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INDUSTRIAL
COMMERCIAL
EQUIPMENT
MANUFACTURING LTD.

Installation and User Manual

AH SERIES PACKAGED UNITS

- DX or Chilled Water Cooling
- Gas, Electric, Steam or Hot Water Heat

Models AH-020 to AH-700
5 to 180 Tons
Refrigerant: R-410A, R-407C, R-22, R-134a

NOTE: Prestart-up: Compressors with oil heaters require minimum time or temperature before starting. (ie: min 8 hrs, min 120 ºF)

Contents

APPENDICES

1. Description

Hazard Identification Information

⚠ WARNING

Warnings indicate potentially hazardous situations, which can result in property damage, severe personal injury, or death if not avoided.

⚠ CAUTION

Cautions indicate potentially hazardous situations, which result in personal injury or equipment damage if not avoided.

Safety Considerations

Installation and servicing of air-conditioning equipment can be hazardous due to system pressure and electrical components. Only trained and qualified service personnel should install, repair, or service air-conditioning equipment.

Untrained personnel can perform basic maintenance functions of cleaning coils and filters and replacing filters. All other operations should be performed by trained service personnel. When working on air-conditioning equipment, observe precautions in the literature, tags and labels attached to the unit, and other safety precautions that may apply.

Follow all safety codes, including UL 1995 (Issued: 2005/02/18 Ed:3 UL Standard for Safety Heating and Cooling Equipment -) and CSA C22.2#236 (Issued: 2005/02/01 Ed:3 UL Standard for Safety Heating and Cooling Equipment -). Wear safety glasses and work gloves. Use quenching cloth for unbrazing operations. Have fire extinguisher available for all brazing operations.

⚠ WARNING

Before performing service or maintenance operations on unit, turn off main power switch to unit. Electrical shock could cause personal injury.

⚠ WARNING

What to do if you smell gas:

1. DO NOT try to light any appliance.
2. DO NOT touch any electrical switch, or use any phone in your building.
3. IMMEDIATELY call your gas supplier from a neighbor's phone. Follow the gas supplier's instructions.
4. If you cannot reach your gas supplier, call the fire department.

⚠ WARNING

DO NOT store or use gasoline or other flammable vapors and liquids in the vicinity of this or any other appliance.

⚠ WARNING

Improper installation, adjustment, alteration, service, or maintenance can cause injury or property damage. Refer to installation instructions provided with the unit, and this manual. For assistance or additional information, consult a qualified installer, service agency, or the gas supplier.

Unit Description

Figure 1 & 2 shows typical packaged DX cooling unit with the locations of the major components. These figures are for general information only. See the project's certified submittals for actual specific dimensions and locations.

Figure 1: Typical Component Locations

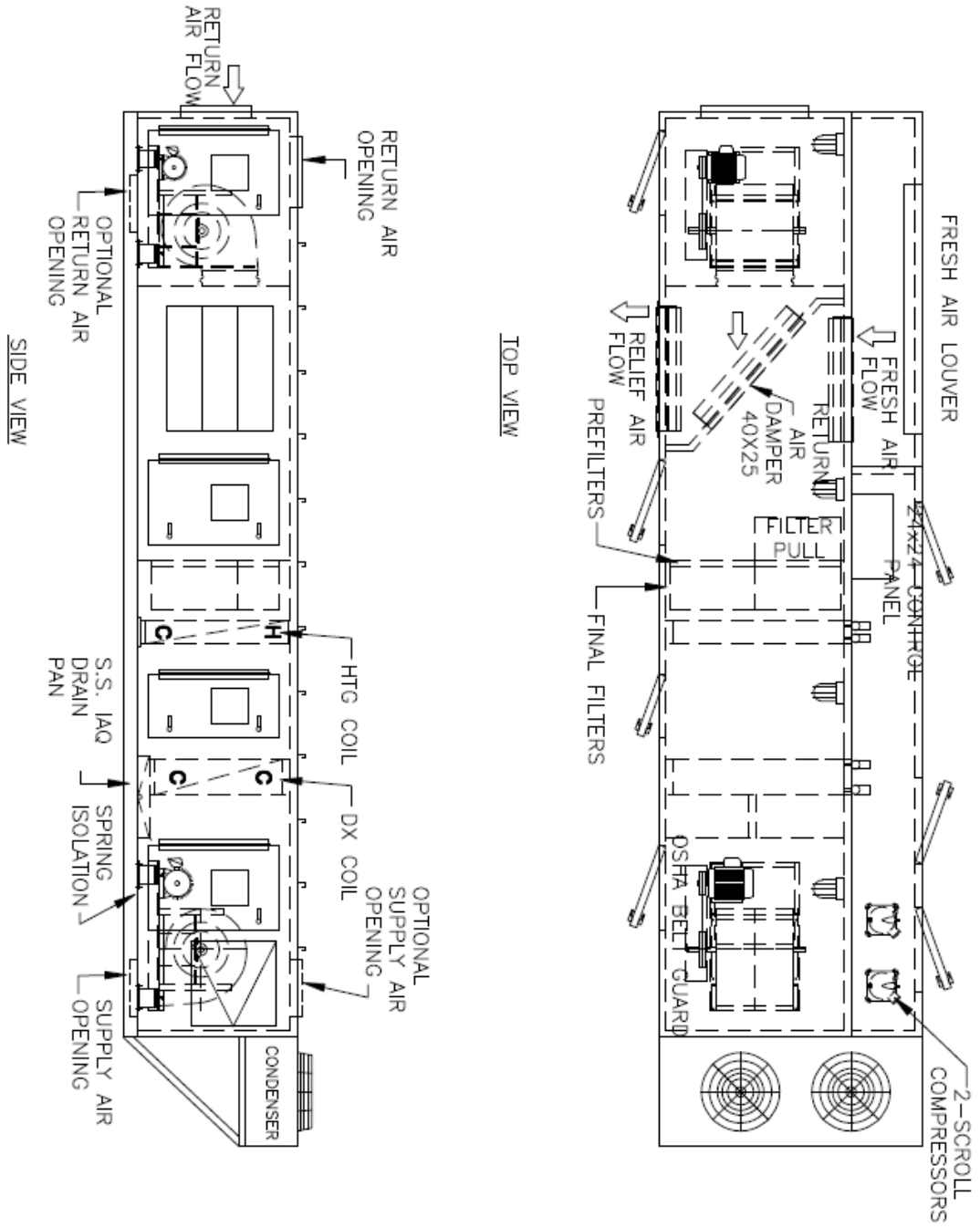
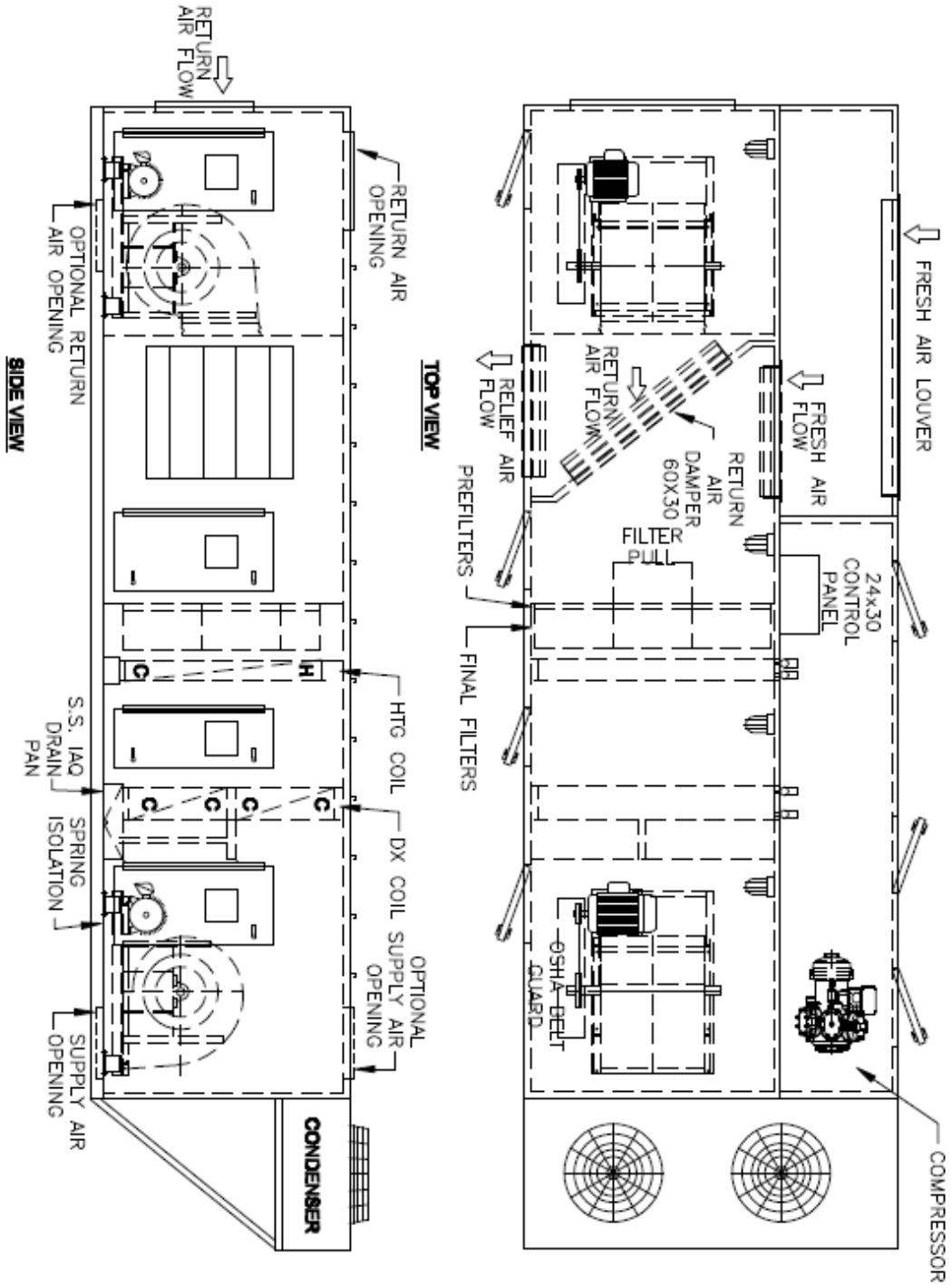


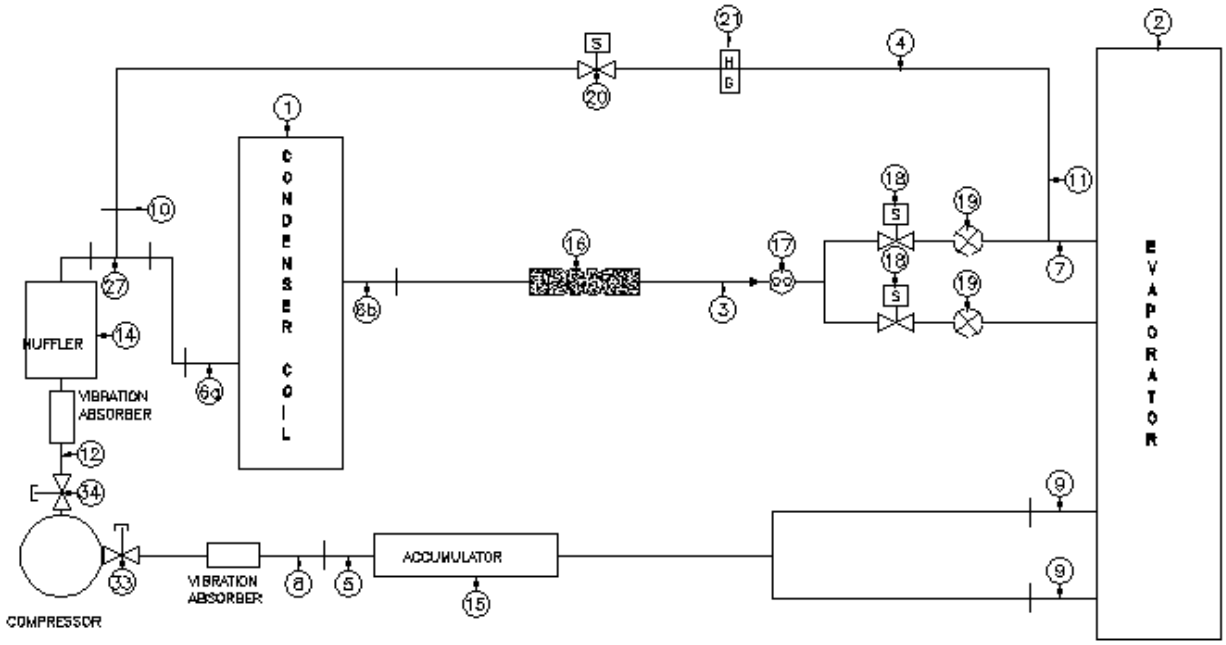
Figure 2: Typical Component Locations



Refrigeration Piping

This Section presents the unit refrigeration piping diagrams (single circuit, dual stage w/ Hot Gas Bypass System).

Figure 3: Circuit Schematic



REF.	LINE
3	LIQUID
4	HOT GAS
5	SUCTION

REF.	CONNECTIONS
8a	CONDENSOR INLET
6b	CONDENSOR LIQUID
7	EVAPORATOR LIQUID
8	COMPRESSOR SUCTION
9	EVAPORATOR SUCTION
10	COMPRESSOR HOT GAS
11	EVAPORATOR HOT GAS
12	COMPRESSOR DISCHARGE

REF.	DESCRIPTION
1	CONDENSER COIL MODEL ---
2	DX COIL MODEL ---
14	DISCHARGE MUFFLER MODEL -
15	SUCTION ACCUMULATOR MODEL - OPTIONAL
16	FILTER/DRIER
17	SIGHT GLASS
18	SOLENOID
19	THERMOSTATIC EXPANSION VALVE
20	HOT GAS SOLENOID
21	HOT GAS REGULATOR
27	TEE
33	SEAL CAP VALVE
34	SEAL CAP VALVE

2. Model Number Description

Unit Model Number

Model	Nom. Casing	Voltage	Discharge Location	Cooling	Heating	Heat Recovery	Humidification
AH -	a1 a2 a3	- b	- c	- d1 d2 d3 d4	- e1 e2	- f1 f2	- g1 g2

a1a2a3: Norminal Casing (20=2000CFM, 60=6000CFM, 80=8000CFM, 120=12000CFM, 150=15000CFM, 180=18000CFM, 210=21000CFM, 240=24000CFM, 320=32000CFM, 400=40000CFM, 480=48000CFM, 600=60000CFM, 700=70000CFM)

b: Voltage
A = 575~600V/3Ø/60HZ, B = 460~480V/3Ø/60HZ, C = 208~230V/3Ø/60HZ, D = 208~230V/1Ø/60HZ, E=120V/1Ø/60HZ

c: Discharge
T = Top, S = Side, E =End, B =Bottom, AC=Vertical

d1: Refrigerant Type
A = R410A, B = R407C, C = R-22, D = R-134a

d2: Configuration
E = Air Cooled Cond. w/ std. DX Coil
F = Cooling Water Coil
DX = DX Coil

d3: Staging
Circuit & Stage
11 = Single Circuit Single Stage
12 = Single Circuit Dual Stage
13 = Single Circuit 3 Stage
14 = Single Circuit 4 Stage
22 = Dual Circuit 2 Stage
24 = Dual Circuit 4 Stage
26 = Dual Circuit 6 Stage
28 = Dual Circuit 8 Stage
36 = Three Circuit 6 Stage
44 = Four Circuit 4 Stage
48 = Four Circuit 8 Stage

d4: Nominal Tonnage Range of 3 Ton – 180 Ton

e1: Type
GIDM = Indirect Gas Heat (4 - Pass Drum & Tube Heat Exchanger)
GIDMH = Indirect Gas Heat (4 - Pass Drum & Tube Heat Exchanger), w/High CFM.
BMA = Direct Gas Heat
BMAE = Electric Heating Unit
DIDM = Indirect Gas Heat (4 - Pass Drum & Tube Heat Exchanger)
DIDMH = Indirect Gas Heat (4 - Pass Drum & Tube Heat Exchanger), w/High CFM.
MTI = Indirect Gas Heat (Multiple Tube Heat Exchanger)
HTDM = Indirect Gas Heat (2 - Pass Drum & Tube Heat Exchanger)
SC = Steam Coil
HW = Hot Water Coil
EC = Electric Heating Coil
AC = Air Turnover

e2: Heating Capacity (from 20 MBH to 7500 MBH) or Electric Capacity (from 1 KW to 550 KW)

f1: HP = Heat Pipe, HC = Heat Core, EW = Enthalpy Wheel, RA = Run Around Glycol

f2: Size or Capacity

g1: EH = Electric Humidifier, GH = Gas to Steam Humidifier, CD = Evaporative Humidifier

g2: Capacity

3. User's Information

⚠ WARNING

Failure to observe the following instructions may result in premature failure of your system, and possible voiding of the warranty.

DX Package Units

Never cut off the main power supply to the unit, except for complete shutdown.

Always control the system from the thermostat, or control panel, and never at the main power supply (except in an emergency, or complete shutdown of the system).

During the cooling season, if the airflow is reduced due to dirty air filters, or other reasons, the cooling coils will get too cold and result in excessive liquid return to the compressor. As the liquid concentration accumulates, oil is washed out of the compressor leaving it starved for lubrication.

The compressors must be on a minimum of four minutes, and off for a minimum of five minutes. The cycle rate must not exceed eight starts per hour.

THE COMPRESSOR LIFE WILL BE SERIOUSLY SHORTENED BY RESULTING REDUCED LUBRICATION, AND THE PUMPING OF EXCESS AMOUNTS OF LIQUID OIL AND REFRIGERANT.

Hydronic Cooling and Heating

Non-compressorized units may contain chilled water and/or hot water coils. Units are provided with internal header connections for field piping. Vent and drain connections can be accessed within the unit.

Piping is to be run via the piping chase inside the coil compartment, accessible through the coil compartment access door on the front of the unit. Piping to coil header connections must be supported independently of the coil to prevent undue stress from weakening connections over time. Allow adequate flexibility for thermal expansion of the piping.

Use proper glycol solutions or brines to help prevent coil freezing. Consult the designer or project engineer if you have concerns about lower than normal entering air temperature (typically air temperatures below 40ºF) that could cause coils to freeze.

Gas or Electric Heating

The system is designed to heat a given amount of air each minute of operation. If the amount of air heated is greatly reduced (approximately 1/3 capacity), the heat exchanger (or heat coil if electric) temperature will increase above acceptable levels, and will result in shut down by a high temperature safety switch incorporated into either the heat exchanger, or the heater area.

⚠ WARNING

GAS HEAT UNITS – If heat shuts off due to safety switch, or gas supply shut off failure, then always close manual gas valve to unit prior to any electrical service. Prolonged overheating of the heat exchanger will shorten its life.

When several units are used in conditioning the space, and any are combination heating-cooling units, all system thermostat switches must be set at either heating, cooling, or set at 'OFF'. Do not run part of a system switched to an opposite mode. Cooling only units should be switched to 'OFF' at the thermostat during the heating season.

Wiring Diagrams

A complete set of unit specific wiring diagrams in both ladder and point-to point form are laminated in plastic and affixed to the inside of the service access door.

Condensate Piping

A drain trap must be connected to the drain connection located on the side or back of the unit. If codes require a condensate drain line, it should be the same pipe size as the drain nipple and should pitch downward for its entire length toward the drain.

A "P" Trap could be required and supplied by others. An air break should be used with long runs of condensate lines.

Normal Thermostat Operation

For Heating

- Set system switch to 'HEAT'
- Set fan switch to 'AUTO' or 'ON'
- Set the desired temperature

For Cooling

- Set system switch to 'COOL'
- Set fan switch to 'AUTO' or 'ON'

Air Circulation

- Set the system switch to 'OFF'
- Set the fan switch to 'ON'

System Off

- Set the system switch to 'OFF'
- Set the fan switch to 'AUTO'
- Do not change temperature setting
- With these settings the system id shut down, except for the 24-volt control system power, and the compressor crankcase heater (approx. 60W).

Night and Vacancy Operation

To reduce the operation time during low load periods, it is recommended that the temperature setting be increased by 5 ºF during non-occupied periods of the cooling season in commercial buildings, such as nights and weekends. Decrease the temperature by 10ºF at these times during the heating season.

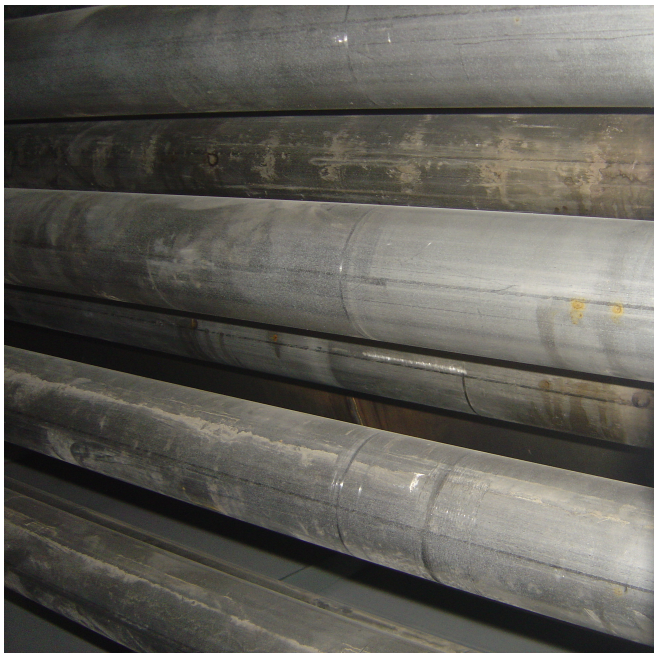
Gas Heating System

The heating section is for use with natural gas supply pressure of 7" to 14" w.c. The unit may also utilize propane gas (If order or after installation of a field conversion kit) with a supply pressure to the valve of 11" to 12" w.c. The rating plate on the furnace must be inspected to make sure the unit is stamped for proper gas. A 1/8" pressure tap should be field supplied by the installer in the piping just ahead of the gas valve.

A centrifugal blower that draws in outside air through a protected opening supplies combustion air on MTI model. This induced draft blower introduces the air to the blower tubes, which assures even primary and secondary airflow.

Gas heating units use high efficiency dimpled heat exchanger, for MTI series, it has multiple tube heat exchanger, for HTDM series, it has 2-pass drum & tube heat exchanger, for GIDM series, it has 4-pass drum & tube heat exchanger. The instruction of all gas heating system units please refer to the relevant operation & installation manual attached.

Figure 4: Gas Heat Exchangers



Hot Gas Bypass Systems on DX Units

Some DX cooling units may contain Modulating Hot Gas Bypass systems as factory installed options. Piping and valves for this systems will be within the casing of the unit w/ access via a hinged access door.

The purpose of external hot gas bypass is to prevent coil freeze-up and compressor damage from liquid slugging during periods of low airflow operation, or with low entering air temperatures.

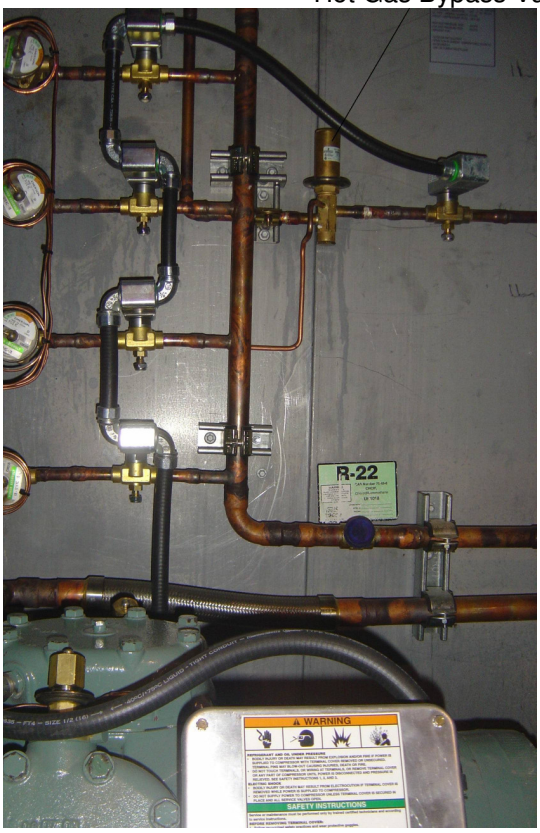
Hot gas bypass is useful when the air conditioning system is subject to variations in load caused by varying air volume or large proportions of outside air. The hot gas bypass valve meters discharge refrigerant gas to the distributor downstream of the expansion valve, and at the entrance to the evaporator distributor tubes. The quantity of the gas varies to control a constant suction pressure, allowing more gas to flow as suction pressure decreases.

Hot gas bypass is a standard feature on most ICE models

.

Figure5: Hot Gas Bypass System

Hot Gas Bypass Valve



Filter Sizes

The required filter sizes of unit depend upon the different requirements of each Air Handling unit.

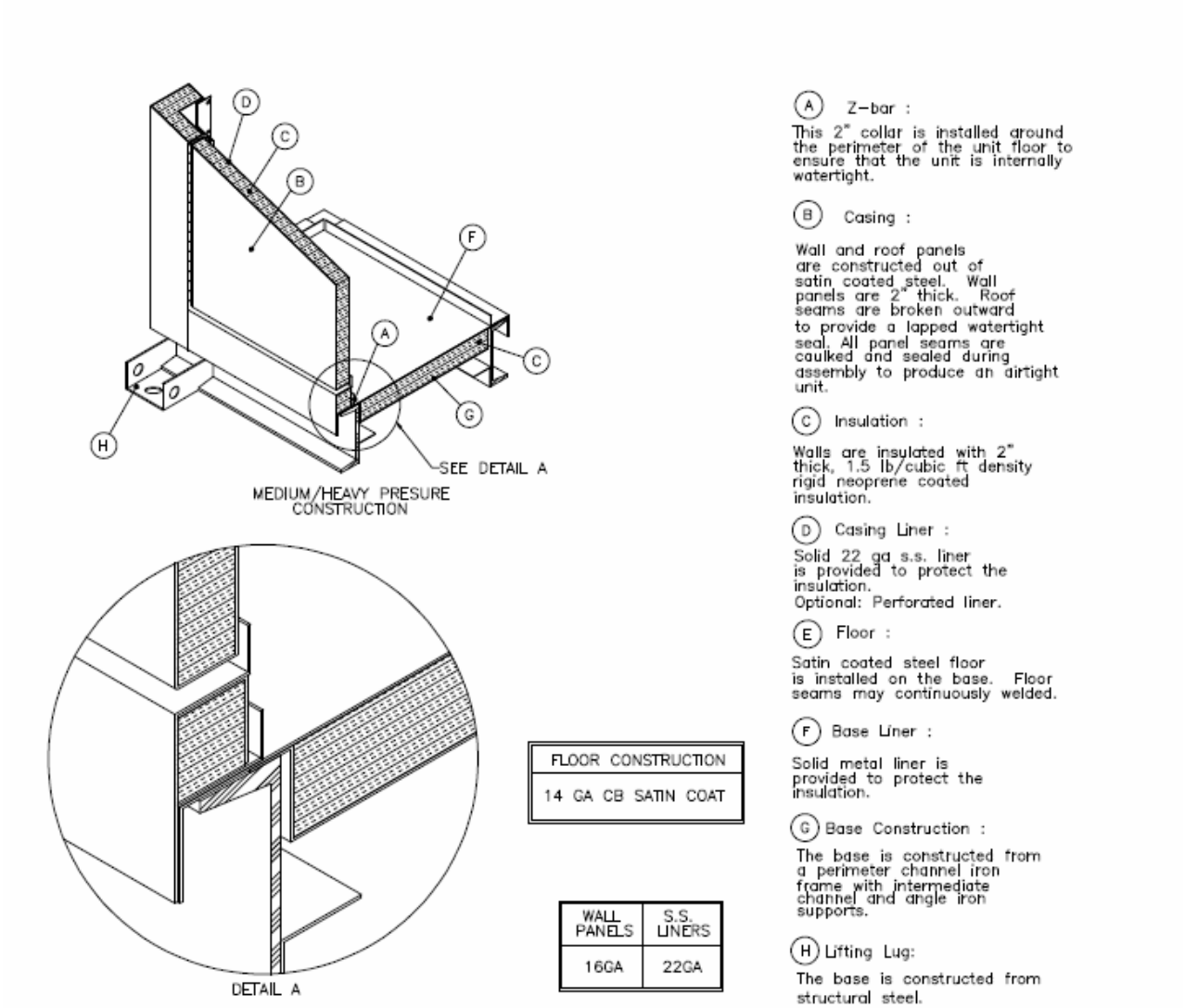
Please refer to the rating plate of each unit for information about size and quantity of filters.

Cabinet Construction

All Air Handling units are insulated with 1" – 1 1/2 "lb, 2" – 1 1/2 "lb, 2" – 3"lb fiber glass insulation. All cabinet roof, floor and doors use double-wall satin coat steel.

Please refer to figure 6 for more details of casing construction.

Figure 6: High Performance Composite Panel



4. Delivery

ALL SHIPMENTS ARE F.O.B. THE FACTORY. IT IS THE RESPONSIBILITY OF THE RECEIVING PARTY TO INSPECT THE EQUIPMENT UPON ARRIVAL.

Receipt & Inspection

The unit should be inspected for damage that may have occurred in transit. Do the following upon receipt:

1. Inspect all items for internal, external, and concealed damage before accepting.
2. Assure carrier is in compliance with Bill of Lading instructions.

If damage is found:

1. Note all damage on Bill of Lading immediately:
   - Photograph damage if possible
   - Do not move or discard damaged packaging materials
2. Call carrier immediately to file a freight claim, and to schedule a freight inspection
3. When damage is repairable, contact ICE Western for replacement parts
4. With permission of carrier, make the repairs
5. Stay in contact with carrier to ensure payment of your claim

If repairs must be made to damaged goods, the factory must be notified before any repair action is taken. Equipment alteration, repair, or unauthorized manipulation of damaged equipment without the manufacturer's consent will void all product warranties. Contact the ICE Western for assistance with handling damaged goods, repairs, and freight claims.

Verify the equipment against the order documents upon delivery. If what you received does not match your order exactly, then notify your Sales Representative at once.

Storage

This equipment is designed for indoor or outdoor use. However, if installation will not occur immediately following delivery, then store equipment in a protected area, and in the proper orientation as marked on the packaging with all internal packaging in place. Secure all loose-shipped items.

5. Installation

General

The installation of this equipment shall be in accordance with the regulations of authorities having jurisdiction and all applicable codes. It is the responsibility of the installer to determine and follow the applicable codes.

NOTE: Low head pressure may lead to poor, erratic refrigerant feed control at the thermostatic expansion valve. The units have automatic control of the condenser fans which should provide adequate head pressure control down to 50ºF (10ºC) provided the unit is not exposed to windy conditions. The system designer is responsible for assuring the condensing section is not exposed to excessive wind or air recirculation.

⚠ CAUTION

Sharp edges on sheet metal and fasteners can cause personal injury.
This equipment must be installed, operated, and serviced only by an experienced installation company and fully trained personnel.

Handling

Be aware of what is contained in the equipment!

Dependent upon the optional accessories that were ordered, this equipment may contain fragile components and delicate electronics. Although the unit is constructed of sturdy materials, avoid impacts and handling methods that may damage internal apparatus and structure, or the exterior painted surfaces of the unit. Take care not to apply destructive force to coils, or other parts protruding beyond the extents of the unit casing. Always handle the unit by its exterior casing.

Keep equipment free from debris, and construction waste during installation. Foreign materials may adversely affect unit operation resulting in premature failures that will not be covered by the manufacturer's warranty. Attach all service panels, and cover all exposed equipment when work is not being performed. Leave unit protected from other construction until start-up is to occur.

⚠ WARNING

Always wear hand and eye protection when handling, installing, servicing, or maintaining equipment. Sharp or pointed edges, moving parts, and flying debris may cause personal injury.

Heating & Cooling Systems

Gas Heating System

The units are equipped with a direct spark ignition system that proves the burner operation with each call for heat. Power to the ignition control is 24V or 120V. Burner ignition is by a high intensity spark.

When heat is called for, the cooling system is inoperable except for the indoor blower motor. Heating is accomplished by firing gas into the heat exchanger assembly.

IMPORTANT NOTICE – All gas-fired heat exchangers are completely tested at the factory before shipment. This will remove nearly all of the oils that have been used in the manufacturing process, however trace amounts may remain. When performing the initial start-up at the jobsite, it is highly recommended that people, or any other living animals, that may be sensitive to the residual odors or gases, NOT be present in the conditioned space during start-up. In all cases, including the initial factory firing and testing, all of the gases will be under the minimum acceptable level of concentration for human occupancy.

⚠ WARNING

Those sensitive to odors or gases from trace amounts of residual oils should NOT be present in the conditioned space during the start-up of a gas-fired installation.

Electric Heating System

Heating is accomplished by passing electrical current through a specified amount of resistance heaters that produce the required heat. The indoor blower motor energizes prior to the heaters.

DX Cooling Section

All direct expansion refrigeration systems are factory assembled, charged with refrigerant, tested, and operated. These systems include liquid line filter driers, expansion valves, and scroll compressors or semi-hermetic Carlyle compressors. Compressors are equipped with a positive pressure forced lubrication system. The air-cooled condenser coil is constructed of copper tubes and mechanically bonded aluminum fins, and air is pulled through by a propeller fan. The evaporator coil is draw through type constructed of copper tubes and mechanically bonded aluminum fins, and may have optional coating for hazardous locations.

Chilled Water or Non-Compressorized Cooling Section

Chilled water, or non-compressorized units, have factory-installed coils. Systems are provided with internal header connections for field piping.

Coils are constructed of copper tubes and mechanically bonded aluminum fins.

