



SIGMA COLD STORE REFRIGERATION UNIT

A8800-01

TECHNICAL MANUAL



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A. INTRODUCTION

General Description



GENERAL DESCRIPTION

SIGMA COLD STORE REFRIGERATION UNIT

A8800-01

The Sigma Cold Store Refrigeration Unit is a forced air cooling system utilising positive displacement vapour compression of R404A refrigerant fluid to affect heat transfer between the refrigerated space and the ambient air.

This dual purpose versatile unit is suitable for freezing applications or for maintaining a positive temperature in the cold store.

The unit is of monobloc construction with the evaporator module being fastened to the rear of the condensing unit, an insulated divider forming a barrier between the refrigerated space and the outside of the cold store. This method of construction means that, with the exception of interfaces with the lights etc. of the cold room, the unit is entirely self contained and is usually shipped as a tested, charged system that is ready to run.

A single phase 13A socket and Lead light is supplied for maintenance on units.



B. EC DECLARATION OF INCORPORATION

EC Declaration of Incorporation

PED Assessment Form



Tel: 01473 890522

Hubbard Products Ltd hereby declares that the products listed below are intended to be incorporated into a refrigeration system and should not be put into operation until the system has been declared as being in conformity with the requirements of the relevant EC Directives.

This declaration is based on the design and construction of the equipment in the form brought onto the market by Hubbard Products Ltd. Any alterations made to the machinery without prior consultation with Hubbard Products Ltd render this declaration invalid.

Machinery Directive (2006/42/EC)
LV Directive (73/23/EEC in the version of (93/68/EEC)
Pressure Equipment Directive (97/23/EEC)

Notified Body:
Zurich Engineering,
126 Hagley Road,
Edgbaston,
Birmingham,
B16 9PF

BS EN 378-1:2008	Specification for refrigerating systems and heat pumps. Safety and environmental requirements. Basic requirements, definitions, classification and selection criteria
BS EN 378-2:2008	Specification for refrigerating systems and heat pumps. Safety and environmental requirements. Design, construction, testing, marking and documentation
BS EN ISO 12100-1:2003	Safety of machinery. Basic concepts, general principles for design. Basic terminology, methodology
BS EN ISO 12100-2:2003	Safety of machinery. Basic concepts, general principles for design. Technical principles
	Electromagnetic compatibility. Generic immunity standard. Industrial environment
BS EN 60204-1:2006	Safety of machinery. Electrical equipment of machines. General requirements

Model name	SIGMA MONOBLOCK
Model Part No	A8800-01
Description	Monoblock unit with one off each of ZF33 and ZF09 compressors, with interconnecting pipework, 8.1 litre suction accumulator, 8 litre liquid receiver with PRV set to 27.6 barg. The working refrigerant is R404A
Serial No	

Signature of HPL designated "responsible person"	T. A. Rando
Position of signatory	Director

P2811 Rev 05



C. TECHNICAL DATA AND OPERATING INSTRUCTIONS

Technical Data

Detailed Description

Carel Controls Operator Manual

Sigma technical data

Compressor type	Twin Copeland scroll
Model	ZF33 + ZF09
Refrigerant	R404A
Charge weight	13kg
Standard oil type	ICI Emkerate RL32H
Standard electrical supply	32A TPN+E
Condenser	Integral condenser with 3 phase EC fans
Condenser air flow	3.9m ³ /sec
Condenser noise level	c.50dB(A) tbc
Evaporator	Integral 2-fan evaporator
Evaporator air flow	2.4m ³ /s
Defrost method	Reverse cycle / hot gas
Drain pan defrost method	Electric heater mat
Weight	690kg (charged)

Cooling capacity as follows:

32°C Ambient

Coldroom temperature (°C)	-30	-25	-20	-25	<-10
Gross cooling capacity (kW)	6.2	8.0	10.1	12.7	15.7
Total absorbed current (A)	25.2	25.6	26.1	26.6	27.1
Approx. Power consumption (kW)	8.1	8.2	8.4	8.5	8.7

38°C Ambient

Coldroom temperature (°C)	-30	-25	-20	-25	<-10
Gross cooling capacity (kW)	5.4	7.0	8.9	11.1	13.8
Total absorbed current (A)	26.1	26.6	27.1	27.6	28.2
Approx. Power consumption (kW)	8.4	8.5	8.7	8.8	9.0

Heating capacity as follows:

Ambient temperature (°C)	-10	-5	0	+5	+10	<+15
Gross heating capacity (kW)	5.8	6.8	8.0	9.4	11.0	12.8
Total absorbed current (A)	11.6	11.6	11.7	11.8	12.0	12.1
Approx. Power consumption (kW)	3.7	3.7	3.7	3.8	3.8	3.9

Noise Level

The finite noise level produced will depend on the storage temperature, ambient temperature and the temperature of the stock loaded. The figures quoted are indicative only and may be used only as a guide.

Typical noise level

High ambient temperatures (32 C and above), coldroom loaded with product above storage temperature: 61 db(A) @ 10m

Medium ambient temperature (20 C-30 C), coldroom loaded with product close to storage temperature: 55 db(A) @ 10m

Medium to low ambient temperature (20 C and below), coldroom loaded with product close to storage temperature 45 db(A) @ 10m

Dawson Sigma – Detailed description

The complete system comprises a pair of Copeland scroll compressors connected in parallel, an integral evaporator with high pressure three-phase fans and a condenser fitted with three backward-curved centrifugal fans with three-phase variable speed EC motors. The evaporator may be defrosted using discharge gas in a reverse cycle system and the evaporator drain pan is heated electrically during defrost using a hermetically sealed heater mat.

The Sigma unit is designed to maintain the insulated container between -30°C and +40°C in ambient temperatures up to 38°C. To accomplish this, the Sigma can automatically operate in either cooling mode or heating mode.

The control panel

The control panel houses the primary Carel controller, battery and battery charger for low-voltage container services, mains isolator, distribution, sub-fusing and starter gear. A separate enclosure is fitted below the main control panel containing terminals for the incoming mains supply and for connection of the container services.

The Carel controller provides all control functions associated with the system, these include temperature control, control of the evaporator / stepper valve, control of the EC condenser fans and selection / control of defrost type and scheduling.

The compressor assembly

The compressor skid includes:

A pair of Copeland scroll compressors, one ZF33 compressor and one ZF09 compressor, the compressors are provided with HP and LP pre-set safety switches, ball valves for isolation and an oil balance line.

A liquid receiver is provided, fitted with a single PRV; the receiver is of the twin dip tube type suitable for use with reverse cycle refrigeration systems and is provided with twin sight glasses for checking the refrigerant charge.

A suction accumulator.

A four-way reversing valve connected to provide either cooling or heating for the insulated coldroom container.

The compressor skid also includes pressure transducers, temperature probes and a bi-directional liquid filter.

The evaporator

The evaporator is of the forced-air type and is fitted with two high pressure three-phase fans. Defrost is accomplished by reversing the refrigeration cycle to defrost the coil and activating the electric drain pan heater. The evaporator is controlled using a Carel E2V stepper valve; the pressure and temperature at the evaporator outlet are communicated to the Carel controller, this information is converted into a measured superheat and the valve is opened or closed in order to maintain the superheat at setpoint.

The condenser

The condenser is fitted with three condenser fans, these are three-phase variable speed EC fans; the actual condensing pressure is communicated to the Carel controller, compared against the setpoint and the speed of the condenser fans is controlled according to the error between discharge pressure and its setpoint.

The condenser is also fitted with a mechanical Danfoss expansion valve with a control solenoid valve; this valve is utilised in reverse cycle (when the condenser becomes the evaporator and vice versa).

Container services

Various container services are supplied from the main control panel and inputs from the container are passed to the Carel controller to allow correct control of the refrigeration system. The container services include:

Container lights (supply only, switched inside container)

Door trim heaters (supply only, controlled inside container)

Mains failure alarm (output from control panel to beacon / sounder on container). This alarm can be muted using the switch on the control panel.

Temperature alarm from the data logger to the beacon / alarm on the container.

Trapped person alarm (output through trapped person switch inside the container to beacon / sounder on container). Operation of the trapped person switch will disable the refrigeration system.

Door switch on access door allowing the controller to control the refrigeration according to door opening; operation of the door switch will be detailed under 'modes of operation'

Modes of operation

The system will operate in different ways as follows:

Turning the unit on or off

The main isolator should be closed and the system switch left in the off position for several hours prior to initial starting to allow the compressor oil to be pre-heated. It is desirable that the oil temperature is several degrees above ambient temperature before the compressors are turned on, this to ensure that refrigerant is not dissolved in the lubricating oil. The time taken to the oil to warm will depend on the starting temperature of the oil and the ambient temperature.

The desired temperature may be set (see the appropriate section in the controller instructions), the unit system switch and 12 volt supply switch can be turned on and the mains failure switch can be set to the on position.

The unit is turned off using the system on / off switch; if the unit is required for use within a short period then the main isolator may be left closed in order to allow the crankcase heaters to maintain the oil temperature avoiding the need for pre-heating on subsequent start up.

If the system is to be completely shut down then the mains failure alarm should be muted and the 12 volt supply switch should be set to off.

Operation in heat or cool mode

At normal start up, the following sequence will be observed:

The Carel controller will initialise; evaporator fans will operate. The controller will now compare the evaporator return air temperature with its setpoint as previously set and will operate in one of the following three ways.

If the return air temperature is close to the setpoint then the system will operate in 'dead zone' mode; the evaporator fans will run and the temperature will be monitored but the compressors will not operate.

If the return air temperature is substantially higher than the setpoint then the system will operate in 'refrigeration' mode; the compressors will run and the condenser fans will operate as required.

If the return air temperature is substantially lower than setpoint then the system will operate in 'heating' mode; the reversing valve will operate, the smaller compressor will run, the condenser fans will operate at a fixed speed and the evaporator fans will cycle as heat is pumped into the container.

Door open mode

If the door is opened for 30 seconds or more, the evaporator fans will be turned off and any running compressor will pump down and stop. The system will remain off for the duration of any sustained door opening.

If the door is open for more than 2 hours then a forced defrost will be initiated when the door is reclosed.

Defrost mode

Defrost will be initiated in one of three ways; a forced defrost after door opening as noted above; defrost may occur on a time scheduled basis or a manual defrost may be initiated.

Timed defrosts normally occur every four hours of running time. Manual defrosts may be performed as detailed in the appropriate section of the controller instructions:

Defrost type will depend on the inside and outside temperature the system is operating under; the controller will select the appropriate defrost type. Defrost may be achieved by reversing the operation of the system and using the heat produced to melt any ice on the coils or by shutting the system down for a pre-set time and allowing any ice to clear naturally.

Reverse cycle defrost will generally proceed as follows; the drain pan heaters are operated; the reversing valve operates; the smaller compressor runs and the condenser fans operate at a fixed speed. The evaporator fans will be off. At the end of the defrost cycle the compressor will pump down and stop; the controller will restart the system, compare the evaporator air on temperature with setpoint and resume either dead zone, heat or cool modes as appropriate.

In off-cycle defrost mode the fans will operate but the compressors will remain off.

Defrosts will terminate once the evaporator coil achieves a preset temperature or on a maximum preset time.

Engineering screens

The Carel controller has engineering screens associated; these screens are password protected. Access to the engineering screens is restricted to trained engineers only; the password is issued during training or may alternatively be issued by Dawsonrentals in exceptional circumstances. There are various screens allowing the engineer to view the operation of the system in real time as follows:

Screen 1

The status of compressors 1 & 2 (block = running, bell = alarm, T = timer before restart)

Evaporator fan status

The demand on the EC fans

The status of the reversing and equalisation valves

Suction and discharge pressure along with suction temperature and evaporator superheat

Mode and status of the system

Screen 2

Time in minutes before the next scheduled defrost

Current condenser air on temperature

Current temperature indicated by the defrost termination temperature

Last defrost duration in minutes

Current defrost duration (only if in defrost)

Duration of current door opening (only if door is open)

Screen 3

This screen shows pictorially, the operation of the evaporator and the action / setting of the stepper valve.

Dawson Sigma defrost modes

The Sigma unit will utilise either 'heat mode', 'off cycle' or 'cool mode' defrost according to the ambient and coldroom temperature when defrost is initiated. The information below shows the various defrost modes and the operation of the system in defrost:

Heat mode defrost

A heat mode defrost is initiated when the coldroom temperature is below 5°C

Defrost mode	System status
Mode 1	Cool mode into defrost
Mode 2	Cool mode dead zone into defrost
Mode 3	Heat mode into defrost
Mode 4	Heat mode dead zone into defrost

In heat mode defrost the system operates in the following manner:

Reversing valve is energised
 Condenser fans run at fixed speed (default 40%)
 Small compressor (compressor 2) only runs
 Evaporator fans are off
 Defrost terminates on temperature (default 22°C) or time (default 30 mins)

Off cycle defrost

An off cycle defrost is initiated when the coldroom temperature is above 5°C and the ambient temperature is above 10°C

Defrost mode	System status
Mode 7	Heat mode into defrost
Mode 8	Heat mode dead zone into defrost
Mode 9	Cool mode into defrost
Mode 10	Cool mode dead zone into defrost

In off cycle defrost the system operates in the following manner:

Reversing valve is de-energised
 Condenser fans are off
 No compressor runs
 Evaporator fans run
 Defrost terminates on time (default 15 mins)

Cool mode defrost

An cool mode defrost is initiated when the coldroom temperature is above 5°C and the ambient temperature is below 10°C

Defrost mode	System status
Mode 5	Heat mode into defrost
Mode 6	Heat mode dead zone into defrost
Mode 11	Cool mode into defrost
Mode 12	Cool mode dead zone into defrost

In cool mode defrost the system operates in the following manner:

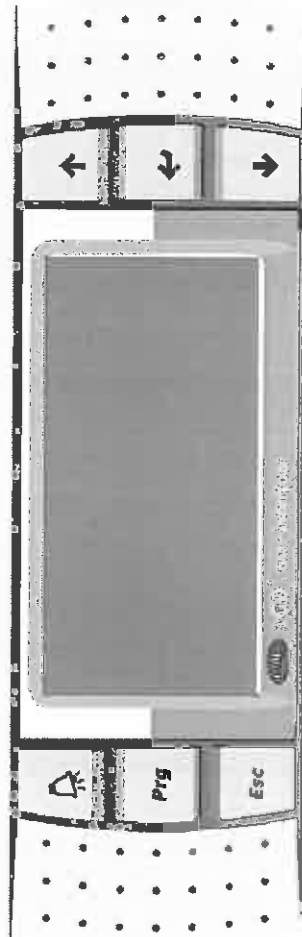
Reversing valve is de-energised
 Condenser fans run according to discharge pressure
 Small compressor (compressor 2) only runs
 Evaporator fans run
 Defrost terminates on time (default 10 mins)

Carel Operator Manual for Dawson's Sigma Unit v2.0

Control Panel Door Indication

12v On	12v dc Supply is operating and functional
Battery Charging	12v dc Battery is being charged
Charging Fault	12v dc Battery Charger is faulty
System Fault	The Carel Control System has a fault - Read Carel Display and press Alarm Key Icon flashing Red
12v Off/On Switch	Turns 12v Off and On, leave in On position
Mains Fail On/Mute Switch	On Mains Failure, switch to mute to silence external Mains Fail Alarm Beacon / Sounder
Lights Off/On Switch	Turns strip light on within control panel
System Off/On	Turns Container on and off for Heating or Cooling
Carel Control System	Control Panel Door and Container Rear Door Mounted Displays to control the container (see below)

- **Alarm Key**, flashes red on any System Alarm, press to view Alarms
- **Program Key**, used to access Menu and Parameter changing
- **Escape Key**, used to escape from Menu or Parameter Data entry
- **Up Key**, used for scrolling through Menu's or Parameter Data Entry
- **Enter Key**, used for confirming selection of Menu or Parameter Data
- **Down Key**, used for scrolling through Menu's or Parameter Data entry



Carel Display Layout

Operator Main Screen																																																							
Time: Date: Unit:01 Temp : -10.5°C Setpoint : -25.0°C Next def: 240m Mode: Cool Mode Status: UnitOn	Time Date Unit Temp Setpoint Next def Mode Status	Current Time Current Date Carel Unit address (pLAN) Current Container Temperature Container Temperature Setpoint Minutes to next Defrost Current Refrigeration Operational Mode Current Container Operational Mode	hh:mm DD/MM/YY 01-32 degC degC mins																																																				
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To execute a Defrost Manually																																																							
Press then and hold for 10secs approx NB : Ensure Main Menu is visible																																																							

To View Alarms		To View Alarm Log	
To View Alarms press 	Scroll through Alarms using  	To View Alarm log press 	Scroll through Alarm Log using  
To Clear Alarms press 	and hold for 5 seconds	Until 	Press ENTER to DATA LOGGER appears on screen then
Clearing of alarms only active if alarms were present and have reset		Press 	Scroll through logs using  
To Exit press  (and repeat)		until Main Menu appears	
To change Container (Box) Temperature Setpoint (password 6161)			
To change Box Setpoint press 	Scroll through Menu using  	(After entering correctly password) Setpoint Screen (B01) with current setpoint displayed	
Choose 	B.Setpoint	To change Box Setpoint press 	 until required SP displayed
Press 	until 6 is displayed	Press 	to confirm setpoint
Press 	until 1 is displayed	Press 	(and repeat) until Main Menu appears
Press 	until 6 is displayed	Press 	
Press 	until 1 is displayed	The Control System (if running) will shutdown on change of setpoint	

Alarm Descriptions	
Compressor 1 Fault	Compressor 1 Alarm (LP or HP or Overload or High Disch or Thermistor)
Compressor 2 Fault	Compressor 2 Alarm (LP or HP or Overload or High Disch)
Door Open Alarm	Door open for longer than System Pumpdown Time on Door Oper
EC Fan Fault	EC Fan Fault on 1 or more of three fans installed
Evaporator Fan 1 Fault	Evaporator Fan 1 Overload Alarm
Evaporator Fan 2 Fault	Evaporator Fan 2 Overload Alarm
Man Trapped Alarm	Man Trapped within unit Alarm (or 12v off)
Minor Alarms Present	Minor Alarms are present, refer to Alarm log
Phase Failure Alarm	PFU has tripped on over / under voltage or phase loss or rotation
Pump Down Time Thresh Reached (PD Fail Alarm)	Pump Down has taken longer than the threshold (Engineering Alarm)
EVD Suction Probe Broken or Disconnected (Probe S1)	Probe S1 Evap Pressure Transducer U/S (5B7)
EVD Suction Probe Broken or Disconnected (Probe S2)	Probe S2 Evap Pressure Transducer U/S (5B8)
Analogue IN 1 Probe Broken or Disconnected	Box Temperature B1 U/S (5B1)
Analogue IN 2 Probe Broken or Disconnected	Discharge / Suction Transducer B2 U/S (5B2)
Analogue IN 3 Probe Broken or Disconnected	Defrost Termination Temperature B3 U/S (5B3)
Analogue IN 4 Probe Broken or Disconnected	Condenser Air On Temperature B4 U/S (5B6)
Analogue IN 6 Probe Broken or Disconnected	Heat Mode Discharge Pressure B6 U/S (5B4)
Key-Switch ON	System has been turned on
Key-Switch OFF	System has been turned off
Unit On By Network (by rotation)	Unit has been switched on by rotation - Dual units only
PLAN Timeout Alarm	Plan communications not established - Dual units only
Connection Timeout (Run/Standby disabled)	Communications not established on Carel pCo5 - Dual units only
Low Superheat (LowSH)	EVD Low Superheat Alarm (Engineering Alarm)
Low Evaporation Temperature (LOP)	EVD Low Evaporation Temperature Alarm (Engineering Alarm)
High Evaporation Temperature (MOP)	EVD High Evaporation Temperature Alarm (Engineering Alarm)
High Condensing Temperature (HiTcond)	EVD High Condensing Temperature Alarm (Engineering Alarm)
EEV Motor Error	EVD Motor / Cable Fault
Low Suction Temperature	EVD Low Suction Temperature (Engineering Alarm)



D. INSTALLATION SAFETY INSTRUCTIONS

IMPORTANT: This document must be read before commencing any work on the cold store unit



INSTALLATION SAFETY INSTRUCTIONS

Introduction

These pages contain important safety information. Please read carefully before commencing any work on the equipment to which the instructions refer.

It is assumed that installation, commissioning, service and maintenance activities will be undertaken only by competent personnel who have been trained for the activity and are familiar with this type of equipment and the handling of refrigerants and their disposal. If in doubt, contact Hubbard Products Limited.

Storage

Equipment should be stored, prior to installation, in warm, dry conditions, free from dust, vibration and extremes of temperature and humidity.

Lifting

No attempt should be made to lift the equipment manually. Provision has been made for the unit to be lifted by forklift or by correctly positioned and secured slings. A test lift, to a height of 2.5 cm is suggested to prove the tackle arrangement. Suitable protective equipment should be used by all personnel involved in the lifting/siting process.

Installation Application

Under no circumstances must the equipment be used for any purpose other than that for which it was specifically designed.

The location should be selected for minimum sun exposure and away from boiler flues or other sources of airborne chemicals that may attack or corrode the various materials used within the unit.

Avoid locations where normal operating noise and air discharge from the unit may be objectionable.

If located in an area accessible to unauthorised persons, steps must be taken to prevent the possibility of vandalism, accidental damage or risk of personal injury.

3.4 CONDENSER AIR RECIRCULATION

Adequate space should be allowed around the Sigma Cold Storage Refrigeration Unit to allow cold ambient air to pass through the condenser to prevent hot air leaving the condenser to return to the cold air inlet.

Minimum distance from condensing unit grill and adjacent vertical surface should be at least one metre.

Condenser air recirculation can cause serious operational difficulties: reduction in refrigeration duty, increase in electrical power consumption and unit trips on refrigerant high pressure switch.

These problems are more evident in hot weather when maximum refrigeration duty is required

CAUTION: DO NOT INSTALL UNITS NEAR HEATERS OR BOILERS

WARNING: BEWARE OF ROTATING FAN BLADES AND UNANNOUNCED STARTING OF FANS

Commissioning

In accordance with BSEN378, check any connected components for the correct refrigerant flow configuration. Ensure that the entire system is leak tight, evacuated and moisture free before charging with the designated refrigerant.

Check that the equipment contains sufficient lubricant for initial run. Check that any additional lubricants nominated by the manufacturer are compatible with the intended use and refrigerant.

Check rotation of fans fitted, ensure that the airflow is in the required direction. Before operating ensure that all shut off valves are positioned at the correct setting for safe running.

Before operating, check all safety pressure switches for operating and setting.

Before operating, ensure that all covers, guards and panels that may have been removed during installation, are correctly replaced and secured.

Servicing and Maintenance

Ultimately the servicing schedule is the responsibility of the end user, however consideration should be given to the following:

Six monthly checks of:

Components. Tightness of all fasteners especially electrical terminals.

Refrigerant gases are subject to the Environmental Protection Act 1990 "Control of Hazardous Substances" and must be treated as such at all times. Lubricants must also be disposed of in a safe and responsible manner. Isolate equipment from the mains electrical supply before carrying out any maintenance work on the equipment. Replace all guards/covers before restarting the equipment.

Substances Hazardous to Health

Under normal operating conditions there should be no substances present that may be hazardous to health.

As already mentioned, consideration must, however, be given to the siting of the unit. COSHH requirements must be adhered to when installing/commissioning/servicing maintaining the system.



E. SERVICE AND MAINTENANCE

MAINTENANCE AND SERVICING

The Sigma Cold Store Refrigeration Unit has been designed to operate continuously provided the unit operating parameters are maintained within the limitations stated in this manual.

It is the responsibility of the equipment owner to arrange regular maintenance for the Sigma Cold Store Refrigeration Unit.

It is recommended the Sigma unit be checked at least twice annually by a qualified refrigeration engineer to ensure the correct operation of the refrigeration circuit components and the ancillary safety devices.

WEEKLY USER MAINTENANCE

1. Check the functionality on the door switches. When doors are opened the refrigeration system should stop functioning and evaporator / condenser fans should come to a standstill.
2. Condenser and evaporator coils. Check the coils surface to ensure that they are free of dirt or debris like leaves, paper and sand. Also remove this type of material from around the coils to prevent future blockages.

WARNING: INCORRECT PROTECTION DEVICE SETTINGS COULD ENDANGER EQUIPMENT AND PERSONNEL SAFETY: HENCE THEY SHOULD NOT BE ALTERED WITHOUT PRIOR CONSENT FROM THE MANUFACTURER

WARNING: 20A mcb AND 13A SOCKET ARE NOT ISOLATED AT CONTROL PANEL. THESE REMAIN LIVE FOR MAINTENANCE PURPOSES

SIX MONTHLY MAINTENANCE

All items under the weekly maintenance schedule and the following:

1. Compressor oil level. After the compressor has been operating on full load for 30 minutes the oil level should be halfway up on the compressor oil sight glass. Oil should not be added unless the compressor has been running for 30 minutes on full load and the level is found to be below the centre mark.
2. Refrigerant charge. Check that there are no bubbles in the liquid line refrigerant sight glass.
3. Check refrigerant sight glass for moisture. If indicator shows the presence of moisture the refrigerant drier core should be replaced.

4. Check the standby battery charge (if fitted).
5. Check functionality of the mains failure visual and audible alarms (if fitted).

WARNING: BEWARE OF ROTATING FAN BLADES AND UNANNOUNCED STARTING OF FANS

CAUTION: DO NOT VAPOR CHARGE R404A. ONLY LIQUID CHARGING THROUGH THE LIQUID LINE CHARGING VALVE IS ACCEPTABLE

ANNUAL MAINTENANCE

All items under the six monthly maintenance schedule and the following:

1. Check refrigeration system suction / discharge pressures and temperatures to ensure they are within the recommended limits.
2. Using an electronic leak detector or soap bubbles check all joints for refrigerant leaks. Pay particular attention to all compression fittings.
3. Colour of compressor oil should be visually inspected through the compressor oil sight glass.
4. Inspect the electrical equipment.

WARNING: SWITCH OFF ALL ELECTRICAL SUPPLY TO THE UNIT BEFORE INSPECTING, ADJUSTING OR REPLACING ANY ELECTRICAL COMPONENT

WARNING: SWITCH COMPRESSOR CRANKCASE HEATER ON AT LEAST ONE HOUR BEFORE STARTING THE UNIT



F. COMPONENT DETAILS

Copeland Scroll Compressor application guidelines

Copeland refrigeration scroll for parallel applications

Henry Pressure Relief Valves

Ramco Reversing Valves

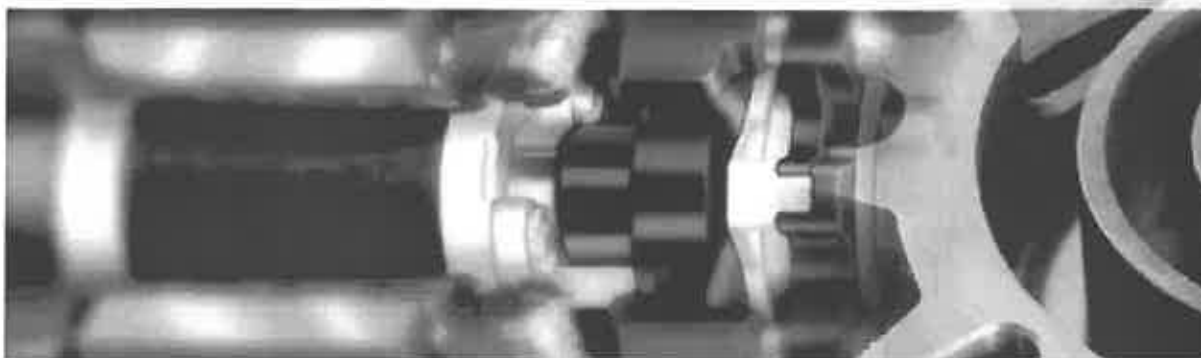
Danfoss Ball Valves

Danfoss Pressure Controls

Carel Electronic Expansion Valves

Carel pCO5 Technical Leaflet

Carel pCO Compact Technical Leaflet



Refrigeration Scroll

ZF09 K4...ZF18 K4

ZS21 K4...ZS45 K4

ZB15 KC...ZB45 KC

Application Guidelines



EMERSON
Climate Technologies

APPLICATION GUIDELINES: COPELAND SCROLL™ COMPRESSORS FOR REFRIGERATION: ZF09K4-ZF18K4, ZS21K4-ZS45K4, ZB15KC-ZB45KC

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1 Introduction

The Copeland Scroll compressor has been under development at Copeland since 1979 and is the most efficient and durable compressor Copeland has ever developed for air conditioning, refrigeration and heat pump applications. It offers very low vibration and sound levels and is tolerant to stresses caused by liquid slugging, flooded starts, and debris commonly found in refrigeration systems.

Available product range in this family is from 2.0 to 6 hp. For detailed information, please, refer to the Copeland Selection Software accessible free of charge from the Copeland Website at www.ecopeland.com or printed product selection catalogues.

These guidelines are not meant to replace the system expertise available from system manufacturers.

2 Safety Instructions

Only qualified personnel should install and repair COPELAND compressors.



- Refrigerant compressors must be employed only for the use they are made for.
- Only approved refrigerant and refrigerating oils must be used.
- Do not start the compressor until it is charged with refrigerant.
- Correctly used, the compressor and the pressure line piping may reach temperatures that may cause burning if touched.



- Wear safety goggles when working on open systems.
- If the refrigerant needs to be removed from the system, do not disperse it in the environment, use the correct equipment & method of removal.
- For storage, use original packaging and avoid collisions and tilting.



- Trained electrical personnel must connect the compressor and its accessories.
- All valid standards for connecting electrical and refrigeration equipment must be observed.
- Limit values for the supply voltage of the unit may not be exceeded.



- It is not allowed to run a test without the compressor being connected to the system and without refrigerant. It is of vital importance that the discharge stop valve has been fully opened before the compressor is started. If the discharge stop valve is closed or partly closed an unacceptable pressure with accordingly high temperatures may develop. When operating with air the so-called diesel effect may occur, i.e. the air sucked in is mixed with oil gas and can explode due to the high temperatures, and thereby destroy the compressor.



3 Nomenclature

The model numbers of Copeland Scroll™ compressors have been designed to include a coded nominal capacity at ARI operating conditions in BTU/h at 60 Hz.

All refrigeration scroll compressors are charged with Ester oil, which is indicated by the letter "E".

4 Model Designation

		<u>Z</u>	<u>S</u>	<u>3</u>	<u>0</u>	<u>K</u>	<u>4</u>	<u>E</u>	-	<u>T</u>	<u>F</u>	<u>D</u>	<u>5</u>	<u>5</u>	<u>1</u>
		1	2	3		4	5			6			7		
1	Z =	Scroll compressor family													
2	S =	High / medium temperature													
	F =	Low temperature													
	B =	High / medium temperature													
3	nominal capacity [BTU/h] @ 60 Hz and ARI conditions using multipliers "K" for 1000 and "M" for 10 000														
4	model variation														
5	POE oil														
6	motor version														
7	bill of material number														

5 Qualified Refrigerants

R404A, R507, R22 and R134a are qualified for all refrigeration scroll compressors.

The ZB compressor family is also qualified for R407C.

It is essential that the glide of R 407C refrigerant blends be given careful consideration when adjusting pressure controls.

The application envelopes for each refrigerant are shown in section 32.



6 Lubrication

The oil level should be maintained at midpoint of the sight glass. If an oil regulator is being used the level should be set within the top half of the sight glass (for parallel operation please refer to guidelines C6.2.5/E).

The compressor is supplied with an initial charge of polyolester (POE) lubricant. In the field the oil level could be topped up with Mobil EAL Arctic 22 CC. The recharge values can be taken from Copeland Selection Software.

They must be operated with these specific oils only. Under no circumstances are ester oils to be mixed with mineral oil and/or alkyl benzene when used with chlorinefree refrigerants.

Ester oil behaves extremely hygroscopically (see Figure 1), and this influences the chemical stability of the oil.

The number of start/stop cycles should be limited to 10 per hour. A high cycling rate will pump oil into the system and may lead to lubrication failure. Oil leaves the compressor at start up regardless of the low oil carry over of the Scroll. The short running time is insufficient to return the oil to the compressor and possibly results in a lack of lubricant.

It must be considered that the entire system will be coated with oil to some extent. Oil viscosity changes with temperature. System gas velocity changes depending on temperature and load. In low load conditions gas velocity may not be high enough to return oil to the compressor. System piping should be designed to return oil under all operating conditions, including part loads.

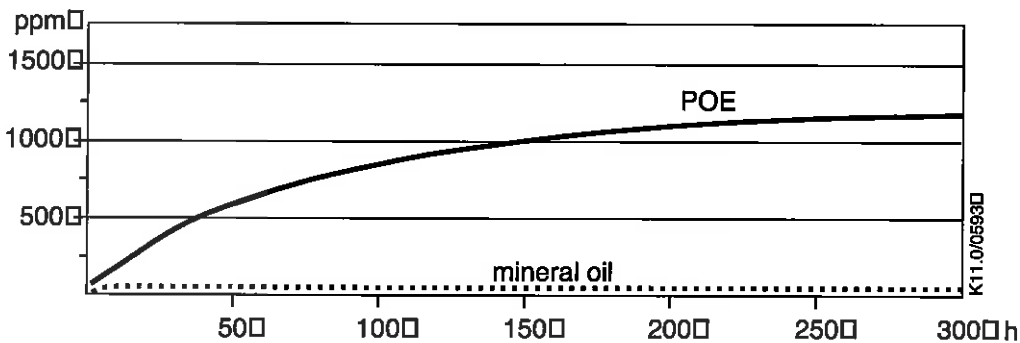


Figure 1 Absorption of moisture in ester oil in comparison to mineral oil (PPM) by weight at 25°C and 50% relative humidity. h = hours

The system should be evacuated down to 0.3 mbar/ 0.22 Torr or lower. If there is uncertainty, as to the moisture content in the system, an oil sample should be taken from various points and tested for moisture. The residual moisture in the installation should be brought below 50 PPM by good evacuation practice and the use of a suitable filter drier with an equilibrium point dryness of 50PPM or less, according to ARI1710-86 or DIN 8948 (please refer to section 26 system evacuation and charging procedure)

Sight glass/moisture indicators currently available can be used with the HFC refrigerants and lubricants; however, the moisture indicator will just show the moisture contents of the refrigerant. The actual moisture level of POE would be higher than the sight glass specifies. This is a result of the high hygroscopicity of the POE oil.

As POE oil is very hygroscopic, it is recommended that the plugs in the compressor line connections be left in place until the compressor is set into position.

7 Refrigerant Injection

For low temperature ZF models, liquid injection is required to keep discharge gas temperatures within safe limits.

The compressor is supplied with a 13/16" UNF diameter injection stub to accept a discharge temperature control (DTC) valve for liquid injection. Inside the compressor, injection takes place in two distinct pockets of the spirals without influencing the suction process. Injection increases the mass flow through the system slightly.

7.1 Liquid Injection Details

Liquid injection is achieved by utilisation of a Discharge Temperature Control Valve (DTC) valve.

The DTC valve eliminates the need for capillary tube, liquid injection solenoid valve and current relay, previously supplied with the ZF compressors (BOM 551)

The same DTC valve can be used for all compressors and approved refrigerants.

The ZF compressors (BOM 556) include a well in the top cap, combined with a valve cap.

The Copeland DTC valve is equipped with a custom bulb profile, which must be installed in the top cap of the compressor, sensing the temperature closest to the discharge port. The bulb/bellows combination injects only when cooling is needed and in the required amounts. The connection to the liquid line is a 3/8" braze.



7.1.1 DTC Valve Specifications

Set Point: $89.4^{\circ}\text{C} \pm 2.4^{\circ}\text{C}$ ($193^{\circ}\text{F} \pm 5^{\circ}\text{F}$)

Liquid Line Connection: 3/8"

7.1.2 Valve Installation

The valve bulb must be installed in the top cap thermal well to adequately control scroll temperatures. The valve should be tightened on the injection fitting to a torque of 24-27 Nm (216-245 in. lbs.) It is recommended the valve is located perpendicular to the compressor orientation however it will function properly in any orientation. The capillary tube connecting the valve to the bulb should be positioned at least 13 mm away from the side of the scroll to avoid contact during operation.

The DTC Valve is supplied with an insulating cap which is applied to the top of the compressor, the valve cap could be replaced with thermal grease. This grease should be applied (minimum of 6 mm thick) to insulate and protect the valve. It is recommended to spread a thin film of thermal grease around the DTC Valve bulb before installing into the top cap well. We also recommend that a shut off valve in the liquid line is installed before the DTC valve, for ease of service.

7.1.3 Compressor or Valve Service

Replacing a ZF compressor using the DTC Valve: We recommend replacing both the DTC Valve and the compressor at the same time. If you wish to use the existing DTC Valve, the valve filter should be cleaned and/or replaced.

Replacing a capillary tube on a ZF compressor: The DTC Valve is not backward compatible on compressors with no thermal well in the top cap.

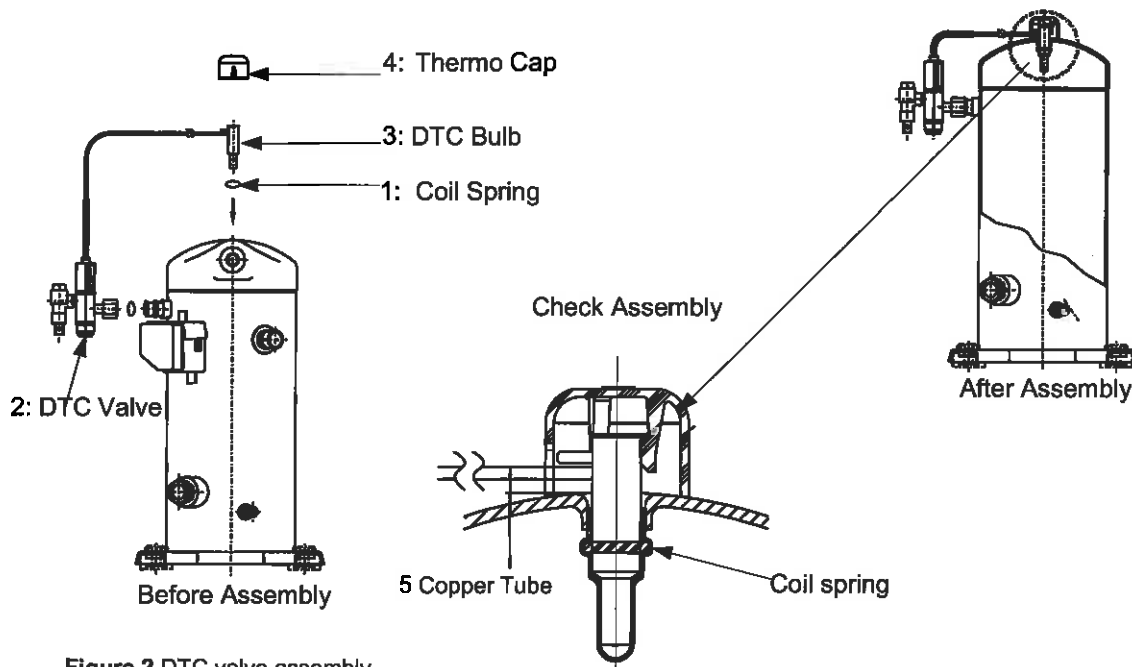


Figure 2 DTC valve assembly

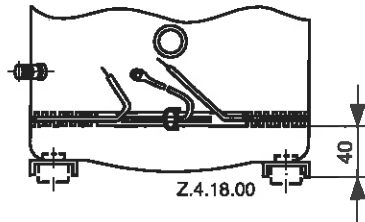
Assembly Procedure

- 1 Verify Coil Spring is seated in the "Groove" located in the well on top of the compressor.
- 2 Thread the Discharge Temperature (DTC) valve onto the injection stub on the side of the compressor.
The Torque setting should be 24-27N/M (216-240 in/Lbs)
- 3 Press the DTC bulb into the well on top of the compressor until the DTC bottoms out in the well.
- 4 Snap the Thermo. cap onto the DTC bulb on top of the compressor
- 5 The copper tube from the DTC bulb should be approximately 0.125mm (1/8") from the top of the compressor



8 Crankcase Heaters

Equipment for heating the oil in the crankcase is necessary if the system configuration enables large amounts of refrigerant to condense in the compressor and be absorbed by the oil. At the high temperature produced by the heater refrigerant is constantly vaporised and problems in oil supply are reduced. For correct mounting location of such a heater, please see Figure 3.



The crankcase heater must be mounted below the oil removal valve located on the bottom shell. The crankcase heater must remain energised during compressor off cycles.

The initial start in the field is a very critical period for any compressor because all load bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions.

Figure 3 Crankcase Heater Location

Due to the Copeland Scroll's inherent ability to handle liquid refrigerant in flooded conditions, no crankcase heater is required when the system charge does not exceed 4.5 kg. If a crankcase heater is fitted, it is recommended the heater must be turned on for a minimum of 12 hours prior to starting the compressor. This will prevent oil dilution and bearing stress on initial start up.

Equipment for heating the oil in the crankcase is necessary if the system configuration enables large amounts of refrigerant to condense in the compressor and be absorbed by the oil. At the high temperature produced by the heater refrigerant is constantly vaporised and problems in oil supply are reduced. For correct mounting location of such a heater please see Figure 3.

9 Pump Down

To control refrigerant migration a pump down system could be used. The discharge check valve with refrigeration scroll compressor is designed for low leak back and will allow the use of a pump down without the addition of an external check valve.

If the compressor is stationary for prolonged periods, refrigerant could migrate into the compressor and therefore a crankcase heater must be installed.

If constant cold air is drawn over the compressor, this could make the crankcase heater ineffective, and therefore a pump down system is recommended.

For ZB models, care should be taken because the scroll sets will unload at a pressure ratio of approximately 10:1. If the unit fails to pump down, the pump down pressure should be reset to a higher value. The low pressure control differential for all models needs to be reviewed since a relatively lower volume of gas will reexpand from the discharge plenum of the compressor into the low side on shut down.

