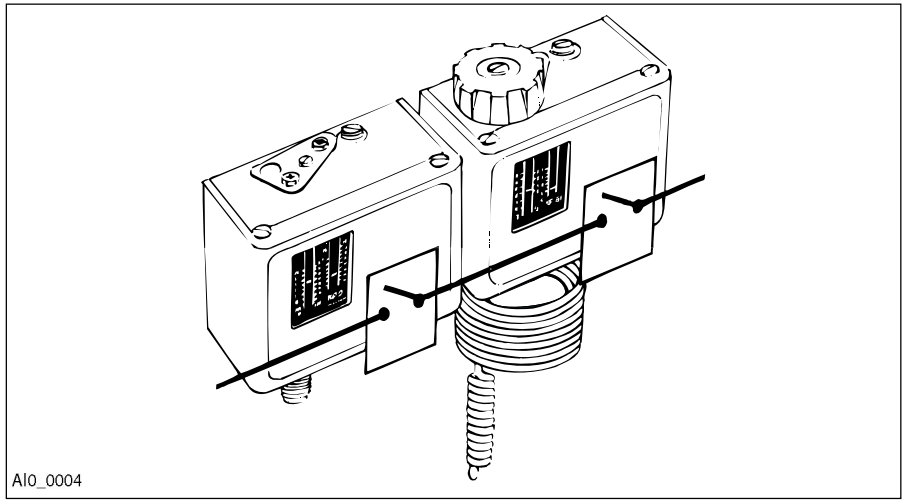
For systems operating with low pressure on the evaporator side, and where the pressure control must regulate (not just monitor): Use KP 2 with a small differential.
An example where pressure control and thermostat are in series:

KP 61 regulates the temperature via compressor stop/start.

KP 2 stops the compressor when suction pressure becomes too low.

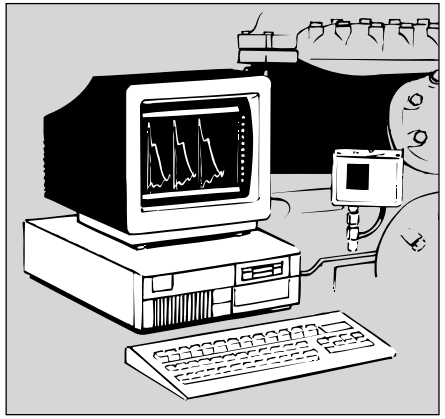
KP 61:
CUT IN = 5°C (2.6 bar)
CUT OUT = 1°C (2.2 bar)

KP 2 low pressure:
CUT IN = 2.3 bar
CUT OUT = 1.8 bar



AI0_0004

For systems where KP is activated occasionally (alarm) and for systems where KP is the signal source for PLC, etc.: Use KP with gold contacts; these give good contact at low voltages.

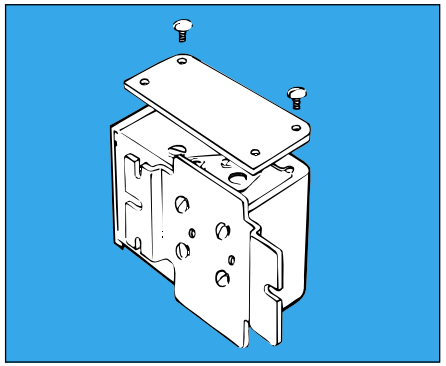


AI0_0005

If the risk of water droplets or water spray is present, the accompanying top plate should be used. The plate increases the grade of enclosure to IP 44 and is suitable for all KP pressure controls. To obtain IP 44, the holes in the backplate of the control must be covered by mounting on either an angle bracket (060-105666) or a wall plate (060-105566).

The top plate is supplied with all units incorporating automatic reset. It can also be used on units with manual reset, but in that case must be purchased separately (code no.: for single unit, 060-109766; for dual unit, 060-109866).

If the unit is to be used in dirty conditions or where it might be exposed to heavy spray - from above or from the side - it should be fitted with a protective cap. The cap can be used together with either an angle bracket or a wall bracket.



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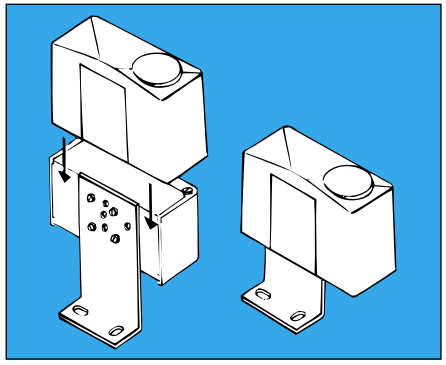


AI0_0008

If the unit risk being exposed to heavy water influence a better grade of enclosure can be achieved when mounting the product in a special IP 55 enclosure.

The IP 55 enclosure is available for both single unit (060-033066) and dual unit (060-035066).

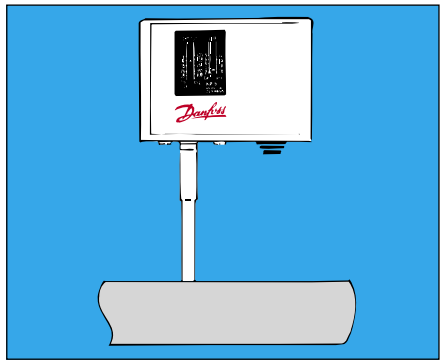
Ak0_0020

The pressure connection of the control must always be fitted to the pipe in such a way that liquid cannot collect in the bellows. This risk is present especially when:

- the unit is located in a low ambient condition, e.g. in an air current,
- the connection is made on the underside of the pipe.

Such liquid could damage the high-pressure control.

Consequently, compressor pulsation would not be damped and might give rise to contact chatter.

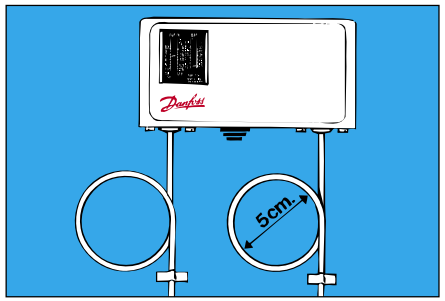


AI0_0009

Placing of surplus capillary tube

Surplus capillary tube can fracture if vibration occurs and might lead to complete loss of system charge. It is therefore very important that the following rules are observed:

- When mounting direct on compressor: Secure the capillary tube so that the compressor/control installation vibrates as a whole. Surplus capillary tube must be coiled and bound.

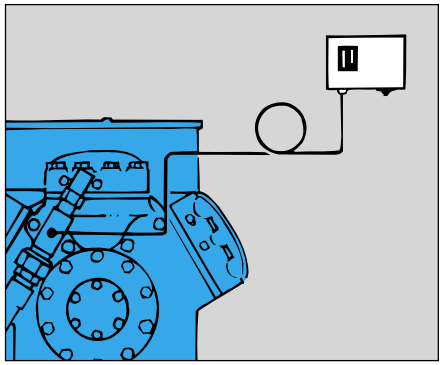


AI0_0010

- Other types of mounting: Coil surplus capillary tube into a loose loop. Secure the length of capillary tube between compressor and loop to the compressor. Secure the length of capillary tube between loop and pressure control to the base on which the pressure control is mounted.

In case of very strong vibrations, Danfoss steel capillary tubes with flare connection are recommended:

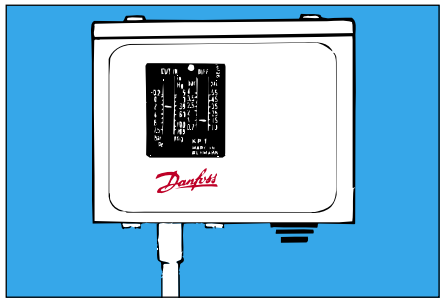
Code no. 0.5 m = 060-016666
Code no. 1.0 m = 060-016766
Code no. 1.5 m = 060-016866



AI0_0011

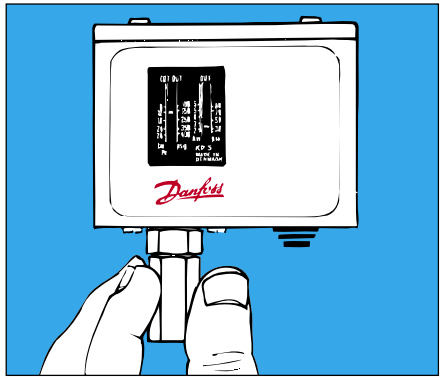
The correct pressure control for your system

KP with solder connections can be used instead of flare connections on hermetic systems.



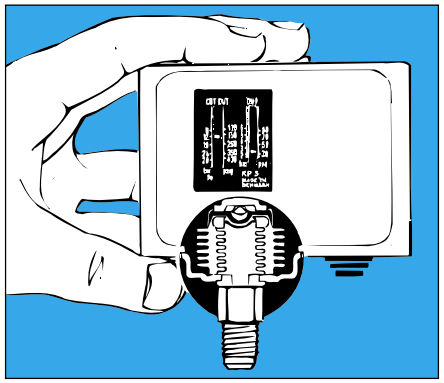
AI0_0006

In ammonia plant where KP pressure controls are used, they must be type KP-A.
A connector with M10 x 0.75 – 1/4 - 18 NPT (code no. 060- 014166).



AI0_0002

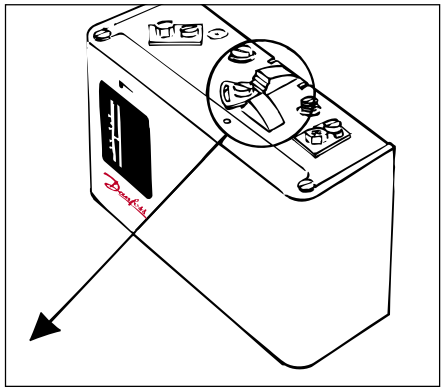
For refrigerating systems containing a large quantity of charge medium and where extra safety is desired/demanded (Fail-safe): Use KP 7/17 with double bellows. The system will stop if one of the bellows ruptures - without loss of charge.



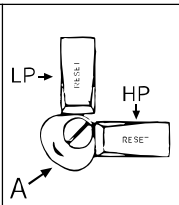
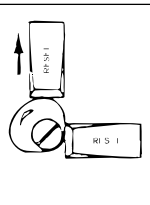
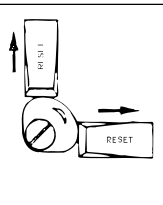
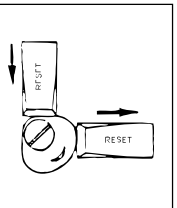
AI0_0003

On the KP 15 dual pressure control with optional automatic or manual reset on low-pressure and high-pressure side, automatic reset must be set when servicing is being carried out. The pressure control can then automatically restart. Remember, the original reset function must be set after servicing.

The pressure control can be protected against being set on automatic reset: Simply remove the washer controlling the reset function!
If the unit is to be protected against tampering, the washer can be sealed with red lacquer.



AI0_0020

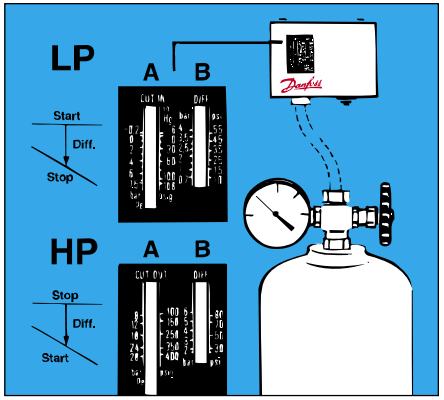
				
Low pressure	Manual reset *)	Automatic reset	Automatic reset	Manual reset
High pressure	Manual reset *)	Manual reset	Automatic reset	Automatic reset

*) Factory setting

AI0_0021

Setting

KP pressure controls can be preset using a compressed air cylinder. Ensure that the changeover contacts are correctly connected for the required function.



AI0_0012

Low-pressure control

Set the start pressure (CUT IN) on the range scale (A). Then set the differential on the differential scale (B).
Stop pressure = CUT IN minus DIFF.

High-pressure control

Set the stop pressure (CUTOUT) on the range scale (A). The set the differential on the differential scale (B).
Start pressure = CUT OUT minus DIFF.
Remember: The scales are indicative only.

Example with four compressors in parallel (R502)

Medium: ice cream at –25°C,
t_0 = –37°C,
p_0 = –0.5 bar,
Δp suction line corresponding to 0.1 bar.

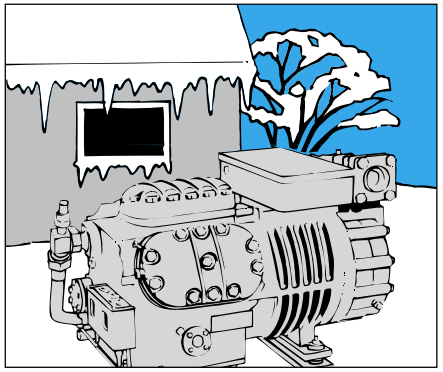
Each pressure control (e.g. KP 2) must be set individually in accordance with the following table.

Compressor	CUT OUT	CUT IN
1	–0.05 bar	0.35 bar
2	0.1 bar	0.5 bar
3	0.2 bar	0.6 bar
4	0.35 bar	0.75 bar
The pressure control must be mounted in such a way that liquid cannot collect in the bellows.		

Setting LP for outdoor location

If the compressor, condenser and receiver are situated outdoors, KP low pressure must be set to a "CUT IN" setting lower than the lowest occurring pressure (temperature around compressor) during winter operation. In this case, after longer standstill periods the pressure in the receiver determines the suction pressure.

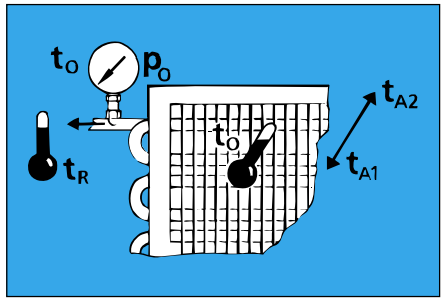
Example:
Lowest occurring temperature around the compressor –20°C means, for R 12, a pressure of 0.5 bar. CUT IN must be set at –24°C (corresponding to 0.3 bar).



AI0_0013

Indicative evaporating pressures (p_e) for different types of systems

Room temp. (t_r)	System type	Difference between t_r and t_{media} (air)	Evaporating pressure (p_e)	RH [%]	Setting of KP2/KP1 (cut in - cut out) D = Operating press. cont. S = Safety press. cont.
+0.5°/+2°C	Fan-cooled meat cold room	10K	1.0 - 1.1 bar (R 134a)	85	0.9 - 2.1 bar (D)
+0.5°/+2°C	Meat cold room with natural air circulation	12K	0.8 - 0.9 bar (R 134a)	85	0.7 - 2.1 bar (D)
–1°/0°C	Refrigeration meat counter (open)	14K	0.6 bar (R 134a)	85	0.5 - 1.8 bar (D)
+2°/+6°C	Milk cold room	14K	1.0 bar (R 134a)	85	0.7 - 2.1 bar (D)
0°/+2°C	Fruit cold room Vegetable chiller	6K	1.3 - 1.5 bar (R 134a)	90	1.2 - 2.1 bar (D)
–24°C	Freezer	10K	0.7 bar (R 22)	90	0.4 - 1.6 bar (S)
–30°C	Ventilated deep freeze room	10K	0.3 bar (R 22)	90	0 - 1.2 bar (S)
–26°C	Ice cream freezer	10K	0.5 bar (R 22)	90	0.2 - 1.4 bar (S)



AI0_0015

Test of contact function

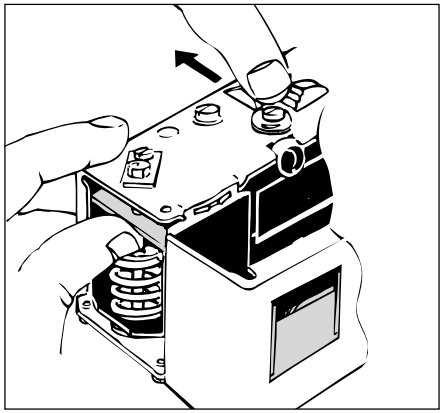
When the electrical leads are connected and the system is under normal operating pressure, the contact function can be tested manually.

Depending on the bellows pressure and setting, the test device must be pressed up or down.

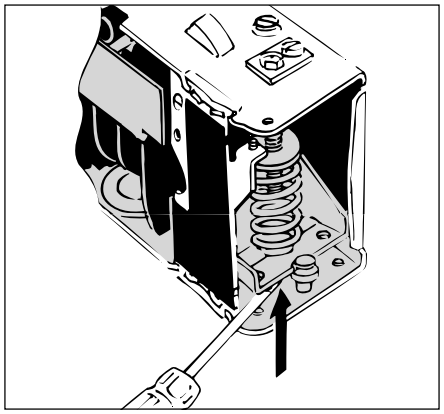
Any reset mechanism becomes inoperative during the test.

On single units:
Use the test device at top left.

On dual units:
Use the test device on the left for low-pressure testing and the one at bottom right for high-pressure testing.


AI0_0018

Warning!
The contact function on a KP Pressure Control must never be tested by activating the device at top right. If this warning is ignored, the control may go out of adjustment. In the worst case function can be impaired.


AI0_0019

Standard model

Finger safe model

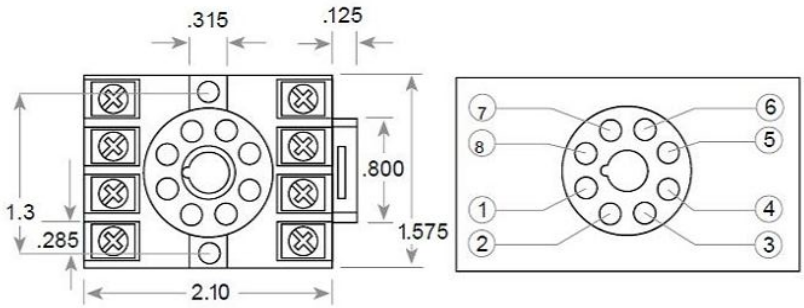
F SUFFIX IS FINGER SAFE

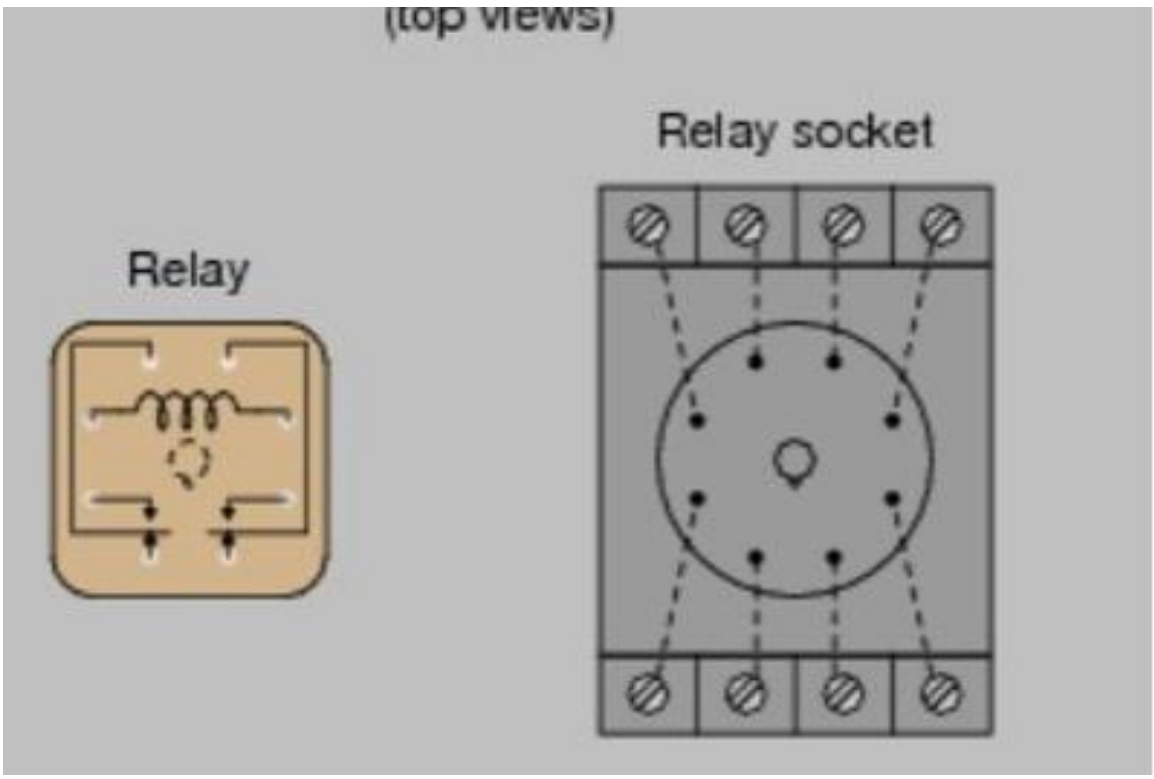
Type
Surface or DIN Rail Mount

Current Carrying Members
Phosphor Bronze Nickel Plated Steel

Terminals
Screw with Captive Wire Clamps

Electrical Rating
10A, 300VAC





Code No. LIT-1927010
Issued February 1, 2009

A19 Series

Remote Bulb Control

Description

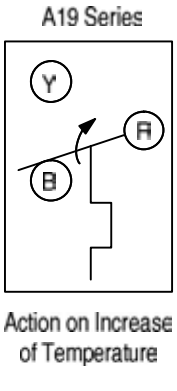
The A19 Series are single-stage temperature controls that incorporate environmentally friendly liquid-filled sensing elements.

Features

- wide temperature ranges available
- constant differential throughout the entire range
- compact enclosure
- fixed or adjustable differential available
- variety of sensing element styles
- unaffected by cross-ambient conditions

Applications

The A19 is suitable for temperature control in heating, ventilating, air conditioning, and refrigeration.



A19 Series
Terminal Arrangement for SPDT

A19ABC-24

Selection Charts

A19 Series Remote Bulb Control[1]

Code Number	Switch Action	Range °F (°C)	Diff F° (C°)	Bulb and Capillary	Bulb Well No. (order separately)	Range Adjuster	Max. Bulb Temp. °F (°C)
Adjustable Differential (Wide Range)							
A19ABA-40C [2]	SPST Open Low	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver Slot	140 (60)
A19ABC-4C	SPDT	50 to 130 (10 to 55)	3 1/2 to 14 (1.9 to 8)	3/8 in. x 5 in., 8 ft. Cap.	WEL14A-603R	Knob	170 (77)
A19ABC-24C [3]	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 8 ft. Cap.	WEL14A-602R	Convertible	140 (60)
A19ABC-36C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 20 ft. Cap.	WEL14A-602R	Convertible	140 (60)
A19ABC-37C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 10 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ABC-74C	SPDT	-30 to 100 (-34 to 38)	3 to 12 (1.7 to 6.7)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
Fixed Differential							
A19AAF-12C	SPDT	25 to 225 (-4 to 107)	3 1/2 (1.9)	3/8 in. x 3 in., 10 ft. Cap.	WEL14A-602R	Screwdriver slot	275 (135)
Fixed Differential (Case Compensated)							
A19AAC-4C	SPDT	0 to 80 (-18 to 27)	5 (2.8)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19AAD-12C	SPST Open Low	-30 to 50 (-34 to 10)	2 1/2 (1.4)	3/8 in. x 4 in., 7 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
Fixed Differential (Close)							
A19AAD-5C [4]	SPST Open Low	30 to 50 (-1 to 10) (**Bulk Milk Cooler**)	2 1/2 (1.4)	3/8 in. x 2 5/8 in., 6 ft. Cap.	WEL16A-601R	Screwdriver slot	190 (88)
A19AAF-20C	SPDT	-30 to 100 (-34 to 38)	2 1/2 (1.4)	3/8 in. x 4 in., 6 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19AAF-21C	SPDT	40 to 90 (4 to 32)	1 1/2 (0.8)	3/8 in. x 5 3/4 in., 6 ft. Cap.	WEL14A-603R	Screwdriver slot	140 (60)
Manual Reset							
A19ACA-14C	SPST Open Low	-30 to 100 (-34 to 38)	Manual Reset	3/8 in. x 4 in. 6 ft .Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ACA-15C	SPST Open Low	-30 to 100 (-34 to 38)	Manual Reset	3/8 in. x 4 in. 10 ft. Cap.	WEL14A-602R	Screwdriver slot	140 (60)
A19ADB-1C	SPST Open High	100 to 240 (38 to 116)	Manual Reset	3/8 in. x 3 1/2 in. 6 ft. Cap.	WEL14A-602R	Knob	290 (143)
A19ADN-1C	SPST Open High	100 to 240 (38 to 116)	Manual Reset	3/8 in. x 4 in. 6 ft. Cap.	WEL14A-602R	Screwdriver slot	290 (143)

1. Specify the control model code number, packing nut code number (if required), and bulb well code number (if required).
2. Replaces White-Rodgers 1609-101
3. Replaces White-Rodgers 1609-12, -13; Ranco 010-1408, -1409, - 1410, -1490, 060-110; Honeywell L6018C-1006, L6021A-1005, T675A-1011, -1508, -1516, -1821, T4301A-1008, T6031A-1011, T6031A-1029
4. Case-Compensated

Remote Bulb Control (Continued)

Selection Charts (Continued)

Replacement Parts

Code Number	Description
CVR28A-617R	Concealed adjustment cover
CVR28A-618R	Visible scale cover
KNB20A-602R	Replacement Knob Kit

Accessories

A packing nut is available for closed tank application.
Specify the part number **FTG13A-600R**.