Service Clearances

In addition to providing adequate space around the unit for piping coils and drains, access to at least one side of the unit is always required to allow for regular service and routine maintenance, which includes filter replacement, drain pan inspection and cleaning, fan bearing lubrication, and belt adjustment. Provide sufficient space—at least equal to the length of the coil—on the side of the unit for shaft removal and coil removal. Space, at least equal to the length of the side coil, is required for coil removal. Space, at least equal to the fin height, is required for top coil. See Figure 7 for servicing space requirements.

For routine maintenance purposes, access normally is obtained through the access doors or by removing panels. Fan and filter sections are always provided with a service door on one side of the unit. If requested, doors can be provided on both sides of the unit. Optional service doors are available for most section types and are provided based on customer request.

If component replacement is required, the top panel also can be removed. If necessary, the unit can be disassembled. Maintain at least 54” of clearance in front of electrical power devices (starters, VFDs, disconnect switches and combination). Electrical power devices that are mounted on the side of the unit typically are up to 12” deep. See Figure 8.

Figure 7: Servicing Space Requirements

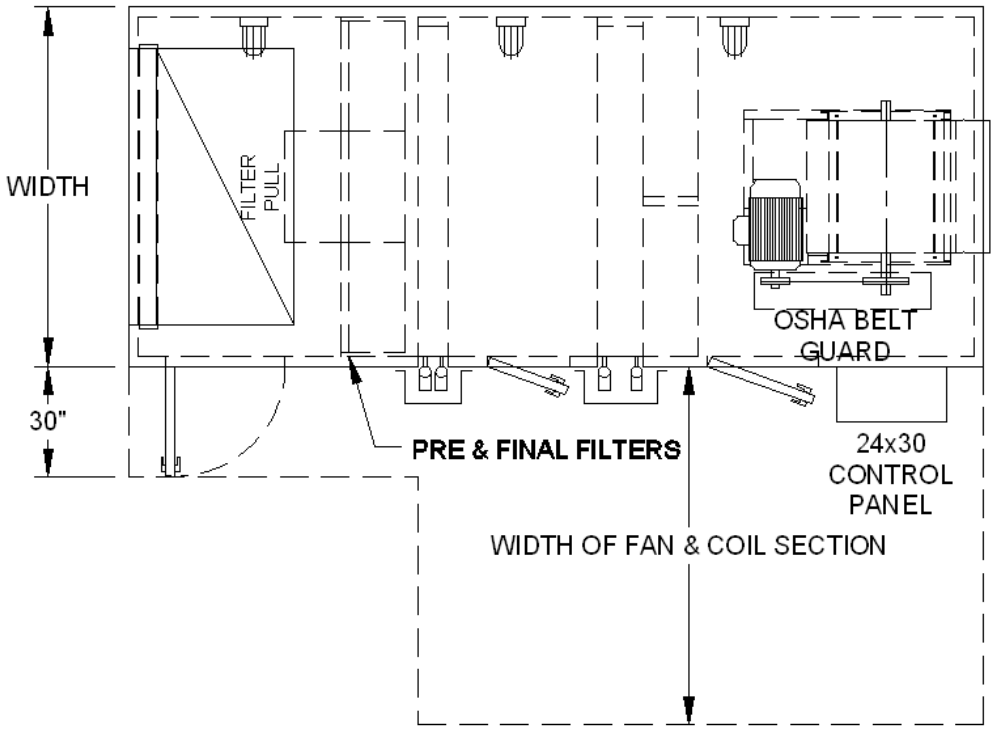
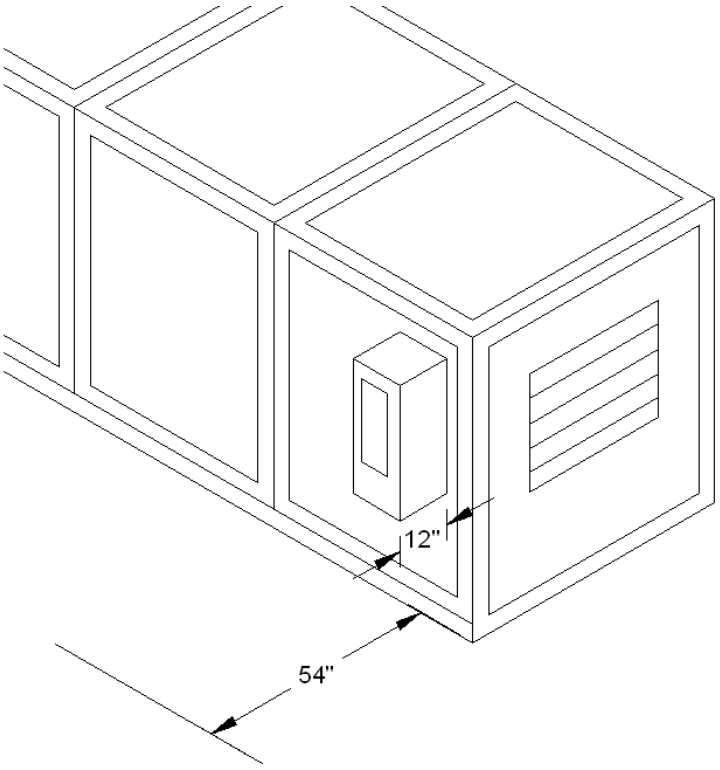


Figure 8: Service Clearance for Electrical Power Devices



Setting the Unit

Units should always be installed level, and above water drainage routes. Outdoor unit operation can be affected by wind. It is good practice to position outdoor unit condensing sections away from prevailing winds.

Protective Shipping Brackets

Before staring the unit, be sure to remove the protective shipping brackets, or bolts.

Ground Setting

Set the unit on a solid slab high enough above the soil grade to allow water to drain away from the base of the unit. The unit should be set on a slab that has been placed over compact, level earth. A poured concrete (permanent) slab is recommended.

Roof Setting with Curb

Mount roof curbs first, and locate so duct connections will clear any structural members of the building. When using the factory curb, make openings in roof decking large enough to allow for duct penetrations and workspace only. Do not make openings larger than necessary. Set the curb to coincide with the openings. CURB MUST BE LEVEL.

NOTE: PRIOR TO SETTING UNIT ON CURB – To ensure proper isolation and seal between the unit and the curb, gasket material MUST BE APPLIED to the curb on ALL SURFACES meeting

with the unit.

Hoisting

Lifting lugs are provided on the bottom of the unit.

If cables or chains are used to hoist the unit, they must be of the appropriate length, and care should be taken to prevent damage to the unit.

It is recommended that the unit be hoisted with the outside air hood (if present) in the shipped position.

Before lifting unit, be sure that all shipping material is removed. Secure hooks and cables at all lifting points/lugs provided on the unit.

Prior to setting the rooftop unit onto the roof curb, be sure that the gasket material has been applied to all curb surfaces meeting with the unit.

Hoist unit to a point directly above the curb and duct openings. Carefully lower and align the unit's utility and duct openings so the unit perimeter fits around the curb. Make sure the unit is properly seated on the curb and is level.

Outside Air Hood (Optional)

Units equipped with outside air intake will have an outside air hood. The outside air hood must be installed prior to unit operation. Ensure the air hood is properly sealed to prevent leakage.

Outdoor air intake adjustments should be made according to building ventilation, or local code requirements.

Figure 9: Lifting Lugs

⚠ WARNING

DO NOT USE OPEN FLAME OR OTHER SOURCE OF IGNITION FOR LEAK TESTING.
When pressure testing the gas supply piping, the furnace must be isolated, or disconnected by closing individual manual shut-off valve from the gas supply. Gas valve can be damaged if subjected to more than 0.5 PSIG pressure.

⚠ WARNING

Install gas fired units so that the flue discharge vent is located a minimum of 120" from openings through which combustion products can enter the building. Never point flue discharge in direction of air intake for other equipment. Unit location must assure combustion and ventilation airflows are never obstructed.

Electrical

Check the unit data plate to make sure it matches the power supply. Connect power to the unit according to the wiring diagram provided with the unit. The power and control wiring may be brought in through the utility entry. Do not run power and control wires in the same conduit.

Protect the branch circuit in accordance with code requirements. The units must be electrically grounded in accordance with the National Electric Code, ANSI/NFPA No. 70. In Canada use current C.S.A. Standard C22.1, Canadian Electric Code Part 1.

Connect power wiring to the terminal block, or optional disconnect switch. The manufacturer has done all wiring beyond this point, and cannot be modified without affecting the unit's agency and/or safety certification, and warranty.

Power can be applied to the unit after the control wiring is connected.

Standard Control Board

This printed circuit board is the central control point for all the electrical components in the unit. Low voltage terminals are provided for connection to the wall mounted thermostat of the customer's selection, or as furnished by ICE Western.

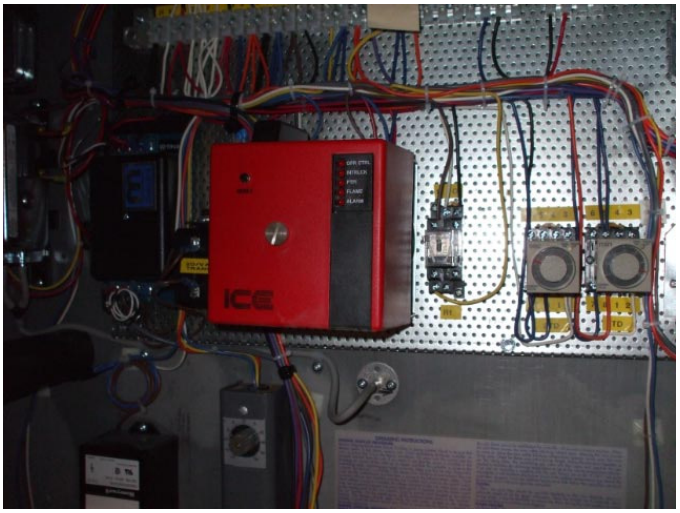
Confirm the optional features that were specified and purchased. This will allow proper selection of the number of control options listed below that may need additional wiring.

Each Air Handling Unit has a standard Cooling Lock-out feature that prevents the compressor cooling mode when the outdoor temperature is below 55ºF. Each unit may has a condenser fan cycle feature that delays the start of the condenser fan until there is satisfactory compressor discharge pressure.

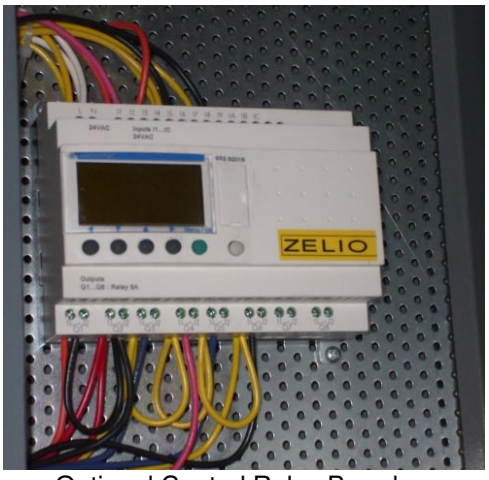
Eight colored LEDs are furnished on the circuit board to provide status information.

Every unit is furnished with a high and low pressure sensor, as well as an outdoor air temperature sensor. These sensors provide a signal to the control board that also present a fault condition or Mode indicator at the LEDs with a code.

Figure 10: Power and Control Wiring

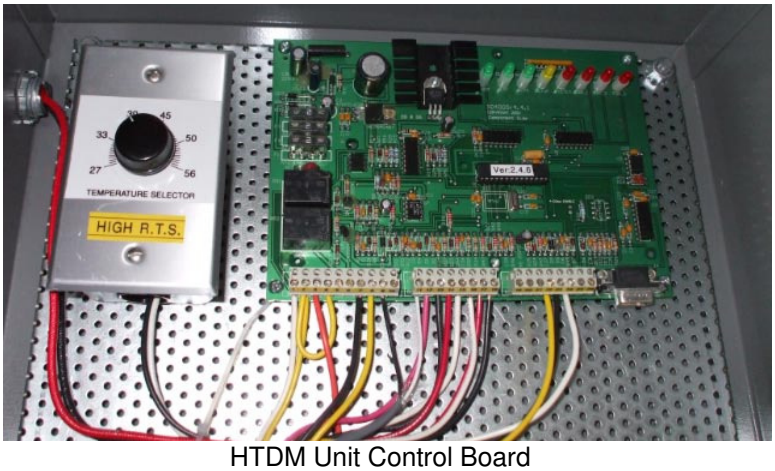


Unit Burner Proving System



Optional Control Relay Board

Ambistat Temperature Controller



HTDM Unit Control Board

Optional Control Board

This Control Relay Board is supplied within the Packaged DX Cooling model when it has been furnished with certain optional features specified by the customer. Among these are an Economizer, Return Air Bypass, Hot Gas Bypass and many other optional features according to the requirements.

Thermostat

The low voltage room thermostat should be located on an inside wall 4 to 5 feet above the floor where it will not be subjected to drafts, sun exposure or heat from electrical fixtures or appliances. The control wire size must be large enough to prevent excess voltage drop that may cause improper operation of the equipment. The Packaged DX Cooling unit control board has approximately a 1/2 amp current flow through the thermostat. Follow the thermostat manufacturer's instructions to set the heat anticipator.

Table1: Low Voltage Thermostat Field Wiring Size

	Length of Wire Run		
T-stat Load Amps	50 Ft.	100 Ft.	150 Ft.
Less than 1.0	18 ga.	18 ga.	16 ga.

Single Stage Heating & Cooling

The terminals on a single stage thermostat should be connected to the similarly labeled terminals on the Control Terminal Strip in the Packaged DX Cooling unit.

Multiple Step Compressor Cooling Models

- The Packaged DX Cooling models with multiple step cooling compressor may use multiple step cooling thermostat connected to the terminals on the Control Terminal Strip in the Packaged DX Cooling unit.

Economizer Option

The economizer option is used to provide cooling at lower outdoor air temperatures and to provide a quantity of ventilation air to the occupied space. The economizer option can be selected with either a sensible outdoor air temperature sensor or an enthalpy sensor that measures the heat content in the outdoor air. The economizer controller can be field installed or factory installed by ICE Western as selected by the customer.

Supply Air Temperature Sensor

A supply air temperature sensor is provided within the equipment. This sensor must be installed in the downstream supply air ductwork at a sufficient distance from the equipment to provide a correctly mixed supply air temperature back to the unit control board.

Factory Installed

When factory installed the control board will use the outdoor air sensor and the cooling signal

from the thermostat to provide a first stage of cooling using the outside air when possible before starting the compressor and mechanical cooling cycle. The thermostat wiring to the control board with single or multi-stages should be wired as listed previously.

Lockout Modes

Gas Heating

The heating mode will be locked out if the ignition system safety monitors trip 3 times during a call for heating.

Electric Heating

The heating mode will be locked out if the high temperature limit switch trips 3 times during a call for heating.

Cooling

The cooling mode will be locked out if the low pressure switch safety switch trips 3 times during a call for cooling or dehumidification.

Cooling operation will be locked out if the Outside Air Sensor is missing or defective.

The economizer operation during dehumidification will be locked out if the Air Sensor is defective.

To reset the lockout condition, reset the tripped device. If the device trips again, call qualified service technician.

Condensate Piping

AH Packaged DX Cooling units are equipped with a condensate drain connection, and 'P' traps are furnished by others. The drain connection must be used and individually trapped to ensure a minimum amount of condensate accumulation in the drain pans.

Although drainage of condensate directly onto the roof may be acceptable in certain areas, is not recommended as it can damage some types of roofing, and roofing materials. Refer to local codes for legalities concerning condensate drainage.

Condensate can be piped to a gutter system, or away from the building into other drainage. Ideally, condensate will be piped into the building drainage system, in which case the drainpipe may need to penetrate the roof external to the unit itself.

The drain line should be pitched away from the unit with at least 1/8" of slope per foot. On longer runs, an air break should be used to ensure proper drainage.

Drain pans in air conditioning equipment have moisture present and require periodic cleaning to remove build up of algae, and/or bacteria. Cleaning the drain pans reduces the probability of plugged drain lines and overflow of the pan itself. All cleaning of the drain pans and inside of the equipment should be done by qualified personnel.

Figure 11: DX Coil Piping and Condenser

Figure 12: Scroll Compressor

Digital Scroll Compressor

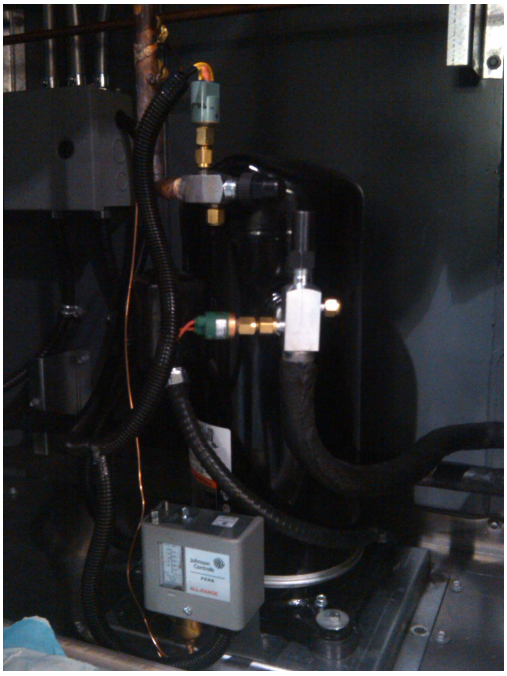
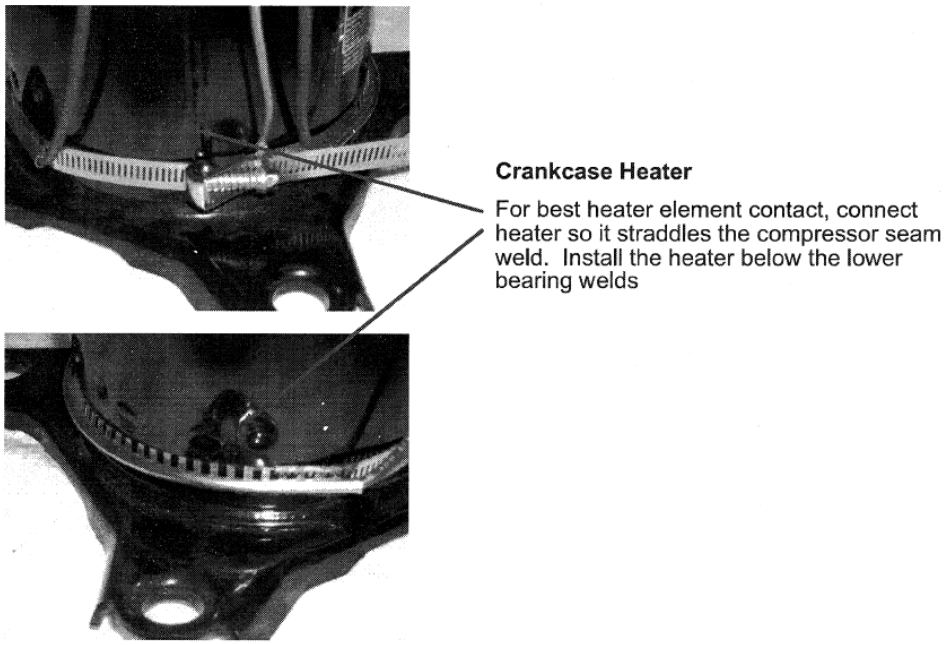


Figure 13: Crankcase Heater



6. Start-Up

General

ONLY QUALIFIED, AUTHORIZED PERSONNEL SHOULD POWER ON, OR START-UP THIS EQUIPMENT.

The use of common sense, and good practice in the installation, and start-up of equipment will prevent many potential problems with the system in the future.

Before starting up the equipment, building construction should be complete, and start-up personnel should:

- Have a working knowledge of general HVAC and mechanical commissioning procedures and practices;
- Be familiar with unit functions, features, optional unit accessories, and all control sequences;
- Have appropriate literature on hand for consultation.

Procedures

EQUIPMENT OPERATION DURING CONSTRUCTION IS NOT RECOMMENDED. CONSTRUCTION SITE POLLUTION CAN AFFECT UNIT OPERATION, AND SERIOUSLY DEGRADE PERFORMANCE. OPERATION DURING CONSTRUCTION WILL VOID ALL MANUFACTURER'S WARRANTIES.

Before the structure is occupied, the installation, and/or start-up personnel must take three essential steps:

1. Pre-Startup Check Out
2. Start-Up
3. Commissioning

Pre-Startup Check Out

All equipment should be thoroughly checked for loose wiring, free spinning condenser fan and blower wheel, and well fitting access panels. Unit should not be operated without proper ductwork, and access panels installed, except as required during start-up and air balancing.

Install gauges, voltmeter, and ammeter before start-up. Observe refrigerant pressures during initial operation. Note, and determine the cause of any excessive sound, or vibration. Follow procedures outlined below to start each piece of equipment.

1. Verify that the unit is completely and properly installed with ductwork connected.
2. Verify that all construction debris is removed, and that the filters are clean.
3. Verify that all electrical work is complete and properly terminated.
4. Verify that all electrical connections in the unit control panel and compressor terminal box are tight, and that the proper voltage is connected.
5. Verify all nameplate electrical data is compatible with the power supply.
6. Verify the phase voltage imbalance is no greater than 10%.
7. Verify that gas piping is complete and leak tight.
8. Verify that the shutoff cock is installed ahead of the furnace, and that all air has been bled from the gas line.
9. Manually rotate all fans and verify that they rotate freely.
10. Verify that the belts are tight and the sheaves are aligned.
11. Verify that all setscrews and fasteners on the fan assemblies are still tight.
12. Verify that the evaporator condensate drain is trapped and that the drain pan is level.
13. If unit is curb mounted, verify that the curb is properly flashed to prevent water leakage.
14. Before attempting to operate the unit, review the control layout description to become familiar

with the control locations.
15. Review the equipment and service literature, and the wiring diagrams to become familiar with the functions and purposes of the controls and devices.
16. Determine which optional controls are included with the unit.
17. Before closing (connecting) the power disconnect switch, open (disconnect) the following unit control circuit switches:
a. Main Control Panel
- Turn system switch to OFF.
- Electric heat units: turn switch to OFF.
- Turn compressor control circuit switches to OFF.
b. Furnace Control Compartment
- Turn furnace switch to OFF.
- Main Control Panel Switch to OFF.

Start-Up

NOTE:
1. Failure to adhere to the following start-up procedures will void all manufacturer's warranties.
2. Completed factory test sheets are in the equipment literature packet shipped inside the unit. Factory run-test readings recorded on the test sheets may be helpful to reference during start-up.

⚠ CAUTION

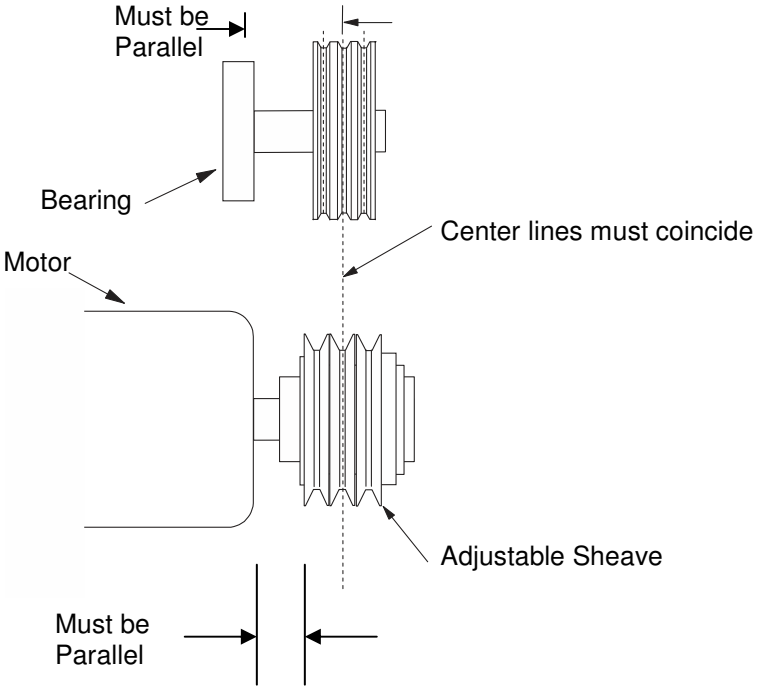
IMPORTANT FOR 3 PHASE UNITS ONLY!

CHECK COMPRESSOR FOR PROPER ROTATION BY STARTING UNIT ONLY AFTER CONNECTING PRESSURE GAUGES TO SUCTION AND DISCHARGE LINES. SCROLL COMPRESSORS WILL BE DESTROYED IF OPERATED IN THE WRONG DIRECTION.

Sheave Alignment

Mounting:
1. Verify both driving and driven sheaves are in alignment and the shafts are parallel. The center line of the driving sheave must be in line with the center line of the driven sheave. See figure 12.
2. Verify that all setscrews are still tight before starting drive. Check setscrew and belt tension after 24 hours of service.

Figure 14: Sheave Alignment

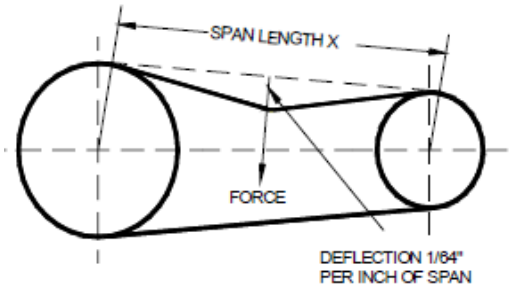


Drive Belt Adjustment

General Rules of Tensioning
1. The ideal tension is the lowest tension at which the belt will not slip under peak load conditions.
2. Check tension frequently during 24-48 hours of operation.
3. Over tensioning shortens belt and bearing life.
4. Keep belts free from foreign material which may cause slippage.
5. Inspect V-belts on a periodic basis. Adjust tension if the belt is slipping. Do not apply belt dressing. This may damage the belt and cause early failure.

Tension Measurement Procedure
1. Measure the belt span. See figure 13.
2. Place belt tension checker squarely on one belt at the center of the belt span. Apply force to the checker, perpendicular to the belt span, until the belt deflection equals to belt span distance divided by 64. Determine force applied while in this position.
3. Compare this force to the values on the drive kit label found on the fan housing.

Figure 15: Drive Belt Adjustment



Fan Start-up

1. Verify all duct isolation dampers are open.
2. Verify the fan rotation is correct.
3. a. Put Unit into summer mode at remote panel.
   b. Dampers should open then end switch will start blower.
   c. Record motor Amps to verify against rated.
4. If damper do not open:
   a. Check fuses.
   b. Check the manual motor protectors or that the circuit breakers have not tripped.
   c. Check the optional phase monitor.

Refrigeration System

I. Capacity control adjustments for Carlyle compressor

Pressure-Operated Control Valve is controlled by suction pressure and actuated by the discharge pressure. Each valve controls 2 cylinders (one bank). On start-up, controlled cylinders do not load up until differential between suction and discharge pressures is approximately 25 psi.

ADJUSTMENTS

Control Set Point (cylinder load-up point) is adjustable from 0 psig to 86 psig.

Turn adjustment nut clockwise to the bottom stop. In this position, the cylinder load-up pressure is 86 psig. Control set point is regulated to desired pressure by turning the adjustment nut counterclockwise. Each full turn clockwise decreases the load-up point by approximately 7.2 psi. Approximately 12 turns changes the pressure from 85 psig to 0 psig.

Pressure Differential between cylinder load-up point and unload point is adjustable from 6 psi to 16 psi.

Turn adjustment screw counterclockwise to the back-stop. In this position, the differential is 6 psi. Differential is set by turning the adjustment screw clockwise. Each full turn clockwise increases the differential by approximately 0.8 psi. Approximately 5 turns changes the differential from 6 psig to 10 psig

Electrically-Operated Control Valve is actuated by an electric solenoid, which must be of the same voltage as the unit control circuit. **No adjustments are necessary.** When the solenoid is de-energized, the orifices and passage-ways in the valve are aligned for loaded condition, shown in figure 14. When the solenoid is energized, the system is unloaded as shown in figure 14.

Suction Cutoff Unload Operation – The capacity control valve shown in figure 14 is the pressure–operated type, which is the one in the following description. In the electrically-actuated valve, the function of a similar poppet valve is the same as in the pressure-operated type but it is moved by a solenoid. The function within the cylinder head is the same for both types of control valve.

LOADED

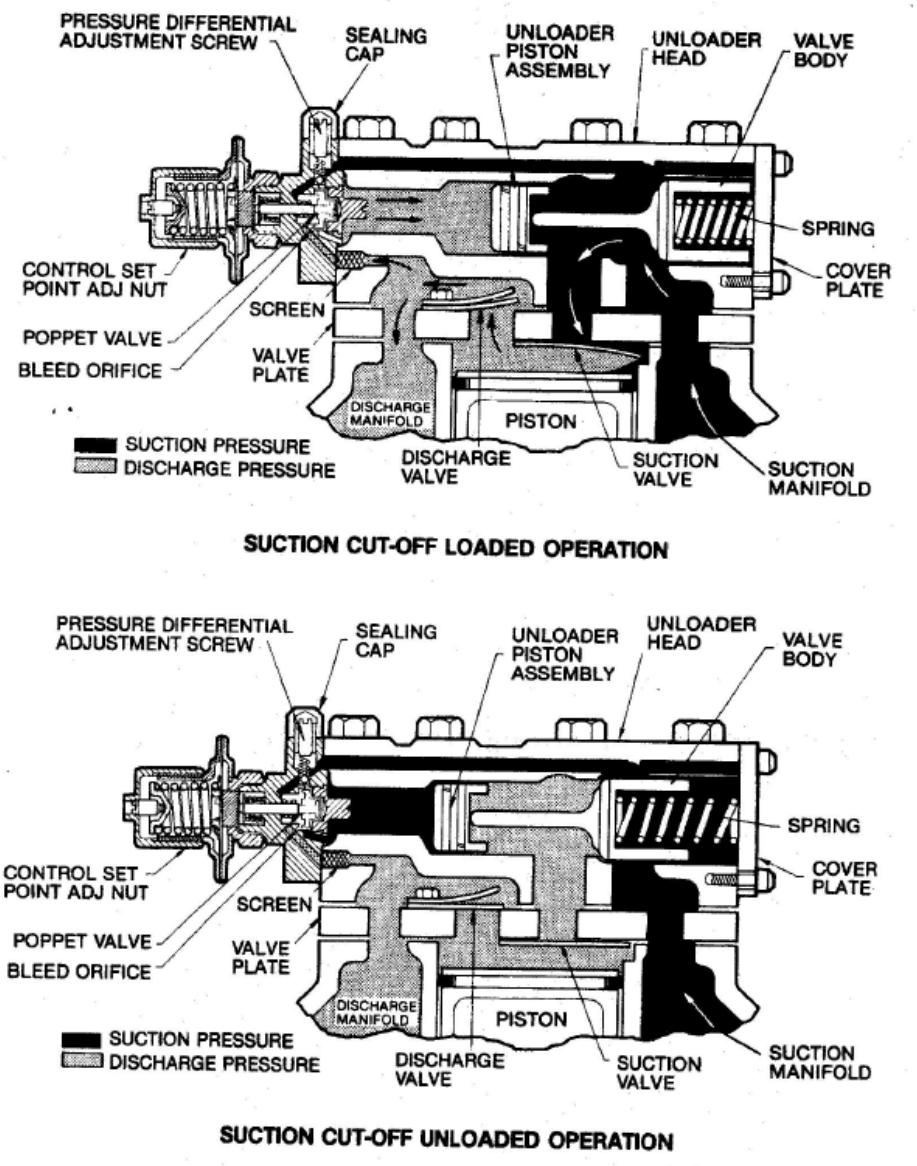
When suction pressure rises high enough to overcome control set point spring, the diaphragm snaps to the left and relieves pressure against the poppet valve. The drive spring moves the poppet valve to the left and it seats in the closed position.

With poppet valve closed, discharge gas is directed into the unload-piston chamber and pressure builds up against the piston. When pressure against unloader piston is high enough to overcome the unloader valve spring, piston moves valve to the right, opening suction port. Suction gas can now be drawn into the cylinders and the bank is running fully loaded.

UNLOADED

As suction pressure drops below set point, control spring expands, snapping diaphragm to right. This forces poppet valve open and allows gas from discharge manifold to vent through base of control valve to suction side. Loss of full discharge pressure against unloader piston allows unloader valve spring to move valve left to closed position. The suction port is blocked, isolating the cylinder bank from the suction manifold. The cylinder bank is now loaded.

Figure 16: Suction Cut-Off Unloaded Operation



II. Adjustments for Dual Pressure Control

(JOHNSON CONTROLS: P70, P72, and P170 Series Controls)

All-Range Controls (Low Side Only)

The low side of All-Range controls displays the CUT IN and CUT OUT setpoints. Turn the range screw to adjust the cut in and cut out setpoints up or down simultaneously which maintains the set differential value. Turn the differential screw to adjust the cut out setpoint and change the differential value.

Dual Pressure Control (High Side)

The high side scale plate of the P70, P72, P170 dual pressure controls display only the CUT OUT setpoint. Turn the range screw to adjust the cutout setpoint. The differential is fixed at about 65 psi.

To adjust the dual pressure controls:

Set low side cut in setpoint by adjusting low side range screw. All-Range Controls: Turn the screw clockwise to raise the cut in setpoint.

Adjust the differential screw. All-Range Controls: Turn the screw clockwise to raise the cut out setpoint.

Set high side cut out setpoint by adjusting high side range screw. Turn screw clockwise to raise the cut out setpoint. (High side differential is fixed.)

III. Hot Gas Bypass Regulator Adjustments

Install an accurate pressure gauge at the control (sensing) point at the outlet side of the valve.

To adjust the valve, loosen Seal Nut and turn Adjusting Stem clockwise to raise the pressure or counterclockwise to lower the pressure.