10 Pressure Controls

Both high and low pressure controls are required and the following working pressures are recommended:

- **Low Pressure**
ZF models, the normal minimum setting should be 0.3 bar g (R404A), 0.0 bar g (R22).
ZS and ZB models, the LP cut out should be set as high as possible. The normal minimum is 2.6 bar g.
- **High Pressure Switch**
The maximum high pressure is 28 bar g.

10.1 Internal Pressure Relief Valve

There is an internal pressure relief valve on all 2.0 to 6.0 hp refrigeration scroll compressors, which opens at a differential pressure of 28 bar $\pm$ 3 bar between high and low pressure sides. A high pressure cut-out may be required according to national regulations and is strongly recommended due to the capabilities of pumping to high pressures once the discharge is obstructed. The IPR valve is a safety device, not an HP switch. It is not designed for repeated operation and there is no guarantee it will re-set correctly if it does have repeated operation.



11 Discharge Temperature Protection

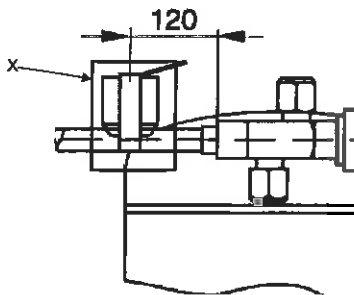


Figure 4 Recommended position of discharge temperature protection

Internal discharge temperatures reached under some extreme operating conditions (such as loss of refrigerant injection charge or extremely high compression ratio) could cause compressor damage.

For this reason Copeland recommends THERMODISC thermostat 37TJ31 X 1976E.

This thermostat has a cutout setting of $99\text{ }^{\circ}\text{C} \pm 4\text{ K}$ with $28 \pm 5\text{ K}$ closing differential and should be installed approximately 120 mm from the discharge valve outlet (see Figure 4).

In order to avoid improper functioning due to false readings this thermostat needs to be insulated (see "X" in Figure 4).

A discharge line thermostat is not required on ZB compressor models. For these models, an internal thermodisc is positioned adjacent to the discharge port. When the thermodisc opens a small gas by pass occurs which trips the motor protector. The internal thermodisc opens at $146^{\circ}\text{C} \pm 4^{\circ}\text{C}$ and closes at $91^{\circ}\text{C} \pm 7^{\circ}\text{C}$.

12 Mufflers

Flow through Copeland Scroll compressors is continuous and has relatively low pulsations. External mufflers, previously applied to piston compressors, may not be required for Copeland Scrolls. Because of variability between systems, however, individual system tests should be performed to verify acceptability of sound performance.

13 Low Ambient cutout

A low ambient cutout is not required to limit heat pump operation.

14 Shut Off

Since the Copeland Scroll compressor is also an excellent gas expander, the compressor may run backwards for a very brief period at shutoff as the internal pressures equalise, and a typical sound is generated. A check valve in the discharge connection of the compressor prevents the compressor from running backwards for more than a second or two. This momentary reversal of direction of the scrolls has no effect on compressor durability and is entirely normal.

15 Starting

During the very brief startup, a short metallic sound is audible, resulting from initial contacting of the spirals and is normal.

No start assist devices are required for singlephase compressors, even if a system utilises nonbleed expansion valves. Due to the design of the Copeland Scroll, the internal compression components always start unloaded even if system pressures are not balanced. In addition, since internal compressor pressures are always balanced at startup, lowvoltage starting characteristics are excellent for Copeland Scroll compressors. Moreover, if low voltage conditions exist at start up, protector trips could result. Start devices are available for single phase models to maximise starting characteristics under abnormal conditions.

16 Deep Vacuum Operation

Do not run a "refrigeration scroll" compressor in a deep vacuum. Failure to heed this advice can result in arcing of the Fusite pins causing permanent damage to the compressor.



17 Brief Power Interruptions

With single-phase refrigeration Copeland Scroll compressors, brief power interruptions of less than 1/2 second may result in powered reverse rotation. This occurs as a result of the highpressure discharge gas expanding backwards through the scrolls at power interruption, causing the scroll to orbit in the reverse direction. When power is reapplied while reverse rotation is occurring, the compressor may continue to run in the reverse direction for several minutes until the compressor's internal protector trips. This has no effect on durability. When the protector resets the compressor will start and run normally.

To avoid the loss of cooling resulting from powered reverse rotation Copeland strongly encourages the use of an electronic control which can sense brief power interruptions and will lock the compressor out of operation for approximately two minutes, or until the compressor has stopped rotating in reverse. This control could be incorporated with the other system controls (such as defrost or thermostat), or be a standalone control. Functional specifications for this control are the following:

Timer opens: 1 electrical cycle (0,02 sec at 50Hz operation) after power is removed and closes: 2 minutes ($\pm 20\%$) (or until the compressor has stopped rotating in reverse) whether power is restored or not.

18 Standard Motor Protection

Conventional inherent internal line break motor protection is provided with models ZF09K4....ZF18, ZS21K4*...ZS45K4, and ZB15KC....ZBS45KC

19 Electrical Installation

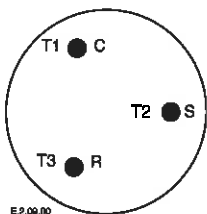
Independently from the internal motor protection, motor protection devices (fuses and circuit breakers) indicated by F6...8 have to be installed before the compressor as shown in figures 5 and 6. Selection of the circuit breakers, fuses have to be carried out according to VDE 0635 or DIN 57635 or IEC 2691 or EN602691.

Motor insulation material class is "B" for models ZF09K4....ZF18, ZS21K4*...ZS45K4, and ZB15KC....ZBS45KC according to VDE 0530 or DIN 57530.

The Fusite connections are marked as in figure 5. Recommended wiring diagrams are shown in figures 6 and 7.

The screw terminals used on this compressor irrespective of applied voltage should be 2.5 to 2.6Nm.

20 SinglePhase Models



Single phase compressors (ZB Only) are connected to the common (C), start (S) and run (R) connections as usual.

Figure 5 Motor terminal connections

21 ThreePhase Models

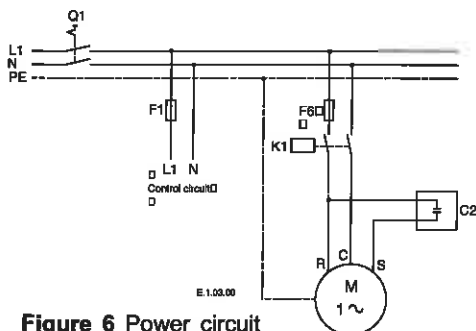


Figure 6 Power circuit single phase

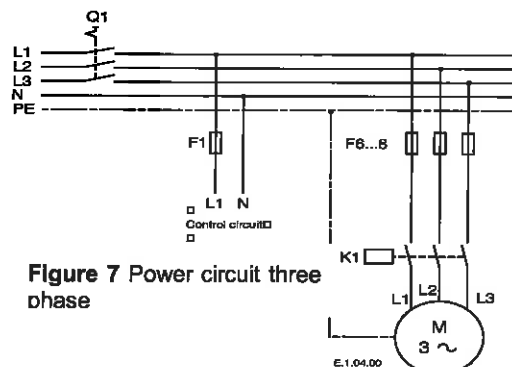


Figure 7 Power circuit three phase

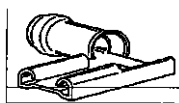
Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Direction of rotation is not an issue with singlephase compressors since they will always start and run in the proper direction. However, three phase compressors will rotate in either direction depending upon phasing of the power to L1, L2 and L3. Since there is a 50/50 chance of connecting power in such a way as to cause rotation in the reverse direction, it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction is achieved when the system is installed and operated.



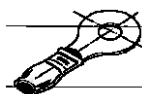
Verification of proper rotation direction is made by observing that suction pressure drops and discharge pressure rises when the compressor is energised. Reverse rotation results in a sound level above that with correct rotation direction, as well as substantially reduced current draw compared to tabulated values and after several minutes of operation the compressor's internal protector will trip.

All three-phase compressors are wired identically internally. As a result, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the same terminals should maintain proper rotation direction.

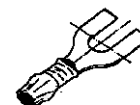
Model	PFJ	TF5	TFC	TFD
ZF09/ZS21/ZB21	-	A	-	A
ZF11/ZS26/ZB26	-	A	-	A
ZF13/ZS30/ZB30	-	B/C	-	B/C
ZF15/ZS38/ZB38	-	B/C	-	B/C
ZF18/ZS45/ZB45	-	B/C	-	B/C
ZB19	A			
ZB21	A			
ZB26	A			



A Flag receptacle



B Ring tongue



C Spade

Figure 8 Cable connectors

22 Cable Connectors

The above table lists recommended types of cable connectors to be used for the various electric terminals of the compressors. "A" and "B" must fit 1/4" or 6.3 mm tab sizes. "C" are to be selected for #10 studs or diameters of 5mm respectively.

Cable sizes are to be selected according to DIN ISO 0100, IEC 364 or national regulations.

23 Compressor Functional Check

No scroll compressor should be started with the suction service valve closed to check how low the compressor will pull suction pressure. This type of test may actually damage a refrigeration Scroll compressor, rather, the following diagnostic procedure should be used to evaluate whether the Scroll compressor is functioning properly.

- Proper voltage to the unit should be verified.
- Normal motor winding continuity and short to ground checks will determine if the inherent overload motor protector has opened or if an internal short to ground has developed. If the protector has opened, the compressor must cool sufficiently to reset.
- With service gauges connected to suction and discharge pressure fittings, turn on the compressor. If the suction pressure falls below normal levels the system is either low on charge or there is a flow blockage in the system.

• Single Phase compressors

If suction pressure does not drop and discharge pressure does not rise to normal levels, either the reversing valve or the compressor is faulty. Use normal diagnostic procedures to check operation of the reversing valve.

• Three Phase Compressor

If suction pressure does not drop and discharge pressure does not rise to normal levels, reverse any two of the compressor power leads and reapply power to make sure compressor was not wired to run in reverse direction. If pressures still do not move to normal values, the compressor is faulty. If the compressor is in a circuit containing a reversing valve, this item may be faulty. Reconnect the compressor leads as originally configured and use normal diagnostic procedures to check operation of the reversing valve. If the reversing valve checks out satisfactorily, then the compressor current draw should be compared to published compressor performance data at the compressor operating conditions (pressures and voltages) and significant deviations (more than $\pm 15\%$) from published values may indicate a faulty compressor.



24 High Potential Testing

Copeland subjects all scroll compressors to a high voltage test after final assembly.

Since high voltage tests lead to premature ageing of the winding insulation we do not recommend additional tests of that nature. They may also be carried out with new machines only.

If it has to be done for any reason disconnect all electronic devices (e.g. motor protection module, fan speed control, etc.) prior to testing. The test voltage of 1000 V plus twice the nominal voltage is applied for 1-4 seconds between motor winding (each one of the phases) and the compressor shell. The maximum leak current limit is approximately 10 mA. Repeated tests have to be performed at lower voltages.

Caution: Do not carry out high voltage or insulation tests if the compressor housing is under vacuum. Copeland Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor can be immersed in refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the scroll is more like semihermetics (which have horizontal motors partially submerged in oil and refrigerant). When Copeland Scroll compressors are high potential tested with liquid refrigerant in the shell they can show higher levels of leakage current than compressors with the motor on top because of the higher electrical conductivity of liquid refrigerant than refrigerant vapour and oil. However, this phenomenon can occur with any compressor when the motor is immersed in refrigerant. The levels of current leakage do not present any safety issue. To lower the current leakage reading the system should be operated for a brief period of time to redistribute the refrigerant to a more normal configuration and the system high potential tested again.

25 Installation

For single operation, four rubber vibration absorber grommets are supplied with each compressor (see fig. 9). They dampen the startup surge of the compressor and prevent sounds and vibrations from being transmitted to the compressor base during operation to a large extent. The metal sleeve inside is intended as a guide to hold the grommet in place. It is not designed as a loadbearing member, and excessive torquing can crush the sleeve. Its inner diameter is approximately 8.5 mm to fit e.g. an M8 screw. The mounting torque should be 13 ± 1 Nm. It is critically important that the grommet is not compressed. A clearance space of approximately 2mm between the bottom of the washer and the top of the grommet spacer is recommended. For multiple or parallel operation please refer to guidelines C6.2.5/E.

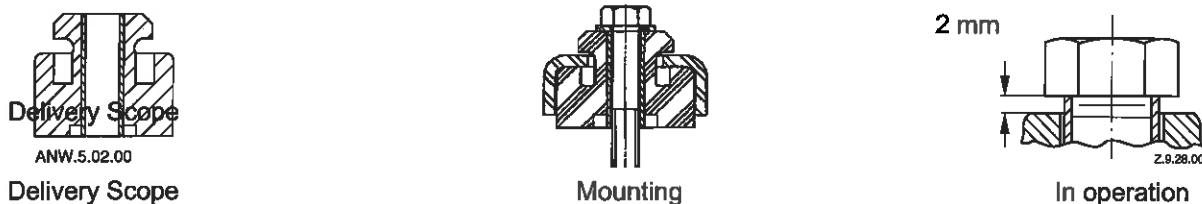


Figure 9 Mounting parts for single operation



26 Shut off Valves and Adapters

The refrigeration scroll compressors are delivered with threads for Rotalock shut off valves. Brazed pipework can also fit compressors with Rotalock connections using adapters "A" and "B" in either straight or angled "C".

It is strongly recommended to periodically re-torque all fixing connections to the original setting after the system has been put into operation. (See Fig 10 and spare parts list ZF/ZS and ZB)

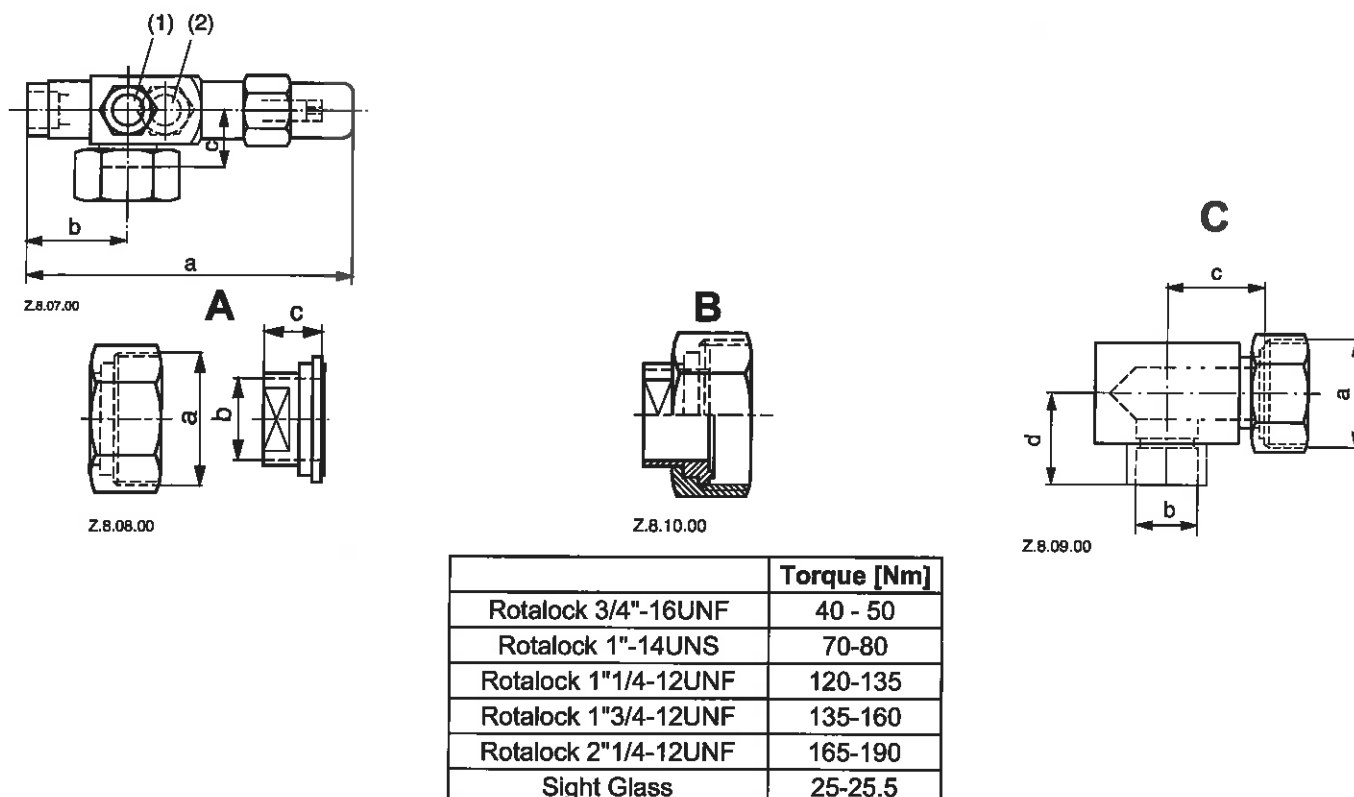


Figure 10 Shut off valves and adaptors

27 Shell Temperature

Under rare circumstances caused by failure of system components such as the condenser or evaporator fan, or loss of charge, and depending on the type of expansion control, the top shell and discharge line can briefly but repeatedly reach temperatures above 177°C as the compressor cycles on its internal protection devices. Care must be taken to ensure that wiring or other materials, which could be damaged by these temperatures, do not come into contact with the shell.

28 System Evacuation and Charging Procedure

Before the installation is put into commission, it has to be evacuated with a vacuum pump. During the initial procedure, suction and discharge shutoff valves on the compressor remain closed. The installation of adequately sized access valves at the furthest point from the compressor in the suction and liquid line is advisable. Pressure must be measured using a vacuum pressure (Torr) gauge on the access valves and not on the vacuum pump; this serves to avoid incorrect measurements resulting from the pressure gradient along the connecting lines to the pump.

These valves could also be used to measure the operating pressures to ensure there are no excessive pressure drops in the suction line and liquid line, which will also give an indication that the expansion device receives full bore liquid, ensuring the system performs at its most efficiently.

Evacuating the system only on the suction side of a Scroll compressor can occasionally result in a temporary nstart condition for the compressor. The reason for this is that the floating seal could axially seal with the scroll set, with the higher pressure on the floating seal. Consequently, until the pressures equalize, the floating seal and scroll set can be held tightly together.



The installation should be evacuated down to 0.3 mbar/ 0.22 Torr or lower. Subsequently, the factory holding charge of dry air in the compressor is released to the ambient. The shutoff valves are opened and the installation, including the compressor, are once more evacuated as described after the system has been recharged with dry nitrogen.

Highest demands are placed on the leak proof design of the installation and also on the leak testing methods. (Please refer to EN378).

Rapid charging on the suction side of Scroll compressors can occasionally result in a temporary nstart condition for the compressor. The reason for this is that if the flanks of the spirals happen to be in a sealed position, rapid pressurization of the low side without opposing high side pressure can cause the spirals to seal axially. Consequently, until the pressures eventually equalize, the spirals can be held tightly together, preventing rotation. The best way to avoid this situation is to charge on both the high and low side simultaneously at a rate, which does not result in axial loading of the spirals. The maximum charging rate can be determined through simple tests.

29 Unbrazing System Components

If the refrigerant charge is removed from a scroll equipped unit by bleeding the high side only, it is sometimes possible for the scrolls to seal, preventing pressure equalization through the compressor.

This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side while the low side shell and suction line contains pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, it is important to check both the high and low side with gauges before unbrazing, or in the case of repairing a unit on an assembly line, bleed refrigerant from both the high and low side. Instructions should be provided in appropriate product literature and assembly (line repair) areas.

30 Compressor Replacement

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through use of suction and liquid line filter dryers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. It is highly recommended that the suction accumulator be replaced if the system contains one. This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

When a single compressor or tandem is exchanged in the field, a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage.

See Section 27 for Rotolock valve, flange fittings, sight glass, and mounting bolt torques values.



31 Suction Line Noise and Vibration

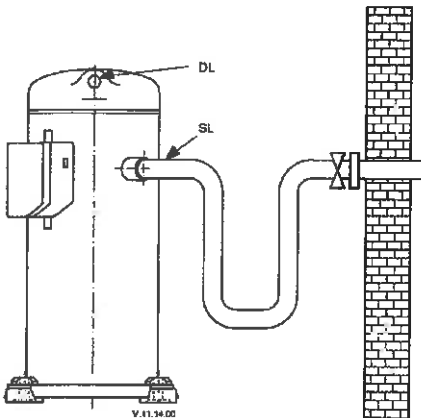


Figure 11 Suction tube design

Copeland Scroll compressors inherently have low sound and vibration characteristics. However, in some respects, the sound and vibration characteristics differ from reciprocating compressors and, in rare instances, could result in unexpected sound complaints with plain air conditioning systems.

One difference is that the vibration characteristic of the Scroll compressor, although low, includes two very close frequencies, one of which is normally isolated from the shell by the suspension of an internally suspended compressor. These frequencies, which are present in all compressors, may result in a low level "beat" frequency, which can be detected as noise coming along the suction line into a house under some conditions. Elimination of the "beat" can be achieved by attenuating either of the contributing frequencies. This is easily done by using one of the common combinations of design configuration described below.

A second difference of the Copeland Scroll compressor is that under some conditions the normal starting motion of the compressor can transmit an "impact" noise along the suction line. This phenomenon, like the one

described above, also results from the lack of internal suspension, and can be easily avoided by using standard line isolation techniques as described below.

Recommended configuration (fig.11):

- Tubing configuration: small shock loop
- Service valve: "angled valve" fastened to unit/wall
- Suction muffler: not required

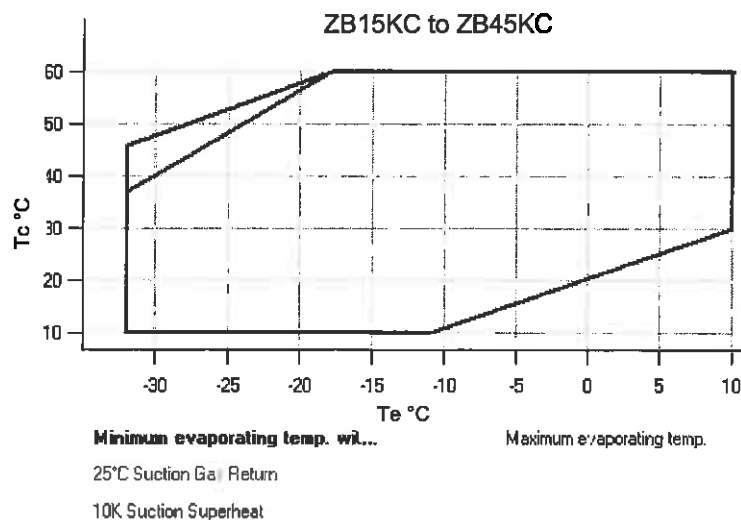
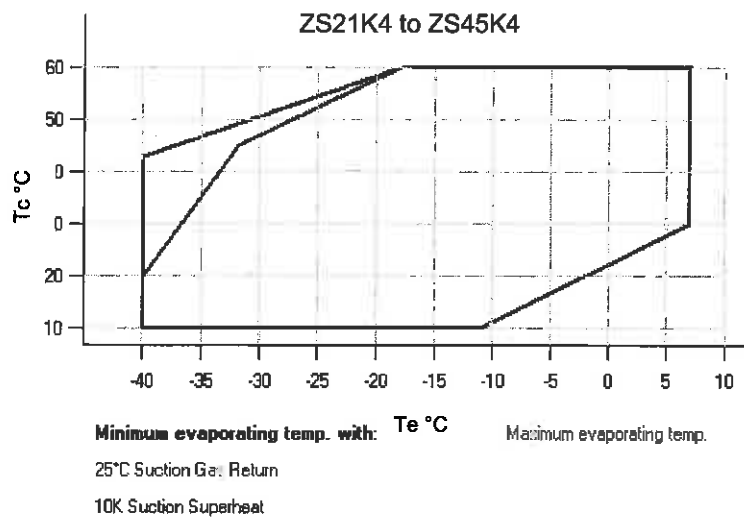
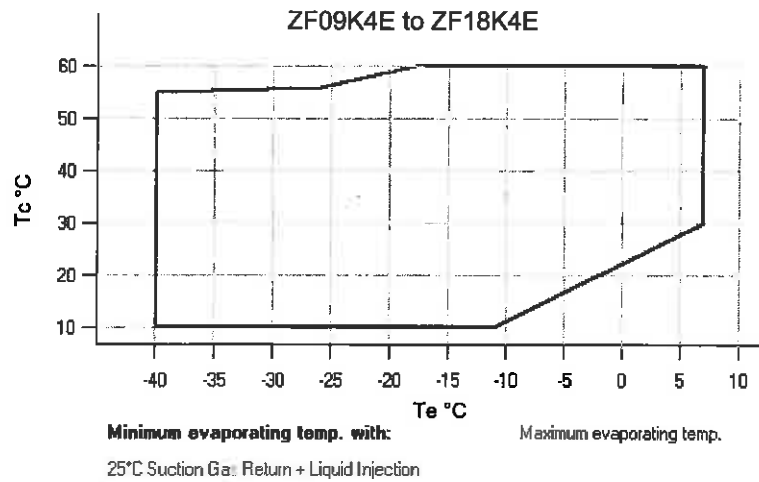
Alternative configuration:

- Tubing configuration: small shock loop
- Service valve: "straightthrough" valve fastened to unit/wall
- Suction muffler: may be required



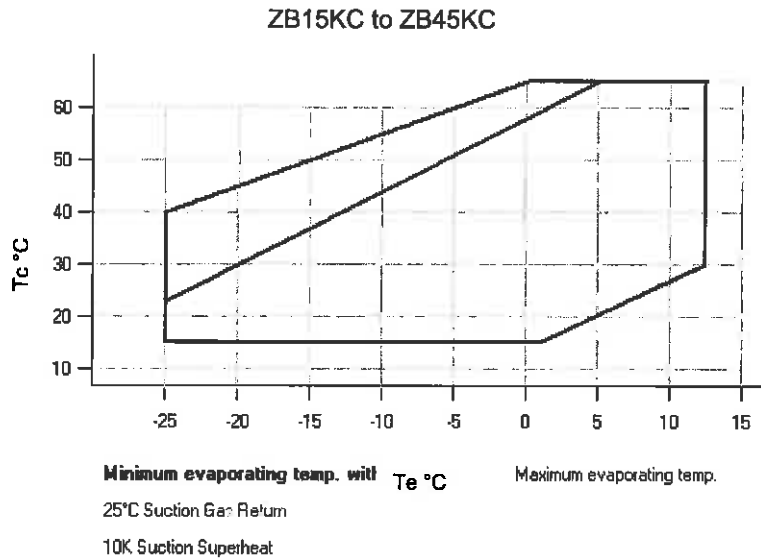
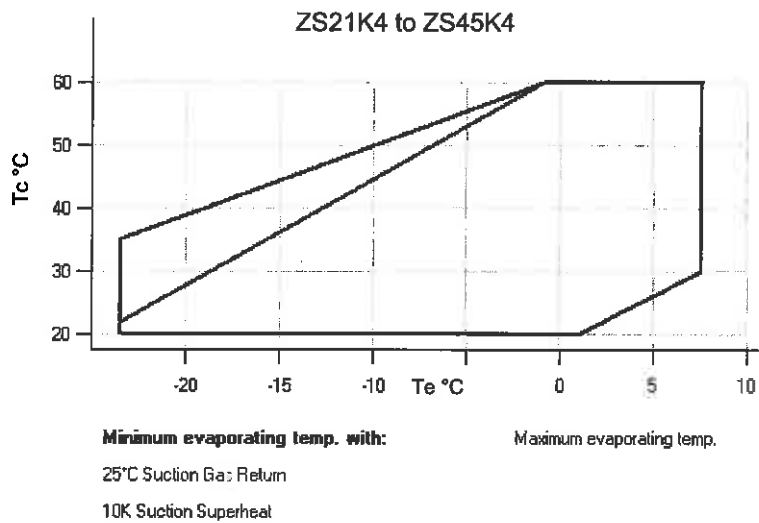
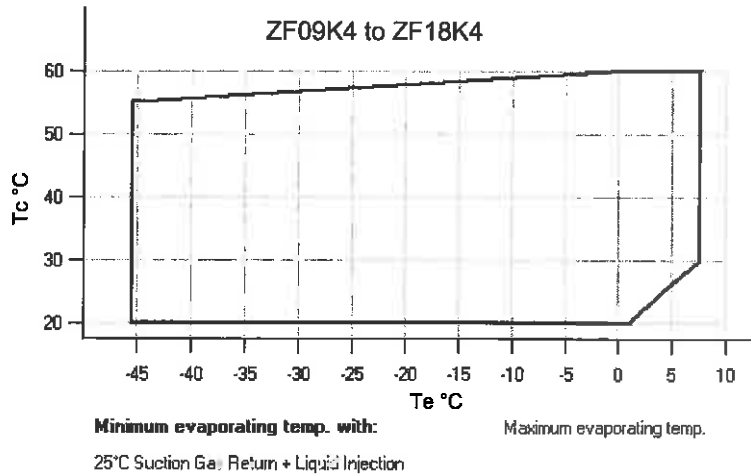
32 Application Envelopes

32.1 R404a Application Envelopes





32.2 R22 Envelopes



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P2811 Rev 05



Refrigeration Scroll for Parallel Applications

Application Guidelines



EMERSON
Climate Technologies

APPLICATION GUIDELINES: COPELAND SCROLL SCROLL COMPRESSORS IN PARALLEL FOR REFRIGERATION APPLICATIONS

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1 Introduction

The concept of parallel operation for refrigeration scroll compressors brings several benefits:

- **Efficient Capacity Control:**
If the load or ambient conditions change, compressors can be switched on and off to match capacity requirements. This is more efficient than running larger semi-hermetic compressors at part load and also will generally give a better power factor. Use of unequal compressors allows many capacity possibilities.
- **Redundancy:**
If one compressor cannot run for any reason, the load can often be met by the remaining compressors.
- **Ease of Service:**
If a compressor needs to be changed for any reason, the small, lightweight nature of the scroll makes this a much less costly operation and causes much less disruption. This is particularly true for the 3 - 6 hp models.
- **Matching Several Evaporating Conditions:**
If there are two or more temperatures to be controlled, individual compressor(s) can be matched to each evaporator while working on a single condenser circuit, and this will give power savings compared with an alternative system working at one (the lowest) suction pressure.

Parallel operation of compressors is not new, but scroll compressors have no positive displacement oil pump, and therefore no oil pressure switch. The high performance Teflon® bearings provide protection for short periods in case of oil losses, but sustained running at high-pressure differences without lubricant will fail the bearings. In order to ensure adequate protection it is necessary to observe the following guidelines.

2 Definitions

- **Oil Equalisation Line:**
Tubing connecting compressor sumps at or below oil level.
- **Regulator**
A device to meter oil into a compressor sump, and control the oil level within limits.
- **Oil Charge Supplied:**
Oil quantity supplied by Copeland when compressor is shipped.
- **Maximum Oil Quantity:**
Maximum amount of oil recommended. Above this amount the oil level will be above the sight glass and could be too high affecting power consumption.
- **Minimum Oil Quantity:**
Minimum amount of oil recommended. Below this amount lubrication may be insufficient and so the life of the compressor may be shortened.
- **Oil Recharge Quantity:**
Amount of oil to refill compressor after drain the oil.

3 Model Range

Model Name			HP	Oil charge supplied [l]	Oil charge quantity [l]
		ZB15	2	1,0	1,0
		ZB19	2,5	1,0	1,0
ZF09	ZS21	ZB21	3	1,24	1,12
ZF11	ZS26	ZB26	3,5	1,24	1,12
ZF13	ZS30	ZB30	4	1,95	1,83
ZF15	ZS38	ZB38	5	1,95	1,83
ZF18	ZS45	ZB45	6	1,77	1,66
ZF24	ZS56	ZB56	7,5	4,14	4,05
ZF33	ZS75	ZB75	10	4,14	4,05
ZF40	ZS92	ZB92	13	4,14	4,05
ZF48	ZS11M	ZB11M	15	4,14	4,05

Tab 1: Model Range

Note: Air-conditioning type applications may use ZR models in parallel. Due to operating envelope limitations ZR models are not normally suitable in Refrigeration applications.



4 Parallel Application Considerations

If compressors are required to operate in parallel it is normally necessary to stop and start them independently for capacity control purposes. There are three major considerations in this type of application:

- **Oil control:**
An adequate oil level at all times is necessary to maintain lubrication of the bearings. Too much oil can result in inefficient operation and excessive oil carry over to the system.
- **Tubing Stress:**
If compressors are mounted close together, care must be taken to ensure that there is sufficient flexibility in the tubing. If this is not done the starting pulse may result in excess stress at the mounting positions and eventually give rise to a leak. Also tube resonance should be avoided.
- **Running sequence:**
A certain logical sequence control is recommended so that each compressor runs for the same amount of time.

5 Oil Control using Regulators

Individual oil control for each compressor is the safest method. Each compressor can be fitted with a regulator which supplies oil only when required. Oil carried over to the system is replaced via the regulator when insufficient oil is being returned from the system. A reservoir of oil is provided, and hence variations in oil quantity in the system can be accommodated. There are many refrigeration scroll compressors operating today with regulators and this method is recommended by Copeland provided that certain design points are observed. Because the scroll compressor has no positive displacement oil pump and no oil pressure switch, it is recommended that the oil control system incorporates protection as detailed below. It will be necessary to add oil to the system and the Copeland approved lubricants are:

HFC-refrigerants: Mobil EAL Arctic 22 CC

HCFC-refrigerants: Suniso 3GS

5.1 Low Pressure Oil Reservoir

This is the traditional method used also in many piston compressor systems. The oil reservoir is maintained at a pressure slightly above the compressor sump pressure and this limits the amount of refrigerant dissolved in the oil in the reservoir. The pressure drop is low when the oil enters the compressor and the amount of flash gas formed in the sump is small.

Float switches or other devices can be used as regulators. It is recommended that the regulator has an electrical output which can be wired into the control circuit and stop the compressor if the oil level falls below the minimum level and remains below the minimum level for a period of time (maximum 2 minutes). This protects against failure of the oil supply to the individual compressor. A level switch in the reservoir will only protect against insufficient oil in the receiver, but not against loss of oil supply to an individual compressor or against a fault on an individual regulator. Regulators currently on the market, which meet these requirements, include AC&R S9040 and the ALCO OMA Traxoil. The Traxoil requires the oil reservoir to be pressurized to 3.5 bar above suction pressure for reliable operation.

When using a regulator care must be taken to set the oil level in the upper half of the sight glass. If an adapter is used to connect the regulator this may have a smaller internal diameter than the glass and this could give rise to a false oil level reading.

When commissioning these systems it is important to allow sufficient time for equilibrium running conditions to be attained. Because the oil carry over rate from the scroll compressors is low it may take some time for stable oil quantities to build up in the coolers. Until this has happened the total oil requirement of the system cannot be determined.



Fig 1: Alco OMA Traxoil

Model	S1 Oil Level Control
Functions:	
- Oil Fill	Yes
- Alarm	Yes
- Compressor Lockout	Yes
Set point	½ Sight glass
Switch/Relay release time	120 sec
Reset mode/Time delay	Auto/ 13 sec
Oil connection	¼" flare
MOPD psi/bar	300/ 20,7
Max. working pressure psi/bar	400/ 27,6
Contact ratings	0,4 A, 125 V 0,2 A, 250 V
Solenoid Coil type/Watts	MCK-1/10W

Tab 2: Properties OMA Traxoil

5.2 High Pressure Oil Reservoir

The need for a separate oil receiver may be avoided if a combined separator/receiver is used, but in this case the oil will be stored at discharge pressure. It will therefore cause much more disturbance and foaming when it enters the compressor sump. For this reason it is desirable to limit the quantity of oil entering the sump when the valve opens. The Alco OMA Traxoil (see Fig 1) is suitable for this type of application and has been proven to operate satisfactorily with a high pressure oil supply.

6 Oil Equalisation Lines without Active Oil Control

Simple systems, which link the compressor sumps via tubes with no control are obviously attractive. They are quite common on air-conditioning applications, but in refrigeration additional considerations apply. They can, of course, only be considered for compressors working at a common suction condition.

If there are large variations in oil quantity in the system due to changing conditions or defrost this may result in too much or too little oil in the compressors. Usually the only means of checking oil level is via the sight glass connection. Once the oil level is above the sight glass it is not possible to determine if the maximum oil quantity is reached. Likewise if no oil is visible in the sight glass, there is a danger of operation below the minimum quantity.

A tube connecting the oil level adjustment valves on the compressors is not adequate because when a compressor is stopped, the pressure in the shell rises and oil will transfer to the running compressor(s). The adjustment valve is located below sight glass level and therefore the stationary compressor will show no oil level. Even if all compressors run together at all times, there will be small pressure differences which will cause the same effect.

Alternative methods using the sight glass connections for oil equalisation connections have been shown to work on specific systems. Notes are given below on some possible methods, but because of wide variations in system design and operating conditions, these methods cannot be given general approval by Copeland. The user has to verify operation in each system type.

6.1 Oil Equalisation Tube at Sight Glass Position

Generously sized suction lines will minimise the flow along the oil connecting tube but will not eliminate it. Use of a large diameter oil header tend to reduce oil transfer. Certain gas pressure equalisation designs have been shown to be satisfactory but each one has to be tested and proven.



6.2 Gas and Oil Equalization Tube at Slight Glass Position

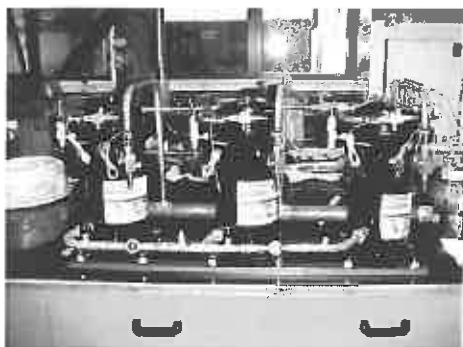


Fig 2: Scrolls in Parallel

Copeland has conducted tests to prove the satisfactory operation of up to three compressors in parallel using a gas and oil equalising tube. The configuration of suction line and equalization line should be as described below (6.3 and 6.4).

This method can be used for:

- Two or three ZF, ZS, ZB Refrigeration Scroll Compressors
- No uneven configurations (all same model)
- All voltages
- Refrigerants R404A, R507, R22
- Same operating envelope as single compressor with injection where required
- Adequate liquid flood back protection must be provided
- Any sequence/combination of compressors is allowed

Model Applicability

			ZB15 KCE
			ZB19 KCE
	ZF09 K4E	ZS21 K4E	ZB21 KCE
	ZF11 K4E	ZS26 K4E	ZB26 KCE
ZF13 KVE	ZF13 K4E	ZS30 K4E	ZB30 KCE
	ZF15 K4E	ZS38 K4E	ZB38 KCE
ZF18 KVE	ZF18 K4E	ZS45 K4E	ZB45 KCE
ZF24 KVE	ZF24 K4E	ZS56 K4E	ZB56 KCE
ZF33 KVE	ZF33 K4E	ZS75 K4E	ZB75 KCE
ZF40 KVE	ZF40 K4E	ZS92 K4E	ZB92 KCE
ZF48 KVE	ZF48 K4E	ZS11 M4E	ZB11 MCE

Tab 3: Model Applicability

6.3 Suction Line Configuration

An adequately sized suction header providing equal distribution of returning refrigerant and oil to each individual compressor must be used. The non-symmetrical design as shown below is acceptable and does not create oil level problems between the compressors.

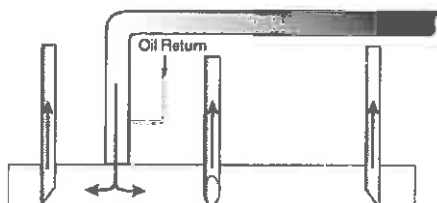


Fig 3: Oil Return



Fig 4: Suction Line Configuration

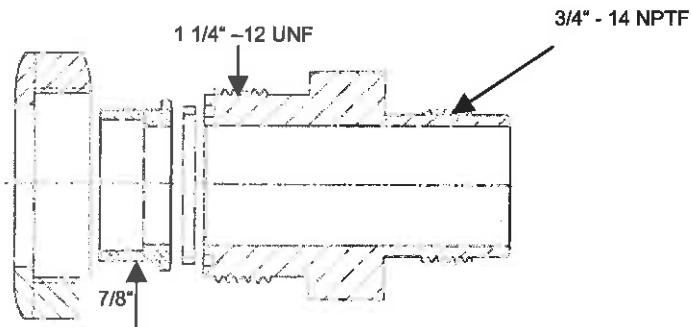


6.4 Oil Equalization Line

The oil equalization line between the two or three compressors must be at least 7/8" (22 mm) with a minimum inner diameter of 19 mm. On no account must the internal diameter of any fitting in this line be less than 19 mm. Adaptors to fit to the sight glass connection on. It is strongly recommended that these are used. Kits consisting of the adaptor shown below, plus conversion to brazed connections are available (see spare parts lists for details). The equalization tube must be level, and the compressors must be mounted level. Tests have shown that smaller tube diameters do not provide proper oil balancing. An oil separator may be used and the oil return line from the separator should be connected to the oil equalization line.

If no oil separator is installed the oil returns into the suction header and is picked up there from the individual compressor suction lines.

Adaptor for Oil Sight Glass Connection



Notes:

- Tightening Torque:
41-54 Nm
- Use Loctite String:
Everseal 483 White Pipe Sealant

Fig 4: Adaptor for oil sight glass connection

6.5 Oil and Gas Equalization plus Oil Regulator

If the Traxoil or other device is fitted to the equalization line (one device serving 2 or 3 compressors) the proper functioning of the system has to be checked to ensure that no nuisance tripping occurs. The Traxoil sight glass, remote from the sump, does not always accurately follow the sump oil level. The oil separator must be of the combined separator/reservoir high pressure type, or alternatively a separate oil reservoir may be used if the separator has its own float valve. The separator float valve outlet must not be connected directly to the Traxoil.