Bulb wells (WEL14A Series) are available for liquid immersion applications.
Refer to the selection chart or to *Bulb Wells Catalog Page, LIT-1922135*.

Technical Specifications

Electrical Ratings

Motor Ratings VAC	120	208	240
Wide Range – Adjustable Differential			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
Fixed Differential and Close Differential			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Case Compensated – Fixed Differential A19AAC-4			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A [1]	22 A, 120 to 277 VAC		
Pilot Duty – 125 VA, 24 to 600 VAC			
A19AAD-12			
AC Full Load A	6.0	3.4	3.0
AC Locked Rotor A	36.0	20.4	18.0
Non-Inductive A	10 A, 24 to 277 VAC		
Pilot Duty – 125 VA, 24 to 277 VAC			
Manual Reset			
AC Full Load A	16.0	9.2	8.0
AC Locked Rotor A	96.0	55.2	48.0
Non-Inductive A	16.0	9.2	8.0
Pilot Duty – 125 VA, 24 to 600 VAC			

1. SPST and N.O. contact of SPDT control;
   SPDT N.C. contact- 16 amps 120 to 277 VAC

MAKING MODERN LIVING POSSIBLE

Maneurop® reciprocating compressors

MT/MTZ 50 - 60 Hz

R-22, R-407C, R-134a, R-404A / R-507A

REFRIGERATION &
AIR CONDITIONING DIVISION

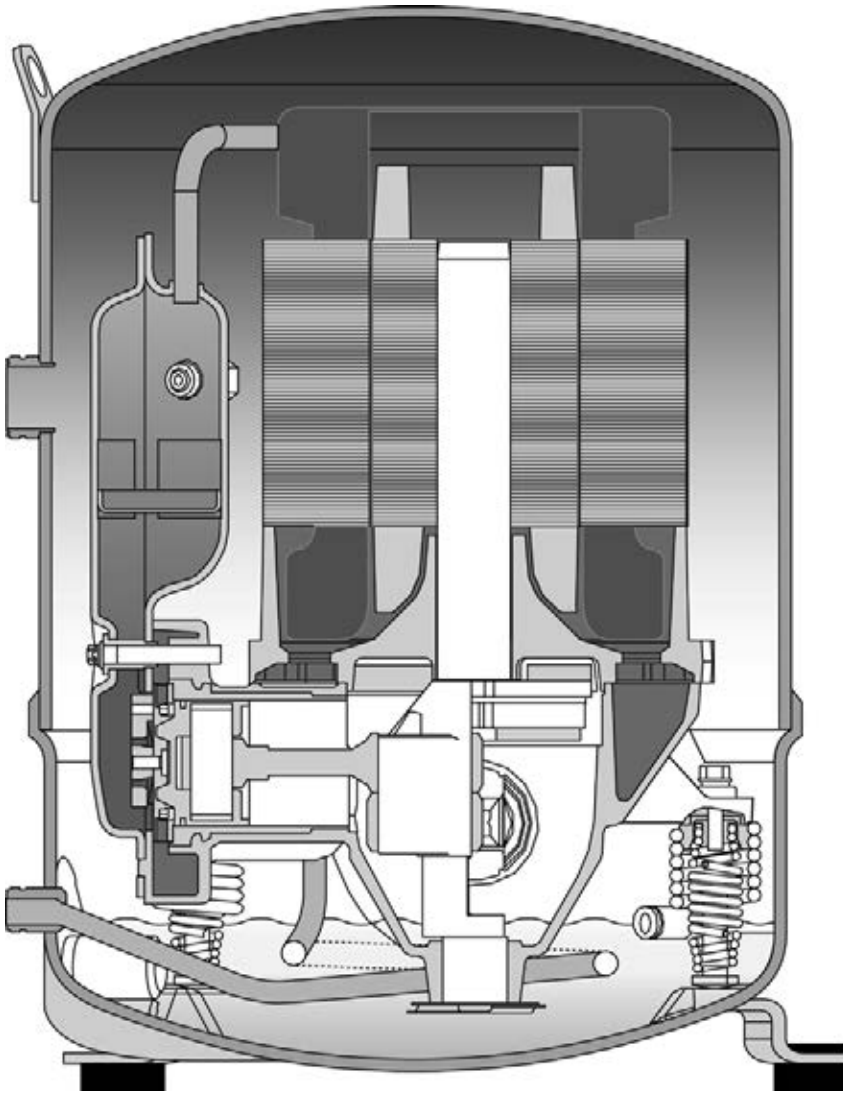
SELECTION &
APPLICATION GUIDELINES

CONTENTS

MANEUROP® RECIPROCATING COMPRESSORS

Maneurop® reciprocating compressors from Danfoss Commercial Compressors are specially designed for applications with a wide range of operating conditions. All components are of high quality and precision in order to assure a long product life.

Maneurop® MT and MTZ series compressors are of the hermetic reciprocating type and are designed for medium and high evaporating temperature applications.



The compressor design allows for the motor to be 100% suction-gas cooled.

The positive benefits of internal motor protection, high efficiency circular valve design and high torque motors provide for a quality installation.

The MT series is designed for use with the "traditional" R-22 refrigerant, using Danfoss mineral oil 160P as lubricant.
The MT series can also be applied with several R-22 based refrigerant blends (substitute refrigerants), using 160 ABM alkylbenzene as lubricant. The MTZ series is specifically designed for use with the HFC refrigerants R-407C, R-134a, R-404A, and R-507A, using 160PZ polyester oil as lubricant.
MTZ compressors can be used in new installations and also to replace Maneurop® MTE compressors in existing installations.

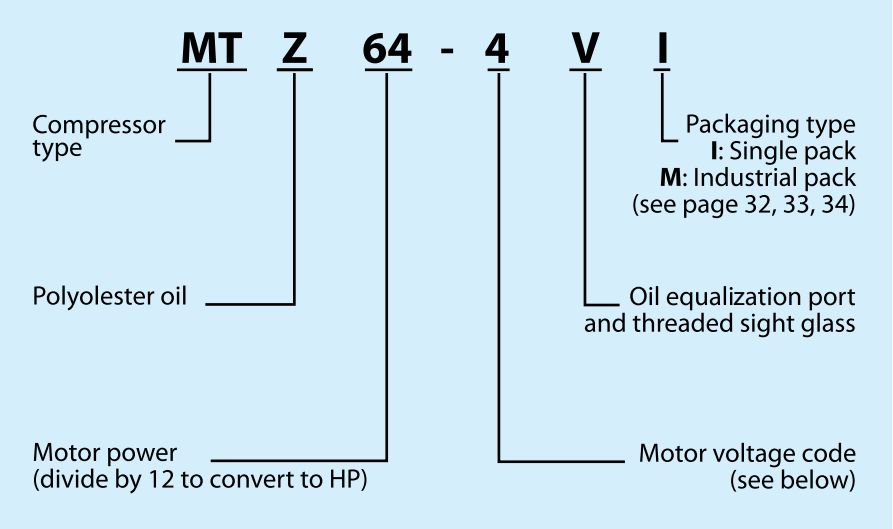
MT and MTZ compressors have a large internal free volume that protects against the risk of liquid hammering when liquid refrigerant enters the compressor.

MT and MTZ compressors are fully suction-gas cooled. This means that no additional compressor cooling is required and allows the compressors to be insulated with acoustic jackets to obtain lower sound levels, without the risk of the compressor overheating.

MT and MTZ compressors are available in 26 different models with displacement ranging from 231 to 4142 cfh. Seven different motor voltage ranges are available for single and three phase power supplies at 50 and 60 Hz. Most compressors exist in two versions:
- standard version
- VE version (oil equalization + oil sight glass).

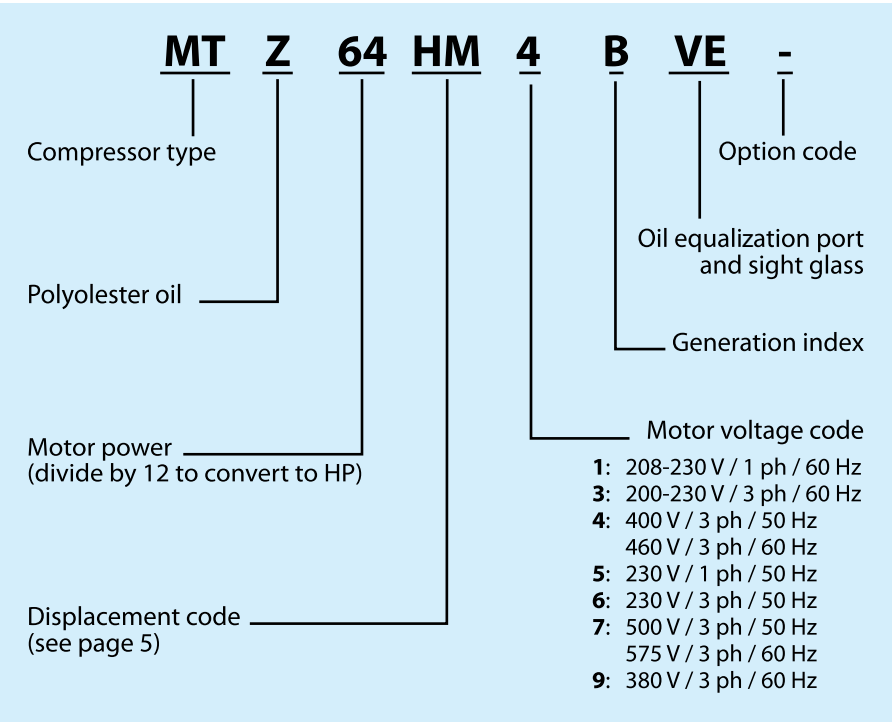
COMPRESSOR MODEL DESIGNATION

Code numbers
(for ordering)



Available code numbers are listed on pages 32-33

Compressor reference
(indicated on the compressor nameplate)



Versions

	S version (standard)		VE version (optional)	
Models	**Oil sight glass**	**Oil equalization connection**	**Oil sight glass**	**Oil equalization connection**
MT/MTZ018-040 (1 cyl.)	-	-	threaded	3/8"flare
MT/MTZ044-081 (2 cyl.)	-	-	threaded	3/8"flare
MT/MTZ100-160 (4 cyl.)	brazed	-	threaded	3/8"flare

SPECIFICATIONS

Technical specifications

Compressor model	Displacement			Cyl. number	Oil charge	Net weight	Available motor voltage codes						
	Code	in³/rev	cfh at 3600 rpm		oz	lbs	1	3	4	5	6	7	9
MT/MTZ018	**JA**	1.84	231	1	32	46	●	●	●	●	○	-	-
MT/MTZ022	**JC**	2.33	291	1	32	46	●	●	●	●	●	-	●
MT/MTZ028	**JE**	2.93	367	1	32	51	●	●	●	●	●	-	●
MT/MTZ032	**JF**	3.29	411	1	32	53	●	●	●	●	●	○	○
MT/MTZ036	**JG**	3.69	461	1	32	55	●	●	●	●	●	○	●
MT/MTZ040	**JH**	4.14	518	1	32	57	●	●	●	-	●	-	-
MT/MTZ044	**HJ**	4.65	581	2	61	77	●	●	●	-	●	●	●
MT/MTZ045	**HJ**	4.65	581	2	61	77	-	●	●	-	-	-	-
MT/MTZ050	**HK**	5.23	653	2	61	77	●	●	●	●	●	●	●
MT/MTZ051	**HK**	5.23	653	2	61	77	-	●	●	-	-	-	-
MT/MTZ056	**HL**	5.87	733	2	61	82	●	●	●	-	●	●	●
MT/MTZ057	**HL**	5.87	733	2	61	82	-	●	●	-	-	-	-
MT/MTZ064	**HM**	6.57	822	2	61	82	●	●	●	-	●	-	●
MT/MTZ065	**HM**	6.57	822	2	61	82	-	●	●	-	-	-	-
MT/MTZ072	**HN**	7.38	922	2	61	88	-	●	●	-	●	-	●
MT/MTZ073	**HN**	7.38	922	2	61	88	-	●	●	-	-	-	-
MT/MTZ080	**HP**	8.29	1036	2	61	88	-	●	●	-	●	-	●
MT/MTZ081	**HP**	8.29	1036	2	61	88	-	●	●	-	-	-	-
MT/MTZ100	**HS**	10.45	1306	4	132	132	-	●	●	-	●	●	●
MT/MTZ125	**HU**	13.15	1643	4	132	141	-	●	●	-	●	●	○
MT/MTZ144	**HV**	14.76	1845	4	132	148	-	●	●	-	●	●	●
MT/MTZ160	**HW**	16.57	2071	4	132	152	-	●	●	-	●	●	●

● Available in MT and MTZ ○ Available in MTZ only

Approvals and certificates

Maneurop® MT/MTZ compressors comply with the following approvals and certificates

Certificates are listed on the product datasheets:
http://www.danfoss.com/odsg

CE (European Directive) 0062	All models
UL (Underwriters Laboratories) c UL us	All 60 Hz models
CCC (China Compulsory Product Certification)	Depending on the model and motor voltage code.
Gost certificate (for Russia)	Depending on the model and voltage code.

SPECIFICATIONS

Nominal performance data for R-404A and R-22

R-404A	Refrigeration											
Compressor model	50 Hz, EN12900 ratings To = 14°F, Tc = 113°F, SC = 0 F, SH = 18°F				50 Hz, ARI ratings To = 20°F, Tc = 120°F, SC = 0°F, SH = 20°F				60 Hz, ARI ratings To = 20°F, Tc = 120°F, SC = 0°F, SH = 20°F			
	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh
MTZ018-4*	6500	1.21	2.73	5.40	7070	1.31	2.86	5.40	8980	1.76	2.86	5.09
MTZ022-4*	8950	1.48	3.06	6.04	9665	1.62	3.24	5.96	12300	2.05	3.27	6.00
MTZ028-4*	11700	1.96	4.04	5.98	12600	2.14	4.30	5.88	15980	2.68	4.23	5.95
MTZ032-4*	13600	2.16	4.25	6.28	14550	2.37	4.56	6.15	17450	2.98	4.56	5.85
MTZ036-4*	15950	2.58	4.95	6.18	17400	2.83	5.33	6.02	20150	3.33	5.09	6.04
MTZ040-4*	18200	2.95	5.87	6.18	19400	3.24	6.29	5.97	23000	3.76	5.88	6.11
MTZ044-4	17600	3.16	6.37	5.57	18900	3.43	6.66	5.51	24250	4.18	6.58	5.79
MTZ045-4*	18350	2.77	5.35	6.59	19750	3.02	5.67	6.53	24250	3.85	5.85	6.30
MTZ050-4	27000	3.61	6.53	5.81	22470	3.92	6.92	5.73	28300	4.82	7.04	5.87
MTZ051-4*	21380	3.22	5.95	6.63	22880	3.50	6.33	6.54	28550	4.42	6.53	6.46
MTZ056-4	23900	4.00	7.07	5.98	25600	4.38	7.57	5.85	31800	5.44	7.80	5.84
MTZ057-4*	22900	3.51	6.83	6.52	24750	3.85	7.25	6.43	32400	4.98	7.52	6.50
MTZ064-4	27760	4.54	8.30	6.11	29700	4.96	8.84	5.99	36730	6.11	8.98	5.91
MTZ065-4*	27250	4.20	7.82	6.49	29340	4.60	8.35	6.37	36000	5.67	8.31	6.35
MTZ072-4	31250	4.99	8.64	6.28	33330	5.45	9.28	6.11	40470	6.91	9.76	5.85
MTZ073-4*	30460	4.69	8.95	6.49	32680	5.11	9.50	6.39	40850	6.53	9.73	6.25
MTZ080-4	35930	5.84	10.12	6.15	38250	6.38	10.87	5.99	45760	8.03	11.35	5.70
MTZ081-4*	35750	5.61	10.20	6.39	38780	6.14	10.94	6.22	46450	7.81	11.35	5.94
MTZ100-4*	41940	6.76	12.21	6.22	44500	7.35	12.94	6.11	52850	8.72	12.79	6.06
MTZ125-4*	53650	8.44	13.79	6.35	57380	9.21	14.86	6.22	68200	11.37	15.41	6.00
MTZ144-4*	63150	9.78	16.29	6.45	67240	10.65	17.47	6.31	80350	12.99	17.93	6.18
MTZ160-4*	69350	11.08	18.26	6.25	73970	12.09	19.64	6.11	87300	14.73	20.17	5.92

* 50 Hz, EN12900 data for indicated models are ASERCOM certified

R-404A data are also valid for refrigerant R-507A

R-22	Refrigeration				Air Conditioning							
Compressor model	50 Hz, EN12900 ratings To = 14°F, Tc = 113°F, SC = 0 F, SH = 18°F				50 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F				60 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F			
	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. W/W	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh
MT018-4	5770	1.00	2.27	5.77	13250	1.45	2.73	9.16	15900	1.74	2.73	9.16
MT022-4	8500	1.29	2.55	6.63	18305	1.89	3.31	9.69	22000	2.27	3.31	9.69
MT028-4	12750	1.81	3.59	7.04	25200	2.55	4.56	9.87	30200	3.06	4.56	9.87
MT032-4	13500	2.11	3.73	6.39	27500	2.98	4.97	9.22	33000	3.58	4.97	9.22
MT036-4	16400	2.35	4.30	6.97	31650	3.37	5.77	9.38	38000	4.05	5.77	9.38
MT040-4	17800	2.67	4.86	6.66	35800	3.86	6.47	9.27	42900	4.63	6.47	9.27
MT044-4	18100	2.72	6.03	6.66	37700	3.89	7.37	9.69	45200	4.66	7.37	9.69
MT045-4	16600	2.46	5.02	6.76	35900	3.53	6.37	10.17	44000	4.32	6.42	10.18
MT050-4	19850	2.95	5.22	6.73	42100	4.32	8.46	9.74	50500	5.18	8.46	9.74
MT051-4	20050	2.94	5.53	6.83	41800	4.19	7.20	9.97	50200	5.04	7.26	9.95
MT056-4	23300	3.44	6.21	6.80	47000	5.04	10.27	9.32	56400	6.05	10.27	9.32
MT057-4	22000	3.18	6.39	6.93	47000	4.58	8.19	10.24	56400	5.58	8.23	10.10
MT064-4	26100	3.89	7.06	6.69	54000	5.66	9.54	9.53	64800	6.80	9.54	9.53
MT065-4	26470	3.64	7.03	7.27	53700	5.27	9.16	10.18	64400	6.32	9.33	10.18
MT072-4	29100	4.29	7.58	6.80	58500	6.31	10.54	9.26	70200	7.57	10.54	9.26
MT073-4	29750	4.19	8.48	7.10	62100	6.12	10.98	10.15	74600	7.33	10.77	10.16
MT080-4	33200	4.84	8.24	6.86	66700	7.13	11.58	9.36	80000	8.55	11.58	9.36
MT081-4	35380	4.89	9.52	7.24	70800	7.08	12.48	9.99	85000	8.50	12.34	10.00
MT100-4	38700	5.79	11.82	6.69	79900	7.98	14.59	10.00	95900	9.58	14.59	10.00
MT125-4	52100	7.55	12.28	6.90	103900	10.66	17.37	9.74	124700	12.80	17.37	9.74
MT144-4	59000	8.47	17.06	6.97	117300	11.95	22.75	9.80	140700	14.35	22.75	9.80
MT160-4	65540	9.49	16.81	6.90	130700	13.40	22.16	9.75	156900	16.08	22.16	9.75

To: Evaporating temperature at dew point (saturated suction temperature)
Tc: Condensing temperature at dew point (saturated discharge temperature)
SC: Subcooling,
SH: Superheat

ARI capacity and power input data are +/- 5%
ASERCOM: Association of European Refrigeration Compressor and Controls Manufacturers
ARI: Air Conditioning and Refrigeration Institute

SPECIFICATIONS

Nominal performance data for R-407C and R-134a

R-407C	Air Conditioning											
Compressor model	50 Hz, EN12900 ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F				50 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F				60 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F			
	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh
MTZ018-4*	11850	1.27	2.73	9.32	13150	1.38	2.86	9.53	17250	1.73	2.82	9.98
MTZ022-4*	15540	1.71	3.27	9.12	17140	1.86	3.47	9.23	21450	2.26	3.45	9.48
MTZ028-4*	20080	2.17	4.30	9.29	22340	2.36	4.57	9.45	28070	2.82	4.41	9.93
MTZ032-4*	22700	2.43	4.57	9.36	25030	2.65	4.90	9.43	30702	3.20	4.80	9.61
MTZ036-4*	25650	2.93	5.58	8.74	28280	3.21	5.99	8.82	34120	3.90	5.78	8.74
MTZ040-4*	29580	3.40	6.46	8.71	32720	3.71	6.92	8.81	40030	4.46	6.69	8.98
MTZ044-4	30530	3.34	6.10	9.12	33710	3.63	6.49	9.27	43030	4.36	6.84	9.85
MTZ045-4*	31180	3.12	5.84	10.01	34490	3.38	6.18	10.21	43480	4.25	6.34	10.23
MTZ050-4	34800	3.79	6.90	9.19	38490	4.11	7.34	9.34	48150	4.95	7.33	9.72
MTZ051-4*	35590	3.69	6.51	9.66	39380	4.01	6.95	9.82	48190	4.87	7.06	9.89
MTZ056-4	39960	4.32	7.85	9.26	44190	4.69	8.36	9.42	54370	5.66	8.41	9.60
MTZ057-4*	39900	4.02	7.45	9.90	44400	4.37	7.91	10.16	54880	5.40	8.03	10.15
MTZ064-4	45010	4.84	8.79	9.29	49830	5.26	9.35	9.47	60450	6.35	9.47	9.50
MTZ065-4*	45630	4.61	8.35	9.90	50720	5.02	8.91	10.10	61750	6.14	9.01	10.05
MTZ072-4	50540	5.50	9.81	9.19	55940	5.97	10.48	9.36	67930	7.21	10.78	9.41
MTZ073-4*	52230	5.42	9.85	9.66	58230	5.87	10.48	9.91	70970	7.30	10.61	9.72
MTZ080-4	57204	6.29	11.02	9.08	63280	6.83	11.83	9.25	76910	8.24	12.35	9.33
MTZ081-4*	59360	6.29	11.31	9.43	66010	6.83	12.08	9.67	78100	8.24	11.99	9.47
MTZ100-4*	69940	7.38	13.05	9.49	77520	8.00	13.83	9.69	96380	9.86	14.22	9.77
MTZ125-4*	91880	9.48	15.14	9.70	101740	10.32	16.28	9.85	121650	12.83	18.07	9.47
MTZ144-4*	101670	10.68	17.55	9.53	112940	11.59	18.80	9.74	139680	14.42	19.81	9.68
MTZ160-4*	116420	12.40	20.08	9.39	129160	13.46	21.50	9.59	154430	16.64	22.46	9.27

* 50 Hz, EN12900 data for indicated models are ASERCOM certified

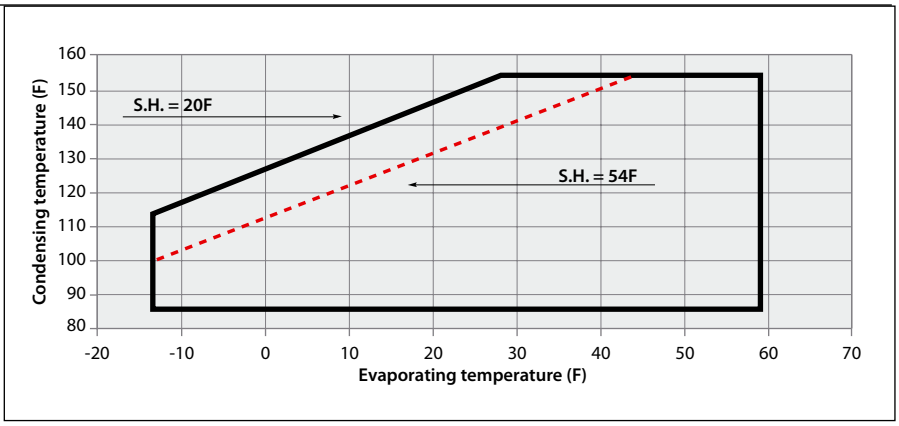
R-134a	Air Conditioning											
Compressor model	50 Hz, EN12900 ratings To = 41 °F, Tc = 122 °F, SC = 0 °F, SH = 18 °F				50 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F				60 Hz, ARI ratings To = +45°F, Tc = 130°F, SC = 15°F, SH = 20°F			
	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh	Cooling capacity BTU/h	Power input kW	Current input A	E.E.R. BTU/Wh
MTZ018-4	7890	0.92	2.12	8.57	8710	0.99	2.19	8.81	11200	1.22	2.09	9.20
MTZ022-4	10250	1.11	2.42	9.22	11440	1.20	2.51	9.56	14860	1.54	2.56	9.63
MTZ028-4	12740	1.41	3.18	9.05	14380	1.53	3.30	9.40	19260	2.04	3.37	9.43
MTZ032-4	14990	1.74	3.80	8.61	16910	1.87	3.94	9.03	20940	2.39	3.89	8.76
MTZ036-4	18240	1.97	3.88	9.26	20490	2.13	4.09	9.60	24490	2.75	4.20	8.91
MTZ040-4	19470	2.15	4.58	9.08	27860	2.33	4.89	9.36	27870	3.08	4.72	9.03
MTZ044-4	20900	2.36	5.51	8.88	23460	2.52	5.65	9.29	29850	3.14	5.47	9.51
MTZ045-4	20800	2.06	4.56	10.11	23390	2.22	4.73	10.53	30120	2.84	4.70	10.59
MTZ050-4	24490	2.68	5.33	9.12	27560	2.88	5.50	9.57	34460	3.60	5.36	9.57
MTZ051-4	24280	2.44	5.02	9.96	27360	2.63	5.20	10.39	34530	3.29	5.33	10.48
MTZ056-4	27460	2.99	5.61	9.19	30980	3.21	5.83	9.63	38010	3.95	5.92	9.62
MTZ057-4	26230	2.62	5.93	10.01	29780	2.84	6.17	10.47	38870	3.82	6.37	10.16
MTZ064-4	31280	3.36	6.66	9.32	35350	3.62	6.96	9.77	45290	4.68	7.11	9.67
MTZ065-4	30600	3.02	6.53	10.11	34700	3.26	6.81	10.63	44400	4.20	6.77	10.56
MTZ072-4	36000	3.74	6.83	9.63	40470	4.01	7.20	10.09	50000	5.19	7.59	9.64
MTZ073-4	34940	3.50	7.66	9.97	39790	3.78	7.99	10.52	50000	4.81	7.88	10.39
MTZ080-4	47260	4.31	8.03	9.56	46380	4.64	8.45	10.00	56520	5.99	8.79	9.42
MTZ081-4	40130	4.02	8.44	9.97	45490	4.35	8.83	10.44	56320	5.47	8.68	10.29
MTZ100-4	47030	4.89	9.84	9.60	53040	5.28	10.24	10.04	63970	6.50	10.11	9.84
MTZ125-4	57990	5.84	10.24	9.94	65130	6.29	10.80	10.35	79920	7.71	11.09	10.23
MTZ144-4	71820	7.27	13.11	9.87	80670	7.83	13.78	10.30	96960	9.81	14.28	9.87
MTZ160-4	78820	7.98	13.90	9.87	88320	8.57	14.67	10.29	107650	10.91	15.54	9.86