The regulator should be set under actual operating conditions. For hot gas bypass this condition occurs under minimal system load conditions. The regulator should be adjusted to maintain minimum desired suction pressure. Hot gas flow through the valve can be detected by listening to the gas flow through the regulator or by feeling the outlet pipe for warmth. When it is not possible to simulate minimum load conditions, an approximate setting may be obtained by adjusting the valve until gas flow begins, observing the gauge reading, and then turning the adjusting stem counterclockwise for the required number of turns to obtain the desired minimum pressure. This setting should be checked and readjusted as needed under actual conditions.

IV. Typical Malfunctions Of Solenoid Valve

(SPORLAN: Solenoid Valves)

Coil Burnout

a. Coils burnouts are extremely rare unless caused by one of the following:

b. Improper electrical characteristics.

c. Continuous over-voltage, more than 10%.

d. Under-voltage of more than 15%. This applies only if the operating conditions are such that reduced MOPD causes stalling of the plunger, which results in excessive current draw.

e. Incomplete magnetic circuit due to the omission of parts such as: coil housing, coil sleeves, coil spring, coil housing bottom plate or plunger on the MKC molded model coils.

f. Mechanical interference with plunger movement which may be caused by a deformed enclosing tube.

g. Voltage spike.

h. Valve ambient exceeds 120ºF.

i. Fluid or gas temperatures greater than 240 ºF, while the valve ambient is 120 ºF.

Failure To Open (Normally Closed Types)

a. Coil burned out or an open circuit to coil connections.

b. Improper electrical characteristics.

c. In pilot operated valves, dirt, scale or sludge may prevent the piston, disc or diaphragm from lifting. This could also be caused by a deformed body.

d. High differential pressure that exceeds the MOPD rating of the valve.

e. Diameter reduction of synthetic seating material in pilot port because of high temperatures and/or pressures, or severe pulsations.

Failure To Close

a. Valve is oversized.

b. In pilot operated valves, dirt, scale or sludge may prevent the piston, disc or diaphragm from lifting. This could also be caused by a deformed body.

c. Held open by the manual lift stem.

d. In pilot operated valves only, a damaged pilot port may prevent closing.

e. A floating disc due to severe discharge pulses.

f. Have voltage feedback to the coil after the coil de-energizes.

V. Superheat Adjustment Of Thermal Expansion Valves

(EMERSON: T-Series Thermal Expansion Valves)

T-Series Thermal Expansion Valves are factory-set for a static superheat. However, the superheat should be adjusted for the application. Improper superheat adjustment may result in system malfunction. To properly adjust thermal expansion valve to other superheat settings:

a. Remove seal cap on side of valve.

b. Turn the adjusting stem in a clockwise direction to increase the superheat, and counterclockwise to decrease superheat.

NOTE: Allow adequate time between adjustments for system to stabilize before checking superheat.

c. When the desired superheat setting is achieved, reinstall the seal cap.

Gas Heating

1. Ensure that gas lines have been purged of air
- wait 5 minutes after purging to allow gas to clear before continuing with startup.
2. Turn the unit power on.
3. Turn the unit blower on, and check for correct rotation.
4. If correct, take blower amp readings, and compare to see if the amp draw is within the safety factor area of the motor. Once correct, turn blower off.
5. Turn on the first stage of heating.
6. Check to see that induced draft motor starts.
7. Check to see that main burner lights within 5 seconds of the heating call.
8. Check gas input and manifold pressure, and adjust if necessary.
9. Ensure blower started after burner ignition.
10. Observe burner flames for light blue color, and even flames across burner (propane flames will have yellow tips). Set with co analyzer.
11. Check temperature rise across heating section while all stages are on.
12. If temperature rise is within range, turn all heating calls off.
13. Check that blower stops after heat turns off.

Electric Heating

1. Turn the unit power on.
2. Turn the unit blower on, and check for correct rotation.
3. If correct, take blower amp readings, and compare to see if the amp draw is within the safety

factor area of the motor. Once correct, turn blower off.
4. Turn on the first stage of heating.
5. Check amp draw of each element of each stage.
6. Check temperature rise across heating section while all stages are on.
7. If temperature rise is within range, turn all heating calls off.
8. Check to see that blower stops.

Optional Equipment

Operation of each of the following, if equipped in the unit, must be checked according to that item's manufacturer's specifications:

- Clogged filter switch
- Supply air smoke detector
- Return air smoke detector
- Hot gas bypass

Commissioning

The commissioning of an HVAC system is the process of achieving, verifying, and documenting the performance of that system to meet the operational needs of the building. This may not be a formal process in smaller structures, such as a normal residence, but some form of owner acceptance will occur. Adjustments made during the commissioning phase may include air balancing, or configuration of controls, and operational sequences.

Air Balancing

High performance systems commonly have complex air distribution and fan systems. Unqualified personnel should not attempt to adjust fan operation, or air circulation, as all systems have unique operating characteristics. Professional air balance specialists should be employed to establish actual operating conditions, and to configure the air delivery system for optimal performance.

Water Balancing

A hydronic specialist with a complete working knowledge of water systems, controls, and operation must be employed to properly balance the entire system. Unqualified personnel should not attempt to manipulate temperatures, pressures, or flow rates, as all systems have unique operating characteristics, and improper balancing can result in undesirable noises and operation.

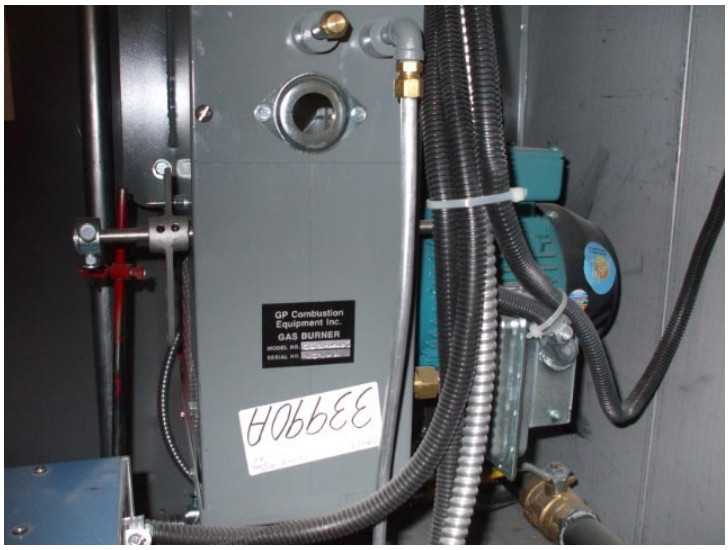
Controls

A variety of controls and electrical accessories may be provided with the equipment. Identify the controls on each unit by consulting appropriate submittal, or order documents, and operate according to the control manufacturer's instructions. If you cannot locate installation, operation, or maintenance information for the specific controls, then contact your sales representative, or the control manufacturer for assistance.

⚠ WARNING

Do not alter factory wiring. Deviation from the supplie
wiring diagram will void all warranties, and may resul
in equipment damage or personal injury.
Contact the factory with wiring discrepancies.

Figure 17: Gas Burner



UNIT START-UP CHECKLIST

MODEL NO: _____ SERIAL NO: _____.
DATE: _____ TECHNICIAN: _____.

I. PRE-START-UP:

☐ Verify that all packaging materials have been removed from unit
☐ Verify installation of outdoor air hood
☐ Verify that condensate connection is installed per installation instructions
☐ Verify that all electrical connections and terminals are tight
☐ Check that indoor-air filters are clean and in place
☐ Check that outdoor air inlet screens are in place
☐ Verify that unit is level
☐ Check fan wheels and propeller for location in housing and verify setscrew is tight
☐ Verify that fan sheaves are aligned and belts are properly tensioned
☐ Verify that compressors are rotating in the correct direction
☐ Verify installation of thermostat/space sensor
☐ Verify configuration values for electronic controls
☐ Verify that crankcase heaters have been energized for at least 24 hours

II. START-UP

ELECTRICAL

Supply voltage L1-L2 _____ L2-L3 _____ L3-L1 _____.

Compressor AMPS – Compressor A1 L1_____ L2 _____ L3 _____.
– Compressor B1 L1_____ L2 _____ L3 _____.
– Compressor C1 L1_____ L2 _____ L3 _____.
Condenser Fan AMPS – Fan #1 L1_____ L2 _____ L3 _____.
– Fan #2 L1_____ L2 _____ L3 _____.

Supply Fan AMPS _____ L1_____ L2 _____ L3 _____.

TEMPERATURES

Outdoor-air temperature _____ ºF DB (Dry Bulb)
Return-air temperature _____ ºF DB _____ ºF WB (Wet Bulb)
Cooling supply air _____ ºF

PRESSURE

Refrigerant suction Circuit A _____ PSIG
Circuit B _____ PSIG
Circuit C _____ PSIG
Refrigerant discharge Circuit A _____ PSIG
Circuit B _____ PSIG
Circuit C _____ PSIG
Oil Pressure A _____ PSIG B _____ PSIG

REFRIGERANT

Type: ☐ R22 ☐ R407C ☐ R410A ☐ R134a

☐ Verify refrigerant charge using charging charts

GENERAL

☐ Economizer minimum vent and changeover settings to job requirements

7. Operation & Maintenance

General

Preventive maintenance is the best way to avoid unnecessary expense and inconvenience. Have this system inspected at regular intervals by a qualified service technician. The required frequency of inspections depends upon the total operating time and the indoor and outdoor environmental conditions.

Planned Maintenance

Routine maintenance should cover the following items:
- Tighten all belts, wire connections, and setscrews.
- Clean the evaporator and condenser coils mechanically or with cold water, if necessary. Usually any fouling is only matted on the entering air face and can be removed by brushing.
- Lubricate the motor and fan shaft bearings.
- Align or replace the belts as needed.
- Clean or replace the filters as needed.
- Check each circuit's refrigerant sight glass when the circuit is operating under steady-state, full load conditions. The sight glass should then be full and clear. If it is not, check for refrigerant leaks. (A partially full sight glass is not uncommon at part load conditions.)
- Check for proper superheat.
- Check for proper subcooling.
- Check for blockage of the condensate drain. Clean the condensate pan as needed.
- Check the power and control voltages.
- Check the running amperage of all motors.
- Check all operating temperatures and pressures.
- Check and adjust all temperature and pressure controls as needed.
- Check and adjust all damper linkages as needed.
- Check the operation of all safety controls.
- Examine the gas furnace.
- Check the condenser fans and tighten their setscrews.
- Lubricate the door latch mechanisms.

Cooling

Coils should be inspected and cleaned at least once per year to ensure there is no obstruction to airflow.

Evaporator Coil

Dirty evaporator coils will eventually freeze up, and often result in a time consuming, and expensive service call. Clean filters will help to prevent dirt from accumulating on the evaporator; however the evaporator should be cleaned annually with a soft bristled brush, and/or a non-corrosive coil cleaning solution.

Condenser Coil

One of the most overlooked maintenance requirements is the need to keep air moving freely across air-cooled condensing coils. Dirty condensers, like evaporators, can significantly increase cooling costs during the year. As a minimum, clean the condenser coil at the beginning of each cooling season. It is preferable to use a medium pressure water spray from the inside

of the condenser cabinet with a non-corrosive coil cleaning solution. TURN OFF all power to the unit before cleaning.

Comb out any visible exterior fin damage to help maintain unit efficiency.

Condenser Fan

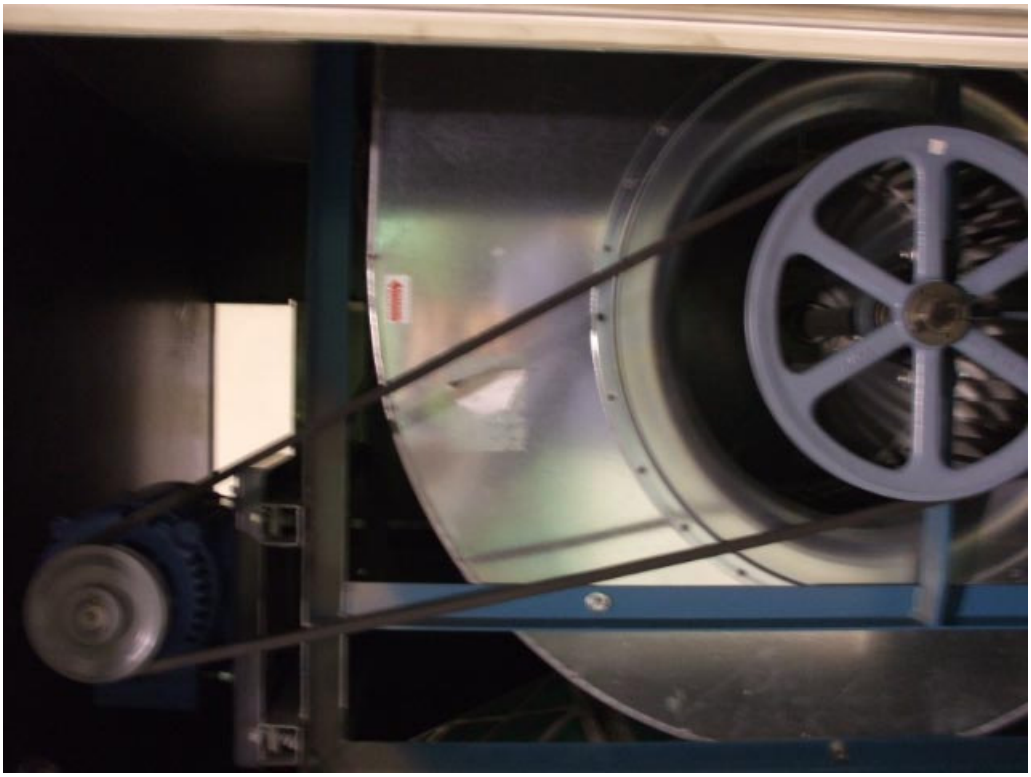
Always check condenser fan blades to ensure unobstructed, free rotation after manipulating the unit cabinet in any way, and before turning power back on to the condenser. Clean the fan blades if they are dirty.

Blower Assembly

Clean blower wheels are necessary to reduce electrical use, maintain capacity and reduce stress on the unit. The blower wheel and blower section need to be inspected periodically, and cleaned of dust, or debris.

To inspect and clean the blower; set thermostat to the “OFF” position; turn the electrical power to the unit to the “OFF” position at the disconnect switch.

Figure 18: Blower Section



Gas Furnace

Planned maintenance is the best way to avoid unnecessary expense and inconvenience. Have this system inspected at regular intervals by a trained and experienced service technician. The following service intervals are typical for average situations but will have to be adjusted to you’re your particular circumstances.

Fuel pressure settings and control settings should be made only by persons thoroughly experienced with the burner and control system, and must not be tampered with by persons without such experience.

Always replace covers on burner controls and boxes as the electrical contacts are sensitive to dust and dirt. Perform maintenance of controls, gas valves, and other components in accordance with instructions contained in the manufacturer's bulletins.

Monthly

Check air filters and replace if dirty.

Twice Yearly

1. Burner Air - Check burner fan wheel for dirt buildup and lint. Check combustion air intake louver and flue box for dirt buildup and accumulation of windborne debris.
2. Cleaning - Inspect flue tubes and combustion chamber, cleaning as required. Keep burner vestibule clean. Dirt and debris can result in burner air blockages.

Yearly

1. Gas Train - Check all valves, piping and connections for leakage. Inspect and clean flame rod, ignition electrode, and burner manifold.
2. Condensate Pan/Drain/P-Trap – Check pan, drain, and p-traps for accumulation of debris. Check that p-traps are filled with water at the start of each cooling season.

Chilled Water

Check remote chiller operations as per the manufacturer's instructions. Check coolant flow valves for correct operation and settings.

Filters

Open the filter access door. Slide filters towards you to inspect. Replace old filters with the size indicated on each filter. Filters should be checked every 30 days and replaced or cleaned as necessary.

IT IS IMPORTANT TO KEEP FILTERS, COILS, AND BLOWERS CLEAN!

Figure 19: Filter Section

Cleaning

Inspect and clean unit interior at the beginning of each heating and cooling season and as operating conditions require.

Service

In the event the unit is not functioning correctly and a service company is required, only a company with service technicians qualified and experienced in both heating and air conditioning should be permitted to service the systems in order to keep warranties in effect. The service tech may call ICE Western if assistance is required.

BEFORE CALLING, THE MODEL AND SERIAL NUMBER OF THE UNIT WILL BE NEEDED FOR ICE WESTERN TO HELP ANSWER QUESTIONS REGARDING THE UNIT.

8. Pressure – Temperature Chart

Temperature		R22	R407C		R410A	R134a
ºF	ºC	PSIG	Liquid Pressure (PSIG)	Vapor Pressure (PSIG)	PSIG	PSIG
20	-6.7	43.0	51.6	38.0	78.3	18.4
25	-3.9	48.8	58.2	43.6	87.3	22.1
30	-1.1	54.9	65.2	49.6	96.8	26.1
35	1.7	61.5	72.6	56.1	107	30.4
40	4.4	68.5	80.7	63.1	118	35.0
45	7.2	76.0	89.2	70.6	130	40.1
50	10.0	84.0	98.3	78.7	142	45.5
55	12.8	92.6	108	87.3	155	51.3
60	15.6	102	118	96.8	170	57.5
65	18.3	111	129	106	185	64.1
70	21.1	121	141	117	201	71.2
75	23.9	132	153	128	217	78.8
80	26.7	144	166	140	235	86.8
85	29.4	156	180	153	254	95.4
90	32.2	168	195	166	274	104
95	35.0	182	210	181	295	114
100	37.8	196	226	196	317	124
105	40.6	211	243	211	340	135
110	43.3	226	261	229	365	147
115	46.1	243	280	247	391	159
120	48.9	260	300	266	418	171
125	51.7	278	321	286	446	185
130	54.4	297	342	307	476	199
135	57.2	317	365	329	507	214
140	60.0	337	389	353	539	229
145	62.8	359	-	-	573	246
150	65.6	382	-	-	608	263

Twin City Fan & Blower

INSTALLATION, OPERATION & MAINTENANCE MANUAL

Centrifugal Fans

ENGINEERING SUPPLEMENT

ES-52

Issue Date: 1-1-94
Rev. Date: 2-1-06

Contents

Introduction

The purpose of this manual is to provide instructions that complement good general practices when installing or operating fans manufactured by Twin City Fan & Blower. It is the responsibility of the purchaser to provide qualified personnel experienced in the installation, operation, and maintenance of air moving equipment.

Instructions given in the body of this manual are general in nature and apply to a variety of models manufactured by Twin City Fan & Blower. Most units can be installed and maintained with the instructions given.

Special applications may require additional information. These instructions are supplied in the form of attached appendices. Use the instructions in the appendix if the directions in this manual differ from instructions in the appendix.

As always, follow good safety practices when installing, maintaining and operating your air moving equipment. A variety of safety devices are available. It is the user's responsibility to determine adequate safety measures and to obtain the required safety equipment.

Shipping and Receiving

All Twin City Fan & Blower products are carefully constructed and inspected before shipment to insure the highest standards of quality and performance.

Compare all components with the bill of lading or packing list to verify that the proper unit was received.

Check each unit for any damage that may have occurred in transit. Any damage should be reported immediately to the carrier and the necessary damage report filed.

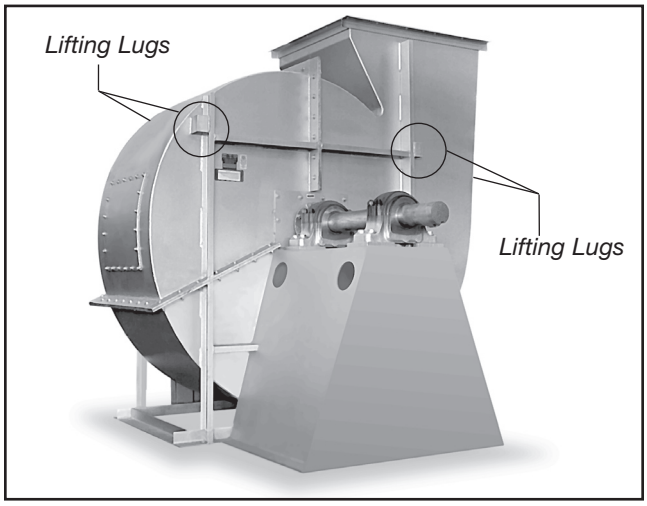
Handling

Handling of all air moving equipment should be conducted by trained personnel and be consistent with safe handling practices. Verify the lift capacity and operating condition of handling equipment. Maintain handling equipment to avoid serious personal injury.

Units shipped completely assembled may be lifted with slings and spreader bars. Use well-padded chains, cables or nylon straps. On most units, lifting lugs are provided for attaching chains (see Figure 1). Lift the fan in a fashion that protects the fan and fan coating from damage. Never lift a fan by the inlet or discharge flange, shafting or drives, wheel or impeller, motor or motor base, or in any other manner that may bend or distort parts.

Partial or disassembled units require special handling. All parts should be handled in a fashion which protects the coatings and parts from damage. Components should be handled such that forces are not concentrated and bending or distortion cannot occur.

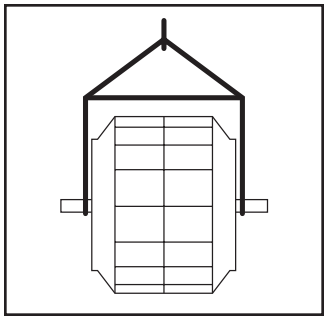
Figure 1. Lifting Lug Locations



Housing should be lifted using straps and spreaders. Do not distort housing or side plates when lifting.

Bearing pedestals should be lifted using straps or padded chains. Under no circumstances should an attached or separated bearing pedestal be lifted by the shaft, bearings, drives, motor or wheel.

Figure 2. Moving Shaft and Wheel with Spreader Bar



The shaft and wheel assembly may be lifted using a hoist and a spreader with a sling around the shaft at points nearest the wheel (see Figure 2). Take care not to scratch the shaft where the wheel or bearings will be mounted. Never lift or support the assembly by the wheel. Always support the assembly by the shaft when lifting or storing. Do

not support the shaft or the wheel on housing sides. Use only the key provided with the shaft and wheel.

Wheels shipped separately can be lifted by slings running through the blades and around the hub. Never lift the wheel by blades or flanges. Always transport wheels by lifting. Do not roll the wheel as this can damage coatings and change the balance of the wheel.

Bent shafting is a source of vibration and bearing failure, so handle the shaft with care. Any scratches on the shaft may be removed with fine emery cloth or a stone.

Short Term Storage

If fan installation is to be delayed, store the unit in a protected area. Protect the fan and motor bearings from moisture and vibration (or shock loading).

Long Term Storage

Prior to Storage – Fan bearings (and motor bearings per the motor manufacturer's specifications) are to be greased at the time of going into extended storage. On belt drive units the belt tension should be reduced to less than half the specified value for the fan's design to prevent a sag/set from forming in the shafts and belts. If the unit was supplied with a motor, the motor windings should be measured at this time and recorded for comparison prior to placing in service. If the fan housing was supplied with a drain connection, this plug should be removed to prevent any moisture from accumulating in this portion of the unit during storage.

Storage Procedure – Fans should be stored indoors whenever possible where control over temperature, shock and dust is reasonably maintained. If units are to be stored outside in the elements, they should be covered with a water-resistant material. The bearings should be shielded individually from water and dirt; however, do not tightly seal to avoid trapping condensation. Stored equipment should be stored on a clean, dry floor or blocked up off the ground on blocks to prevent unit from setting in any water or directly on the ground. If shock or vibration will be present during storage, the unit may need to be placed on some type of vibration dampening material to aid in preventing brinelling of the bearing surfaces.

Periodic Check – On a monthly interval, the equipment should be checked to ensure that it has remained in an acceptable stored condition. The fan (and motor if supplied) should be rotated several times by hand while adding enough grease to replenish the bearing surfaces with fresh grease and to maintain a full bearing cavity. Grease used must be compatible with that already supplied in the motor and fan bearings. The fan impeller should be left at approximately 180 degrees from that of the previous month to prevent the shaft and impeller from taking a set in one position. Storage records should be maintained which indicate the above requirements have been followed. Consult the motor manufacturer for proper storage, space heater connection and lubrication if the unit was supplied with one.

Start-Up – When the unit is removed from storage, all bearing grease should be purged and replenished with fresh grease as per the lubrication decal. The motor should be measured to verify that the resistance is still at a satisfactory level compared to the value recorded prior to storage.

Foundations and Supporting Structures

Floor mounted fans should be installed on a flat, level, rigid concrete foundation with a mass at least three to five times that of the assembly supported as a guide, depending on the size and speed of the fan. Foundation shall be suitable for static and dynamic loads and foundation frequencies be separated at least 20% from the rotational speed/speed ranges. The plan area should be no more than twice that required by the equipment. Foundations with larger areas should have correspondingly larger mass. Anchor bolts should be "L" or "T" shaped with sufficient length for nuts, washers, shims, and threads for draw-down. Each bolt should be placed in a sleeve or pipe with a diameter larger than the bolt to allow for adjustment.

If the fans are mounted on a sub-structure, an inertia base with spring isolator system should be considered.

Fans mounted to or within a structure should be placed as close as possible to a rigid member such as a wall or column. The structure must be designed for rotating equipment; static design for strength is not sufficient to insure proper operation. Supports for suspended fans must be cross-braced to prevent side sway. Structural resonance should be at least 20% from fan operating speed. Vibration isolators should be used where applicable.

Any ducting should have independent support; do not use the fan to support ducting. Isolating the fan from ductwork with flex connections eliminates transmission of vibration. Fans handling hot gases require expansion joints at both the inlet and discharge to prevent excessive loads caused by thermal growth.

Fan Installation – Factory Assembled Units

Follow proper handling instructions given earlier.

1. Move the fan to the final mounting position.
2. Remove skid, crates, and packing materials carefully.
3. If supplied, place vibration pads or isolation base on mounting bolts. Line up holes in fan base with bolts.
4. Place fan on mounting structure. Carefully level unit using shims as required at all mounting hole locations. Bolt down the unit.
5. Any grout may now be used. Bolt the fan in position before applying grout. Do not depend upon grout to support rotating equipment.
6. Continue with Operations Checklist.

Additional instructions may be given for some fan models, components and accessories in the appendix.

Fan Installation – Disassembled Units

A unit is considered "disassembled" if any component required for proper operation is shipped or supplied separately or in pieces. Reference earlier instructions concerning proper handling of fan components.

Instructions for Mounting and Assembly of Unit:

1. Move lower housing/framework to mounting location.
2. If vibration pads or bases are used, place on bolts first. Place lower housing assembly onto bolts.
3. Level and shim if required. Bolt into place.
4. If separated pedestal or bearing pedestal:
   a. Bring bearing pedestal to desired location.
   b. Place any vibration base or pads into place. Set bearing pedestal on bolts.
   c. Never distort bearing pedestal by forcing it to align with a non-level surface. Shim beneath the pedestal as required.

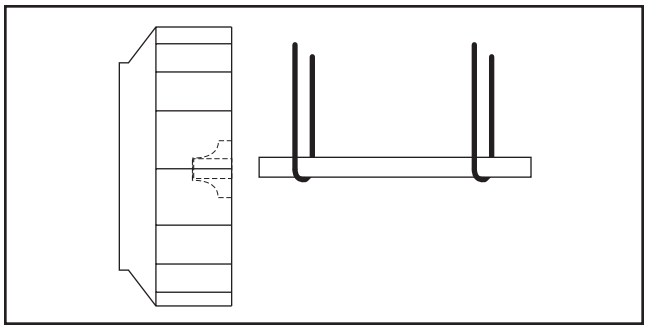
d. Check bearing centerline height. Change centerline height to match centerline height of housing. High temperature units may require the housing centerline to be lower when cold so that it will be centered when hot.

e. Measure from housing to bearing pedestal to bring bearing pedestal into square with housing (a large square may also suffice).

f. Bolt into position.

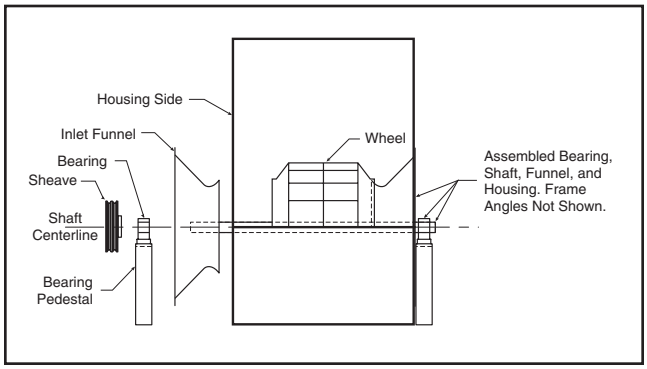
5. Shaft and wheel assembly preparation:
   a. Clean protective coating off shaft with solvent. Do not touch clean areas of shaft with hands. Perspiration can cause rust or pitting over time.
   b. Remove keys from shaft.
   c. Clean inside of wheel bore with solvent. Make sure setscrews will not interfere when inserting shaft into wheel bore.
6. Arrangement 1, 9 or 10: Drive Component Assembly (See Figure 3):
   a. Insert shaft into wheel from back side of wheel.
   b. When shaft is flush with wheel hub, put key into keyway and tighten wheel setscrews.
   c. Insert shaft through opening in drive side. (If split housed unit, lower into position.)
   d. Install bearings onto shaft. Do not tighten bearing setscrews at this time. The bearing housing should be perpendicular and the bearing base parallel to the axis of the shaft to prevent loads caused by misalignment.
   e. Mount assembly, bolt bearings to drive stand. Shaft must be parallel with side of bearing pedestal. After aligning and bolting bearings to pedestal, tighten bearing setscrews. Continue with step 8.

Figure 3. Drive Component Assembly



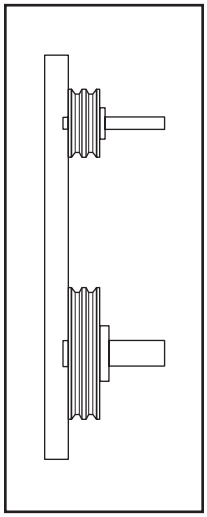
7. Arrangement 3 (Split-housed) units (See Figure 4):
   a. Parts on DWDI units are assembled in the following order as viewed from opposite drive side: Bearing bar assembly and opposite bearing, funnel, (housing side), wheel, (housing side), funnel, drive side bearing bar assembly, drive bearing and sheaves. Mount bearing bar assembly to housing. Center wheel in funnels.
   b. Parts on SWSI units are assembled in the following order as viewed from opposite drive side: Bearing bar assembly and opposite bearing, funnel, (housing side), wheel, (housing side), drive side bearing bar assembly, drive bearing and sheaves. Mount bearing bar assembly to housing. (See Figure 6 for wheel-funnel overlap.)
   c. Assemble parts in above order on shaft.
   d. Move assembly into position. Lightly bolt bearings into place.

Figure 4. Split-housed Drive Component Assembly



   e. Shaft should be parallel with discharge of housing. Move bearings to accommodate.
   f. Level shaft; shim bearings if required. Tighten bearing setscrews.
8. Install motor on base. Carefully align shafts for drive installation.
9. Mount drives as follows:
   a. Slip (do not pound) proper sheave onto corresponding shaft. CAUTION: PLACING FAN SHEAVE ON MOTOR CAN OVERSPEED WHEEL AND CAUSE STRUCTURAL FAILURE.
   b. Align sheaves with a straightedge extended along the perimeters of both sheaves, just making contact in two places on outside perimeters of both sheaves (see Figure 5).
   c. Tighten down sheave bolts.
   d. Install a matched set of belts. Slide the motor to obtain slack and tighten belts. Using a pry will damage belts.
   e. Tighten belts to proper belt tension. Ideal tension is just enough tension so that belts do not slip under peak load. Recheck sheave alignment.
   f. After initial installation of belts, recheck belt tension again after a few days to adjust belt tension. (New belts require a break-in period of operation.)

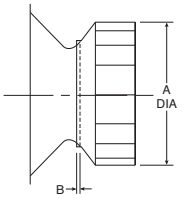
Figure 5. Sheave Alignment



10. Install any safety devices or accessories supplied. (Accessories commonly used are inlet vanes, shaft seals and shaft coolers, plugs, dampers, and inlet or discharge screens. Refer to appropriate documents in appendix.)
11. Grout may now be applied. Grout is used to distribute loads and should not be used as the sole support of any rotating equipment.
12. When connecting the fan to the system, it is recommended that the inlet and discharge be isolated from the system with flex connections (where practical) to block transmitted vibration. All duct connections to the fan should be independently supported. Do not use fan to support duct.