7 Oil Return to Running Compressors

Systems without active oil control are covered in section 6. For systems using oil regulation it is still recommended to arrange for oil to be returned to the running compressors. If oil returns to the compressor at approximately the same rate as it leaves, then the oil level will be maintained. It is always preferable to design the suction manifold in such a way that oil returning with the suction gas can only enter the running compressor(s). This can be done in a number of ways. Perhaps the most common is to use a suction header with vertical pick ups to each compressor which induce sufficient velocity to lift the oil. Again, certain designs have been shown to be satisfactory but each one has to be tested proven. With some system designs this is sufficient to ensure adequate oil level at all times, but there is no fail safe pressure switch if one compressor loses oil.

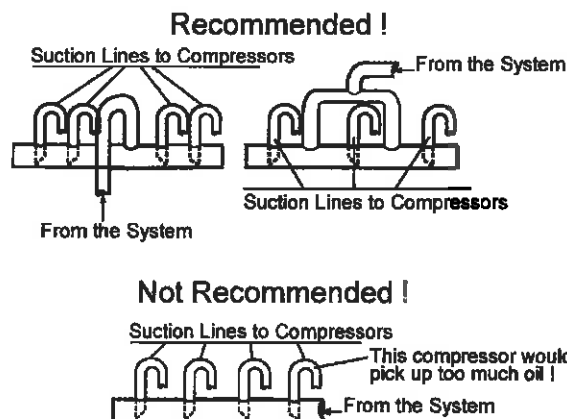


Fig 5: Suction Lines to Compressors – Recommendation



8 Tubing and Mounting Considerations

8.1 Starting Pulse

The standard mount for the scroll compressor is a soft rubber mount. This is designed to transmit the lowest possible disturbance to the mounting frame. Because of the flexibility of this mount, it is essential that tubing to each compressor is designed to accommodate the movement which will occur, particularly on start up.

The three phase motors used in the refrigeration scroll compressors exhibit a high starting torque characteristic. The reaction of the stator is directly on the shell because there are no internal spring mounts. This reaction causes easily observable movement of the shell when the standard mounts are used and this is normal. However, if the suction and discharge tubing of the compressor is closely clamped to the frame or linked to another compressor, the tubing will restrain the movement – the motor reaction force will be taken by the tubing and may cause excessive stress and premature failure of tubing joints.

Care should be taken to avoid this situation in parallel arrangements of compressors where it is desired to minimise the space between them (see also 8.3.).

8.2 Resonance

The discharge pulse can in some configurations give rise to resonance of tubing. It is desirable to avoid a natural frequency of between 45 and 55 Hz for the section of tubing between the compressor and the first clamp. Often it is not possible to determine this in advance, but in the unlikely event of a resonance problem arising, a change in tube configuration will usually resolve it.

8.3 Recommendations for Tubing and Mounting

Always allow some flexibility in the tubing to the suction and discharge connections. If the standard mounts are used there should be at least two bends and a vertical section before the tube joins a header. Test the finished assembly by rocking the compressor on its mounts. Vibration eliminators may be used but are not essential if the tubing has sufficient flexibility. Vibration eliminators should be fitted in the vertical plane.

An alternative harder mount as detailed in Fig. 7 is recommended. This will allow more loads to be transmitted via the feet, and the very small additional vibration transmission is not usually a problem in refrigeration applications. It is still desirable to incorporate a vertical section of tube between the compressor and the first rigid mount. This will give flexibility and minimise the risk of resonance.

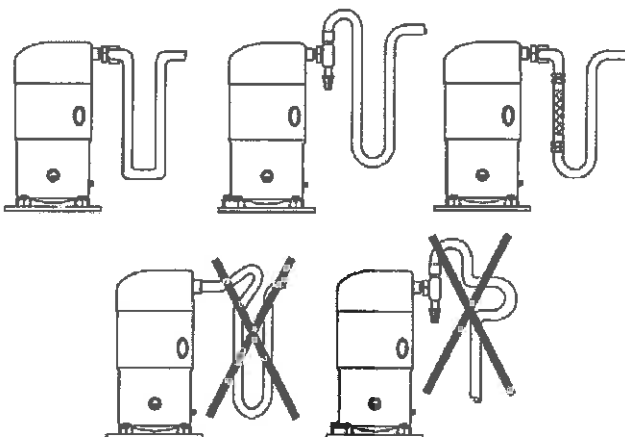


Fig 6: Tubing Recommendation

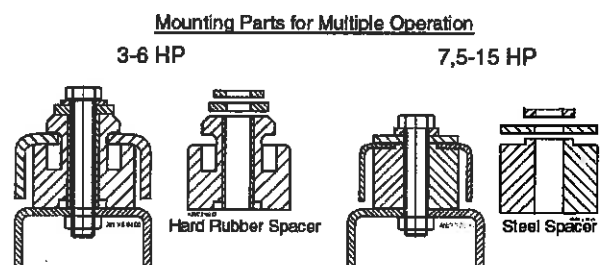


Fig 7: Mounting Parts for Multiple Operation



9 Additional Design Points

The topics described in the Application Guidelines are applicable. The following additional points are for parallel installations.

9.1 Check valves and Pump Down

Pump down is not normally used or necessary for parallel Scroll installations. All Scroll compressors are fitted with an internal check valve, and ZF/ZS models have a dynamic discharge valve also. Therefore external check valves are not needed.

9.2 Heat Exchangers for Economised Scrolls (Vapour Injection)

A single heat exchanger may be used in multiple compressor installations. A plate heat exchanger with a single circuit on the liquid side, and multiple circuits on the vapour side is a good solution (see Fig. 8 & 9 below). It is essential that solenoid valves are fitted to ensure that refrigerant is not fed to the injection port of a stationary compressor.

If a single circuit heat exchanger is used, the solenoid valves must be fitted in the vapour lines as shown in the figures below. A TEV can be used to regulate the injection. Depending on the configuration, the operational envelope may be restricted due to higher vapour temperatures than with the capillary tube. Discharge temperature thermostats should always be fitted.

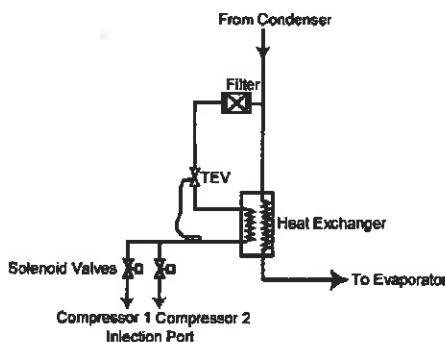


Fig 8: Heat exchanger configuration example 1

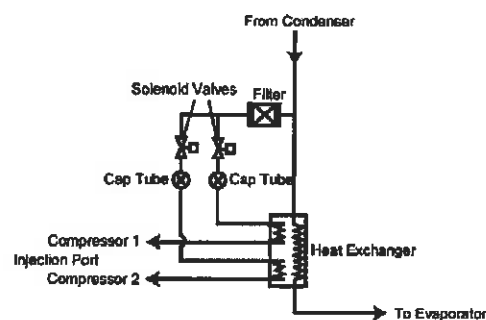


Fig 9: Heat Exchanger configuration example 2

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EMERSON
 Climate Technologies

P2811 Rev 05

PRESSURE RELIEF VALVES

The function of a Pressure Relief Valve is to protect against over-pressure. For safety reasons, excessive over-pressure in any part of the refrigeration system must be avoided

Applications

A typical application for a Henry Technologies pressure relief valve (PRV) is to protect a liquid receiver from being over-pressurised. In the event of a fire, any liquid refrigerant inside the receiver will evaporate resulting in an increase in pressure. The PRV will safely control this increase in pressure by venting the vapour from the receiver. Another application is to protect equipment from compressor over-pressure.

Henry Technologies pressure relief valves are designed to discharge vapour and should not be used to vent liquid refrigerant. The valves are "back-pressure dependent" and are therefore required to discharge to atmosphere.

The brass and stainless steel series valves are suitable for use with HCFC and HFC refrigerant gases. The stainless steel series valves are also suitable for ammonia.

Once a PRV has discharged, replacement is recommended, as the set pressure can no longer be guaranteed. Refer to Installation Section for further information.

In line with the Institute of Refrigeration Guidelines (UK), Henry Technologies recommend that a PRV should be replaced at least every 5 years. These intervals may have to be reduced if other regulations apply.

It is recommended to have a relief valve pressure setting at least 25% higher than the maximum system operating pressure. The PRV set pressure should not be higher than the design pressure (MWP) of the vessel.

How it works

A conventional PRV is designed to open at a predetermined pressure - the set pressure. A spring exerts a sealing force on a valve seat via a piston seal assembly. At a pressure equal to the set pressure, the piston will start to lift resulting in a small amount of flow through the valve. From this point, the pressure force acting on the piston increases significantly and overcomes the spring force. This imbalance of forces causes the valve to "pop" fully open. By design, the difference in pressure from the valve set point to the fully open condition is no more than 10%. System pressure is controlled/reduced by venting the refrigerant vapour through the valve. The valve then re-closes at a pressure where the spring force overcomes the piston force. Under normal system operating conditions, the pressure at the valve inlet is below the set pressure. Only under abnormal operating conditions should the PRV be open.

Main features

- Proven safe design
- Category IV PED compliant
- Precision machined parts for reliability
- High flow capacity
- Compact
- Non-stick teflon valve seal
- Blow-out proof seal design
- Seal material with high chemical resistance
- Tamper proof
- Test Certificates available on request
- Non-standard pressure settings available on request



Technical Specification

All Henry Technologies PRV's are designed and manufactured to the intent of ASME VIII Division 1.

For 526, 5230 and 5231 series models:-

Set pressure range = 14 to 31 barg
Allowable operating temperature = -40°C to +107°C

For 5232 and 524 series models:-

Set pressure range = 10.3 to 31 barg
Allowable operating temperature = -40°C to +107°C

For 53 series models:-

Set pressure range = 10.3 to 31 barg
Allowable operating temperature = -29°C to +135°C

Materials of Construction

For all 52 series valves, the main body and outlet connection are made from brass. Valve internals such as the piston and adjusting gland are either made from brass, plated steel or stainless steel.

For the 53 series valves, the main body is made from stainless steel. The outlet connection and valve internals are made from either plated steel or stainless steel.

For all valves, the seal is made from premium quality teflon (PTFE). All springs are made from high strength plated alloy steel.

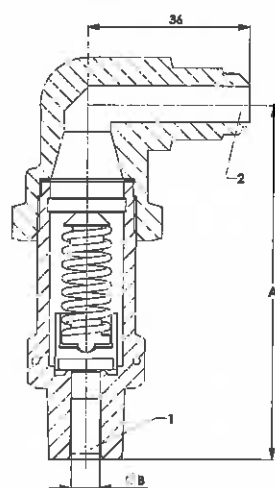
PRESSURE RELIEF VALVES



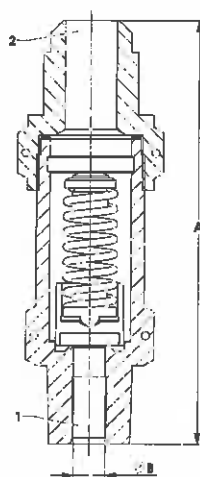
Angle Relief Valve - Brass								
Part No	Conn Size (Inch)		Dimensions (mm)		Flow Area (mm ²)	K _{dr}	Weight (kg)	CE Cat
	Inlet	Outlet	A	ØB				
526E-xx.x BAR-CE	3/8 MPT	3/8 SAE Flare	78	6.35	31.67	0.41	0.26	Cat IV

Straight-through Relief Valves - Brass								
Part No	Conn Size (Inch)		Dimensions (mm)		Flow Area (mm ²)	K _{dr}	Weight (kg)	CE Cat
	Inlet	Outlet	A	ØB				
5230A-xx.x BAR-CE	1/4 MPT	1/2 SAE Flare	85	6.35	31.67	0.68	0.18	Cat IV
5231A-xx.x BAR-CE	3/8 MPT	1/2 SAE Flare	85	6.35	31.67	0.68	0.19	Cat IV
5231B-xx.x BAR-CE	1/2 MPT	5/8 SAE Flare	91	6.35	31.67	0.68	0.22	Cat IV
5232A-xx.x BAR-CE	1/2 MPT	3/4 SAE Flare	109	9.5	71.26	0.67	0.44	Cat IV
5240-xx.x BAR-CE	1/2 MPT	3/4 FPT	95	9.5	71.26	0.67	0.41	Cat IV
5242-xx.x BAR-CE	3/4 MPT	3/4 FPT	95	9.5	71.26	0.67	0.45	Cat IV
5244-xx.x BAR-CE	1 MPT	1 FPT	106	12.7	126.68	0.68	0.66	Cat IV
5246-xx.x BAR-CE	1 1/4 MPT	1 1/4 FPT	145	17.9	250.41	0.60	1.48	Cat IV

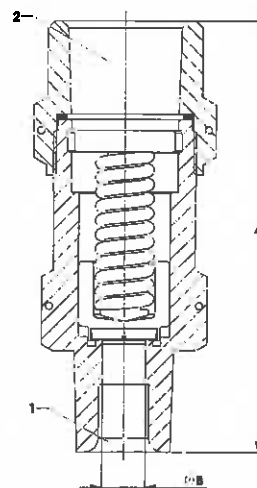
Straight-through Relief Valves - Stainless Steel								
Part No	Conn Size (Inch)		Dimensions (mm)		Flow Area (mm ²)	K _{dr}	Weight (kg)	CE Cat
	Inlet	Outlet	A	ØB				
5340-xx.x BAR-CE	1/2 MPT	3/4 FPT	94	9.5	71.26	0.67	0.39	Cat IV
5342-xx.x BAR-CE	3/4 MPT	3/4 FPT	94	9.5	71.26	0.67	0.43	Cat IV
5344A-xx.x BAR-CE	3/4 MPT	1 FPT	106	12.7	126.68	0.68	0.56	Cat IV
5344-xx.x BAR-CE	1 MPT	1 FPT	106	12.7	126.68	0.68	0.62	Cat IV
5345-xx.x BAR-CE	1 MPT	1 1/4 FPT	149	17.9	250.41	0.6	1.25	Cat IV
5346-xx.x BAR-CE	1 1/4 MPT	1 1/4 FPT	145	17.9	250.41	0.6	1.37	Cat IV



526 SERIES



523 SERIES



524 & 53 SERIES

- ① Inlet
- ② Outlet

Standard settings are (barg): 10.3, 13.8, 14.0, 16.2, 17.2, 20.7, 24.1, 24.8, 25.9, 27.6, 29.3 and 31.0

PRESSURE RELIEF VALVES



Valve Capacity Ratings (kg Air/min) @ 20°C.								
Part No	Standard Pressure setting (barg)							
	10.3	14	16.2	20.7	24.1	24.8	27.6	31
*526E-CE	N/A	3	3.4	4.4	5	5.1	5.8	6.5
*5230A-CE	N/A	4.9	5.8	7.3	8.4	8.6	9.6	10.8
*5231A-CE								
*5231B-CE								
5232A-CE	8.4	11.5	12.7	16	18.6	19.1	21.2	23.9
5240-CE								
5242-CE								
5340-CE								
5342-CE	15.1	20.7	23	29	33.6	34.5	38.2	42.8
5244-CE								
5344-CE								
5344A-CE								
5246-CE	26.5	34.5	40.2	50.7	58.8	60.5	66.9	75.0
5345-CE								
5346-CE								

*Minimum set pressure is 14 barg.

Performance data

The valve discharge capacities are presented in the table for standard pressure settings.

For other pressure settings, the capacity can be determined by using a standard pressure setting as a basis.

Example:

The 526E valve capacity is required for a pressure setting of 15 barg.

$$\text{Capacity (new setting)} = \left(\frac{P(\text{new setting}) + 1.013}{P(\text{std setting}) + 1.013} \right) \times \text{Capacity (std setting)}$$

In this case, the most convenient standard pressure set to use is 14 barg.

$$\text{Capacity (15 barg)} = \left(\frac{15 + 1.013}{14 + 1.013} \right) \times 3.0 = \left(\frac{16.013}{15.013} \right) \times 3.0 = 3.2 \text{ kg/min of air}$$

All capacities are shown in kg/min of air @ 20°C. Air is used as a reference medium.

To convert from air to refrigerant capacity, the following formula can be used:-

$$W_r = \frac{W_{\text{air}}}{r_w}$$

Where:-

W_r = Mass flow of refrigerant, kg/min

W_{air} = Mass flow of air, kg/min

r_w = Conversion factor

For simplicity, r_w factors are presented for a number of common refrigerants. Using these factors will give an approximate solution. If a high degree of accuracy is required, the user should consult reference (1). This reference details a formula for the r_w factor.

Refrigerant	Conversion factor, r_w
R22	0.61
R134a	0.57
R404A	0.59
R407C	0.62
R410A	0.67
R717	1.33

Current European Refrigeration Standards do not use air capacity for valve selection. To suit some users Henry Technologies has however included this information.

In line with current European standards, an alternative approach is recommended by Henry Technologies. Flow capacity is calculated using the valve flow area, A , and the de-rated coefficient of discharge, K_{dr} . These parameters are listed in the Dimension Tables.

PRESSURE RELIEF VALVES



Selection Guidelines

For safety reasons, relief valve selection should only be carried out by suitably qualified engineers.

It is important to select/size a relief valve taking into account all possible sources of over-pressure such as external heat, internal heat, compressor operation and liquid expansion. System control methodology, type of equipment used, etc. dictate the number of over-pressure sources that need to be taken into account for PRV selection.

Henry Technologies pressure relief valves are designed to discharge refrigerant vapour and are therefore not recommended for protection against liquid over-pressure.

As a pressure relief valve is a safety device, it is essential that a proper selection is made. The European Standards EN378 (reference 2) and EN13136 (reference 3) are recommended for selection. In some cases, existing National Standards should be consulted.

An example selection is included using the recommended approach from the above references. This example shows the calculation for an external fire case only. Different formulae are required for the other sources of over-pressure.

Example

A liquid receiver is to be protected from over-pressure due to fire.

Receiver dimensions = 2.2m long (L) x 0.254m outside diameter (D)

Refrigerant = R404A

Pressure setting = 20.7 barg

$$Q_{md} = \frac{3600 \times \varphi \times A_{surf}}{h_{vap}}$$

Q_{md} = Minimum required discharge capacity, of refrigerant, of the pressure relief valve, kg/hour

φ = Density of heat flow rate, kW/m². The standards assume a value of 10 kW/m² but state that a higher value can be used if necessary. This figure relates to an un-lagged vessel.

A_{surf} = External surface area of the vessel, m²

h_{vap} = Heat of vapourisation calculated at 1.1 times the set pressure, in bar a, of the pressure relief valve, kJ/kg

Note:

When the relief valve setting is close to the critical pressure of the refrigerant, this sizing method may not be applicable.

$$A_{surf} = (\pi \times D \times L) + 2 \left(D^2 \times \frac{\pi}{4} \right)$$

Hence,

$$A_{surf} = (\pi \times 0.254 \times 2.2) + 2 \left(0.254^2 \times \frac{\pi}{4} \right) = 1.86 \text{ m}^2$$

Calculate the heat of vapourisation, h_{vap} , taken at 1.1 times set pressure:-

$$(20.7 \times 1.1) + 1.013 = 23.78 \text{ bar a}$$

From refrigerant property tables, use saturated vapour and liquid enthalpies at the above pressure.

Vapor = 285.8 kJ/kg; Liquid = 181.2 kJ/kg

$$h_{vap} = (285.8 - 181.2) = 104.6 \text{ kJ/kg}$$

$$Q_{md} = \frac{3600 \times 10 \times 1.86}{104.6} = 640 \text{ kg/hr, R404A}$$

To calculate the mass flow rate through a PRV, the equation is:-

$$Q_m = 0.2883 \times C \times A \times K_{dr} \times \sqrt{\frac{P_o}{V_o}}$$

This equation assumes critical flow.

C = Function of the isentropic exponent

A = Flow area of PRV, mm²

K_{dr} = De-rated coefficient of discharge of PRV

P_o = Actual relieving pressure, $P_o = 1.1 P_{set} + P_{atm}$, bar a

V_o = Specific volume of saturated vapor @ P_o , m³/kg

Refrigerant data should be referenced for the C and V_o values.

The objective is to select a PRV which results in $Q_m > Q_{md}$. In this way, the relieving capacity of the PRV is greater than required thus avoiding excessive vessel pressure. The user must select a valve model with an adequate (A x K_{dr}) factor.

For this example, a 523 series model has been selected with an orifice size of 6.35mm. From the dimension table, A = 31.67 mm², K_{dr} = 0.68

$$Q_m = 0.2883 \times 2.49 \times 31.67 \times 0.68 \times \sqrt{\frac{23.78}{0.0074}} = 876.4 \text{ kg/hr, R404A}$$

Therefore, for this example suitable models are 5230A, 5231A or 5231B. The final choice depends on the preferred inlet and outlet connection sizes.

Additional notes:-

1. If a Henry Technologies rupture disc is used in conjunction with a Henry Technologies PRV, then the PRV capacity should be de-rated by 10%. In the above example, the PRV capacity would be de-rated to 788.8 kg/hr (876.4 x 0.9).
2. It is important not to grossly over-size a PRV as the performance can be affected. Contact Henry Technologies for further guidance.
3. Inlet and outlet piping must be sized to an appropriate standard to avoid excessive pressure losses. Excessive pressure losses affect valve performance. Consult reference 3.

References:-

(1) ANSI/ASHRAE 15-2004 (2) EN 378-2:2000* (3) EN 13136:2001*

* Latest revisions at time of publication. At time of publication, these standards were under review. The user should ensure the latest revisions are referenced.

Installation – Main issues

1. Connect the relief valve at a location above the liquid refrigerant level, in the vapour space. Stop valves should not be located between the vessel and the relief valve except the three-way type.
2. Do not discharge the relief valve prior to installation or when pressure testing the system.
3. Pressure relief valves should be mounted vertically.
4. Relief valves should be changed out after discharge. Most systems are subject to accumulations of debris. Particles of metal and dirt are generally blown onto relief valve seats during discharge. This inhibits the relief valve from re-sealing at the original set pressure. A valve can also relieve at a lower pressure than the stamped valve setting due to the force of the re-closing action.
5. The pipe-work must not impose loads on the relief valve. Loads can occur due to misalignment, thermal expansion, discharge gas thrust, etc.

ARANCO

4-Way Reversing Valves

Reversing Valves



People



Products



Performance

- *Wide Application Range*
- *High Reliability*
- *Minimum Pressure Drop*
- *Low Leakage Risk*
- *UL Approved*

AIR CONDITIONING



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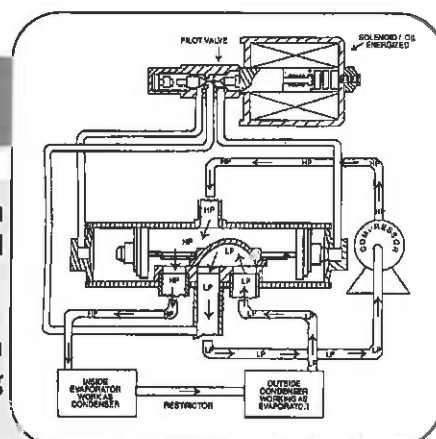
Application and Principle of Operation

The 4-way Reversing Valve is the key component to provide Heating and Cooling from the system to the air conditioned space by reversing the flow direction of refrigerant. It is used at room air conditioners, packaged and central air conditioners. The reversing Valves are designed for Heat Pump Systems with capacity from 3kW to 580kW. They are suitable for most refrigerants as R407C - R410A - R134A.

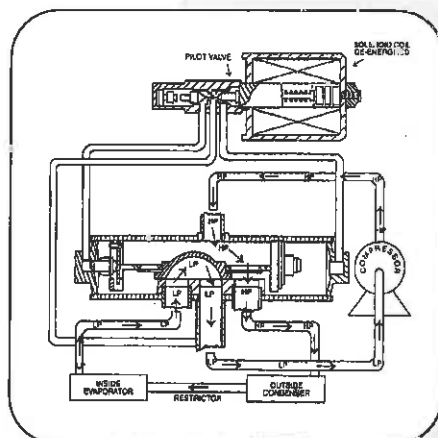
Coil energized

The 4-way valves are used in reversible applications such as heat pumps or reversible air conditioning units and chillers.

The 4-way valve allows an inversion of the refrigeration cycle, changing from cooling mode in Summer to heating mode in Winter.



Heating Cycle

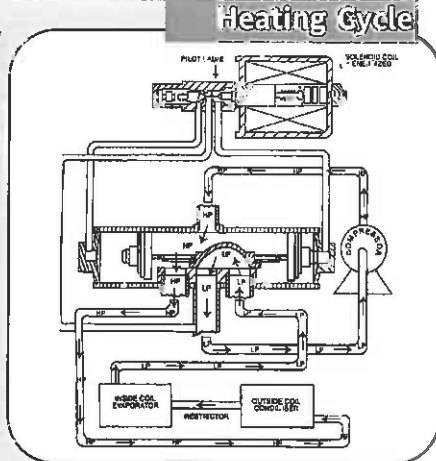


Cooling Cycle

The cycle inversion is initiated by a small solenoid pilot valve, which triggers the movement of a slide, thus inverting the flow direction of the refrigerant.

The valve is connected to the suction and discharge pipes.

The pilot valve ensures a very reliable changeover from cooling to heating mode; the changeover happens instantaneously with a minimum pressure differential.

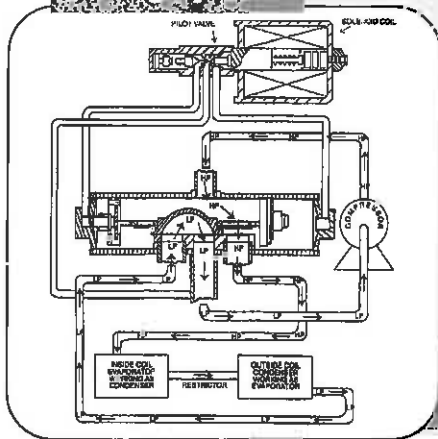


Cooling Cycle

The valve design also guarantees a minimum pressure drop and very low risk of leakage.

The models offer a wide range of connection sizes, configurations and capacity for specific applications. The standard models are available in small quantities per box providing increased flexibility.

Coil de-energized



Heating Cycle

Installation and Cautions

Notice

Heat pumps and heat/cool units:

many original equipment manufacturers connect the system tubing to the Ranco reversing valve based on which mode (heat or cool) the system will operate, should the solenoid coil fail.

For example, solenoid coil energized for cooling (Figure 1); solenoid coil failure mode to heat cycle.

Solenoid coil energized for heating (Figure 2); solenoid coil failure mode to cooling cycle.

Prior to replacing the valve, confirm which mode (heat or cool) the solenoid coil controls when energized.

Viewed facing three tubes and solenoid on right.

Solenoid coil fails, cycle goes to heating. Solenoid coil energized for cooling (de-energized for heat); solenoid fails, valve goes to heat cycle.



Figure 1

1. Connects to Compressor Discharge
2. Solenoid Coil Energized for Cooling
3. Connects to Outside Condensor
4. Connects to Suction Line
5. Connects to Inside Evaporator (coil)
6. Solenoid Coil Energized for Heat

Viewed facing three tubes and solenoid on right.

Solenoid coil fails, cycle goes to cooling. Solenoid coil energized for heat (de-energized for cooling); solenoid fails, valve goes to cooling cycle.



Figure 2

REPLACING VALVE ASSEMBLY

SYSTEM REPAIR - Follow the original equipment manufacturer's recommendations for replacement of refrigerant components.

SYSTEM EVACUATION - Follow original equipment manufacturer's recommendations and/or RSES SAM Section 83 (630-46).

COMPRESSOR MOTOR BURNOUT - Follow original equipment manufacturer's recommendations and/or RSES SAM Section 91.

CAUTION

To prevent possible electrical shock or equipment damage, disconnect electrical power to unit before and during installation.

DO NOT restore electrical power to unit until the device is properly installed.

GENERAL INSTALLATION PROCEDURES - REMOVAL

- Use only an oxy-acetylene torch to unsolder connections. Other type torches may not have the heat capacity to do the job with minimum time and temperature.
- Protect the valve from excessive heat. Temperatures above 110°C are apt to damage internal parts. Wrapping a wet rag around the valve body while using the torch will help to dissipate heat.
- Inadequate heat is also a problem.

Not only will the soldered joints be difficult to separate, but also the build up of heat over the longer period of time required will transfer to the valve body and possibly damage its internal parts.

- The joint should separate in seconds, not minutes. Use enough heat to accomplish this, while relying on the wet

rag to protect the valve body. Also remember that the remelt temperature of any solder alloy is much higher than the initial soldering temperature.

- After removing the valve, inspect the lines to make sure they are round and do not have any large solder blobs, which will interfere with the mechanical fit of the new joints.

VALVE INSTALLATION

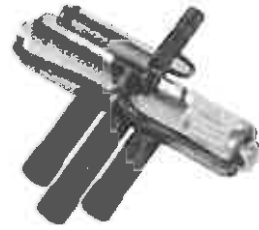
- Avoid any rough handling of the new valve during installation. This especially includes the use of vise-type pliers to manipulate the valve body while

CAUTION

Protect tubes from entry of all foreign matter such as moisture, metal filings, dust or dirt. It takes only a tiny bit of scale,

flux, lint or the like to clog a pilot valve

- Use wet rags around the valve body and adjoining tubing to prevent overheating. Direct the flame of the torch away from the valve body. Excess heat over 110°C may distort internal parts.
- Use low temperature brazing rod as local code will permit, and use an inert gas to prevent oxide scale on the inside of the tubing.
- Preferably use a phosphorus-bearing silver solder which requires no external flux. The entrance of even a tiny bit of flux may be enough to damage a new valve
- If you must use silver solder with externally applied flux, be sure the sections to be joined are bright and clean and that you use the flux sparingly. This will do the job, but because this kind exceptional skill and care in its use, most valve manufacturers are reluctant to recommend it.



Part Number	R407C kW min/max (US ton min/max)	R410A kW min/max (US ton min/max)	R134A kW min/max (US ton min/max)	CTS				Style	Mass (W/O coil)	Qty/box	Coil
				S.E.C.		Discharge					
				mm	Inch	mm	Inch				
V0-406050100	1,34 / 3,02 (0,38 / 0,86)	1,55 / 3,83 (0,44 / 1,09)	1,16 / 2,36 (0,33 / 0,67)	9,64	3/8	8,12	5/16	B	210	36	LDL/LDK
V1-408050100	1,41 / 4,57 (0,40 / 1,30)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,40 / 1,10)	12,84	1/2	8,01	5/16	A	285	36	LDL/LDK
V1-408060100	1,41 / 4,57 (0,40 / 1,30)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,40 / 1,10)	12,84	1/2	9,67	3/8	A	285	36	LDL/LDK
V1-406060100	1,41 / 4,57 (0,40 / 1,30)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,40 / 1,10)	9,64	3/8	9,67	3/8	A	285	36	LDL/LDK
V1-406050100	1,41 / 4,57 (0,40 / 1,30)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,40 / 1,10)	9,64	3/8	8,01	5/16	A	285	36	LDL/LDK
V1-406050200	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	9,64	3/8	8,12	5/16	B	310	36	LDL/LDK
V1-406060200	1,41 / 4,57 (0,4 / 1,3)	1,76 / 5,98 (0,50 / 1,70)	1,41 / 3,87 (0,4 / 1,1)	9,64	3/8	9,67	3/8	B	310	36	LDL/LDK
V2-408060100	2,81 / 6,33 (0,8 / 1,8)	3,17 / 7,74 (0,90 / 2,20)	2,46 / 4,92 (0,7 / 1,4)	12,84	1/2	9,67	3/8	A	285	36	LDL/LDK
V2-408060200	2,81 / 6,33 (0,8 / 1,8)	3,17 / 7,74 (0,90 / 2,20)	2,46 / 4,92 (0,7 / 1,4)	12,84	1/2	9,67	3/8	B	310	36	LDL/LDK
V2-410060300	3,87 / 7,03 (1,1 / 2,0)	4,57 / 8,79 (1,30 / 2,50)	3,17 / 5,63 (0,9 / 1,6)	16,03	5/8	9,67	3/8	C	315	36	LDL/LDK
V2-410060400	3,87 / 7,03 (1,1 / 2,0)	4,57 / 8,79 (1,30 / 2,50)	3,17 / 5,63 (0,9 / 1,6)	16,03	5/8	9,67	3/8	D	335	36	LDL/LDK
V3-410080700	3,87 / 9,50 (1,1 / 2,7)	4,57 / 11,96 (1,30 / 3,40)	3,17 / 7,39 (0,9 / 2,1)	16,03	5/8	12,84	1/2	E	310	36	LDL/LDK
V3-4100H0700	3,87 / 9,50 (1,1 / 2,7)	4,57 / 11,96 (1,30 / 3,40)	3,17 / 7,39 (0,9 / 2,1)	16,03	5/8	12,70 O.D.	1/2 O.D.	E	310	36	LDL/LDK
V3-412080800	3,87 / 9,85 (1,1 / 2,8)	4,57 / 12,31 (1,30 / 3,50)	3,17 / 7,74 (0,9 / 2,2)	19,18	3/4	12,84	1/2	E	350	36	LDL/LDK
V6-414120100	3,87 / 18,99 (1,1 / 5,4)	4,57 / 23,92 (1,30 / 6,80)	3,17 / 14,77 (0,9 / 4,2)	22,36	7/8	19,18	3/4	A	810	18	LDL/LDK
V6-414100100	3,87 / 18,99 (1,1 / 5,4)	4,57 / 23,92 (1,30 / 6,80)	3,17 / 14,77 (0,9 / 4,2)	22,36	7/8	16,03	5/8	A	810	18	LDL/LDK
V6-414080100	3,87 / 18,99 (1,1 / 5,4)	4,57 / 23,92 (1,30 / 6,80)	3,17 / 14,77 (0,9 / 4,2)	22,36	7/8	12,83	1/2	A	810	18	LDL/LDK
V6-412080100	3,87 / 18,99 (1,1 / 5,4)	4,57 / 23,92 (1,30 / 6,80)	3,17 / 14,77 (0,9 / 4,2)	19,18	3/4	12,83	1/2	A	745	18	LDL/LDK
V10-414080100	11,25 / 33,06 (3,2 / 9,4)	13,01 / 41,85 (3,70 / 11,90)	9,85 / 26,03 (2,8 / 7,4)	22,35	7/8	12,83	1/2	A	1.200	12	LDL/LDK
V10-414120100	11,25 / 33,06 (3,2 / 9,4)	13,01 / 41,85 (3,70 / 11,90)	9,85 / 26,03 (2,8 / 7,4)	22,35	7/8	19,18	3/4	A	1.200	12	LDL/LDK
V10-414140400	11,25 / 33,06 (3,2 / 9,4)	13,01 / 41,85 (3,70 / 11,90)	9,85 / 26,03 (2,8 / 7,4)	22,35	7/8	22,36	7/8	A	1.220	12	LDL/LDK
V10-418140100	11,25 / 37,63 (3,2 / 10,7)	13,01 / 47,48 (3,70 / 13,50)	9,85 / 29,54 (2,8 / 8,4)	28,78	1 1/8	22,36	7/8	A	1.310	12	LDL/LDK
V10-418120100	11,25 / 37,63 (3,2 / 10,7)	13,01 / 47,48 (3,70 / 13,50)	9,85 / 29,54 (2,8 / 8,4)	28,78	1 1/8	19,18	3/4	A	1.310	12	LDL/LDK
V10-414100100	11,25 / 33,06 (3,2 / 9,4)	13,01 / 41,85 (3,70 / 11,90)	9,85 / 26,03 (2,8 / 7,4)	22,35	7/8	16,03	5/8	A	1.200	12	LDL/LDK
V10-414120200	17,23 / 33,06 (4,9 / 9,4)	19,73 / 41,85 (5,61 / 11,90)	14,42 / 26,03 (4,1 / 7,4)	22,35	7/8	19,18	3/4	A	1.190	12	LDL/LDK
V10-4180M0200	17,23 / 37,63 (4,9 / 10,7)	19,73 / 47,48 (5,61 / 13,50)	14,42 / 29,54 (4,1 / 8,4)	28,78	1 1/8	19,05 O.D.	3/4 O.D.	A	1.300	12	LDL/LDK
V10-418100200	17,23 / 37,63 (4,9 / 10,7)	19,73 / 47,48 (5,61 / 13,50)	14,42 / 29,54 (4,1 / 8,4)	28,78	1 1/8	16,03	5/8	A	1.300	12	LDL/LDK
V10-418120200	17,23 / 37,63 (4,9 / 10,7)	19,73 / 47,48 (5,61 / 13,50)	14,42 / 29,54 (4,1 / 8,4)	28,78	1 1/8	19,18	3/4	A	1.300	12	LDL/LDK
V10-418140200	17,23 / 37,63 (4,9 / 10,7)	19,73 / 47,48 (5,61 / 13,50)	14,42 / 29,54 (4,1 / 8,4)	28,78	1 1/8	22,36	7/8	A	1.300	12	LDL/LDK
V12-4220T0200	22,86 / 46,78 (6,5 / 13,3)	26,38 / 58,91 (7,50 / 16,75)	18,99 / 36,93 (5,4 / 10,5)	35,13	1 3/8	28,58 O.D.	1 1/8 O.D.	F	2.030	6	LDL/LDK

PLEASE NOTE: Capacities shown are based on:

Evaporating temperature: 7,2°C; Sub Cooling: 5,0°C; Condensing Temperature: 54,4°C; Superheat: 5,0°C; Pressure Drop: 0,014 MPa

AVAILABLE PIPE CONFIGURATIONS



Reversing Valves and Solenoid Coils Table



N-Series



Part Number	R407C kW min/max (US ton min/max)	R410A kW min/max (US ton min/max)	R134A kW min/max (US ton min/max)	CTS				Style	Mass (W/O coil)	Qty/box	Coil
				S.E.C		Discharge					
				mm	Inch	mm	Inch				
N15C00S *	15,83 / 54,51 (4,50 / 15,50)	15,83 / 61,55 (4,50 / 17,50)	12,31 / 40,80 (3,50 / 11,60)	28,80	1 1/8	22,40	7/8	A	1.260		LDL/LDK
N20C00G *	17,59 / 72,45 (5,00 / 20,60)	17,60 / 81,60 (5,00 / 23,20)	13,72 / 54,16 (3,90 / 15,40)	32,00	1 1/4	25,60	1	A	3.100	1	LDL/LDK
N20C10G	17,59 / 72,45 (5,00 / 20,60)	17,60 / 81,60 (5,00 / 23,20)	13,72 / 54,16 (3,90 / 15,40)	32,00	1 1/4	25,60	1	A	3.200	1	LDL/LDK
N20C01G *	17,59 / 72,45 (5,00 / 20,60)	17,60 / 81,60 (5,00 / 23,20)	13,72 / 54,16 (3,90 / 15,40)	34,90	1 3/8	28,60	1 1/8	A	3.100	1	LDL/LDK
N20C11G	17,59 / 72,45 (5,00 / 20,60)	17,60 / 81,60 (5,00 / 23,20)	13,72 / 54,16 (3,90 / 15,40)	34,90	1 3/8	28,60	1 1/8	A	3.200	1	LDL/LDK
N30C00G *	26,38 / 108,68 (7,50 / 30,90)	26,40 / 122,40 (7,51 / 34,80)	20,40 / 81,24 (5,80 / 23,10)	38,30	1 1/2	32,00	1 1/4	A	3.200	1	LDL/LDK
N30C10G	26,38 / 108,68 (7,50 / 30,90)	26,40 / 122,40 (7,51 / 34,80)	20,40 / 81,24 (5,80 / 23,10)	38,30	1 1/2	32,00	1 1/4	A	3.300	1	LDL/LDK
N40C10G	35,17 / 144,90 (10,00 / 41,20)	35,20 / 163,20 (10,01 / 46,40)	27,08 / 108,32 (7,70 / 30,80)	45,00	1 7/8	38,10	1 1/2	A	7.500	1	LDL/LDK
N50C10G	35,17 / 181,13 (10,00 / 51,50)	35,20 / 204,00 (10,01 / 58,00)	27,08 / 135,40 (7,70 / 38,50)	54,20	2 1/7	38,10	1 1/2	A	7.600	1	LDL/LDK

PLEASE NOTE: Capacities shown are based on:

Evaporating temperature: 7,2°C; Sub Cooling: 5,0°C; Condensing Temperature: 54,4°C; Superheat: 5,0°C; Pressure Drop: 0,014 MPa

* Without mounting brackets

VH-Series



Part Number	R407C kW min/max (US ton min/max)	R410A kW min/max (US ton min/max)	R134A kW min/max (US ton min/max)	CTS				Style	Mass (W/O coil)	Qty/box	Coil
				S.E.C		Discharge					
				mm	Inch	mm	Inch				
VH10120	17,59 / 72,45 (5,00 / 20,60)	— / —	13,72 / 54,16 (3,90 / 15,40)	31,80	1 1/4	25,40	1	A	3.100	1	LDL/LDK
VH10122	17,59 / 72,45 (5,00 / 20,60)	— / —	13,72 / 54,16 (3,90 / 15,40)	34,90	1 3/8	28,60	1 1/8	A	3.100	1	LDL/LDK
VH15120 *	26,38 / 108,68 (7,50 / 30,90)	— / —	20,40 / 81,24 (5,80 / 23,10)	38,30	1 1/2	32,00	1 1/4	A	3.200	1	LDL/LDK
VH15122	26,38 / 108,68 (7,50 / 30,90)	— / —	20,40 / 81,24 (5,80 / 23,10)	38,30	1 1/2	32,00	1 1/4	A	3.300	1	LDL/LDK
VH20321	35,17 / 144,90 (10,00 / 41,20)	— / —	27,08 / 108,32 (7,70 / 30,80)	44,90	1 3/4	38,10	1 1/2	A	7.500	1	LDL/LDK
VH20322	35,17 / 144,90 (10,00 / 41,20)	— / —	27,08 / 108,32 (7,70 / 30,80)	41,30	1 5/8	41,30	1 5/8	A	7.500	1	LDL/LDK
VH90120	35,17 / 181,13 (10,00 / 51,50)	— / —	27,08 / 135,40 (7,70 / 38,50)	54,20	2 1/8	38,10	1 1/2	A	7.600	1	LDL/LDK
VH91120	42,20 / 217,35 (12,00 / 61,80)	— / —	32,36 / 162,49 (9,20 / 46,20)	66,70	2 5/8	41,50	1 5/8	A	8.200	1	LDL/LDK
VH32085	70,34 / 289,80 (20,00 / 82,40)	— / —	54,16 / 216,65 (15,40 / 61,60)	Flange RBK 65A	Flange RBK 65A	Flange RBK 50A	Flange RBK 50A		55.000	1	LDL/LDK
VH32123	105,51 / 436,11 (30,00 / 124,00)	— / —	81,24 / 324,97 (23,10 / 92,40)	Flange RBK 65A	Flange RBK 65A	Flange RBK 50A	Flange RBK 50A		73.000	1	LDL/LDK
VH32163	140,68 / 579,60 (40,00 / 164,80)	— / —	108,32 / 432,59 (30,80 / 123,00)	Flange RBK 65A	Flange RBK 65A	Flange RBK 50A	Flange RBK 50A		82.000	1	LDL/LDK

PLEASE NOTE: Capacities shown are based on:

Evaporating temperature: 7,2°C; Sub Cooling: 5,0°C; Condensing Temperature: 54,4°C; Superheat: 5,0°C; Pressure Drop: 0,014 MPa

* Without mounting brackets

Solenoid Coils

Ranco LDK and LDL Solenoid Coils

RANCO offers Type LDK and LDL solenoid coils for use with the entire range of RANCO Heat Pump Reversing Valves. These color coded epoxy encapsulated, continuous duty, moisture resistant magnetic coils are designed to operate the pilot valve controlling the Reversing Valves listed above.