To: Evaporating temperature at dew point (saturated suction temperature)
Tc: Condensing temperature at dew point (saturated discharge temperature)
SC: Subcooling,
SH: Superheat

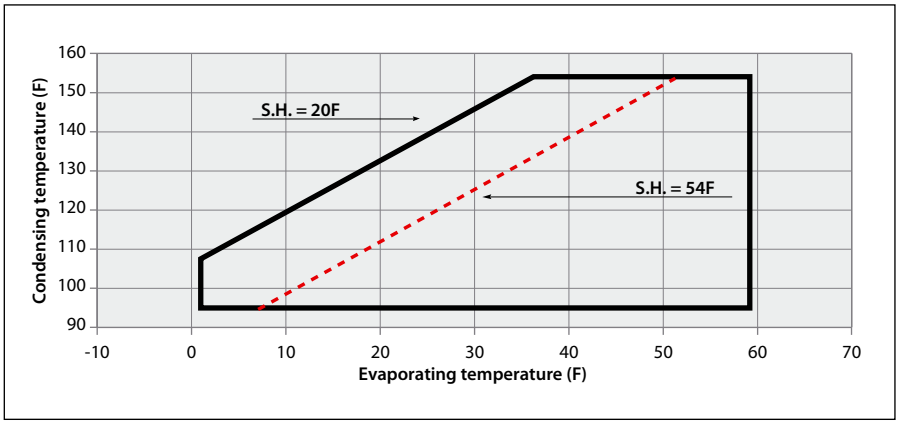
ARI capacity and power input data are +/- 5%
ASERCOM: Association of European Refrigeration Compressor and Controls Manufacturers
ARI: Air Conditioning and Refrigeration Institute

OPERATING ENVELOPES

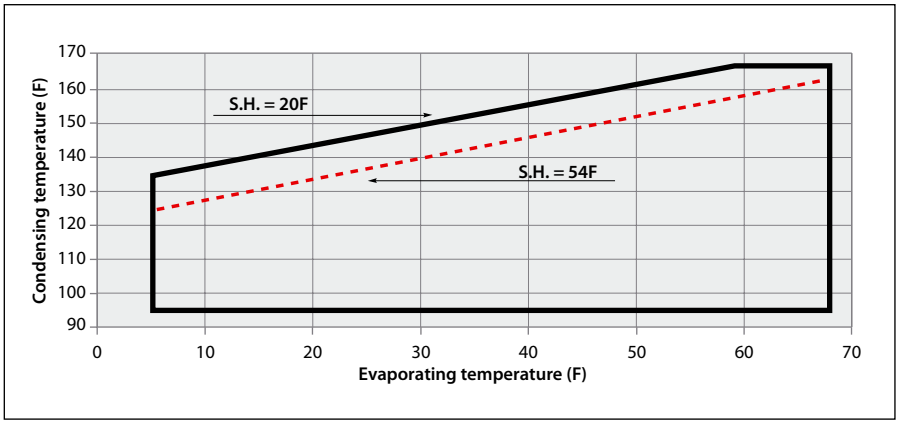
MT
R-22



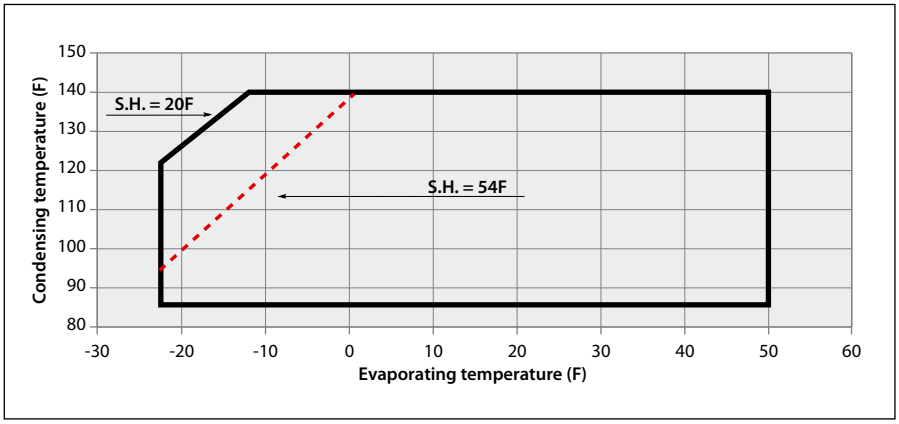
MTZ
R-407C at DEW point



MTZ
R-134a



MTZ
R-404A/R-507A



OPERATING ENVELOPES

Zeotropic refrigerant mixtures

Refrigerant mixtures can be either zeotropic or azeotropic.
In a zeotropic mixture (like R-407C) on the other hand the composition of vapor and liquid changes during the phase transition. When the effect of this phase transition is very small, the mixture is often called a near-azeotropic mixture. R-404A is such a near-azeotropic mixture.

An azeotropic mixture, on the other hand, (like R-502 or R-507A) behaves like a pure refrigerant. During a phase transition (from vapor to liquid or from liquid to vapor) the composition of vapor and liquid stays the same.
The composition change causes phase shift and temperature glide.

Phase shift

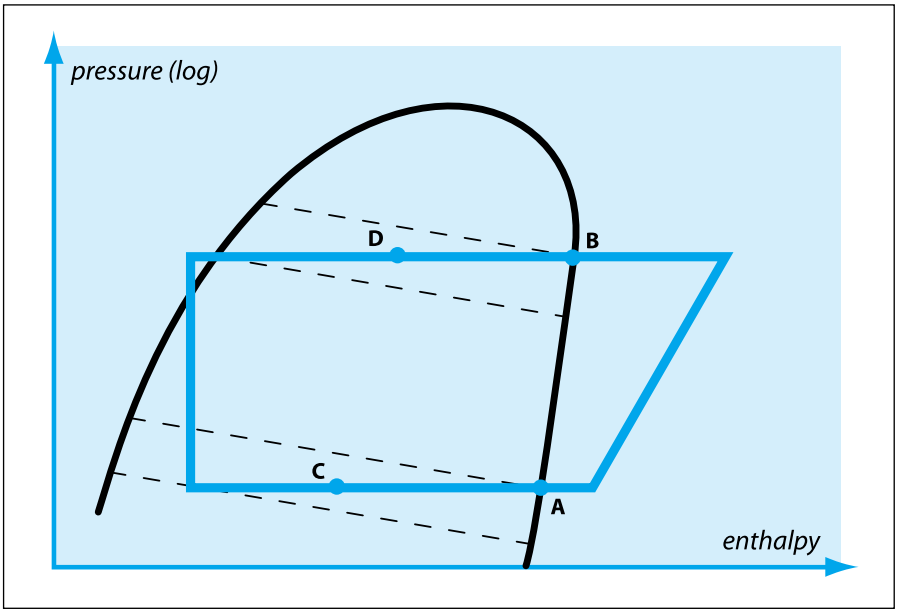
In parts of the system where both vapor and liquid phase are present (evaporator, condenser, liquid receiver), the phases do not have the same composition. In fact both phases form two different refrigerants. Therefore zeotropic refrigerants need some special attention.

Zeotropic refrigerants must always be charged in liquid phase. Flooded evaporators and suction accumulators should not be applied in systems with zeotropic refrigerants. This also applies to near-azeotropic mixtures.

Temperature glide

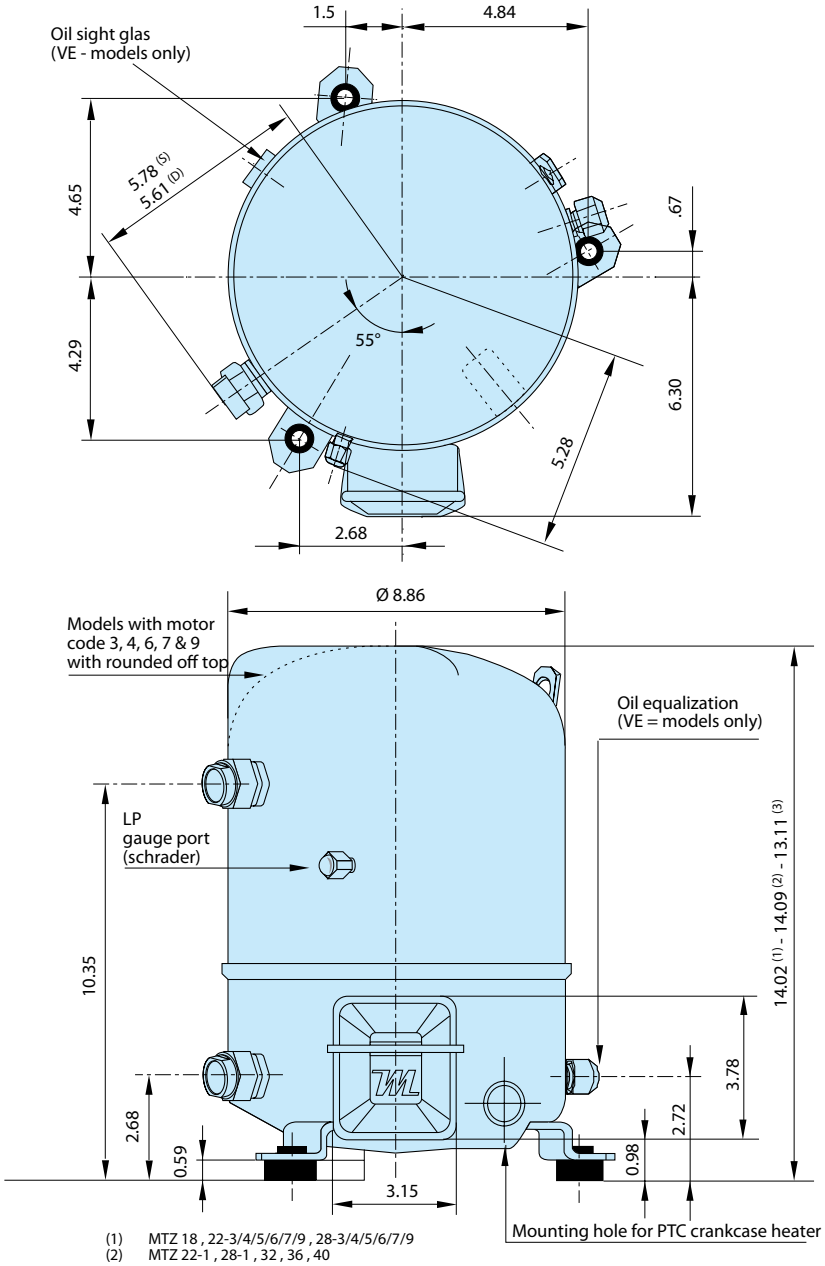
During the evaporating process and the condensing process at constant pressure, the refrigerant temperature will decrease in the condenser and rise in the evaporator. Therefore when speaking about evaporating and condensing temperatures, it is important to indicate whether the temperature under discussion is a dew point temperature or a mean point value.
In the figure below, the dotted lines are lines of constant temperature. They do not correspond to the lines of constant pressure. Points A and B are dew point values on the saturated vapor line. Points C and D are mean point values.
These are temperatures that correspond more or less with the average temperature during the evaporating and condensing process. For the same R-407C cycle, mean point temperatures are typically about 3.5°F to 5.5°F lower than dew point temperatures. In accordance with ASERCOM recommendations, Danfoss Commercial Compressors uses dew point temperatures for selection tables, application envelopes, etc.
To obtain exact capacity data at mean point temperatures, the mean point temperatures must be converted to dew point temperatures, using refrigerant data tables from the refrigerant manufacturer.

Dew point temperature and mean temperature for R-407C



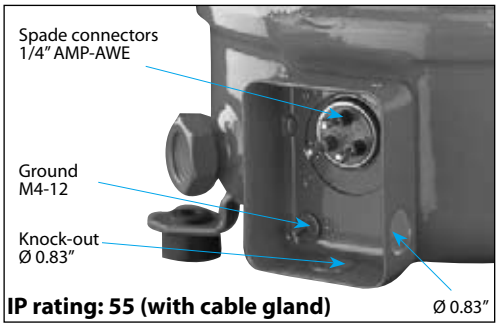
OUTLINE DRAWINGS

1 cylinder

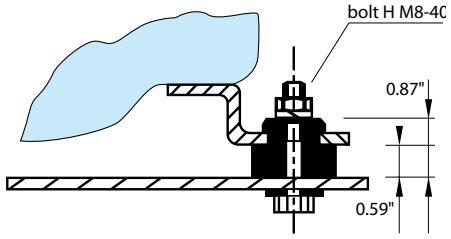


(1) MTZ 18 , 22-3/4/5/6/7/9 , 28-3/4/5/6/7/9
(2) MTZ 22-1 , 28-1 , 32 , 36 , 40

Terminal box



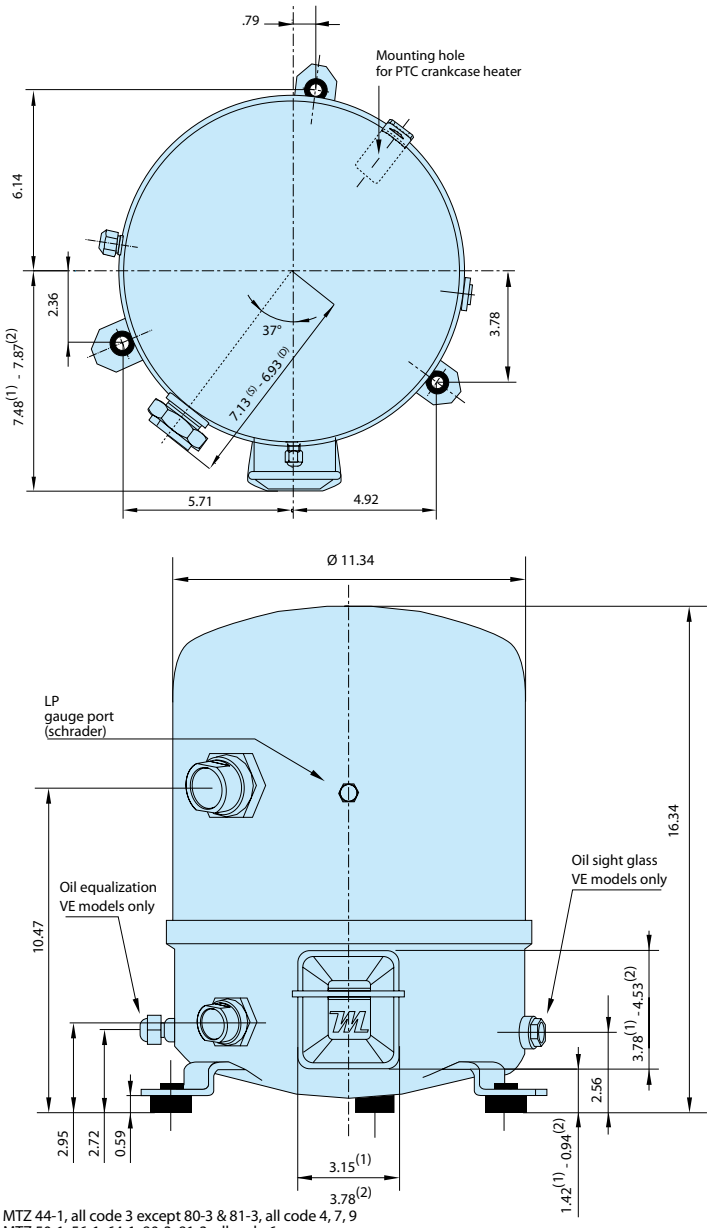
Silent block



	Rotolock connections size		Pipe sizing		Rotolock valve	
	Suction	Discharge	Suction	Discharge	Suction	Discharge
MT/MTZ018 MT/MTZ022 - 3/4/5/6 MT/MTZ028 - 3/4/5/6	1"	1"	1/2"	3/8"	V06	V01
MT/MTZ022 - 1	1"1/4	1"	5/8"	3/8"	V09	V01
MT/MTZ028 - 1 MT/MTZ032 MT/MTZ036 MT/MTZ040	1"1/4	1"	5/8"	1/2"	V09	V06

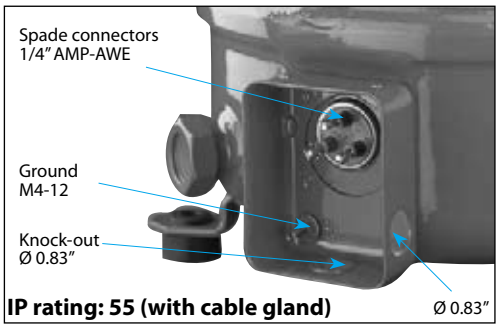
OUTLINE DRAWINGS

2 cylinders



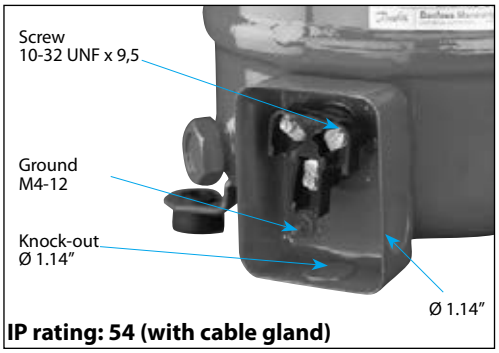
(1) MTZ 44-1, all code 3 except 80-3 & 81-3, all code 4, 7, 9
(2) MTZ 50-1, 56-1, 64-1, 80-3, 81-3, all code 6

Terminal box for model (1)



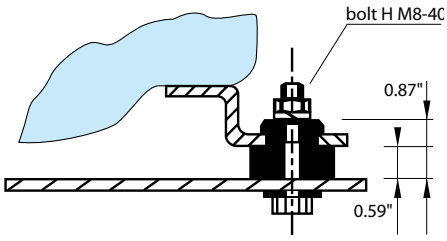
IP rating: 55 (with cable gland)

Terminal box for model (2)



IP rating: 54 (with cable gland)

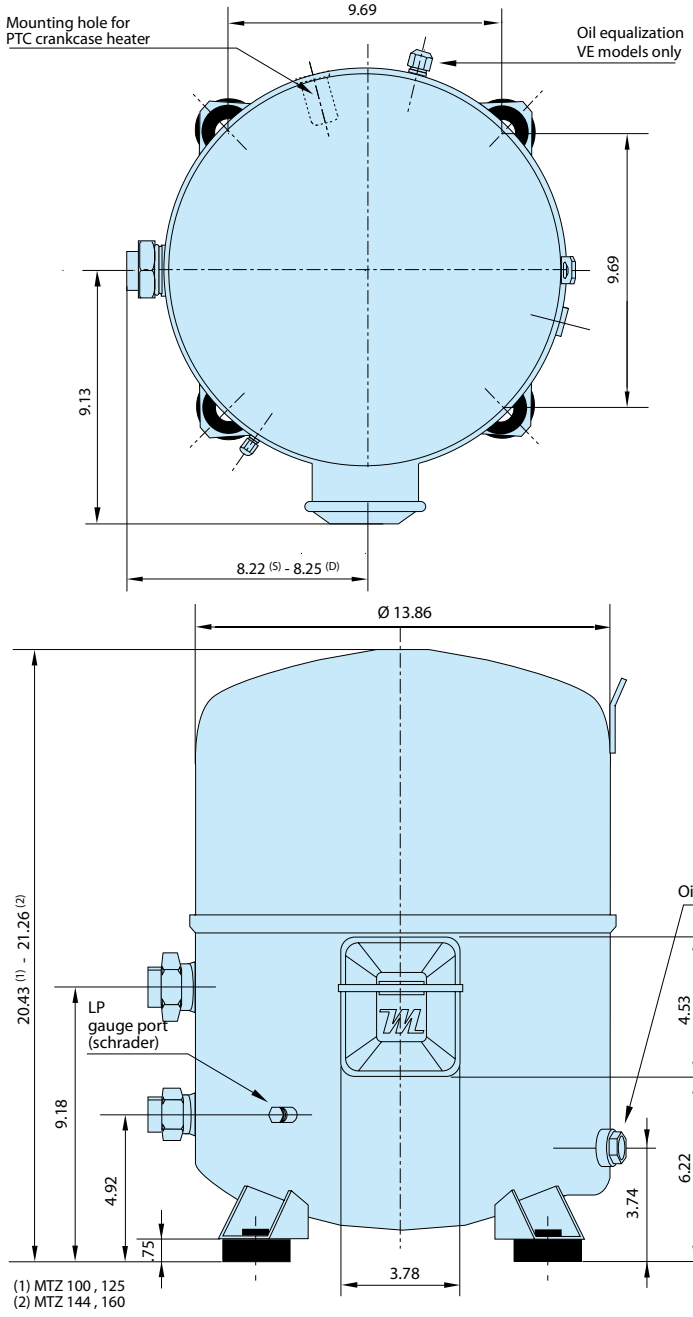
Silent block



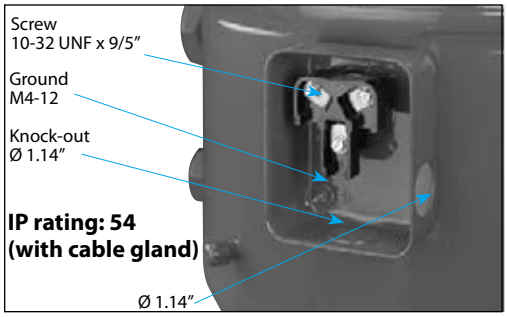
	Rotolock connections size		Pipe sizing		Rotolock valve	
	Suction	**Discharge**	**Suction**	**Discharge**	**Suction**	**Discharge**
MT/MTZ044 MT/MTZ045 MT/MTZ050 MT/MTZ051 MT/MTZ056 MT/MTZ057 MT/MTZ064 MT/MTZ065 MT/MTZ072 MT/MTZ073	1"3/4	1"1/4	7/8"	3/4"	V07	V04
MT/MTZ080 MT/MTZ081	1"3/4	1"1/4	1"1/8	3/4"	V02	V04

OUTLINE DRAWINGS

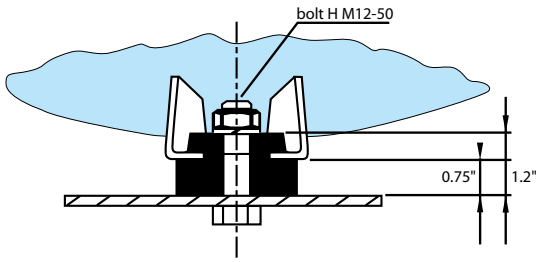
4 cylinders



Terminal box



Silent block



	Rotolock connections size		Pipe sizing		Rotolock valve	
	Suction	Discharge	Suction	Discharge	Suction	Discharge
MT/MTZ100 MT/MTZ125 MT/MTZ144 MT/MTZ160	1"3/4	1"1/4	1"1/8	3/4"	V02	V04

ELECTRICAL CONNECTIONS AND WIRING

Single phase electrical characteristics

	LRA - Locked Rotor Current (A)		MCC - Maximum Continuous Current (A)		Winding resistance (Ω) (± 7 % at 68° F)			
Motor Code	1	5	1	5	1		5	
Winding					run	start	run	start
MT/MTZ018	51	40	13	10	1.36	4.82	1.80	4.70
MT/MTZ022	49.3	41	17	15	1.25	2.49	1.78	4.74
MT/MTZ028	81	51	25	20	0.74	1.85	1.16	3.24
MT/MTZ032	84	70	26.5	20	0.64	2.85	0.90	4.30
MT/MTZ036	84	60	30	22	0.64	2.85	0.89	4.35
MT/MTZ040	99	-	34	-	0.53	2.00	-	-
MT/MTZ044	97	-	31	-	0.45	1.90	-	-
MT/MTZ050	114	92	36	29	0.37	1.79	0.52	2.65
MT/MTZ056	136	-	42.5	-	0.32	1.61	-	-
MT/MTZ064	143	-	46	-	0.32	2.10	-	-

Nominal capacitor values and relays

50 Hz	PSC/CSR*		CSR only	
Models	**Run capacitors (1)**		**Start capacitors (2)**	**Start relay**
	(A) µF	**(C) µF**	**(B) µF**	
MT/MTZ018 JA-5	20	10	100	3ARR3J4A4
MT/MTZ022 JC-5	20	10	100	
MT/MTZ028 JE-5	20	10	100	
MT/MTZ032 JF-5	25	10	135	
MT/MTZ036 JG-5	25	10	135	
MT/MTZ050 HK-5	30	15	135	

60 Hz	PSC/CSR*		CSR only	
Models	**Run capacitors (1)**		**Start capacitors (2)**	**Start relay**
	(A) µF	**(C) µF**	**(B) µF**	
MT/MTZ018 JA-1	15	10	100	3ARR3J4A4
MT/MTZ022 JC-1	30	15	100	
MT/MTZ028 JE-1	25	25	135	
MT/MTZ032 JF-1	25	20	100	
MT/MTZ036 JG-1	25	20	100	
MT/MTZ040 JH-1	35	20	100	
MT/MTZ044 HJ-1	30	15	135	
MT/MTZ050 HK-1	30	15	135	
MT/MTZ056 HL-1	35	20	200	
MT/MTZ064 HM-1	30	25	235	

* PSC: Permanent Split Capacitor
CSR: Capacitor Start Run

(1) Run capacitors: 440 volts

(2) Start capacitors: 330 Volts

Trickle circuit

The trickle circuit provides for heating the compressor crankcase by feeding a small current to the auxiliary winding and the run capacitor. *See the drawings page 14.*
By using PSC or CSR starting systems, compressor models MT/MTZ018-022 can be operated without crankcase heaters as the heater function is provided by the trickle circuit. For the larger single phase compressor models MT/MTZ028-064, the use of the PTC crankcase heater is recommended.