Figure 6. Wheel-Funnel Overlap

HIB, RTF, HRT, BC, BCS, TSL, BAF, BAE, EPF & EPQ



HIB, RTF, HRT* Wheel Placement

Size	A	B	B*		Size	A	B	B*	
			19	23				19	23
180	20.50	0.31	—	—	**400**	45.25	0.69	1.03	0.97
200	22.50	0.34	—	—	**450**	50.00	0.75	1.13	1.06
220	25.00	0.38	—	—	**490**	55.13	0.81	1.25	1.13
240	27.50	0.44	—	—	**540**	61.00	0.91	1.38	1.25
270	30.38	0.47	0.50	0.50	**600**	67.50	1.00	1.31	1.31
300	33.50	0.50	0.69	0.69	**660**	74.25	1.13	1.56	1.44
330	37.00	0.56	0.69	0.69	**730**	82.00	1.22	1.75	1.63
360	41.00	0.63	0.81	0.81	**800**	90.75	1.34	1.06	1.31

*Use second 'B' columns for HRT-19 and HRT-23 dimensions

BC, BCS, TSL & BAF SWSI Wheel Placement

Size	122	135	150	165	182	200	222	245	270	300	330
A	12.25	13.50	15.00	16.50	18.25	20.00	22.25	24.50	27.00	30.00	33.00
B	0.32	0.34	0.38	0.44	0.56	0.63	0.69	0.75	0.88	0.97	1.06

Size	365	402	445	490	542	600	660	730	807	890
A	36.50	40.25	44.50	49.00	54.25	60.00	66.00	73.00	80.75	89.00
B	0.94	1.03	1.13	1.25	1.38	1.56	1.69	1.88	2.09	2.28

EPF, EPQ Wheel Placement

Size	122	150	165
A	13.00	14.13	16.16
B	0.25	0.25	0.25

BAE Wheel Placement

Size	122	135	150	165
A	12.25	13.50	15.00	16.50
B	0.31	0.34	0.38	0.44

EPF, EPQ & BAE SWSI Wheel Placement

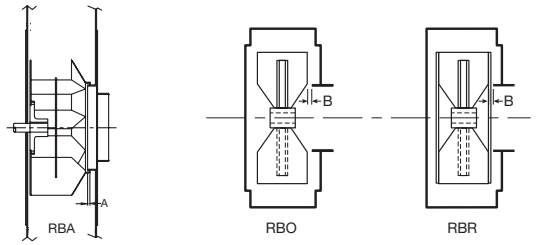
Size	182	200	222	245	270	300	330	365	402	445	490
A	19.00	20.82	23.16	25.51	28.11	31.23	34.36	38.00	41.90	46.33	51.01
B	0.38	0.41	0.46	0.50	0.55	0.62	0.68	0.75	0.83	0.91	1.01

Size	542	600	660	730	807
A	56.48	62.47	68.71	76.00	84.07
B	1.11	1.23	1.36	1.50	1.66

APF & APQ Wheel Placement

Size	121	141	161	181	201	221	251	281	321	351	391	441	491	551	631	711	791
A	13.00	14.13	16.16	18.44	19.94	22.78	25.06	28.25	31.81	35.81	39.81	44.56	50.06	55.75	63.69	71.69	79.63
B	0.25	0.25	0.25	0.31	0.31	0.31	0.50	0.50	0.56	0.63	0.63	0.75	0.78	0.81	1.03	1.28	1.38

RBA, RBO & RBR



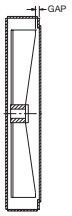
RBA Wheel Placement

Size	907	909	911	913	915	917	919	921	923	926	929	933	937	941	945	949	954	960
A	0.25	0.38	0.47	0.53	0.59	0.69	0.69	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

RBO, RBR Wheel Placement

Size	913	915	917	919	921	923	926	929	933	937	941	945	949	954	960
B	0.53	0.53	0.59	0.69	0.78	0.88	0.97	1.03	1.22	1.38	1.56	1.69	1.81	1.88	2.16

Note: On sizes 905-911 wheel is to be centered in housing.

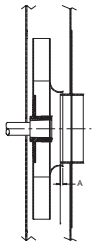


MBW, MBO & MBR

MBW, MBO, MBR Wheel Placement

Size	196	224	252	280	308	336	365	421	477	533	589
MBW	0.50	0.44	0.38	0.25	0.38	0.44	0.56	0.63	0.75	0.75	0.88
MBO	0.50	0.44	0.38	0.25	0.38	0.44	0.56	0.63	0.75	0.75	0.88
MBR	0.25	0.25	0.25	0.25	0.25	0.38	0.50	0.69	0.81	0.94	1.00

Note: On sizes 421-589 wheel is to be centered in housing.

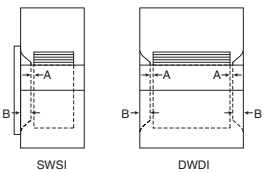


BCN

BCN Wheel Placement

Size	270	300	330	365	402	445	490	542	600	660	730
A	0.09	0.09	0.13	0.13	0.13	0.16	0.16	0.19	0.22	0.22	0.25

FC



FC Wheel Placement

Size	A	B	Size	A	B
10.5	0.47	0.69	**30**	0.75	4.38
12	0.25	1.88	**33**	0.81	5.00
15	0.44	2.19	**36**	0.75	5.00
18	0.50	2.25	**39**	1.06	6.38
21	0.69	2.88	**42**	1.69	7.50
24	0.81	3.00	**48**	1.50	7.13
27	0.69	3.13	**54**	1.00	10.50

Fan Operation - Safety

For general safety practices for air moving equipment, see AMCA Bulletin 410.

Twin City Fan & Blower has many safety accessories available. These safety devices include (but are not limited to) belt guards, shaft guards, inlet and discharge screens. The use, abuse, or non-use of safety devices is the responsibility of the purchaser.

Facility-related safety conditions include fan accessibility and location. How easily can non-service personnel access the unit? Is the fan in a hazardous duty environment? Was the unit ordered for this duty? Other concerns must also be addressed. All fans should be powered through switches which are easily accessible to service personnel from the fan. Every switch should have the ability to be “locked-off” by the service person and the key to be retained by this person to prevent accidental power of the fan while service is in process.

Operation Check List

Verify that proper safety precautions have been followed:
- ☐ Electrical power must be locked off.

Check fan mechanism components:
- ☐ System connections are properly made and tightened.
- ☐ Bearings are properly lubricated.
- ☐ Wheel, drives and fan surfaces are clean and free of debris.
- ☐ Rotate the impeller by hand to verify it has not shifted in transit.
- ☐ Check fan/wheel overlap. See Figure 6.
- ☐ Drives on correct shafts (not reversed).
- ☐ Check position of guards to prevent rubbing.

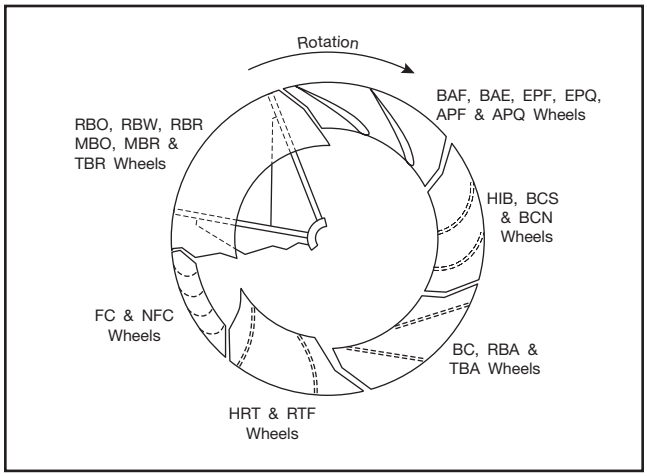
Check fan electrical components:
- ☐ Motor is wired for proper supply voltage.
- ☐ Motor was properly sized for power and rotational inertia of rotating assembly.
- ☐ Motor is properly grounded.
- ☐ All leads are properly insulated.

Trial “bump”:
- ☐ Turn on power just long enough to start assembly rotating.
- ☐ Check rotation for agreement with rotation arrow. Does the assembly make any unusual noise? (See Figure 7.)
- ☐ Check drive alignment and tension. Does this meet with drive manufacturer’s recommendations?
- ☐ Correct any problems which may have been found. (Follow safety guidelines - shut power off.) Perform checklist again until unit is operating properly.
- ☐ Run unit up to speed.

Verify fastener tightness. These may have loosened during shipment or installation.
- ☐ Setscrews attaching wheel hub to shaft.
- ☐ Setscrews in drive sheaves or coupling.
- ☐ Nuts on inlet funnel.
- ☐ Nuts and bolts holding motor.
- ☐ Nuts holding housing frame to base and base to ground.
- ☐ Nuts on accessories including shaft seal, access doors and pie-splits.
- ☐ Bolts in taper-lock bushings.
- ☐ Grease line connections.

After one week of operation, check all nuts, bolts and setscrews and tighten if necessary.

Figure 7. Proper Wheel Rotation



Maintenance of Fans

This section contains general maintenance instructions for your Twin City Fan & Blower unit. For specific information about maintenance of components, particularly for special application fans, see the attached documents.

General Motor Maintenance

The three basic rules of motor maintenance are keep the motor clean, dry and properly lubricated.

Keeping motors and windings clean is important because dirt and dust serve as thermal insulators. Heat normally dissipated by the motor is trapped causing overheating and/or premature failure. Blow dust and dirt out of windings and off the motor periodically. Use low pressure (50 psig) airstream so that winding damage does not occur. Keep the area surrounding the motor open so the air can circulate through the motor cooling fan. Follow normal maintenance schedule given to the right.

Motors should be kept dry to avoid electrical short circuits. Motors kept in storage for long periods of time can have moisture condense on the windings. Be certain the motor is dry before using.

Some smaller motors are lubricated for life. Motor bearing lubrication, if required, must follow a rigorous schedule. Motors less than 10 hp running about eight hours a day in a clean environment should be lubricated once every five years; motors 15 to 50 hp, every 3 years; and motors 50 to 150 hp, yearly. For motors in a dusty or dirty environment or running 24 hours a day, divide the service interval by 2. If the environment is very dirty or high temperatures exist, divide the service interval by 4. Lubrication requirements are normally attached to the motor. Do not overlubricate.

Drive Maintenance

V-belt drives need periodic inspection and occasional belt replacement. When inspecting drives, look for dirt buildup, burrs or obstructions which can cause premature belt or drive replacement. If burrs are found, use fine emery cloth or a stone to remove the burr. Be careful that dust does not enter the bearings.

Check the sheaves for wear. Excessive slippage of belts on sheaves can cause wear and vibration. Replace worn sheaves with new ones. Carefully align sheaves to avoid premature sheave failure.

Observe belts for wear. If fraying or other wear is observed to be mostly on one side of the belts, the drives may be misaligned. Reinstall the drives according to instructions given for Fan Installation – Disassembled Units. Never use belt dressing on any belts.

Figure 8. Safety & Lubrication Instructions for Fans with Ball Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)*
Ball Bearing Pillow Blocks

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA									
½" thru 1 11/16"	6	6	5	3	3	2	2	2	1
1 15/16" thru 2 7/16"	6	5	4	2	2	1	1	1	1
2 11/16" thru 2 15/16"	5	4	3	2	1	1	1		
3 7/16" thru 3 15/16"	4	3	2	1	1	1			

* Suggested initial greasing interval: Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

1. Lubricate with a high quality NLGI No. 2 or No. 3 multipurpose ball bearing grease having rust inhibitors and antioxidant additives. Some greases having these properties are:

   Shell - Alvania No. 2 — Mobil - Mobilith AW2/Mobilith SHC100
   Gulf - Gulfcrown No. 2 — American - Rykon Premium 2

2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Figure 9. Safety & Lubrication Instructions for Fans with Unit Roller Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)*
Spherical Roller Bearing - Solid Pillow Blocks

Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4500
Shaft DIA									
1 3/16" thru 1 7/16"	6	4	4	2	1	1	1	1	½
1 11/16" thru 2 3/16"	4	2	1½	1	½	½	½	½	½
2 7/16" thru 3 7/16"	3	1½	1	½	½	¼	¼		
3 15/16" thru 4 15/16"	2½	1	½	¼					

*Suggested initial greasing interval: Relubricate while running, if safety permits, until some purging occurs at seals. Adjust lubrication frequency depending on condition of purged grease. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required.

1. Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100°F. Some greases having these properties are:

   Shell - Alvania No. 2 — Mobil - Mobilith AW2/Mobilith SHC100
   Texaco - Premium RB2 — American - Rykon Premium 2

2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Figure 10. Safety & Lubrication Instructions for Fans with Split Roller Bearings

WARNING

1. This equipment must not be operated without proper guarding of all moving parts. While performing maintenance be sure remote power switches are locked off. See AMCA Publication 410 for recommended safety practices.
2. Before starting: Check all setscrews for tightness, and rotate wheel by hand to make sure it has not moved in transit.

Relubrication Schedule (Months)* Spherical Roller Bearing - Split Pillow Blocks										Grease to be added at each interval
Speed (RPM)	**500**	**750**	**1000**	**1500**	**2000**	**2500**	**3000**	**3500**	**4000**	
Shaft DIA										
1 7/16" thru 1 15/16"	6	4½	4	4	3½	2½	2½	1	1	0.50 oz.
2 3/16" thru 2 11/16"	5	4½	4	2½	2½	1½	½	¼	¼	0.75 oz.
2 15/16" thru 3 15/16"	4½	4	3½	2½	1½	1	½			2.00 oz.
4 7/16" thru 4 15/16"	4	4	2½	1	½					4.00 oz.
5 7/16" thru 5 15/16"	4	2½	1½	1						7.00 oz.

*Suggested initial greasing interval - remove bearing cap and observe condition of used grease after lubricating. Adjust lubrication frequency as needed. Hours of operation, temperature, and surrounding conditions will affect the relubrication frequency required. Clean and repack bearings annually. Remove old grease, pack bearing full and fill housing reservoirs on both sides of bearing to bottom of shaft.

1. Lubricate with a multipurpose roller bearing NLGI No. 2 having rust inhibitors and antioxidant additives, and a minimum oil viscosity of 500 SSU at 100°F. Some greases having these properties are:

   Shell - Alvania No. 2 Mobil - Mobilith AW2/Mobilith SHC100
   Texaco - Premium RB2 American - Rykon Premium 2

2. Lubricate bearings prior to extended shutdown or storage and rotate shaft monthly to aid corrosion protection.

Static Oil Lubrication

1. Use only highest quality mineral oil with a minimum viscosity of 100 SSU at the oil's operating temperature. The oil's operating temperature is approximately 10° greater than the bearing's housing. SAE values having this viscosity at the following operating temperature are:

   150° - SAE 20 160° - SAE 30 180° - SAE 40

2. Static oil level should be at the center of the lower-most roller (Do not overfill.)
3. Complete lubrication change should be made annually.

When replacing belts, replace the entire set. After initial replacement and tensioning, recheck belt tension after a few days to adjust belt tension again. (New belts require a break-in period of operation.)

Bearing Maintenance

For instructions covering special lubrication intervals, bearing assembly or disassembly, or installation details, see attached documents. Any bearing which is disassembled should be kept separate from other bearing parts as components may not be interchangeable. Maintain cleanliness of components and bearings to prevent bearing contamination.

Bearing failure can occur from many causes. See Troubleshooting section for details.

Note: All speeds shown do not apply to all shaft sizes in that group. Consult the factory if in doubt of maximum speed for a particular bearing.

Lubrication

Proper lubrication of bearings helps assure maximum bearing life. All fans are equipped with decals indicating relubrication intervals for normal operating conditions. However, every installation is different and the frequency of lubrication should be established accordingly.

Experience has shown that airborne moisture and heavy dust will dramatically reduce the life of the bearing lubricant. If any of these adverse conditions exist, it is recommended that bearings be regreased after several days of operation. Lubrication intervals can then be adjusted based on the condition of the purged grease.

Figure 8 illustrates the decal for ball bearings, Figure 9 the decal for solid pillow block spherical roller bearings, and Figure 10 shows the decal for split pillow block spherical roller bearings. Observation of the condition of the grease expelled from the bearings at the time of relubrication is the best guide as to whether regreasing intervals and the amount of grease added should be altered. This observation is particularly important when bearings operate continuously over 160°F.

Greases are made with different bases. There are synthetic base greases, lithium base, sodium base, etc. Avoid mixing greases with different bases. They could be incompatible and result in rapid deterioration or breakdown of the grease.

All bearings are filled with grease before leaving the factory. When the fans are started, the bearings may discharge excess grease through the seals for a short period of time. Do not replace the initial discharge because leakage will cease when the excess grease has worked out. Sometimes the bearing has a tendency to run hotter during this period and one should not get alarmed unless it lasts over 48 hours or gets above 220°F. When relubricating, use a sufficient amount of grease to purge the seals. Rotate bearings during relubrication where good safety practice permits.

For bearings with oil lubrication, sight gauges are installed so that a proper level can be reviewed and maintained. Sight gauges should be read with bearings not rotating.

Wheel and Shaft Maintenance

Periodically inspect the shaft and wheel for dirt buildup, corrosion, and signs of excess stress or fatigue. Clean the components and, when appropriate, apply new coatings. (Any addition of coatings or weld can create an imbalance.) Check the balance of the assembly.

Structural Maintenance

All structural components or devices used to support or attach the fan to a structure should be checked at regular intervals. Vibration isolators, bolts, foundations, etc., are subject to failure from corrosion, erosion, and other causes. Improper mounting can lead to poor operation characteristics or fan fatigue and failure.

Check metallic components for corrosion, cracks, or other signs of stress. Concrete should be checked to ensure the structural integrity of the foundation.

Troubleshooting Guidelines

Use current safety practices when investigating fan or system performance problems. General safe practices and performance troubleshooting guidelines can be found in AMCA Publications 410 and 202, respectively. Fan application and field measurement procedures can be found in AMCA Publications 201 and 203.

Troubleshooting Performance Problems

The lists below indicate possible areas to check when air or sound values do not match expectations. Most fan problems can be pinpointed to one of these common causes.

Air Capacity Problems:

1. Resistance of system not at design rating. If resistance is lower than expected, both airflow and horsepower may be up. If resistance is higher than anticipated, air volume will be down.
2. Fan speed is not at design speed.
3. Air density not at design values. Also check air performance measurement techniques/procedures.
4. Devices for air modulation are closed or plugged. Also check filters.
5. Wheel mounted improperly or is rotating in reverse.
6. Parts of system or fan have been damaged or need cleaning.

Noise Problems:

1. Air performance is incorrect and fan is not at design point of operation. Fan forced to operate in an unstable flow region.
2. Bearing failure. Check bearings (lubrication).
3. Supply voltage high or inconsistent supply frequency. Adjustable frequency controllers can generate motor noise.
4. Objects which are installed in a high velocity airstream can generate noise. This includes flow sensors, turning vanes, etc.
5. Poor fan inlet conditions.
6. Acoustics or sound measurement procedure incorrect.

Vibration Problems:

1. Misalignment of drive components.
2. Poor foundations or mounting structure (resonances).
3. Foreign material attached to rotating components.
4. Damaged rotating components (bearings, shaft, fan, wheel, sheaves).
5. Broken, loose or missing setscrews.
6. Loose bolts.
7. Vibration transmitted by another source.
8. Water accumulating in airfoil blades.
9. Fan is operating in stall or unstable flow region.

NOTE: All fans manufactured by Twin City Fan & Blower are factory balanced prior to shipment. Handling and movement of the fan during shipment may cause the rotating assembly to shift. Balance should be checked once the fan is installed. If a final trim balance is required, it is the end user's responsibility to bring the fan back to factory specifications. Final trim balancing is not the responsibility of Twin City Fan & Blower.

Motor Problems:

1. Incorrect wiring.
2. Speed of fan too high.
3. Parts improperly installed - binding.
4. Bearings improperly lubricated.
5. WR^2 capability of motor too low for application.
6. Protection devices may be improperly sized.

Drive Problems:

1. Belts improperly tensioned.
2. Drive alignment is poor.

Bearing Problems:

Generally speaking, Twin City Fan & Blower uses three types of bearings:

1. Ball bearing with set screw lock.
2. Spherical roller bearings with set screw lock.
3. Spherical roller bearings with adapter lock/taper lock feature to attach them to the shaft.

Ball bearings – These are self-aligning bearings and should present no alignment problems with one exception: i.e., on Sealmaster bearings there is a pin beneath the grease fitting which prevents the bearings outer race from rotating. Should this pin jam, the bearing loses its alignment feature.

Common failure causes are (1) set screws loosening and shaft turning within the bearing, and (2) crowned bearing supports. Loosen one bolt and measure the clearance between the pillow block and the support. Add shim to compensate.

Spherical Roller Bearings with Set Screw Lock – The self-aligning characteristic of these bearings are inherent in the spherical roller design. The closer that these bearings are to perfect alignment, the cooler they will operate.

Common failure causes are the same as with ball bearings, mainly set screws loosening and crowned bearing supports.

Spherical Roller Bearings with Adapter Lock – Again, the self-aligning feature is inherent in the spherical design. Good alignment results in a cooler operating bearing. The faster the bearing operates the more critical this becomes.

A common cause of failure is improper installation practice. Removing too much clearance from the bearing can result in preloading the bearing, resulting in premature failure; and removing not enough can result in the shaft rotating within the bearing. Properly tightened, this method of attaching a bearing to a shaft is second only to a press fit. Crowned bearing supports can also preload these bearings and should be checked by loosening one side of the bearing and checking for clearance.

Lubrication – The major cause of bearing failure is contamination of grease, insufficient grease, or incompatibility of grease. If a fan is to be stored for any length of time at the job site, the bearings immediately should be filled with grease while rotating the shaft and then the bearings should be regreased and rotated monthly. This will prevent moisture, which condenses within the bearing, from corroding the raceways. Most greases used on fan pillow blocks are lithium base. Use the greases shown on the bearing decal. Do not mix the bases without completely purging out the initial grease.

Initially, follow the lubrication instruction on the side of the fan. The frequency of lubrication should be adjusted depending on the condition of the old grease being purged. This is the responsibility of the user. If the grease is dirty, the lubrication frequency should be more often.

a. Noise – If a bearing is increasing in noise intensity and/or vibration, it will probably result in failure.

b. Temperature – If a bearing temperature begins to gradually rise, it will generally result in failure. A bearing can operate up to 200 degrees and operate

satisfactorily if the temperature remains constant and the bearing receives adequate lubrication. Remember that a roller bearing under the same load and speed will be somewhat more noisy and run warmer than a ball bearing. This is normal.

Rough handling and/or dropping a fan can result in brinelling the bearing. This appears as a clicking noise at first, then gradually worsens until failure.

When replacing a bearing, always align the bearings first, then bolt the pillow blocks to their support, rotate the shaft, fasten the bearings to it. If the bearing is fastened to the shaft first, tightening the pillow block bolts may bind the shaft and preload the bearings.

Limitation of Warranties and Claims

Seller warrants to the original purchaser that the goods sold hereunder shall be free from defects in workmanship and material under normal use and service (except in those cases where the materials are supplied by the buyer) for a period of one year from the date of original installation or eighteen (18) months from the date of shipment, whichever occurs first. The liability of seller under this warranty is limited to replacing, repairing, or issuing credit (at cost, F.O.B. factory and at seller's discretion) for any part or parts which are returned by buyer during such period provided that:

a. seller is notified in writing within ten (10) days following discovery of such defects by buyer, or within ten (10) days after such defects should reasonably have been discovered, whichever is less;

b. the defective unit is returned to seller, transportation charges prepaid by buyer.

c. payment in full has been received by seller or said products; and

d. seller's examination of such unit shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, improper installation, repair, alteration, act of God, or accident.

e. seller cannot guarantee sound pressure levels or dBA.

No warranty made hereunder shall extend to any seller product whose serial number is altered, effaced or removed. Seller makes no warranty, express or implied, with respect to motors, switches, controls, or other components of seller's product, where such components are warranted separately by their respective manufacturers. THIS WARRANTY IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. In no event shall seller be liable to buyer for indirect, incidental collateral, or consequential damages of any kind. (BUYER'S FAILURE TO PAY THE FULL AMOUNT DUE WITHIN SIXTY (60) DAYS OF DATE OF INVOICE SHALL OPERATE TO RELEASE SELLER FROM ANY AND ALL LIABILITY OR OBLIGATION ARISING PURSUANT TO ANY WARRANTY, EXPRESS OR IMPLIED, WHETHER STATUTORY OR OTHERWISE, INCLUDING ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, MADE IN CONNECTION WITH ANY CONTRACT FORMED HEREUNDER. BUYER AGREES THAT SUCH FAILURE TO PAY SHALL CONSTITUTE A VOLUNTARY WAIVER OF ANY AND ALL SUCH WARRANTIES ARISING PURSUANT TO SUCH CONTACT.)

Twin City Fan & Blower

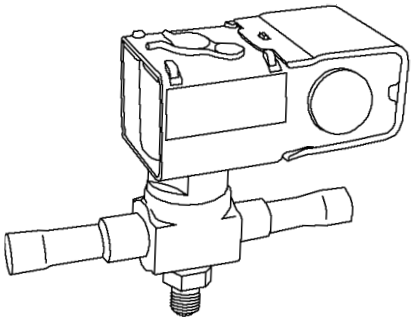
A Twin City Fan Company

5959 Trenton Lane · Minneapolis, MN 55442-3237
Phone (763) 551-7600 · Fax (763) 551-7601 · www.tcf.com

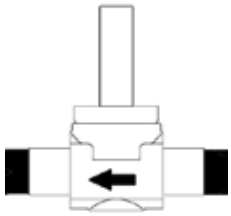
MEMBER

ISO 9001 CERTIFIED

Solenoid Valves
200RB/500RB Model



EMERSON
Climate Technologies

① 

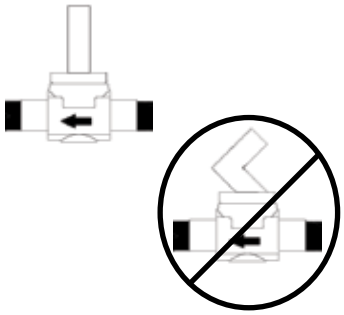
R-11, R-12, R-22, R-113, R-114, R-115, R-123, R-124, R-125, R-134a, R-401A, R-401B, R-402A, R-402B, R-404A, R-407A, R-407B, R-407C, R-500, R-502, R-507

Refrigerant Compatibility
Compatibilidad con Refrigerantes
Compatibilidade do Refrigerante
Compatibilité du réfrigérant
冷媒適合性
냉매 호환성
冷媒兼容性

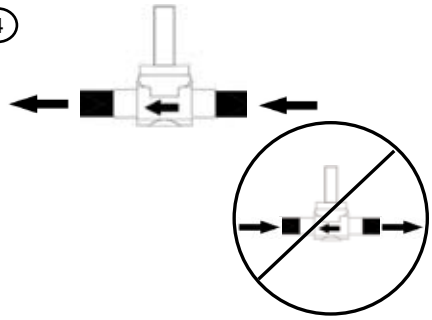
②

Model	Coil				
	AM	AH	DM	MM	ASC2
200RB	●	●	●	●	●
500RB			●	●	●

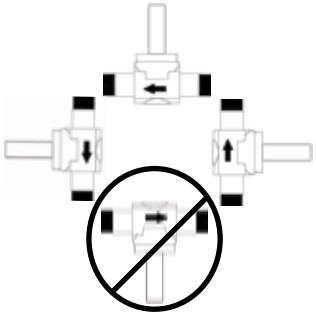
Verify Coil
Verifique la Bobina
Verifique a bobina
Vérifier la bobine
コイルの確認
코일 대조 확인 하시오
确认线圈型号

③ 

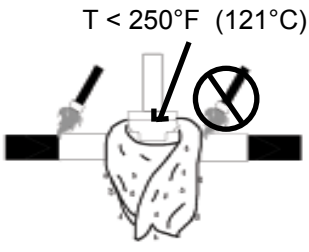
Do Not Bend Enclosing Tube
No doble el casquillo del Embolo de la Aguja
Não danifique o tubo de apoio da bobina
Ne pas plier le tube
エンクロージングチューブを曲げることは禁止
연결관을 구부리지 마시오
不要压弯阀杆

④ 

Flow Follows Arrow
El Flujo sigue la Flecha
Barra Indica Posição do Fluido
L'écoulement doit suivre la flèche
矢印方向に冷媒流
화살표방향으로 흐름
流向箭头

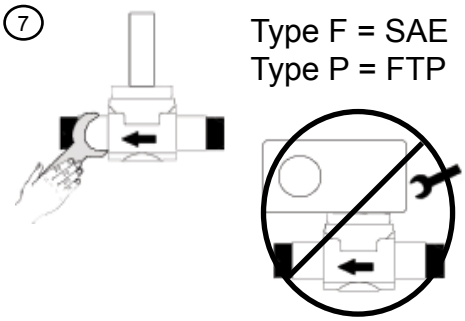
⑤ 

Valve Orientation
Orientación de Válvulas
Orientação da Válvula
Orientation de la valve
バルブの向き
밸브 방향
阀的安装角度

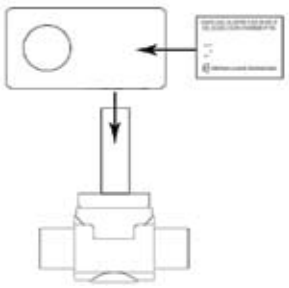
⑥ 

Type T

Solder Techniques
Técnicas para Soldar
Técnicas de Soldagem
Technique de soudure
溶接方法
용접 기술
焊接技术

⑦ 

Use Wrench On Valve Body Only
Utilice la llave sólo en el cuerpo de la Válvula
No corpo use sómente uma chave de boca
Utiliser la clé a molette sur le corps seulement
レンチ使用は、バルブ本体のみ
밸브 본체에는 렌치를 사용 하시오
扳手只能用在阀体上

⑧ 

Coil Installation
Instalación de la Bobina
Instalação da bobina
l'installation de la bobine
コイルの取付
코일 설치
安装线圈

Coil Electrical Data			
VAC/Hz	Maximum Amps		VA Holding
	Inrush	Holding	
24/50	2.0	0.96	23
24/60	1.6	0.74	18
120/50	0.45	0.21	25
120/60	0.36	0.16	19
208/50	0.19	0.08	17
208/60	0.15	0.06	12
220/50	0.24	0.10	24
240/60	0.19	0.08	19
480/50	0.11	0.05	24
480/60	0.09	0.04	19

Transformer Selection

Selección del Transformador

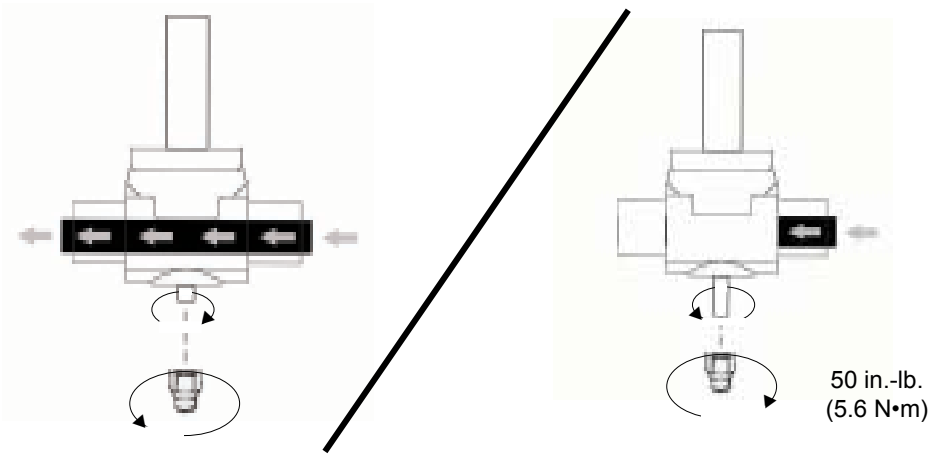
Selecione transformador capacidade suficiente

Sélection du transformateur

トランスフォーマの選択

변압기

选择变压器



Manual Override

Vástago de Operación Manual

Acionamento manual

Ouverture manuel de la tige

マニュアルオーバーライド

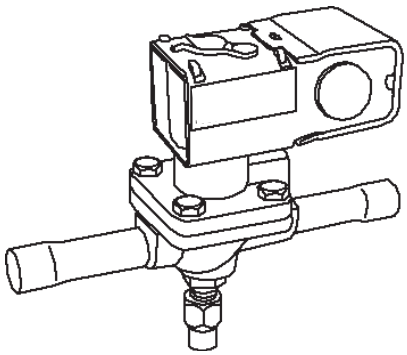
수동으로 변경

手动开阀

EMERSON
Climate Technologies

PA-00295 Oct 2006

Solenoid Valves
240RA/540RA Models



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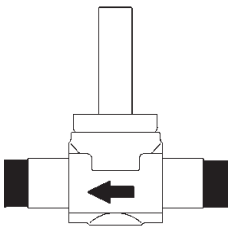
①

R-11
R-12
R-22
R-113
R-114
R-115
R-123
R-124
R-125
R-134a
R-401A



R-401B
R-402A
R-402B
R-404A
R-407A

R-407B
R-407C
R-500
R-502
R-507

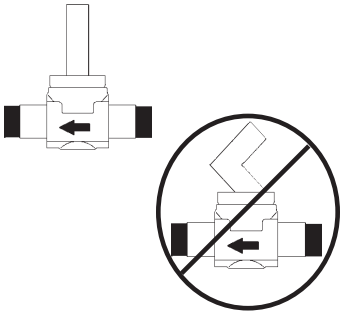
Refrigerant Compatibility
Compatibilidad con Refrigerantes
Compatibilidade do Refrigerante
Compatibilité du réfrigérant
冷媒適合性
냉매 호환성
冷媒兼容性

②

Model	Coil				
	AM	AH	DM	MM	ASC2
240RA	●	●	●	●	●
540RA	●	●	●	●	●

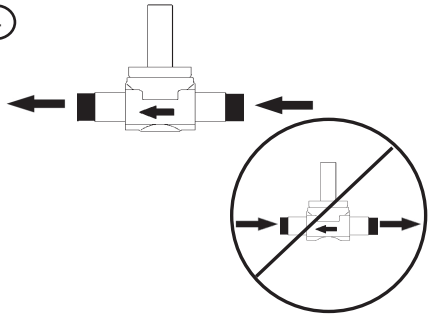
Verify Coil
Verifique la Bobina
Verifique a bobina
Vérifier la bobine
コイルの確認
코일 대조 확인 하시오
确认线圈型号

③



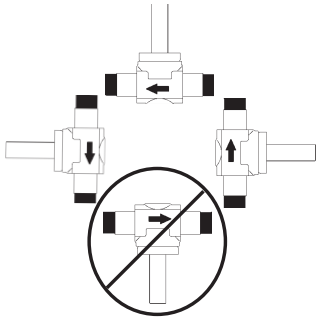
Do Not Bend Enclosing Tube
No doble el casquillo del Embolo de la Aguja
Não danifique o tubo de apoio da bobina
Ne pas plier le tube
ンクロージングチューブを曲げることは禁止
연결관을 구부리지 마시오
不要压弯阀杆

④



Flow Follows Arrow
El Flujo sigue la Flecha
Barra Indica Posição do Fluido
L'écoulement doit suivre la flèche
矢印方向に冷媒流
화살표방향으로 흐름
流向箭头