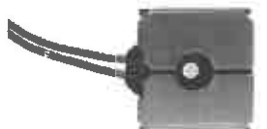
LDK



Coil Type	Color	Voltage	Frequency	Wattage 50/60 Hz	UL Thermal Class	Cable Length	
						mm	inch
LDK-11	Red	24 V~	50/60 Hz	5/4	A	1200	48
LDK-31	Black	120 V~	50/60 Hz	5/4	A	1200	48
LDK-41	Green	208 / 240 V~	50/60 Hz	5/4	A	1200	48
LDK-51	Blue	277 V~	50/60 Hz	5/4	A	1200	48
LDK-73	Yellow	12 V _{DC}	-	10	F	1200	48
LDK-83	Orange	24 V _{DC}	-	10	F	1200	48

Included with the LDK solenoid coil is a W29 wiring harness with 120 mm leads.
Other cable length available on request.

LDL



Coil Type	Color	Voltage	Frequency	Wattage 50/60 Hz	UL Thermal Class	Cable Length	
						mm	inch
LDL-11	Red	24 V~	50/60 Hz	5/4	A	1200	48
LDL-31	Black	120 V~	50/60 Hz	5/4	A	1200	48
LDL-41	Green	208 / 240 V~	50/60 Hz	5/4	A	1200	48
LDL-51	Blue	277 V~	50/60 Hz	5/4	A	1200	48

Other cable length available on request.

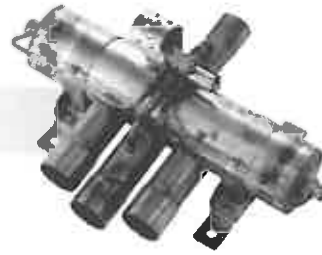
V-N Reversing Valve Operating Specification

Min. Δ Pressure to Reverse	0,15 MPa	Max. Operating Temper.	121°C Min.
Max. Δ Pressure to Reverse	3,04 MPa	Min. Operating Voltage	85% of Rated Volts
Max. working Pressure	4,68 MPa (V Series)	Max. Operating Voltage	110% of Rated Volts
	4,17 MPa (N Series)		
Min. Bursting Pressure	17,23 MPa (V Series)		
	16,7 MPa (N Series)		

VH Reversing Valve Operating Specification

Min. Δ Pressure to Reverse	0,34 MPa	Max. Operating Temper.	120°C Min.
Max. Δ Pressure to Reverse	2,25 MPa	Min. Operating Voltage	85% of Rated Volts
Max. working Pressure	3,3 MPa	Max. Operating Voltage	110% of Rated Volts
Min. Bursting Pressure	16,5 MPa		

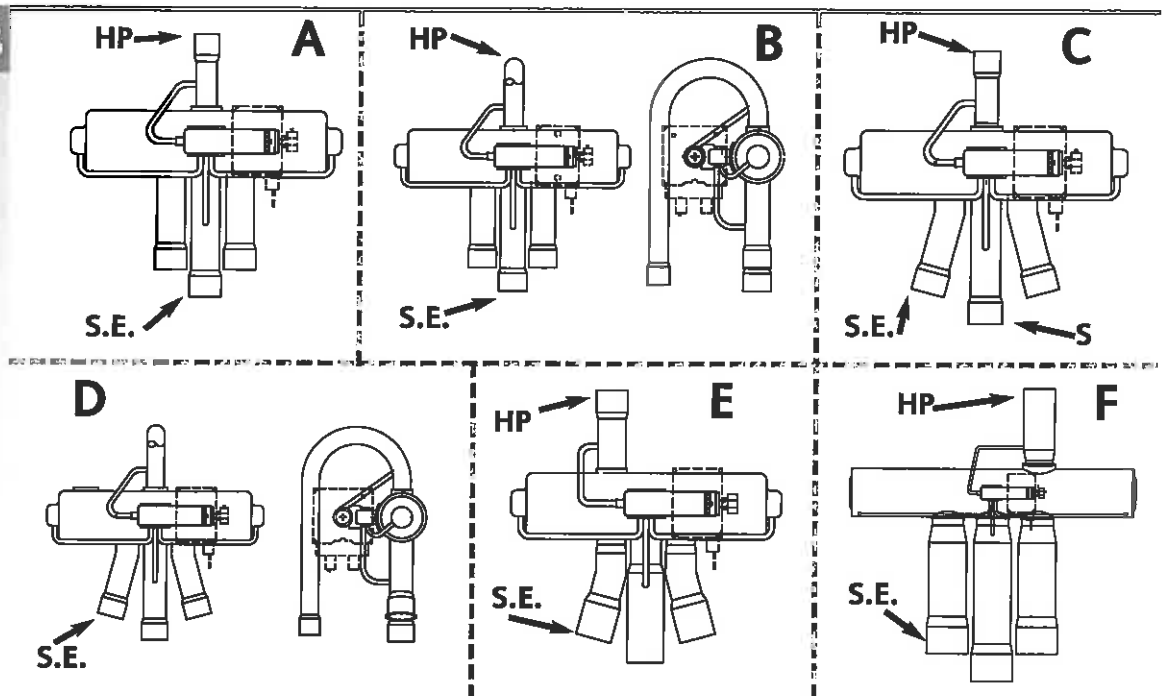
Description / Application



These solenoid operated Reversing Valves are slide type, 4-way with a 4-way Pilot valve and operate under the full pressure of the heat pump system.

The valves are used on unitary, split system, and window-type heat pump applications. There are six different styles designed to meet your particular system need.

Styles



Legenda

HP	High Pressure
S	Suction
S.E.	Connected to High Pressure when Solenoid is Energized

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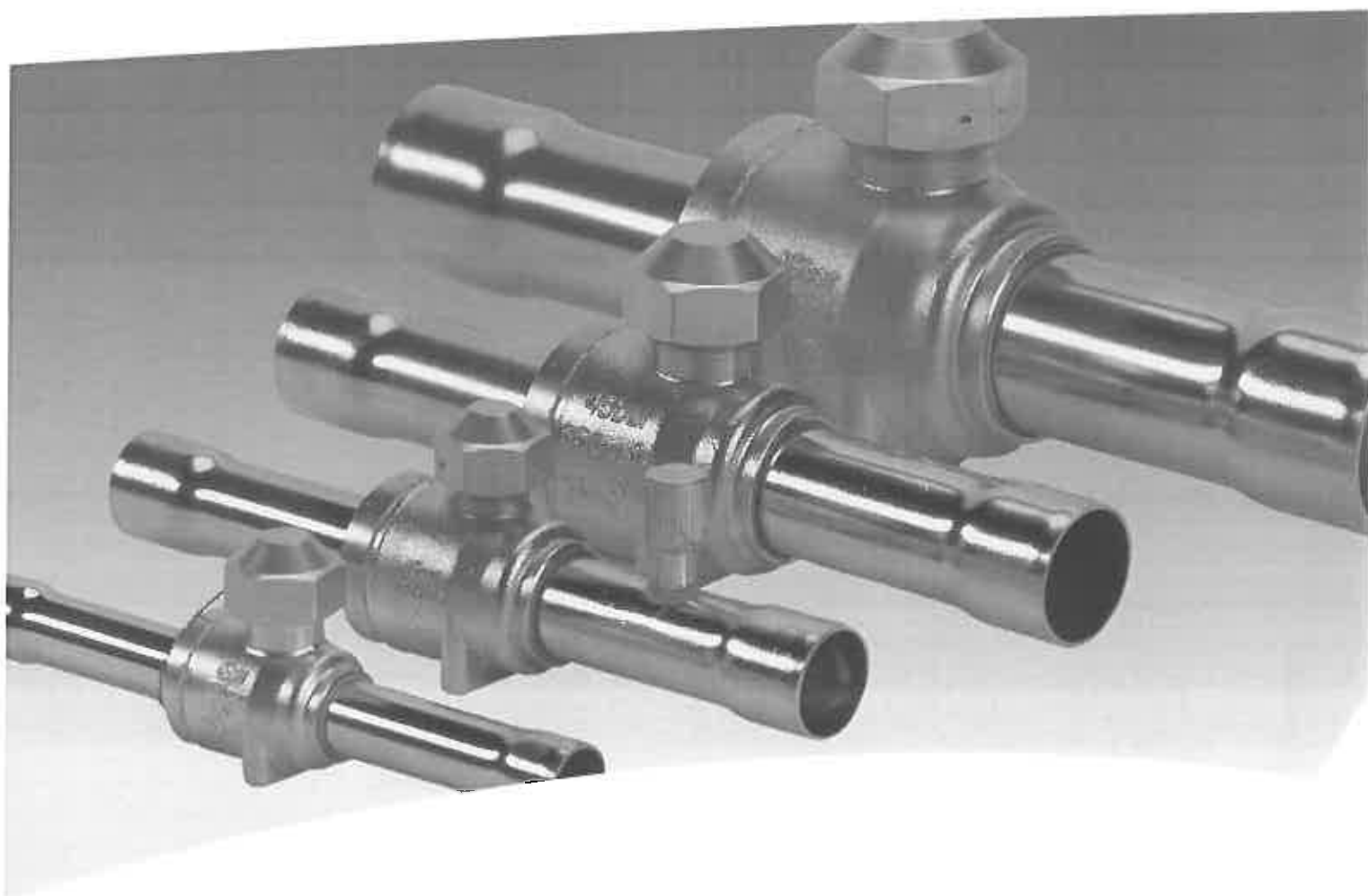
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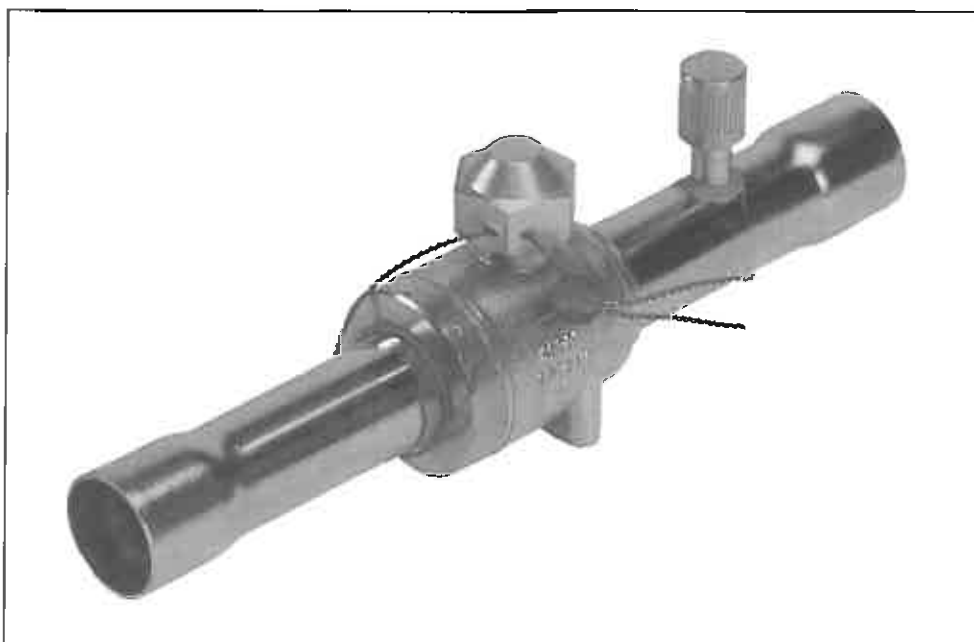
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Danfoss



Ball valves, type GBC

Introduction



Danfoss ball valves, type GBC, are manually operated shut-off valves suitable for bi-directional flow.

GBC valves are used in liquid, suction and hot-gas lines in refrigeration and air-conditioning systems.

GBC valves offer maximum tightness across the seat/seal.

The ball valves give maximum flow in the fully open position. They are designed for operation within a broad temperature range.

GBC valves are equipped with a one-piece seal cap and can be wire sealed to prevent unintentional cap removal or tampering in-between services.

Features

- Flow without pressure drop.
- ¼ turn from fully open to fully closed valve.
- Rotation stop for fully open and fully closed valve.
- Ball status Indicator on spindle top indicating open or closed position.
- Holes for panel mounting.
- Bi-directional flow, i.e. valve orientation is unimportant.
- Laser welded construction.
- Burst-proof spindle design.
- Valve seal of modified PTFE.
- Valve design prevents liquids from being trapped internally.
- One-piece seal cap for safety purpose – complies with European Safety Directive EN 378*.

Technical data

Refrigerants	CFC, HCFC, HFC
Temperature range	-40 → +150°C (-40 → +300°F)
Max. working pressure (PS/MWP)	45 bar (653 psig)
Max. test pressure	65 bar (943 psig)
Approvals	

*Safety and environmental requirements

Technical leaflet

Ball valves, type GBC

Ordering

The product range consists of two valve types: one with and one without access port. Both versions can be supplied in inch or

millimetre sizes from $\frac{1}{4}$ in. to $3\frac{1}{8}$ in. (6 mm to 54 mm). All valves have holes for panel mounting.



GBC without access port

GBC without access port

Type	Solder ODF connection		Solder ODF connection		K _v value *) [m ³ /h]
	[in.]	Code no.	[mm]	Code no.	
GBC 6s	$\frac{1}{4}$	009G7020	6	009G7030	1.96
GBC 10s	$\frac{3}{8}$	009G7021	10	009G7031	5.68
GBC 12s	$\frac{1}{2}$	009G7022	12	009G7032	10.58
GBC 16s	$\frac{5}{8}$	009G7023	16	009G7023	14.11
GBC 18s	$\frac{3}{4}$	009G7024	18	009G7035	20.42
GBC 22s	$\frac{7}{8}$	009G7025	22	009G7025	28.17
GBC 28s	$1\frac{1}{8}$	009G7026	28	009G7033	51.95
GBC 35s	$1\frac{3}{8}$	009G7027	35	009G7027	80.89
GBC 42s	$1\frac{5}{8}$	009G7028	42	009G7034	121.07
GBC 54s	$2\frac{1}{8}$	009G7029	54	009G7029	224.96
GBC 67s	$2\frac{5}{8}$	009G7036			245.78
GBC 79s	$3\frac{1}{8}$	009G7037			222.52



GBC with access port

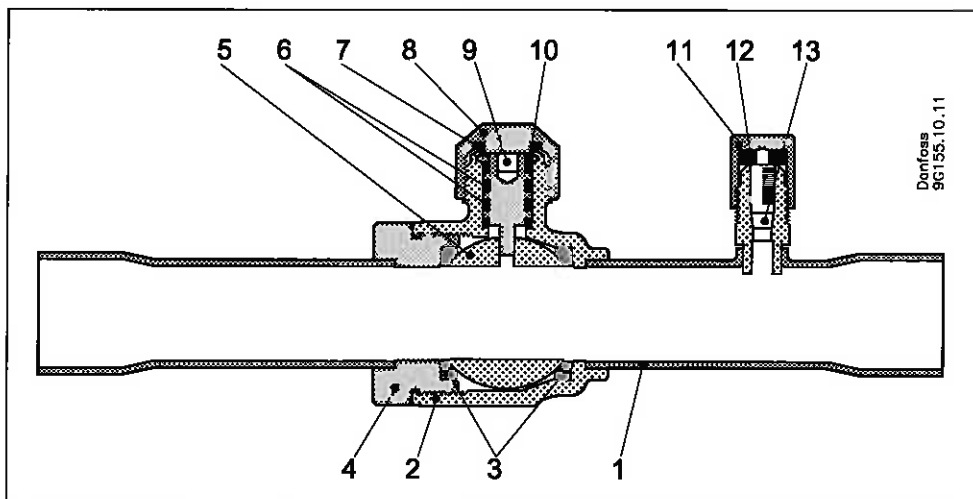
GBC with access port

Type	Solder ODF connection		Solder ODF connection		K _v value *) [m ³ /h]
	[in.]	Code no.	[mm]	Code no.	
GBC 6s	$\frac{1}{4}$	009G7050	6	009G7060	1.96
GBC 10s	$\frac{3}{8}$	009G7051	10	009G7061	5.68
GBC 12s	$\frac{1}{2}$	009G7052	12	009G7062	10.58
GBC 16s	$\frac{5}{8}$	009G7053	16	009G7053	14.11
GBC 18s	$\frac{3}{4}$	009G7054	18	009G7065	20.42
GBC 22s	$\frac{7}{8}$	009G7055	22	009G7055	28.17
GBC 28s	$1\frac{1}{8}$	009G7056	28	009G7063	51.95
GBC 35s	$1\frac{3}{8}$	009G7057	35	009G7057	80.89
GBC 42s	$1\frac{5}{8}$	009G7058	42	009G7064	121.07
GBC 54s	$2\frac{1}{8}$	009G7059	54	009G7059	224.96
GBC 67s	$2\frac{5}{8}$	009G7066			245.78
GBC 79s	$3\frac{1}{8}$	009G7067			222.52

*) CFD calculated values (Computational Fluid Dynamics)

Construction

1. Connection
2. Laser-welded valve body
3. Ball seat (modified PTFE)
4. Valve adapter
5. Stainless steel ball
6. Double spindle O-ring seal (chloroprene)
7. Cap O-ring seal (chloroprene)
8. Seal cap
9. Spindle
10. Support gasket
11. Access port cap
12. Seal gasket
13. Schraeder valve

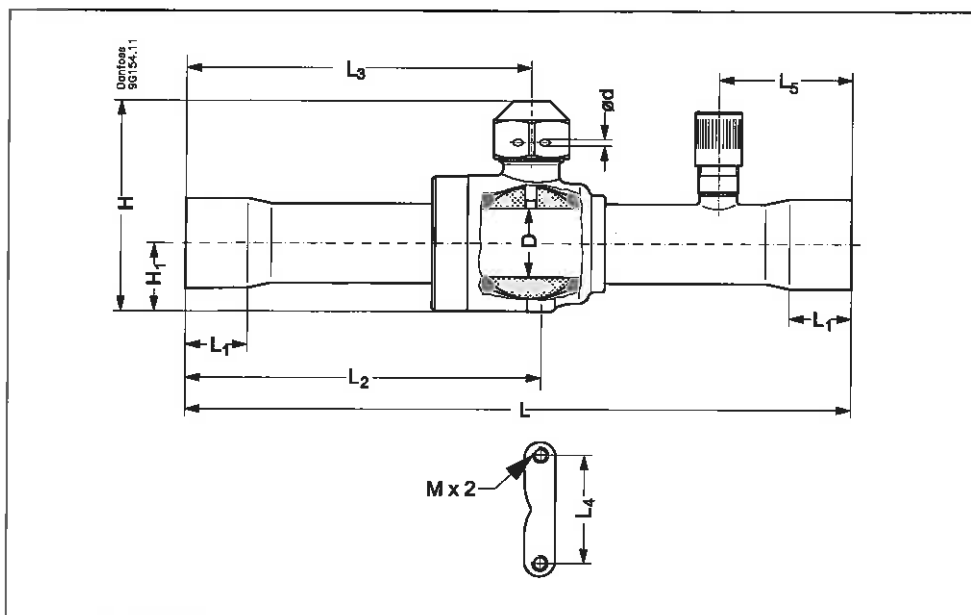


Direct flow gives maximum through-flow with minimum pressure drop across valve. The combination of laser-welded valve body (2), ball seat/seal (3), double spindle O-ring seal (6), and cap O-ring (7) gives absolutely minimum leakage.

Technical leaflet

Ball valves, type GBC

Dimensions and weights



Type	Connection		H	H ₁	L	L ₁	L ₂	L ₃	L ₄	L ₅	M	D	d	Weight
	[in.]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[Kg]*
GBC 6s		6	50	15	138	7	74	72	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 6s	1/4		50	15	138	7	74	72	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 10s	3/8		50	15	138	8	74	72	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 10s		10	50	15	138	9	74	72	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 12s		12	50	15	160	10	85	83	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 12s	1/2		50	15	160	10	85	83	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 16s	3/4		50	15	160	12	85	83	22	31	M4 × 0.7	14.0	1.5	0.2
GBC 18s		18	57	19	185	14	99	96	30	37	M4 × 0.7	19.0	1.5	0.4
GBC 18s	3/4		57	19	185	14	99	96	30	37	M4 × 0.7	19.0	1.5	0.4
GBC 22s	1/2		57	19	185	17	99	96	30	37	M4 × 0.7	19.0	1.5	0.4
GBC 28s		28	75	25	208	20	112	108	38	44	M4 × 0.7	25.5	1.5	0.9
GBC 28s	1 1/8		75	25	208	20	112	108	38	44	M4 × 0.7	25.5	1.5	0.9
GBC 35s	1 3/8		85	30	251	25	136	130	48	44	M6 × 1.0	32.0	1.5	1.4
GBC 42s	1 5/8		102	35	281	29	151	145	55	56	M6 × 1.0	38.0	1.5	2.2
GBC 42s		42	102	35	281	29	151	145	55	56	M6 × 1.0	38.0	1.5	2.2
GBC 54s	2 1/8		123	46	305	34	167	157	74	56	M6 × 1.0	50.0	1.5	4.2
GBC 67s	2 5/8		123	46	305	37	167	157	74	56	M6 × 1.0	50.0	1.5	4.4
GBC 79s	3 1/8		123	46	305	42	167	157	74	56	M6 × 1.0	50.0	1.5	4.5

* Calculated value

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Instructions

Danfoss

060R9750

060R9750

Pressure Controls

KP1, KP1W, KP1A, KP2, KP5, KP5A, KP6W, KP6B, KP6S, KP6AW, KP6AB, KP6AS, KP7W, KP7B, KP7S

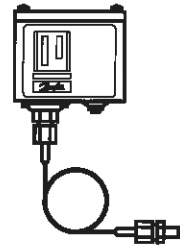
KP 1, 2, 5, 7: HFC, HCFC, CFC
 KP 6: HFC, HCFC, CFC, CO₂
 KP 1A, 5A, 6A: R 717 (NH₃)



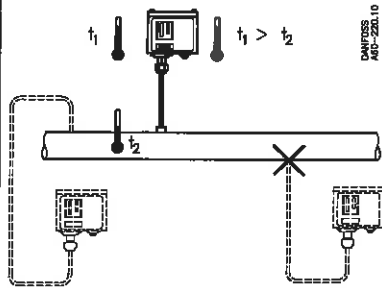
KP 1, 2, 5, 6, 7



KP 1, 2, 5, 6, 7



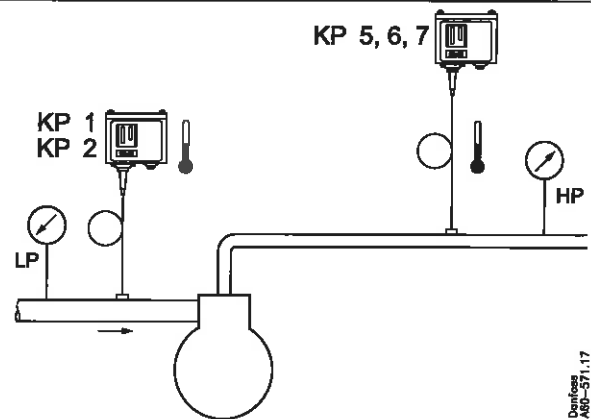
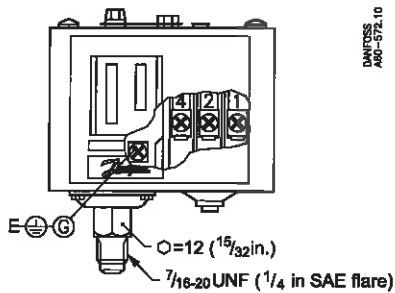
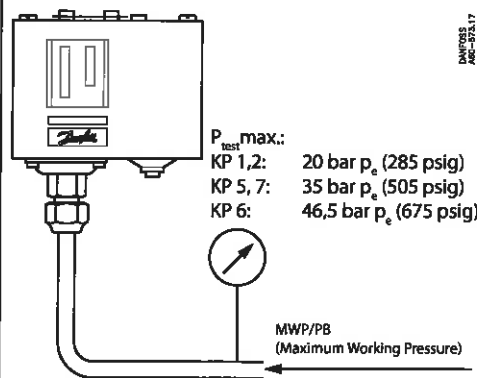
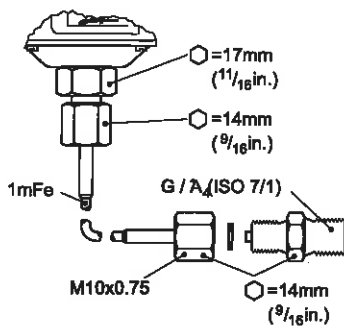
KP 1A, 5A



Relative humidity RH: 30 to 98%
 vibrations resistance: 4g (10-1000 Hz)

DANFOSS
A60-572.10

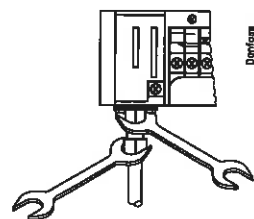
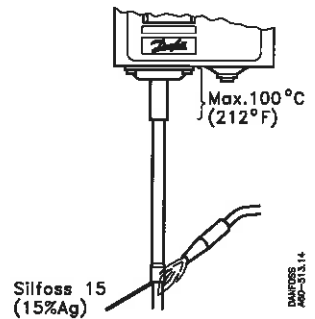
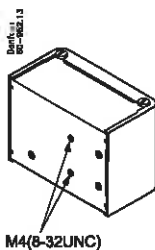
t1 min. KP 1,2,5: -40C (-40F)
 t1 min. KP 6,7: -25C (-13F)
 t1 max.: 65C (150F)

DANFOSS
A60-571.17DANFOSS
A60-572.10DANFOSS
A60-572.17

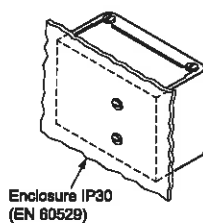
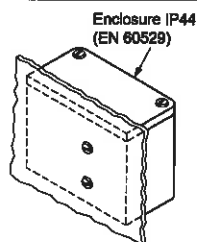
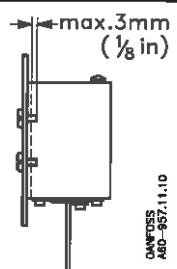
P_{test} max.:
 KP 1,2: 20 bar p_e (285 psig)
 KP 5, 7: 35 bar p_e (505 psig)
 KP 6: 46,5 bar p_e (675 psig)

MWP/PB
 (Maximum Working Pressure)

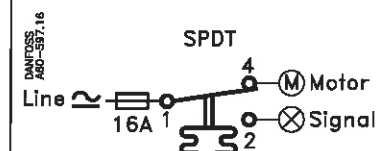
Type	Range	MWP/PB
KP 1	-0.2 → 7.5 bar	250 psi / 17 bar
KP 1, reset	-0.9 → 7 bar	250 psi / 17 bar
KP 1W	0.5 → 3 bar	250 psi / 17 bar
KP 2	-0.2 → 5 bar	250 psi / 17 bar
KP 5	8 → 32 bar	505 psi / 35 bar
KP 6	8 → 42 bar	675 psi / 46.5 bar
KP 7	8 → 32 bar	505 psi / 35 bar

DANFOSS
A60-571.12DANFOSS
A60-571.14

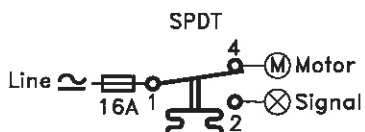
M4(8-32UNC)

Enclosure IP30
(EN 60529)Enclosure IP44
(EN 60529)DANFOSS
A60-957.11.10

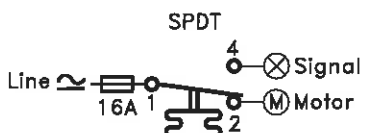
DKRCCPICA0A200-520H1366



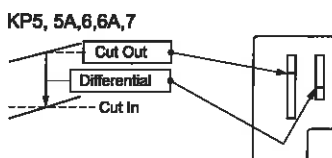
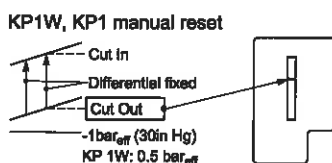
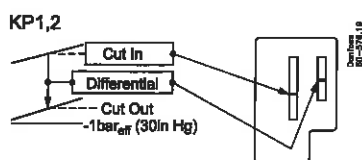
Contact 1-4 opens on pressure drop



Contact 1-4 opens on pressure drop



Contact 1-2 opens on pressure rise



Electrical rating - General

LR 112A	AC 1: 16A	400 V $\approx$	DC 13
	AC 3: 16A		12 W
	AC 15: 10A		220 V $\approx$

Short circuit protection: Fuse 16 Amp.

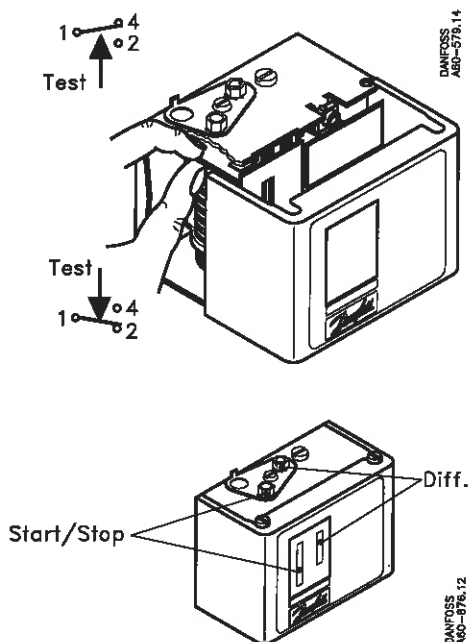
When used acc. to UL regulations

Listed refrigeration controller 61B5

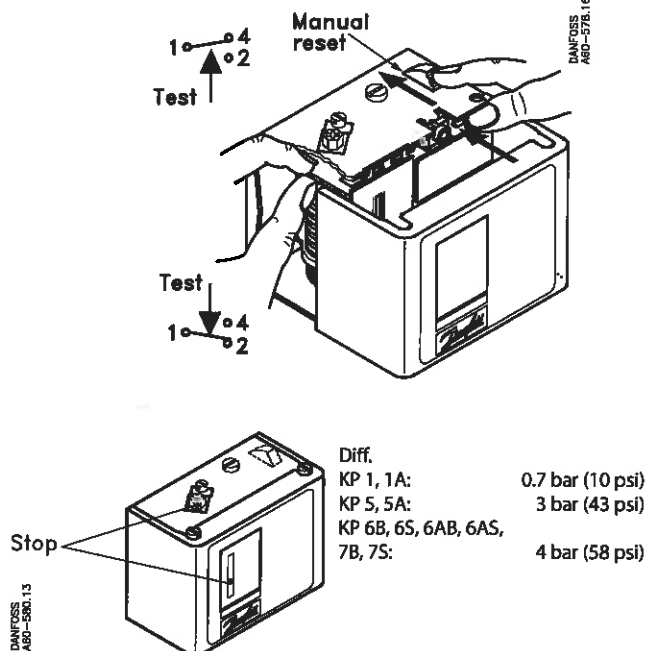
Voltage	FL	LR	Resist.	Pilot
AC	DC	A	A	load
240		8	48	8A
120		16	96	16A
	240			12W

Use copper wire only
Tightening torque 20 lb. in.

Manual reset

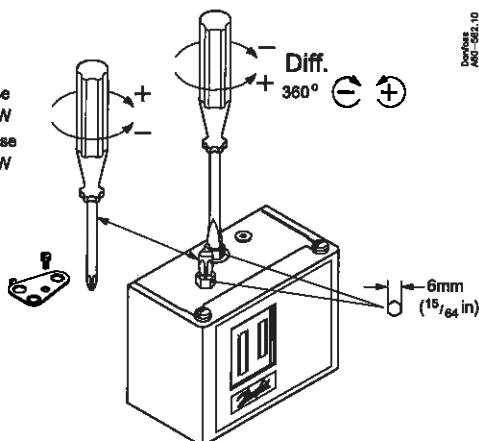


Manual reset



Range

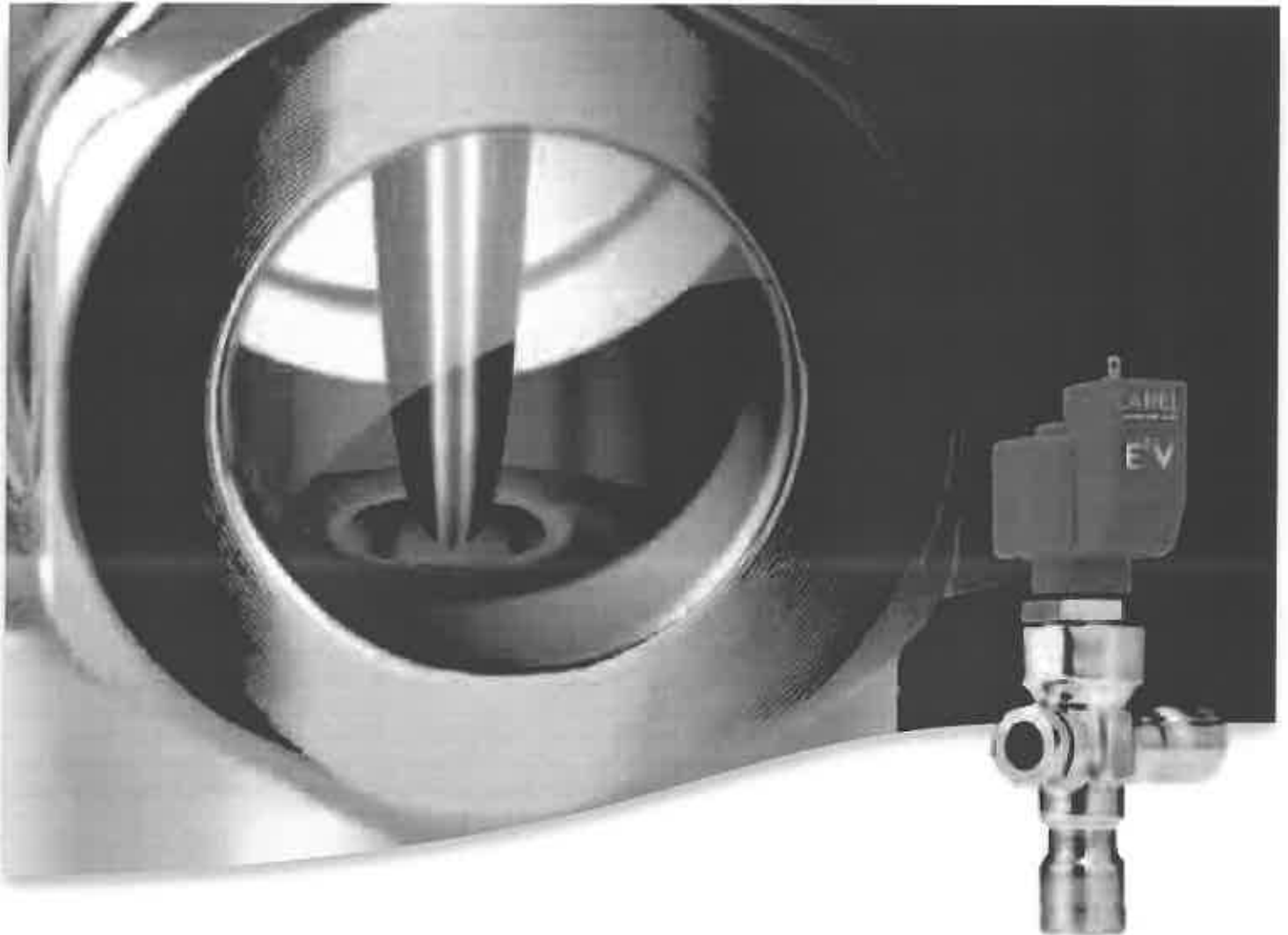
- ⊕ Increase
360° CW
- ⊖ Decrease
360° CW



CAREL



connectivity, monitoring and remote management systems
electronic expansion valves and drivers



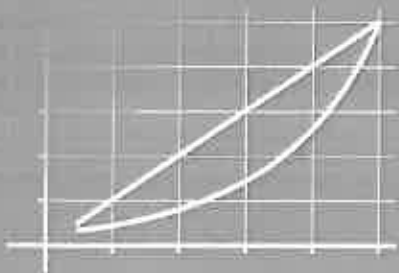
E²V smart electronic expansion valve

carel.com

E²V smart - high technology for even more flexible operation

The CAREL E²V-smart series electronic expansion valves combine the renowned reliability of the CAREL E²V with the versatility of a removable cartridge, covering a range of cooling capacities from 1 kW to 40 kW.

- efficient control of refrigeration and air-conditioning units; over an extended range of applications;
- completely removable for extremely simple installation;
- high reliability and high quality materials;
- equipercentile profile: guarantees precise control even when operating at part load

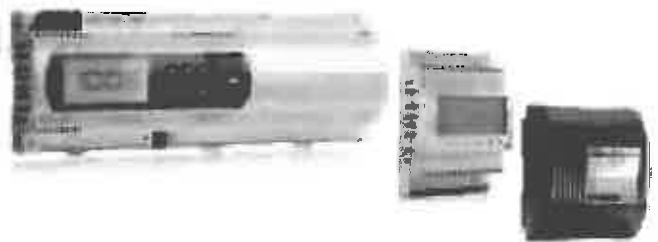


Modulation of refrigerant flow guarantees a wide operating range, due to the combination of the fixed opening and the moving element with a travel of 15 mm driven by stepper motor.

The E²V-smart has been carefully designed down to the smallest detail, to guarantee high reliability, and ensures correct operation with fluid flow in both directions. This simplifies the refrigerant circuit for reverse-cycle operation and reduces installation costs.

E²V-smart is made from modular components that are assembled during installation; this solution simplifies maintenance and inspection of the individual components.

CAREL products such as the EVD EVO, MPXPRO and pCO⁵ feature native support for valve control.



Easy installation and maintenance

The valve kinematic mechanism can be easily removed, simplifying welding by avoiding the risk of damage and allowing replacement if needed



Perfect seal on closing

In the closed position the valve provides perfect sealing to refrigerant flow, thanks to the Teflon gasket on the actuator and the calibrated spring that presses this against the edge of the opening



High reliability and high quality materials

The valve kinematic mechanism is made entirely from high quality materials. The construction without reduction gears means the mechanism is reliable and long-lasting, guaranteeing extended product life

Components

Removable stator

Easy to install and no contact with the refrigerant.

Removable cartridge

Guarantees maximum flexibility in installation, thanks to the possibility to weld the valve body separately from the cartridge.

Teflon gasket

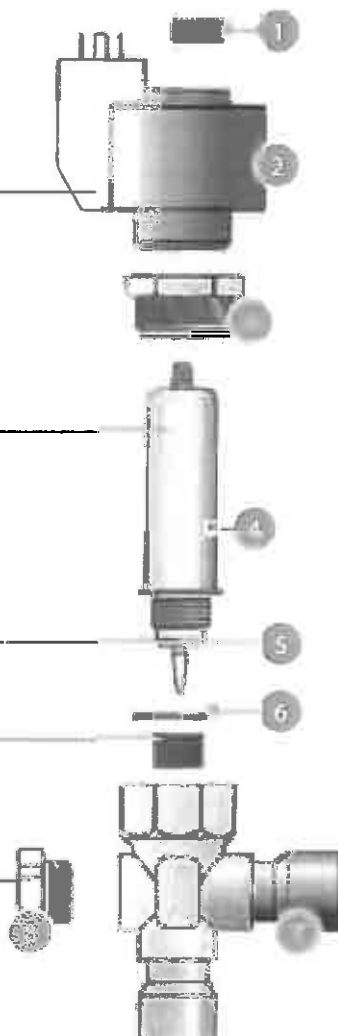
Guarantees perfect seal when valve closed

Built-in filter

Optional. Easy management of refrigerant filtering

Add-on sight glass

Optional. Shows the movement of the valve and the quality of expansion



- 1 threaded cap;
- 2 resin-bonded stepper motor with connector pins;
- 3 ring nut;
- 4 removable cartridge with kinematic mechanism and movement (control rod);
- 5 Teflon seal gasket;
- 6 Teflon gaskets;
- 7 body with fittings to be welded to the circuit pipework;
- 8 threaded sight glass with 2 o-rings (optional).