PSC wiring

PSC wiring may be used for refrigerant circuits with capillary tubes or expansion valves with bleed ports. Pressure equalization must be ensured before start-up because of the low starting torque characteristics of this system.

CSR wiring

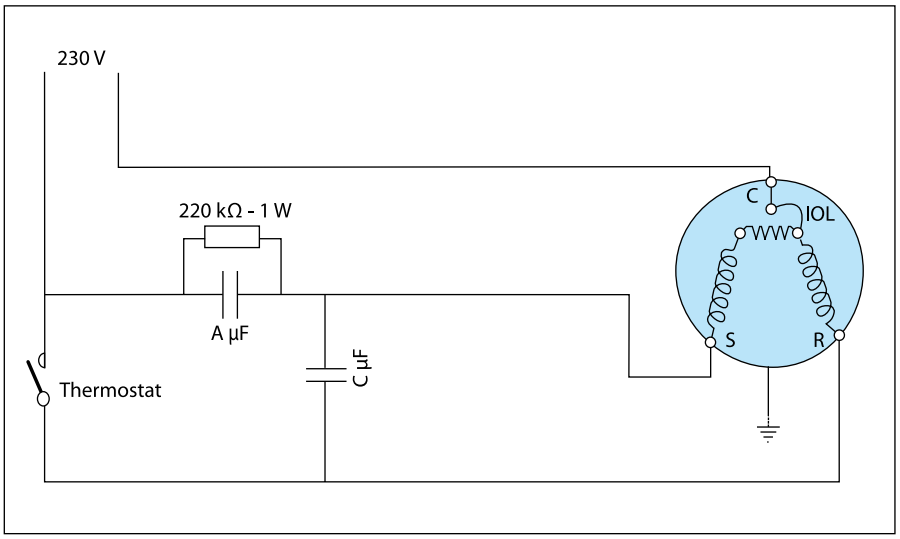
CSR wiring provides additional motor torque at start-up by the use of a start capacitor in combination with the run capacitor. This system can be used for refrigerant circuits with capillary tubes or expansion valves. The start capacitor is only connected during starting; a potential relay is used to disconnect the capacitor after the start sequence.
Single phase compressor motors are internally protected by a temperature and current sensing bimetallic protector, which senses the main and start winding currents and the winding temperature. Once the protector has tripped, it may take from two to four hours for the compressor to reset and restart.
Check that the power supply corresponds to compressor characteristics (refer to compressor nameplate).

ELECTRICAL CONNECTIONS AND WIRING

Suggested wiring diagrams

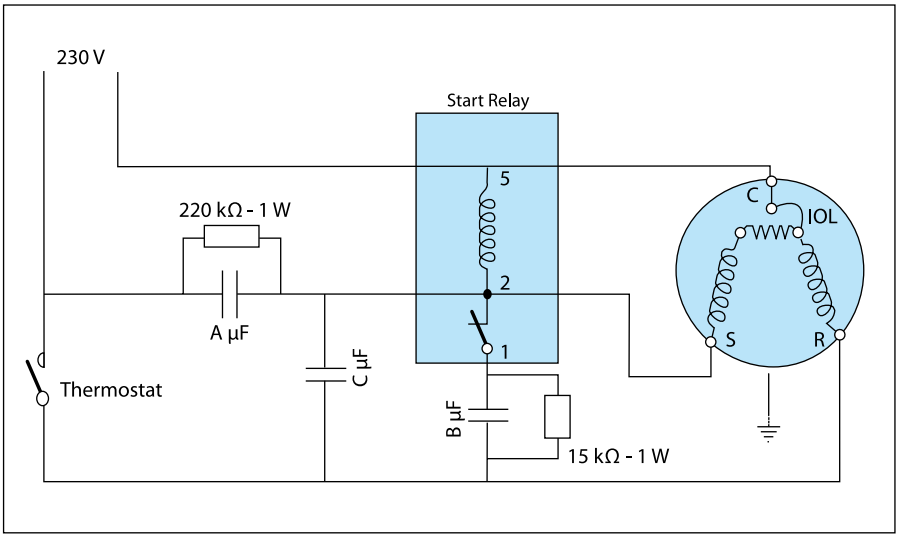
Single phase PSC wiring with trickle circuit

IOL Motor protector
A & C Run capacitors
C Common
S Start winding (auxiliary)
R Run winding (main)



Single phase CSR wiring with trickle circuit

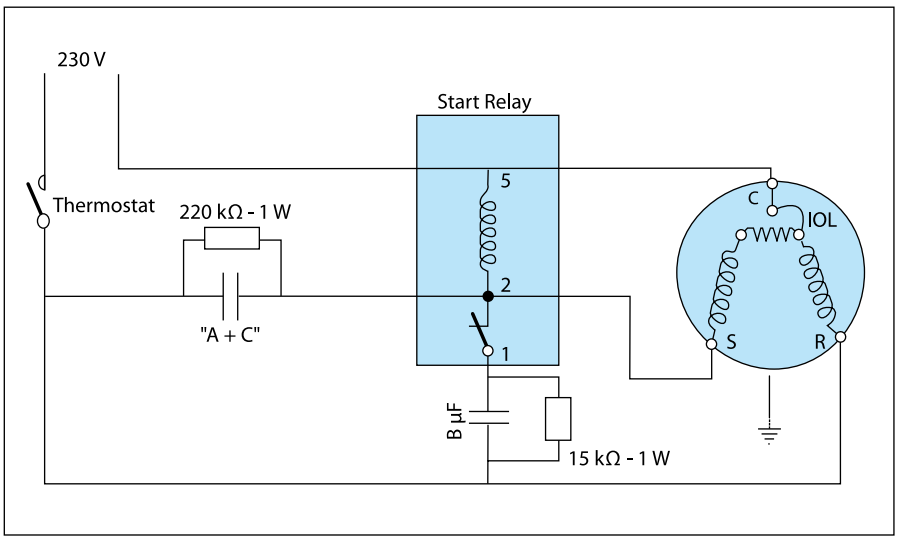
IOL Motor protector
A & C Run capacitors
B Start capacitor
C Common
S Start winding (auxiliary)
R Run winding (main)



Single phase CSR wiring without trickle circuit

IOL Motor protector
A + C Run capacitors
B Start capacitor
C Common
S Start winding (auxiliary)
R Run winding (main)

Capacitors **A** and **C** are replaced by a single capacitor of size **A + C**



ELECTRICAL CONNECTIONS AND WIRING

Three phase electrical characteristics

	LRA - Locked Rotor Current (A)					MCC - Maximum Continuous Current (A)					Winding resistance (Ω) (± 7 % at 68° F)				
Motor Code	**3**	**4**	**6**	**7**	**9**	**3**	**4**	**6**	**7**	**9**	**3**	**4**	**6**	**7**	**9**
MT/MTZ018	38	20	30	-	-	9	5	7	-	-	2.49	10.24	3.38	-	-
MT/MTZ022	38	16	-	-	22.5	11	6	8.5	-	6	2.49	10.24	3.38	-	6.58
MT/MTZ028	57	23	-	-	32	16	7.5	11.5	-	8.5	1.37	7.11	2.30	-	4.80
MT/MTZ032	60	25	44	22	35	18	8	13	5.5	9	1.27	6.15	1.27	8.90	4.20
MT/MTZ036	74	30	74	26	35	17	9	17	7	9.5	1.16	5.57	1.16	8.60	4.10
MT/MTZ040	98	38	74	-	-	22	10	18	-	-	0.95	4.56	0.95	-	-
MT/MTZ044	115	42	77	44	78	22	9.5	16	8.5	13	0.74	3.80	1.13	5.83	1.68
MT/MTZ045	115	48.5	-	-	-	17	9.5	-	-	-	0.69	3.22	-	-	-
MT/MTZ050	115	42	77	44	78	25	12	19	10	13.5	0.72	3.80	1.39	5.83	1.68
MT/MTZ051	120	48.5	-	-	-	22	11.5	-	-	-	0.69	3.60	-	-	-
MT/MTZ056	130	60	105	50	72	26	12	23	11	15	0.57	2.41	0.76	3.86	-
MT/MTZ057	130	64	-	-	-	24	12	-	-	-	0.55	2.39	-	-	-
MT/MTZ064	137	67	124	-	72	29	15	25	-	17.5	0.57	2.41	0.76	-	1.64
MT/MTZ065	135	64	-	-	-	28	14	-	-	-	0.55	2.39	-	-	-
MT/MTZ072	135	80	143	-	100	30	15.5	27	-	18.5	0.55	1.90	0.56	-	1.32
MT/MTZ073	155	80	-	-	-	32	17	-	-	-	0.48	1.90	-	-	-
MT/MTZ080	140	80	132	-	102	36	18	29	-	22.5	0.48	1.90	0.56	-	1.30
MT/MTZ081	140	80	-	-	-	36	19	-	-	-	0.48	1.90	-	-	-
MT/MTZ100	157	90	126	62	110	43	22	35	17	26	0.50	1.85	0.67	3.10	1.26
MT/MTZ 125	210	105	170	75	150	54	27	43	22	30	0.38	1.57	0.43	2.51	0.84
MT/MTZ 144	259	115	208	90	165	64	30	51	25	40	0.27	1.19	0.37	2.00	0.72
MT/MTZ 160	259	140	208	99	165	70	36	51	29	46	0.27	1.10	0.37	1.76	1.10

Motor protection and suggested wiring diagrams

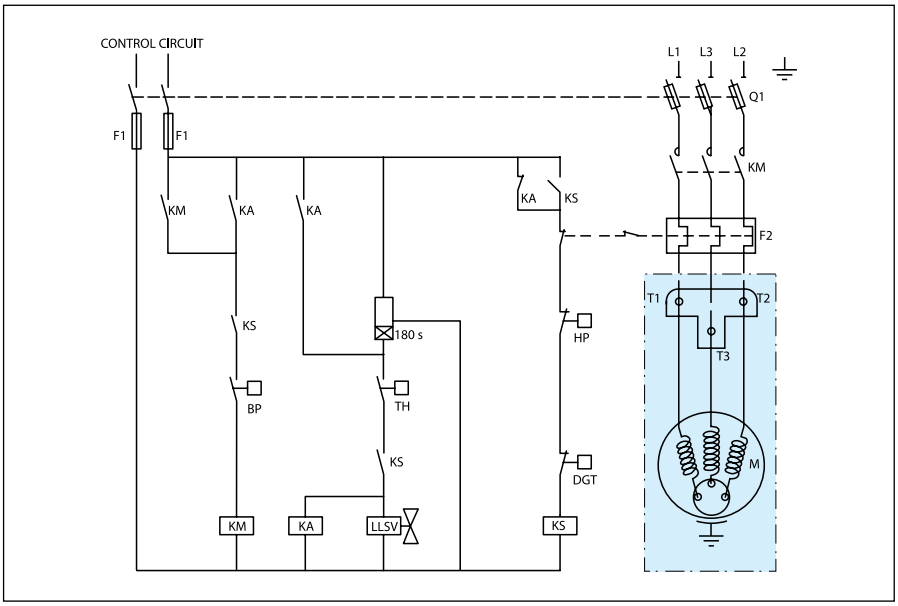
MT and MTZ 3-phase compressors are protected by an internal motor protector connected to the neutral point of star connected stator windings. The protector cuts out all 3 phases simultaneously.

Note: once the overload protector has tripped it may take up to 3 hours to reset and restart the compressor.

For all 3-phase compressors, a PTC crankcase heater is required.

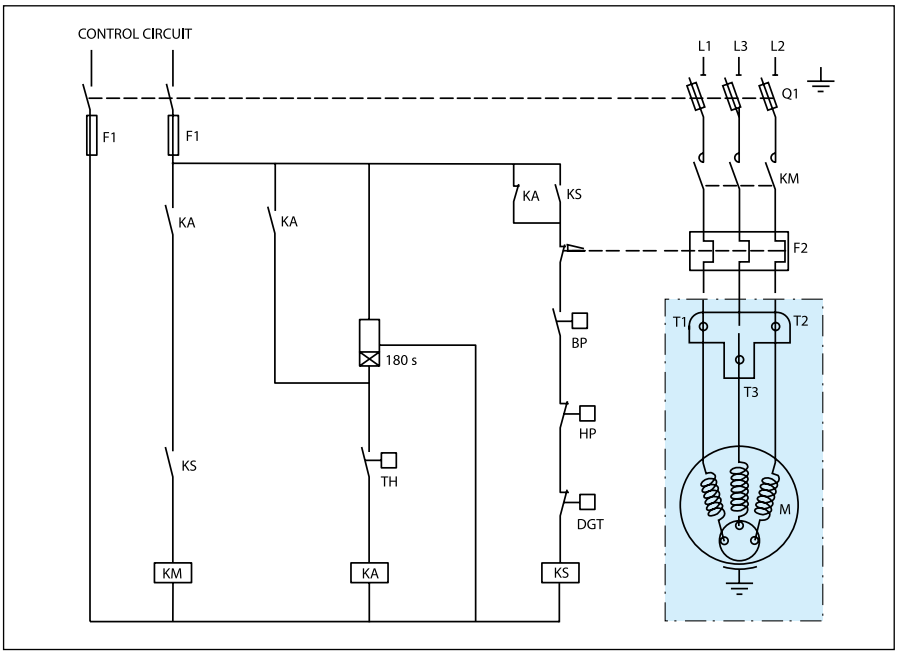
Wiring diagram with pump-down cycle

Control device ..... TH
Optional short cycle timer (3 min) 5 pts ..... 180 s
Control relay ..... KA
Liquid Solenoid valve ..... LLSV
Compressor contactor ..... KM
Safety lock out relay ..... KS
Pump-down control & L.P. switch ..... BP
H.P. switch ..... HP
Fused disconnect Q1
Fuses F1
External overload protection F2
Compressor motor ..... M
Motor safety thermostat ..... thM
Discharge gas thermostat ..... DGT



ELECTRICAL CONNECTIONS AND WIRING

Wiring diagram without pump-down cycle



Control device ..... TH
Optional short cycle timer (3 min) 5 pts ..... 180 s
Control relay ..... KA
Compressor contactor ..... KM
Safety lock out relay ..... KS
H.P. switch ..... HP
Fused disconnect Q1
Fuses F1
External overload protection F2
Compressor motor ..... M
Discharge gas thermostat ..... DGT

Soft starters

Starting current of Maneurop® 3-phase compressors can be reduced by using a soft starter. Two different versions are available: CI-tronic™ soft starters type MCI (recommended) and soft start kits with statoric resistors (type SCR). Starting current can be reduced by up to 50% depending on the compressor model and the type of soft starter. Also mechanical stresses that occur at starting are reduced, which increases the life of internal components.

For details of the CI-tronic™ MCI soft starters, please refer to literature DKACT.PD.C50.C1.02.

For details of the SCR soft start kits, please contact Danfoss.

The number of starts should be limited to 6 per hour. HP/LP pressure equalization is required before starting.

Voltage application range

Motor Code	Nominal voltage	Voltage application range
1	208-230 V / 1 ph / 60 Hz	187 - 253 V
3	200-230 V / 3 ph / 60 Hz	180 - 253 V
4	400 V / 3 ph / 50 Hz	360 - 440 V
	460 V / 3 ph / 60 Hz	414 - 506 V
5	230 V / 1 ph / 50 Hz	207 - 253 V
6	230 V / 3 ph / 50 Hz	207 - 253 V
7	500 V / 3 ph / 50 Hz	450 - 550 V
	575 V / 3 ph / 60 Hz	517 - 632 V
9	380 V / 3 ph / 60 Hz	342 - 418 V

IP rating

The IP rating of the compressor terminal boxes, according to CEI 529, are shown in the outline drawings section.

The IP ratings are only valid when correctly sized cable glands of the same IP rating are applied.

IP 5 5

First numeral, level of protection against contact and foreign objects
5 Complete protection against contact and against harmful dust deposits

Second numeral, level of protection against water
4 Protection against water splashing from any direction
5 Protection against jets of water from any direction

General information

When choosing a refrigerant, various factors must be taken into consideration:
- Legislation (now and in the future)
- Safety
- Application envelope in relation to expected running conditions
- Compressor capacity and efficiency
- Compressor manufacturer recommendations & guidelines

Additional points could influence the final choice:
- Environmental considerations
- Standardization of refrigerants and lubricants
- Refrigerant cost
- Refrigerant availability

The table below gives an overview of the different refrigerant - lubricant - compressor combinations for Maneurop®, MT & MTZ compressors.

Refrigerant	Type	Compressor type	Lubricant type	Danfoss lubricant	Application
R-22	HCFC	MT	Mineral	White oil, **160P**	Medium / High temperature
R-407C	HFC	MTZ	Polyolester	Polyolester oil **160PZ**	Medium / High temperature
R-134a	HFC	MTZ	Polyolester	Polyolester oil **160PZ**	Medium / High temperature
R-404A	HFC	MTZ	Polyolester	Polyolester oil **160PZ**	Medium temperature
R-507A	HFC	MTZ	Polyolester	Polyolester oil **160PZ**	Medium temperature
Transitional refrigerants, R-22 based		MT	Alkylbenzene (ABM)	Alkylbenzene oil **160 ABM** **Note:** Initial mineral oil charge has to be replaced by 160 ABM oil.	Medium / High temperature
Hydrocarbons		Danfoss does not authorise the use of hydrocarbons in Maneurop® MT/MTZ compressors			

The Montreal protocol states that CFC refrigerants such as R-12 and R-502 may no longer be applied in new installations in the signatory members countries.
Therefore capacity and other data for these refrigerants are not published in this document. Maneurop® MT compressors, however, are suitable for use with these refrigerants and can still be used as replacements in existing installations.

R-22

R-22 is an HCFC refrigerant and is still a wide use today. It has a low ODP (Ozone Depletion Potential) and therefore it will be phased out in the future. Check local legislation. Always use mineral white oil 160P with R-22.

The Maneurop® MT compressor is dedicated for R-22 and is supplied with an initial mineral oil charge.

R-407C

Refrigerant R-407C is an HFC refrigerant with thermodynamic properties similar to those of R-22.
R-407C has zero ozone depletion potential (ODP=0). Many installers and OEMs consider R-407C to be the standard alternative for R-22. R-407C is a zeotropic mixture and has a temperature glide of about 11 K. For more specific information about zeotropic refrigerants; refer to section "Zeotropic refrigerant mixtures". R-407C must be charged in the liquid phase.

Always use Danfoss 160PZ polyolester oil with Maneurop® MTZ compressors which is supplied with the MTZ compressor for R-407C applications.
Maneurop® MT compressors should never be used with R-407C, even when the mineral oil is replaced with polyolester oil.

REFRIGERANTS AND LUBRICANTS

R-134a

Refrigerant R-134a is an HFC refrigerant with thermodynamic properties comparable to those of the CFC refrigerant R-12. R-134a has zero ozone depletion potential (ODP=0) and is commonly accepted as the best R-12 alternative. For applications with high evaporating and high condensing temperatures, R-134a is the ideal choice. R-134a is a pure refrigerant and has no temperature glide. For R-134a applications always use the Maneurop® MTZ compressor. Use Danfoss 160PZ polyolester oil, which is supplied with the MTZ compressor.
Maneurop® MT compressors should never be used for R-134a, even when the mineral oil is replaced by polyolester oil.

R-404A

Refrigerant R-404A is an HFC refrigerant with thermodynamic properties comparable to those of the CFC refrigerant R-502. R-404A has zero ozone depletion potential (ODP = 0) and is commonly accepted as one of the best R-502 alternatives. R-404A is especially suitable for low evaporating temperature applications but it can also be used with medium evaporating temperature applications. R-404A is a mixture with a very small temperature glide, therefore must be charged in its liquid phase, but for most other aspects this small glide can be ignored. Because of the small glide, R-404A is often called a near-azeotropic mixture. For more information refer to section "Zeotropic refrigerant mixtures". For low evaporating temperature applications down to -49°F, Maneurop® NTZ compressors should be used. Refer to the NTZ selection and application guidelines. For medium temperature R-404A applications, always use the Maneurop® MTZ compressor with 160PZ polyolester oil, which is supplied with the MTZ compressor.
Maneurop® MT compressors should never be used with R-404A, even if the mineral oil replaced by polyolester oil.

R-507A

Refrigerant R-507A is an HFC refrigerant with thermodynamic properties comparable to those of the CFC refrigerant R-502 and virtually equal to those of R-404A. R-507A has no ozone depletion potential (ODP = 0) and is commonly accepted as one of the best R-502 alternatives. As with R-404A, R-507A is particularly suitable for low evaporating temperatures but it can also be used in medium evaporating temperature applications. R-507A is an azeotropic mixture with no temperature glide. For low evaporating temperature applications down to -49°F, Maneurop® NTZ compressors should be used. Refer to the NTZ selection and application guidelines. For medium temperature R-507A applications, always use the Maneurop® MTZ compressor and Maneurop® 160PZ polyolester oil which is supplied with the MTZ compressor.
Maneurop® MT compressors should never be used for R-507A, even with the mineral oil replaced by polyolester oil.

R-22 based transitional refrigerants

A wide variety of R-22 - based transitional refrigerants exist (also called service refrigerants or drop-in blends). These were developed as temporary R-12 or R-502 alternatives. Some examples are R401A, R401B, R409A and R409B as R-12 alternatives and R402A, R402B, R403A and R403B as R-502 alternatives. Because of the R-22 component, they all have a (low) ozone depletion potential. Maneurop® MT compressors can be applied with these transitional refrigerants. In such applications, the initial mineral oil charge must be replaced by Maneurop®160 ABM alkylbenzene oil.

Hydrocarbons

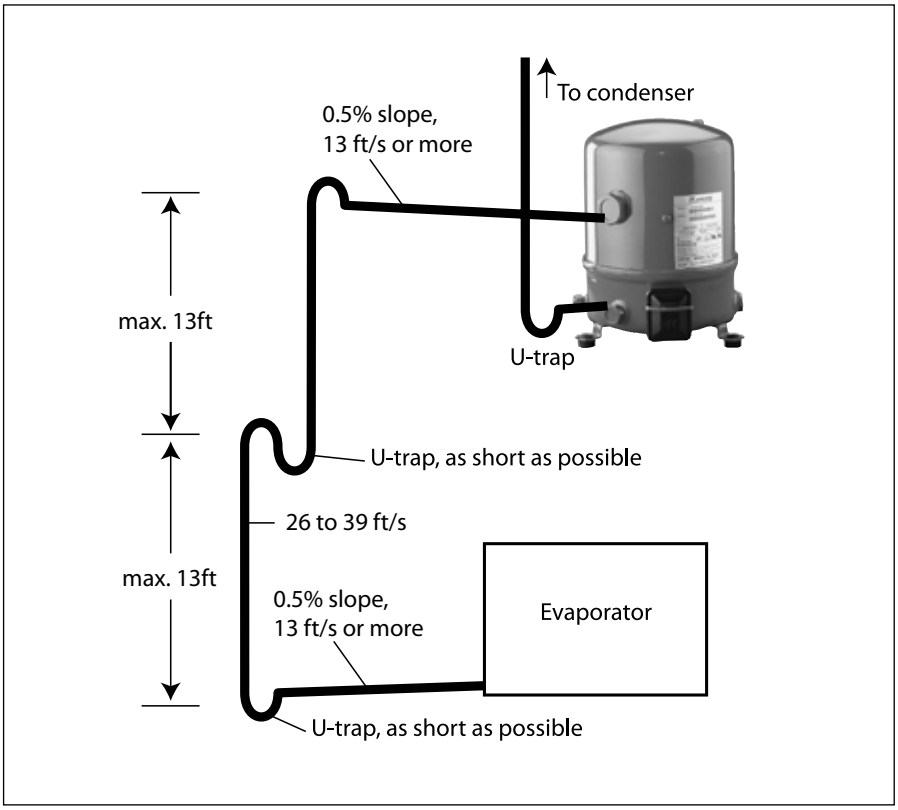
Hydrocarbons such as propane, isobutane, etc. are extremely flammable. Danfoss does not approve the use of hydrocarbons with Maneurop® MT or MTZ compressors in any way, even with a reduced refrigerant charge.