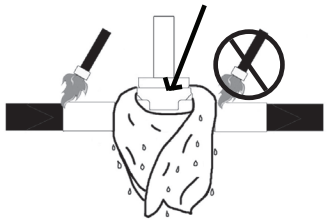
⑤



Valve Orientation
Orientación de Válvulas
Orientação da Válvula
Orientation de la valve
バルブの向き
밸브 방향
阀的安装角度

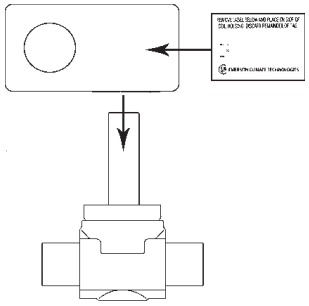
⑥

T < 250°F (121°C)



Solder Techniques
Técnicas para Soldar
Técnicas de Soldagem
Technique de soudure
溶接方法
용접 기술
焊接技术

⑦



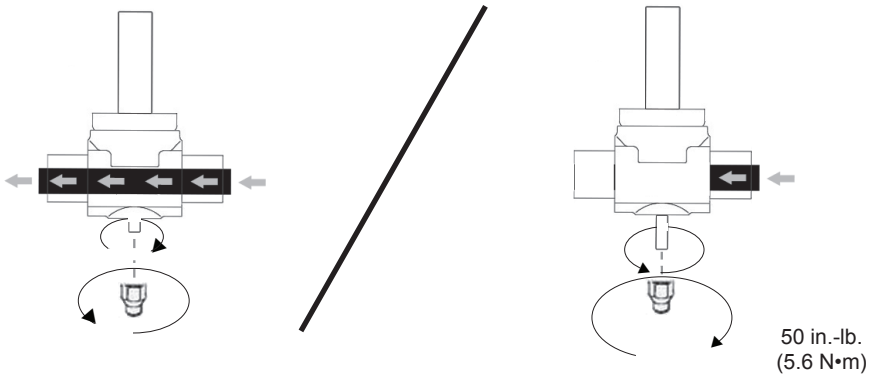
Coil Installation
Instalación de la Bobina
Instalação da bobina
l'installation de la bobine
コイルの取付
코일 설치
安装线圈

⑧

Coil Electrical Data			
VAC/Hz	Maximum Amps		VA Holding
	Inrush	Holding	
24/50	2.0	0.96	23
24/60	1.6	0.74	18
120/50	0.45	0.21	25
120/60	0.36	0.16	19
208/50	0.19	0.08	17
208/60	0.15	0.06	12
220/50	0.24	0.10	24
240/60	0.19	0.08	19
480/50	0.11	0.05	24
480/60	0.09	0.04	19

Transformer Selection
Selección del Transformador
Selecione transformador capacidade suficiente
Sélection du transformateur
トランスフォーマの選択
변압기
选择变压器

240RA Only



Manual Override

Vástago de Operación Manual

Acionamento manual

Ouverture manuel de la tige

マニュアルオーバーライド

수동으로 변경

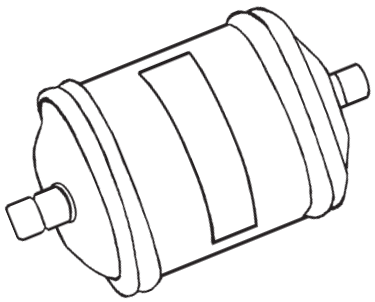
手动开阀

EMERSON
Climate Technologies

PA-00296 Oct 2006

EK, ADK & BOK Filter Drier

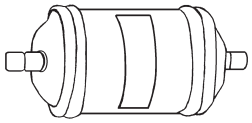
Installation Instructions



EMERSON
Climate Technologies

1

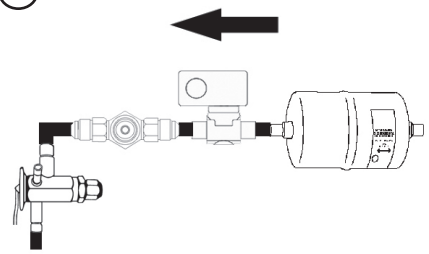
R-11
R-12
R-22
R-113
R-114
R-115
R-123
R-124
R-125
R-134a
R-401A



R-401B
R-402A
R-402B
R-404A
R-407A
R-407B
R-407C
R-410A
R-500
R-502
R-507

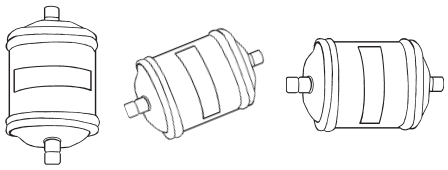
Refrigerant Compatibility
Compatibilidad con Refrigerantes
Compatibilidade do Refrigerante
Compatibilité du réfrigérant
冷媒適合性
냉매 호환성
冷媒兼容性

2



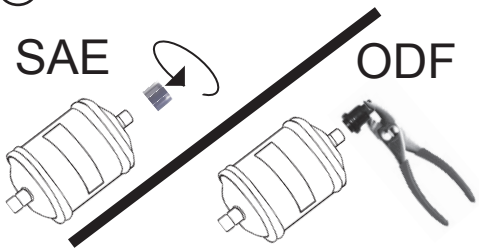
System Location
Localización en el Sistema
Localização do Sistema
Emplacement du système
取付位置
시스템 설치장소
系统中的位置

3



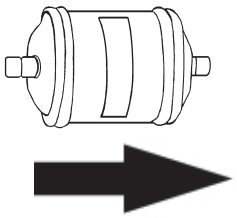
All Positions OK
Todas las Posiciones OK
Todas as Posições São Possíveis
Toute position OK
取付姿勢の制約無し
잘 설치 되었음
所有位置皆可

4



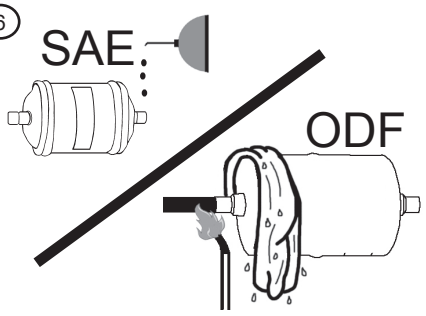
Remove Seals
Remueva los Empaques
Remova os Tampões
Enlever les capuchons
シールを取外す
봉인을 제거
拿去密封端盖

5



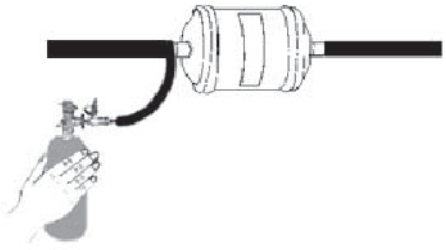
Flow Follows Arrow
El Flujo sigue la Flecha
Barra Indica Posição do Fluido
L'écoulement doit suivre la flèche
矢印方向に冷媒流
화살표방향으로 흐름
流向箭头

6



Installation Precautions
Precauciones de Instalación
Precauções na Instalação
Précautions d'insatallation
取付時の注意
설치시 주의점
安装注意事项

7



Pressurize And Check For Leaks
Presurize y Verifique si existen Fugas
Pressurize e Verifique Vazamentos
Pressuriser et vérifier pour les fuites
圧力をかけて漏れを検査
압력을 가하여 누설을 점검
增压及检查泄漏

EMERSON
Climate Technologies

PA-00292 Jul 2006

HMI Moisture Liquid Indicator

General Information

Only one indicated element is required for all common refrigerants. This element is highly sensitive to moisture and will gradually change color in direct relation to an increase or decrease in the moisture content of the system. The dry-caution-wet system operating conditions are then easily determined by matching the element color with the two colors displayed on the reference label. Colors change as often as the system moisture content changes.

MWP - 680 psig

IMPORTANT: 12 hours is recommended after installation of the Moisture Liquid Indicator before attempting to determine the system moisture content.

Safety Instructions

1. Read all instructions thoroughly. Failure to comply can result in valve failure, system damage, or personal injury.
2. The indicator element will indicate an unsafe condition before installation. This is normal and simply reflects the room humidity condition.
3. The exclusive fused glass eyepiece in the Moisture Liquid Indicator provides a clear, wide-angle view of the liquid refrigerant flow so that bubbles or flash gas are easily seen. This indicates an insufficient system charge, low head pressure, insufficient liquid subcooling or some form of restriction in the liquid line.

Installation Instructions

1. The Moisture Liquid Indicator may be installed anywhere in the liquid line and in any position. It is normally installed downstream from the filter-drier and immediately ahead of the thermal expansion valve.
2. Extended cooper connections with bar stock body permits use of any soft solder or commonly used brazing alloys. When soldering or brazing, direct the flame away from the body. Wet rags or chill blocks must be used when brazing to prevent damaging the Moisture Liquid Indicator. See Figure 1.

Following installation of a Moisture Liquid Indicator or an EK filter-drier, the system should be allowed to reach equilibrium as previously noted. If a caution or wet system condition is still indicated following this period, the filter-drier or the replaceable cores should be replaced. This practice should be continued until the system has dried and a safe condition is indicated.

Figure 1

CAUTION: This product is intended for use on all CFC, HCFC and HFC refrigerants. Do not use on any unlisted fluid media without prior approval of the Emerson Climate Technologies Flow Controls Division Applications Engineering Department. Use on fluids not listed above could result in deterioration of the moisture indicator element. Not for use on refrigerants classified by ASHRAE standard 34 as Class A1/A2, A2, A3, B2 and B3.

PS1 Single High and Low Pressure & PS2 Dual Pressure Refrigeration Controls

THE FLEXIBLE CONTROL

- Emerson Type PS1 Single and PS2 Dual Pressure Controls are designed for cycling, cutout and alarm applications on the high and low pressure sides of refrigeration systems.
- Standard pressure ranges and construction are ideally suited to conventional fluorocarbon and new alternative refrigerants (**not Ammonia**).
- High rated single pole double throw (SPDT) switch action on all PS series controls provides either open or close on pressure rise (pressure drop) operation to provide maximum application flexibility. The other switch contact can be used for an alarm or signal function if desired.
- A convertible reset feature on selected dual pressure controls allows the user to select either Automatic or Manual Reset Cutout on the high pressure side.
- PS2 Dual Pressure Controls incorporate 2 independent SPDT switches with factory installed jumper for conventional operation with high and/or low pressure cutout alarm or signal, if desired. Removal of the jumper on dual pressure controls provides totally independent high and low pressure SPDT switch operation.
- The parts package includes a lockplate and knob which allows the user to lock both the range and differential screws or the range or differential screw with a knob on the unlocked screw.

Details of the Emerson "Flexible" Control options are in the installation Instructions.

SAFETY INSTRUCTIONS

1. Read all Instructions thoroughly. Failure to comply can result in control failure, system damage or personal injury.
2. Do not use with ammonia or on hazardous or corrosive fluids.
3. Do not install in Hazardous Locations.
4. Disconnect electrical power before installation. Do not reapply power until control installation is complete, wiring connections secured and cover is installed.
5. Before making pressure control connections, depressurize system and make certain lines are at atmospheric pressure.

SPECIFICATIONS – SWITCH RATINGS

Maximum Load	120VAC	240VAC
Full Load Amps	24 FLA	24 FLA
Locked Rotor Amps	144 LRA	144 LRA
Horsepower	2 HP	3 HP
Pilot Duty	720VA	720VA
NonInductive	24 amps	24 amps

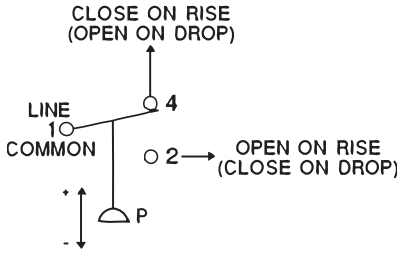
INSTALLATION INSTRUCTIONS–GENERAL

1. **Cover Removal**—Loosen cover screw and lift cover up.
2. **Mounting**—Mount the control in a protected area with the included angle mounting bracket and screws, or on a flat surface from the front.
   CAUTION: If other screws are used, use 8-32 screws that do **not** penetrate into the control more than 1/8''.
3. **Pressure Connections/Capillary /Pressure Lines**: Proper installation of capillary and pressure lines will insure a trouble–free installation.
   - If the control is mounted on the compressor, all lines must be secured to the compressor so they do not vibrate independently from the compressor.
   - If the control is mounted remote from the compressor an open coiled vibration loop, 2 to 3 coils, 2 to 3'' diameter should be provided between the rigid compressor base and the moving compressor. The lines coming from the coil should be secured to the base and compressor so the coil takes all the vibration. Avoid any "violin string" runs of pressure connection lines.
   - Sharp bends or kinks **must** be avoided in the capillary or pressure lines. Do not allow the lines to rub and abrade against any moving surface. Avoid any excessive handling or reforming of the copper lines to minimize work hardening of the copper.
   - A generous loop (3 to 4") should be provided in the capillary below the control.
     Pressure connections should be self-draining. High and low pressure connections to refrigeration lines should be **on the top or now lower than the** side of the line to minimize refrigerant oil from entering the line, which slows the control's ability to respond to pressure changes. Pressure connections to the compressor body should be slanted to allow the connection to self-drain to the compressor body.
4. **WARNING: Before making any electrical connections, check with a voltmeter as there could be more than one power source**.
5. **Electrical Connections** – Make certain the load to be connected is within the electrical rating of the control.
   - All wiring should conform to National Electrical Code and local regulations. Use **14AWG or larger copper conductors ONLY**.

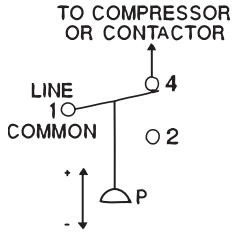
   See Switch Connection Diagrams later in this installation instructions sheet.
   - The terminals are of a clamp design. Loosen the terminal screw with a Phillips head or small screwdriver, insert approximately 3/8'' stripped wire and tighten.

PS1 SINGLE LOW PRESSURE CONTROL SWITCH CONNECTIONS

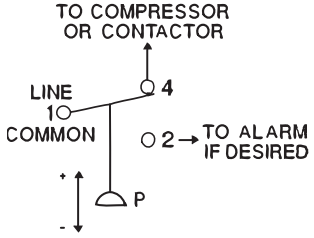
SINGLE LOW PRESSURE SWITCH RESPONSE



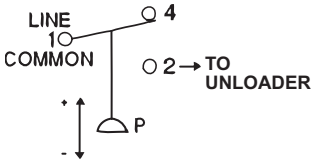
LOW PRESSURE CYCLING OR PUMPDOWN



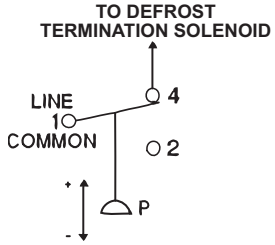
LOW PRESSURE CUTOUT/ALARM



UNLOADER CONTROL

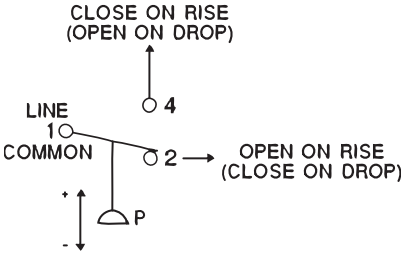


DEFROST TERMINATION

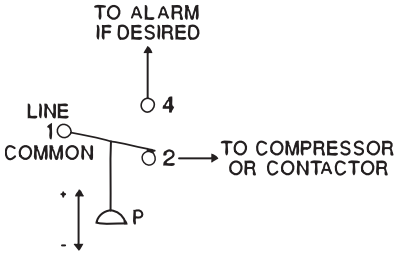


PS1 SINGLE HIGH PRESSURE CONTROL SWITCH CONNECTIONS

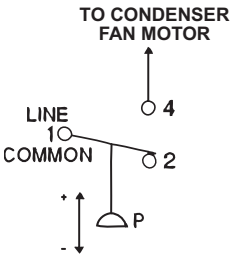
SINGLE HIGH PRESSURE SWITCH RESPONSE



HIGH PRESSURE CUTOUT



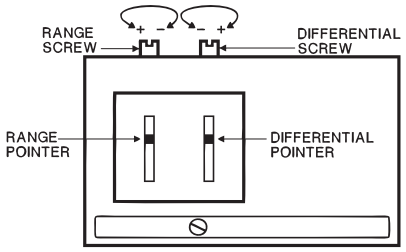
CONDENSER FAN CYCLING



NOTE: In above diagrams, **P = Pressure**

SETTINGS & ADJUSTMENTS

Adjustable Range & Differential Controls



Controls may have external adjustments (shown), or internal adjustments. If the control has internal adjustments, the cover must be removed to access the adjustment screws.

Procedure

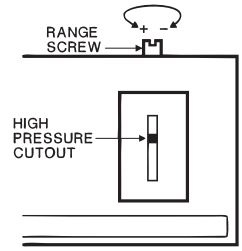
1) Adjust the Range Screw/Pointer to the desired "High Event" setting.
2) Adjust the Differential screw to the desired differential.

Low Event = High Event – Differential

✧ Adjustment of the Range Screw changes both high and low events.

✧ Adjustment of the Differential Screw changes the "Low Event" only.

Adjustable Range Fixed Differential Controls or High Side Dual Pressure



Procedure

1) Adjust the Range Screw to the desired "High Event" setting.

Low Event = High Event – Fixed Differential

✧ Adjustment of the Range Screw changes both the high and low events.

Do not set the Low Event below the lowest allowable event

Low Event – High Event = Differential

Lowest Allowable Events

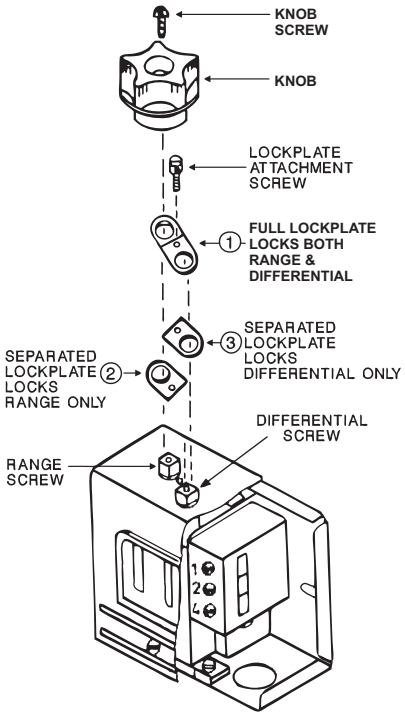
Low Pressure Control = 27" Hg
High Pressure Control = 50 PSIG

CONTROL SETTING & CHECKOUT

❍ **Low Pressure Controls** – With an accurate pressure gauge attached to the suction service valve, slowly close the liquid line valve to allow the system to pump down.
Observe the control's Low Event Switching Pressure – slowly open the liquid line to allow suction pressure to rise. Observe the control's High Event Switching Pressure – adjust the control range and differential set points as required to achieve the desired settings.

❍ **High Pressure Controls** – With a high pressure gauge attached to a high pressure service port, restrict the air flow thru an air-cooled condenser, or reduce the water flow thru a water-cooled condenser to cause discharge pressure to rise. Observe the control's High Event Switch Point and adjust as necessary. Restore normal cooling and observe the control's Low Event Switch Point, adjusting as required.

Before leaving a new control installation, it is best to observe a minimum of 3 cycles to assure proper operation.



NOTE: If only one screw is locked, knob can be applied to unlocked screw.

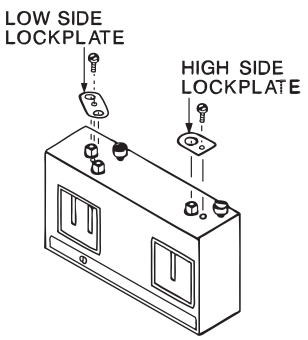
NOTE: The Range Screw(s) and Lockplate attachment screw are cross-drilled to allow the use of a wire seal.

LOCKPLATE AND KNOB

The lockplate can be used to lock:

1. Both Range and Differential Screws. Neither setting can be adjusted. To use lockplate options 2 or 3, break one end off the lockplate along the creaseline (see exploded view diagram at left).
2. Range Screw Only. Range screw is locked so that high event is fixed – adjusting the differential screw allows low event only to be changed.
3. Differential Screw Only. Differential is locked so that differential is fixed – adjusting range screw moves both high and low event up or down together.

Lockplate Installation on Dual Pressure Control



SPECIFICATIONS – TEMPERATURE & PRESSURE RANGES

Temperature Range -20°F to +140°F

Pressure Range – see control label on box.

Maximum Pressure – During installation and service, the control's power element should not be exposed to pressure exceeding those listed in the table below.

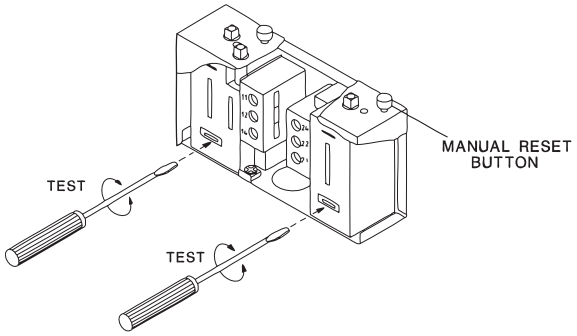
Control Range	Maximum Allowable Pressure
24" to 42 PSIG	230 PSIG
15" to 100 PSIG	360 PSIG
90 to 450 PSIG	500 PSIG

SPECIFICATIONS – ENCLOSURE

NEMA CLASS I – Mount the control body in an area protected from the weather, water or excessive moisture, dirt, dust and corrosive or explosive atmospheres.

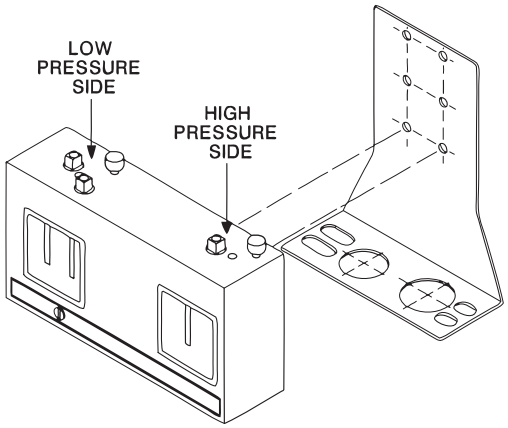
MANUAL OPERATION

The control can be easily manually operated as illustrated below



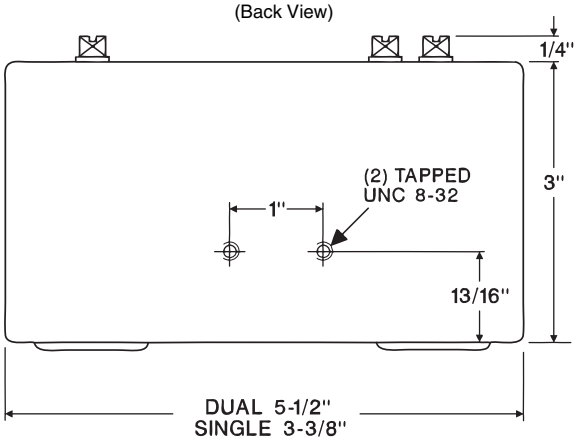
CONTROL MOUNTING

Dual Pressure Control Illustrated



MOUNTING DIMENSIONS

(Back View)

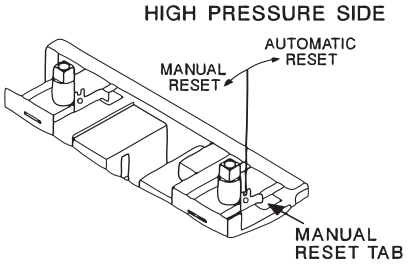


CONVERTIBLE RESET CONTROLS

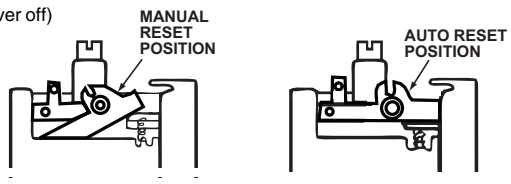
The high pressure side of dual pressure controls is furnished with the convertible reset feature that can be changed from manual to automatic reset as illustrated and described below.

❍ With the tab rotated counterclockwise so it does not touch the manual reset tab, the control will operate in the manual mode.
With the tab rotated clockwise so it holds the manual reset tab down fully, the control will operate as an automatic reset control.

TOP VIEW
(cover off)

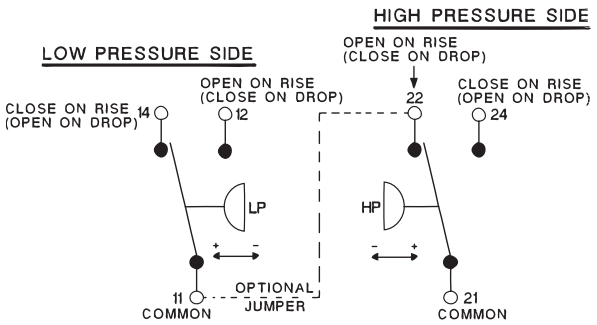


SIDE VIEWS
(cover off)



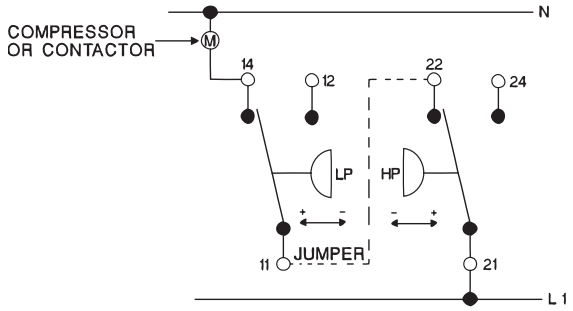
PS2 DUAL PRESSURE CONTROL SWITCH CONNECTIONS

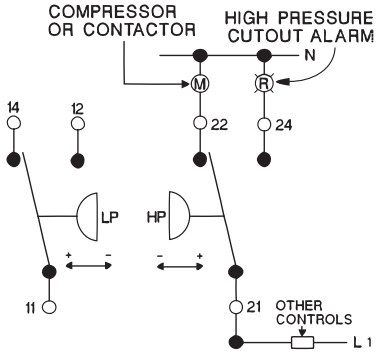
DUAL PRESSURE SWITCH RESPONSE



DUAL PRESSURE SWITCH RESPONSE

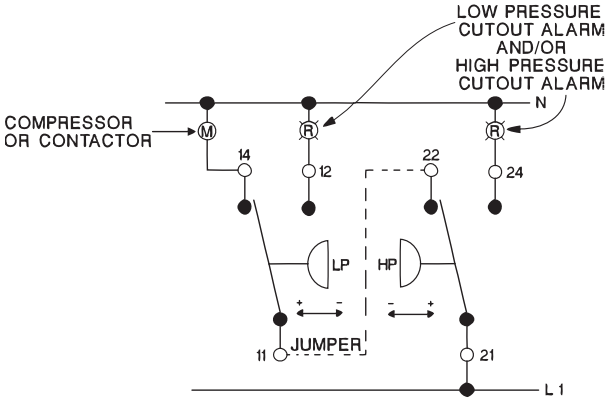
Low Pressure Side – Cycling pumpdown or cutout. Close high. Open low.
High Pressure Side – Cutout. Open high. Close low.





ISOLATED HIGH/LOW PRESSURE FUNCTIONS – JUMPER REMOVED

Isolated Low Pressure Switch can be used in separate circuit for unloading, low pressure cutout with time delay or other functions.



CONVENTIONAL HOOKUP WITH ALARM

Low Pressure Side – Cycling pumpdown or cutout. Close high. Open low.
High Pressure Side – Cutout. Open high. Close low.

NOTE: In above diagrams, **P = Pressure; LP = Low Side Pressure; HP = High Side Pressure**

P70, P72, and P170 Series Controls for High Pressure Applications

Application

P70, P72, and P170 Series Controls for High Pressure Applications provide high-side pressure control on commercial refrigeration and air conditioning applications.

IMPORTANT: Except for those models listed as *Refrigeration Pressure Limiting Controls*, use the P70, P72, and P170 Series Controls for High Pressure Applications only as an operating control. Where failure or malfunction of a P70, P72, or P170 pressure control could lead to personal injury or property damage to the controlled equipment or other property, additional precautions must be designed into the control system. Incorporate and maintain other devices such as supervisory or alarm systems or safety or limit controls intended to warn of, or protect against, failure or malfunction of the P70, P72, or P170 pressure control.

- **P70C, P70D, P170C, and P170D type models** with Single-Pole Single-Throw (SPST) Open-High switch action are the most popular models and are typically used as high pressure Cutout controls. The **C type models** are automatic reset controls. The **D type models** have a manual reset lockout mechanism. Some **P70C, P70D, P170C, and P170D type models** are UL Listed as refrigeration pressure limiting controls. See Table 2 for standard models available.
- **P70A and P170A type models** feature SPST Open-Low switch action and typically are used for condenser-fan cycling control.
- **P70 and P170 Series models** with Single-Pole Double-Throw (SPDT), or 4-Wire, 2-Circuit switch action allow users to install alarm devices or other control circuits.
- **P72 Series models** have a Double-Pole Single-Throw (DPST) switch with load-carrying contacts that can provide direct control of 208-240 VAC single-phase motors up to 3 hp, 480 and 600 VAC single-phase noncompressor motors, and 208-220 VAC 3-phase motors up to 5 hp. See Table 6.

Controls are available in several pressure ranges and are compatible with most common refrigerants.

They may also be used on air, water and other noncorrosive fluid applications. Ammonia compatible models are also available.

CAUTION: Risk of Property Damage.
Mount the pressure control separately from the electrical cabinet and seal all electrical piping to prevent ammonia from migrating to electrical components. Where there may be exposure to ammonia, use only ammonia compatible control modules and pressure connections. System shutdown due to improper adjustment may cause property damage.

The **Manual Reset Lockout** mechanism does not allow the pressure control to automatically reset after the control has Cutout, providing shutdown capability for unmonitored equipment. See *Manual Reset Operation.*

NEMA 1 enclosures are standard on most models. **NEMA 3R enclosures** are also available on quanity orders.

Dimensions

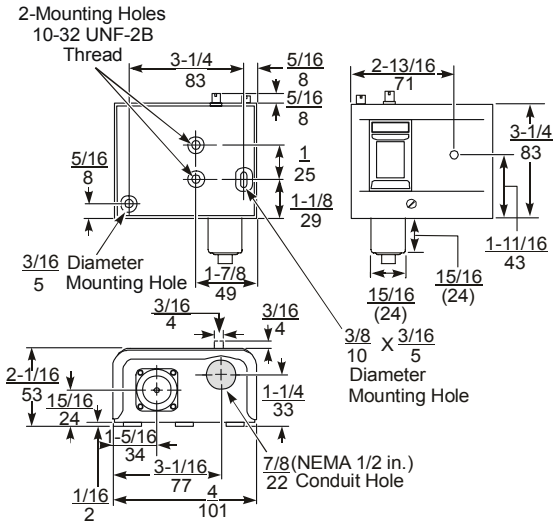


Figure 1: Dimensions for P70, P72, and P170 Pressure Controls with NEMA 1 Enclosures, in. (mm)

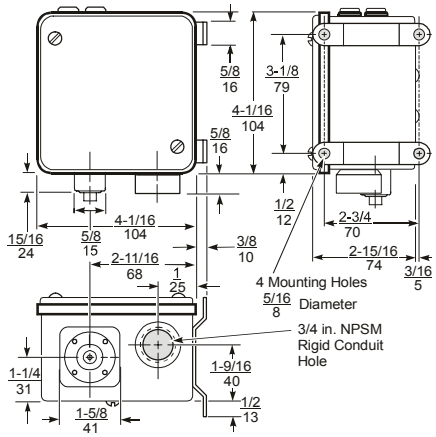


Figure 2: Dimensions for P70, P72, and P170 Pressure Controls with NEMA 3R Enclosures, in. (mm)

Mounting

Mount the control in an accessible position, where the control and pressure connection are not subject to damage.

Mount the pressure control upright and level. Position the pressure connection line to allow drainage away from control bellows. Locate pressure tap points on the top side of the refrigerant lines to reduce the possibility of oil, liquids, or sediment accumulating in the bellows, which could cause control malfunction.

Mount controls with NEMA 1 enclosures on horizontal or vertical flat surfaces.

Use two screws or bolts through the two outer holes on the back of the control case to mount the control directly to a flat, vertical surface.

Use the two inner holes with the Universal Mounting Bracket (and screws supplied) when mounting the control to a flat, horizontal surface. See Figure 3.

Mount controls with NEMA 3R enclosures in a level, upright position with the bellows and conduit connection facing down. Ensure that all gaskets are in place. Mounting NEMA 3R enclosures in any position other than upright and level may trap water in the enclosure and submerge internal control components.

IMPORTANT: Use only the mounting screws supplied with the Universal Mounting Bracket to avoid damaging internal components. Be careful not to distort or bend the control case when mounting the control to an uneven surface. Using other screws or bending the control case will void the warranty.

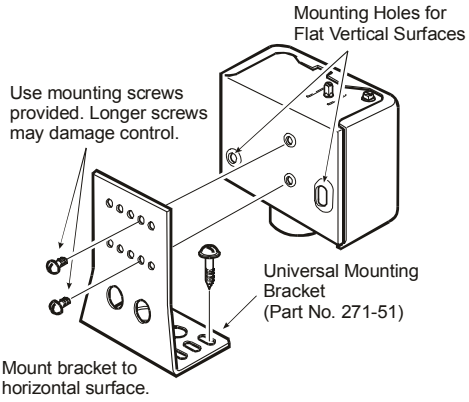


Figure 3: Mounting the P70, P72, and P170 Pressure Controls with NEMA 1 Enclosures, in. (mm)

Pressure Connections

P70, P72, and P170 high pressure controls are connected to the controlled equipment by a capillary (except ammonia models). These controls are available with a variety of pressure connection styles.

Follow these guidelines when installing pressure connection lines:

IMPORTANT: If these controls are installed on equipment that contains hazardous or regulated materials, such as refrigerants or lubricants, you must comply with all standards and regulations governing the containment and handling of those materials.