Technical specifications

CAREL F³-smart technical specifications

Compatibility	R22, R134a, R404A, R407C, R410A, R744, R507A, R417A
Maximum operating pressure (MOP)	up to 45 bars (653 psi)
Maximum operating press. diff. (MOPD)	35 bars (508 psi)
PED	Group 2, article 3, par. 3
Refrigerant temperature	-40T65 °C (-40T149 °F)
Room temperature	-30T50 °C (-22T122 °F)

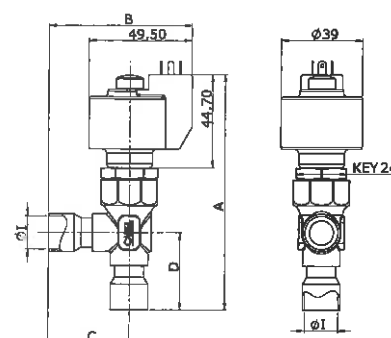
Contact CAREL INDUSTRIES for different operating conditions or alternative refrigerants

CARLL L³-smart stator

Phase current	450 mA
Control frequency	50 Hz (up to 150 Hz for emergency closing)
Phase resistance (25 °C)	36 Ohm ±100%
Index of protection	IP65 with E2VCON****, IP67 with E2VCAB***
Step angle	15°
Linear progress/step	0.03 mm (0.0012 inch)
Connections	4 wires (AWG 18/22)
Complete closing steps	550
Control steps	480

Dimensions

Type of valve	A mm (inch)	B mm (inch)	C mm (inch)	D mm (inch)	E mm (inch)
E2V**SSF**	109,8 (4.32)	65,7 (2.59)	35,7 (1.41)	34 (1.34)	12 (0.47)
E2V**SWF**	107,8 (4.24)	63,7 (2.51)	33,7 (1.33)	32 (1.26)	12,7 (1/2)
E2V**SSM**	112,8 (4.44)	68,7 (2.70)	38,7 (1.52)	37 (1.46)	16 (5/8)



Cooling capacity (kw)

AIR-CONDITIONING

condensing temp.= 38 °C, evaporation temp.= 4,4 °C

	R22	R134a	R404a	R410a	R407c	R507a
E2V05	1.7	1.3	1.2	2	1.7	1.2
E2V09	2.6	2	1.8	3.1	2.6	1.8
E2V11	4.5	3.5	3.3	5.4	4.7	3.2
E2V14	6.9	5.3	5	8.3	7.1	4.9
E2V18	9.9	7.6	7.1	11.8	10.1	6.9
E2V24	19.6	15.1	14.1	23.6	20.2	13.8
E2V30	31.2	23.9	22.3	37.5	32	21.8
E2V35	39.5	30.3	28.4	47.5	40.6	27.7

subcooling 1 °C

LT REFRIGERATION

condensing temp.= 40 °C, evaporation temp.= 40 °C

	R22	R134a	R404a	R410a	R407c	R507a
E2V05	2	1.4	1.3	2.3	1.9	1.2
E2V09	3	2.1	2	3.6	2.9	1.9
E2V11	5.3	3.8	3.5	6.4	5.2	3.4
E2V14	8.1	5.8	5.4	9.9	8	5.2
E2V18	11.5	8.2	7.6	14	11.3	7.4
E2V24	23	16.3	15.2	27.9	22.6	14.8
E2V30	36.4	25.9	24.1	44.2	35.9	23.4
E2V35	46.3	32.9	30.5	56.2	45.5	29.8

subcooling 5 °C

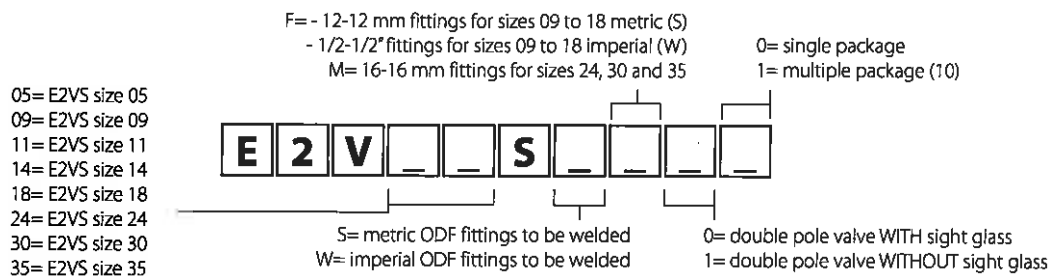
NT REFRIGERATION

condensing temp.= 40 °C, evaporation temp.= -15 °C

	R22	R134a	R404a	R410a	R407c	R507a
E2V05	1.9	1.4	1.4	2.3	2	1.3
E2V09	2.9	2.2	2.1	3.6	3	2
E2V11	5.2	3.9	3.7	6.4	5.3	3.6
E2V14	8	6	5.7	9.8	8	5.5
E2V18	11.4	8.5	8	13.9	11.5	7.8
E2V24	22.6	16.9	16	27.6	22.9	15.6
E2V30	35.8	26.7	25.5	43.7	36.3	24.8
E2V35	45.5	34	32.2	55.6	46.2	31.5

subcooling 5 °C

Codes



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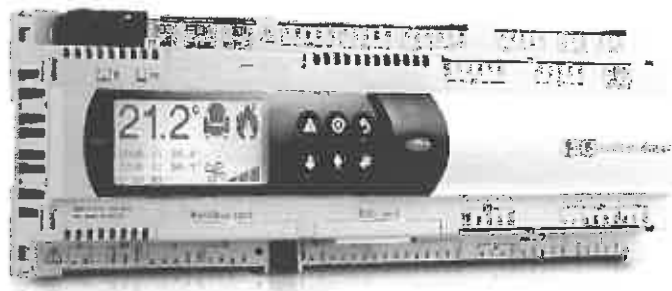
www.carel.co.th

CAREL Turkey

www.carel.com.tr

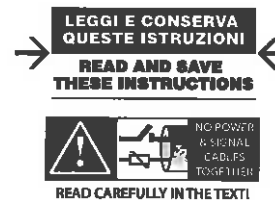
pCO⁵
controllo elettronico
electronic controller

CAREL



ITA Foglio istruzioni

ENG Technical leaflet



Integrated Control Solutions & Energy Savings

TECHNICAL SPECIFICATIONS

pCO⁵ is a microprocessor electronic controller compatible as concerns both hardware and software with the pCO⁵ family. Developed by CAREL in compliance with the European RoHS directives, these controllers can be used for multiple applications in the air-conditioning and refrigeration sectors. They ensure maximum versatility of application, allowing specific products to be developed to customer requirements. pCO⁵ runs the control program, and comes with a set of terminals for connecting the various devices (compressors, fans,...). The program and the parameters are saved to FLASH-MEMORY and EPROM, meaning all data is retained even in the event of power failures (without requiring a backup battery).

pCO⁵ can connect to a pLAN (pCO Local Area Network) and, in addition to other pCO⁵ devices, can also be connected to all other pCO sistema controllers and all pGD family terminals. Each controller in the pLAN network can exchange any variable, either digital or analogue, depending on the application program used. Up to 32 units can be connected (pCO controllers or terminals), for effective sharing of information.

pCO⁵ comes with two additional RS485 built-in serial ports compared to the other pCO controllers, one FieldBus and the other supervisor/telemaintenance (BMS). The BMS serial line is connected, using the CAREL or Modbus® communication protocol over RS485, by fitting the pCO⁵ with an optional serial card or alternatively using the built-in serial port.

Other optional cards can be used to connect a supervisor over standards other than RS485. Finally, the FieldBus serial connection, using the optional or built-in card, provides connection to controlled field devices (for example: valves, pCO⁵ I/O expansions, electronic valve external drivers,...). The pCO5 Medium size also features an optional new integrated solution: version with built-in EVD EVO valve driver, single or twin.

Versions available:

- SMALL, MEDIUM, LARGE, EXTRALARGE (digital output with normally open contacts), valve driver;
- with or without Built-In terminal;
- with additional NAND FLASH memory;
- with or without solid state relay (SSR) digital outputs 24Vac/Vdc or 110/230 Vac/Vdc;
- with or without USB Master and Slave.

Uploading the application program

The application program can be loaded onto the flash memory in different ways:

1. by key:
 - smart key code PCOS00AKY0;
 - USB pen drive;
2. by PC:
 - 485 serial port (28.8 kbps and 115.2 kbps) using USB-485 adapter code "CVSTDUTLFO"
 - USB slave

To upload via PC the "pCO Manager" program is required, available free-of-charge at the ksa.carel.com website.

Power supply

A class 2 safety transformer with a minimum rating of 50 VA (100 VA on the versions with built-in valve driver) and a 2.5 AT fuse must be used in the installation to supply just one pCO⁵ controller. The power supply to the pCO⁵ controller and terminal (or pCO⁵ controllers and terminals) should be separated from the power supply to the other electrical devices (contactors and other electromechanical components) inside the electrical panel. If the secondary of the transformer is earthed, make sure that the earth wire is connected to terminal G0. This is true for all the devices connected to the pCO⁵. If more than one pCO⁵ is connected, make sure that the G and G0 references are observed (G0 must be maintained for all boards).

If using the pLAN network and for further details, see the CAREL pCO sistema manual code +030220335.

FieldBus options

opto-isol. 485	PCO100FD10
ILAN	PCO100TLN0
Belimo MPBUS	PCO100MPB0
modem	PCO100FD20
hydronic CAN	PCO100HBF0
Komex	PCO100KXF0

BMS options

hydronic CAN	PCO100HBB0
485/Modbus®	PCO1004850
modem	PCO100MDM0
Ethernet/BACnet board	PCO1000V80
BACnet MS/TP board	PCO1000BA0
Komex	PCO100KXB0
LortWorks FTT10	PCO1000F0
LortWorks FTT10 standard chiller profile	PCO1000IF0

Connectors

Example of connector codes: PC05CON***, see the following table for the description:

PC05CON	*	*	0
	0= screw 1= spring loaded	S= small M= medium L= large Z= extra large 2= medium with valve driver	

Display

Built-in PGD1 (132x64 pixels), with backlit keypad.

TECHNICAL SPECIFICATIONS

Physical specifications

dimensions	SMALL version installable on 13 DIN modules, 110 x 227.5 x 60 mm MEDIUM, LARGE, EXTRALARGE and VALVE DRIVER versions installable on 18 DIN modules, 110 x 315 x 60 mm
assembly	DIN rail

Plastic case

- fitted on DIN rail as per DIN 43880 and IEC EN 50022;
- material: technopolymer;
- flame retardance: V2 (to UL94) and 850 °C (IEC 60695);
- ball pressure test: 125 °C;
- resistance to creeping current: ≥ 250 V;
- colour: grey RAL 7035;

Electrical specifications

power supply (controller with terminal connected)	Versions without built-in valve driver: 24 Vac +10/-15% 50 to 60 Hz and 28 to 36 Vdc +10/-20%; maximum current 45 VA/20 W Versions with built-in valve driver: 24 Vac +10/-15% 50 to 60 Hz; maximum current: 80 VA/35 W
terminal block	with male/female plug-in connectors, max voltage 250 Vac; cable cross-sect: min. 0.5 mm ² - max 2.5 mm ²
CPU	H8SX1651, 32 bit, 44 MHz
memory (FLASH MEMORY)	2+2 MB. Further 32 MB NAND Flash memory also available.
data memory (static RAM)	512 kB at 16 bit s(296 kB Bios; 216 kB application)
parameter data memory	13 kB at 16 bit (max limit: 100,000 writes per memory location) plus 32 kB EPROM (not available in pLAN)
working cycle time (applications of avg. complexity)	0.2 s (typical)
clock with battery	standard
clock precision	100 ppm
battery specifications	Lithium button battery, code CR2430, voltage 3 Vdc (dimensions 24x3 mm)

Digital inputs

type	ID1 to ID18 optically-isolated (voltage contact), B4, B5, B9, B10 non optically-isolated (free contact)			
maximum number voltage inputs optically-isolated	8: SMALL; 14: MEDIUM & EXTRALARGE ; 18: LARGE. As per combinations shown below:			
	no. 24 Vac opto inputs 50/60 Hz o 24 Vdc	no. 24 Vac/Vdc or 230 Vac opto inputs (50/60 Hz)	total inputs	
SMALL	8	none	8	
MEDIUM/ EXTRALARGE	12	2	14	
LARGE	14	4	18	
maximum number inputs free contact not optically-isolated	2: SMALL, MEDIUM & EXTRALARGE (B4 and B5); 4: LARGE (B4, B5, B9, B10)			
Classification of measurement circuits (IEC EN 61010-1)	Category 1 (J5, J7, J20) 24 Vac/Vdc - Category 3 (J8, J19) 230 Vac			

Voltage-free digital input current (B4, B5, B9, B10)	5 mA
Digital input current with 24 Vac voltage signal	5 mA
Digital input current with 230 Vac voltage signal	5 mA

WARNINGS:

- IDH digital inputs 230 Vac 50/60 Hz (10/-15%) protected by a single 500 mA T fuse;
- the two 230/24 Vac inputs at J8 and J12 have the same common and so both will be either 24 Vac/Vdc or 230 Vac. There is double insulation between the two inputs and the rest of the controller;
- the external contact connected to the digital inputs must have a minimum current of 5 mA;
- for DC digital inputs (Vdc), either the + or the - can be connected to the common (IDC1).

Note: separate as much as possible the probe signal and digital input cables from the cables to inductive loads and power cables, to avoid possible electromagnetic disturbance.

Fast digital input specifications (B4 and B5)

When configured as fast digital inputs, B4 and B5 can measure a signal with a maximum frequency of 2 KHz and a resolution of ± 1 Hz. This is possible as the BIOS provides the application program two pairs of variables that count the zero crossing of the input signal and the corresponding frequency in Hz.

Analogue inputs

analogue conversion type	10-bit A/D converter embedded in CPU
maximum number	universal: (inputs B1, B2, B3, B6, B7, B8) CAREL NTC temperature sensor (-50/190 °C; R/T 10 k Ω at 25 °C), NTC HT 0T150 °C, voltage: 0 to 1 Vdc, 0 to 5 V ratiometric or 0 to 10 Vdc, current: 0 to 20 mA or 4 to 20 mA, selectable via software. Input resistance for 0 to 20 mA= 100 Ω passive: (inputs B4, B5, B9, B10) CAREL NTC temp. sensor (see universal), PT1000 (-100/200 °C; R/T 1000 Ω at 0°C) or volt-free digital input (5 mA), selected via software;
time constant for each input	5: SMALL; 8: MEDIUM & EXTRALARGE; 10: LARGE
precision	0,5 s
class. of measurement circuits (IEC EN 61010-1)	± 0.3 % of full scale
input impedance	Category I NTC 10 k Ω 4-20 mA 100 Ω 0-1 V 100 k Ω 0-5 V 20 k Ω 0-10 V 12,7 k Ω PT1000 10 k Ω

WARNING: the 21 Vdc available at terminal +Vdc (J2) can be used to power any active probes; the maximum current is 150 mA, protected against short-circuits. To power the 0 to 5 Vdc ratiometric probes, use the +5VREF (Imax: 60 mA) available at terminal J24. Only use these voltages to power the active probes connected to pCO².

Analogue outputs

type	0 to 10 Vdc optically-isolated on Y1, Y2, Y3, Y4, Y5 and Y6 / phase control on Y3 and Y4
maximum number	4: SMALL, MEDIUM & EXTRALARGE ; 6: LARGE
power supply	24 Vac/Vdc external on VG(+), VG(-)
resolution	8 bit
maximum load	1.5 k Ω (7 mA)
precision	± 2 % of full scale on outputs: Y1, Y2, Y3, Y4, Y5 and Y6

WARNINGS:

- A 0 to 10 Vdc analogue output can be connected in parallel to other outputs of the same type, or alternatively to an external source of voltage. The higher voltage will be considered. Correct operation is not guaranteed if actuators with voltage inputs are connected. Power the VG-VG0 analogue outputs at the same voltage on G-G0: Connect G0 to VG0 and G to VG. This is valid for both alternating and direct current power supplies.
- For phase control outputs (PWM), note that synchronicity (zero crossing) is taken from G/G0 and only with 24 Vac power supply (not Vdc).

Digital outputs

type	relays
max. number	8: SMALL; 13: MEDIUM; 18: LARGE; 29: EXTRALARGE

For the connections see Figs. 3 and 4 (reference NO*, NC* and C*). Note that outputs with changeover contacts are kept separate (i.e. without poles

shared between outputs). The groups of 3 outputs have 2 "common" contacts for easier installation.

Make sure that the current running through the common terminals does not exceed the rated current of an individual terminal, that is, 8 A. Minimum relay contact current: 50 mA.

Insulation distance	The relay outputs have different features, depending on the model of pCO ⁵ . The outputs can be divided into groups. Between groups (cells in the table) there is double insulation and consequently these may have different voltages. There is also double insulation between each terminal of the digital outputs and the rest of the controller. The relays belonging to the same group (individual cell in the table) have basic insulation and therefore must have the same power supply (24 Vac or 230 Vac).											
Makeup of the groups	version	relays with same insulation										
		group 1	group 2	group 3	group 4	group 5	group 6	group 7	group 8	group 9	group 10	group 11
	SMALL	1-3	4-6	7	8	-	-	-	-	-	-	-
	Type of relay	Type A	Type A	Type A	Type A	-	-	-	-	-	-	-
	MEDIUM	1-3	4-6	7	8	9-11	12	13	-	-	-	-
	Type of relay	Type A	Type A	Type A	Type A	Type A	Type A	Type A	-	-	-	-
	LARGE	1-3	4-6	7	8	9-11	12	13	14	15	16-18	-
	Type of relay	Type A	Type A	Type A	Type A	Type A	Type A	Type A	Type A	Type A	Type A	-
	EXTRALARGE	1-3	4-6	7	8	9-11	12	13	14-16	17-20	21-24	25-29
	Type of relay	Type A	Type A	Type A	Type A	Type A	Type A	Type A	Type B	Type B	Type B	Type B
NOTE: the relays in the individual cells of the table have basic insulation, while there is double insulation between groups of cells.												
Changeover contacts	1: SMALL (relay 8); 3: MEDIUM & EXTRALARGE (relays 8, 12 & 13); 5: LARGE (relays 8, 12, 13, 14 & 15)											
Switchable power	warning: the relay outputs have different features, depending on the model of pCO ⁵											
	type A relay	relay type: SPDT, 2000 VA, 250 Vac, 8 A resistive pCO ⁵ approval: UL873: 2,5 A resistive, 2 A FLA, 12 A LRA, 250 Vac, C300 pilot duty (30,000 cycles) EN 60730-1: 2 A resistive, 2 A inductive, cosφ=0.6, 2(2) A (100,000 cycles)										
	type B relay (only EXTRALARGE version)	relay type: SPDT, 1250 VA, 250 Vac, 5 A resistive pCO ⁵ approval: UL873: 1 A resistive, 1 A FLA, 6 A LRA, 250 Vac, D300 pilot duty (30,000 cycles) EN 60730-1: 1 A resistive, 1 A inductive, cosφ=0.6, 1(1) A (100,000 cycles)										
SSR outputs	1: SMALL (output 7); 2: MEDIUM & EXTRALARGE (outputs 7 & 12); 3 or 4: LARGE (outputs 7, 12 & 14 or 7, 12, 14 & 15) working voltage: 24 Vac/Vdc; maximum power: 10 W, resistive load working voltage: 110/230 Vac/Vdc; maximum power: 10 W, resistive load											

Plug-in connectors

Electrical specifications of the plug-in connectors used:

Type of connector	Pitch 5.08
Rated voltage	250 V
Rated current	12 A
Cable size	0.25 mm ² - 2.5 mm ² (AWG: 24 to 12)
Stripping length	7 mm
Screw thread size	M3
Tightening torque	0.5-0.6 Nm

Cable AWG and size cross-reference

AWG	Size (mm ²)	Current
20	0.5	2
15	1.5	6
14	2.5	8

pCO⁵ serial connections

There are three types of serial connections

- pLAN
- BMS
- FieldBus

The FieldBus serial card features Master hardware and so BMS Slave devices must be connected to it. The protocols used for FieldBus are generally Master (Carel or ModBus®) however Slave can also be used (Carel or ModBus®). The opposite is also true: Slave protocols will be used on the BMS (Slave hardware) however Master is also possible.

Limits:

- FieldBus serial (Master): a maximum of 16 Slave devices (BMS) can be connected, with the address set between 1 and 207 plus one other FieldBus with Slave function.
- BMS serial (Slave): generally connected to a FieldBus or PC. If connected to a FieldBus a maximum of 16 devices can be connected. If connected to a PC up to 207 BMS devices can be connected.

- pLAN (Multi Master): maximum 32 devices.

Serial ZERO: PLAN - J10, J11

- Integrated on main board
- Not optically-isolated
- HW driver: RS485
- Connectors: Telephone jack + 3-pin plug-in p. 5.08

Serial ONE: BMS 1 Serial Card

- Not integrated on main board
- HW driver: not present
- Can be used with all pCO family optional BMS cards

Serial TWO: FieldBus 1

- Not integrated on main board
- HW driver: not present
- Can be used with all pCO family optional FieldBus cards

Serial THREE: BMS 2 - J25

- Integrated on main board
- Not optically-isolated (Optically-isolated version also available)
- HW driver: RS485
- 3-pin plug-in connector p. 5.08

Serial FOUR: FieldBus 2 - J26 (and J23 on Large and ExtraLarge version)

- Integrated on main board
- Not optically-isolated
- HW driver: RS485
- 3-pin plug-in connector p. 5.08
- J23 and J26 are electrically insulated but both managed by the same serial port (FOUR).

pLAN network/user terminal connection

type	asynchronous half duplex RS485
transmission speed	62.5 Kbps or 115.2 Kbps selectable via software
PGD0, PGD1 terminal connector	6-pin telephone (J10)
pLAN network/other terminals	3-pin plug-in connector (J11)
maximum number of units connectable	32

The maximum distance between the pCO and the user terminal is shown in the following table.

type of cable	power supply distance	power supply
telephone	10 m	taken from pCO (150 mA)
AWG24 shielded cable	200 m	taken from pCO (150 mA)
AWG20/22 shielded cable	500 m	separate power supply via TCONN6J000

The maximum distance between two pCO⁵ devices with AWG20/22 shielded cable is 500 m.

Note:

- J10 can only be connected to one terminal (pCOT, pCOI, pCD0, pGD1) or two terminals when the backlighting for the display is not activated.
- Except PGD0 and PGD1 terminals, the other terminals should be always powered with separate power supplies.
- The 21 Vdc available at +Vterm (J24) can be used to power an external terminal as an alternative to the one connected to terminal J10, with maximum current 1.5 W.

VERSION WITH ELECTRONIC EXPANSION VALVE DRIVER

The pCO5 Medium size features an optional new integrated solution: the version with built-in EVD EVO driver, single or twin. The driver card is housed on the pCO5 in the socket provided for the inputs / outputs on the Large size board, hence the reason it's only available on the pCO5 Medium (not Small, Large, nor ExtraLarge) and doesn't require an external power supply..

The built-in driver replicates all the hardware and functions logical of the "EVD Evolution TWIN" driver, i.e. independently controls one or two electronic expansion valves with two-pole stepper motors. The only difference between the two versions is the absence of the relay output. For details on the valve control logic, setup and installation see the EVD EVO manual (code + 0300005EN).

In the same way as EVD EVO, on the pCO5 the integrated driver is available in the CAREL and Universal versions. The "Universal" models are used to control both CAREL electronic expansion valves and products made by other manufacturers (see the table below), while the CAREL models only manage CAREL valves.

Valve compatibility table

Manufacturer	Compatible models
CAREL	E*V****
ALCO	EX4; EX5; EX6; EX7; EX8 330 Hz (rec'd by CAREL); EX8 500 Hz (to ALCO specs)
SPORLAN	SEI 0.5-11; SER 1.5-20; SEI 30; SEI 50; SEH 100; SEH175
Danfoss	ETS 12.5-25B; ETS 50B; ETS 100B; ETS 250; ETS 400
CAREL	Two CAREL EVs connected together
SPORLAN	SER(I) G, J, K

Serial communication and programming

Communication between the pCO5 and its built-in EVD EVO driver is managed internally using the Fieldbus2 serial port. The FieldBus2 serial port (J26) is however electrically insulated from the driver serial line: this ensures that in the event of external faults on the line connected to FBus2, the internal driver can continue working independently and correctly.

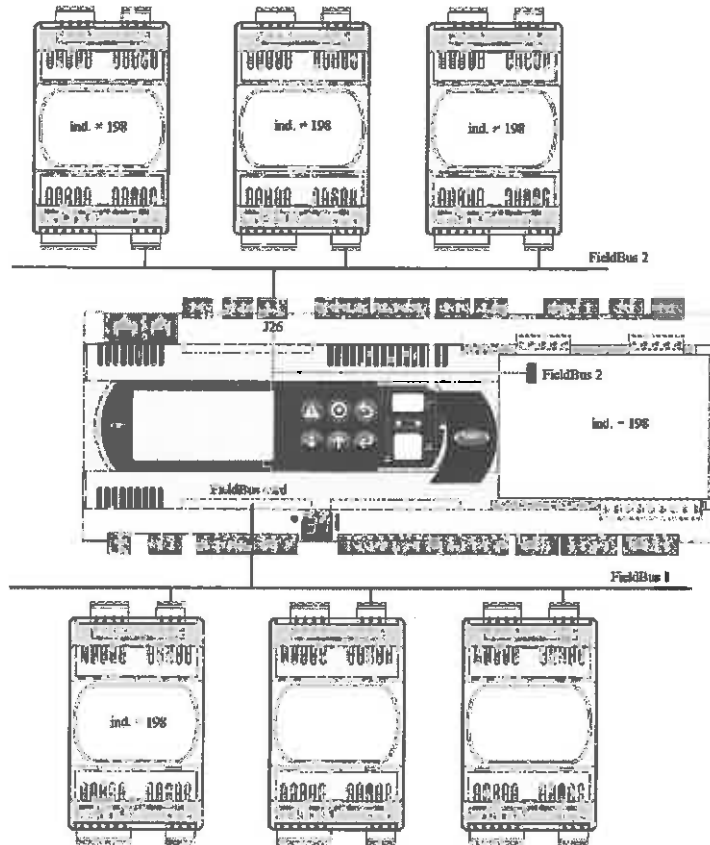
The driver can only be configured exclusively using the pCO5 application developed in 1Tool, no external displays are available for the EVD EVO.

The 1tool development environment features a module for managing the EVD EVO: the same module can be used to manage the internal driver, as if it were managing an external EVD EVO connected to the FBus2 port.

pCO5 Medium manages the integrated driver board as an EVD EVO Twin external connected to Field Bus 2. At a 1Tool application program level, the valve driver must be connected to FBus2. Consequently, any other devices physically connected to the Fbus port (J26) must have the same communication protocol (CAREL Standard Master or Modbus® Master), the same baud-rate, stop bits and parity.

It must also be remembered that the address of the internal driver is 198 (default for EVD EVO), so any other devices connected to J26 must have an address other than 198. External EVD EVO drivers can be connected to FieldBus 1 (optional card) without limits.

Example application:



To ensure efficient data exchange between the driver EVD EVO and the pCO5, when developing the 1Tool application, if there are devices connected to the FBUS2 port (terminal J26) using the Modbus protocol®, the number of variables exchanged in total over the serial line should be evaluated.

Electrical connections

- To simplify installation of the pCO5 with integrated EVD EVO, the power supply G-GO at the base of the pCO5 is connected internally, using a shielded cable, to the EVD EVO: the driver thus does not need to be powered independently.
- It's recommended to keep the digital and analogue input cables separate from the valve power cable. All the analogue and digital inputs are earthed to GND, and consequently the application, even temporary, of voltages exceeding ± 5 V to these connections may cause irreversible damage to the driver. As GND is the common earth for all the inputs, this should be replicated on the terminal block.

Technical specifications

Collegamento motore	shielded 4-wire cable CAREL code E2VCABS*00, or AWG22 shielded 4-wire cable Lmax = 10 m, or AWG14 shielded 4-wire cable Lmax = 50 m			
Motor connection	Digital input to be activated with voltage-free contact or transistor to GND. Closing current 5 mA; Maximum length < 10 m			
Digital input connection	maximum length 10 m or less than 30 m with shielded cable			
S1	rationometric pressure probe (0 to 5 V)	resolution 0.1 % fs	measurement error: 2% fs maximum; 1% typical	
	electronic pressure sensor (4 to 20 mA)	resolution 0.5 % fs;	measurement error: 8% fs maximum; 7% typical	
	combined rationometric pressure probe (0 to 5 V)	resolution 0.1 % fs	measurement error: 2 % fs maximum; 1 % typical	
	4 to 20 mA input (max. 24 mA)	resolution 0.5 % fs	measurement error: 8 % fs maximum; 7 % typical	
	S2	low temperature NTC	10 k Ω at 25°C, -50T90 °C	measurement error: 1°C in the range -50T50 °C; 3 °C in the range +50T90 °C
		high temperature NTC	50 k Ω at 25°C, -40T150 °C	measurement error: 1.5 °C in the range -20T115 °C, 4 °C in the range outside of -20T115 °C
		combined NTC	0 k Ω at 25°C, -40T120 °C	measurement error: 1°C in the range -40T50 °C; 3 °C in the range +50T90 °C
		0 to 10 V input (max 12 V)	resolution 0.1% fs	measurement error: 9% fs maximum; 8% typical
	S3	rationometric pressure probe (0 to 5 V):	resolution 0.1 % fs	measurement error: 2% fs maximum; 1% typical
		electronic pressure sensor (4 to 20 mA)	resolution 0.5 % fs;	measurement error: 8% fs maximum; 7% typical
		combined rationometric pressure probe (0 to 5 V)	resolution 0.1 % fs	measurement error: 2 % fs maximum; 1 % typical
		4 to 20 mA input (max. 24 mA)	resolution 0.5 % fs	measurement error: 8 % fs maximum; 7 % typical
	S4	low temperature NTC	10 k Ω at 25°C, -50T105 °C;	measurement error: 1 °C in the range -50T50 °C; 3°C in the range 50T90 °C
		high temperature NTC	0 k Ω at 25°C, -40T150 °C	measurement error: 1.5 °C in the range -20T115 °C; 4 °C in the range outside of -20T115 °C
		combined NTC	10 k Ω at 25°C, -40T120 °C	measurement error 1 °C in the range -40T50 °C; 3 °C in the range +50T90 °C
Probes	programmable output: +5 Vdc+/-2% or 12 Vdc+/-10%			
Power to active probes (VREF)				

Example CAREL codes

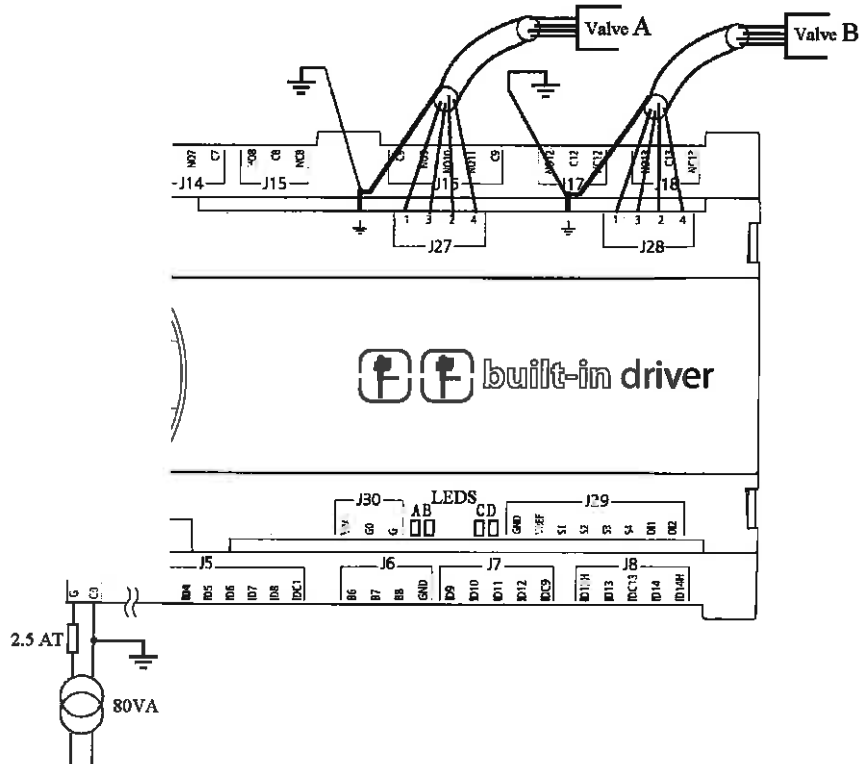
PCO5000000A20: PCO5 MEDIUM + EVD EVO EMBEDDED FOR 2 CAREL EXV

PCO50000U0C20: PCO5 MEDIUM + USB + NAND + EVD EVO EMBEDDED FOR 2 CAREL EXV

PCO50000U0C60: PCO5 MEDIUM + USB + NAND + EVD EVO EMBEDDED FOR 2 UNIV. EXV

PCO50000U0F20: PCO5 MEDIUM + USB+NAND+PGD1 +EVD EVO EMBEDDED FOR 2 CAREL EXV

Connection diagram and signals



Valve connectors J27 and J28:

- 1 = green
- 3 = brown
- 2 = yellow
- 4 = white

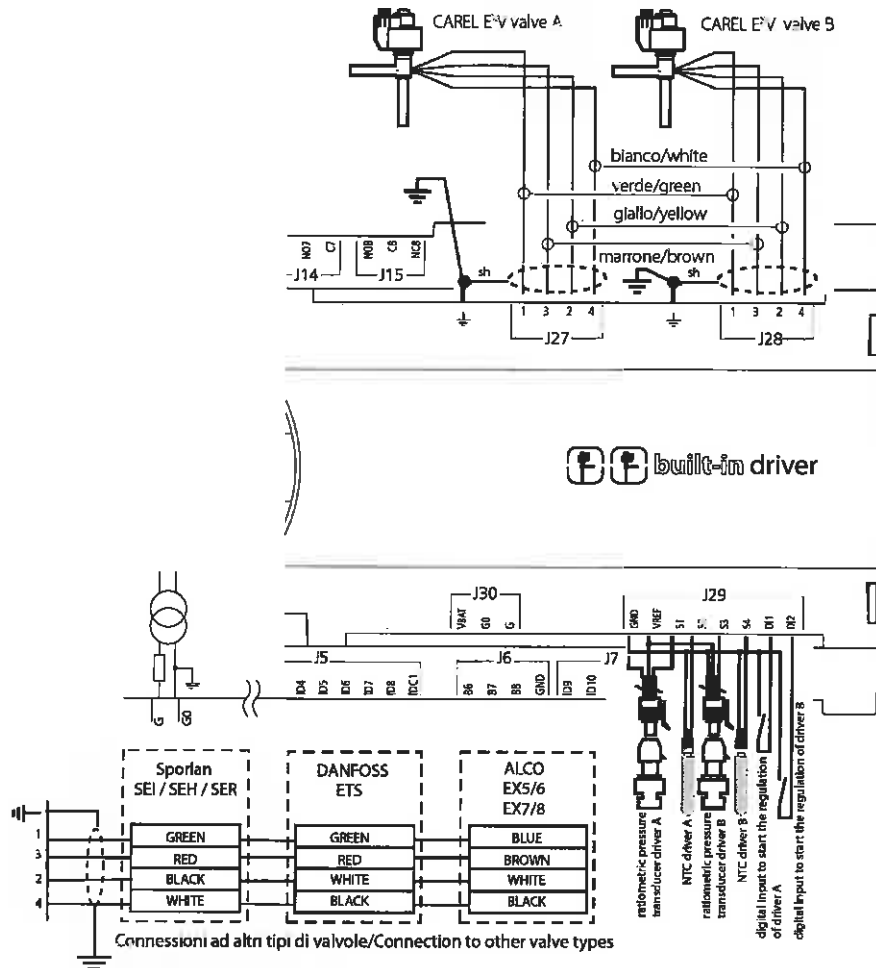
- Connect the valve cable shield to the spade and earth.
- G0 must be connected to earth on the transformer secondary.

Indicator LEDs:

- A (yellow) = Close valve A (J27)
- B (green) = Open valve A (J27)
- C (yellow) = Close valve B (J28)
- D (green) = Open valve B (J28)

- Flashing if the valve is moving.
- On steady if the valve is at the end of travel.

Connections based on the type of valves



Other specifications

storage conditions	-40T70 °C, 90% rH non-condensing
operating conditions	-25T60 °C, 90% rH non-condensing
index of protection	IP20, IP40 on the front panel only
environmental pollution	2
class according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances in the versions without valve driver, Class 1 in versions with valve driver.
PTI of the insulating materials	PCB: PTI250; insulation material: PTI 175
period of stress across the insulating parts	long
type of action	1C; 1Y for SSR versions
type of disconnection or microswitching	microswitching
category of resistance to heat and fire	category D (UL94 - V2)
immunity against voltage surges	category 2
ageing characteristics (operating hours)	80,000
no. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
software class and structure	Class A
category of immunity to voltage surges (IEC EN 61000-4-5)	Category 3
The device is not designed to be hand-held when powered.	

Product certifications

Electrical safety	EN 60730-1, EN 60730-2
Electromagnetic compatibility	Versions without valve driver: EN 61000-6-1, EN 61000-6-2, EN 61000-6-2/EC, EN 61000-6-2/IS1, EN 61000-6-3, EN 61000-6-4; EN 55014-1, EN 55014-2, EN 55014-2/EC, EN 55014-2/A1, EN 55014-2/IS1, EN 55014-2/A2 Versions with valve driver: EN 61000-6-1, EN 61000-6-2, EN 61000-6-2/EC, EN 61000-6-2/IS1, EN 61000-6-3, EN 61000-6-4

WARNINGS

- for applications subject to considerable vibrations (1.5 mm pk-pk 10/55 Hz), secure the cables connected to the pCO⁵ around 3 cm from the connectors using clamps;
- cables longer than 10 m, excepted the cables for relays and 230 Vac digital inputs, must be shielded with shield connected to the ground;
- in residential environments (EN55014), in the versions without valve driver the connection cable between the pCO⁵, the terminal and the other serial boards must be shielded and earthed at both ends;
- the device must be installed according to the standards and legislation in force in the country where it is used;
- for safety reasons the equipment must be housed inside an electrical panel, so that the only accessible part is the display and the keypad;
- all the extra low voltage connections (analogue and 24 Vac/Vdc digital inputs, analogue outputs, serial bus connections, power supplies) must have reinforced or double insulation from the mains network;
- in the event of malfunctions, do not attempt to repair the device, but rather contact the CAREL service centre;
- make sure that the temperature inside the panel where the pCO⁵ is installed does not exceed the operating conditions

ACCESSORIES

PCOS00AKY0	pCO Sistema smart key
0907877AXX	external ferrite for pCO ⁵ power cable
S90CONN002	pGD terminal connection cable L= 0.8 m
S90CONN000	pGD terminal connection cable L= 1.5 m
S90CONN001	pGD terminal connection cable L= 3 m

DIMENSIONS

pCO₅ MEDIUM, LARGE, EXTRALARGE, VALVE DRIVER dimensions

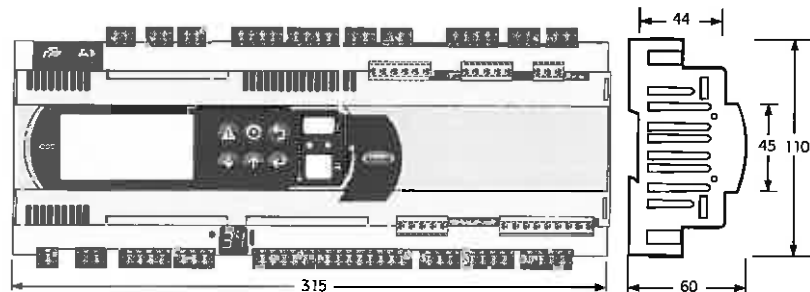


Fig. 1

pCO₅ SMALL dimensions

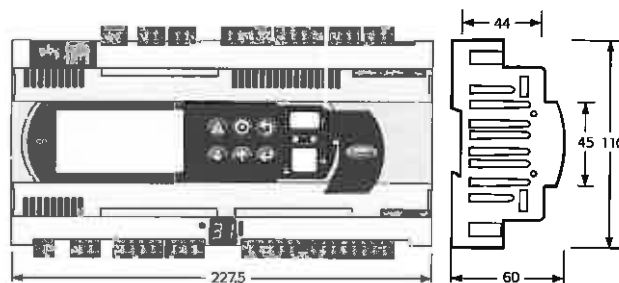


Fig. 2

INSTALLATION WARNINGS

intended environments and connection

Avoid installing the boards in environments with the following characteristics:

- relative humidity greater than 90%;
- strong vibrations or knocks;
- exposure to continuous water sprays;
- exposure to aggressive and polluting atmospheres (e.g.: sulphur and ammonia fumes, saline mist, smoke) so as to avoid corrosion and/or oxidation;
- strong magnetic and/or radio frequency interference (there avoid installing the units near transmitting antennae);
- exposure of the pCO₅ to direct sunlight and to the elements in general;
- large and rapid fluctuations in the room temperature;
- environments where explosives or mixes of flammable gases are present;
- exposure to dust (formation of corrosive patina with possible oxidation and reduction of insulation);

For connection, the following warnings must be heeded:

- power supplies other than those specified may seriously damage the system;
- use cable ends suitable for the corresponding terminals. Loosen each screw and insert the cable ends, then tighten the screws. When the operation is completed, slightly tug the cables to check they are sufficiently tight;
- separate as much as possible the probe signal and digital input cables from the inductive load and power cables to avoid possible electromagnetic disturbance. Never run power cables (including the electrical cables) and probe signal cables in the same conduits. Do not install the probe cables in the immediate vicinity of power devices (contactors, circuit breakers or similar);
- reduce the path of the sensor cables as much as possible, and avoid spiral paths that enclose power devices.
- avoid touching or nearly touching the electronic components fitted on the boards to avoid electrostatic discharges (extremely damaging) from the operator to the components;

- separate the power supply to the digital outputs from the pCO² power supply;
- disconnect the controller from the power supply before performing any maintenance or assembly operations;
- if the device is used in a manner not specified by the manufacturer, the rated protection of the device may be compromised.