Piping design

Oil in a refrigeration circuit is required to lubricate moving parts in the compressor. During normal system operation small quantities of oil will continually leave the compressor, with the discharge gas. With good system piping design this oil will return to the compressor. As long as the amount of oil circulating through the system is small it will contribute to good system operation and improved heat transfer efficiency. Excess oil in the system, however, will have a negative effect on condenser and evaporator efficiency. If, in a poorly designed system, the amount of oil returning to the compressor is lower than the amount of oil leaving the compressor, the compressor will become starved of oil and the condenser, evaporator and/or refrigerant lines will become filled with oil. In such situations, additional oil charge will only correct the compressor oil level for a limited period of time and increase the amount of surplus oil in the rest of the system.
Only correct piping design can ensure a good oil balance in the system.

Suction lines

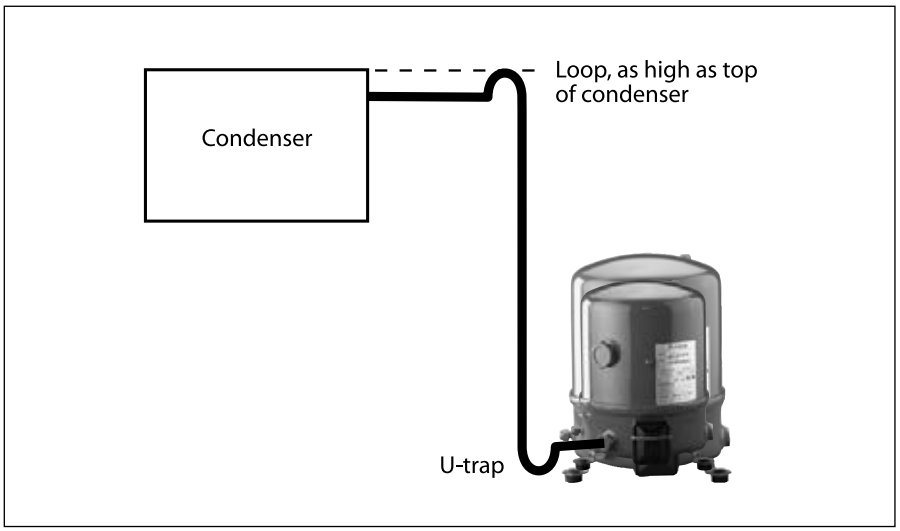
Horizontal suction line sections shall have a slope of 0.5% in the direction of refrigerant flow (5/8" for every 10' of pipe). The cross-section of horizontal suction lines shall be such that the resulting gas velocity is at least 13 fps. In vertical risers, a gas velocity of 26 to 40 fps is required to ensure proper oil return. A U-trap is required at the foot of each vertical riser. If the riser is higher than 13 ft, additional U-traps are required for each additional 13 ft. The length of each U-trap must be as short as possible to avoid the accumulation of excessive quantities of oil (see figure below).
For compressors mounted in parallel, the common suction riser should be designed as a double riser. Also refer to the News bulletin "Mounting instructions for installation of Maneurop® compressors in parallel" and "Parallel application guidelines".
Gas velocities higher than 40 fps will not contribute significantly to better oil return. They will, however, cause higher noise levels and result in higher suction line pressure drops which will have a negative effect on system capacity.



The suction rotolock valves that can be ordered from Danfoss as accessories are designed for average pipe sizes, and selected for systems running at nominal conditions.
The pipe sizes selected for specific systems may differ from these recommended sizes.
It is recommended that the suction lines be insulated to limit suction gas superheat.

Discharge line

When the condenser is mounted above the compressor, a loop above the condenser and a U-trap close to the compressor are required to prevent liquid draining from the condenser into the discharge line during standstill.



Oil charge and oil separator

In most installations the initial compressor oil charge will be sufficient. In installations with line runs exceeding 20 m, or with many oil traps, or an oil separator, additional oil may be required. In installations with risk of slow oil return, such as in multiple evaporator or multiple condenser installations, an oil separator is recommended. Also refer to page 29.

Filter driers

For new installations with MTZ compressors, Danfoss recommends using the Danfoss DML 100%-molecular sieve solid core filter drier. Molecular sieve filter driers with loose beads from third party suppliers should be avoided.

For servicing of existing installations where acid formation is present, Danfoss DCL solid core filter driers containing activated alumina are recommended.

The drier should be oversized rather than undersized. When selecting a drier, always take into account its capacity (water content capacity), the system refrigerating capacity and the system refrigerant charge.

Operating limits

High Pressure

A high pressure safety switch is required to stop the compressor should the discharge pressure exceed the values shown in the table below. The high pressure switch can be set to lower values depending on the application and ambient conditions. The HP switch must either be in a lockout circuit, or be a manual reset device to prevent compressor cycling around the high pressure limit. When a discharge valve is used, the HP switch must be connected to the service valve gauge port, which cannot be isolated.

SYSTEM DESIGN RECOMMENDATIONS

Low pressure

A low pressure safety switch is recommended to avoid compressor operation at too lower suction pressures.

		MT R-22	MTZ R-407C	MTZ R-134a	MTZ R-404A / R-507A
Test pressure low side	psig	360	360	360	360
Working pressure range high side	psig	158 - 402	181 - 426	115 - 328	191 - 402
Working pressure range low side	psig	15 - 102	20 - 96	9 - 68	15 - 104
Relief valve opening pressure difference	psig	435	435	435	435
Relief valve closing pressure difference	psig	115	115	115	115

Low ambient temperature operation

At low ambient temperatures, the condensing temperature and condensing pressure in air cooled condensers will decrease. These lower pressures may be insufficient to supply enough liquid refrigerant to the evaporator. As a result, the evaporator temperature will sharply decrease with risk of frosting. At compressor start-up, the compressor can pull a deep vacuum and it can be cut off by low pressure protection. Depending on the low pressure switch setting and delay timer, short cycling can occur. To avoid these problems, several solutions are possible, all based on reducing condenser capacity:

- Locating condensor indoors
- Liquid flooding of condensers (note: this solution requires extra refrigerant charge, which can introduce other problems. A non-return valve in the discharge line is required and special care should be taken when designing the discharge line.)
- Reduce air flow to condensers.

Other problems can occur when the compressor is operating at low ambient temperature. For example, during shut down periods, liquid refrigerant can migrate to a cold compressor. For such conditions a belt-type crankcase heater is strongly recommended.

Because Maneurop compressor motors are 100% suction gas cooled, they can be externally insulated.

Refer to section "Liquid refrigerant migration & charge limits" for more details.

Operating voltage and cycle rate

Operating voltage range

Operating voltage limits are shown in the table on page 4. The voltage applied to the motor terminals must always be within these limits. The maximum allowable voltage unbalance for 3-phase compressors is 2%. Voltage unbalance causes high current draw on one or more phases, which in turn leads to overheating and possible motor damage.

Voltage unbalance is given by the formula:

$$\text{\% voltage unbalance:} \quad \frac{|V_{avg} - V_{1\text{-}2}| + |V_{avg} - V_{1\text{-}3}| + |V_{avg} - V_{2\text{-}3}|}{2 \times V_{avg}} \times 100$$

V_{avg} = Mean voltage of phases 1, 2 and 3
$V_{1\text{-}2}$ = Voltage between phases 1 and 2
$V_{1\text{-}3}$ = Voltage between phases 1 and 3
$V_{2\text{-}3}$ = Voltage between phases 2 and 3.

Cycle rate limit

There may be no more than 12 starts per hour (6 when a soft start accessory is used). A higher number reduces the service life of the motor-compressor unit. If necessary, use an anti-short-cycle timer in the control circuit.

A time-out of six minutes is recommended. The system must be designed in such a way to guarantee a minimum compressor run time in order to provide proper oil return and sufficient motor cooling after starting.

Note that the oil return rate varies as a function of the system design.

Liquid refrigerant control and charge limits

Refrigeration compressors are basically designed as gas compressors. Depending on the compressor design and operating conditions, most compressors can also handle a limited amount of liquid refrigerant. Maneurop® MT and MTZ compressors have a large internal volume and can therefore handle relatively large amounts of liquid refrigerant without major problems. However even when a compressor can handle liquid refrigerant, it is not favorable to a long service life. Liquid refrigerant can dilute the oil, wash oil out of bearings and result in high oil carry over, resulting in loss of oil from the sump. Good system design can limit the amount of liquid refrigerant in the compressor, and have a positive effect on the compressor service life.
Liquid refrigerant can enter a compressor in different ways, with different effects on the compressor.

Off-cycle migration

During system standstill and after pressure equalization, refrigerant will condense in the coldest part of the system. The compressor can easily be the coldest spot, for example when it is placed outside in low ambient temperatures. After a while, the full system refrigerant charge can condense in the compressor crankcase. A large amount will dissolve in the compressor oil until the oil is completely saturated with refrigerant. If other system components are located at a higher level, this process can be even faster because gravity will speed the flow of liquid refrigerant to flow back to the compressor. When the compressor is started, the pressure in the crankcase decreases rapidly.
At lower pressures the oil holds less refrigerant, and as a result part of the refrigerant will violently evaporate from the oil, causing the oil to foam. This process is often called "boiling".
The negative effects on the compressor from migration are:

- oil dilution by liquid refrigerant
- oil foam, transported by refrigerant gas and discharged into the system, causing loss of oil and in extreme situations risk of oil slugging
- in extreme situations with high system refrigerant charge, liquid slugging could occur (liquid entering the compressor cylinders).

Liquid floodback during operation

During normal and stable system operation, refrigerant will leave the evaporator in a superheated condition and enter the compressor as a superheated vapor.
Normal superheat values at compressor suction are 9°F to 54°F. The refrigerant leaving the evaporator, however, can contain an amount of liquid refrigerant for various reasons:

- wrong dimensioning, wrong setting or malfunction of expansion device
- evaporator fan failure or blocked air filters.

In these situations, liquid refrigerant will continuously enter the compressor.
The negative effects from continuous liquid floodback are:

- permanent oil dilution
- in extreme situations with high system refrigerant charge and large amounts of floodback, liquid slugging could occur.

Liquid floodback at changeover cycles in reversible heat pumps

In heat pumps, changeover from cooling to heating cycles, defrost, and low load short cycles may lead to liquid refrigerant floodback or saturated refrigerant return conditions.
The negative effects are:

- oil dilution
- in extreme situations with high system refrigerant charge and large amounts of floodback, liquid slugging could occur.

Liquid floodback and zeotropic refrigerants

Liquid floodback in systems working with a zeotropic refrigerant such as R-407C introduces additional negative effects. A part of the refrigerant leaves the evaporator in liquid phase and this liquid has a different composition than the vapor.
This new refrigerant composition may result in different compressor operating pressures and temperatures.

SYSTEM DESIGN RECOMMENDATIONS

Crankcase heater

A crankcase heater protects against the off-cycle migration of refrigerant and proves effective if oil temperature is maintained 18°F above the saturated LP temperature of the refrigerant. Tests must be conducted, therefore, to ensure that the appropriate oil temperature is maintained under all ambient conditions. A PTC crankcase heater is recommended on all stand-alone compressors and split systems. PTC crankcase heaters are self-regulating.
Under extreme conditions such as very low ambient temperature a belt type crankcase heater could be used in addition to the PTC heater, although this is not a preferred solution for 1 and 2 cylinder compressors. The belt crankcase heater must be positioned on the compressor shell as close as possible to the oil sump to ensure good heat transfer to the oil.
Belt crankcase heaters are not self-regulating. Control must be applied to energize the belt heater once the compressor has been stopped and then to de-energize it while the compressor is running. The belt heater must be energized 12 hours before restarting the compressor following an extended down period.
If the crankcase heater is not able to maintain the oil temperature 18°F above the saturated LP temperature of the refrigerant during off cycles or if repeated floodback is occuring, a pumpdown cycle using an LLSV is required. In such cases, a suction accumulator is recommended.

Liquid line solenoid valve & pump-down

In refrigeration applications, a Liquid Line Solenoid Valve (LLSV) is highly recommended. During the off-cycle, the LLSV isolates the liquid charge in the condenser side, thus preventing refrigerant transfer or excessive migration of refrigerant into the compressor. Furthermore, when using an LLSV in with a pumpdown cycle, the quantity of refrigerant in the low-pressure side of the system will be reduced.
A pump-down cycle design is also required when evaporators are fitted with electric defrost heaters.

Suction accumulator

A suction accumulator offers considerable protection against refrigerant floodback at start-up, during operation or after the defrost operation. This device also helps to protect against off-cycle migration by means of providing additional internal free volume to the low pressure side of the system.
The suction accumulator must be selected in accordance with the accumulator manufacturer's recommendations. As a general rule, Danfoss recommends sizing the accumulator for at least 50% of the total system charge. Tests, however, must be conducted to determine the optimal size.
A suction accumulator must not be used in systems with zeotropic refrigerant mixtures.

Sound

Running compressors cause sound and vibration. These phenomena are closely related.
Sound produced by a compressor is transmitted in every direction in all media: ambient air, the mounting feet, the pipework and the refrigerant in the pipework.
The easiest way to reduce the sound transmitted in ambient air is to fit a Danfoss acoustic hood accessory. Because Maneurop® compressors are 100% suction gas cooled, and require no body cooling, they can be insulated. Values for the sound reduction achieved with acoustic hoods are shown also in the table below. For compressors mounted inside, sound insulation of the plantrom is an alternative to sound insulation of the compressor.
Sound transmitted by mounting feet, pipework and refrigerant should be reduced in the same way as vibration.
Please refer to the next section.

Sound power level for MTZ with R-404A, motor code 4
Te = 14°F,
TC = 113°F

	Sound power level at 50 Hz dB(A)		Sound power level at 60 Hz dB(A)	
	without hood	with hood*	without hood	with hood*
MTZ018	73	65	73	66
MTZ022	74	68	77	71
MTZ028	71	64	73	66
MTZ032	71	64	73	66
MTZ036	70	64	76	69
MTZ040	70	65	72	67
MTZ044	80	74	82	76
MTZ045	80	74	82	76
MTZ050	83	76	84	78
MTZ051	83	76	84	78
MTZ056	81	74	81	74
MTZ057	81	74	81	74
MTZ064	80	74	84	78
MTZ065	80	74	84	78
MTZ072	79	72	82	75
MTZ073	79	72	82	75
MTZ080	79	73	84	78
MTZ081	79	73	84	78
MTZ100	85	79	87	81
MTZ125	84	78	86	80
MTZ144	83	77	86	80
MTZ160	83	77	86	80

* Sound data with hood are valid for the Danfoss acoustic hood accessory.

Model	Acoustic hood accessory	code no.
MT/MTZ018 - 040	Acoustic hood for 1 cyl compressors	**7755001**
MT/MTZ044 - 081	Acoustic hood for 2 cyl compressors	**7755002**
MT/MTZ100 - 160	Acoustic hood for 4 cyl compressors	**7755003**

Vibration

The mounting grommets delivered with the compressor should always be used. They reduce vibration transmitted by the compressor mounting feet to the base frame.
The base on which the compressor is mounted should be sufficiently rigid and of adequate mass to ensure the full effectiveness of the mounting grommets.
The compressor should never be directly mounted to the base frame without the grommets. If it is, significant high vibration transmission will occur and the compressor service life will be reduced.
Suction and discharge lines must have adequate flexibility in 3 planes. Vibration absorbers may be required.
Care must be taken to avoid tubing having frequencies resonant close to the compressor frequency.
Vibration is also transmitted by the refrigerant gas. Maneurop® compressors have built in mufflers to reduce this vibration.
To further reduce vibration an additional muffler can be installed.

Note: Maneurop® MT & MTZ compressors have been designed and qualified for stationary equipment used in A/C and refrigeration applications.
Danfoss does not warrant these compressors for use in mobile applications, such as trucks, railways, subways, etc.

System cleanliness

System contamination is one of the main factors affecting equipment reliability and compressor service life.
It is, therefore, important to ensure system cleanliness when constructing a refrigeration system. During the building process, system contamination can be caused by:

- Brazing and welding oxides
- Filings and particles from removing burrs from pipe-work
- Brazing flux
- Moisture and air.

Only use clean and dehydrated refrigeration grade copper tubes and silver alloy brazing material. Clean all parts before brazing and always purge nitrogen or CO_2 through the pipes during brazing to prevent oxidation. If flux is used, take every precaution to prevent it entering the piping. Do not drill holes (e.g. for Schräder valves).
in parts of the installation that are already completed, when filings and burrs can not be removed. Carefully follow the instructions below regarding brazing, mounting, leak detection, pressure test and moisture removal. All installation and service work must be done only by qualified personnel using correct procedures and using tools (charging systems, tubes, vacuum pump, etc.) dedicated for the refrigerant that will be used.

Compressor handling, mounting and connection to the system

Compressor handling

Maneurop® MT and MTZ compressors are provided with a lifting lug. This lug should always be used to lift the compressor. Once the compressor is installed, the compressor lifting lug should never be used to lift the complete installation.
Keep the compressor in an upright position during handling.

Compressor mounting

Mount the compressor on a horizontal plane with a maximum slope of 3°. All MT and MTZ compressors are supplied with three or four rubber mounting grommets, each complete with metal sleeves, nuts, and bolts. Refer to the outline drawings on page 18 to 21.

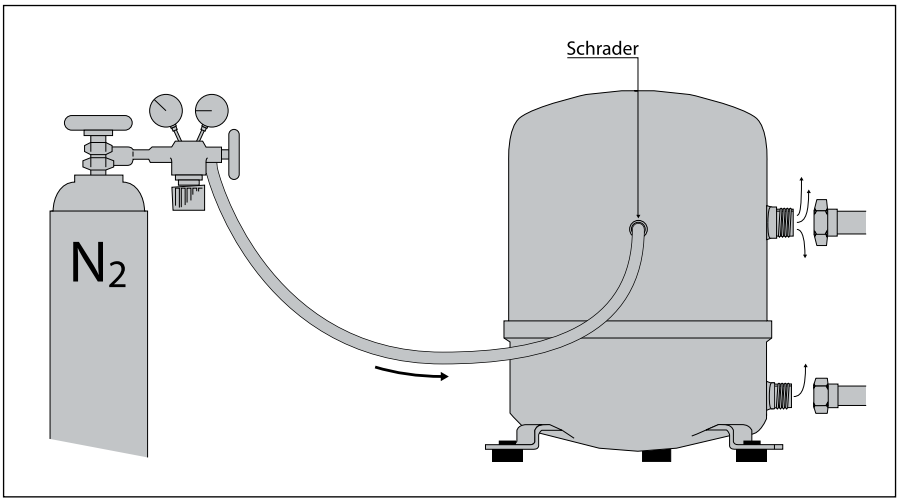
The grommets largely attenuate compressor vibration transmitted to the base frame. The compressor must always be mounted with these grommets. Refer to the table below for torque values.

Designation		Recommended torque in. lb
Cable screw of T connector in electrical box	screw 10/32 - UNF x 3	17
Rotolock valves and solder sleeves	1"	59
	1"1/4	66
	1"3/4	81
Mounting grommet bolts	1 - 2 - 4 cylinder	11
Oil sight glass	-	37
Oil equalization connection	1 - 2 - 4 cylinder	22

Compressor connection to the system

New compressors have a protective nitrogen holding charge. The suction and discharge caps should only be removed just before connecting the compressor to the installation to avoid air and moisture entering the compressor.
Whenever possible the compressor must be the last component to be integrated in the system. It is advisable to braze the solder sleeves or service valves to the pipework before the compressor is mounted. When all brazing is finished and when the entire

system is ready, the compressor caps can be removed and the compressor connected to the system with a minimum exposure to ambient air.
If this procedure is not possible, the sleeves or valves may be brazed to the pipes when mounted on the compressor.
In this situation nitrogen or CO_2 must be purged through the compressor via the Schräder valve to prevent air and moisture ingress. Purging must start when the caps are removed and continue during the brazing process.
When rotolock valves are used on the compressor, they must be closed immediately after mounting, thus keeping the compressor isolated from the atmosphere or from a system not yet dehydrated.
Note: When the compressor is built into a "rack" or "pack" configuration that is not installed immediately in its final location, a vacuum pull-down and moisture removal must be performed to the rack as if it were a complete system (see below). The rack must be charged with nitrogen or CO_2 and open tubes must be blocked with caps or plugs.



System pressure test

It is recommended that an inert gas or nitrogen be used for pressure testing. Dry air may also be used but care should be taken since it can form a flammable mixture with the compressor oil. When performing a system pressure test, the maximum allowed pressure for the different components should not be exceeded.
For MT/MTZ compressors the maximum test pressures are shown in the table below.

	1-2-4 cylinder compressors
Maximum compressor test pressure, low side	362 psi(g)
Maximum compressor test pressure, high side	435 psi(g)

Do not exceed 435 psig pressure differential between high pressure side and low pressure side of the compressor because this will open the internal compressor relief valve.

Leak detection

Whenever possible (if valves are present) the compressor must be kept isolated from the system. Perform leak detection using the final refrigerant. Pressurize with nitrogen or another system-neutral gas and use a leak detector for the applied refrigerant. A helium leak detector can also be used.
Leaks must be repaired respecting the instructions written above. Use of other gasses such as oxygen, dry air, or acetylene is not recommended, as these gasses can form a

flammable mixture. Never use CFC or HCFC refrigerants for leak detection in HFC systems.
Note 1: Leak detection with refrigerant may not be allowed in some countries. Check local regulations.

Note 2: Leak detecting additives shall not be used as they may affect the lubricant properties.
Warranty may be voided if leak detecting additives have been used.

Vacuum pull-down moisture removal

Moisture interferes with proper functioning of compressors and refrigeration systems.
Air and moisture reduce service life, increase condensing pressure, and cause excessively high discharge temperatures, that can destroy the lubricating properties of the oil. Air and moisture also increase the risk of acid formation, giving rise to copper plating. All these phenomena can cause mechanical and electrical compressor failure.
To eliminate these factors, a vacuum pull-down according to the procedure given below is recommended.

1. Whenever possible (if valves are present) the compressor must be kept isolated from the system.

2. After leak detection, the system must be pulled down under a vacuum of 500 microns. A two stage vacuum pump must be used, with a capacity appropriate to the system volume. Use connection lines with a large diameter and connect them to the service valves and (not to the Schräder connection) to avoid too high pressure losses.

3. When a vacuum level of 500 microns is reached, the system must be isolated from the vacuum pump. Wait 30 minutes, during which the system pressure should not rise. When the pressure rapidly increases, the system is not leak tight. Leak detection must be repeated and the vacuum pull-down procedure should be restarted from step 1. When the pressure slowly increases, this indicates the presence of moisture. In this case steps 2 and 3 should be repeated.

4. Connect the compressor to the system by opening the valves. Repeat steps 2 and 3.

5. Break the vacuum with nitrogen or the final refrigerant.

6. Repeat steps 2 and 3 on the total system.
At commissioning, system moisture content may be up to 100 ppm. During operation the filter drier must reduce this to a level < 20 ppm.
Warning :
Do not use a megohmmeter or apply power to the compressor while it is under vacuum, as this may cause motor winding damage.
Never run the compressor under vacuum as it may cause compressor motor burn-out.

Start-up

Before initial start-up, or after a prolonged shut down period, energize the crankcase heater (if fitted) 12 hours prior to start-up, or turn on power for single phase compressors with trickle circuit.

Refrigerant charging

Zeotropic and "near-azeotropic" refrigerant mixtures such as R-407C and R-404A must always be charged in the liquid phase. For the initial charge, the compressor must not run and service valves must be closed. Charge refrigerant as close as possible to the nominal system charge before starting the compressor. Then slowly add refrigerant in the liquid phase, on the low pressure side as far away as possible from the running compressor.
The refrigerant charge quantity must be suitable for both winter and summer operation. Refer also to section "Protection against flooded starts and liquid floodback" for information about refrigerant charge limits.
Warning: when a liquid line solenoid valve is used, the vacuum in the low pressure side must be broken before applying power to the system.

Oil charge and oil level

The oil charge must be checked before commissioning (1/4 to 3/4 of the oil sight glass). Check the oil level again after a minimum of 2 hours operation at nominal conditions. In most installations the initial compressor oil charge will be sufficient. In installations with line runs exceeding 20 m or with many oil traps or an oil separator, additional oil may be required. Normally the quantity of oil added should be no more than 2% of the total refrigerant charge (this percentage does not take into account oil contained in accessories such as oil separators or oil traps). If oil has already been added, and the oil level in the compressor keeps decreasing, the oil return in the installation is insufficient. Refer also to section "Piping design".
In installations where slow oil return is likely such as in multiple evaporator or multiple condenser installations, an oil separator is recommended. Refer to the table on page 17 to select the correct oil.

Suction gas superheat

Optimum suction gas superheat is 15°F. A lower superheat will contribute to better system performance (higher mass flow and more efficient use of evaporator surface). Low superheat values however increase the risk of unwanted liquid floodback to the compressor.
For very low superheat values an electronically controlled expansion valve is recommended.
Maximum allowable superheat is about 54°F. Higher values can be accepted but in these cases, tests have to be performed to check that the maximum discharge temperature of 265°F will not be exceeded. Note that high superheat values decrease the compressor application envelope and system performance.