Avoid Sharp Bends in the Capillary Tube

Sharp bends can weaken or kink capillary tubes, which may result in leaks or restrictions.

Allow for Slack in the Capillary Tube

Leaving a little slack in the capillary tube helps dampen mechanical vibration that can weaken or damage capillary tubes.

Coil and Secure Excess Capillary Tubing

Carefully loop any excess capillary tubing into smooth, circular coils (approximately 2 to 3 in.[50 to 75 mm] diameter). Securely fasten the coiled tubing.

Avoid Contact between the Capillary Tubing and Sharp or Abrasive Objects

Vibration of sharp or abrasive objects in contact with capillary tubes can result in leaks.

Do Not Overtighten Flare Nuts on Pressure Connection Line Fittings

Overtightening flare connections may damage the threads on the flare nuts or flare connectors, and may result in leaks. Do not exceed 9 ft·lb (12 N·m) of torque when tightening brass flare connections.

Avoid Severe Pressure Pulsation at Pressure Connections

Install pressure connection lines to pressure tap points away from the compressor to minimize the effects of pressure pulsation from reciprocating compressors.

IMPORTANT: After installing the control, evacuate pneumatic and pressure connection lines to remove air, moisture and other contaminants in a manner consistent with applicable environmental regulations and standards.

Wiring

P70, P72, and P170 controls for high pressure applications are available with several switch options and electrical ratings. Check the label inside the control cover for model number, switch action, and electrical rating. See Table 1 for switch actions and models. See *Electrical Ratings*.

Check the wiring terminal designations on the control switch-block, and refer to the following guidelines and applicable wiring diagrams when wiring the control.

WARNING: Risk of Electrical Shock. Disconnect each of multiple power supplies before making electrical connections. More than one disconnect may be required to completely de-energize equipment. Contact with components carrying hazardous voltage can cause electric shock and may result in severe personal injury or death.

IMPORTANT: Use only the terminal screws that are supplied with the switch-block. Using other screws may cause damage to the switch-block and will void the warranty.

IMPORTANT: Use copper conductors only. Make all wiring connections in accordance with local, national, and regional regulations. Do not exceed the controls.

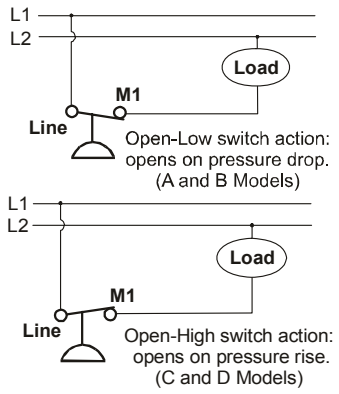


Figure 4: Typical Wiring for SPST Switch (P70A, B, C, D and P170A, C, D Type Models)

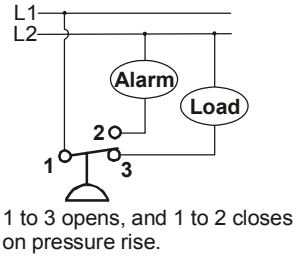


Figure 5: Typical Wiring for SPDT Switch (P70E and F Type Models)

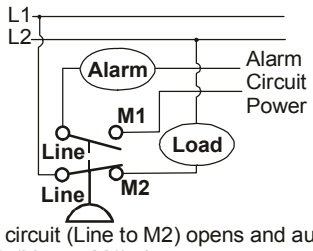


Figure 6: Typical Wiring for 4-Wire, 2-Circuit Switch (P70J, K and P170K Type Models)

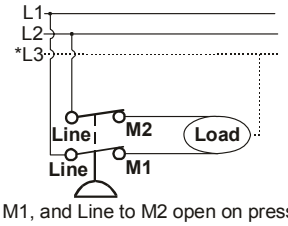


Figure 7: Typical Wiring for DPST Switch (P72C and D Type Models)

Table 1: Pressure Control Switch Action, Low Events, High Events, Model Types, and Electrical Ratings Tables References

Switch and Action	Low Event	High Event	Model Types - Electrical Rating Table References
Single-Pole Single-Throw (SPST) Open-Low	Cutout (Opens Line to M1)	Cut In (Closes Line to M1)	P70A, P70B, P170A See Table 3.
Single-Pole Single-Throw (SPST) Open-High	Cut In (Closes Line to M1)	Cutout (Opens Line to M1)	P70C, P70D, P170C, P170D See Table 3.
Single-Pole Double-Throw (SPDT)	Opens 1 to 2 and Closes 1 to 3	Closes 1 to 2 and Opens 1 to 3	P70E, P70F See Table 4.
4-Wire, 2-Circuits, 1-NO, 1-NC Open-Low	Cutout (Opens M2 to Line and Closes M1 to Line)	Cut In (Closes M2 to Line and Opens M1 to Line)	P70G, P70H See Table 5.
4-Wire, 2-Circuits, 1-NO, 1-NC Open-High	Cut In (Closes M2 to Line and Opens M1 to Line)	Cutout (Opens M2 to Line and Closes M1 to Line)	P70J, P70K, P170K See Table 5.
Double-Pole Single-Throw (DPST) Open-Low	Cutout (Opens M1 to Line and M2 to Line)	Cut In (Closes M1 to Line and M2 to Line)	P72A, P72B See Table 6.
(DPST) Open-High	Cut In (Closes M1 to Line and M2 to Line)	Cutout (Opens M1 to Line and M2 to Line)	P72C, P72D See Table 6.

Adjustments

Adjustments of the P70, P72, and P170 high pressure controls vary, depending on the model. The following guidelines and diagrams illustrate the procedures for adjusting these controls. Refer to the product label inside the control cover for model number and switch action. Refer to Table 1 for switch action, low event, and high event for the various control models.

High Pressure Cutout - Automatic Reset

High pressure Cutout controls with automatic reset have a scaleplate that displays the Cut In and Cutout setpoints. (See the visible scale on the control.) Turn the range screw to adjust the Cut In and Cutout setpoints up or down simultaneously, while maintaining a constant pressure differential. Turn the differential screw to adjust (only) the low event on the left side of the scale (which changes the differential pressure value).

High Pressure Cutout - Manual Reset Lockout

High pressure Cutout controls with the Manual Reset Lockout option have a scaleplate that displays the Cutout setpoint. There is no pointer for the Cut In setpoint. (See the visible scale on the control.)

Turn the range screw to adjust the Cutout setpoint on the right side of the scale. There is no differential screw on Manual Reset Lockout models. The differential pressure value is fixed.

Condenser Fan Cycling - Open-Low Switch Action

Condenser fan cycling pressure controls have a scaleplate that displays the Cut In setpoint and Differential setting. (See visible scale on the control.) Turn the range screw to adjust the Cut In setpoint on the right side of the scale. Turn the differential screw to adjust the Differential setting on the left side of the scale (which changes the Cutout pressure value).

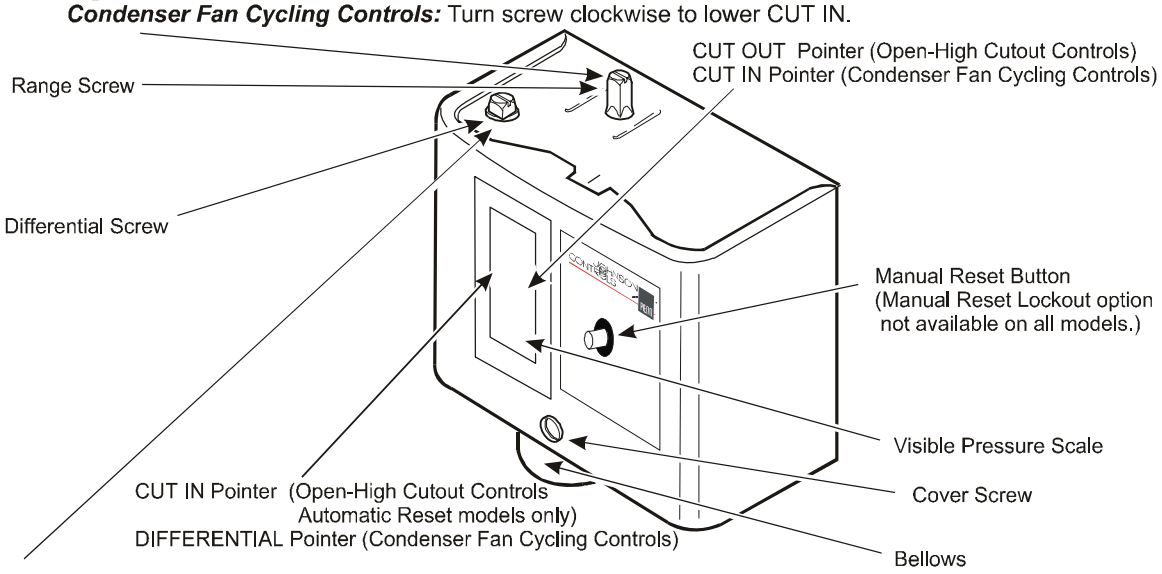
IMPORTANT: Do not adjust pointers beyond the highest or lowest indicator marks on the control's pressure scale. Adjusting pointers beyond indicator marks may damage screw threads, may cause inaccurate control operation, and will void the warranty.

IMPORTANT: Use the pressure control settings recommended by the manufacturer of the controlled equipment. Do not exceed the pressure ratings of the controlled equipment or any of its components when checking pressure control operation or operating the controlled equipment.

Step 1. Set high event by adjusting range screw.

High Pressure Cutout Controls: Turn screw clockwise to raise CUT OUT.

Condenser Fan Cycling Controls: Turn screw clockwise to lower CUT IN.



Step 2. Adjust the differential screw.

High Pressure Cutout Controls: Turning the differential screw changes CUT IN setpoint.
(Auto-Reset models only) Turn screw clockwise to lower CUT IN setpoint.

Condenser Fan Cycling Controls: Turning the differential screw changes the differential setting.
Turn screw clockwise to increase DIFFERENTIAL.

Figure 8: Adjusting P70, P72, and P170 Controls for High Pressure Applications

IMPORTANT: After mounting and wiring control, attach a reliable set of gauges to the controlled equipment, and operate the equipment (at least) three cycles at the pressures necessary to verify control setpoints and proper equipment operation.

Manual Reset Operation

Pressure controls with the Manual Reset option lock out when they reach Cutout pressure and must be manually reset by the user to restart the controlled equipment. The manual reset mechanism is **trip-free** and cannot be overridden by blocking or tying the reset button down.

On equipment with locked-out controls, first determine and remedy the cause of the lockout, and allow the sensed pressure to drop at least 70 psig below the Cutout setpoint. Then, press and release the reset button on the front of the control to restore operation of the controlled equipment.

Table 2: Standard P70, P72, and P170 Control Models for High Pressure Applications

Model Number	Switch Action	Range Psig (kPa)	Differential Psi (kPa)	Pressure Connection	Maximum Working Pressure (MWP) Psi (kPa)
Condenser Fan Cycling Control Models (for Noncorrosive Refrigerants)					
P70AA-118	SPST Open-Low	100 to 400 psig (690 to 2758)	Minimum 35 (241) Maximum 200 (1379)	36 in. Capillary with 1/4 in. Flare Nut	475 (3275)
P72AA-27	DPST Open-Low	100 to 400 psig (690 to 2758)	Minimum 35 (241) Maximum 200 (1379)		
P170AA-118	SPST Open-Low			1/4 in. Male Flare Connector	
All-Range Control Models (for Noncorrosive Refrigerants)					
P70CA-2*	SPST Open-High	50 to 500 (345 to 3448)	Minimum 60 (414) Maximum 150 (1034)	1/4 in. Male Flare Connector	525 (3620)
P70CA-3*				36 in. Capillary with 1/4 in. Flare Nut	
P70DA-1*			Manual Reset Lockout		
P70KA-1*	4-Wire, 2-Circuit Line-M1 Close-High Line-M2 Open-High				
P72CA-2*	DPST Open-High		Minimum 60 (414) Maximum 150 (1034)		
P72DA-1*			manual Reset Lockout		
P170CA-3*	SPST Open-High		Minimum 60 (414) Maximum 150 (1034)	1/4 in. Male Flare Connector	
P170DA-1*			Manual Reset Lockout		
P170KA-1*	4-Wire, 2-Circuit Line-M1 Close-High Line-M2 Open-High				
Ammonia-Compatible Models					
P70AA-119	SPST Open-Low	50 to 300	Minimum 20 (138) Maximum 120 (827)	1/4 in. SS Female NPT	525 (3620)
P70CA-5*	SPST Open-High	50 to 500 (345 to 3448)	Minimum 60 (414) Maximum 150 (1034)		
P70DA-2*			Manual Reset Lockout		

Continued on next page . . .

Model Number	Switch Action	Range	Differential	Pressure Connection	Maximum Working Pressure (MWP)
High Pressure Control Models for High Pressure Non-corrosive Refrigerants					
P70AA-400	Condenser Fan Cycling SPST Opens Low	100 to 470 (689 to 3241)	Adjustable 35 to 200 (241 to 1379)	36 in. Capillary with 1/4 in. Flare Nut	690 (4757)
P170AA-400				1/4 in. Male Flare Connector	
P70CA-400*	SPST Opens High	200 to 610 (1379 to 4206)	Adjustable 60 to 150 (413 to 1034)	36 in. Capillary with 1/4 in. Flare Nut	
P170CA-400*				1/4 in. Male Flare Connector	
P70DA-400*		200 to 610 (1379 to 4206)	Manual Reset Lockout	36 in. Capillary with 1/4 in. Flare Nut	
P170DA-400*				1/4 in. Male Flare Connector	

***** Models that are UL Listed as refrigeration pressure limiting controls. For models not included in this table, contact the Refrigeration Application Engineering Group at 1-800-275-5676 for details and availability.

Note: See *Dimensions* and *Technical Specifications* for additional model information including Maximum Working Pressure.

Electrical Ratings

Table 3: SPST Electrical Ratings (P70A, B, C, D, and P170A, B, C, D Models)

	Standard Single-Phase Ratings					Hermetic Compressor Single-Phase Ratings
	120 VAC	**208 VAC**	**240 VAC**	***480 VAC**	***600 VAC**	**208/240 VAC**
Motor Full-Load Amperes	24	18.7	17	5	4.8	24
Motor Locked-Rotor Amperes	144	112.2	102	30	28.8	144
Non-Inductive Amperes	22	22	22	--	--	--
Pilot Duty	125 VA at 120 to 600 VAC; 57.5 VA at 120 to 300 VDC					

* Not for compressor motor loads

Table 4: SPDT Electrical Ratings Standard Differential Switch (P70E Models)

	Standard Single-Phase Ratings			
	120 VAC	**208 VAC**	**240 VAC**	***277 VAC**
Motor Full Load Amperes	16.0	9.2	8.0	7.0
Motor Locked Rotor Amperes	96.0	55.2	48.0	42.0
Non-Inductive Amperes	16.0	16.0	16.0	16.0
Pilot Duty	125 VA at 120 to 600 VAC			125 VA at 24 to 600 VAC

* Rating for P70EC models only

Table 5: 4-Wire, 2-Circuit Electrical Ratings (P70G, H, J, K, and P170K Models)

	Standard Single-Phase Ratings									
	Line-M2 (Main Contacts)						Line-M1 (Auxiliary Contacts)			
	120 VAC	208 VAC	240 VAC	277 VAC	*480 VAC	*600 VAC	120 VAC	208 VAC	240 VAC	277 VAC
Motor Full Load Amperes	16.0	9.2	8.0	--	5	4.8	6.0	3.3	3.0	--
Motor Locked Rotor Amperes	96.0	55.2	48.0	--	30	28.8	36.0	19.8	18.0	--
Non-Inductive Amperes	16.0	9.2	8.0	7.2	--	--	6.0	6.0	6.0	6.0
Pilot Duty (for both sets of contacts)	125 VA at 24 to 600 VAC; 57.5 VA at 120 to 300 VDC									

* Not for compressor motor loads

Table 6: DPST Electrical Ratings (P72A, B, C and D Type Models)

	Standard Ratings							Hermetic Compressor Ratings	
	120 VAC 1Ø	208 VAC 1Ø	240 VAC 1Ø	208 VAC 3Ø	220 VAC 3Ø	*480 VAC 1Ø	*600 VAC 1Ø	208 VAC 1Ø	240 VAC 1Ø
Motor Full-Load Amperes	24	18.7	17	15.9	15	5	4.8	24	24
Motor Locked-Rotor Amperes	144	112.2	102	95.4	90	30	28.8	144	144
AC Non-Inductive Amperes	24	24	24	24	24	--	--	--	--
DC Non-Inductive Amperes	3	0.5	0.5	0.5	0.5	--	--	--	--
Pilot Duty	125 VA at 120 to 600 VAC; 57.5 VA at 120 to 300 VDC								

* Not for compressor motor loads

Technical Specifications

Product	P70, P72, and P170 Controls for High Pressure Applications		
Switch Action	P70, P170: SPST; 4-Wire/2-Circuit; or SPDT PENN® switch P72: DPST		
Pressure Connection	P70, P72 Standard Models Various connections available	P170 Standard Models 1/4 in. SAE male flare	Ammonia Compatible Models 1/4 in. stainless steel female NPT connection
Ambient Temperature	P70E and P70F: 50 to 104°F (10 to 40°C) All Other Models: -40 to 140°F (-40 to 60°C)		
Case and Cover	NEMA 1 Enclosures: Case is galvanized steel; cover is plated and painted steel. NEMA 3R Enclosures: Case and cover are plated and painted steel.		
Dimensions (H x W x D)	NEMA 1 Enclosure: 3-1/4 x 4 x 2-1/16 in. (83 x 101 x 53 mm) NEMA 3R Enclosure: 4-1/16 x 4-1/16 x 2-15/16 in. (104 x 104 x 74 mm)		
Approximate Shipping Weight	Individual Pack (NEMA 1): 2.4 lb (1.08 kg); Bulk Pack (NEMA 1, multiples of 25 controls): 60 lb (27.2 kg)		
Compliance	For information on specific models, contact the Refrigeration Application Engineering Group at 1-800-275-5676.		
Accessories	271-51 Universal Mounting Bracket (supplied with standard controls)		

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, contact the Refrigeration Application Engineering Group at 1-800-275-5676. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

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Controles para Aplicaciones de Presión Alta Series P70, P72 y P170

Aplicación

Los Controles de las Series P70, P72 y P170 para Aplicaciones de Presión Alta proporcionan control de presión del lado de alta en aplicaciones de refrigeración comercial y de aire acondicionado.

IMPORTANTE: Con excepción de los modelos listados como *Contoles de Límite de Presión de Refrigeración*, el propósito de los controles de las Series P70, P72 y P170 para Aplicaciones de Presión Alta es de controlar equipo bajo condiciones de operación normales. Donde un mal funcionamiento o falla de un control de presión P70, P72, o P170 pueda resultar en una condición anormal de operación, que a su vez pueda causar lesión personal o daño al equipo u otra propiedad, se deben instalar otros aparatos (controles limitadores o de seguridad) o sistemas (de alarma o supervisión) para advertir o proteger contra éstas fallas o mal funcionamiento del control de presión P70, P72, o P170, y mantenerse como parte del sistema de control.

- **Modelos del Tipo P70C, P70D, P170C y P170D** con acción del interruptor de Un Polo – Un Tiro (SPST) con acción Abren en Alta son los modelos más populares y se usan típicamente como controles de Desconexión de presión alta. Los **modelos de tipo C** son controles con restablecimiento automático. Los **modelos de tipo D** tienen un mecanismo de bloqueo de restablecimiento manual. Algunos **modelos del tipo P70C, P70D, P170C y P170D** están Listados por UL como controles de límite de presión de refrigeración.
- **Los modelos del tipo P70A y P170A** están disponibles con interruptor SPST con acción abren en Baja y se usan típicamente para controlar el ciclo del abanico del condensador.
- **Los modelos de la Serie P70 y P170** tienen un interruptor de Un Polos-Dos Tiro (SPDT), o de 4 Alambres-2 Circuitos que permiten que los usuarios instalen aparatos de alarma u otros circuitos de control.
- **Los modelos de la Serie P72** tienen un interruptor de Dos Polos-Un tiro (DPST) con contactos para llevar la carga que puede proporcionar control directo a motores de monofásicos de 208-240 VCA hasta 3 HP, motores monofásicos de 480 y 600 VCA no de compresor y motores trifásicos de 208-220 VCA hasta 5 HP. Refiérese a la Tabla 6.

Estos controles están disponibles en varios rangos de presión y son compatibles con los refrigerantes más comúnes. También se usan en aplicaciones de aire, agua, y otros líquidos no corrosivos. También tenemos modelos compatibles con amoníaco.

PRECAUCION: Riesgo de Daño del Equipo. El amoníaco es muy corrosivo a componentes de cobre y latón. En aplicaciones de amoníaco se deben usar sólo modelos de control y conexiones de presión compatibles con amoníaco. El control de presión se debe instalar separadamente del gabinete eléctrico y se deben sellar todos los conductos eléctricos para evitar que el amoníaco se filtre a los componentes eléctricos.

El mecanismo de **Bloqueo de Restablecimiento Manual** no permite que el control se restablezaca automáticamente después de llegar al punto de Desconexión, y proporciona la capacidad de apagado para equipo no monitoreado. Ver *Ajuste de Operación de Restablecimiento Manual*.

Las cajas NEMA 1 son estándares en la mayoría de los modelos.

Las cajas NEMA 3R también están disponibles.

Dimensiones

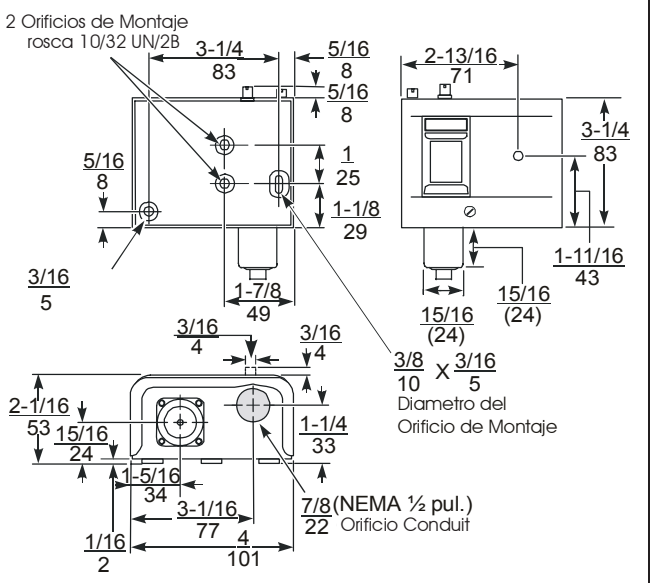


Figura 1: Dimensiones para los Controles de Presión P70, P72, y P170 con Cajas NEMA 1, pulg. (mm)

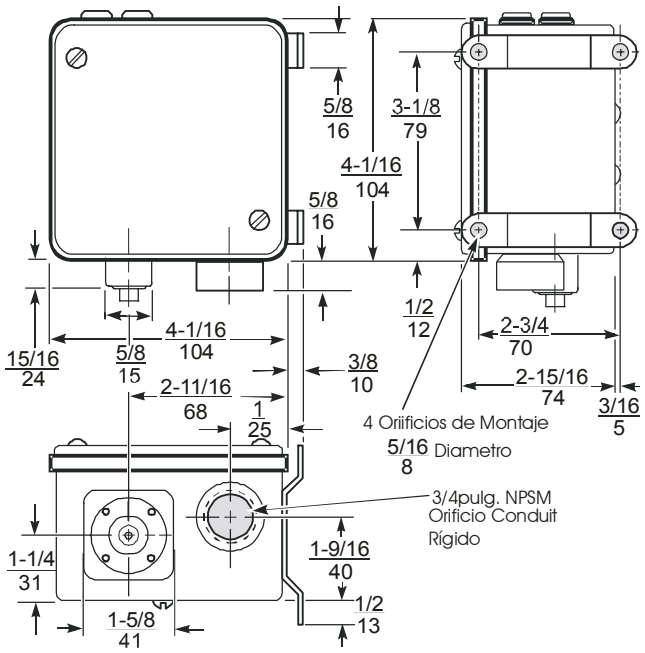


Figura 2: Dimensiones para Controles de Presión P70, P72, y P170 con Cajas NEMA 3R, pulg. (mm)

Instalación

Instale el control en una posición accesible, donde el control y la línea de conexión de presión no se dañen.

Instale el control de presión en una posición vertical y nivelada. Coloque la línea de conexión de presión de manera que se pueda drenar lejos del fuelle del control. Los puntos de entrada de la presión se deben localizar en el lado superior de la Lneaa del refrigerante para reducir la posibilidad de que el aceite, líquidos, o sedimento se acumulen en el fuelle, que podría causar un mal funcionamiento del control.

Instale los controles con cajas NEMA 1 en superficies planas horizontales o verticales.

Use dos tornillos o pernos a través de los dos orificios exteriores en el reverso de la caja de control cuando se instale directamente en una superficie plana y vertical.

Use los dos orificios internos con el soporte de Instalación Universal (y los tornillos provistos), al instalar el control en una superficie plana y horizontal. Ver Figura 3.

Instale los controles con cajas NEMA 3R en una posición nivelada y vertical, con el fuelle y la conexión conduit hacia abajo. Asegúrese que todos los empaques estén en su lugar. La instalación de cajas NEMA 3R en cualquier posición otra que vertical y nivelada puede atrapar agua en la caja y sumergir los componentes internos del control.

IMPORTANTE: Use sólo los tornillos de montaje provistos con el soporte de Instalación Universal para evitar daño a los componentes internos. No tuerza la caja del control cuando instale el control a una superficie irregular.

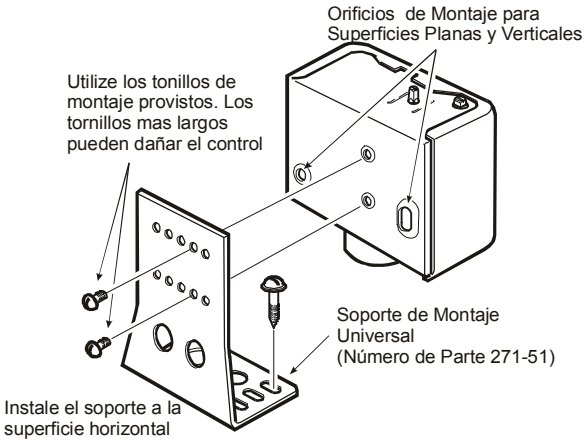


Figura 3: Instalación del los Controles de Presión P70, P72 y P170 con Cajas NEMA 1, pulg. (mm)

Conexiones de Presión

Los controles de presión alta P70, P72 y P170 se conectan al equipo controlado por medio de un capilar (excepto en modelos para amoníaco). Están disponibles en diferentes tipos de conexión de presión.

Siga estas pautas al instalar las líneas de conexión de presión:

IMPORTANTE: Si estos controles se instalan en equipo que contiene materiales peligrosos o regulados, tal como refrigerantes o lubricantes, el instalador y usuario deben observar todas las reglamentaciones que gobiernan el manejo y contención de esos materiales.

Evite Dobleces Agudos en el Tubo Capilar

Los dobleces agudos pueden debilitar los tubos del capilar, que resultarían en fugas u obstrucciones.

Permita Soltura en el Tubo Capilar

Dejar el tubo capilar un poco flojo puede ayudar a amortiguar la vibración mecánica que pueda debilitar o dañar los tubos capilares.

Enrolle y Asegure el Exceso del Tubo Capilar

Cuidadosamente enrolle cualquier exceso de tubo capilar en bobinas lisas y redondas (aproximadamente 2 pulg. de diámetro). Sujete el capilar enrollado.

Evite el Contacto entre el Tubo Capilar y Objetos Agudos o Abrasivos

La vibración de los objetos agudos o abrasivos que estén en contacto con los tubos capilares pueden resultar en fugas.

No Apriete Demasiado las Tuercas Abocinadas en los Conectores de la Línea de Conexión de Presión

Si aprieta las conexiones abocinadas demasiado puede dañar los hilos en las tuercas abocinadas o los conectores abocinados, y resultar en fugas. No exceda 9 pies-lbs (12 Nm) de torque al apretar las conexiones de latón abocinadas.

Evite la Pulsación de Presión Severa en las Conexiones de Presión

Instale las Líneas de conexión de presión que van a los puntos de entrada de presión lejos del compresor para minimizar los efectos de pulsación de presión en los compresores recíprocos.

IMPORTANTE: Después de instalar el control, vacíe las líneas del control y conexión de presión de acuerdo con los reglamentos locales, nacionales y regionales aplicables para remover el aire, humedad y otros contaminantes

Alambrado

Los controles P70, P72 y P170 para aplicaciones de presión alta están disponibles con varias opciones de interruptor y rangos eléctricos. Revise la etiqueta dentro de la tapa del control para el número del modelo, acción del interruptor, y clasificación eléctrica. Ver la Tabla 1 para las acciones de los interruptores y los modelos. Vea *Clasificaciones Eléctricas*.

Revise las designaciones de la terminales alambrado en el interruptor del control, y refiérase a las siguientes pautas y al diagrama de alambrado aplicable cuando se instale el control.

ADVERTENCIA: Riesgo de Descarga Eléctrica. Desconecte la corriente eléctrica antes de iniciar las conexiones eléctricas para evitar una posible descarga eléctrica. Puede ser necesario ejecutar más de una desconexión para desenergizar el control y el equipo.

IMPORTANTE: Use los tornillos de terminal provisos con el interruptor. El uso de otros tornillos de terminal invalidará la garantía y puede dañar el interruptor.

IMPORTANTE: Hace todas las conexiones de la instalación eléctrica de acuerdo con las reglamentaciones nacionales, locales, y regionales. Use sólo conductores de cobre. No exceda la clasificación eléctrica del control.

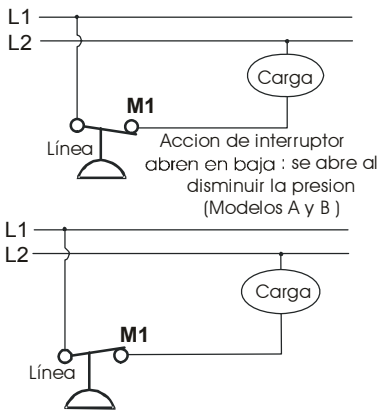


Figura 4: Alambrado Típico para Interruptores SPST (Modelos P70A, B, C, D y P170A, C, D)

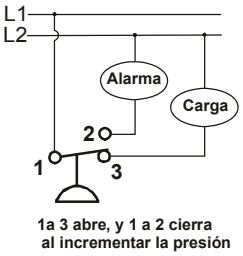


Figura 5: Alambrado Típico para Interruptores SPDT (Modelos P70E y F)

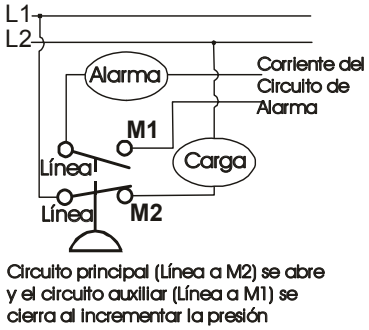


Figura 6: Alambrado Típico para Interruptores de 4 Alambres - 2 Circuitos (Modelos P70J, K y P170K)

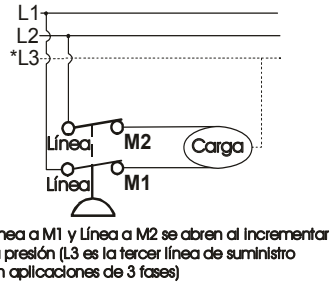


Figura 7: Alambrado Típico para Interruptores DPST (Modelos P72C y D)

Tabla 1: Controles de Presión Sencilla con Acción del Interruptor, Eventos Bajos, Eventos Altos, Tipos de Modelo, y Tabla de Referencia de Clasificación Eléctrica

Interruptor y Acción	Evento Bajo	Evento Alto	Tipos de Modelos – Tabla de Referencia de Clasificación Electrica
Un Polo-Un Tiro (SPST) Abre en baja	Desconexión (Abre Línea a M1)	Conexión (Cierra Línea a M1)	P70A, P70B, P170A Ver Tabla 3.
Un Polo-Un Tiro (SPST) Abre en alta	Conexión (Cierra Línea a M1)	Desconexión (Abre Línea a M1)	P70C, P70D, P170C, P170D Ver Tabla 3.
Un Polo-Dos Tiros (SPDT)	Abre 1 a 2 y Cierra 1 a 3	Cierra 1 a 2 y Abre 1 a 3	P70E Ver Tabla 4.
4-Alambres, 2-Circuitos, 1 N.A., 1 N.C. Abre en baja	Desconexión (Abre M2 a Línea y Cierra M1 a Línea)	Conexión (Cierra M2 a Línea y Abre M1 a Línea)	P70G, P70H Ver Tabla 5.
4-Alambres, 2-Circuitos, 1 N.A., 1 N.C. Abre en alta	Conexión (Cierra M2 a Línea y Abre M1 a Línea)	Desconexión (Abre M2 a Línea y Cierra M1 a Línea)	P70J, P70K, P170K Ver Tabla 5.
Dos Polos-Un Tiro (DPST) Abre en baja	Desconexión (Abre M1 a Línea y M2 a Línea)	Conexión (Cierra M1 a Línea y M2 a Línea)	P72A, P72B Ver Tabla 6.
(DPST) Abre en alta	Conexión (Cierra M1 a Línea y M2 a Línea)	Desconexión (Abre M1 a Línea y M2 a Línea)	P72C, P72D Ver Tabla 6.

Ajustes

Los ajustes de los controles de Presión Alta P70, P72 y P170 varían, dependiendo del modelo. Las siguientes pautas y diagramas ilustran los procedimientos para ajustar estos controles. Refiérase a la etiqueta del producto dentro de la tapa del control para el número del modelo y la acción del interruptor. Refiérase a la Tabla 1 para la acción del interruptor, evento bajo, y evento alto de los diferentes modelos de control.