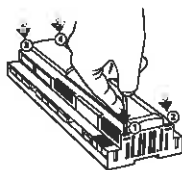
pCO² does not provide protection against short-circuits and overloads, consequently suitable protection devices (2.5 AT fuses) must be installed on the power supply lines and on the 230 Vac digital input lines (500 mA fuse).

pCO² is not a device that guarantees electrical safety, but rather suitable operation: to prevent short-circuits from causing fire in the electrical panels, the customer must install appropriate electromechanical protection devices on the lines in question (fuses or the like). In addition, the type of software does not guarantee electrical safety.



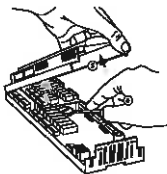
WARNING: separate as much as possible the probe and digital input signal cables from the cables carrying power to avoid possible electromagnetic disturbance.

NEVER RUN POWER CABLES (INCLUDING THE ELECTRICAL PANEL WIRING) AND SIGNAL CABLES IN THE SAME CONDUITS.



GUIDELINES FOR DISPOSAL

- Do not dispose of the product as municipal waste; it must be disposed of through specialist waste disposal centres.
- The product contains a battery that must be removed and separated from the rest of the product according to the instructions provided, before disposing of the product.
- Improper use or incorrect disposal of the product may have negative effects on human health and on the environment.
- The public or private waste collection systems defined by local legislation must be used for disposal.
- In the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.



LARGE version



EXTRALARGE version

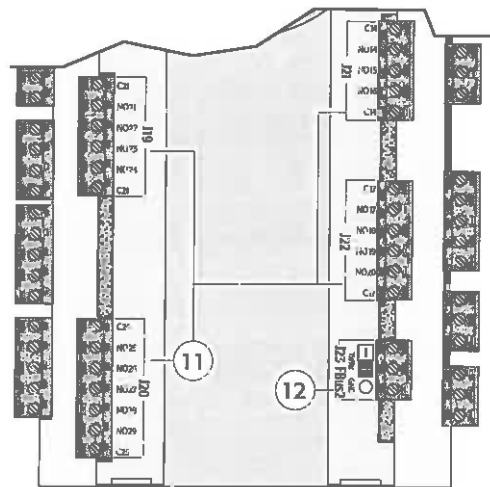


Fig. 4

Key (Fig. 3-4-5)

1. power supply connector [G (+), G0 (-)];
2. pLAN address button, 7 segment display and LED (power ON and overload +Vdc connector);
3. additional power supply for the terminal and 0 to 5 V ratiometric probes;
4. universal NTC analogue inputs, 0 to 1 V, 0 to 5 V ratiometric, 0 to 10 V, 0 to 20 mA, 4 to 20 mA;
5. passive NTC analogue inputs, PT1000, ON/OFF;
6. 0 to 10 V analogue outputs;
7. 24 Vac/Vdc digital inputs;
8. 230 Vac or 24 Vac/Vdc digital inputs;
9. display terminal connector (external panel with direct signals);
10. connector for all the standard pCO series terminals and for downloading the application program;
11. relay digital outputs;
12. Fieldbus2 connector;
13. pLAN network connector;
14. cover for inserting the supervisor serial card option (BMS1);
15. cover for inserting the field card option (Fieldbus1);
16. BMS2 connector;
17. Fieldbus2 connector;
18. Built-In terminal (LCD, buttons and LEDs);
19. USB Host and Slave connector
20. Electronic valve connector
21. Valve driver analogue and digital inputs
22. External power supply from Evbat module

Version with VALVE DRIVER

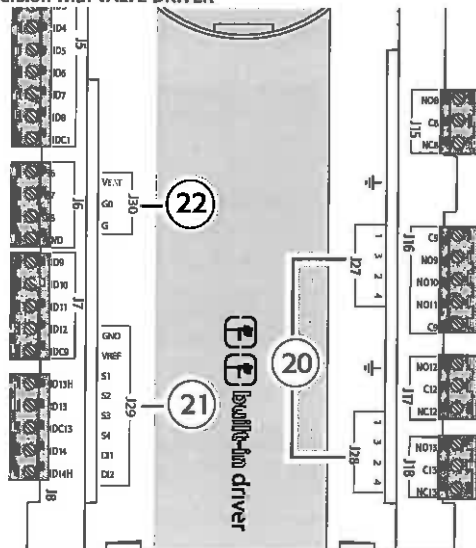


Fig. 5

pCO⁵ simulator

Contact CAREL for availability of pCO⁵ simulator. If the new functions on the pCO⁵ are not needed, the pCO³ simulator can be used.

NOTES FOR THE INSTALLER

Procedure for setting the controller and terminal pLAN address

Setting the controller address

The address can be set using the button accessible from the hole on the left of the 7 segment display or alternatively using the software procedure, in the same way as for the pCO⁵. Pressing the button once shows the pLAN address. 5 s after the button release the display turn off.

Procedure using the button and 7 segment display:

1. press the button for 3 s
2. the address saved is shown flashing
3. press the button repeatedly until reaching the desired address or alternatively hold for autorepeat
4. wait 10 s to save. The display flashes quickly. Turn the pCO⁵ off and on again to activate the new address.

To cancel the operation turn off the controller less than 7 s after the last button is pressed.

The software procedure is as follows:

1. power down the pCO⁵;
2. prepare a standard CAREL terminal with the address set to 0 (this is not necessary if the pCO⁵ built-in terminal is used). To do this, see the following paragraph;
3. connect the terminal to the pCO⁵;
4. disconnect any other devices connected in the pLAN from the pCO⁵ (J11 connector);
5. power up the pCO⁵ while pressing UP + ALARM together. This combination of buttons is the same on the built in terminal. Alternatively, on the PCOT terminals, use the combination of  & .
6. after a few seconds the following screen is displayed:

```

PLAN ADDRESS: 0
UP: INCREASE
DOWN: DECREASE
ENTER: SAVE & EXIT
  
```

7. to only set the address, simply use on the UP and DOWN buttons and then press ENTER to confirm;
8. now set the pLAN address of the terminal and configure the pLAN network.

Setting the terminal address

pCO⁵/pCOT terminal

The address of the terminal is set using the dipswitches on the rear of the terminal.

pGD01/2/3 terminal

The default address set in the factory is 32.

The address of the terminal can only be set after having powered the terminal using the telephone connector.

To enter configuration mode, press the 3 $\downarrow\uparrow$ buttons together (even when the terminal is already on), available on all versions, for at least 5 seconds; the screen shown in the following figure will be displayed, with the cursor flashing in the top left corner:

```

Display address
setting.....:nn
I/O Board address:xx
  
```

- to set the terminal address (display address setting) press $\downarrow$ once: the cursor will move to the address field (nn).
- use the $\downarrow\uparrow$ buttons to select the desired value, and confirm by pressing $\downarrow$ again. If the value selected is different from the value saved previously, the screen shown in the following figure will be shown and the new value will be saved to the permanent memory on the display.

```

Display address
changed
  
```

If the field nn is set to 0, the terminal will communicate with the pCO⁵ controller using the "point-to-point" protocol (not pLAN), and the field xx will not be displayed, as it no longer has meaning.

pCO⁵: assigning the list of private and shared terminals

To modify the list of terminals associated with each individual pCO⁵ board, proceed as follows:

- enter configuration mode by pressing $\downarrow\uparrow$ as described in the previous paragraph;
- press $\downarrow$ until the cursor reaches the field xx (I/O board address);
- use the $\downarrow\uparrow$ buttons to select the address of the desired pCO⁵ board. The values available correspond to the pCO⁵ boards that are effectively on line. If the pLAN network is not working correctly, or no pCO⁵ board is available, the field cannot be modified and will show "--";

- pressing $\downarrow$ once again displays the following sequence of screens:

Terminal Config	
Press ENTER to continue	
↓	
P12:Adr	Priv. Shared
Trm1 02	Sh
Trm2 03	Pr
Trm3 None	--DI?:NO

- once again pressing $\downarrow$ moves the cursor from one field to the next, and $\downarrow$ / $\uparrow$ change the value of the current field.
The field Pxx shows the address of the selected board; in the example in the figure, 12 has been selected;
 - to exit the configuration procedure and save the data, select the field "OK ?", set Yes and confirm by pressing $\downarrow$.
- The fields in the "Adr" column represent the addresses of the terminals associated with the pCO⁵ board with address 12, while the Priv/Shared column indicates the type of terminal.
Important: the pGD terminals cannot be configured as "Sp" (shared printer) as they have no printer output.
If the terminal remains inactive (no button pressed) for more than 30 seconds, it automatically exits the configuration procedure without saving any changes.

USB PORT OPERATION

pCO⁵ is supplied with two different USB ports (host and slave), to be used during installation and diagnostics.

The host port is used to connect USB data storage peripherals (pen drives, portable hard disks, etc.) and then perform a series of operations:

1. upload files present on the removable peripheral to the pCO⁵: application, parameters in buffer memory, configuration files for logs, Bios.
2. download files from the pCO⁵ to the removable peripheral: application, parameters in buffer memory, logs, Bios.

To access the menu used to manage the contents of the removable peripheral connected to the host port, simply hold ALARM+ENTER for a few seconds, until the first Bios system screen is shown. Selecting the FLASH/USB MEMORY item and then USB PEN DRIVE accesses the main menu used to choose the operation, upload or download. When selecting UPLOAD, a further option is shown to specify manual access the contents of the pen drive (browsing the directories and files) or automatic access (direct access to the configuration files). In addition, if the peripheral connected contains a file called AUTORUN.TXT that is compliant with the corresponding specifications, the terminal will automatically show a screen for the direct activation of the specific function this refers to. For details on creating such files, see the manual code +030220335.

The DOWNLOAD option is used to download the application, the logs, the parameters and the Bios. Note that during the upload and download procedures through the host port, operation of the pCO⁵ Bios is limited solely to USB management.

The USB slave port can be connected directly to a PC, without needing additional devices. To use this function, the pCO Manager software is required.

The following operations are available through this port:

1. upload files to the pCO⁵,
1. download data to the PC from the pCO⁵,
2. manage the NAND flash,
3. commissioning.

Applications or Bios can be uploaded through the slave port. The application includes any files relating to the parameters in the buffer memory and any configuration files for acquiring the logs. The download operations allowed are all those featured in pCO Manager, that is, downloading the logs and the contents of T and P memories.

The slave port connection can also be used to manage the NAND flash, with the possibility to upload/download the files, delete files or completely format the memory. The same port can also be used for commissioning, as long as a suitable application is used, together with the information contained in the .2cf file.

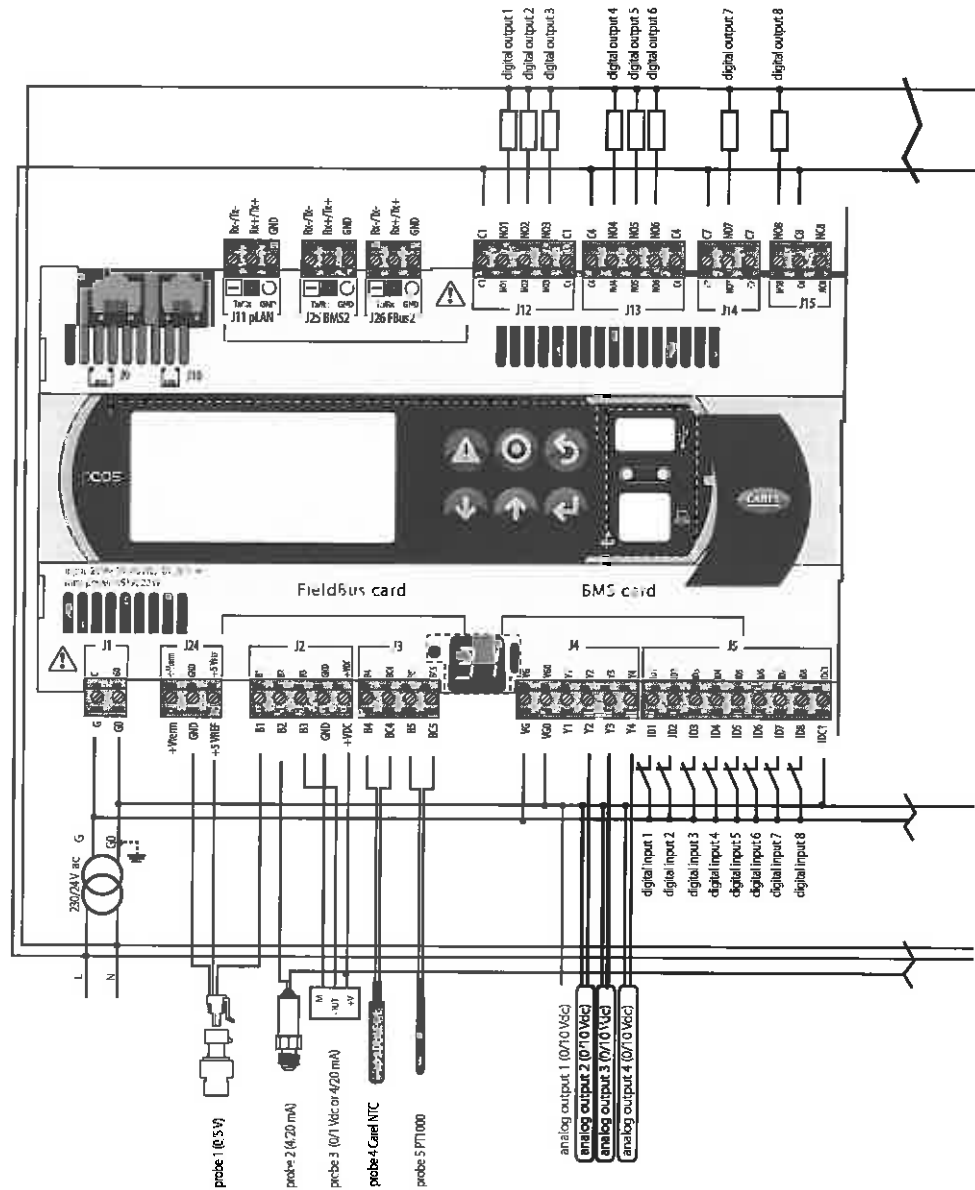
WARNINGS: The two USB ports cannot be used together. The two ports must be used distinctly to ensure correct operation of the pCO⁵.

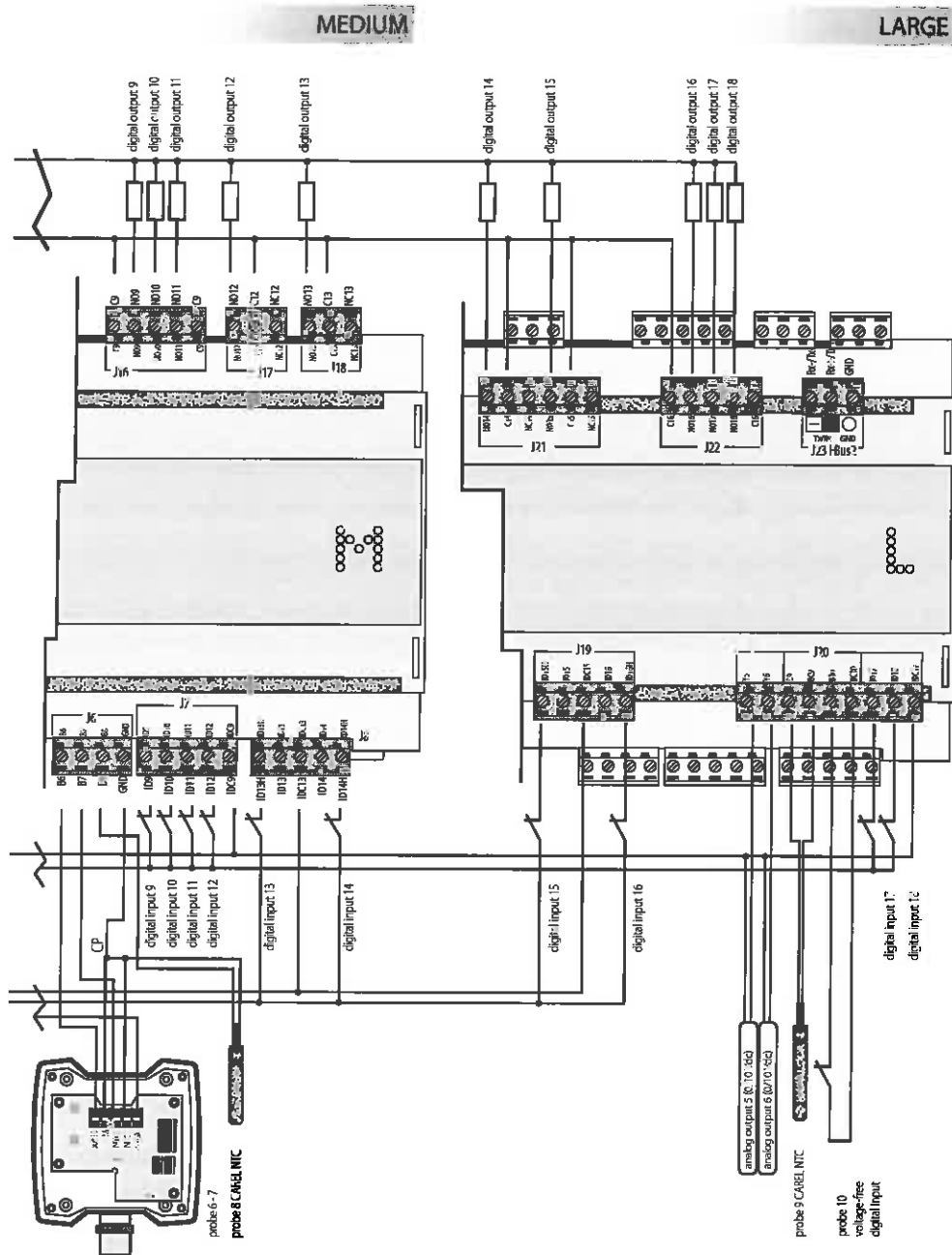
NOTES ON USING PCO MANAGER, BOOT AND BIOS

It is always recommended to use the most recent version of pCO Manager available on <http://ksa.carel.com>. The BIOS and BOOT on the pCO⁵ are specific files, different from the pCO^{4/2/3/PS} BIOS and BOOT files. As a result, these files cannot be loaded on the pCO⁵, and, obviously, the BOOT and BIOS files for the pCO⁵ cannot be loaded on pCO^{4/2/3/PS}.

EXAMPLE: GENERAL WIRING DIAGRAM

SMALL





IMPORTANT WARNINGS

The CAREL product is a state-of-the-art device, whose operation is specified in the technical documentation supplied with the product or can be downloaded, even prior to purchase, from the website www.carel.com.

The customer (manufacturer, developer or installer of the final equipment) accepts all liability and risk relating to the configuration of the product in order to reach the expected results in relation to the specific final installation and/or equipment.

The failure to complete such phase, which is required/indicated in the user manual, may cause the final product to malfunction; CAREL accepts no liability in such cases.

The customer must use the product only in the manner described in the documentation relating to the product.

The liability of CAREL in relation to its products is specified in the CAREL general contract conditions, available on the website www.carel.com and/or by specific agreements with customers.

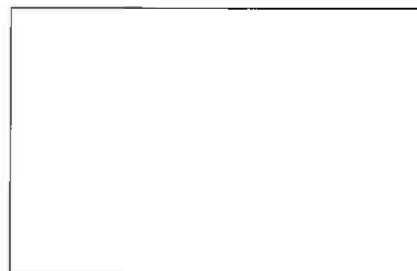
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pCO compact
controllo elettronico
electronic controller

CAREL



ITA Foglio istruzioni

ENG Technical leaflet

→ **LEGGI E CONSERVA
QUESTE ISTRUZIONI** ←
**READ AND SAVE
THESE INSTRUCTIONS**

Integrated Control Solutions & Energy Savings



Symbol:



Warning: the symbol in the plastic cover of the control, means to refer to this technical leaflet, during the electrical installation.

CAREL**1. INTRODUCTION**

The new pCO compact series is the result of the need for a controller than can manage considerable information flows. This feature adds to the numerous advantages of a programmable controller.

pCO compact is compatible with the pCO family at both a hardware and software level, the controller has been developed by CAREL in compliance with the European RoHS directive. Ideal as system coordinator, the simultaneous access to one supervisory systems and master functions make it versatile for all types of applications and requirements in the HVAC/R sector.

The application program can be downloaded to the flash memory using the smart key PCOS00AKY0, or from a PC using the CVSTDUTLFO USB-485 adapter and the pCO manager, or 1 tool program, or directly by USB connection in the provided models.

The pCO compact can also execute a control program, and is fitted with a set of terminals for connection to devices such as probes, compressors, fans, etc.

The fast digital input can be used to directly read energy meters.

The program and the parameters are saved to FLASH memory and EEPROM, meaning the data is stored even in the event of power failures and without the need for a backup battery.

The program can be loaded from a PC (28.8 kbps and 115.2 kbps) or using the special programming key called the Smart Key. The optional connection to the supervisor-telemaintenance serial line using the CAREL or Modbus® communication protocol, over the RS485 standard, is made by fitting the pCO compact with one optional serial cards. Other optional cards can be used to connect to a supervisor over standards other than RS485 (communicating via BACnet, LON, SNMP, HTTP, e-mail, Konnex).

pCO compact has 3 serial interfaces, specifically:

- one BMS serial interfaces for serial cards
- one opto-isolated Field-Bus serial interface (alternatively can be used for the tLAN)
- one pLAN serial interface for acquiring or sharing data.

The built-in user interface consists of a White positivo LCD, with 132x64 pixel resolution and a six-button membrane keypad.

1.1 Versions available

The controller is available in two models: TYPE A and TYPE B, yet a different only maximum number of I/Os available.

Models	Description	Carel code
TYPE A	BASIC (RELAY)	PCOX000AA0
	BASIC (2 SSR)	PCOX002AA0
	+ BUILT-IN DISPLAY (RELAY)	PCOX000BA0
	+ BUILT-IN DISPLAY (2 SSR)	PCOX002BA0
	+ USB (RELAY)	PCOX000CA0
	+ USB (2 SSR)	PCOX002CA0
	+ USB + BUILT-IN DISPLAY (RELAY)	PCOX000DA0
TYPE B	+ USB + BUILT-IN DISPLAY (2 SSR)	PCOX002DA0
	BASIC (RELAY)	PCOX000AB0
	BASIC (2 SSR)	PCOX002AB0
	BASIC (4 SSR)	PCOX004AB0
	+ BUILT-IN DISPLAY (RELAY)	PCOX000BB0
	+ BUILT-IN DISPLAY (2 SSR)	PCOX002BB0
	+ BUILT-IN DISPLAY (4 SSR)	PCOX004BB0
	+ USB (RELAY)	PCOX000CB0
	+ USB (2 SSR)	PCOX002CB0
	+ USB (4 SSR)	PCOX004CB0
	+ USE + BUILT-IN DISPLAY (RELAY)	PCOX000DB0
	+ USB + BUILT-IN DISPLAY (2 SSR)	PCOX002DB0
	+ USB + BUILT-IN DISPLAY (4 SSR)	PCOX004DB0

Tab. 1.a

1.2 Installation

Mechanical fastening

The pCO compact is installed on a DIN rail. To fasten the unit to the DIN rail, press it lightly against the rail. The rear tabs will click into place, locking the unit to the rail. Removing the unit is just as simple, using a screwdriver through the release slot to lever and lift the tabs. The tabs are kept in the locked position by springs.

1.3 Power supply

The power supply is connected between G and G0, with G0 clamp connected to earth (PE). For AC installation, use a 30 VA class II safety transformer, output voltage 24 Vac, supplying one pCO compact controller only.

If supplying multiple pCO compact controllers with the same transformer, the rated power of the latter must be $n \times 30$ VA, where "n" is the number of controllers being supplied by the transformer, regardless of the version of controller.

- The power supply to the pCO compact controller and terminal (or series of pCO compact controllers and terminals) should be separate from the power supply to the other electrical devices (contactors and other electromechanical components) inside the electrical panel.
- A 250 V (5x20) 800 mA fuse must be installed in the power supply line of the controller and a 50 mA - 250 V (5x20) must be installed in the power supply of SYNC clamp (only for 48 Vdc power supply). The power supply is functionally insulated from the rest of the I/O circuit, including the serial connections.
- The power cable should be wound twice around a ferrite (i.e. KITAGAWA part no. RI 18-28-10 - CAREL code 0907877AXX).
- The synchronicity line (SYNC) must be supplied by a class 2 safety transformer with 24 Vac output using the two pins on terminal "J2" called SYNC.

If the controller has a 24 Vac power supply, this can also be used to supply the SYNC signal. It is necessary to follow exactly the wiring connection in fig. 4.b.

If, on the other hand, the controller has a DC power supply 48 Vdc (36 Vmin...72 Vmax), the SYNC connection must be supplied by a special transformer (at least 1 VA) connecting the 24 Vac output to the two SYNC pin. In this case, it must be protected by a 250 V 50 mA fuse (follow the Fig. 4.c).

- To make the power supply connection to terminal J1, use a cable with a minimum cross-section of 1mm².

1.4 BMS serial options

	item	code	description
1	Modbus [®] /CAREL RS485	PCOS004850	opto-isolated RS485 serial
2	LON	PCO1000F0	LON FTT10 serial
3	Ethernet [™] BACnet [™] / SNMP / Modbus [®]	PCO1000WB0	Ethernet [™] serial
4	BACnet [™] RS485	PCO1000BA0	BACnet [™] MS/TP 485 serial
5	RS232	PCO100MDM0	RS232 serial
6	CANbus	PCOS00HBB0	CANbus for slave serial port (BMS)
7	KONNEX	PCOS00KXB0	KONNEX serial BMS port

Tab. 1.b

CAREL**1.5 Connectors****Electrical specifications of the plug-in connectors used**

Step: 5.08 mm; Rated voltage: 250 V; Rated current: 12 A; Cable size: 0.25 mm² - 2.5 mm² (AWG: 24 to 12);

Stripping length: 7 mm; Screw thread size: M3; Tightening torque: 0.5- 0.6 Nm

Step: 3.81 mm; Rated voltage: 160 V; Rated current: 8 A; Cable size: 0.25 mm² - 1.5 mm² (AWG: 28 to 16);

Stripping length: 7 mm; Screw thread size: M2; Tightening torque: 0.22- 0.25 Nm.

1.6 Installation warnings - operating environments and connections

Avoid assembling the boards in environments with the following characteristics:

- relative humidity greater than 90%;
- strong vibrations or knocks;
- exposure to continuous water sprays;
- exposure to corrosive or pollutant gases (e.g. sulphur or ammonia fumes, saline mist, smoke) so as to avoid corrosion and oxidation;
- strong magnetic and/or radio interference (therefore avoid installing the unit near transmitting antennae);
- exposure of the pCO compact to direct sunlight or the elements in general;
- large and rapid fluctuations in ambient temperature;
- environments where explosives or mixes of flammable gases are present;
- exposure to dust (formation of corrosive patina with possible oxidation and reduction of insulation).

**For connection, the following warnings must be observed:**

- provide a power supply switch in accordance with the local disposal legislation;
- using a different power supply from the one specified may seriously damage the system;
- use cable ends suitable for the terminals. Loosen each screw and insert the cable ends, then tighten the screws. When completed, lightly tug the cables to check that they are tight;
- separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance. Never run power cables (including the electrical cables) and probe signal cables in the same conduits. Do not install the probe cables in the immediate vicinity of power devices (contactors, circuit breakers or similar);
- reduce the path of the probe cables as much as possible, and avoid spiral paths that enclose power devices;
- avoid touching or nearly touching the electronic components fitted on the boards, so as to avoid electrostatic discharges (extremely dangerous) from the operator to the components;
- separate the power supply to the digital outputs from the power supply to the pCO compact;
- when tightening the cables to the terminals do not exert excessive pressure on the screwdriver, to avoid damaging the pCO compact;
- disconnect the controller from the power supply before performing any maintenance or assembly operations;
- the controller has to be integrated inside an instrument panel and it has not to be reachable in order to avoid strokes and impacts;
- if the device is used in a manner not specified by the manufacturer, the rated protection of the device may be compromised.
- in case of failure of the control and of optional boards, please only refer to CAREL service;
- install optional boards and connectors only supplied by CAREL.

1.7 Maintenance

- Disconnect the device (turn OFF) before accessing inside parts or during maintenance;
- all service and/or maintenance operations must be performed by specialist and qualified personnel, in accordance with the safety standards and legislation in force.



2. TECHNICAL SPECIFICATIONS

2.1 Mechanical specifications

dimensions	available in 6 DIN module format 105x115x60 mm
assembly	DIN rail

2.2 Plastic case

- Fitted on DIN rail as per DIN 43880 and IEC EN 50022
- Material: technopolymer
- Flame retardance: V2 (UL94) and 960 °C (IEC 695)
- Ball pressure test 125 °C
- Resistance to creeping current ≥ 250 V
- Colour grey RAL7035

2.3 Electrical specifications

Isolated power supply	DC power supply: 48 Vdc (36 V min to 72 V max) AC power supply: 24 Vac $\pm 10\%$ to -15% , 50/60 Hz Maximum power input: MEDIUM ver. P=6W, P=8VA, I _{max} =400mA LARGE ver. P=11W, P=14VA, I _{max} =700mA
CPU	H8SX/1651 32-bit, 50 MHz
FLASH program memory	2+2 Mbytes
SRAM data memory	512 Kbytes, 16-bit
EEPROM parameter data memory	13 Kbytes + 32 kB
NAND FLASH memory	32 MByte
Duration of working cycle	0.2 s typical (applications of average complexity)
Clock	Available as standard and integrated on main board

Tab. 2.a

Battery specifications

The battery used inside the pCO compact is a "button" sized lithium battery, code CR2430, 3 Vdc, dimensions 24 mm x 3 mm.

CAREL**2.4 SERIAL specifications**

Item	Type	Reference	Main specifications																								
Serial ZERO	PLAN	J4, J5	- Integrated on main board - Not opto-isolated - HW driver: RS485 - Connectors: Telephone jack + 3-pin plug-in p. 3.81 <table border="1"> <thead> <tr> <th colspan="4">CABLE LENGHT</th></tr> <tr> <th>Connector</th><th>Shielded cable type</th><th>Lmax (m)</th><th>Power supply</th></tr> </thead> <tbody> <tr> <td>J4</td><td>Telephone</td><td>50</td><td>given by pCO compact (150 mA)</td></tr> <tr> <td>J4</td><td>AWG24</td><td>200</td><td>given by pCO compact (150 mA)</td></tr> <tr> <td>J4</td><td>AWG20/22</td><td>500</td><td>separated by TCONN6J000</td></tr> <tr> <td>J5</td><td>AWG20/22</td><td>500</td><td>-</td></tr> </tbody> </table>	CABLE LENGHT				Connector	Shielded cable type	Lmax (m)	Power supply	J4	Telephone	50	given by pCO compact (150 mA)	J4	AWG24	200	given by pCO compact (150 mA)	J4	AWG20/22	500	separated by TCONN6J000	J5	AWG20/22	500	-
CABLE LENGHT																											
Connector	Shielded cable type	Lmax (m)	Power supply																								
J4	Telephone	50	given by pCO compact (150 mA)																								
J4	AWG24	200	given by pCO compact (150 mA)																								
J4	AWG20/22	500	separated by TCONN6J000																								
J5	AWG20/22	500	-																								
Serial ONE	BMS 1	Serial Card 1	- Not integrated on main - HW driver: not featured - Allows all the pCO family optional BMS cards to be used - Maximum cable lenght: refer to technical leaflet of the serial card																								
Serial TWO	Opto-isolated FIELD Bus	J8	- Integrated on main board - Opto-isolated serial - HW driver: opto-isolated RS485 3-pin plug-in connector p. 3.81 - Maximum lenght of shielded cable AWG20/22: 500 m:																								
	tLAN	J6/J7	Instead of the FieldBus serial, the following can be used: - tLAN serial available on a 2-pin connector, p. 3.81 (J7) - connection to a PLD terminal available via special 4-pin connector (J6) - J7: maximum lenght of shielded cable (2 wires + shield) AWG20/22: 30 m - J6: maximum lenght of 4-wires cable (see accessories table): 2 m for domestic application, 10 m for residential application																								

Tab. 2.b

Note:

Use only STP or S/UTP cable with both extremity of shield connected to PE (see par. "Electrical connections").

- The serial 2 has been designed to be MASTER. This implicates that possible pCO compact SLAVES, can not be connected using his own serial 2. Nevertheless it is possible connect only one pCO compact using his own serial 2.

2.5 pLAN network/user terminal connection

Type	Asynchronous half duplex RS485
Transmission speed	62.5 Kbps or 115.2 Kbps selected via software
Maximum number of units connectable	Maximum 32 units allowed
Connector for terminal	6-pin shielded telephone (J4)
Connector for pLAN network, Graphic terminal, Aria terminal	3-pin plug-in connector, pitch 3.81 mm (J5)

Tab. 2.c

Note:

- J4 can only be connected to one terminal (pCOT, pCOI, pGD0 and pGD1) or two terminals without using the backlighting for the display.
- The Graphic terminal and Aria terminal must be always powered with separate power supplies.

2.6 tLAN network connection

Type	Asynchronous half duplex 0/5 Vdc, non-differential
Transmission speed	9.6 Kbps or 19.2 Kbps selected via software
Maximum number of units connectable	Maximum 5 units allowed
Connector for tLAN network	2-pin plug-in connector, pitch 3.81 mm (J7)

Tab. 2.d

Note:

- The tLAN serial (J7) can be used as an alternative to either the FieldBus serial available on the 3-pin connector p. 5.08 (J8); or to the PLD terminal connection available on the special 4-pin connector (J6).

2.7 Analogue inputs

Maximum lenght cable	10 m	
Analogue conversion	A/D converter, 10-bit CPU built-in	
Models	TYPE A	TYPE B
CAREL NTC -50T90 °C; R/T 10 k Ω at 25 °C or HT NTC 0T150 °C	B1, B2, B3, B4, B5, B6, B7, B8	B1, B2, B3, B4, B5, B6
Voltage, 0 to 1 Vdc	B1, B2, B3, B4, B5, B6	
Voltage, 0 to 5 Vdc ratiometric	B1, B2, B5, B6	
Voltage, 0 to 10 Vdc	B1, B2, B5, B6	
Current, 0 to 20 mA or 4 to 20 mA	B1, B2	
PT1000 -100T200 °C; R/T 1000 Ω at 0 °C	B3, B4	
Voltage-free digital input (5 mA)	B5, B6, B7, B8	B5, B6
Total	8	6

Tab. 2.e

Warning: for the power supply to any active probes, the +21 V available on the VDC terminal can be used, maximum current available $I_{max}=60$ mA, protected against short-circuits. For the power supply to the 0 to 5 Vdc ratiometric probes, use the +5 VREF, maximum current available $I_{max}=60$ mA, protected against short-circuits.

Specifications

Time constant	0.5 s
Precision	± 0.3 % of full scale
Classification of measuring circuits	Category 1 (IEC EN 61010-1)

Tab. 2.f

Warning: separate as much as possible the probe and digital input signal cables from the cables carrying inductive loads and power cables to avoid possible electromagnetic disturbance.

CAREL**2.8 Digital inputs**

Maximum length cable	10 m	
Type	Not optically isolated, voltage free contact	
Power supply	Internal	
Models	TYPE A	TYPE B
Multifunction analogue inputs (see note)	B5, B6, B7, B8	B5, B6
Fast digital input	ID1	ID1
Normal digital input	ID2	ID2
Total	6	4

Tab. 2.g

Note:

Multifunction analogue inputs: these analogue inputs can be programmed via software as digital inputs instead of analogue inputs. All the digital inputs refer to GND.

Specifications of the fast digital input (ID1)

The fast digital input (ID1) can be configured via software in two distinct operating modes, as follows:

- first mode: normal or standard digital input
- second mode: fast digital input

When configured as a fast digital input, ID1 can measure a signal with a maximum frequency of 2 KHz, resolution +/- 1 Hz. This is made possible by the BIOS, which provides the SW application with two variables that count the number of times the input signal crosses zero and the corresponding frequency in Hz.

Specifications of the normal and fast digital input

The maximum current available to the digital input is 5 mA (consequently the rating of the external contact must be at least 5 mA).

2.9 Analogue outputs

Maximum length cable	10 m	
Type	Not optically isolated	
Power supply	Internal	
Models	TYPE A	TYPE B
0 to 10 Vdc analogue output	Y2	Y2, Y3, Y4
PWM analogue output with 5 Vdc pulse of programmable duration	Y1	Y1
Total	2	4

Tab. 2.h

Specifications

Resolution	8 bit
Precision	± 2% of full scale on Y2
Settling time	2 s
Maximum load	1 k Ω (10 mA) for Y2 0 to 10 V, 470 Ω (10 mA) for Y1 PWM

Tab. 2.i

2.10 Digital outputs

pCO compact TYPE A has 7 digital outputs, while pCO compact TYPE B has 6 digital outputs with electromechanical relays or Solid state relay (SSR). To simplify assembly, the common terminals of some relays have been grouped together based on the insulation distance.

Within a group, the outputs have single insulation between them and thus must be powered at the same voltage (generally 24Vac or 110-230Vac). Between the groups there is reinforced insulation, thus the groups can be powered at different voltages.

Output technical specification	Insulation group	Connector	Models				
			Type A	Type A (2 SSR)	Type B	Type B (2 SSR)	Type B (4 SSR)
SPDT relay: UL873: 2,5 A res., 2 A FLA, 12 A LRA, 250 Vac, C300 pilot duty (30.000 cycles) EN60730-1: 2 A res., 2 A inductive $\cos(\phi)=0,6$, 2 (2) A (100.000 cycles)	1	J3	1	-	1	-	1
	2	J10	1	-	1	-	1
relè SPST: UL873: 1 A res., 1 A FLA, 6 A LRA, 250 Vac, D300 pilot duty (30.000 cycles) EN60730-1: 1 A res., 1 A inductive, $\cos(\phi)=0,6$, 1 (1) A (100.000 cycles)	3	J11	5	5	2	2	-
	4	J12	-	-	2	2	-
Relè Power MOSFET Photovoltaic Operation voltage: 24 Vac/Vdc Maximum power: 10 W	1	J3	-	1	-	1	-
	2	J10	-	1	-	1	-
	3	J11	-	-	-	-	2
	4	J12	-	-	-	-	2
Outputs total			7	7	6	6	6

Tab. 2.J

2.11 USB Port



The USB connections have to be used only during commission and maintenance action.

Removing the cover from the front of the pCO compact devices fitted of USB port, there are 2 types of USB port; one of these has the function of USB SLAVE (USB standard type B connector) and the other USB HOST (USB standard type A connector).

The two connectors cannot be used at the same time.

The USB link can be used to download and upload the BIOS and applications, as well as carry out the commissioning operations.

Configurations available:

Hardware configuration	Type	Upload FW		Download FW		Commissioning
		USB HOST	USB DEVICE	USB HOST	USB DEVICE	
TYPE A	+ USB	with external PGD0/1 terminal only	•	with external PGD0/1 terminal only	logs and parameters only	•
	+ USB+BUILT-IN DISPLAY	•	•	•	logs and parameters only	•
TYPE B	+ USB	with external PGD0/1 terminal only	•	with external PGD0/1 terminal only	logs and parameters only	•
	+ USB+BUILT-IN DISPLAY	•	•	•	logs and parameters only	•

Note: FW = BIOS and/or Application.

The USB HOST can be used, for example, to connect a memory key; the USB SLAVE can be connected to a PC.

CAREL**2.12 Summary tables****Hardware configurations available**

Models	PWM output	0...10 V output	Analogue inputs	Digital inputs	Group 1 output	Group 2 output	Group 3 output	Group 4 output
TYPE A	Y1	Y2	B1, B2		NO1: - relay (1) - SSR (3)	NO2: - relay (1) - SSR (3)	NO3, NO4, NO5, NO6, NO7: - Relay (2)	-
			B3, B4					
			B5, B6					
			B7, B8					
				ID1 (veloce)				
				ID2				
TYPE B	Y1	Y2, Y3, Y4	Max 8	Max 6	NO1: - relè (1) - SSR (3)	NO2: - relè (1) - SSR (3)	NO3, NO4: - Relay (2) - SSR (4)	NO5, NO6: - Relay (2) - SSR (4)
			B1, B2					
			B3, B4					
			B5, B6					
				ID1 (veloce)				
				ID2				
			Max 6	Max 4				

Tab. 2.k

(1) Note: the relay is present instead of the SSR in the models not designed for having SSR.

Relay specifications:

UL873: 2,5 A res., 2 A FLA, 12 A LRA, 250 Vac, C300 pilot duty (30.000 cycles)

EN60730-1: 2 A res., 2 A inductives, $\cos(\phi)=0,6$, 2 (2) A (100.000 cycles)

(2) Note: the relay is present instead of the SSR in the models not designed for having SSR.

Relay specifications:

UL873: 1 A res., 1 A FLA, 6 A LRA, 250 Vac, D300 pilot duty (30.000 cycles)

EN60730-1: 1 A res., 1 A inductives, $\cos(\phi)=0,6$, 1 (1) A (100.000 cycles)

(3) Note: the SSR is present instead of the relay in the models designed for having 2 SSR.

SSR specification:

Relay Power MOSFET Photovoltaic, Operation voltage: 24 Vac/Vdc, Maximum power: 10 W

(4) Note: the SSR is present instead of the relay in the models designed for having 4 SSR

SSR specification:

Relay Power MOSFET Photovoltaic, Operation voltage: 24 Vac/Vdc, Maximum power: 10 W

Types of analogue/digital inputs

All the analogue inputs are can be configured via software, according to the following table, in the models TYPE A and TYPE B.