ACCESSORIES AND SPAREPARTS

The tables below show an extract of the available accessories and spare parts for Maneurop® reciprocating compressors. For an exhaustive list please refer to Accessories & Spare parts catalogue, ref. FRCC.EK.002.A1.02

Rotolock accessories

Type	Code no.	Description	Application	Packaging	Pack size
V06-V01	**7703004**	Valve set, V06 (1"~1/2"), V01 (1"~3/8")	MT/MTZ018-028 (exept 028 code 1)	Multipack	4
V09-V06	**7703005**	Valve set, V09 (1-1/4"~5/8"), V06 (1"~1/2")	MT/MTZ032-040 (& 028 code 1)	Multipack	4
V07-V04	**7703006**	Valve set, V07 (1-3/4"~7/8"), V04 (1-1/4"~3/4")	MT/MTZ044-072	Multipack	6
V02-V04	**7703009**	Valve set, V02 (1-3/4"~1-1/8"), V04 (1-1/4"~3/4")	MT/MTZ080-160	Multipack	6
C06-C01	**7703011**	Angle adapter set, C06 (1"~1/2"), C01 (1"~3/8")	MT/MTZ018-028 (exept 028 code 1)	Multipack	4
C09-C06	**7703012**	Angle adapter set, C09 (1-1/4"~5/8"), C06 (1"~1/2")	MT/MTZ032-040 (& 028 code 1)	Multipack	4
C07-C04	**7703013**	Angle adapter set, C07 (1-3/4"~7/8"), C04 (1-1/4"~3/4")	MT/MTZ044-072	Multipack	6
C02-C04	**7703014**	Angle adapter set, C02 (1-3/4"~1-1/8"), C04 (1-1/4"~3/4")	MT/MTZ080-160	Multipack	6
G01	**8156130**	Gasket, 1"	Models with 1" rotolock connection	Multipack	10
G01	**7956001**	Gasket, 1"	Models with 1" rotolock connection	Industry pack	50
G09	**8156131**	Gasket, 1-1/4"	Models with 1-1/4" rotolock connection	Multipack	10
G09	**7956002**	Gasket, 1-1/4"	Models with 1-1/4" rotolock connection	Industry pack	50
G07	**8156132**	Gasket, 1-3/4"	Models with 1-3/4" rotolock connection	Multipack	10
G07	**7956003**	Gasket, 1-3/4"	Models with 1-3/4" rotolock connection	Industry pack	50
	8156009	Gasket set, 1", 1-1/4", 1-3/4", Oil sight glass gaskets black & white	All 1-2-4 cylinder models	Multipack	10

Crankcase heaters

Type	Code no.	Description	Application	Packaging	Pack size
PTC35W	**7773001**	PTC crankcase heater, 35 W, incl. heat transfer paste	All models	Multipack	10
PTC35W	**7973009**	PTC crankcase heater, 35 W, incl. heat transfer paste	All models	Industry pack	50
PTC35W	**7773125**	PTC crankcase heater, 35 W, mounting without paste	All models	Multipack	10
PTC35W	**7973011**	PTC crankcase heater, 35 W, mounting without paste	All models	Industry pack	50
	7773106	Belt type crankcase heater, 55 W, 230 V, CE mark, UL	MT/MTZ018-040	Multipack	4
	7773002	Belt type crankcase heater, 54 W, 240 V, UL	MT/MTZ018-040	Multipack	4
	7773013	Belt type crankcase heater, 54 W, 400 V, UL	MT/MTZ018-040	Multipack	4
	7773111	Belt type crankcase heater, 54 W, 460 V, UL	MT/MTZ018-040	Multipack	4
	7773109	Belt type crankcase heater, 65 W, 110 V, CE mark, UL	MT/MTZ044-081	Multipack	6
	7973001	Belt type crankcase heater, 65 W, 110 V, CE mark, UL	MT/MTZ044-081	Industry pack	50
	7773107	Belt type crankcase heater, 65 W, 230 V, CE mark, UL	MT/MTZ044-081	Multipack	6
	7973002	Belt type crankcase heater, 65 W, 230 V, CE mark, UL	MT/MTZ044-081	Industry pack	50
	7773117	Belt type crankcase heater, 65 W, 400 V, CE mark, UL	MT/MTZ044-081	Multipack	6
	7773010	Belt type crankcase heater, 50 W, 110 V, UL	MT/MTZ044-081	Multipack	6
	7773003	Belt type crankcase heater, 50 W, 240 V, UL	MT/MTZ044-081	Multipack	6
	7773009	Belt type crankcase heater, 50 W, 400 V, UL	MT/MTZ044-081	Multipack	6
	7773006	Belt type crankcase heater, 50 W, 460 V, UL	MT/MTZ044-081	Multipack	6
	7773119	Belt type crankcase heater, 75 W, 575 V, UL	MT/MTZ044-081	Multipack	6
	7773110	Belt type crankcase heater, 75 W, 110 V, CE mark, UL	MT/MTZ100-160	Multipack	6
	7773108	Belt type crankcase heater, 75 W, 230 V, CE mark, UL	MT/MTZ100-160	Multipack	6
	7973005	Belt type crankcase heater, 75 W, 230 V, CE mark, UL	MT/MTZ100-160	Industry pack	50
	7773118	Belt type crankcase heater, 75 W, 400 V, CE mark, UL	MT/MTZ100-160	Multipack	6
	7773004	Belt type crankcase heater, 75 W, 240 V, UL	MT/MTZ100-160	Multipack	6
	7773014	Belt type crankcase heater, 75 W, 400 V, UL	MT/MTZ100-160	Multipack	6
	7773008	Belt type crankcase heater, 75 W, 460 V, UL	MT/MTZ100-160	Multipack	6
	7773105	Belt type crankcase heater, 75 W, 575 V, UL	MT/MTZ100-160	Multipack	6

Acoustic hoods

Type	Code no.	Description	Application	Packaging	Pack size
	7755001	Acoustic hood for 1 cylinder compressor	MT/MTZ018-040	Single pack	1
	7755002	Acoustic hood for 2 cylinder compressor	MT/MTZ044-081	Single pack	1
	7755003	Acoustic hood for 4 cylinder compressor	MT/MTZ100-160	Single pack	1

ACCESSORIES AND SPAREPARTS

3-phase soft start equipment

Type	Code no.	Description	Application	Packaging	Pack size
SCR01	**7702003**	Soft start kit with statoric resistors, prewired box, SCR01	MT/MTZ044-081	Single pack	1
SCR03	**7705001**	Soft start kit with statoric resistors, prewired box, SCR03	MT/MTZ100-160	Single pack	1
MCI 15 C	**7705006**	Electronic soft start kit, MCI 15C	MT/MTZ018-081	Single pack	1
MCI 25 C	**7705007**	Electronic soft start kit, MCI 25C	MT/MTZ100-160	Single pack	1

Single phase PSC starting kits

Type	Code no.	Description	Application	Packaging	Pack size
PSC	**7701026**	PSC starting kit, 20 µF, 10 µF	MT/MTZ018-028 code 5	Multipack	4
PSC	**7701024**	PSC starting kit, 25 µF, 10 µF	MT/MTZ032-036 code 5	Multipack	4
PSC	**7701025**	PSC starting kit, 15 µF, 10 µF	MT/MTZ018 code 1	Multipack	4
PSC	**7701035**	PSC starting kit, 30 µF, 15 µF	MT/MTZ022 & 044-050 code 1 & 050-5	Multipack	4
PSC	**7701151**	PSC starting kit, 25 µF, 25 µF	MT/MTZ028 code 1	Multipack	4
PSC	**7701152**	PSC starting kit, 25 µF, 20 µF	MT/MTZ032-036 code 1	Multipack	4
PSC	**7701153**	PSC starting kit, 35 µF, 20 µF	MT/MTZ040 code 1	Multipack	4
PSC	**7701036**	PSC starting kit, 30 µF, 20 µF	MT/MTZ056 code 1	Multipack	6
PSC	**7701037**	PSC starting kit, 30 µF, 25 µF	MT/MTZ064 code 1	Multipack	6

Single phase CSR starting kits & starting kits in prewired box

Type	Code no.	Description	Application	Packaging	Pack size
CSR	**7701022**	CSR starting kit, 20 µF, 10 µF, 98 µF	MT/MTZ018-028 code 5	Multipack	4
CSR	**7701030**	CSR starting kit, 25 µF, 10 µF, 98 µF	MT/MTZ032-036 code 5	Multipack	4
CSR	**7701021**	CSR starting kit, 15 µF, 10 µF, 98 µF	MT/MTZ018 code 1	Multipack	4
CSR	**7701038**	CSR starting kit, 15 µF, 30 µF, 98 µF	MT/MTZ022 code 1	Multipack	4
CSR	**7701154**	CSR starting kit, 25 µF, 25 µF, 140 µF	MT/MTZ028 code 1	Multipack	4
CSR	**7701155**	CSR starting kit, 25 µF, 20 µF, 98 µF	MT/MTZ032-036 code 1	Multipack	4
CSR	**7701156**	CSR starting kit, 35 µF, 20 µF, 98 µF	MT/MTZ040 code 1	Multipack	4
CSR	**7701042**	CSR starting kit, 30 µF, 15 µF, 140 µF	MT/MTZ044-051 code 1	Multipack	6
CSR	**7701043**	CSR starting kit, 30 µF, 20 µF, 98 µF + 98 µF	MT/MTZ056 code 1	Multipack	6
CSR	**7701044**	CSR starting kit, 30 µF, 25 µF, 98 µF + 140 µF	MT/MTZ064 code 1	Multipack	6
CSR	**7701028**	CSR starting kit, prewired box, 20 µF, 10 µF, 98 µF	MT/MTZ018-028 code 5	Single pack	1
CSR	**7701054**	CSR starting kit, prewired box, 25 µF, 10 µF, 98 µF	MT/MTZ032-036 code 5	Single pack	1
CSR	**7701147**	CSR starting kit, prewired box, 15 µF, 30 µF, 98 µF	MT/MTZ022 code 1	Single pack	1
CSR	**7701148**	CSR starting kit, prewired box, 25 µF, 25 µF, 140 µF	MT/MTZ028 code 1	Single pack	1
CSR	**7701149**	CSR starting kit, prewired box, 25 µF, 20 µF, 98 µF	MT/MTZ032-036 code 1	Single pack	1
CSR	**7701150**	CSR starting kit, prewired box, 35 µF, 20 µF, 98 µF	MT/MTZ040 code 1	Single pack	1
CSR	**7701049**	CSR starting kit, prewired box, 30 µF, 15 µF, 140 µF	MT/MTZ044-050 code 1	Single pack	1

Kickstart kits

Type	Code no.	Description	Application	Packaging	Pack size
	7701060	Kickstart kit; relay + start capacitor 227 µF	MT/MTZ018 code 1 & 5	Single pack	1
	7701059	Kickstart kit; relay + start capacitor 280 µF	MT/MTZ022-064 code 1 & 5 excl 050-5	Single pack	1

Lubricants

Type	Code no.	Description	Application	Packaging	Pack size
160PZ	**7754019**	POE lubricant, 160PZ, 33.8 oz can	MTZ with R-404A, R-507A, R-134a,	Multipack	12
160PZ	**7754020**	POE lubricant, 160PZ, 67.6 oz can	MTZ with R-404A, R-507A, R-134a,	Multipack	8
160P	**7754001**	Mineral oil, 160P, 67.6 oz can	MT or LT with R-22 or R-502	Multipack	8
160P	**7754002**	Mineral oil, 160P, 169 oz can	MT or LT with R-22 or R-502	Multipack	4
160ABM	**7754009**	Alkylbenzene oil 160ABM, 67.6 oz can	MT or LT with transitional refrigerants	Multipack	8

ORDERING INFORMATION AND PACKAGING

Ordering information

Maneurop® MT & MTZ reciprocating compressors can be ordered from Danfoss Commercial Compressors in either industrial packs (also called multiple packaging) or in single packs (also called individual packaging).

The code numbers ending in "M" in the tables represent compressors in industrial pack. For ordering single units, please replace the last letter "M" by letter "I".

MT compressors in industrial pack (multiple packaging) R-22

Compressor model	Design[1])	Code no.						
		1	3	4	5	6	7	9
		208-230/1/60	200-230/3/60	460/3/60 400/3/50	230/1/50	230/3/50	575/3/60 500/3/50	380/3/60
MT018	S	-	MT18-3M	MT18-4M	MT18-5M	-	-	-
	VE	MT18-1VM	MT18-3VM	MT18-4VM	MT18-5VM	-	-	-
MT022	S	MT22-1M	MT22-3M	MT22-4M	MT22-5M	-	-	-
	VE	MT22-1VM	MT22-3VM	MT22-4VM	MT22-5VM	MT22-6VM	-	MT22-9VM
MT028	S	MT28-1M	MT28-3M	MT28-4M	MT28-5M	MT28-6M	-	-
	VE	MT28-1VM	MT28-3VM	MT28-4VM	MT28-5VM	MT28-6VM	-	MT28-9VM
MT032	S	-	MT32-3M	MT32-4M	MT32-5M	MT32-6M	-	-
	VE	MT32-1VM	MT32-3VM	MT32-4VM	MT32-5VM	MT32-6VM	-	-
MT036	S	-	MT36-3M	MT36-4M	MT36-5M	MT36-6M	-	-
	VE	MT36-1VM	MT36-3VM	MT36-4VM	MT36-5VM	MT36-6VM	-	MT36-9VM
MT040	S	MT40-1M	MT40-3M	MT40-4M	-	MT40-6M	-	-
	VE	MT40-1VM	MT40-3VM	MT40-4VM	-	MT40-6VM	-	-
MT044	S	MT44-1M	MT44-3M	MT44-4M	-	-	-	MT44-9M
	VE	MT44-1VM	MT44-3VM	MT44-4VM	-	MT44-6VM	MT44-7VM	MT44-9VM
MT045	S	-	-	MT45-4M	-	-	-	-
	VE	-	MT45-3VM	MT45-4VM	-	-	-	-
MT050	S	-	MT50-3M	MT50-4M	-	-	-	MT50-9M
	VE	MT50-1VM	MT50-3VM	MT50-4VM	MT50-5VM	MT50-6VM	MT50-7VM	MT50-9VM
MT051	S	-	MT51-3M	MT51-4M	-	-	-	-
	VE	-	MT51-3VM	MT51-4VM	-	-	-	-
MT056	S	-	MT56-3M	MT56-4M	-	-	MT56-7M	MT56-9M
	VE	MT56-1VM	MT56-3VM	MT56-4VM	-	MT56-6VM	MT56-7VM	MT56-9VM
MT057	S	-	-	MT57-4M	-	-	-	-
	VE	-	MT57-3VM	MT57-4VM	-	-	-	-
MT064	S	-	MT64-3M	MT64-4M	-	-	-	MT64-9M
	VE	MT64-1VM	MT64-3VM	MT64-4VM	-	MT64-6VM	-	MT64-9VM
MT065	S	-	MT65-3M	MT65-4M	-	-	-	-
	VE	-	MT65-3VM	MT65-4VM	-	-	-	-
MT072	S	-	MT72-3M	MT72-4M	-	-	-	MT72-9M
	VE	-	MT72-3VM	MT72-4VM	-	MT72-6VM	-	MT72-9VM
MT073	S	-	MT73-3M	MT73-4M	-	-	-	-
	VE	-	MT73-3VM	MT73-4VM	-	-	-	-
MT080	S	-	-	MT80-4M	-	-	-	MT80-9M
	VE	-	MT80-3VM	MT80-4VM	-	MT80-6VM	-	MT80-9VM
MT081	S	-	-	MT81-4M	-	-	-	-
	VE	-	MT81-3VM	MT81-4VM	-	-	-	-
MT100	Sv	-	MT100-3M	MT100-4M	-	MT100-6M	MT100-7M	MT100-9M
	VE	-	MT100-3VM	MT100-4VM	-	MT100-6VM	MT100-7VM	MT100-9VM
MT125	Sv	-	MT125-3M	MT125-4M	-	MT125-6M	MT125-7M	-
	VE	-	MT125-3VM	MT125-4VM	-	MT125-6VM	MT125-7VM	-
MT144	Sv	-	MT144-3M	MT144-4M	-	-	-	MT144-9M
	VE	-	MT144-3VM	MT144-4VM	-	MT144-6VM	MT144-7VM	MT144-9VM
MT160	Sv	-	MT160-3M	MT160-4M	-	MT160-6M	-	MT160-9M
	VE	-	MT160-3VM	MT160-4VM	-	MT160-6VM	MT160-7VM	MT160-9VM

[1]) S = Single compressor, no oil sight glass, no oil equalization connection
Sv = Single compressor, brazed oil sight glass, no oil equalization connection
VE = Single compressor, threaded oil sight glass, 3/8" oil equalization connection

ORDERING INFORMATION AND PACKAGING

MTZ compressors in industrial pack (multiple packaging)

R-404A / R-507A / R-134a / R-407C

Compressor model	Design[1])	Code no.						
		1	3	4	5	6	7	9
		208-230/1/60	200-230/3/60	460/3/60 400/3/50	230/1/50	230/3/50	575/3/60 500/3/50	380/3/60
MTZ018	S	MTZ18-1M	MTZ18-3M	MTZ18-4M	MTZ18-5M	-	-	-
	VE	MTZ18-1VM	MTZ18-3VM	MTZ18-4VM	MTZ18-5VM	MTZ18-6VM	-	-
MTZ022	S	MTZ22-1M	MTZ22-3M	MTZ22-4M	MTZ22-5M	MTZ22-6M	-	-
	VE	MTZ22-1VM	MTZ22-3VM	MTZ22-4VM	MTZ22-5VM	MTZ22-6VM	-	MTZ22-9VM
MTZ028	S	MTZ28-1M	MTZ28-3M	MTZ28-4M	MTZ28-5M	MTZ28-6M	-	-
	VE	MTZ28-1VM	MTZ28-3VM	MTZ28-4VM	MTZ28-5VM	MTZ28-6VM	-	MTZ28-9VM
MTZ032	S	MTZ32-1M	MTZ32-3M	MTZ32-4M	MTZ32-5M	MTZ32-6M	MTZ32-7M	-
	VE	MTZ32-1VM	MTZ32-3VM	MTZ32-4VM	MTZ32-5VM	MTZ32-6VM	MTZ32-7VM	MTZ32-9VM
MTZ036	S	MTZ36-1M	MTZ36-3M	MTZ36-4M	MTZ36-5M	MTZ36-6M	-	-
	VE	MTZ36-1VM	MTZ36-3VM	MTZ36-4VM	MTZ36-5VM	MTZ36-6VM	MTZ36-7VM	MTZ36-9VM
MTZ040	S	MTZ40-1M	MTZ40-3M	MTZ40-4M	-	MTZ40-6M	-	-
	VE	MTZ40-1VM	MTZ40-3VM	MTZ40-4VM	-	MTZ40-6VM	-	-
MTZ044	S	-	MTZ44-3M	MTZ44-4M	-	-	MTZ44-7M	MTZ44-9M
	VE	MTZ44-1VM	MTZ44-3VM	MTZ44-4VM	-	MTZ44-6VM	MTZ44-7VM	MTZ44-9VM
MTZ045	S	-	-	MTZ45-4M	-	-	-	-
	VE	-	MTZ45-3VM	MTZ45-4VM	-	-	-	-
MTZ050	S	-	MTZ50-3M	MTZ50-4M	-	-	MTZ50-7M	MTZ50-9M
	VE	MTZ50-1VM	MTZ50-3VM	MTZ50-4VM	MTZ50-5VM	MTZ50-6VM	MTZ50-7VM	MTZ50-9VM
MTZ051	S	-	-	MTZ51-4M	-	-	-	-
	VE	-	MTZ51-3VM	MTZ51-4VM	-	-	-	-
MTZ056	S	-	MTZ56-3M	MTZ56-4M	-	-	MTZ56-7M	MTZ56-9M
	VE	MTZ56-1VM	MTZ56-3VM	MTZ56-4VM	-	MTZ56-6VM	MTZ56-7VM	MTZ56-9VM
MTZ057	S	-	-	MTZ57-4M	-	-	-	-
	VE	-	MTZ57-3VM	MTZ57-4VM	-	-	-	-
MTZ064	S	-	MTZ64-3M	MTZ64-4M	-	-	-	MTZ64-9M
	VE	MTZ64-1VM	MTZ64-3VM	MTZ64-4VM	-	MTZ64-6VM	-	MTZ64-9VM
MTZ065	S	-	-	MTZ65-4M	-	-	-	-
	VE	-	MTZ65-3VM	MTZ65-4VM	-	-	-	-
MTZ072	S	-	MTZ72-3M	MTZ72-4M	-	MTZ72-6M	-	MTZ72-9M
	VE	-	MTZ72-3VM	MTZ72-4VM	-	MTZ72-6VM	-	MTZ72-9VM
MTZ073	S	-	-	MTZ73-4M	-	-	-	-
	VE	-	MTZ73-3VM	MTZ73-4VM	-	-	-	-
MTZ080	S	-	-	MTZ80-4M	-	-	-	MTZ80-9M
	VE	-	MTZ80-3VM	MTZ80-4VM	-	MTZ80-6VM	-	MTZ80-9VM
MTZ081	S	-	-	MTZ81-4M	-	-	-	-
	VE	-	MTZ81-3VM	MTZ81-4VM	-	-	-	-
MTZ100	Sv	-	MTZ100-3M	MTZ100-4M	-	MTZ100-6M	MTZ100-7M	MTZ100-9M
	VE	-	MTZ100-3VM	MTZ100-4VM	-	MTZ100-6VM	MTZ100-7VM	MTZ100-9VM
MTZ125	Sv	-	MTZ125-3M	MTZ125-4M	-	MTZ125-6M	MTZ125-7M	MTZ125-9M
	VE	-	MTZ125-3VM	MTZ125-4VM	-	MTZ125-6VM	MTZ125-7VM	MTZ125-9VM
MTZ144	Sv	-	MTZ144-3M	MTZ144-4M	-	MTZ144-6M	MTZ144-7M	MTZ144-9M
	VE	-	MTZ144-3VM	MTZ144-4VM	-	MTZ144-6VM	MTZ144-7VM	MTZ144-9VM
MTZ160	Sv	-	MTZ160-3M	MTZ160-4M	-	MTZ160-6M	-	MTZ160-9M
	VE	-	MTZ160-3VM	MTZ160-4VM	-	MTZ160-6VM	MTZ160-7VM	MTZ160-9VM

[1]) S = Single compressor, no oil sight glass, no oil equalization connection
Sv = Single compressor, brazed oil sight glass, no oil equalization connection
VE = Single compressor, threaded oil sight glass, 3/8" oil equalization connection

Packaging

Model	Single pack		Multipack				Industrial pack			
	Dimensions in	Net weight lb	Nbr	Dimensions in	Gross weight lb	Static stacking	Nbr	Dimensions in	Gross weight lb	Static stacking
1 cylinder										
MT/MTZ018	l: 13.0 w: 11.6 h: 15.2	46	6	l: 39.4 w: 23.6 h: 20.0	313	4	12	l: 47.2 w: 31.5 h: 19.7	615	4
MT/MTZ022		46			313				615	
MT/MTZ028		51			333				650	
MT/MTZ032		53			348				672	
MT/MTZ036		55			362				710	
MT/MTZ040		57			370				725	
2 cylinders										
MT/MTZ044-050	l: 15.6 w: 14.4 h: 17.9	77	6	l: 45.3 w: 31.5 h: 22.0	500	4	6	l: 47.2 w: 31.5 h: 21.7	648	4
MT/MTZ045-051		82			527				675	
MT/MTZ056-064		82			527				675	
MT/MTZ057-065		86			560				734	
MT/MTZ072-080		88			567				754	
MT/MTZ073-081		90			578				765	
4 cylinders										
MT/MTZ100	l: 19.1 w: 15.6 h: 23.6	132	6	l: 47.2 w: 39.4 h: 28.7	877	4	6	l: 47.2 w: 31.5 h: 25.6	855	4
MT/MTZ125		141			912				891	
MT/MTZ144		148			948				926	
MT/MTZ160		152			979				957	

Single pack: One compressor in a cardboard box.
In some publications this packaging may be indicated as 'individual packaging'.

Multipack: A full pallet of compressors, each individually packed in a cardboard box. Mainly available for to wholesalers and Danfoss distribution centers.

Industrial pack: A full pallet of unpacked compressors. Mainly available for to OEM customers.
In some publications this packaging may be indicated as 'Multiple packaging'.

Nbr: Number of compressor in a pack

The Danfoss product range for the refrigeration and air conditioning industry

Danfoss Refrigeration & Air Conditioning is a worldwide manufacturer with a leading position in industrial, commercial and supermarket refrigeration as well as air conditioning and climate solutions.

We focus on our core business of making quality products, components and systems that enhance performance and reduce total life cycle costs – the key to major savings.

Controls for Commercial Refrigeration

Controls for Industrial Refrigeration

Electronic Controls & Sensors

Industrial Automation

Household Compressors

Commercial Compressors

Sub-Assemblies

Thermostats

We are offering a single source for one of the widest ranges of innovative refrigeration and air conditioning components and systems in the world. And, we back technical solutions with business solution to help your company reduce costs, streamline processes and achieve your business goals.