Desconexión de Presión Alta – Restablecimiento Automático

Los controles de Desconexión de Presión Alta con restablecimiento automático tienen un placa de escala que despliega los puntos de ajuste de Conexión y Desconexión. (Ver la escala visible en el control). Gire el tornillo de rango para cambiar los puntos de ajuste de Conexión y Desconexión, simultáneamente hacia arriba y abajo mientras se mantiene un diferencial de presión constante. Gire el tornillo del diferencial para ajustar (sólo) el evento bajo en el lado izquierdo de la escala (que cambia el valor de presión del diferencial).

Desconexión de Presión Alta – Bloqueo del Restablecimiento Manual

Los controles de Desconexión de Presión Alta con la opción de Bloqueo de Restablecimiento Manual tienen un placa de escala que despliega el punto de ajuste de desconexión. No existe ningún indicador para el punto de ajuste de Conexión. (Ver la ecala visible en el control.). Gire el tornillo de rango para cambiar el punto de ajuste de Conexión en el lado derecho de la escala. Los modelos de Bloqueo de Restablecimiento Manual no cuentan con tornillo de diferencial. El valor de la presión del diferencial está fijo.

Ciclado del Abanico del Condensador – Acción del Interruptor de Abierto Bajo

Los controles de presión que ciclado del abanico del condensador tienen un placa de escala que despliega el punto de ajuste de Conexión y el ajuste del Diferencial. (Ver la escala visible en el control.) Gire el tornillo de rango para cambiar el punto de ajuste de Conexión en el lado derecho de la escala. Gire el tornillo del diferencial para cambiar el ajuste en el lado izquierdo de la escala (que cambia el valor de presión de Desconexión).

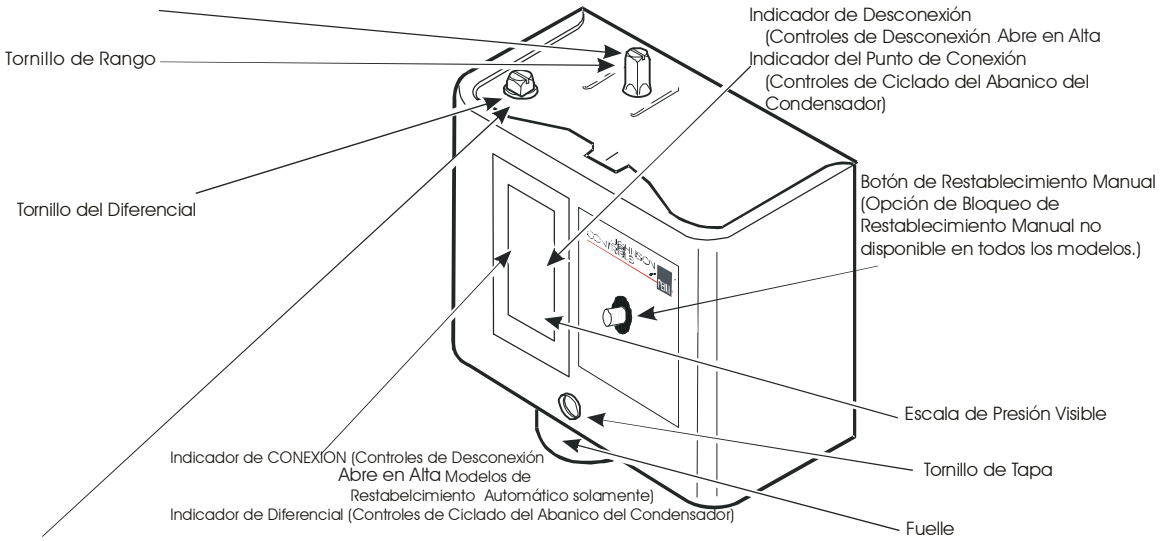
IMPORTANTE: No ajuste los indicadores más allá de las marcas mas alta o mas baja del indicador en la escala de presión del control. El ajuste de los indicadores más allá de éstas marcas puede dañar los hilos del tornillo y resultar en una operación incorrecta del control.

IMPORTANTE: Use los ajustes de control de presión recomendados por el fabricante del equipo que va a ser controlado. No exceda las clasificaciones de presión del equipo controlado ni de cualquiera de sus componentes al verificar la operación de control de la presión o al operar el equipo controlado.

Paso 1. Establezca evento alto ajustado el tornillo de rango

Controles de Desconexión de Presión Alta: Gire el tornillo hacia la derecha para incrementar el punto de DESCONEXION

Controles de Ciclado del Albanico del Condensador: Gire el tornillo hacia la derecha para disminuir el punto de DESCONEXION.



Paso 2. Ajuste del Tornillo del Diferencial.

Controles de Desconexión de Presión Alta: Girar el tornillo del diferencial cambia el punto de CONEXION.

(Solo modelos de Auto-Restablecimiento) Girar el Tornillo hacia la derecha para disminuir el punto de CONEXION.

Controles de Ciclado del Abanico del Condensador: Girar el tornillo del diferencial cambia el ajuste del diferencia.

Girar el tornillo hacia la derecha para incrementar el DIFERENCIAL.

Figura 8: Ajuste de Controles P70, P72 y P170 para Aplicaciones de Presión Alta

IMPORTANTE: Después de montar y alambrar el control, instale un juego de medidores confiables al equipo controlado, y opere el equipo (por lo menos) tres ciclos bajo las presiones necesarias para verificar los puntos de ajuste del control y la operación del equipo apropiada.

Operación de Restablecimiento Manual

Los controles de presión con la opción de Restablecimiento Manual se bloquean cuando se alcanzan la presión de Desconexión y deben restablecerse manualmente por el usuario para reiniciar el equipo controlado. El mecanismo de restablecimiento manual **de movimiento libre** y no puede restablecerse al bloquear o sujetar el botón de restablecimiento.

En equipo con los controles bloqueados, determine y resuelva la razón del bloqueo, y permita que la presión detectada caiga por lo menos 70 psig más abajo del punto de ajuste de Desconexión. Después, presione y suelte el botón de restablecimiento que se localiza al frente del control para restablecer la operación del equipo controlado.

Table 2: Modelos de Control Estándar P70, P72 y P170 para Aplicaciones de Presión Alta

Número del Modelo	Acción del Interruptor	Rango psig (kPa)	Diferencial psi (kPa)	Conexión de Presión
Modelos de Control de Ciclado del Abanico del Condensador (para Refrigerantes No Corrosivos)				
P70AA-118	SPST Abre en baja	100 a 400 psig (690 a 2758)	Mínimo 35 (241) Máximo 200 (1379)	Capilar de 36 pulg. con Tuerca Abocinada de 1/4 pulg.
P70AA-2		0 a 150 psig (0 a 1034)	Mínimo 12 (83) Máximo 70 (482)	
P72AA-27	DPST Abre en baja	100 a 400 psig (690 a 2758)	Mínimo 35 (241) Máximo 200 (1379)	
P170AA-118	SPST Abre en baja			Conector Abocinado Macho de 1/4 pulg.
Modelos de Control de Todo Rango (para Refrigerantes No Corrosivos)				
P70CA-2*	SPST Abre en Alta	50 a 500 psig (345 a 3448)	Mínimo 60 (414) Máximo 150 (1034)	Conector Abocinado Macho de 1/4 pulg.
P70CA-3*				Capilar de 36 pulg. con Tuerca Abocinada de 1/4 pulg.
P70DA-1*			Restablecimiento Manual	
P70KA-1*	4-Alambres, 2-Circuitos Línea-M1 Cierra en Alta Línea-M2 Abre en Alta			
P72CA-2*	DPST Abre en Alta		Mínimo 60 (414) Máximo 150 (1034)	
P72DA-1*			Restablecimiento Manual	
P170CA-3*	SPST Abre en Alta		Mínimo 60 (414) Máximo 150 (1034)	Conector Abocinado Macho de 1/4 pulg.
P170DA-1*			Restablecimiento Manual	
P170KA-1*	4-Alambres, 2-Circuitos Línea-M1 Cierra en Alta Línea-M2 Abre en Alta			
Modelos Compatibles con Amoníaco				
P70AA-119	SPST Abre en Baja	50 a 300 psig (345 a 2068)	Mínimo 20 (138) Máximo 120 (827)	NPT Hembra de Acero Inoxidable de 1/4 pulg.
P70CA-5*	SPST Abre en Alta	50 a 500 psig (345 a 3448)	Mínimo 60 (414) Máximo 150 (1034)	
P70DA-2*			Restablecimiento Manual	

* Modelos que son listados por UL como controles de límite de presión de refrigeración.

Nota: Ver *Dimensiones y Especificaciones Técnicas* para mayor información del modelo que incluye la Presión Operacional Máxima y las clasificaciones de la Máxima Sobrepresión.

Clasificaciones Eléctricas

Tabla 3: Clasificaciones Eléctricas SPST (Modelos P70A, B, C, D, y P170A, B, C, D)

	Clasificaciones de Motores Monofásicos Estándares					Clasificaciones para Compresor Hermético Monofásico
	120 VCA	**208 VCA**	**240 VCA**	***480 VCA**	***600 VCA**	**208/240 VCA**
Amperios del Motor con Carga Completa	20	18.7	17	5	4.8	20
Amperios del Motor con el Rotor Bloqueado	120	112.2	102	30	28.8	120
Amperios No Inductivos	22	22	22	--	--	--
Servicio Piloto	125 VA de 120 de 600 VCA; 57.5 VA de 120 a 300 VCD					

* No es para cargas de motores de compressores.

Tabla 4: Clasificaciones Eléctricas del Interruptor de Diferencial Estándar (Modelos P70E)

	Clasificaciones de Motores Monofásicos Estándares			
	120 VCA	**208 VCA**	**240 VCA**	**277 VCA***
Amperios del Motor con Carga Completa	16.0	9.2	8.0	7.0
Amperios del Motor con el Rotor Bloqueado	96.0	55.2	48.0	42.0
Amperios No Inductivos	16.0	16.0	16.0	16.0
Servicio Piloto	125 VA de 120 hasta 600 VCA			125 VA de 24 hasta 600 VCA

* Clasificaciones para modelos P70EC solamente

Tabla 5: Clasificaciones Eléctricas de 4 Alambres – 2 Circuitos (Modelos P70G, H, J, K, y P170K)

	Clasificaciones de Motores Monofásicos Estándares									
	Línea-M2 (Contactos Principales)						Línea-M1 (Contactos Auxiliares)			
	120 VCA	**208 VCA**	**240 VCA**	**277 VCA**	***480 VCA**	***600 VCA**	**120 VCA**	**208 VCA**	**240 VCA**	**277 VCA**
Amperios del Motor con Carga Completa	16.0	9.2	8.0	--	5	4.8	6.0	3.3	3.0	--
Amperios del Motor con el Rotor Bloqueado	96.0	55.2	48.0	--	30	28.8	36.0	19.8	18.0	--
Amperios No Inductivos	16.0	9.2	8.0	7.2	--	--	6.0	6.0	6.0	6.0
Servicio Piloto (para ambos juegos de contactos	125 VA de 24 a 600 VCA; 57.5 VA de 120 a 300 VCD									

* No para cargas de motor de compresor

Tabla 6: Clasificaciones Eléctricas DPST (Modelos P72A, B, C y D)

	Clasificaciones Estándares							Rangos del Compresor Hermético	
	120 VCA 1Ø	208 VCA 1Ø	240 VCA 1Ø	208 VCA 3Ø	220 VCA 3Ø	*480 VCA 1Ø	*600 VCA 1Ø	208 VCA 1Ø	240 VCA 1Ø
Amperios del Motor con Carga Completa	24	18.7	17	15.9	15	5	4.8	24	24
Amperios del Motor con el Rotor Bloqueado	144	112.2	102	95.4	90	30	28.8	144	144
Amperios No Inductivos CA	24	24	24	24	24	--	--	--	--
Amperios No Inductivos CD	3	0.5	0.5	0.5	0.5	--	--	--	--
Servicio Piloto	125 VA de 120 a 600 VCA; 57.5 VA de 120 a 300 VCD								

* No es para cargas del motor de compresor

Especificaciones Técnicas

Producto	Controles P70, P72 y P170 para Aplicaciones de Alta Presión			
Acción del Interruptor	P70, P170: SPST; 4-Alambres/2-Circuitos; o Interruptor SPDT PENN®		P72: DPST	
Conexión de Presión	Modelos Estándares P70, P72 disponibles con varias conexiones.	Modelos Estándares P170, conector macho abocinado de 1/4 pulg. SAE	Modelos Compatibles con Amoníaco 1/4 pulg. NPT conexión hembra de acero inoxidable	
Máxima Presión Operacional	para rango 0-150 psig: 150 psig (1034 kPa)	para rango 50-300 psig: 300 psig (2068 kPa)	para rango 100-400 psig: 400 psig (2758 kPa)	para rango 50-500 psig: 500 psig (3448 kPa)
Máxima Sobrepresión (non-recurrente)	para rango 0-150 psig: 525 psig (3620 kPa)	para rango 50-300 psig: 400 psig (2758 kPa)	para rango 100-400 psig: 475 psig (3275 kPa)	para rango 50-500 psig: 525 psig (3620 kPa)
Condiciones Ambientales	Tipos P70E y P70F: 50 a 104°F (10 a 40°C) Todos los Otros Modelos: -40 a 140°F (-40 a 60°C)			
Caja y Tapa	Caja NEMA 1: Caja de acero galvanizado; tapa de acero cromado y pintado. Caja NEMA 3R: Caja y tapa de acero cromado y pintado.			
Dimensiones (A x A x P)	Caja NEMA 1: 3-1/4 x 4 x 2-1/16 pulg. (83 x 101 x 53 mm) Caja NEMA 3R: 4-1/16 x 4-1/16 x 2-15/16 pulg. (104 x 104 x 74 mm)			
Peso de Embarque Aproximado	Empaque Individual (NEMA 1): 2.4 lb (1.08 kg); Empaque Múltiple (NEMA 1, multiplos de 25 controls): 60 lb (27.2 kg)			
Listados de Agencias	Para información sobre modelos especificos, contacte al Grupo de Ingeniera de Aplicación de Refrigeración a 1-800-275-5676.			
Accesorios	Soporte de Instalación Universal 271-51 (provisto con controles estándares)			

Las especificaciones del desempeño son nominales y de acuerdo a estándares aceptables de la industria. Para aplicación en condiciones que estén fuera de éstas especificaciones, contácte al Grupo de Ingeniería de Aplicación de Refrigeración al 1-800-275-5676. Johnson Controls, Inc. no será responsable de daños que resulten de una aplicación incorrecta o un mal uso de su productos.

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Instruction Sheet
PA-00266
June 2006

B Series
Balanced-Port Thermal Expansion Valves

Installation & Service Instructions

Safety Instructions

Warning: Before opening any system, make sure the pressure in the system is brought to and remains at atmospheric pressure. Use approved refrigerant recovery methods when necessary. Failure to comply can result in system damage and/or personal injury.

1, Read installation instructions thoroughly. Failure to follow instructions may result in valve failure, system damage, or personal injury.

2. Do not use on service conditions or fluids not specifically cataloged, without prior written approval of the Emerson Climate Technologies Engineering Department. Use of Thermal valves on applications not specifically cataloged can result in valve failure and/or system damage.

3. Protect against excessive vibration, it may cause a tubing break, which will cause valve failure and/or personal injury

4. On valves with solder connections, **wrap wet cloths around** valve. Direct torch away from valve to avoid valve damage.

5. Do not exceed maximum working pressure of 450 psig. - excess internal pressure could cause damage to diaphragm, resulting in valve malfunction.

6. Do not exceed maximum working temperature (see Table 1) - excess temperatures could cause internal damage, resulting in valve malfunction.

TABLE 1
Maximum Dehydration Temperature °F

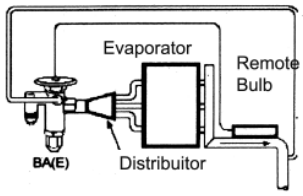
	THERMOSTATIC CHARGE		
REFRIGERANT	C	Z	WMOP/CA
R12	190	250	250
R22	160	185	250
R502	150	170	250

This Table refers to the maximum dehydration temperatures when the bulb and valve body are subjected to the same temperature. On L, C, and Z charges, 250°F maximum valve body temperature is permissible (**if the bulb temperature**) does not exceed those shown in the table.

Installation Instructions

1. Warning: Before opening any system, make sure the pressure in the system is brought to and remains at atmospheric pressure. Use approved refrigerant recovery methods when necessary. Failure to comply can result in system damage and/or personal injury.

2. Valves may be installed in any position, but should be located as close as possible to the distributor or evaporator inlet.

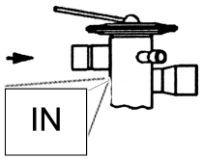


3. Foreign matter in the Thermal valve may cause diaphragm failure, flooding, or starving of the valve. Use of an Emerson liquid line filter-drier is strongly recommended.

4. Valves are factory set to a specific superheat. If adjustment is needed, refer to Superheat Adjustment section for proper procedure. Improper adjustment of superheat can result in system damage.

5. Proper valve sizing is important. An oversized valve may result in erratic control. An undersized valve considerably reduces system capacity.

6. Be sure valve is installed with its flow arrow corresponding to the flow direction thru the piping.



Instruction Sheet
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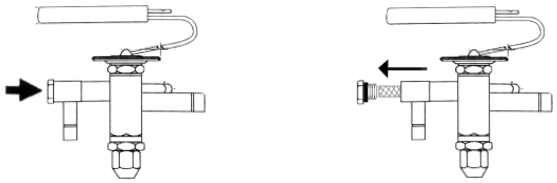
June 2006

B Series
Balanced-Port Thermal Expansion Valves

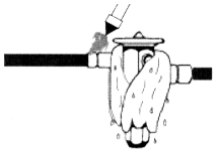
Installation & Service Instructions

7. **For BA(E)S, BN(E)S Valves**, remove strainer nut and strainer before brazing. Replace strainer nut.



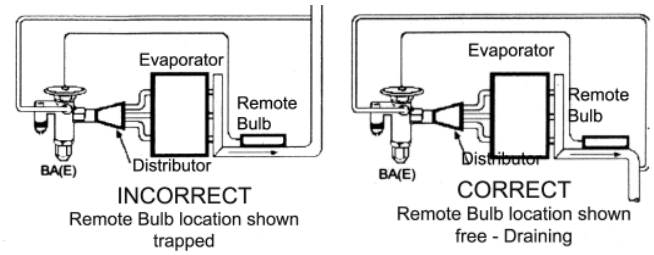
NOTE: For improve the quality of our valve, we use a neopreon Oring in the strainer nut, the brazing heat would produce extreme damage in the piece.

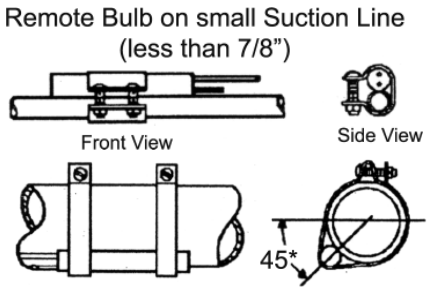
8. Installing connections to valve. an valves with solder connections, wrap wet cloths around valve. to prevent valve damage while brazing. Direct torch away from valve.



9. To replace strainer, remove strainer nut and install new strainer. Replace nut and torque nut to 50 inch pounds.

10. Attach the remote bulb to the suction line as close to the evaporator outlet as possible. Position the bulb at the 4 or 8 o'clock position. Clean surface of suction line where the remote bulb is to be attached, then securely fasten the bulb with straps provided. If the remote bulb can be affected by the surrounding ambient, then the bulb should be insulated with a material that will not absorb water.





11. Connect one end of the external equalizer line to the valve. Connect the other end to the suction line slightly downstream from the remote bulb location and positioned so that it cannot siphon oil from the suction line.

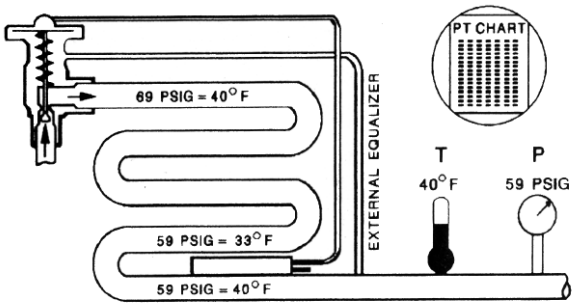
12. Check for leaks, sufficient system refrigerant charge, and be sure no flash gas is present before attempting to check valve operation.

13. The expansion valve must be free of all contaminants - install an Emerson Climate Technologies liquid line filter-drier before the valve.

Measuring Superheat

1. Determine the suction pressure with an accurate gauge at the evaporator outlet.

$TEMP_T - TEMP_P = SUPERHEAT$
$40° - 33° = 7°$



On self-contained systems, the suction pressure may be read at the compressor suction connection

2. From refrigerant pressure-temperature tables, determine saturation temperature at observed suction pressure (TEMP p).

3. Measure temperature of suction gas at Thermo Valve remote bulb location (TEMPT).

4. Subtract saturation temperature (read from tables in step 2) from temperature measured in step 3, the difference is the superheat of the suction gas.

EMERSON
Climate Technologies

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Instruction Sheet
PA-00266
June 2006

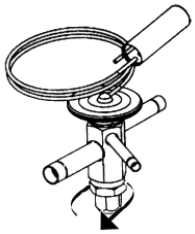
B Series
Balanced-Port Thermal Expansion Valves

Installation & Service Instructions

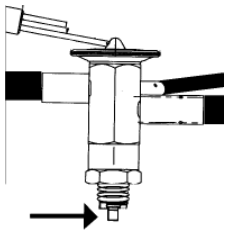
Superheat Adjusment

Emerson's Thermal valves are factory set to a specific superheat - however, the superheat should be adjusted for the application. To adjust the valve to other superheat settings:

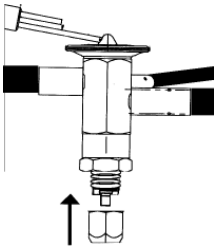
1. Remove the seal cap from bottom of valve.

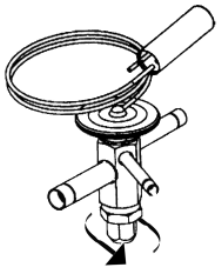


2. Turn the adjustment screw clockwise to increase superheat and counterclockwise to decrease superheat. One complete 360* turn changes the superheat approximately 3-4°F, regardless of the refrigerant type. As much as 30 minutes may be required for the system to stabilize after the adjustment is made.



3. Replace and hand-tighten seal cap.





Caution: There are 10 turns on the adjustment stem. When adjusting superheat setting - when stop is reached, any further turning adjustment will damage valve.

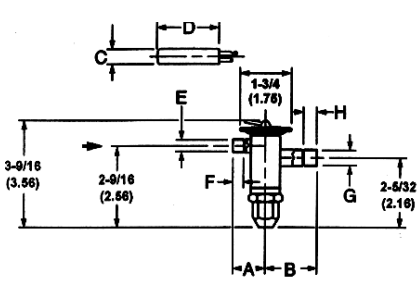
Nomenclature Selection

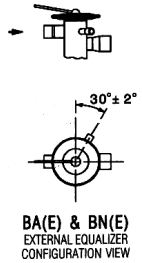
B	A	E	S	1/2	HCA	ODF	5'
Valve Type	Style A = Adjustable N = Non-Adjustable	Externally Equalized (omit for internal)	Removable Strainer (optional)	Capacity Tons	Charge H = R22 M = R134a S = R404A P = R507	Connection ODF Angle	Cap Tube 30" Standard or 5' Optional

Dimesional Data

BA(E) DIMENSIONAL DATA

TYPE	INLET	OUTLET	A	B	E	F	G	H
BA(E) STRAIGHT THRU ODF	1/4	3/8	1-45/64(1.70)	1-47/64(1.73)	1/4(.25)	5/16(.31)	3/8(.38)	5/16(.31)
	3/8	3/8	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	3/8(.38)	5/16(.31)
	3/8	1/2	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	1/2(.50)	3/8(.38)
	1/2	1/2	1-47/64(1.73)	1-47/64(1.73)	1/2(.50)	3/8(.38)	1/2(.50)	3/8(.38)
	1/2	5/8	1-47/64(1.73)	1-3/4(1.75)	1/2(.50)	3/8(.38)	5/8(.63)	1/2(.50)
	5/8	5/8	1-3/4(1.75)	1-3/4(1.75)	5/8(.63)	1/2(.50)	5/8(.63)	1/2(.50)
	1/4	5/8	1-45/64(1.70)	1-3/4(1.75)	1/4(.25)	5/16(.31)	5/8(.63)	1/2(.50)
	3/8	5/8	1-47/64(1.73)	1-3/4(1.75)	3/8(.38)	5/16(.31)	5/8(.63)	1/2(.50)
	1/4	1/2	1-45/64(1.70)	1-47/64(1.73)	1/4(.25)	5/16(.31)	1/2(.50)	3/8(.38)
	1/2	7/8	1-47/64(1.73)	1-47/64(1.73)	1/2(.50)	3/8(.38)	7/8(.88)	3/4(.75)
	3/8	7/8	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	7/8(.88)	3/4(.75)
	5/8	7/8	1-3/4(1.75)	1-47/64(1.73)	5/8(.63)	1/2(.50)	7/8(.88)	3/4(.75)





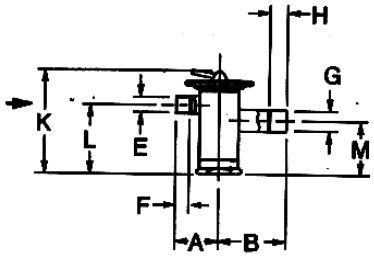
BA(E) & BN(E)
EXTERNAL EQUALIZER
CONFIGURATION VIEW

BA(E) & BN(E) Remote Bulb Dimensions

REFRIGERANT CHARGE	D LENGTH	C DIAMETER
HCA, NCA, HAA	2-5/16(2.31)	3/4(.75)
MC, MZ, MW (MOP), RW (MOP) RC, SC, SZ, SW (MOP), PC, PZ, PW (MOP)	2-3/32(2.09)	1/2(.50)

BN(E) DIMENSIONAL DATA

TYPE	INLET	OUTLET	A	B	E	F	G	H
STRAIGHT THRU ODF	1/4	3/8	1-45/64(1.70)	1-47/64(1.73)	1/4(.25)	5/16(.31)	3/8(.38)	5/16(.31)
	3/8	3/8	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	3/8(.38)	5/16(.31)
	3/8	1/2	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	1/2(.50)	3/8(.38)
	1/2	1/2	1-47/64(1.73)	1-47/64(1.73)	1/2(.50)	3/8(.38)	1/2(.50)	3/8(.38)
	1/2	5/8	1-47/64(1.73)	1-3/4(1.75)	1/2(.50)	3/8(.38)	5/8(.63)	1/2(.50)
	5/8	5/8	1-3/4(1.75)	1-3/4(1.75)	5/8(.63)	1/2(.50)	5/8(.63)	1/2(.50)
	1/4	5/8	1-45/64(1.70)	1-3/4(1.75)	1/4(.25)	5/16(.31)	5/8(.63)	1/2(.50)
	3/8	5/8	1-47/64(1.73)	1-3/4(1.75)	3/8(.38)	5/16(.31)	5/8(.63)	1/2(.50)
	1/4	1/2	1-45/64(1.70)	1-47/64(1.73)	1/4(.25)	5/16(.31)	1/2(.50)	3/8(.38)
	1/2	7/8	1-47/64(1.73)	1-47/64(1.73)	1/2(.50)	3/8(.38)	7/8(.88)	3/4(.75)
	3/8	7/8	1-47/64(1.73)	1-47/64(1.73)	3/8(.38)	5/16(.31)	7/8(.88)	3/4(.75)
	5/8	7/8	1-3/4(1.75)	1-47/64(1.73)	5/8(.63)	1/2(.50)	7/8(.88)	3/4(.75)



EMERSON
Climate Technologies

11911 Adie Road P.O. Box 411400 St. Louis MO 63141 USA CUSTOMER SERVICE (314) 569-4666

Instruction Sheet
PA-00266
June 2006

B Series
Balanced-Port Thermal Expansion Valves

Installation & Service Instructions

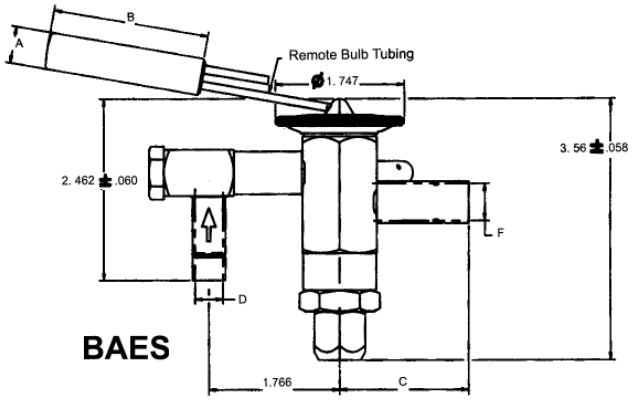
Dimesional Data

BAES/BNES Dimensional Data

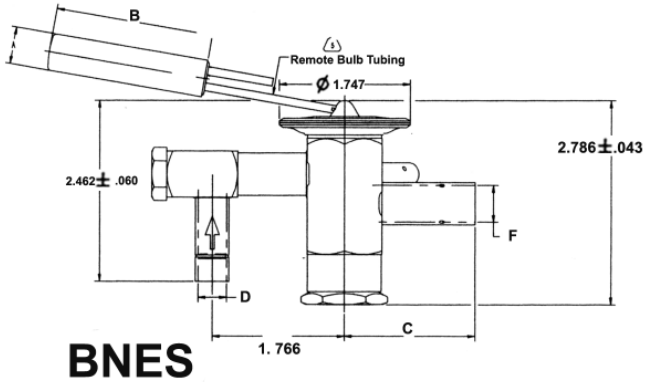
ODF CONNECTIONS, ANGLE STYLE ONLY

CONNECTIONS				
ODF INLET	ODF OUTLET	C	D	F
1/4"	3/8"	1.734	.254	.379
1/4"	1/2"	1.734	.254	.504
1/4"	5/8"	1.750	.254	.629
3/8"	3/8"	1.734	.379	.379
3/8"	1/2"	1.734	.379	.504
3/8"	5/8"	1.750	.379	.629
3/8"	7/8"	1.734	.379	.879
1/2"	1/2"	1.734	.504	.504
1/2"	5/8"	1.750	.504	.629
1/2"	7/8"	1.734	.504	.879

DIMENSIONS SHOWN ARE IN INCHES.



BAES



BNES

Remote Bulb Tubing Length
30" or 5' Standard

BAES & BNES Remote Bulb Dimensions		
	A	B
REFRIGERANT CHARGE	Diameter	Length
HCA, NCA, HAA	3/4 (.75)	2 3/8 (2.38)
MC, MZ, MW (MOP), RW (MOP) RC, SC, SZ, SW (MOP), PC, PZ, PW (MOP)	1/2 (.50)	2 1/8 (2.13)

Application & Operation

The BA(E) valve is currently replacing conventional TXV's on air conditioning and refrigeration systems with any combination of the following system operating conditions:

1. Widely varying evaporator loads

2. Widely varying head pressures

3. Widely varying pressure drop available across the thermostatic expansion valve and refrigerant distributor

4. Fluctuating or extremely low liquid temps.

Severe conditions are those which drastically increase a conventional expansion valve's maximum capacity: high head pressures for example, also, low liquid temperatures that would be experienced on a system with mechanical sub coolers during summer operation. BA(E) high system performance is possible because the large diaphragm allows the valve to operate with the valve pin controlling very close to the seat. This provides, stable control at minimum changes in stroke, enabling a large port to handle small loads.

Problems can occur with refrigeration systems during both high and low ambient conditions when the condensing temperature is allowed to follow the ambient. As the evaporator temperature remains reasonably constant, this results in extreme pressure drop changes across the valve. These pressure drop changes can result in a conventional valve not maintaining a constant superheat at the evaporator outlet. These superheat changes can result in the evaporator starving in low ambient conditions and flooding in the higher ambient, depending on the valve design. Another variable factor for this situation is how low the head pressure is allowed to decrease. This of course depends on whether heat reclaim is utilized for heating purposes, or if hot gas will be used for evaporator defrost.

Emerson's BA(E) Thermal Expansion Valves are designed to meet the specific demands of refrigerated display cases, reach-in & walk-in coolers and freezers, and **commercial applications ranging from medium (+50°F)to low(-50°F) temperature**, with proper charge.

EMERSON
Climate Technologies

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TRAE+ Balanced Port Thermal Expansion Valve Cage

SAFETY INSTRUCTIONS

Warning: Before opening any system, make sure the pressure in the system is brought to and remains at atmospheric pressure. Use approved refrigerant recovery methods when necessary. Failure to comply can result in system damage and/or personal injury.

1. Read installation instructions thoroughly. Failure to follow instructions may result in valve failure, system damage, or personal injury.
2. Do not use on service conditions or fluids not specifically cataloged, without prior written approval of the Emerson Climate Technologies Flow Controls Division Applications Engineering Department. Use of thermal expansion valves on applications not specifically cataloged can result in valve failure and/or system damage.
3. Protect against excessive vibration. If may cause a tubing break which will cause valve failure and/or personal injury.
4. Do not exceed maximum working pressure of 450 psig - excess internal pressure could cause damage to diaphragm, resulting in valve malfunction.
5. Do not exceed maximum working temperature (see table 1) - excess temperature could cause internal damage, resulting in valve malfunction.
6. **Warning**: Do not place open flame on or near remote bulb.