Symbol	NTC	ID	PT1000	4 to 20 mA	0 to 5 V	0 to 1 V	0 to 10 V
B1, B2	•			•	•	•	•
B3, B4	•		•			•	
B5, B6	•	•			•	•	•
B7, B8	•	•					

Tab. 2.o

2.13 Table of accessories

	code	description
1	PCOXCON0A0	plug-in screw connector kit for pCO compact MEDIUM type A
2	PCOXCON0B0	plug-in screw connector kit for pCO compact LARGE type B
3	PCOS00AKY0	pCO sistema smart key
4	0907877AXX	external ferrite for pCO compact power cable
5	PSTCON01B0	pLD terminal connection cable L= 1.5 m
6	PSTCON03B0	pLD terminal connection cable L= 3 m
7	PSTCON05B0	pLD terminal connection cable L= 5 m
8	S90CONN002	pGD terminal connection cable L= 0.8 m
9	S90CONN000	pGD terminal connection cable L=1.5 m
10	S90CONN001	pGD terminal connection cable L= 3 m

Tab. 2.p

2.14 Other specifications

Operating conditions	-10/60 °C, 90% rH non-condensing
Storage and transport conditions	-20/70 °C, 90% rH non-condensing
Index of protection	IP40 front panel only
Environmental pollution	2
Classification according to protection against electric shock	to be integrated into Class 1 and/or 2 appliances
Period of stress across the insulating parts	long
Type of action	1 C
Type of disconnection or microswitching	microswitching
Category of resistance to heat and fire	Category D (UL94-V0)
Immunity against voltage surges	Category 2
Ageing characteristic (operating hours)	80,000
No. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
Software class and structure	Class A
Category of immunity against surges	Category 3 (IEC EN 61000-4-5)

Tab. 2.q

The device is not designed to be hand-held

3. MECHANICAL DIMENSIONS

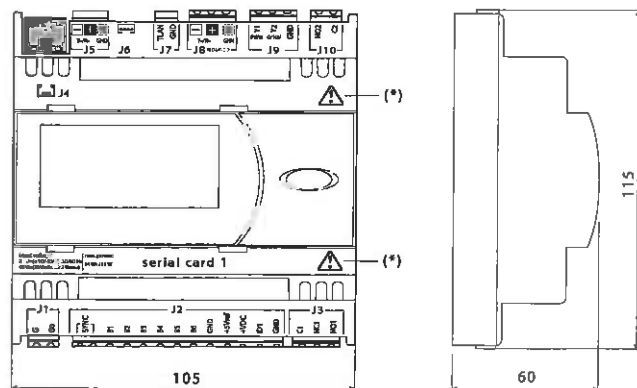
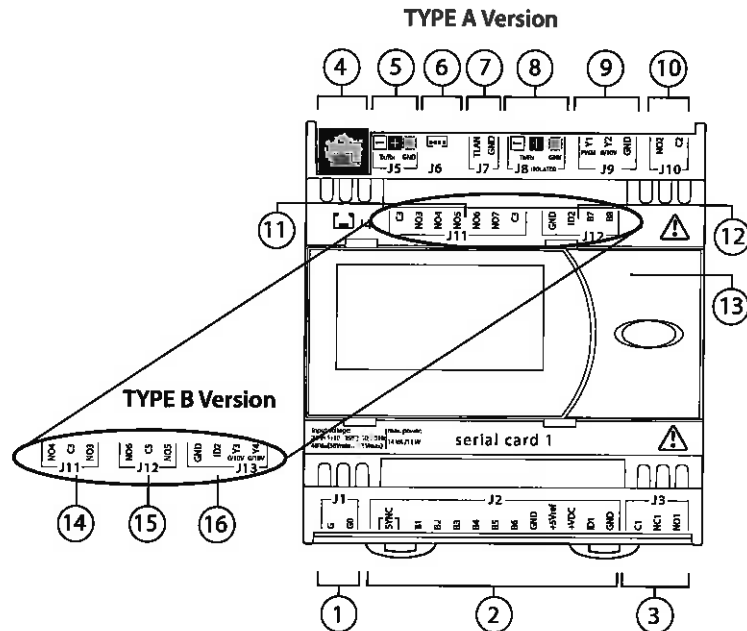


Fig. 3.a

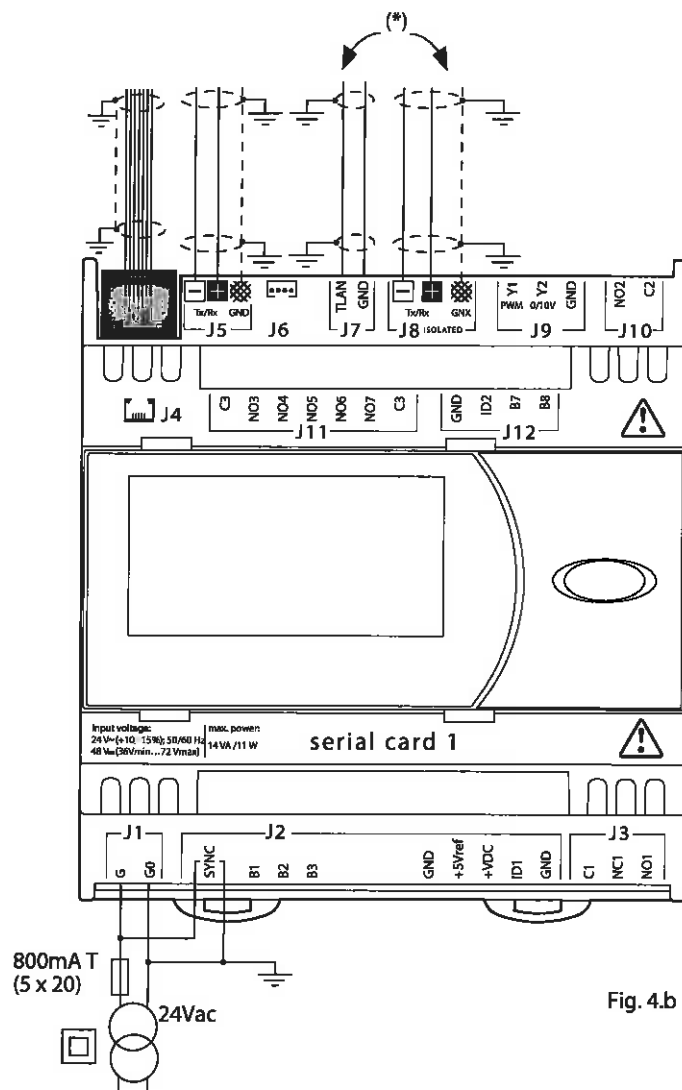
(*) The icon  means to refer to this technical leaflet, during the electrical installation.

CAREL**4. DESCRIPTION OF THE TERMINALS****Legenda:**

1	power supply connector (G, G0) 24 Vac or 48 vdc (36 Vdc min...72 Vdc max)
2	*"SYNC" synchronicity inputs for phase control and NTC, 0...1 V, 0 to 5 V, 0 to 20 mA, 4 to 20 mA +5 Vref for probe power supply, 5 V ratiometric and + VDC (+21 Vdc) for active probes
3	digital output
4	connector for all pCO series standard terminals and downloading the application program
5	pLAN connector
6	pLD terminal connector
7	tLAN connector
8	opto-isolated "Field-Bus" serial connector
9	0 to 10 V and PWM (phase control) analogue outputs
10	digital output
11	digital outputs (Type A)
12	NTC analogue inputs and digital inputs (Type A)
13	removable door to access the USB ports
14	digital outputs (Type B)
15	digital outputs (Type B)
16	digital input and analogue outputs 0 to 10 V (Type B)

4.1 Electrical connections

AC power supply



COMMON power supply for controller & SYNC

(*) the use of tLAN port excluded the use of Field Bus port and vice versa.

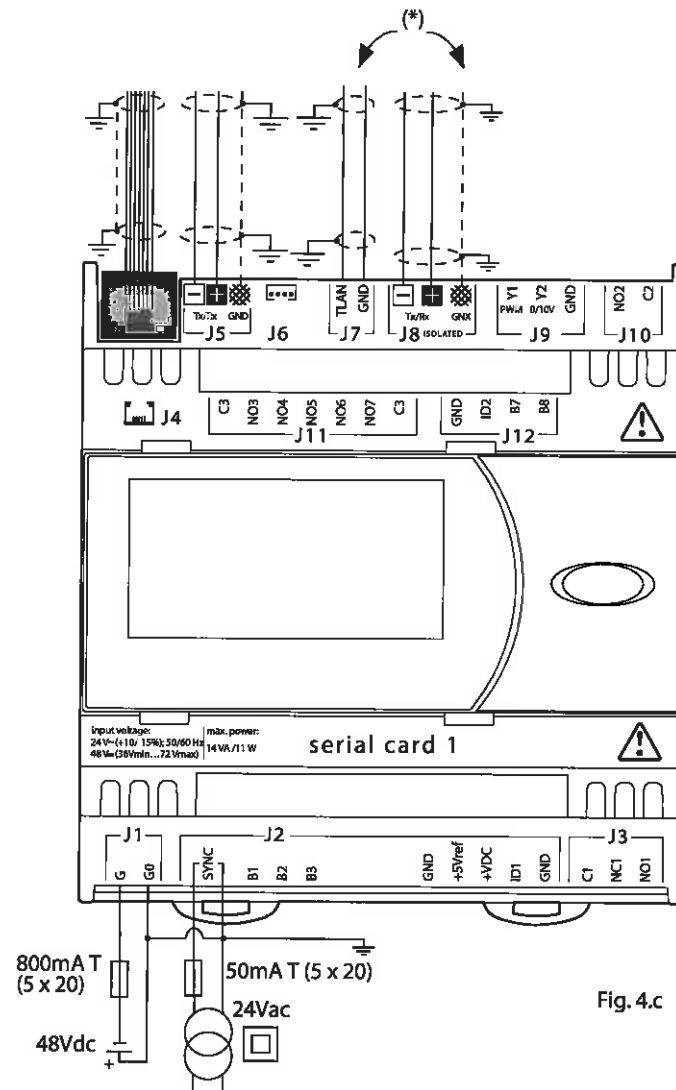
CAREL**DC power supply**

Fig. 4.c

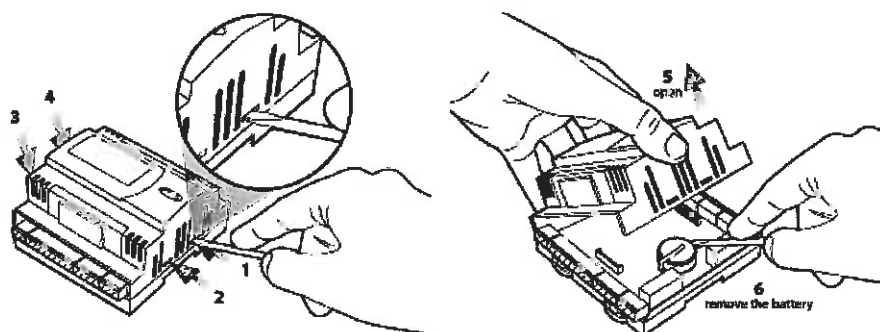
Fig. 4.c

SEPARATE power supply for controller & SYNC

(*) the use of tLAN port excluded the use of Field Bus port and vice versa.

Guidelines for disposal

- Do not dispose of the product as municipal waste; it must be disposed of through specialist waste disposal centres.
- The product contains a battery that must be removed and separated from the rest of the product according to the instructions provided, before disposing of the product.
- Improper use or incorrect disposal of the product may have negative effects on human health and on the environment.
- The public or private waste collection systems defined by local legislation must be used for disposal.
- In the event of illegal disposal of electrical and electronic waste, the penalties are specified by local waste disposal legislation.



CAREL

CAREL INDUSTRIES HQs

Via dell'Industria, 11 - 35020 Brugine - Padova (Italy)
Tel. (+39) 049.9716611 - Fax (+39) 049.9716600
e-mail: carel@carel.com - www.carel.com

Agenzia / Agency:

+050003340 - 1,1 - 13.04.2010

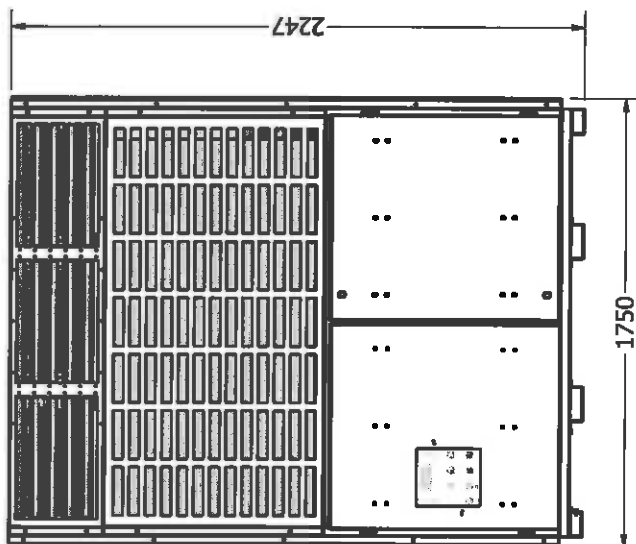
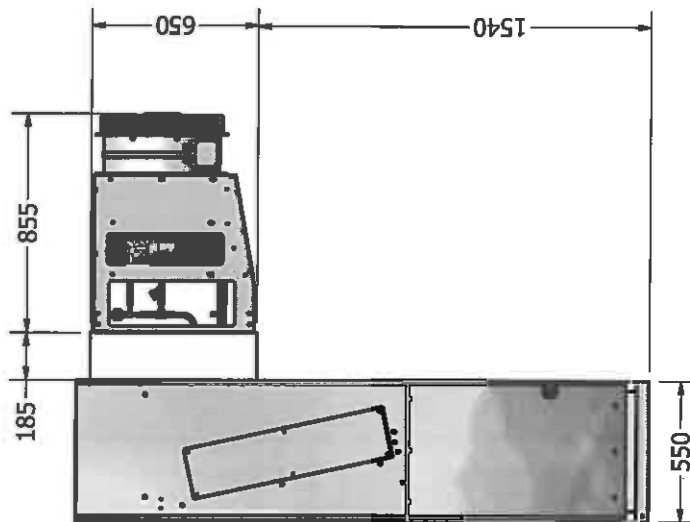
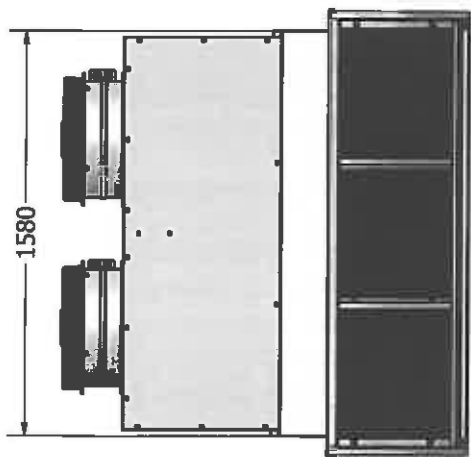


G. DRAWINGS

A8800-01 Dawson Sigma Final Assembly

D2828-01/02/03 Rev 01 Pipework Circuit

D2810 Rev 01 Electrical Drawings Sheets 1 – 18



 HILLVIEW, OTLEY, IPSWICH, IPS SMP TEL (01473) 880522 FAX (01473) 880587 © 2007 HRS, OTLEY, IPSWICH	DAWSON SIGMA FINAL ASSY			
TITLE DRG NO MODEL DS A8800-01 / 00 CHECKED				
GENERAL TOLERANCES MACHINED PARTS 0.50mm 0.50- SHEET METAL 0.50mm 0.50- PIPEWORK 1.00mm 3.00- HOLE CENTRES 0.25mm UNLESS OTHERWISE SPECIFIED				
MATERIAL AS ABOVE				
DRN BY SCALE NO	AM DATE 09/09/11 FINISH S/C			
3RD ANGLE PROJECTION SCN NO	DATE			

DO NOT SCALE. DIMENSIONS IN mm UNLESS STATED. REMOVE ALL BURRS AND SHARP EDGES. MANUFACTURE TO CONFORM TO RELEVANT SECTIONS OF HM:05:039

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P2811 Rev 05

Checked issue

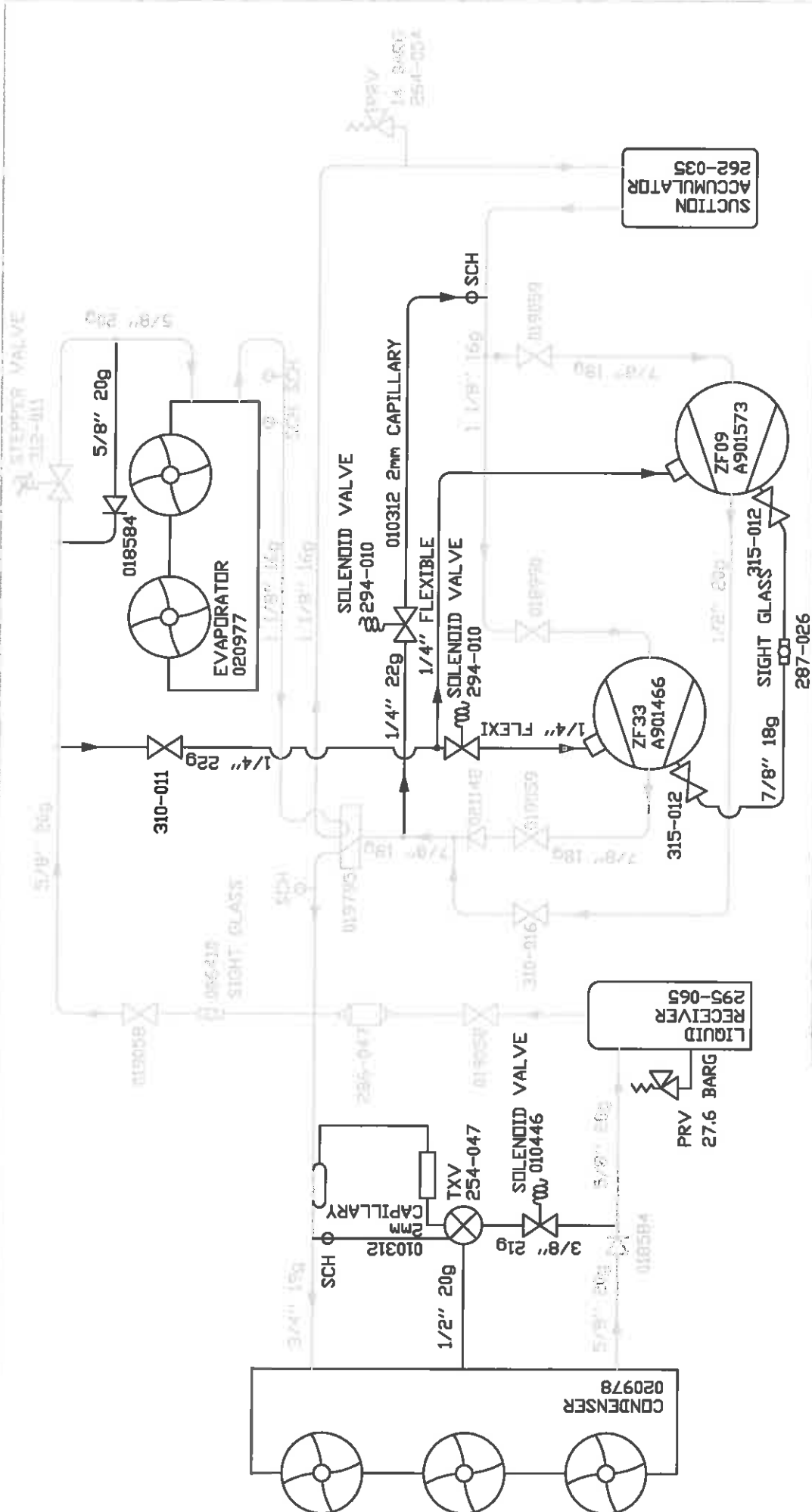


TEL: (0476) 893032
FAX: (0476) 893037

SIGMA PIPEWORK CIRCUIT

1	18.01.12	SL	03/11/2011	SIGMA	D2828-01/01	AM	CIFRERO
---	----------	----	------------	-------	-------------	----	---------

DO NOT SCALE DIMENSIONS IN MM UNLESS STATED OTHERWISE. REMOVE ALL BURRS AND CHAMFER EDGES. INTERNAL MANUFACTURE TO CONFORM TO THE RELEVANT SECTIONS OF BS EN 10559



HUBBARD

VALVE & PIPE SOLUTIONS

121000/33000/02

74001/73000/02

© 2010 HUBBARD PIPEWORK SOLUTIONS

SIGMA PIPEWORK CIRCUIT REFRIGERATION CYCLE

REV	DATE	BY	CHKD	APPD	DESCRIPTION
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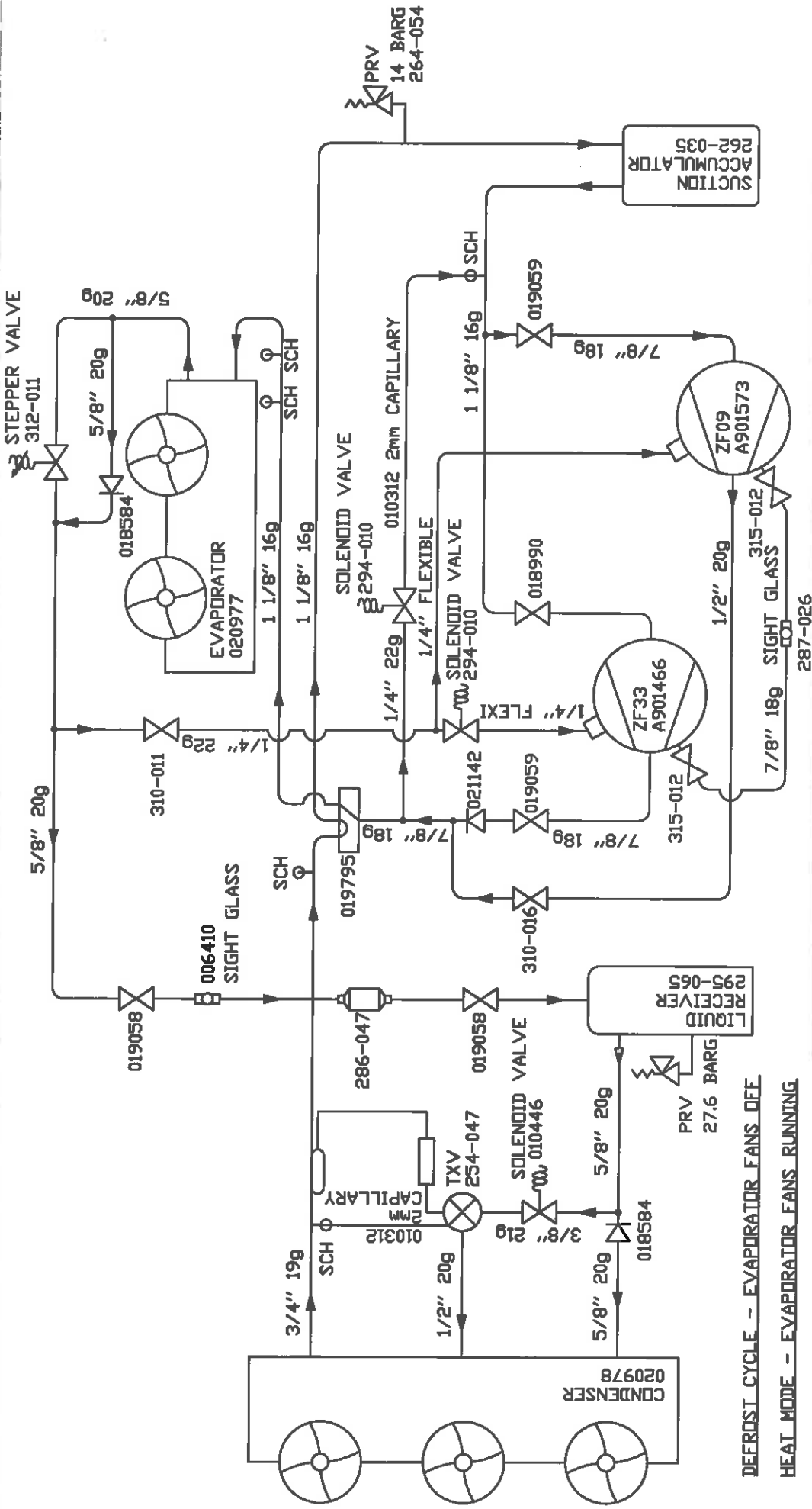
SL 03/11/2011

SIGMA D2828-02/01

AM

Copyright HPL August 2012

DO NOT SCALE DIMENSIONS IN AN UNLESS SPECIFIED. REMOVE ALL DIMS AND SHARP CORNERS. INTERNAL MANUFACTURE TO CONFORM TO THE RELEVANT SECTIONS OF VDI5009



HUBBARD, OTLEY, PEARCE, LTD
 TEL: 0147 7830722
 FAX: 0147 7830787
 20010 H.P.L. OTLEY, W. YORKS

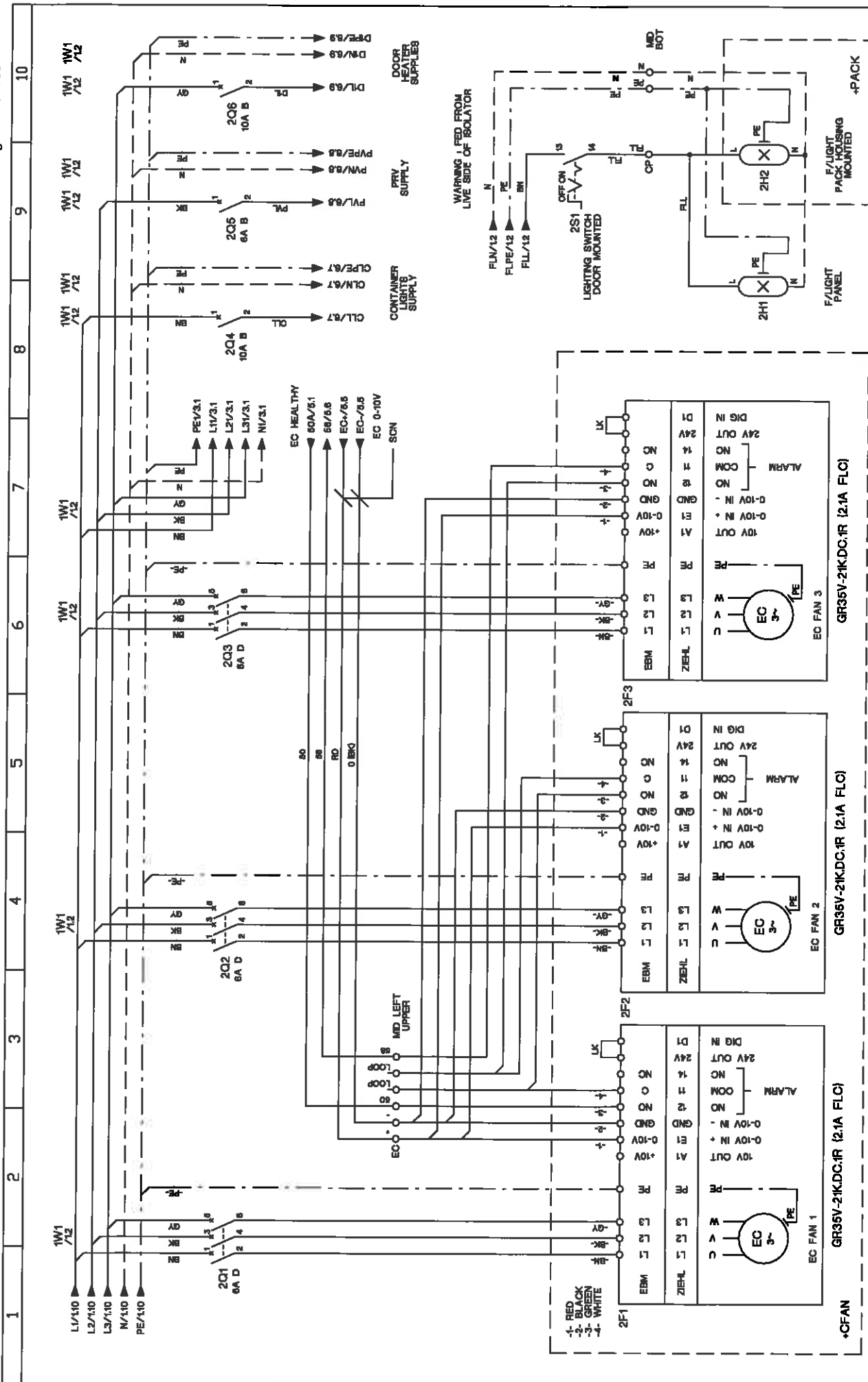
**SIGMA PIPEWORK CIRCUIT
 DEFROST + HEAT CYCLES**

1	18.01.12	SL	03/11/2011	100%
NO	DATE	CODE	TIME	PERCENT

SIGMA D2828-03/01

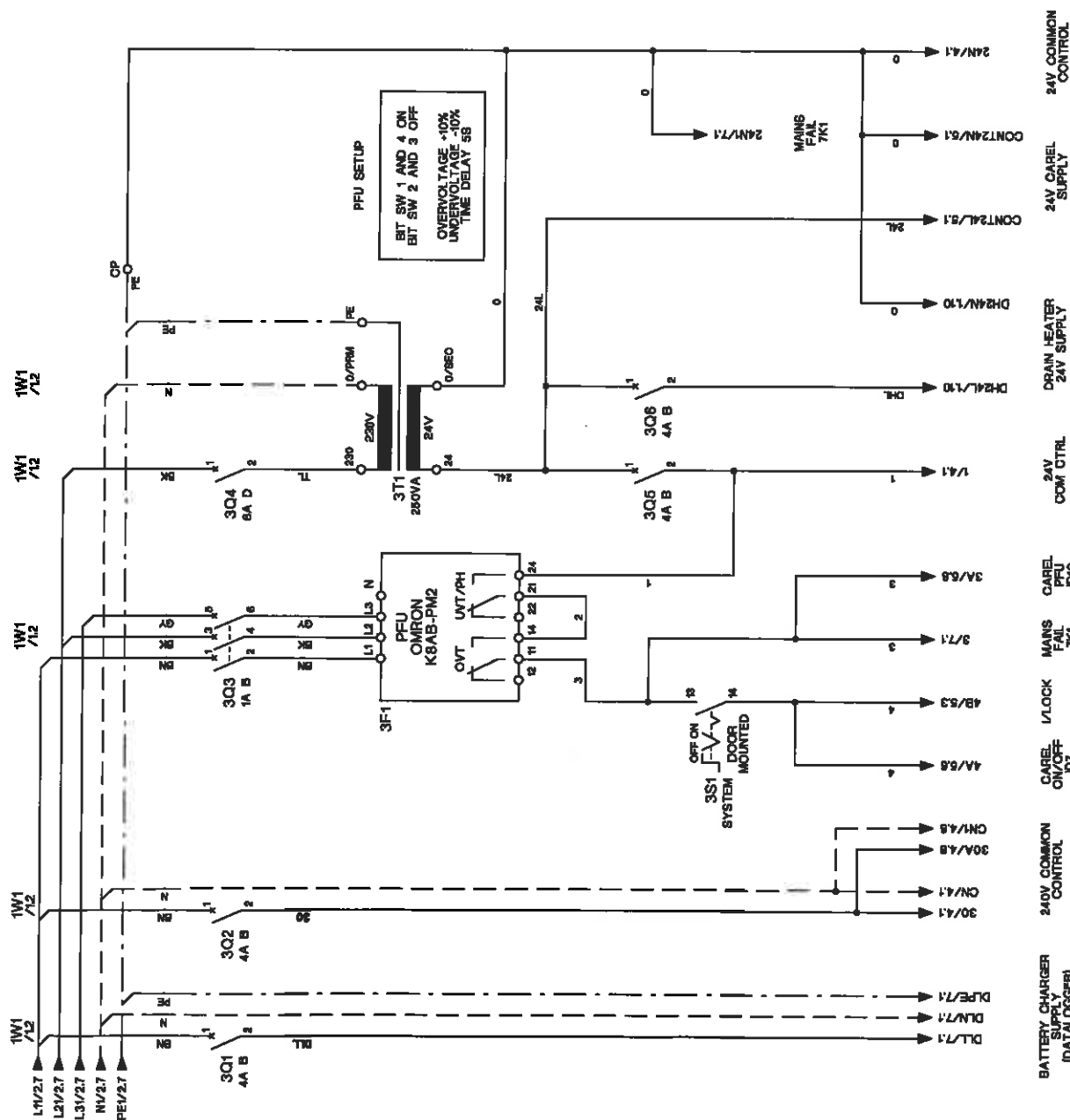


REV	01	POD 11897-03	NAME	DATE	DRAWN	JRS	HUBBARD REFRIGERATION SOLUTIONS	
			JRS	10/29/12	DATE	12/25/11	 HUBBARD REFRIGERATION SOLUTIONS 15000 HWY 101, SUITE 100 FARMINGTON, CT 06030 TEL: 860-646-1111 FAX: 860-646-1112 WWW.HUBBARDREF.COM	
					CHECKED		© 2010 HUBBARD REFRIGERATION SOLUTIONS COPYRIGHT OF HUBBARD REFRIGERATION SOLUTIONS	
					APPROVED			
							CLIENT	DWG TITLE
							DAWSON RENTALS	POWER & DISTRIBUTION
							PRODUCT	PAGE 1
							SIGMA	
							INSTALLATION	LOCATION
							SCALE	CP
							DWG NO	NEXT PAGE NO. 2
							REV	SHT 1 OF 18
							D2810	01



REV	DESCRIPTION	DATE	DRAWN	JRG	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	DAWSON RENTALS	POWER & DISTRIBUTION	LOCATION	SHT 2
01	POD 1987-93	07/20/2012	07/20/2012	07/20/2012	HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18
					HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	DAWSON RENTALS	POWER & DISTRIBUTION	CP	OF 18

FOR DUAL CIRCUIT CONTAINERS
ONLY FIT T CONN IN DUTY UNIT ONLY



**BATTERY CHARGER
SUPPLY
(DATA LOGGER)**

CAREL
ON/OFF
107

CARL
PFL
IND

24V
COM CTRL

**DRAIN HEATER
24V SUPPLY**

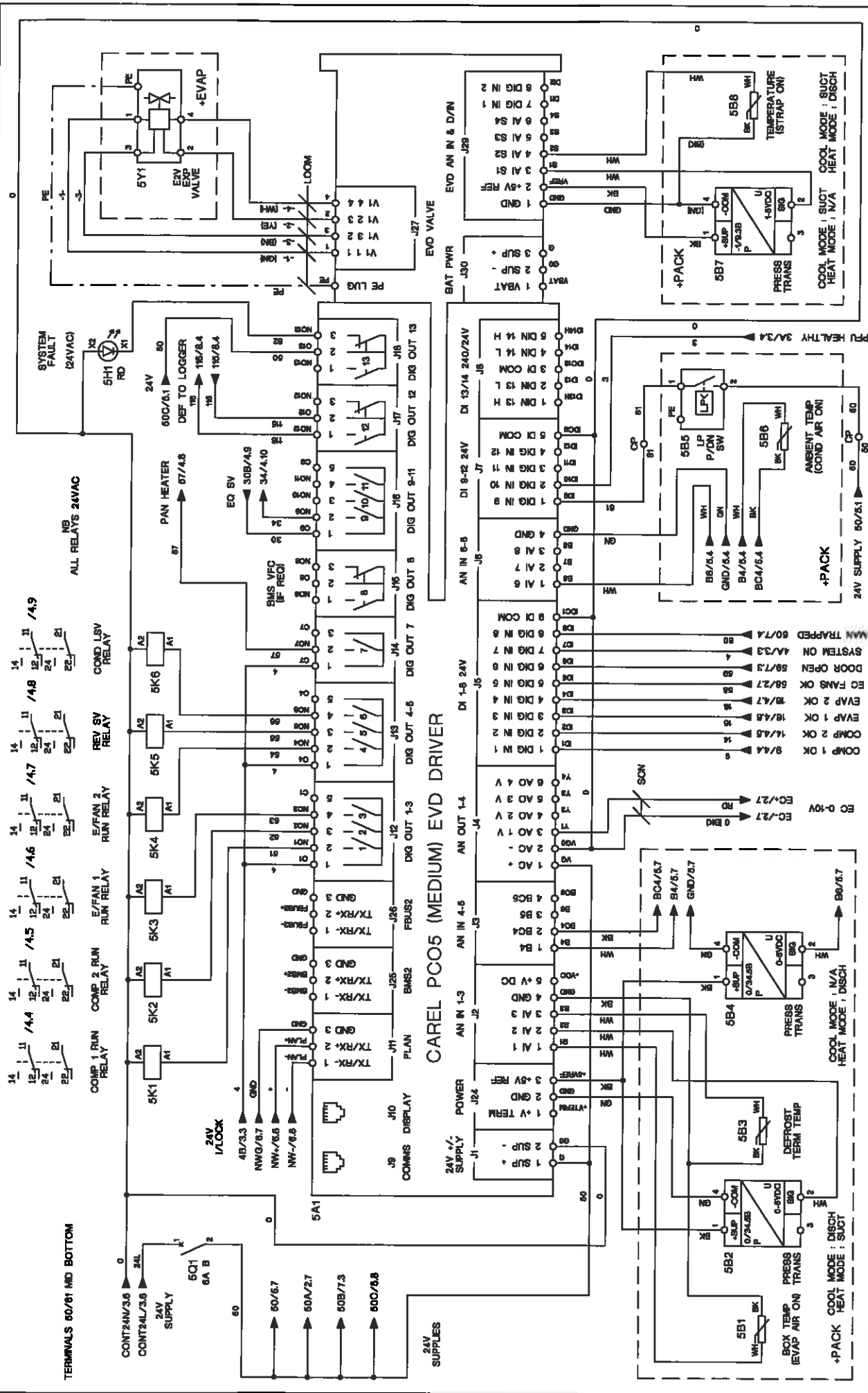
24V CARBON
SUPPLY

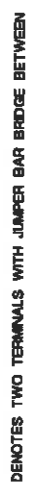
IV COMMON CONTROL

[illegible]

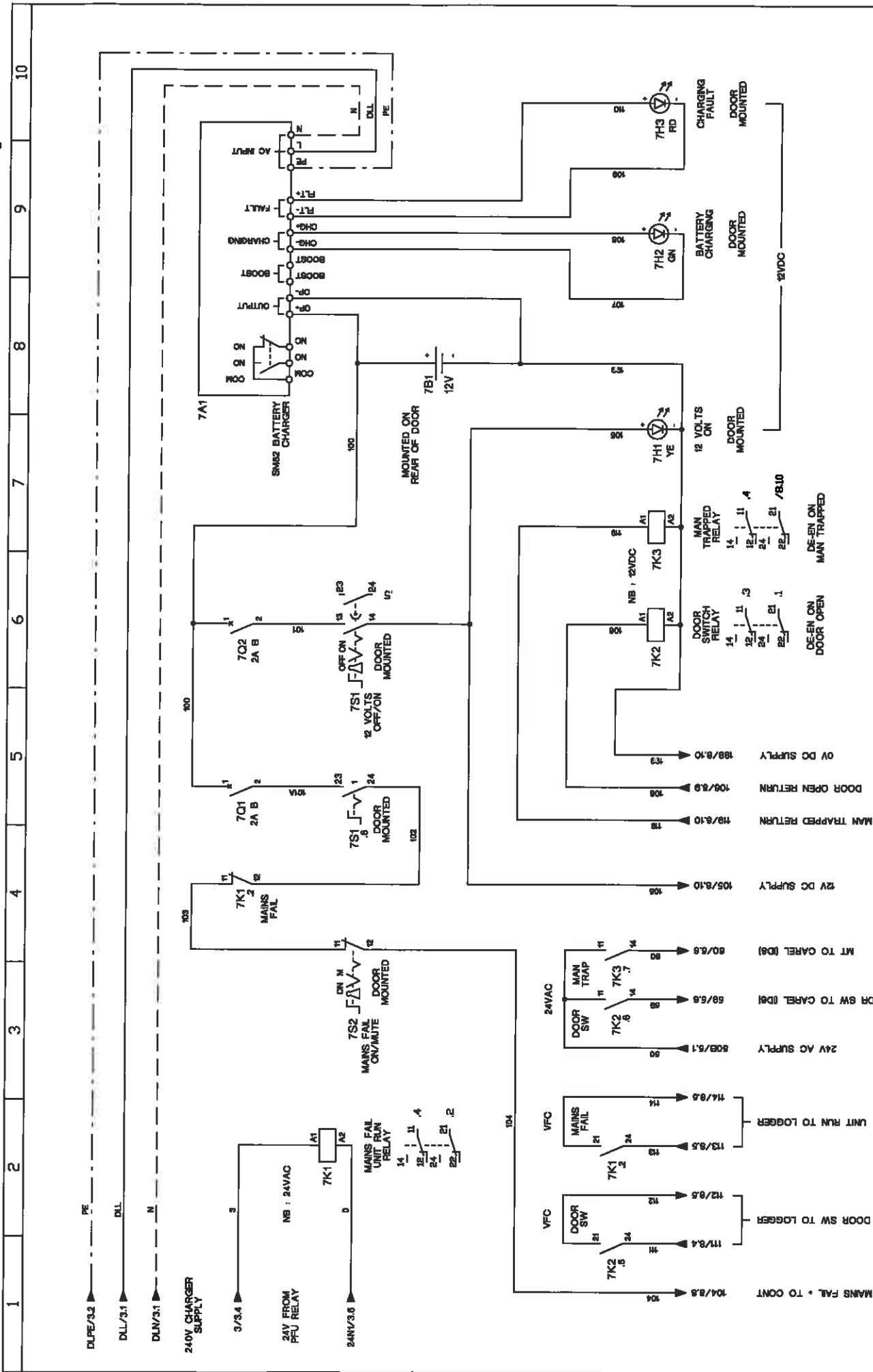


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REV	AMENDMENT	NAME	DATE	DRAWN	JWS	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	DAWSON RENTALS	DWG TITLE	INSTALLATION	LOCATION	SHT
01	POO 1987-89	JWS	9/28/82			HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	SIGMA	12VDC BATTERY CHARGER CIRCUITS	CP	CP	7
						REFRIGERATION SOLUTIONS				SCALE	NEXT PAGE NO	OF
						2010 HRS DITLEY PERSON				DWG NO		18
												REV
												01