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USCO.PC.004.A3.22 - Replace GA 035 - 03/03 US

Produced by Danfoss USCO-mks - 03/2007

08/29/2012

Hey Dave, I finished the Preventive Maintenance / clean-up of your refrigeration unit control panel last night. Everything seems to be in good condition with the exception of the “A” Condensing Unit Compressor that you are already aware of. I affixed all of the pertinent electrical information that I found online to the inside cover of the new Capacitor Cabinet that I installed. I also printed out the entire Danfoss Maneurop Service Manual that I found online and left that with the unit. I combined all of the previous service records that you had with your documentation and highlighted all the corresponding part numbers that pertain to your particular units; to save time for any future service that may be required.

This was an interesting job – the kind I thrive on! There were many issues with the previous set up which is usually the case with a lot of equipment that suffers chronic failures. The number one issue was improper selection of the Start and Run Capacitors as well as the potential relays or “Hard Start” kits. The capacitor micro-farad ratings and voltage ratings were too low for this equipment. Most service guys like to carry “one size fits all” spare parts on their service trucks which is fine in most cases. The problem here is that the kits they provided were supposed to be good for up to 5 H.P. Compressors maximum. The units you have are actually rated at 5 ½ H.P.! There’s no way they could have known that without the service manual in hand. The other issue was the lack of the Bleed-Down Resistors across the Start Capacitors Terminals. The contacts will actually blow on the potential relays under certain conditions. It won’t happen every time but if the equipment shuts down with the capacitor charged at more than 60% – it can fry the relays contacts. The Potential Relays that were being used did not correspond with the required specifications for your equipment either. I would stick with the original equipment. The MARS Replacements you had on hand did not have high enough “Continuous Coil Voltage Ratings”. They were rated at 300 and some volts whereas the original equipment’s ratings were something like 532 volts. Big difference! Take all of these issues into account and add in a compressor that’s electric coils are breaking down and you’re sure to get just what you got - chronic equipment failures!

I sorted through all of your spare parts and put them back into the cardboard box. Get rid of them! You can’t use them on this equipment.

I left (3) new start capacitors, (4) new run capacitors and (1) potential relay as spares plus the (2)start and (2)run capacitors that I installed. You should get a couple more of the potential relays to have on hand just in case you need them. Try eBay, they're a lot cheaper but make sure they are new. I lost your phone number again so give me a call and I'll let ya know how much the extras are and yes the phone is finally working :) Thanks a lot!

Correct Parts List for your Dual 5 ½ H.P. Refrigeration Compressors:
(2) 220 k-ohm 1-watt resistors for the Run Capacitors
(2) 15 k-ohm 1-watt Resisters for the Start Capacitors
(2) 55 micro-farad capacitors - 440 Volt AC - Run Capacitors
(2) 235 micro-farad capacitors - 330 Volt AC - Start Capacitors
(2) 3ARR3J4A4 Start Relays for taking the start capacitor off line as the compressor comes up to about 3/4 speed.

Bleed Resistors and Potential Relays

A Start Capacitor, when used with a Potential Relay requires a bleed resistor. The drawing shows that the discharge path* of the start capacitor is directly across the normally closed relay's points. If the charge in the capacitor exceeds 60% of its rated voltage, the points will be damaged. That possibility can happen at any time - on compressor shut down

Current relays are normally open so they don't need bleed resistors as a discharging capacitor does not affect the points.

Excerpts from Electrical Handbooks to Ponder

Copeland Electrical Handbook

Tecumseh Service Handbook

Start Capacitor Bleeder Resistors

All standard Copeland start capacitors are supplied with bleed-resistors securely attached and soldered to their terminals.

The use of capacitors without these resistors will result in sticking relay contacts and/or erratic relay operation especially where short cycling is likely to occur. This is due to the start capacitor discharging through the relay contacts as they close, following a very short running cycle. The resistor permits the capacitor charge to bleed down at a much faster rate, preventing arcing and overheating of the relay contacts.

The use of capacitors supplied by Copeland is recommended. In case of an emergency exchange, a 15,000-18,000 ohm, two watt resistor should be soldered across the terminals of each start capacitor. Care should be taken to prevent their shorting to the case or other nearby metallic objects.

If sticking contacts are encountered on any start relay, the first item to check is the start capacitor resistor. If damaged, or not provided, install a new resistor and clean or replace the relay.

A. Start Capacitor Bleeder Resistors

Modern high power factor, low current single phase compressor motors which require start and run capacitors used with potential type relays can create electrical circuits which could cause starting relay damage resulting in compressor failure.

The high voltage stored in the start capacitor could discharge across the contacts of the starting relay thus welding them and preventing the relay from functioning. Capacitor failure and/or start winding failure could result.

To eliminate this, Tecumseh Products Company start capacitors are equipped with bleeder resistors wired across the capacitor terminals. No start capacitor used in conjunction with a potential relay and run capacitor should be installed without such a bleeder resistor.

In an emergency where no bleeder resistor equipped capacitors are available, then a two watt 15,000 ohm resistor can be obtained and soldered across the capacitor terminals.

Hunt Country Vineyards – Chiller Problems Summarized – 09/14/2012 TMB

1. Little documentation on hand. Little service records (no service logs affixed to the equipment) by previous service attempts at remedying the problems with the system.
2. Poor design by the manufacturer G&D Chillers by having the start/run capacitors installed in the same enclosure as the electrical controls. When the capacitors blew they obliterated the electrical drawing affixed to the inside of the enclosure door, making them unreadable. They also wreaked havoc by contaminating the controls located within the enclosure. Piss-Poor setup in my opinion!
3. Improperly installed "pump down" switches (toggles for compressor "A "and "B") locations. They should have been located on the load side of the alternating relay contacts! They were located on the line side instead which prevented the proper operation of the alternating relay as well as its duplexing cycle features.
4. Wrong sizes start and run capacitors.
5. No bleed down resistors across the capacitors! Bleed down resisters are required to prevent damage to the potential relay contacts when the compressor start winding are taken off line during startup of motor. If the start capacitor charge is more than 60% the potential relay contacts are susceptible to damage.
6. Wrong size potential start relays – not sufficiently rated for continuous coil voltage. Marginally sized for the 5 ½ H.P. compressors. Pick up and drop voltages questionable.
7. ETC – Electronic Temperature Switch was NOT programmed properly! This is a two stage thermostat with a remote sensing probe installed in the chiller coolant line to monitor its temperature. The unit is supposed to be programmed properly then LOCKED OUT via and internal switch to prevent tampering. The switch was not activated and the program was inadvertently/erroneously changed by someone. Once that happened – nothing will operate properly on the system. Stage #2 on the ETC should be set at a higher temperature well above that of stage #1 and the differential setting SHOULD NOT overlap! Stage #1 from the ETC HAS TO TERMINATE on the #1 pin on the Alternating Relay for continued proper operation! The placement of the "Pump down Toggle Switches" prevented this from happening.
8. Crank Case Heaters are supposed to be left on for between four to twelve hours prior to firing the compressors. The way this unit is set up and being used DOES NOT allow for this to happen. This is especially important during colder months because it allow the crank case oil to become thicker (less viscous) which in turns makes it harder for the compressor to start. It can be catastrophic to the compressor if the pump down solenoid valve fails in an "open valve" situation. The liquid refrigerant can migrate to the unheated hermetically sealed compressor

which loads it up with the uncompressible liquid and when the unit cycles on – BLOWN COMPERESSOR!

9. Too much refrigerant in the compressor!
10. Should have been an interlocking device/ delay timer added to the stage #2 pump down switch added by Van Ernst Refrigeration (on 10/03/03 according to their service tag) because of the possibility of too large of a voltage drop when both compressors kick on at the same time. This will happen every time the ambient outdoor temperature is higher than the stage #2 set point temperature. i.e. when the units are first turned on in warmer weather. (40-degrees F per my newly programmed settings on the ETC - Electronic Temperature Switch). The voltage drop issue is an inherent problem with rural electrical systems that serve several loads over a large section of land – such as a farm yard.

Things required for a "Fool Proof Operation" :

a. Add separate circuit breaker for the crank case heaters and leave on continuously, 24-7-365.
b. Add time delay relay between the ETC stage #2 and the Alternating Relay Pin #2 to prevent simultaneous startup of both compressors at once.
c. Obtain exact replacement for spare parts – start and run capacitors, potential start relays, bleed down resistors. DONE but should have more on hand just in case!
d. Set ETC Stage #1 to 21 degrees F with a 4 degree differential setting. Set Stage #2 to 40 degree F with a 4 degree differential setting. DONE!
e. Double check refrigerant pressures.
f. Check both High – Low Pressure switches for proper operation. Replace if necessary.
g. Rewire both compressor pump down switches per instructions and leave BOTH on continuously during chiller usage or better yet – REMOVE THEM COMPLETELY after rectifying the above mentioned issues.

END of Summary – 09/14/2012 Tom Brady ----------

FREE
ON US

ON SIZES

W

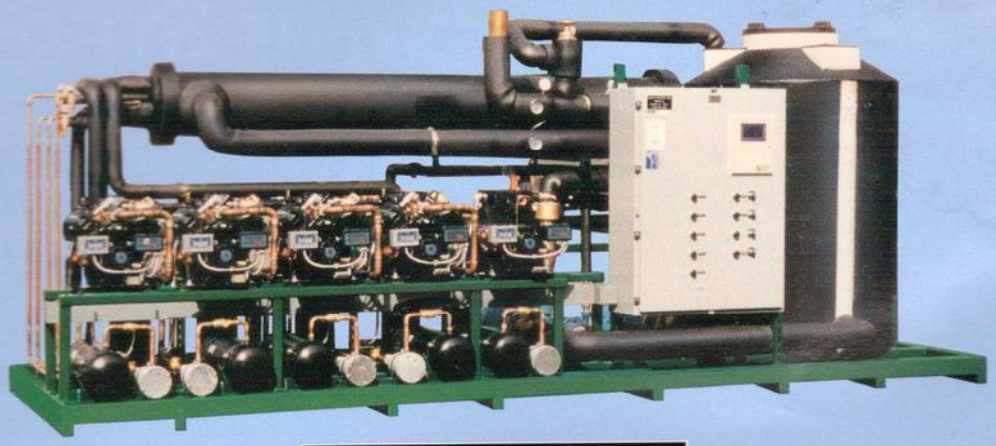
H

(R-22)

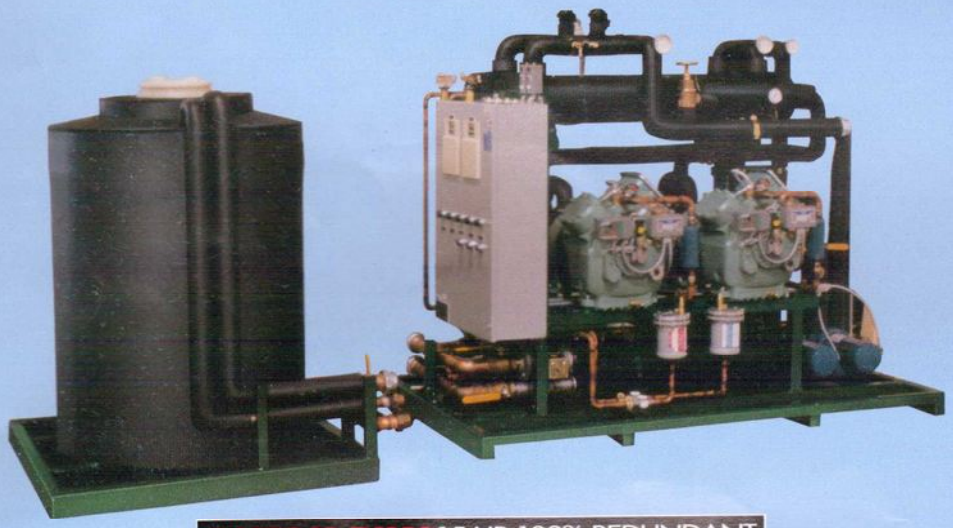
50 F
LEAVING
UID TEMP

14530
19840
34740
45290
58240
63160
86270
113540
127780
138960
172540
227080
255560
277920

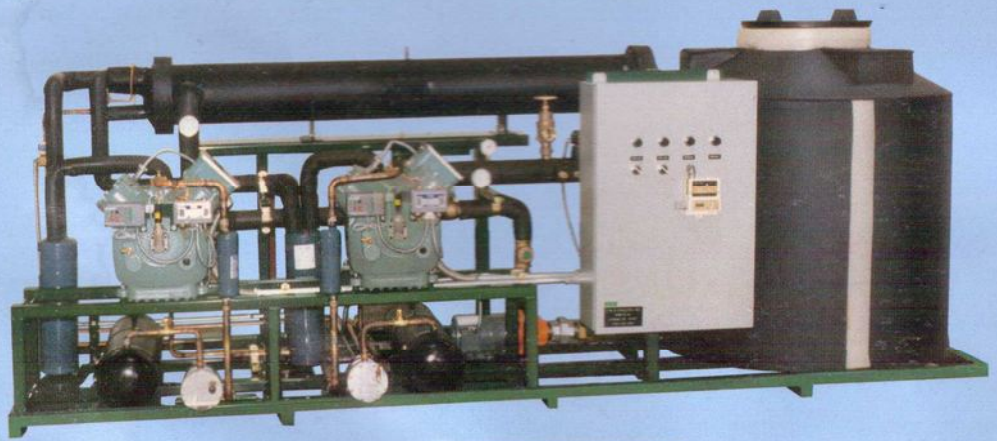
Engineered Today for Tomorrow's Technology



CUSTOM 110 TON 9 STAGE



CUSTOM DUAL 15 HP 100% REDUNDANT



CUSTOM 30 TON 4 STAGE

For nearly a decade, **G&D CHILLERS** has been recognized as innovative fabricators of dependable, extended-service commercial chillers. The variety of satisfied end users range from food processors, wineries and breweries to high technology manufacturers.

With this wealth of experience, the Custom Fabricating Division evolved as a logical next step. With few exceptions, the staff of **G&D CHILLERS can now Custom Fabricate cooling units to meet every need.**

Our engineering department works directly with clients' specifications to fabricate components in whatever capacities and configurations their jobs call for. Working drawings are then passed to production, assuring correct and rapid completion.

Whether your cooling needs are medical, technical or industrial, whether you require permanent or portable chillers, G&D can Custom Fabricate to meet your needs.

In addition to custom chillers, the following items are also available from G&D: control components, ETL listed control panels, and glycol heaters

I E T Y O F I N D U S T R I E S

Plastic Moulding Machines | Fish Hatcheries | Deionized Water

Maneurop® Compress : Troubleshooting Chart

Item	Complaint	Symptoms	Cause	Solution
1	System short of capacity.	Lower than expected suction and discharge pressures	Low refrigerant charge	Check for leaks, repair, and recharge. Check item 5 below
		Higher than expected head pressure	Dirty condenser	Clean. Check item 2 below
			Condenser air short circuiting	Remove obstructions, causes for air short circuiting
		Lower than normal suction pressure	Incorrect superheat - too high	Adjust superheat
2	Head pressure too high	Tripping high pressure switch or compressor trips on internal overload	Dirty condenser	Clean
			Condenser air short circuiting or location too hot	Remove obstructions, causes for air short circuiting
			Defective condenser fan motor or blade	Replace
			Air or non-condensable gases in the system	Purge the system
			Refrigerant over charge	Remove excess refrigerant
3	Head pressure too low	Sight glass with bubbles	Refrigerant leak or system undercharged	Check for leaks, repair and recharge
			Plugged filter drier	Replace filter drier
			Insufficient subcooling	Check condenser subcooling circuit
4	Suction pressure too high		Excessive load on the system	Check load and improve conditions
			TEV stuck open due to ice or defect	Check, repair, or replace TEV
			Incorrect superheat setting of the expansion valve	Adjust superheat
5	Suction pressure too low	Sight glass with bubbles	See item 3	
		Warm suction line, signs of frost on the TEV and low system capacity	Plugged TEV or strainer	Clean TEV and strainer
6	Noisy compressor	Oil level below midpoint of the compressor sight glass during operation	Lack of oil	Avoid compressor short cycling or run compressor enough to return oil to crankcase, correct low load conditions. Add oil.
		Noticeable knock in compressor	Worn or scored bearings	Replace the compressor
		Frosted suction line and compressor shell*	Liquid floodback	Check superheat and TEV operation
7	Compressor doesn't pump		Broken suction valves	Change compressor
			Broken discharge line	Change compressor
			Internal pressure safety valve stuck open	Check item 13 and change compressor if necessary
			Bypass solenoid stuck open	Repair or change solenoid valve
8	Compressor will not start	Blown fuse or open disconnect	Short circuit or other electrical failure	Check electrical circuit and wiring
		Tripped or damaged overload	Overheating or overcurrent	Wait 2-3 hours for o/l to reset and check refrigerant charge or power quality to the compressor
		Open pressure switch	Loss of refrigerant charge	Check for leaks, repair and recharge
		Loose wires	Vibration, bad crimping or under-torque	Check terminals at compressor, contactor and wiring in general
			Motor seized	Check oil level. Restart 3-ph compressor by switching 2 phases, change if it does not restart

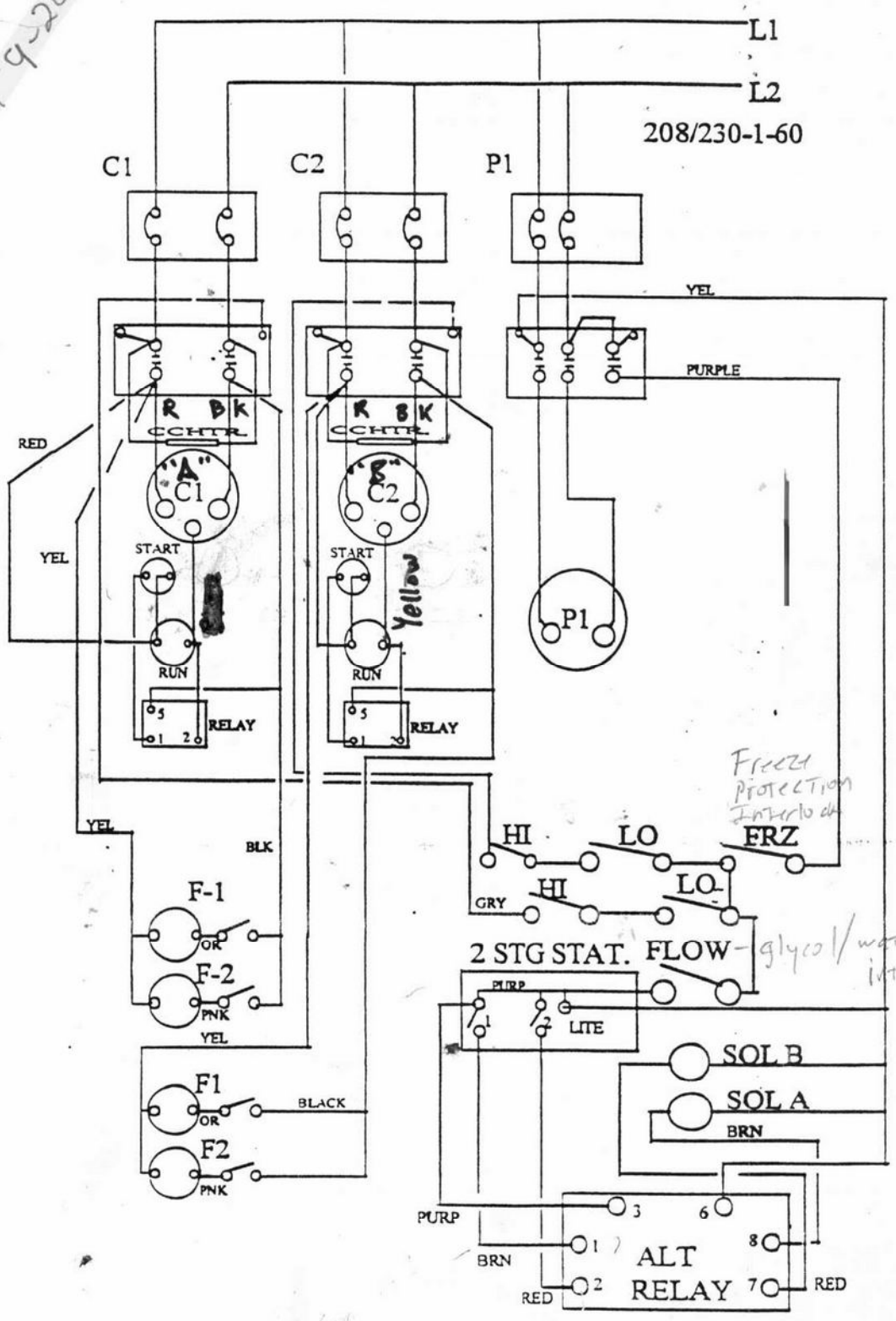
Maneurop® Compressor Troubleshooting Chart

Item	Complaint	Symptoms	Cause	Solution
9	Compressor starts but start relay does not drop out	High running current, overload trips	Incorrect wiring of start components	Check wiring
			Incorrect or defective start relay	Confirm operation, model and make
			Incorrect or defective start capacitor	Confirm integrity and specs, check if fitted with discharge resistance
			Incorrect or defective run capacitor	Confirm integrity and specs
			Low voltage	
10	Compressor runs but cuts out on overload	Internal overload tripping	Excessive head pressure due to dirty condenser or lack of condenser air or water flow	Same as on item 2 above
			Low voltage or unbalanced	Fit undervoltage protection
		MUST WAIT 2-3 HOURS TO CHECK IF IT WILL RESET	Faulty electrical connections causing single phasing or high current surges	Remake the connections
			Sticking start relay on single phase machines leaving start cap on circuit	Replace relay and ensure start cap is fitted with a discharge resistance
11	Compressor starts but cycles on overload	Internal overload tripping	Loss of charge causing insufficient motor cooling	Check for leaks, repair, and recharge
		MUST WAIT 2-3 HOURS TO CHECK IF IT WILL RESET	Voltage is low or unbalanced if 3-ph	1-ph fit undervoltage protection, 3-ph correct imbalance
			Defective or wrong run cap	Check and replace
			Defective overload	Check current and replace compressor if necessary
12	Compressor runs but cycles on...	Overload	See items 10 and 11	See items 10 and 11
		Thermostat	Thermostat differential set too close	Check and widen differential
		High pressure switch	See item 2	See item 2
		Low pressure switch	Leaking liquid line solenoid valve (LLSV)	Replace LLSV
			Leaking compressor valves	Replace compressor
			Undercharged system	Check for leaks and recharge
13	Internal pressure safety valve (IPRV)** opens		Discharge service valve closed	Open discharge service valve
			High pressure switch malfunction	Reset or replace high pressure switch, see item 2
14	Will not start, trips on overload	Start relay damaged or burned out	Too low or too high line voltage	Correct and replace
			Incorrect wiring	Replace and rewire according to compressor manufacturers wiring diagram
			Excessive cycling	Same as item 11
15	Start capacitor damaged or burned out		Incorrect relay	Check with manufacturer and replace
			Too high or too low line voltage	Correct and replace
			Excessive short cycling	Same as item 11 above
			Incorrect wiring	Replace and rewire according to compressor manufacturers wiring diagram
			Wrong start or run cap	Correct and replace

*Suction line and compressor frost can be expected in low temp systems

**IPRV opens at 450 psi Δp/closes at 120 psi Δp

Original System set up from the factory - See Additions Alterations on 9-2013 TMB

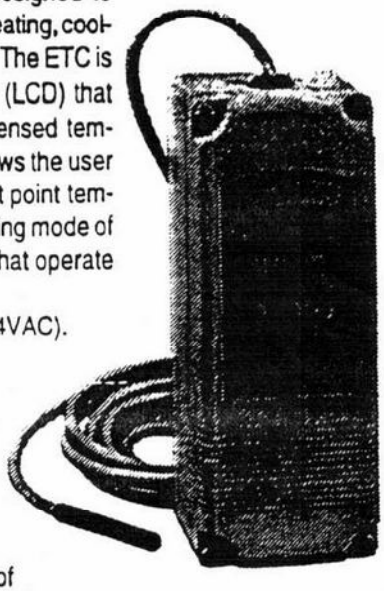


Form No. 7515004-001 Rev. A

ETC TWO STAGE ELECTRONIC TEMPERATURE CONTROL

PRODUCT DESCRIPTION

The Ranco ETC is a microprocessor-based family of electronic temperature controls, designed to provide on/off control for commercial heating, cooling, air conditioning and refrigeration. The ETC is equipped with a liquid crystal display (LCD) that provides a constant readout of the sensed temperature, and a touch keypad that allows the user to easily and accurately select the set point temperature, differential and heating/cooling mode of the operation. Models are available that operate on either line voltage (120/208/240 VAC) or low voltage (24VAC).



APPLICATIONS

With its wide temperature setpoint range and selectable heating or cooling modes, the ETC can be used for a wide variety of applications including multiple compressor control, two stage heating, ventilation control, automatic changeover, condenser fan cycling, space and return air temperature control, water cooled condensers and control with alarm function.

FEATURES

- Wide setpoint temperature range (-30°F to 220°F) and differential adjustment (1°F to 30°F).
- Simple keypad programming of setpoint temperature, differential and cooling/heating modes.
- Two individually programmable stages for heating and/or cooling.
- LCD readout of sensor temperature, control settings, relay status and onboard diagnostics.
- Remote temperature sensing up to 400 feet.
- Two SPDT output relays.
- User-selectable Fahrenheit/Celsius scales.
- Lockout switch to prevent tampering by unauthorized personnel.
- Choice of line voltage and low voltage models available.
- Optional 0 to 10 volt analog output available for remote temperature indication.