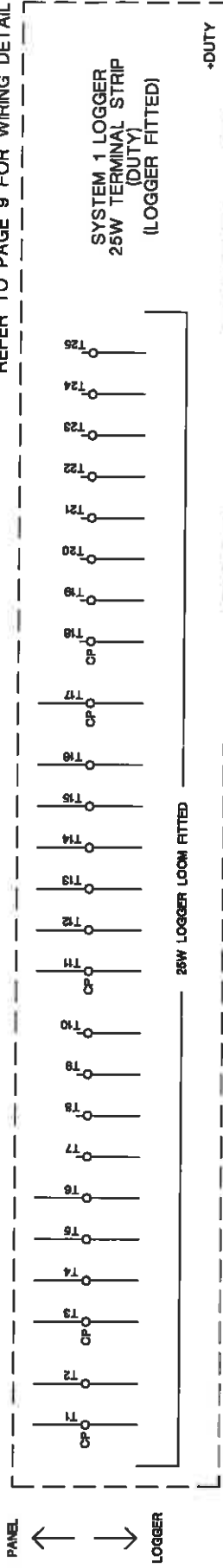
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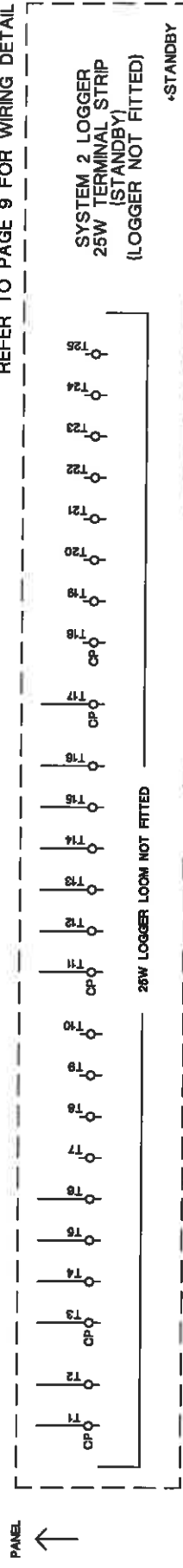
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THIS PAGE ONLY APPLICABLE FOR DUAL CIRCUIT DUTY / STANDBY REFRIGERATION CONTAINERS

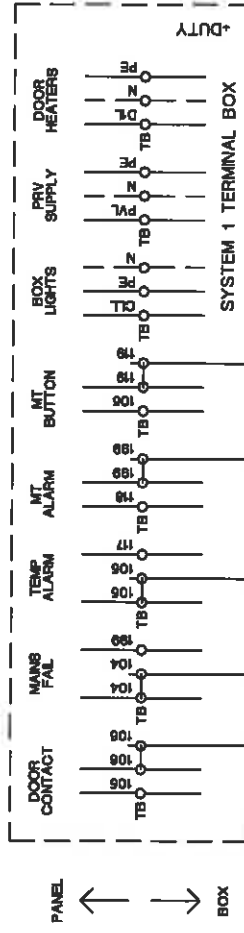
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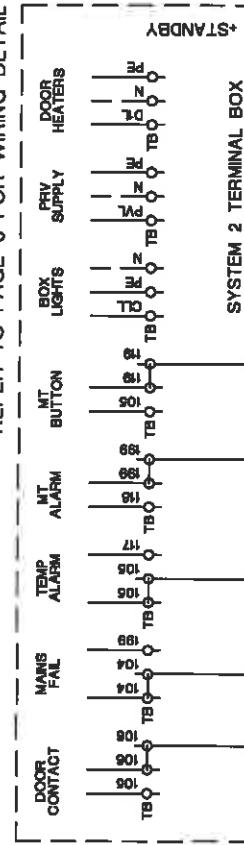
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REFER TO PAGE 6 FOR WIRING DETAIL



REFER TO PAGE 6 FOR WIRING DETAIL

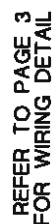


YE (DOOR CONTACT)
WH (MANS FAIL)
RD (L2V)
BK (DN)
GN (MAN TRAPPED PRI)
BU (SPARE)

8C (DEF STANI) INSTALLED BY OTHERS

REV / AMENDMENT	NAME	DATE	DRAWN	JRS	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	DAWSON RENTALS	DWG TITLE	DUTY / STANDBY DUAL CIRCUIT WIRING SYSTEM 1 (DUTY) SYSTEM 2 (STANDBY)	INSTALLATION	LOCATION	SHT 9 OF 18
BT / POC 1887-43	JRS	18/02/22	DATE	18/02/22	HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	SIGMA	DWG NO	D2810	SCALE	CP	REV
			CHECKED		REVISION NO 1							
			APPROVED		REVISION NO 2							

IC BELDEN INSTALLED BY OTHERS



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HRS Part	Manufacturer	Mft Part No	Description 1	Description 2	Supplier	Location	Device ID	Page	Unit
021101	CompuTronic	4270-3000	SM82 Batt Charger	6/12V 5A 2400 supply	FW Murphy	CP	7A1	7.8	Each
021102	Yusec	NP 12-12	Battery 12V 12AH NP	Lead Acid Battery	FW Murphy	CP	7B1	7.8	Each
176-053	Electric Centre	ABBP-100U	B/Head Fitting ES	100w Maximum	Electric Centre	PACK	2H1	2.9	Each
176-056	WF Electrical	W14526	Striplight 16W T4 FL	524mm	WF	CP	2H2	2.8	Each
184-134	Chint	NP2-BZ101	Mtg Contact Blk NO	22.5mm Contact and Mounting Block	Chint	CP	2S1	2.9	Each
184-134	Chint	NP2-BZ101	Mtg Contact Blk NO	22.5mm Contact and Mounting Block	Chint	CP	3S1	3.3	Each
184-134	Chint	NP2-BZ102	Mtg Contact Blk NC	22.5mm Contact and Mounting Block	Chint	CP	7S1	7.6	Each
184-151	Siemens	3RT20 16-1AB02	S00 Cont 24ac 7A C	3kW AC23 / 18A AC1/ 50Hz / NC Aux	Siemens	CP	7S2	7.4	Each
184-151	Siemens	3RT20 16-1AB02	S00 Cont 24ac 7A C	3kW AC23 / 18A AC1/ 50Hz / NC Aux	Siemens	CP	1K2	4.5	Each
184-151	Siemens	3RT20 16-1AB02	S00 Cont 24ac 7A C	3kW AC23 / 18A AC1/ 50Hz / NC Aux	Siemens	CP	1K3	4.6	Each
184-151	Siemens	3RT20 16-1AB02	S00 Cont 24ac 7A C	3kW AC23 / 18A AC1/ 50Hz / NC Aux	Siemens	CP	1K4	4.7	Each
184-152	Siemens	3RT20 26-1AB00	S0 Cont 24ac 25A	11kW AC23 / 40A AC1 / 50Hz / NO-NC Aux	Siemens	CP	1K5	4.8	Each
186-123	Siemens	3RV28 01-1E	S0/00 MMS Aux /NO/NC	Front Mounted for S00 & S0 MMS	Siemens	CP	1K1	4.4	Each
186-123	Siemens	3RV28 01-1E	S0/00 MMS Aux /NO/NC	Front Mounted for S00 & S0 MMS	Siemens	CP	1-1Q1	1.3	Each
186-123	Siemens	3RV28 01-1E	S0/00 MMS Aux /NO/NC	Front Mounted for S00 & S0 MMS	Siemens	CP	1-1Q2	1.5	Each
186-123	Siemens	3RV28 01-1E	S0/00 MMS Aux /NO/NC	Front Mounted for S00 & S0 MMS	Siemens	CP	1-1Q3	1.6	Each
187-118	Chint	NP2-BD2	2w Selector Sw Actr	Front Mounted for S00 & S0 MMS	Siemens	CP	1-1Q4	1.7	Each
187-118	Chint	NP2-BD2	2w Selector Sw Actr	22.5mm	Chint	CP	2S1	2.9	Each
187-131	Siemens	3RV20 11-1GA10	S00 MMS 4.5-6.3A	Manual Motor Starter	Siemens	CP	3S1	3.3	Each
187-132	Siemens	3RV20 21-4DA10	S0 MMS 20-25A	Manual Motor Starter	Siemens	CP	1Q2	1.5	Each
187-133	Chint	NP2-BG2B	2w Sel Sw Actr Key	22.5mm	Siemens	CP	1Q1	1.3	Each
187-133	Chint	NP2-BG2B	2w Sel Sw Actr Key	22.5mm	Chint	CP	7S1	7.6	Each
187-134	Socomec	2200 3006	Sw Disc 63A SPM 3p	Sioco M / 30kW AC23 / Direct & Ext op	Chint	CP	7S2	7.4	Each
187-144	Siemens	3RV20 11-0KA10	S00 MMS 0.9-1.25A	Manual Motor Starter	WF Electrical	CP	Q1	1.1	Each
187-144	Siemens	3RV20 11-0KA10	S00 MMS 0.9-1.25A	Manual Motor Starter	Siemens	CP	1Q3	1.7	Each
188-044	Socomec	1407 0532	Shaft Siroom 320mm	Manual Motor Starter	WF Electrical	CP	1Q4	1.8	Each
188-045	Socomec	1407 0532	Handle Siroom S00	For S0 & S00 Type Handles / 16A-125A	WF Electrical	CP	Q1	1.1	Each
188-049	Socomec	1419 0000	Shaft Guide S00 S0	IP65 Dr I/L Defeatable 16A-80A Red/Yell	WF Electrical	CP	Q1	1.1	Each
188-111	Omron	K8AB-PM2	PFU Omron K8AB-PM2	UV / OV / Ph Loss & Reversal	CCA	CP	Q1	1.1	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	3F1	3.4	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	5K1	5.3	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K2	5.3	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K3	5.4	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K4	5.4	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K5	5.5	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K6	5.6	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	6K7	5.6	Each
188-119	Relpol	RM84-2012-25-5024	RM84 2PDT Relay 24ac	8 pin / BA / Plug-In	Motion29	CP	7K1	7.2	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K1	5.3	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K2	5.3	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K3	5.4	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K4	5.4	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K5	5.5	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	5K6	5.6	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K1	7.2	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K2	7.2	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K3	7.6	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K4	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K5	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K6	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K7	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K8	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K9	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K10	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K11	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K12	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K13	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K14	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K15	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K16	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K17	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K18	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K19	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K20	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K21	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K22	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K23	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K24	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K25	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K26	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K27	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K28	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K29	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K30	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K31	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K32	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K33	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K34	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K35	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K36	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K37	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K38	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K39	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K40	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K41	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K42	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K43	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K44	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K45	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K46	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K47	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K48	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K49	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K50	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K51	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K52	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K53	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K54	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K55	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K56	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K57	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K58	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K59	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K60	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K61	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K62	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K63	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K64	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K65	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K66	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K67	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K68	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K69	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K70	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K71	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K72	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K73	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K74	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT	DIN Rail 8-pin for RM Relays	Motion29	CP	7K75	7.7	Each
188-120	Relpol	GZT-80	GZT80 Rel Base 2PDT						

AMENDMENT POD 1197-43	NAME JRB	DATE 8/25/92	DRAWN JRB	JRB	HUBBARD REFRIGERATION SOLUTIONS HILLYARD ST FRENCH 98 01P TEL. NO 1-410 881 9173 800-882 FAX NO 1-410 881 9173 830L37 WWW.HUBBARD-DC.COM		CLIENT DAWSON RENTALS	DWG TITLE REPORT BILL OF MATERIALS	INSTALLATION REP-B	LOCATION	SHT B2 OF 18	REV 01
			CHECKED		REFRIGERATION SOLUTIONS		PRODUCT SIGMA		SCALE DWG NO	D2810		
			APPROVED		COPYRIGHT © HUBBARD REFRIGERATION SOLUTIONS							

Wire			Source					Destination						
Number	Size	Colour	Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
BK	BDN	BK	5A1	PLAN	6	2	CP		TB	NW	6	8	TB	
BK	6	BK	Q1	3	1	1	CP		1W1	1	1	2	CP	
BK	BDN	BK	5A1	4SVREF	5	2	CP		5B2	1	5	2	PACK	
BK	BDN	BK	5B2	1	5	2	PACK		5B4	1	5	4	PACK	
BK	1.5	BK	1K2	4	5	5	CP		1M2	1	1	5	CP	
BK	1.5	BK	1W1	1	5	5	CP		1Q2	1	1	5	CP	
BK	2.5	BK	1F4	L2	4	2	CP		1M1	1	1	3	CP	
BK	2.5	BK	1K1	4	1	3	CP		1M1	1	1	3	CP	
BK	2.5	BK	1W1	4	1	3	CP		1Q1	1	1	3	CP	
BK	BDN	WH	5A1	BC4	5	2	CP		5B6	1	5	2	PACK	
BK	BDN	BK	5B1	BK	5	1	PACK		5B3	1	5	2	PACK	
BK	BDN	BK	5B3	BK	5	2	PACK		5A1	1	5	2	CP	
BK	1.5	BK	DH	24N	1	10	CP		1U4	1	1	10	EFAN	
BK	1.5	BK	1K3	4	1	7	CP		1M3	1	1	7	EFAN	
BK	1.5	BK	1K4	4	1	8	CP		1M4	1	1	8	CP	
BK	1.5	BK	1W1	4	1	4	CP		2Q1	1	2	1	CP	
BK	1.5	BK	1W1	4	1	4	CP		2Q2	1	2	1	CP	
BK	1.5	BK	1W1	4	1	4	CP		2Q3	1	2	1	CP	
BK	1.5	BK	2Q1	4	2	6	CP		2F1	1	2	6	CP	
BK	1	BK	2Q2	4	2	4	CP		2F2	1	2	4	CP	
BK	1	BK	2Q3	4	2	6	CP		2F3	1	2	6	CP	
BK	1.5	BK	1W1	4	1	8	CP		1Q3	1	1	8	CP	
BK	1.5	BK	1W1	4	1	8	CP		1Q4	1	1	8	CP	
BK	6	BK	Q1	4	1	1	CP		INC	1	1	1	TB	
BK	1	BK	1W1	4	1	3	CP		3Q3	1	3	3	CP	
BK	1	BK	3Q3	4	3	3	CP		3F1	1	3	3	CP	
BK	1.5	BK	1W1	4	1	9	CP		2Q5	1	2	9	CP	
BK	BDN	BK	5A1	4	5	5	CP		5B7	1	5	5	CP	
BK	BDN	BK	1W1	4	5	5	CP		3Q4	1	3	5	CP	
BK	BDN	BK	3A1	2	3	8	TB		3A1	1	3	8	TB	
BK	BDN	BK	3A2	5	3	8	CONTAINER		3A2	1	3	8	CONTAINER	
BK	BDN	BK	3A2	5	3	8	CONTAINER		1W1	1	1	2	CP	
BN	6	BN	Q1	1	3	1	CP		3Q2	1	3	1	CP	
BN	1	BN	1W1	RD	1	2	CP		1M2	1	1	2	CP	
BN	1.5	BN	1K2	2	1	5	CP		1Q2	1	1	5	CP	
BN	1.5	BN	1W1	RD	1	5	CP		1Q5	1	1	5	CP	
BN	1.5	BN	1W1	RD	1	4	CP		1Q6	1	1	4	CP	
BN	1.5	BN	1W1	RD	1	6	CP		1M1	1	1	6	CP	
BN	2.5	BN	1F4	L1	4	2	CP		1M1	1	1	3	CP	
BN	2.5	BN	1K1	2	1	3	CP		1Q1	1	1	3	CP	
BN	2.5	BN	1W1	RD	1	3	CP		1Q1	1	1	3	CP	
BN	1	BN	1W1	RD	1	1	CP		3Q1	1	3	1	CP	
BN	1.5	BN	1K3	2	1	7	CP		1M3	1	1	7	EFAN	
BN	1.5	BN	1K4	2	1	8	CP		1M4	1	1	8	EFAN	
BN	1.5	BN	1W1	RD	1	4	CP		2Q1	1	2	1	CP	
BN	1.5	BN	1W1	RD	1	4	CP		2Q2	1	2	1	CP	
BN	1.5	BN	1W1	RD	1	4	CP		2Q3	1	2	1	CP	
BN	1.5	BN	2Q1	2	2	1	CP		2F1	1	2	2	CP	
BN	1	BN	2Q2	2	2	1	CP		2F2	1	2	2	CP	
BN	1.5	BN	2Q3	2	2	1	CP		2F3	1	2	2	CP	
BN	1.5	BN	1W1	RD	1	6	CP		1Q3	1	1	6	CP	
BN	1.5	BN	1W1	RD	1	7	CP		1Q4	1	1	7	CP	
BN	1.5	BN	Q3	1	1	8	CP		2S1	1	1	8	CP	
BN	1.5	BN	Q1	1	1	3	CP		Q2	1	1	3	CP	
BN	1.5	BN	Q1	2	1	1	CP		Q2	1	1	1	CP	
BN	1.5	BN	Q1	2	1	1	CP		Q3	1	1	1	CP	
BN	1.5	BN	Q1	2	1	1	CP		INC	1	1	1	TB	
BN	1.5	BN	1W1	RD	1	8	CP		2Q4	1	2	8	CP	
BN	1	BN	1W1	RD	1	8	CP		3Q3	1	3	8	CP	
BN	1	BN	3Q3	2	3	3	CP		3F1	1	3	3	CP	
BN	1.5	BN	1Q7	RD	1	9	CP		1Q7	1	1	9	CP	

[illegible]

Wire				Source				Destination						
Number	Size	Colour	Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
BN	1.5	BN	Q2	1	1	1	CP		1X1	L	1	1	CP	
CH1	1.5	BN	Q5	2	1	4	CP		1K1	21	1	4	CP	
CH2	1.5	BN	Q6	2	1	6	CP		1K2	21	1	6	CP	
CLL	1.5	BN	Q4	2	1	8	CP		TB	CLL	6	7	TB	
D1L	1.5	GY	TB	2	6	7	TB		6H4	L	6	7	CONT	
D1L	1.5	GY	TB	2	6	10	CP		TB	D1L	6	9	TB	
DHL	1.5	PK	TB	2	6	9	TB		6U2	L	6	9	CONT	
DLL	1	BN	3Q1	2	3	5	CP		1U4	L	1	10	EFAN	
DLL	1.5	BN	2H1	2	3	1	CP		7A1	L	7	8	CP	
DLL	1.5	BN	2S1	2	3	8	CP		CP	FLL	7	8	CP	
FLL	1.5	BN	OP	2	2	9	CP		CP	FLL	2	9	CP	
GN	BDN	GN	5A1	FLL	2	9	CP		2H2	L	2	9	PACK	
GN	BDN	GN	5A1	GND	5	2	CP		5B4	L	5	4	PACK	
GN	BDN	GN	3A2	GND	5	3	CP		5B2	L	5	3	PACK	
GN	BDN	GN	5A1	GND	5	3	CP		3A1	L	5	2	PACK	
GN	BDN	GN	5B7	GND	5	2	CP		5B7	L	5	2	PACK	
GN	BDN	FOIL	5A1	GND	5	2	CP		5B8	L	5	2	PACK	
GY	1.5	GY	1K2	6	5	9	CP		TB	BK	6	7	TB	
GY	1.5	GY	1W1	6	5	5	CP		1M2	W	6	5	CP	
GY	2.5	GY	1F4	6	5	5	CP		1Q2	W	6	5	CP	
GY	2.5	GY	1K1	6	5	5	CP		1M1	W	6	5	CP	
GY	2.5	GY	1W1	6	5	5	CP		1Q1	W	6	5	CP	
GY	1.5	GY	1K3	6	5	5	CP		1M3	W	6	5	CP	
GY	1.5	GY	1K4	6	5	5	CP		1M4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		2Q1	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		2Q3	W	6	5	CP	
GY	1.5	GY	2Q1	6	5	5	CP		2F1	W	6	5	CP	
GY	1.5	GY	2Q3	6	5	5	CP		2F2	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		2F3	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1Q3	W	6	5	CP	
GY	1.5	GY	Q1	6	5	5	CP		1Q4	W	6	5	CP	
GY	1.5	GY	Q1	6	5	5	CP		1W1	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		INC	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		3Q3	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		3F1	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		2Q6	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K1	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K1	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K2	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K2	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K3	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K3	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP		1K4	W	6	5	CP	
GY	1.5	GY	1W1	6	5	5	CP							

Wire			Source				Destination							
Number	Size	Colour	Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
N	1	BU	1W1	N	3	1	CP		7A1	N	7	8	CP	
N	1.5	BU	4Y4	N	4	9	PACK		CP	N	4	9	CP	
N	1.5	BU	TB	N	6	9	TB		6U2	N	6	9	CONT	
N	1.5	BU	1X1	N	1	1	CP		CP	N	1	2	CP	
N	1.5	BU	1W1	N	2	8	CP		TB	N	6	7	TB	
N	1.5	BU	2H1	N	2	8	CP		CP	N	2	8	PACK	
N	1.5	BU	TB	N	6	7	PACK		CP	N	2	10	CP	
N	6	BU	1W1	N	6	7	TB		6H4	N	6	7	CONT	
N	1.5	BU	1W1	N	1	2	CP		CP	N	1	9	CONT	
N	1.5	BU	1W1	N	2	9	CP		1U3	N	1	9	EFAN	
N	1.5	BU	TB	N	6	8	CP		TB	N	6	8	TB	
N	1	BU	4Y1	N	4	8	PACK		6U1	N	4	8	CONT	
N	1.5	BU	1W1	N	3	5	CP		CP	N	3	5	CP	
P1	1	PU	TB	P1	6	2	CP		3T1	N	6	2	TB	
P2	1	PU	TB	P2	6	2	TB		6B1	N	6	2	TB	
P3	1	PU	6B3		6	3	TB		6B2	N	6	3	TB	
PC1	1	PU	6B1		6	6	TB		TB	N	6	6	TB	
PC1	1	PU	6B2		6	6	TB		6B2	N	6	6	TB	
PE	1.5	BN	TB	PC1	6	3	TB		TB	N	6	3	TB	
PE	1.5	GN/YE	1M2	E	1	5	TB		6B3	N	1	5	INC	
PE	2.5	GN/YE	1M1	E	1	3	CP		INC/PE	N	1	3	INC	
PE	1	GN/YE	INC/PE	PE	1	2	EFAN		7A1	N	1	4	INC	
PE	1.5	GN/YE	1M3	E	1	7	CP		INC/PE	N	1	7	INC	
PE	1.5	GN/YE	5A1	PE	1	8	INC		1M4	N	1	8	INC	
PE	1	GN/YE	2F-1	PE	5	2	CP		5Y1	N	5	2	EVAP	
PE	1	GN/YE	INC/PE	PE	2	4	OFAN		2F2	N	2	2	CP	
PE	1.5	GN/YE	1X1	PE	2	6	CP		2F3	N	2	6	OFAN	
PE	1.5	GN/YE	INC/PE	PE	1	1	CP		INC/PE	N	1	1	INC	
PE	1.5	GN/YE	2H1	PE	2	8	INC		CP	N	2	10	CP	
PE	1.5	GN/YE	CP	PE	2	9	CP		2H2	N	2	9	CP	
PE	1.5	GN/YE	INC/PE	PE	6	7	TB		TB	N	6	7	PACK	
PE	1.5	GN/YE	TB	PE	6	7	TB		6H4	N	6	7	CONT	
PE	1.5	GN/YE	INC/PE	PE	1	9	INC		1U3	N	1	9	EFAN	
PE	1.5	GN/YE	INC/PE	PE	2	8	TB		6U1	N	2	8	TB	
PE	1.5	GN/YE	INC/PE	PE	6	9	CP		TB	N	6	9	CONT	
PE	1.5	GN/YE	INC/PE	PE	3	5	CP		6U2	N	3	5	CONT	
PE	1	GN/YE	CP	PE	4	8	CP		3T1	N	4	8	CP	
PE	1	GN/YE	CP	PE	4	9	CP		4Y1	N	4	9	PACK	
PE	1	GN/YE	CP	PE	4	10	CP		4Y2	N	4	10	PACK	
PE	1	GN/YE	CP	PE	4	9	CP		4Y3	N	4	9	PACK	
PE	1.5	BN	1K5	PE	1	9	CP		4Y4	N	4	9	PACK	
PE	1.5	BN	2Q6	PE	2	9	CP		1U3	N	2	9	EFAN	
PVL	1.5	BK	TB	2	6	8	TB		TB	N	6	8	TB	
PVL	1.5	BK	EC	PVL	6	8	TB		6U1	N	6	8	CONT	
RD	BDN	RD	RD	1	2	2	CP		3A1	N	2	2	CP	
RD	BDN	RD	RD	6	3	8	TB		3A1	N	6	3	CONT	
RD	BDN	RD	RD	1	3	8	TB		3A1	N	1	3	CONTAINER	
RD	BDN	RD	RD	0	3	8	TB		3A2	N	0	3	TB	
RD	BDN	RD	RD	2	3	5	CP		3A1	N	2	3	CP	
RD	BDN	RD	RD	B2	3	5	CP		3A1	N	230	3	CP	
RD	BDN	RD	RD	B3	3	5	CP		3T1	N	2	3	PACK	
RD	BDN	RD	RD	B4	3	5	CP		6B2	N	WH	6	PACK	
RD	BDN	RD	RD	B6	3	5	CP		6B3	N	WH	6	PACK	
RD	BDN	RD	RD	B6	3	5	CP		6B6	N	2	4	PACK	
RD	BDN	RD	RD	WH	3	5	CP		6B4	N	5A1	6	PACK	
RD	BDN	RD	RD	WH	3	5	CP		6B1	N	5A1	6	PACK	
RD	BDN	RD	RD	WH	3	5	CP		6B7	N	2	5	PACK	
RD	BDN	RD	RD	WH	3	5	CP			N	2	5	PACK	

REV	AMENDMENT	NAME	DATE	DRAWN	JTB	HUBBARD REFRIGERATION SOLUTIONS	
01	MOD 11987-43	JTB	11/25/92	DATE	12/29/91	HUBBARD HILVERDY OTLEY RESEARCH & DEV TEL NO (441) 661 4475 880682 FAX NO (441) 661 4473 830887 WWW.HUBBARD.CO.UK	
				CHECKED		REFRIGERATION SOLUTIONS	
				APPROVED		COPYRIGHT © HUBBARD REFRIGERATION SOLUTIONS	
						© 1992 HRS OTLEY RESEARCH	
							
							
						CLIENT DAWSON RENTALS	
						PRODUCT SIGMA	
						DWG TITLE REPORT WIRE LIST	
						INSTALLATION REP_W	
						LOCATION D2810	
						SCALE NEXT PAGE NO 1/41	
						DWG NO 01	
						SHT W/3 OF 18	

Wire				Source				Destination							
Number	Size	Colour		Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
WH	BDN	WH		5A1	S2	5	2	CP		5B8	WH	5	10	PACK	
WH	BDN	WH		3A2	4	3	8	CP		3A1	4	3	8	TB	
+	1	RD		5A1	PLAN+	5	2	CP		TB		6	8	TB	
0	1	WH		1K1	A2	4	4	CP		1K2	A2	4	5	CP	
0	1	WH		1K2	A2	4	5	CP		1K3	A2	4	6	CP	
0	1	WH		1K3	A2	4	6	CP		1K4	A2	4	7	CP	
0	1	WH		1K4	A2	4	7	CP		1K5	A2	4	8	CP	
0	1	WH		3T1	0/SEC	3	5	CP		CP	PE	3	6	CP	
0	1	WH		5A1	G0	5	2	CP		5K1	A2	5	3	CP	
0	1	WH		5A1	IDC1	5	2	CP		5A1	VG0	5	3	CP	
0	1	WH		5A1	IDC9	5	2	CP		5A1	IDC1	5	2	CP	
0	1	WH		5K1	VG0	5	2	CP		EC	-	5	2	CP	
0	1	WH		5K2	A2	5	3	CP		5K2	A2	5	3	CP	
0	1	WH		5K3	A2	5	3	CP		5K3	A2	5	3	CP	
0	1	WH		5K4	A2	5	4	CP		5K4	A2	5	4	CP	
0	1	WH		5K5	A2	5	5	CP		5K5	A2	5	5	CP	
0	1	WH		5K6	A2	5	6	CP		5K6	A2	5	6	CP	
0	1	WH		CP	PE	3	6	CP		5A1	IDC9	5	2	CP	
0	1	WH		CP	PE	3	6	CP		1K1	A2	4	2	CP	
0	1	WH		DH	24N	1	10	CP		5A1	G0	5	2	CP	
0	1	WH		DH	24N	1	10	CP		5A1	G0	5	2	CP	
0	1	WH		EC	-	2	4	CP		7K1	A2	7	2	CP	
1	1	PK		1-IQ1	13	2	4	CP		5H1	X2	5	8	CP	
1	1	PK		1-IQ2	13	4	6	CP		1-IQ2	13	4	6	CP	
1	1	PK		1-IQ4	13	4	7	CP		1-IQ4	13	4	7	CP	
1	1	PK		3F1	24	4	4	CP		1-IQ3	13	4	6	CP	
1	1	PK		3Q5	2	3	5	CP		3Q5	2	3	5	CP	
-1	1	LOOM		5A1	2	3	5	CP		1-IQ1	13	4	6	CP	
-1	1	BDN		2F1	+	2	2	CFAN		5Y1	+	4	10	EVAP	
-1	1	BDN		EC	+	2	2	CP		EC	+	2	2	CP	
-1	1	BDN		EC	+	2	2	CP		2F2	+	2	2	CFAN	
-1	1	BDN		1K1	22	1	4	CP		2F3	+	2	2	CFAN	
2	1	PK		3F1	21	3	5	CP		1U1	BN	1	4	CP	
-2	1	LOOM		5A1	2	3	5	CP		3F1	14	3	5	EVAP	
-2	1	BDN		2F1	2	2	2	CFAN		5Y1	2	5	10	EVAP	
-2	1	BDN		EC	2	2	2	CP		EC	2	2	2	CP	
-2	1	BDN		EC	2	2	2	CP		2F2	2	2	2	CFAN	
2CH	1	BN		1K2	22	1	6	CP		2F3	2	2	2	CFAN	
3	1	PK		3F1	11	3	4	CP		1J2	BN	1	6	CP	
3	1	PK		3F1	11	3	4	CP		5A1	ID10	3	5	CP	
3	1	PK		3S1	13	3	3	CP		7K1	A1	7	2	CP	
3	1	PK		3S1	13	3	3	CP		3F1	A1	7	2	CP	
-3	1	LOOM		5A1	ID10	5	2	CP		7K1	A1	7	2	CP	
-3	1	BDN		5A1	3	5	2	CP		3S1	13	3	3	CP	
-3	1	BDN		2F1	NO	2	1	CFAN		5Y1	50	5	10	EVAP	
4	1	PK		3S1	14	3	3	CP		EC	3	5	2	CP	
4	1	PK		3S1	14	3	3	CP		5A1	C1	2	2	CP	
4	1	PK		3S1	14	3	3	CP		5A1	C7	3	2	CP	
4	1	PK		5A1	C4	5	2	CP		5A1	ID7	3	2	CP	
-4	1	LOOM		5A1	4	5	2	CP		5A1	C1	3	2	CP	
-4	1	BDN		5A1	58	5	2	CP		5Y1	C	5	2	EVAP	
-4	1	BDN		2F1	C	2	2	CFAN		2F3	C	5	2	CFAN	
-4	1	BDN		EC	LOOP	2	3	CP		EC	LOOP	2	2	CP	
-4	1	BDN		EC	LOOP	2	3	CP		2F2	C	2	2	CFAN	
-4	1	BDN		EC	LOOP	2	3	CP		2F2	C	2	2	CFAN	
-4	1	BDN		EC	LOOP	2	3	CP		2F3	C	2	2	CFAN	
5	1	PK		1-IQ1	14	4	4	CP		2F3	C	2	2	CFAN	
5	1	PK		C1	5	4	4	CP		C1	5	4	4	CP	
6	1	PK		F2	2	4	4	CP		1F3	1	4	4	CP	
6	1	PK		C1	6	4	4	CP		C1	2	4	4	CP	
7	1	PK		C1	7	4	4	CP		1F1	1	4	4	CP	

REV AMENDMENT	NAME	DATE	DRAWN	JRB	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	REPORT	LOCATION	SHT	W4
01	POO 1987-03	1987-03			HUBBARD REFRIGERATION SOLUTIONS	DAWSON RENTALS	WIRE LIST	REP. W	OF	18
								SCALE		
								DWG NO	D2810	01

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P2811 Rev 05

Wire			Source				Destination							
Number	Size	Colour	Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
7	1	PK	G1	7	4	2	CP		IF2	1	4	3	G1	
8	1	PK	IF1	4	4	2	CP		C1	8	4	2	CP	
8	1	PK	C1	8	4	2	CP		IF4	M1	4	2	CP	
9	1	PK	IF4	M2	4	2	CP		C1	11	4	2	CP	
9	1	PK	5A1	ID1	6	2	CP		5A1	11	4	2	CP	
10	1	PK	G1	9	4	2	CP		1K1	ID1	5	2	CP	
10	1	PK	1-TQ2	14	4	4	CP		1K1	A1	4	4	CP	
11	1	PK	C2	14	4	6	CP		C2	11	4	6	CP	
11	1	PK	2F2	2	4	6	CP		2F3	1	4	6	CP	
12	1	PK	2F3	2	4	6	CP		C2	12	4	6	CP	
12	1	PK	C2	13	4	6	CP		C2	12	4	6	CP	
13	1	PK	C2	13	4	6	CP		2F1	1	4	6	CP	
13	1	PK	2F1	4	4	5	CP		2F2	1	4	5	CP	
14	1	PK	5A1	ID2	4	5	CP		C2	14	4	5	CP	
14	1	PK	C2	14	5	5	CP		5K2	11	4	5	CP	
15	1	PK	5K2	14	4	5	CP		1K2	A1	4	5	CP	
16	1	PK	1-TQ3	14	4	6	CP		5K3	11	4	6	CP	
16	1	PK	5A1	ID3	5	2	CP		1K3	A1	4	2	CP	
17	1	PK	5K3	14	4	6	CP		5K4	11	4	6	CP	
18	1	PK	1-TQ4	14	4	7	CP		1K4	11	4	7	CP	
18	1	PK	5A1	ID4	5	2	CP		308	A1	4	2	CP	
24L	1	PK	5K4	14	4	7	CP		5Q1	1	3	5	CP	
24L	1	PK	308	1	3	5	CP		308	1	3	5	CP	
24L	1	PK	3T1	24	3	5	CP		C1	30	4	2	CP	
30	1	BN	IF4	T2	3	5	CP		C1	30	4	2	CP	
30	1	BN	3Q2	2	3	2	CP		5K5	11	4	2	CP	
30	1	BN	3Q2	2	3	2	CP		C1	30	4	2	CP	
30	1	BN	5A1	C9	3	2	CP		5K5	11	4	2	CP	
30	1	BN	5K5	11	4	8	CP		5K6	11	4	8	CP	
30	1	BN	5K6	11	4	9	CP		1K1	13	4	10	CP	
31	1	BN	5K5	11	4	8	CP		CP	31	4	8	CP	
31	1	BN	CP	31	4	8	CP		4Y1	1	4	8	CP	
32	1	BN	5K6	14	4	9	CP		CP	32	4	9	CP	
33	1	BN	1K1	32	4	9	CP		4Y2	1	4	9	CP	
33	1	BN	CP	14	4	10	CP		CP	33	4	10	CP	
34	1	BN	CP	33	4	10	CP		4Y3	1	4	10	CP	
34	1	BN	CP	34	4	9	CP		4Y4	1	4	10	CP	
34	1	BN	CP	34	4	9	CP		5A1	NO8	5	2	CP	
50	1	PK	5A1	C13	4	2	CP		5A1	VG	5	2	CP	
50	1	PK	5A1	G	6	2	CP		5A1	VG	5	2	CP	
50	1	PK	5A1	VG	5	2	CP		7K3	11	5	2	CP	
50	1	PK	501	2	5	2	CP		5A1	G	5	2	CP	
50	1	PK	7K2	11	5	2	CP		EC	50	5	3	CP	
50	1	PK	CP	50	5	3	CP		5B5	2	5	3	CP	
50	1	PK	CP	50	5	3	CP		5Q1	2	5	3	CP	
50	1	PK	EC	50	5	3	CP		7K3	11	5	3	CP	
50	1	PK	5A1	NO1	5	2	CP		5K1	A1	5	2	CP	
62	1	PK	5A1	NO2	5	2	CP		5K2	A1	5	2	CP	
53	1	PK	5A1	NO3	5	2	CP		5K3	A1	5	2	CP	
54	1	PK	5A1	NO4	5	2	CP		5K4	A1	5	2	CP	
55	1	PK	5A1	NO5	5	2	CP		5K5	A1	5	2	CP	
56	1	PK	5A1	NO6	5	2	CP		5K6	A1	5	2	CP	
57	1	PK	5A1	NO7	5	2	CP		1K5	A1	5	2	CP	
58	1	PK	EC	58	5	3	CP		5A1	ID6	5	3	CP	
59	1	PK	5A1	ID6	5	3	CP		7K2	14	5	3	CP	
60	1	PK	5A1	ID8	5	3	CP		7K3	14	5	3	CP	
61	1	PK	5A1	ID9	5	3	CP		CP	61	5	3	CP	
61	1	PK	CP	61	5	3	CP		5B5	1	5	3	CP	
62	1	PK	5A1	NO13	5	3	CP		5H1	X1	5	3	CP	

REV	AUGMENT	NAME	DATE	DRAWN	JWS	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	DWG TITLE	INFORMATION	LOCATION	SHT W/5
01	FOO 1099-43	JRS	10/25/92			SELVEN PLY SHIP PESMACH INC 94P TEL. NO 1-441 101 9175 894622 FAX NO 1-441 101 9173 879837 WWW.HUBBARD.CO.UK	DAWSON RENTALS	REPORT WIRE LIST	REP. W		OF 18
				DATE	12SEP91				SCALE	NEXT PAGE NO	W/5
				CHECKED							
				APPROVED							
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Wire			Source					Destination						
Number	Size	Colour	Device ID	Connection	Pg	Col	Location	Installation	Device ID	Connection	Pg	Col	Location	Installation
100	1	RD	7B1	+	7	8	CP		7A1	OP+	7	8	CP	
100	1	RD	7Q1	1	7	5	CP		7Q2	1	7	8	CP	
100	1	RD	7Q2	1	7	6	CP		7B1	+	7	8	CP	
101	1	RD	7Q1	2	7	6	CP		7S1	13	7	5	CP	
101A	1	RD	7Q1	2	7	5	CP		7S1	23	7	5	CP	
102	1	RD	7K1	12	7	4	CP		7S1	24	7	5	CP	
103	1	RD	7K1	11	7	4	CP		7S2	11	7	4	CP	
104	1	RD	7S2	12	7	4	CP		TB	104	6	3	TB	
104	1	RD	TB	104	6	3	TB		6H1	X1	6	3	CONT	
105	1	RD	7K3	22	8	10	CP		7S1	14	6	6	CP	
105	1	RD	7K3	22	8	10	CP		TB	105	6	6	TB	
105	1	RD	7K3	22	8	10	CP		TB	105	6	2	TB	
105	1	RD	7S1	14	7	6	CP		7H1	+	7	7	CP	
105	1	RD	TB	105	6	6	TB		6H2	X1	6	4	CONT	
105	1	RD	TB	105	6	6	TB		6S1	11	6	6	CONT	
106	1	RD	7K2	A1	7	8	CP		TB	108	6	2	TB	
107	1	BK	7A1	CHG-	7	8	CP		7H2	+	7	9	CP	
108	1	RD	7A1	CHG+	7	8	CP		7H3	+	7	10	CP	
109	1	BK	7A1	FLT-	7	8	CP		CP	-	7	10	CP	
110	1	RD	7A1	FLT+	7	8	CP		CP	+	7	10	CP	
111	1	OR	7K2	24	7	1	CP		CP	T13	8	4	CP	
112	1	OR	7K2	21	7	1	CP		CP	T14	8	5	CP	
113	1	OR	7K1	24	7	2	CP		CP	T15	8	5	CP	
114	1	OR	7K1	21	7	2	CP		CP	T16	8	5	CP	
115	1	OR	5A1	C12	5	2	CP		CP	T11	8	4	CP	
116	1	OR	5A1	NO12	5	2	CP		CP	T12	8	4	CP	
117	1	BK	TB	117	6	4	TB		6H2	X2	6	4	CONT	
118	1	RD	7K3	21	6	5	CP		TB	118	6	5	TB	
118	1	RD	TB	118	6	5	CP		6H3	X1	6	5	CONT	
118	1	RD	7K3	A1	6	7	CP		TB	119	6	6	TB	
119	1	RD	TB	119	6	6	TB		6S1	12	6	8	CONT	
119	1	BK	7B1	119	7	7	CP		7A1	OP-	7	8	CP	
119	1	BK	7H1	119	7	7	CP		7B1	A2	7	7	CP	
119	1	BK	7K2	A2	7	6	CP		7K3	199	6	5	TB	
119	1	BK	7K2	A2	7	6	CP		TB	A2	7	7	CP	
119	1	BK	7K3	A2	7	7	CP		6H1	199	6	7	CONT	
119	1	BK	TB	199	6	3	TB		6H3	X2	6	3	CONT	
119	1	BK	TB	199	6	3	TB			X2	6	5	CONT	

REV AMENDMENT	NAME	DATE	DRAWN	JRS	HUBBARD REFRIGERATION SOLUTIONS	CLIENT	DAWSON RENTALS	DWG TITLE	REPORT	INSTALLATION	LOCATION	SHT	W6
01	POO 1987-03	JRS	DATE	1987-03	HUBBARD	DAWSON RENTALS	PRODUCT	SIGMA	WIRE LIST	REP-W	SCALE	OF	18
			CHECKED		REFRIGERATION SOLUTIONS					DWG NO	D2810	REV	01
			APPROVED		© 2010 HRS DTLBY FRMCH								