SPECIFICATIONS

Input Voltage	120 or 208/240 VAC (24 VAC optional), 50/60 Hz
Temperature Range	-30°F to 220°F
Differential Range	1°F to 30°F
Switch Action	SPDT
Sensor	Thermistor, 2 in. long x 0.25 in. diameter with 8 ft. cable

Relay Electrical Ratings

	120V	208/240V
NO Contact		
Full-load amps	9.8 A	4.9 A
Locked rotor amps	58.8 A	29.4 A
Resistive amps	9.8 A	4.9 A
Horsepower	1/2 hp	1/2 hp
NC Contact		
Full-load amps	5.8 A	2.9 A
Locked rotor amps	34.8 A	17.4 A
Resistive amps	5.8 A	2.9 A
Horsepower	1/4 hp	1/4 hp

Pilot Duty: 125 VA at 120/208/240 VAC

Control Ambient Temperature	
Operating	-20°F to 140°F (-29°C to 60°C)
Storage	-40°F to 176°F (-40°C to 80°C)
Ambient Humidity	0 to 95%, RH, Non-condensing
0 to 10 V Output Impedance	1K
Enclosure	NEMA 1, Plastic
Agency Approvals	UL Listed, File E94419, Guide XAPX CSA Certified, File LR68340, Class 4813-02

ETC ORDERING INFORMATION

Code Number	Input Voltage	No. of Stages	0 - 10 V Output
ETC-211000-000	120/240	2	No
ETC-211100-000	120/240	2	Yes
ETC-212000-000	24	2	No
ETC-212100-000	24	2	Yes

OPERATION

Liquid Crystal Display (LCD)

The LCD display provides a constant readout of the sensor temperature and indicates if either of the two output relays is energized. When the **S1** annunciator is constantly illuminated during operation, the Stage 1 relay is energized. Likewise, when the **S2** annunciator is constantly illuminated during operation, the Stage 2 relay is energized. The display is also used in conjunction with the keypad to allow the user to adjust the setpoint temperatures, differentials and heating/cooling modes for each stage.

Control Setup

The temperature setpoint refers to the temperature at which the normally open (NO) contacts of the output relay will open. Determine the loads to be controlled and the operating modes required for each stage, cooling or heating.

- When the cooling mode is chosen, the differential is above the setpoint. The relay will de-energize as the temperature falls to the setpoint.
- When the heating mode is chosen, the differential is below the setpoint. The relay will de-energize as the temperature rises to the setpoint.

The ETC two stage control can be set up for two stages of heating, two stages of cooling or one stage cooling plus one stage heating. Refer to Figures 1, 2 and 3 for a visual representations of different control setups.

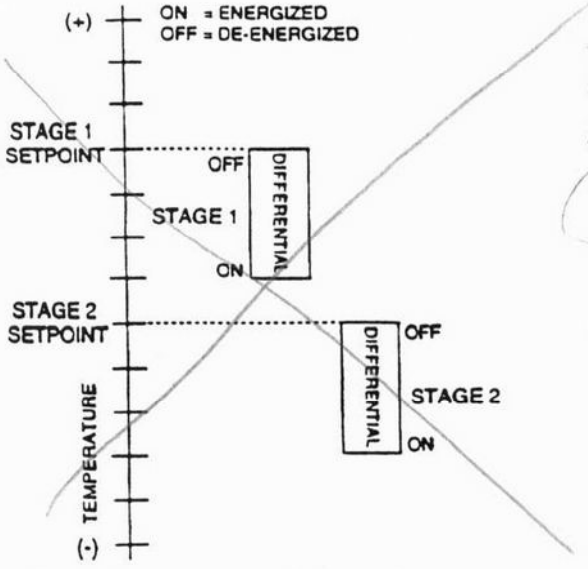


Figure 1: Two Stage Heating Example

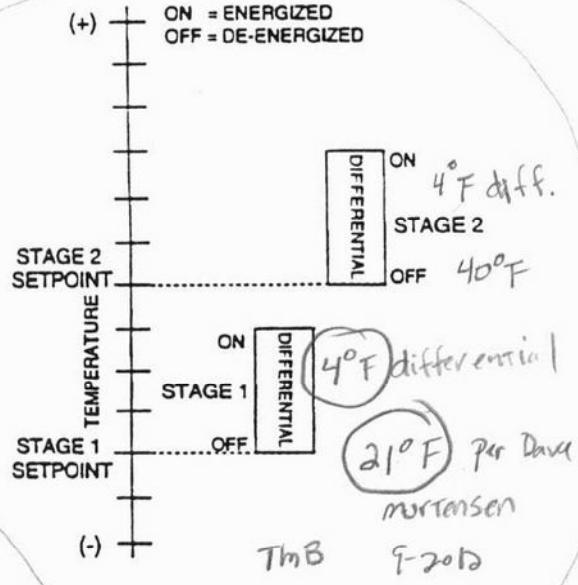


Figure 2: Two Stage Cooling Example

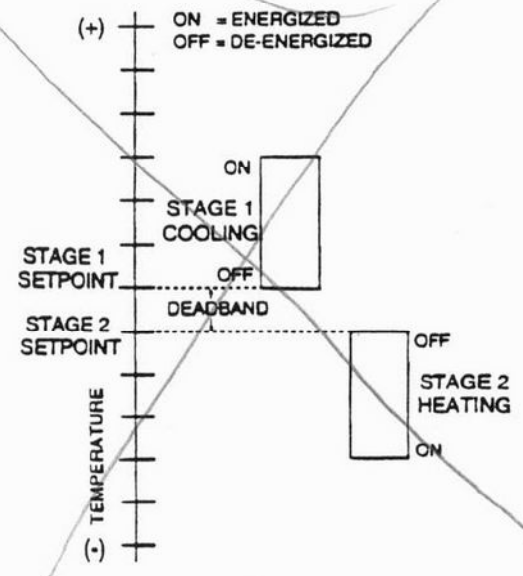


Figure 3: One Stage Cooling and One Stage Heating Example

Programming Steps and Display

The ETC two stage can be programmed in seven simple steps using the LCD display and the three keys on the face of the control.

Step 1- To start programming, press the **SET** key once to access the Fahrenheit/Celsius mode. The display will show the current status, either **F** for degrees Fahrenheit or **C** for degrees Celsius. Then press either the up ↑ or down ↓ arrow key to toggle between the **F** or **C** designation.

Stage 1

Step 2- Press the **SET** key again to access the stage 1 setpoint. The LCD will display the current setpoint and the **S1** annunciator will be blinking on and off to indicate that the control is in the setpoint mode. Then press either the up ↑ key to increase or the down ↓ key to decrease the setpoint to the desired temperature.

Step 3- Press the **SET** key again to access the stage 1 differential. The LCD will display the current differential and the **DIF 1** annunciator will be blinking on and off to indicate that the control is in the differential mode. Then press either the up ↑ key to increase or the down ↓ key to decrease the differential to the desired setting.

Step 4- Press the **SET** key again to access the stage 1 cooling or heating mode. The LCD will display the current mode, either **C1** for cooling or **H1** for heating. Then press either the up ↑ or down ↓ key to toggle between the **C1** or **H1** designation.

Stage 2

Step 5- Press the **SET** key again to access the stage 2 setpoint. The LCD will display the current setpoint and the **S2** annunciator will be blinking on and off to indicate that the control is in the setpoint mode. Then press either the up ↑ key to increase or the down ↓ key to decrease the setpoint to the desired temperature.

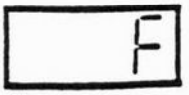
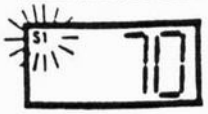
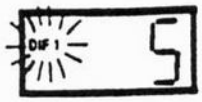
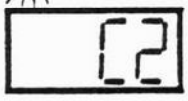
Step 6- Press the **SET** key again to access the stage 2 differe . The LCD will display the current differe and ... **DIF 2** annunciator will be blinking on and off to indic. t the control is in the differential mode. Then press either the up ↑ key to increase or the down ↓ key to decrease the differential to the desired setting.

Step 7- Press the **SET** key again to access the stage 2 cooling or heating mode. The LCD will display the current mode, either **C2** for cooling or **H2** for heating. Then press either the up ↑ or down ↓ key to toggle between the **C2** or **H2** designation. Press the **SET** key once more and programming is complete.

Refer to Page 3 for an illustrated guide to programming the ETC.

NOTE: The ETC will automatically end programming if no keys are depressed for a period of thirty seconds. Any settings that have been input to the control will be accepted at that point.

All control settings are retained in non-volatile memory if power to ETC is interrupted for any reason. Re-programming is not necessary after power outages or disconnects unless different control settings are required.

Step	Annunciator	Description	Display
	F or C	Fahrenheit or Celsius Scale	
2	S1 (blinking)	Stage 1 Setpoint Temperature	
3	DIF 1 (blinking)	Stage 1 Differential Temperature	
4	C1/H1	Stage 1 Cooling or Heating Mode	
5	S2 (blinking)	Stage 2 Setpoint Temperature	
6	DIF 2 (blinking)	Stage 2 Differential Temperature	
7	C2/H2	Stage 2 Cooling or Heating Mode	

TROUBLESHOOTING ERROR MESSAGES

Display Messages

E1- Appears when either the up ↑ or down ↓ key is pressed when not in the programming mode.
To correct: If the **E1** message appears even when no keys are being pressed, replace the control.

E2- Appears if the control settings are not properly stored in memory.
To correct: Check all settings and correct if necessary.

EP- Appears when the probe is open, shorted or sensing a temperature that is out of range.
To correct: Check to see if the sensed temperature is out of range. If not, check for probe damage by comparing it to a known ambient temperature between -30°F and 220°F. Replace the probe if necessary.

EE- Appears if the EEPROM data has been corrupted.
To correct: This condition cannot be field repaired. Replace the control.

CL- Appears if calibration mode has been entered.
To correct: Remove power to the control for at least five seconds. Reapply power. If the **CL** message still appears, replace the control.

Lockout Switch

The ETC is provided with a lockout switch to prevent tampering by unauthorized personnel. When placed in the **LOCK** position, the keypad is disabled and no changes to the settings can be made. When placed in the **UNLOCK** position, the keypad will function normally.

To access the lockout switch, disconnect the power supply and open the control. The switch is located on the inside cover about 2 inches above the bottom. (see Figure 4). To disable the keypad, slide the switch to the left **LOCK** position. To enable the keypad, slide the switch to the right **UNLOCK** position. All ETC controls are shipped with this switch in the **UNLOCK** position.

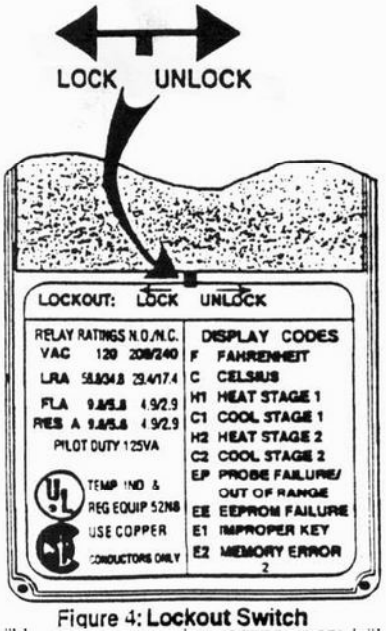


Figure 4: **Lockout Switch**

INSTALLATION INSTRUCTIONS

IMPORTANT

1. All ETC series controls are designed as operating controls only. If an operating control failure could result in personal injury or loss of property, a separate safety control and/or alarm should be installed.

2. The schematic drawings and other information included in these installation instructions are for the purpose of illustration and general reference only.

3. These instructions do not expand, reduce, modify or alter the Ranco Terms in any way; and no warranty or remedy in favor of the customer or any other person arises out of these instructions.

4. Ranco ETC controls have been approved by Underwriters' Laboratories as UL Listed; however, approval does not extend to their use for any other purpose. Ranco assumes no responsibility for any unconventional application of its control unless such application has been approved in writing by Ranco.

5. It is the responsibility of the installer and the user to assure that his or its application and use of all Ranco products are in compliance with all federal, state and local requirements, including, without any limitation, all requirements imposed under the National Electric Code and any applicable building codes.

PROPYLENE GLYCOL CHART

Percent by volume	Percent by weight	Freezing point, °F	Boiling point, °F	Specific Gravity 60/60° F	Specific Gravity 40/60° F	Refractive Index n_D 77 °F	Degrees Brix[b]
20	20.6	20	214	1.021	1.026	1.3550	14.75
21	21.6	19		1.022	1.027	1.3561	15.50
22	22.6	18		1.023	1.028	1.3572	16.00
23	23.6	17		1.024	1.029	1.3583	16.75
24	24.5	16	215	1.025	1.031	1.3594	17.50
25	25.5	15		1.026	1.032	1.3605	18.25
26	26.5	14		1.027	1.033	1.3616	18.75
27	27.4	13		1.028	1.034	1.3627	19.50
28	28.4	12		1.029	1.035	1.3638	20.25
29	29.4	11	216	1.029	1.037	1.3649	21.00
30	30.3	9		1.030	1.038	1.3660	21.50
31	31.3	8		1.031	1.039	1.3671	22.25
32	32.3	7		1.032	1.040	1.3682	22.75
33	33.3	5		1.033	1.041	1.3693	23.50
34	34.3	4	217	1.034	1.042	1.3703	24.00
35	35.3	2		1.035	1.044	1.3714	24.75
36	36.2	1		1.036	1.045	1.3725	25.50
37	37.2	-1		1.037	1.046	1.3736	26.00
38	38.2	-3	218	1.038	1.047	1.3747	26.50
39	39.2	-4		1.039	1.048	1.3758	27.25
40	40.2	-6		1.040	1.049	1.3768	27.75
41	41.2	-8	219	1.040	1.050	1.3779	28.25
42	42.2	-10		1.041	1.050	1.3790	29.00
43	43.2	-12		1.042	1.051	1.3800	29.50
44	44.1	-14	220	1.043	1.052	1.3811	30.25
45	45.1	-16		1.044	1.053	1.3821	30.75
46	46.1	-18		1.045	1.054	1.3832	31.25

For most applications, G&D Chillers recommends no less than or no more than 35% propylene mixture.

ASSIGNMENT OF WARRANTIES

G&D Chillers assigns to the user any warranties which are made by manufactures and suppliers of components of the system and which are assignable but seller makes no representations as to the effectiveness or extent of such warranties and assumes no responsibility for any matters which may be warranted by such manufacturers or suppliers.

OBTAINING PERFORMANCE UNER THESE WARRANTIES

Within a reasonable time (but in no case to exceed 30 days) after discovery of a defect, the user should communicate with the person from whom the system was purchased, or, at the user's option with G&D Chillers, Inc. directly. Subject to the policy set forth in the section immediately following, G&D Chillers, Inc. will repair or replace (at its option), without charge for material, subsequent to its inspection and F.O.B. its plant, any portion of materials warranted hereunder which does not conform to the characteristics of these warranties. If replacement parts or components of the part or portion claimed to be defective, the replacement part or portion shall be invoiced in the full current price amount and shipped freight collect. Credit will be allowed only after G&D Chillers' inspection discloses the claimed defect and shows no signs of treatment or use which would void coverage of these warranties.

ITEMS NOT COVERED BY WARRANTIES

This warranty does not cover damage or defect caused by misuse, improper application, wrong or inadequate electrical current or voltage or freeze damage, water and drain services, negligence, accident in transit, tempering or alterations, changed location or operating use, installation contrary to G&D Chiller's or component manufactures' recommendations, or in any event if the G&D Chillers serial number tag has been altered, defaced, or removed.

This warranty does not cover shipping costs, installation costs, maintenance and service items, including but not limited leaning, lubrication, calibration and adjustment, and further, does not include labor, loss or replacement of refrigerant, driers or transportation charges incidental to the replacement of the system or compressor or any part thereof or charges to remove the same from any premises of the user. Repair or replacement of a defective part, or the crediting to the user of the value thereof, does not extend the original warranty period.

LIMITATIONS

This warranty is in lieu of and excludes all other warranties, express or implied, including merchantability and fitness for a particular purpose.

The liabilities of G&D Chillers, Inc. are limited solely and exclusively to repair or replacement as set forth herein alone and does not include any liability for any incidental, consequential or special damages of any kind direct or indirect, including without limitation lost profits, business of contract, negligence or tort, and user by accepting the

equipment waives, for itself and its successors and assigns, (a) any and all claims for punitive damages and (b) all claims of negligence or strict liability or both.

MISCELLANEOUS

G&D Chillers will require evidence of date of shipment at the time any remedy under this warranty is sought. Accordingly, if the attached user start-up information has not been detached and forwarded to G&D Chillers, Inc. it is recommended that the use do so within 30 days of shipment, as one means of submitting as to the date of shipment.

WARRANTED EQUIPMENT Chiller

(PURCHASER) USER Hunt County Vineyards

MODEL NUMBER GD 5x5

SERIAL NUMBER 030620-1

DATE OF SHIPMENT August 2003

WARRANTY STATEMENT

These warranties are given only to purchasers who buy for commercial or individual use in the ordinary course of each purchaser's business.

GENERAL

We offer with our products the following one year warranty against defects in material and workmanship. Please read your warranty statement carefully. This statement sets forth our responsibilities in the unlikely event of defect and tells you how to obtain performance under the warranty.

G&D CHILLERS, INC. WARRANTIES

ONE YEAR WARRANTY
AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP

The G&D Chillers, Inc. product identified below is warranted to be free of defects in material and workmanship for a period of one year from the start-up date, provided the start-up occurs within 3 months of the shipping date set forth below or from the bill of lading or actual shipping date (whichever is earlier) and the unit has been stored in a suitable environment prior to start-up. The start-up date will be determined only from the completed inspection and start-up sheet received with the unit. If any part or portion of the system fails to conform to these warranted characteristics within the warranty period, G&D Chillers will furnish new or (at its option) factory remanufactured material for repair or replacement of that part or portion. G&D Chillers will warranty labor for a period of 90 days from start-up provided that the purchaser and G&D Chillers agree on the labor required prior to performing the work.

WARRANTY EXTENDS TO FIRST PURCHASER FOR USE, NONTRANSFERABLE.

These warranties are extended to the first person, firm, association or corporation for whom the unit identified herein is originally installed for use (The "user"). These warranties are not transferable without prior written permission of G&D chillers, Inc.

YOUR NEW G&D CHILLER...

will give you years of service with very little maintenance. Our product is, in our opinion, the finest available. We are pleased that you have chosen a G&D Chiller.

In this owner's manual you will find:

We are available to answer any questions you may have regarding your chiller. Call 800-555-0973 or 541-345-3903

Specification
G&D Chillers, Inc.

PACKAGE AIR COOLED WATER + Glycol CHILLER SPECIFICATIONS STANDARD UNITS

The chiller system is assembled on a welded tubular steel frame as a single package. Steel frame is completely fabricated with all welding and drilling functions complete, frame is then sandblasted and powder coated with coating baked on at 450 degrees F for a minimum of 4 hours. Unit includes an embossed aluminum skin with aluminum louvers for condenser air outlet. Unit is factory charged with refrigerant R-22 and run tested prior to shipment. The entire assembly shall be ETL listed.

CONDENSER – AIR COOLED
Copper tube aluminum fins, condenser coil. Direct drive propeller type with DDP motors with built in overload protection. Design test pressure is 150 PSIG low side, 300 high side.

EVAPORATOR
Shell and tube evaporator. Thermostatic expansion valve. Thermometers for return and leaving water temperatures.

CIRCULATING PUMP
End suction centrifugal pump with lexan impellers. Base mounted. Pump fitted with union, check valve, and supply and return shut off valves for service.

RESEVOIR TANK
Constructed of molded, seamless high-density cross-linked polyethylene. Non-corrosive. Insulated with ½" closed cell black foam insulation.

SUPPLY & RETURN PIPING Glycol/water
Constructed of type L copper. Ball valves provided for field connection of supply and return piping. Discharge pressure gauge for setting discharge pressure.

FLUID DYNAMIC BYPASS
Exclusive design valve allows balancing of discharge pressure. Over pressure design allows circuiting back to tank without damage to system or pump. Type L copper piping.

water/Glycol Loop

COMPRESSOR

Hermetic Maneurop compressor with oil level sight glass and rotalock service valves. Crankcase heater. Dual pressure control.

REFRIGERANT PIPING

Type L copper

Liquid line – filter drier, sigh glass/moisture indicator, solenoid valve and thermal expansion valve with external equalizer.

Suction line – fully insulated and designed for proper return at minimum friction loss.

Discharge line – formed of ACR tubing and reformed radius fittings.

Refrigerant charge – Leak tested and evacuated. Shipped with operating charge of R-22.

CONTROL CENTER

All power starting controls and safety/operating controls are mounted in a fully enclosed and weatherproof steel Nema 4 enclosure.

The following controls are included:

- Compressor contactor and circuit breaker
- Pump contactor and circuit breaker
- Flow switch interlock
- Freeze protection interlock
- Operating thermostat
- Fan cycling both fans.

Manufacturer:
G&D Chillers, Inc.
3498 W 1st St. #1
Eugene, OR 97402
Phone: 1-503-345-3903
Fax: 1-503-345-8835

UNIT INSTALLATION

Air-cooled united must sit outside on level, solid location

Location should be free of grass and other debris that could plug condenser fins.

Minimum 24" clearance from condenser side to any buildings, walls, etc.

Louvered side to be open to free air.

UNIT MAINTAINENCE

Condenser should be cleaned at least every 6 months for proper operation and efficiency. Use a garden hose and spray at an angle down.

Check glycol level and water/glycol ratio. 35 % using glycol refractometer.

Check compressor oil in sight glass at bottom of compressor

Inspect for any oil leaks

Oil fan motors every 12 months.

Inspect control panel contacts on compressor contactor. Replace as necessary.

Justin

START UP INSTRUCTIONS

In order to insure performance and longevity, we suggest this unit be started and final adjustments made on site by a qualified refrigeration technician. Prior to startup you may call G&D Chillers at 1-800-555-0973 for instruction. Deviation from these instructions will void any warranty.

Please complete the following and return a copy to G&D Chillers to activate warranty. Unit warranty will be established from this startup date notification. If not received within 10 days from startup, the warranty period will start from shipment and will only cover parts.

Job name: HUNT COUNTY VINEYARDS

Customer: ART HUNT

Address: 4021 ITALY HILL RD

BRANCHPORT NY 14418

Phone: 315-595-2812

FAX: 315-595-2835

Service company: VAN ERNST REFRIGERATION

Service technician: JERRY ERNST

Unit Model No: GD5x5 Unit serial No: 030620-1

Unit voltage: 1|60|208-230

Page 2 – Start up instructions 10/3/03 START-UP

UNIT ELECTRICAL CHECK;

Service voltage to the unit – check one: __208 ✓230 __460

{phase – check one: ✓single __ three

does unit voltage & phase match unit tag ✓yes ___no

OPERATIONAL CHECK

Note: All refrigerant service valves are factory closed.

The freeze stat is set at 100F and is in the tripped position.

Tighten all electrical connections ✓yes FOUND METAL CHIPS IN CONTACTORS FROM SELF TAP SCREWS

Turn on compressor breaker ONLY to energize crankcase heaters.

Heaters should be on no less than 4 hours before opening service valves.

Heaters on minimum of four hours. ✓yes

GLYCOL MIXTURE CHECK;

Refer to chart on panel door and verify % of glycol needed. Allow for lowest ambient outdoor temperature and operating temperature desired. WE RECOMMEND AT LEAST 35%

Verify use of inhibited propylene glycol: ✓yes

Specify method used for measurement:

____Hydrometer _____specific gravity _____bricks

_____Measurement 42 %ratio method _____% mixed

Fill resevoir to 1/3 to ½ full with glycol/water mixture.

Turn on pump – verify rotation on three phase pumps. ✓verified Single Phase

Record pump running amps below 7.8 yes

With pump running and glycol supply & return valves closed, record pressure gauge reading 20 psi

Open refrigerant service valves

Set freeze stat to 10F and press manual reset. ✓yes 10 F setting

Set temperature setting to desired set point ___yes ____F setting

Note: Stat differential is factory set at 5 degrees – DO NOT CHANGE.

Compressor should energize. Fan pressure controls are factory set at:

#1 on at 230#

#2 on at 275

Note: When condenser fans cycle, momentary flashing in sight glass is normal.

RECORD THE FOLLOWING DURING OPERATIONAL CHECK:

	Comp A			Comp B		
Measured voltage:	L1 233	L2 233	L3 233	L2	233	
Compressor running amps	L1 23	L2 23	L3 24	L2	24	
Condenser fan running amps:	Fan 1 = .9	2 = .9	Fan 1 = .9	2 = .9		
Pump running amps	L1 7.9	L2	L3			

TROUBLE SHOOTING GUIDE

SYMPTON	CHECK	ACTION
Pump does not run	1. Check power	Reset pump breaker Reset overload
Pump runs but Compressor will not run	1. Check temperature Setting. 2. Check freeze stat setting. 3. Check green reset on pressure control 4. Check flow switch	1. Lower temperature control 2. Reset manual lockout 3. Clean condenser and verify condenser fan operation. 4. Verify glycol level
Low pressure reading On pressure gauge	1. Pump rotation on 3ph 2. Air lock in piping 3. Adjustment of bypass valve	1. Switch pump leads at breaker 2. Bleed air from high points of system. 3. Turn bypass valve adjustment nut clockwise to increase pressure opposite to decrease.