NOMINAL CAPACITIES			
R-134a Valve Type	**R-22/R-407C Valve Type**	**R-507/R-404A Valve Type**	**Cage Kit**
TRAE9M*	TRAE10H*	TRAE8*	KT20289
TRAE13M	TRAE15H	TRAE12	KT20290
TRAE14M	TRAE20H	TRAE14	KT20291
TRAE22M	TRAE30H	TRAE20	KT20292
TRAE30M	TRAE40H	TRAE30	KT20293

* Select correct charge code.
Cage Wrench KR20294
Kit Includes:

- Cage
- Cage Wrench
- Instruction Sheet

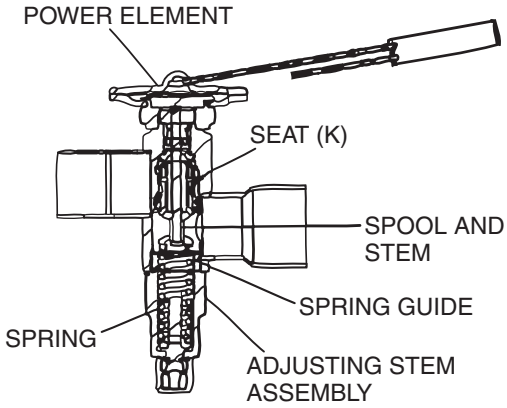
TABLE 1
Maximum Dehydration Temperature °F

	THERMOSTATIC CHARGE		
REFRIGERANT	**C**	**Z**	**WMOP/CA**
R12	190	250	250
R22	160	185	250
R502	150	170	250

This Table refers to the maximum dehydration temperatures when the bulb and valve body are subjected to the same temperature. On L, C, and Z charges, 250°F maximum valve body temperature is permissible (**if the bulb temperature**) does not exceed those shown in the table.

CAGE REPLACEMENT INSTRUCTIONS

1. Before removing superheat adjustment assembly, make sure system is at atmospheric pressure using EPA approved methods. Failure to comply can result in system damage or personal injury.
2. Remove superheat adjustment assembly, superheat spring and spring guide. Care must be taken not to damage threads or surface area.
3. Remove spool and stem assembly.
4. Using KT20294 toll provided, remove seat turning in a counter clockwise direction.
5. Remove spool and stem assembly from new cage before installing seat in valve.
6. Before installing seat, ensure there is no foreign material inside valve or on seat.
7. Lightly oil all seals with same type oil that is in system.
8. Carefully install seat taking care not to damage seals or threads. Torque cage 60 to 64 inch pounds.
9. Reinstall spool and stem assembly.
10. Reassemble spring guide superheat spring and adjustment assembly. Torque assembly 400 to 425 inch pounds.
11. Before restarting system, turn adjustment stem counter clockwise until it stops. Then turn clockwise 6 full turns. This will be close to factory superheat setting.
12. Leak check valve.
13. Adjust superheat to manufacturers' recommendations.



SPOOL AND STEM ASSEMBLY SEAT

REPLACEMENT PARTS	
Part #	**Description**
X-28458	Power Assembly
KT20294	Cage Removal Tool
27676-1	Seal Cap

MEASURING SUPERHEAT

1. Determine the suction pressure with an accurate gauge at the evaporator outlet (see P in figure 2). On self-contained systems, the suction pressure may be read at the compressor suction connections.
2. From refrigerant pressure-temperature tables, determine saturation temperature at observed suction pressure ($TEMP_P$).
3. Measure temperature of suction gas at thermal expansion valve remove bulb location ($TEMP_T$).
4. Subtract saturation temperature (read from tables in step 2) from temperature measured in step 3; the difference is the superheat of the suction gas.

SUPERHEAT ADJUSTMENT

Emerson thermal expansion valves are factory set to a specific superheat - however, the superheat should be adjusted for the application. To adjust the valve to other superheat settings:

1. Remove the seal cap from bottom of valve.
2. Turn the adjustment screw clockwise to increase superheat and counterclockwise to decrease superheat. One complete 360° turn changes the superheat approximately 3-4°F, regardless of the refrigerant type. As much as 30 minutes may be required for the system to stabilize after the adjustment is made.
3. Replace and hand-tighten seal cap.

Caution: There are 12 turns on the adjustment stem. When adjusting superheat setting - when stop is reached, any further turning adjustment will damage valve.

$TEMP_T$ – $TEMP_P$ = SUPERHEAT
40° – 33° = 7°

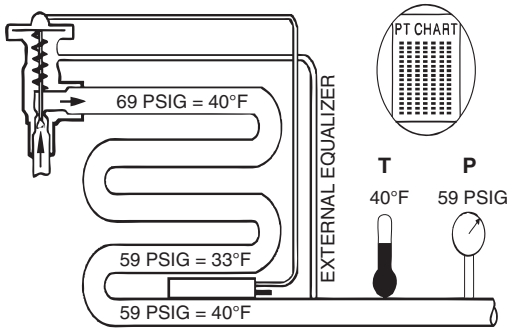


FIGURE 2

TX6
Thermo Expansion Valves
Technical Data

ALCO's TX6 series of Thermo®-Expansion Valves are designed for air conditioning, chillers, rooftops, close control, A/C transportation, heat pumps, industrial cooling process and refrigeration applications. The TX6 is ideal for those applications requiring hermetic / compact size combined with stable and accurate control over wide load and evaporating temperature ranges.

TX6

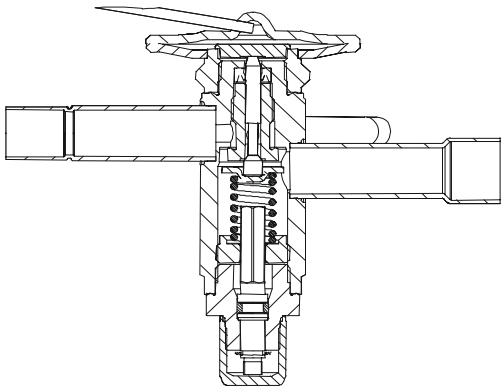
Features

- Balance port construction for constant superheat operation over a wide application range under variation of condensing pressure
- Six sizes up to 97 kW (R410A)
- Compact size
- Hermetic design
- Brazing connections with straight through configuration
- Long life laser welded stainless steel power element resists corrosion
- Large diaphragm eliminates disturbances to the valve and provides smoother and consistent valve control
- Tailored charges for different applications
- External equalizer
- External superheat adjustment
- Brass body

Introduction

Thermo®-Expansion Valves control the superheat of refrigerant vapour at the outlet of the evaporator. They act as a throttle device between the high and low pressure sides of refrigeration system and ensure the rate of refrigerant flow into the evaporator exactly matches the rate of evaporation of liquid refrigerant. Thus the evaporator is fully utilized and no liquid refrigerant may reach the compressor.

When the actual superheat is higher than the setpoint, thermo® expansion valve feeds the evaporator with more liquid refrigerant. Likewise, the valve decreases the refrigerant flow to the evaporator when the actual superheat is lower than the set point.



Construction

The valve body is made from brass, the connections are in a straight through configuration. The diaphragm movement is transferred to a steel metering pin. When the charge pressure increases, the diaphragm will be deflected downward and this motion will be transferred to the pin. The pin will then lift from seat and the liquid can pass through orifice.

The pin design gives the balance port feature. Balance port design will eliminate the undesirable variable influence of inlet pressure i.e. condensing pressure during different air ambient temperature in systems with aircooled condenser.

The balance port design is only available in one direction as arrow indicates on the valve. This means, when the valve operates as Bi-flow in heat pump applications, the advantage of balance port is given in cooling or heating mode.

A spring opposes the force underneath the pin and its tension can be adjusted by the external stem. The static superheat can be adjusted by rotation of the stem. Static superheat increases by turning the stem clockwise and decreased by turning the stem counter clockwise.

Description of bulb charges

The application ranges of Thermo® expansion valves are heavily influenced by the selected charge.

Liquid charges

The behaviour of Thermo®-Expansion Valves with liquid charges is exclusively determined by temperature changes at the bulb and not subject to any cross-ambient interference. They feature a fast

response time and thus react quickly in the control circuit. Liquid charges **cannot incorporate MOP functions.** The maximum bulb temperatures is limited and shall not exceed the values, shown in the following table:

Table 1:

Refrigerant/Charge	Maximum bulb temperature
R 134a / M0	88°C
R 407C / N0	71°C
R 22 / H0	71°C

Gas charges

The behaviour of Thermo®-Expansion Valves with gas charges will be determined by the lowest temperature at any part of the expansion valve (power assembly, capillary tube or bulb). If any parts other than the bulb are subject to the lowest temperature, malfunction of the expansion valve may occur (i.e. erratic low pressure or excessive superheat). ALCO TX6 with gas charges **always feature MOP functions** and include ballasted bulbs. Ballast in the bulb leads to slow opening and fast closure of the valve. Maximum bulb temperature is 120°C.

MOP (Maximum Operating Pressure)

MOP functionality is somewhat similar to the application of a crankcase pressure regulator.

Evaporator pressures are limited to a maximum value to protect compressor from overload conditions.

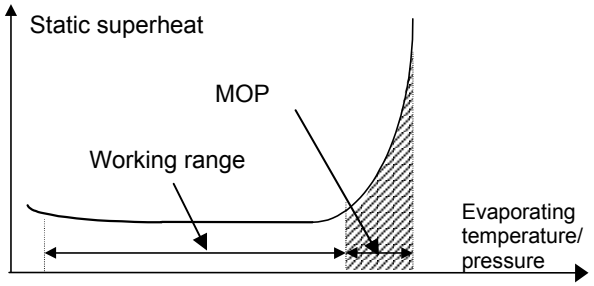
MOP selection should be within maximum allowed low pressure rating of the compressor and should be at approximately 3 K above maximum evaporating temperature.

Table 2: MOP value, gas charge

MOP			Upper limit of evaporating temperature **°C**			
Code	bar	°C	R407C	R22	R 410A	R134a
N1	6.9	+17	+14	-	-	-
H1	6.9	+15	-	+12	-	-
M1	3.8	+14	-	-	-	+10
Z1	12.1	+16			+14	

Note: All pressures are gauge pressure

Performance of TXV with MOP function, gas charge



Valve operates as superheat control in normal working range and operates as pressure regulator within MOP range.

Practical hints:

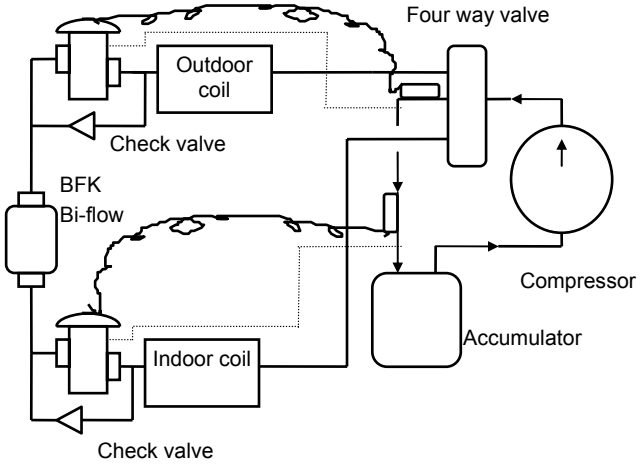
Superheat adjustments influence the MOP:

- Increase of superheat: decrease of MOP
- Decrease of superheat: increase of MOP

Heat pump applications

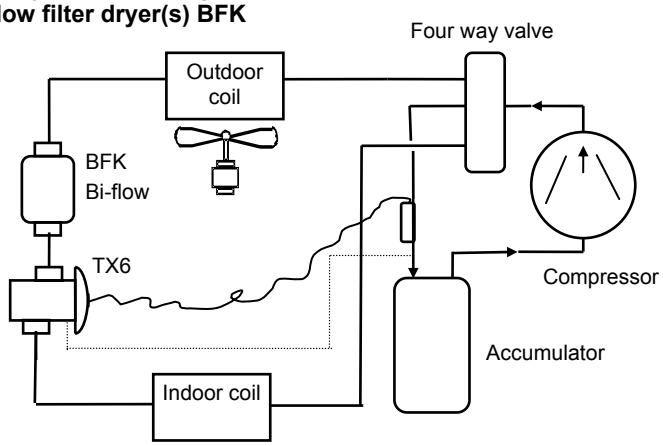
There are several ways to apply an expansion valve in a heat pump. The following figures are showing the most popular applications:

1) System with two expansion valves, single Bi-flow filter dryer and two check valves

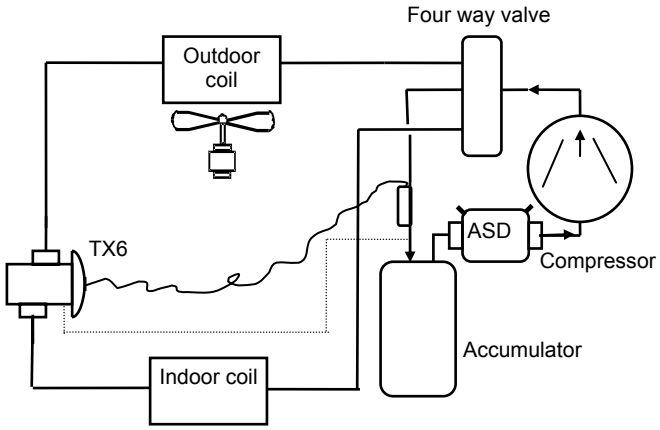


This type of system employs two expansion valves and two check valves. **In this type of application, it is recommended to locate the external equalizer and bulb on the suction line between reversing valve and suction accumulator (if available) or compressor as shown.**

2) System with single Bi-flow expansion Valve and Alco Bi-flow filter dryer(s) BFK



3) System with single Bi-flow expansion Valve and Alco suction filter dryer ASD

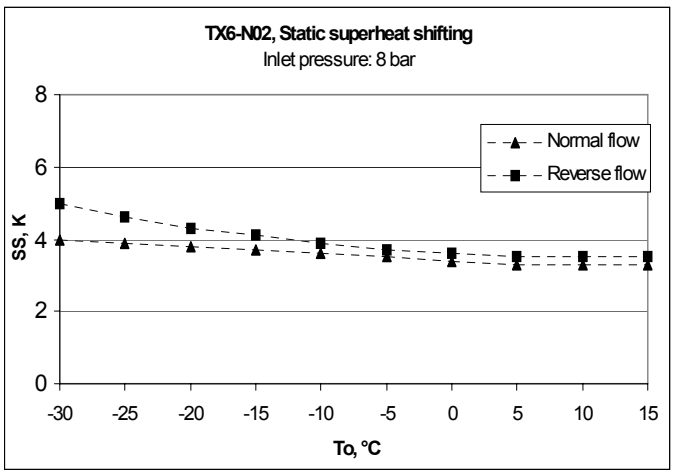


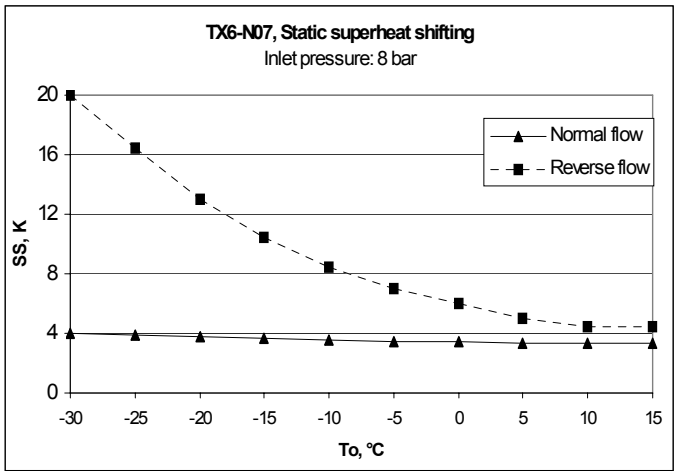
Bi-flow application

For application of TX6 in Bi-flow as single TXV in heat pumps, the following subjects need to be considered:

- TX6 is balance port only in normal flow direction but not in reverse flow direction
- Inlet pressure in reverse flow act on valve pin as closing force. This effect is more significant at higher inlet pressure and lower evaporating temperature
- This effect will prevent the valve from desired opening percentage in reverse flow dependant to port size of valve, inlet pressure and evaporating temperature

Based on the above facts, it is necessary to evaluate the selection of TX6 in Bi-flow application. The following curves and table are as guidance for proper selection of TX6 in BI-flow application.





Size of valve	Condition in reverse flow	Impact on operation of valve	Application of valve in Bi-flow	Consideration for performance improvement
Small port size (TX6-..2 /..3)	High or low operating inlet pressure	Negligible	Recommended	None
	High evaporating temperature	Negligible		
	Low evaporating temperature	Slightly increase of superheat		
Large port size (TX6-..4 /..5 /..6 /..7)	High or low operating inlet pressure	Increase of superheat	This needs to be evaluated *	- Lower system capacity in reverse vs. normal flow
	Higher evaporating temperature	Increase of superheat	This needs to be evaluated *	- Reduction of compressor capacity - Oversized valve
	Lower evaporating temperature	Significant increase of superheat	Not recommended	No solution

*) During system design and prototype unit test.

Other Subjects to be considered in Bi-flow applications:

- In an air to water (liquid) systems, it may require a receiver in order to hold excessive refrigerant in one mode of operation
- Do not install the Bulb of TXV between accumulator and compressor
- It is possible to install several Bi-flow filter dryers in parallel in system with larger capacity
- It is important to provide proper refrigerant distribution through liquid distributor at the inlet of evaporator due to distance between TXV and distributor

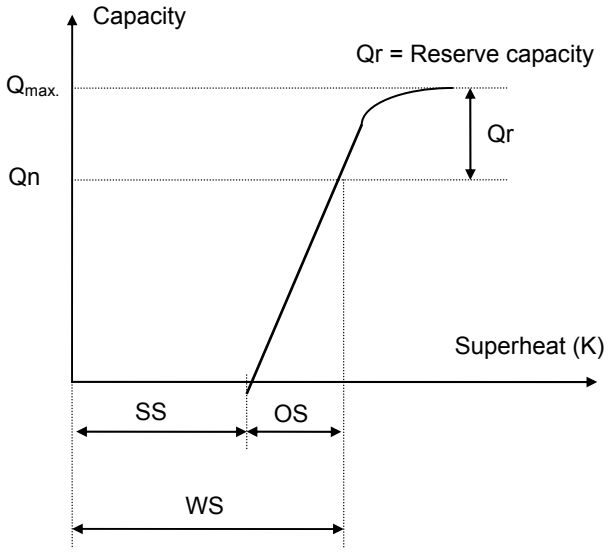
Static superheat setting

The factory setting of a TX6 is made with the valve pin just starting to move away from the seat. The superheat increment necessary to get the pin ready to move is called static superheat (SS). An increase of superheat over and beyond the static superheat (factory setting) is necessary for the valve pin to open to its rated capacity. This additional superheat is known as gradient or opening superheat (OS).

The working superheat (WS), which can be measured in the field, is the sum of static superheat and opening superheat.

The opening superheat of TXV varies if the selected valve operates at higher or lower capacities than the rated capacity. It is highly recommended to select the valve according to the rated capacity. Using reserve capacity leads to larger opening superheat and longer pull down time during start-up or after defrost.

Selecting a larger valve than required in a system may lead to smaller opening superheat and/or hunting of TXV.



Qr ≈ 15% for TX6-..2/3/4/5/6

Qr ≈ 10% for TX6-..7

Standard superheat setting

Charge	Refrigerant/ charge code	Refrigerant	Setting	Given	
			Bulb temperature	Nominal static superheat (SS)	Nominal opening superheat (OS*)
Liquid (no MOP)	M0	R 134a	0°C	3.3 K	3 K
	N0	R 407C			
	H0	R 22			
MOP 3.8 bar	M1	R 134a			
MOP 6.9 bar	N1	R 407C			
	H1	R 22			
MOP 12.1 bar	Z1	R 410A			

*) The given opening superheats valid when the capacity of selected valve is equal to the capacity of system at design / operating conditions. Note : All pressures are gauge pressure.

Nomenclature and identification

TX6 - N 1 7

Valve series

Refrigerant

- **N:** R407C
- **H:** R22
- **M:** R134a
- **Z:** R410A

Charge

- **0:** Liquid
- **1:** Gas MOP (see table 2, page 2)

Capacity size

- **2, 3, 4, 5, 6, 7** (see page 6 and 7)

Selection table

Refrigerant	Nominal capacity Qn	Without MOP		With MOP *)		Connection size	
	kW	Type	PCN	Type	PCN	Equalizer	Inlet x Outlet
	14.4	TX6-N02	801 651	TX6-N12	801 655	Ext. 1/4"	12mm x 16mm
	14.4	TX6-N02	801 653	TX6-N12	801 534	Ext. 1/4"	1/2" x 5/8"
	25.6	TX6-N03	801 652	TX6-N13	801 656	Ext. 1/4"	12mm x 16mm
	25.6	TX6-N03	801 654	TX6-N13	801 535	Ext. 1/4"	1/2" x 5/8"
	35.7	TX6-N04	801 659	TX6-N14	801 667	Ext. 1/4"	16mm x 22mm
	35.7	TX6-N04	801 663	TX6-N14	801 536	Ext. 1/4"	5/8" x 7/8"
R 407C	45.2	TX6-N05	801 660	TX6-N15	801 668	Ext. 1/4"	16mm x 22mm
	45.2	TX6-N05	801 664	TX6-N15	801 537	Ext. 1/4"	5/8" x 7/8"
	66.9	TX6-N06	801 661	TX6-N16	801 669	Ext. 1/4"	22mm x 28mm
	66.9	TX6-N06	801 665	TX6-N16	801 538	Ext. 1/4"	7/8" x 1-1/8"
	87.3	TX6-N07	801 662	TX6-N17	801 670	Ext. 1/4"	22mm x 28mm
	87.3	TX6-N07	801 666	TX6-N17	801 539	Ext. 1/4"	7/8" x 1-1/8"
	13.3	TX6-H02	801 551	TX6-H12	801 555	Ext. 1/4"	12mm x 16mm
	13.3	TX6-H02	801 549	TX6-H12	801 553	Ext. 1/4"	1/2" x 5/8"
	23.7	TX6-H03	801 552	TX6-H13	801 556	Ext. 1/4"	12mm x 16mm
	23.7	TX6-H03	801 550	TX6-H13	801 554	Ext. 1/4"	1/2" x 5/8"
	33.0	TX6-H04	801 585	TX6-H14	801 593	Ext. 1/4"	16mm x 22mm
R 22	33.0	TX6-H04	801 581	TX6-H14	801 589	Ext. 1/4"	5/8" x 7/8"
	41.8	TX6-H05	801 586	TX6-H15	801 594	Ext. 1/4"	16mm x 22mm
	41.8	TX6-H05	801 582	TX6-H15	801 590	Ext. 1/4"	5/8" x 7/8"
	61.9	TX6-H06	801 587	TX6-H16	801 595	Ext. 1/4"	22mm x 28mm
	61.9	TX6-H06	801 583	TX6-H16	801 591	Ext. 1/4"	7/8" x 1-1/8"
	80.8	TX6-H07	801 588	TX6-H17	801 596	Ext. 1/4"	22mm x 28mm
	80.8	TX6-H07	801 584	TX6-H17	801 592	Ext. 1/4"	7/8" x 1-1/8"
	10.3	TX6-M02	801 543	TX6-M12	801 547	Ext. 1/4"	12mm x 16mm
	10.3	TX6-M02	801 541	TX6-M12	801 545	Ext. 1/4"	1/2" x 5/8"
	18.4	TX6-M03	801 544	TX6-M13	801 548	Ext. 1/4"	12mm x 16mm
	18.4	TX6-M03	801 542	TX6-M13	801 546	Ext. 1/4"	1/2" x 5/8"
	25.6	TX6-M04	801 569	TX6-M14	801 577	Ext. 1/4"	16mm x 22mm
R 134a	25.6	TX6-M04	801 565	TX6-M14	801 573	Ext. 1/4"	5/8" x 7/8"
	32.5	TX6-M05	801 570	TX6-M15	801 578	Ext. 1/4"	16mm x 22mm
	32.5	TX6-M05	801 566	TX6-M15	801 574	Ext. 1/4"	5/8" x 7/8"
	48.1	TX6-M06	801 571	TX6-M16	801 579	Ext. 1/4"	22mm x 28mm
	48.1	TX6-M06	801 567	TX6-M16	801 575	Ext. 1/4"	7/8" x 1-1/8"
	62.8	TX6-M07	801 572	TX6-M17	801 580	Ext. 1/4"	22mm x 28mm
	62.8	TX6-M07	801 568	TX6-M17	801 576	Ext. 1/4"	7/8" x 1-1/8"
	16.0			TX6-Z12	801 510	Ext. 1/4"	12mm x 16mm
	16.0			TX6-Z12	801 511	Ext. 1/4"	1/2" x 5/8"
	28.0			TX6-Z13	801 512	Ext. 1/4"	12mm x 16mm
	28.0			TX6-Z13	801 513	Ext. 1/4"	1/2" x 5/8"
	40.0			TX6-Z14	801 514	Ext. 1/4"	16mm x 22mm
R 410A	40.0			TX6-Z14	801 515	Ext. 1/4"	5/8" x 7/8"
	50.0			TX6-Z15	801 516	Ext. 1/4"	16mm x 22mm
	50.0			TX6-Z15	801 517	Ext. 1/4"	5/8" x 7/8"
	74.0			TX6-Z16	801 518	Ext. 1/4"	22mm x 28mm
	74.0			TX6-Z16	801 519	Ext. 1/4"	7/8" x 1-1/8"
	97.0			TX6-Z17	801 520	Ext. 1/4"	22mm x 28mm
	97.0			TX6-Z17	801 521	Ext. 1/4"	7/8" x 1-1/8"

Nominal capacities at +38°C saturated condensing temperature, +4°C saturated evaporating temperature and 1 K subcooling at the inlet of the expansion valve. Valve selection for other operating conditions see pages 7 to 11.

*) See table 2 on page 2 for MOP values.

Dimensioning of Thermo®-Expansion Valves

To apply proper Thermo®-Expansion Valves on a system the following design conditions must be available:

- Cooling capacity Q_0
- Effective pressure differential across TXV Δp
- Evaporating temperature / pressure
- Lowest possible condensing temperature / pressure
- Liquid temperature at the inlet of TXV
- Refrigerant type

To facilate valve dimensioning for other than the standard conditions ALCO offers an **Excel based Selection Tool.** This can be ordered from all Copeland sales offices. See www.eCopeland.com for contact addresses, email or phone numbers.

Otherwise the following formula has to be used:

Cooling capacity x $K_{\Delta p}$ x K_t = Nominal capacity of TXV

- Select K_t-factor according to refrigerant. liquid and evaporating temperature from tables on pages 9-11.
- Determine effective pressure differential across the Thermo®-Expansion Valve using condensing pressure. subtract evaporating pressure and all other possible pressure losses. Select $K_{\Delta p}$-factor from tables on pages 11 … 12.

Example 1

A valve has to be selected for the following conditions:

Refrigerant	R 22
System cooling capacity	45 kW
Evaporating temperature	+5°C
Lowest condensing temperature	+30°C
Liquid temperature	+25°C
Valve without MOP	

Calculation:

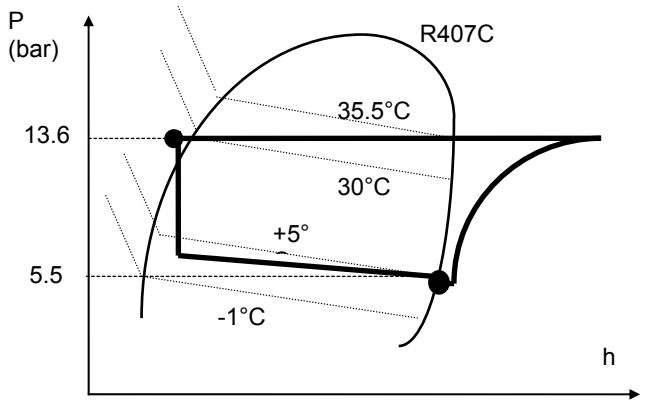
1. Theoretical pressure differential:
   Lowest condensing pressure is Pc = 11.9 bara at +30°C and evaporating pressure is P_0 = 5.8 bara at +5°C
   Differential pressure is Pc - P_0 = 11.9 – 5.9 = 6 bar
2. Pressure losses:
   Across distributor = 1.0 bar
   Others in piping. solenoid valve. drier. sight glass. fitting. etc. = 0.5 bar
   Total pressure losses = 1 + 0.5 = 1.5
3. Effective pressure differential across valve:
   6.0 – 1.5 = 4.5 bar
4. Correction factors:
   Correction factor $K_{\Delta p}$ for the pressure differential 4.5 bar from table on page 9 for R 22
   Δp = 4.5 **$K_{\Delta p}$ = 1.42**
   Correction factor K_t for liquid and evaporating temperature from table on page 9 for R 22 at +25°C / 5°C
   K_t = 0.89
5. Calculation of nominal capacity Q_0 x $K_{\Delta p}$ x K_t = Qn
   45 x 1.42 x 0.89 = 56.9 kW.
   You can select the valve from table on page 6.

It is a TX6-H06 with a nominal capacity of 61.9 kW.

Dimensioning of Thermo®-Expansion Valves for systems with refrigerant R 407C

As opposed to single substances (e.g. R 22. R 134a etc.) where the phase change takes place at a constant temperature / pressure. the evaporation and condensation of zeotropic blend R407C is in a “gliding” form (e.g. at a constant pressure the temperature varies within a certain range) through evaporators and condensers.

The condensing / evaporating pressure must be determined at saturated temperatures (bubble / dew points) for dimensioning of Thermo®-Expansion Valves.



Example 2:

System cooling capacity (R407C)	55 kW
Evaporating temperature (dew point)	+5°C
Lowest condensing temperature (bubble)	+30°C
Liquid temperature	+25°C

Valve without MOP

Calculation:

1. Theoretical pressure differential:
   Differential pressure is Pc - P_0 = 13.6 – 5.5 = 8.1 bar
2. Pressure losses:
   Across distributor = 1 bar
   Others in piping, solenoid valve, drier, sight glass, fitting etc. = 0.6 bar
   Total pressure losses = 1 + 0.6 = 1.6
3. Effective pressure differential across valve:
   8.1 - 1.6 = 6.5 bar
4. Correction factors:
   Correction factor $K_{\Delta p}$ for the pressure differential 9.39 bar from table on page 9 for R 407C
   Δp = 6.5 bar **$K_{\Delta p}$ = 1.31**
   Correction factor K_t for liquid and evaporating temperature from table on page 9 for R 407C at +25°C / +5°C
   K_t = 0.85
5. Calculation of nominal capacity Q_0 x $K_{\Delta p}$ x K_t = Qn
   55 x 1.31 x 0.85 = 61.2

You can select the valve from table on page 6.

It is a TX6-N06 with a nominal capacity of 66.9 kW.

Dimensioning of Thermo®-Expansion Valves for heat pump applications

Example 3:

A heat pump with following design conditions:

Cooling mode

Cooling capacity (R 22)	20 kW
Condensing temperature	+45°C
Evaporating temperature	+5°C
Liquid temerature	45°C

Valve without MOP

1. Theoretical pressure differential:
   Differential pressure is Pc - P_0 = 17.3 – 5.8 = 11.5 bar
2. Pressure losses: total pressure losses = 1.6
3. Effective pressure differential across valve:
   11.5 – 1.6 = 9.9 bar
4. Correction factors:
   Δp = 9.9 **$K_{\Delta p}$ = 0.96**
   at +5°C and 45°C **K_t = 1.07**
5. Calculation of nominal capacity Q_0 x $K_{\Delta p}$ x K_t = Qn
   20 x 0.96 x 1.07 = 20.5 kW

You can select the valve from table on page 6

It is a TX6-H03 with a nominal capacity of 23.7 kW.

Heating mode (Reverse flow)

Heating capacity (R 22)	15 kW
Condensing temperature	+30°C
Evaporating temperature	-10°C
Liquid temperature	+30°C

1. Theoretical pressure differential:
   Differential pressure is Pc - P_0 = 11.9 – 3.5 = 8.4 bar
2. Pressure losses: total pressure losses = 1.6
3. Effective pressure differential across valve:
   8.4 – 1.6 = 6.8 bar
4. Correction factors:
   Δp = 6.8 **$K_{\Delta p}$ = 1.16**
   at -10°C and 30°C **K_t = 0.99**
5. Calculation of nominal capacity Q_0 x $K_{\Delta p}$ x K_t = Qn
   15 x 1.42 x 0.89 = 17.2 kW.

TX6-H03 has sufficient capacity in reverse flow for 17.2 kW.

Liquid temperature entering valve °C	R22 Correction factor K_t Evaporating temperature °C																Liquid temperature entering valve °C
			+20	+ 15	+10	+5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
+ 60			1.24	1.25	1.26	1.28	1.30	1.31	1.38	1.58	1.84	2.16	2.56	3.04	3.55	4.23	+ 60
+ 55			1.16	1.17	1.19	1.20	1.22	1.23	1.29	1.42	1.72	2.02	2.39	2.83	3.30	3.94	+ 55
+ 50			1.10	1.11	1.12	1.13	1.15	1.16	1.21	1.39	1.62	1.89	2.24	2.66	3.10	3.68	+ 50
+ 45			1.04	1.05	1.06	1.07	1.08	1.10	1.15	1.31	1.52	1.79	2.11	2.50	2.91	3.46	+ 45
+ 40			0.99	1.00	1.01	1.02	1.03	1.04	1.09	1.24	1.45	1.69	2.00	2.37	2.75	3.27	+ 40
+ 35			0.94	0.95	0.96	0.97	0.98	0.99	1.03	1.18	1.37	1.61	1.89	2.24	2.60	3.09	+ 35
+ 30			0.90	0.91	0.92	0.93	0.94	0.95	0.99	1.13	1.31	1.55	1.83	2.13	2.47	2.93	+ 30
+ 25			0.86	0.87	0.88	0.89	0.89	0.90	0.94	1.08	1.25	1.46	1.72	2.03	2.36	2.80	+ 25
+ 20			0.83	0.83	0.84	0.85	0.86	0.87	0.90	1.03	1.19	1.40	1.64	1.94	2.25	2.66	+ 20
+ 15				0.80	0.81	0.81	0.82	0.83	0.87	0.99	1.14	1.34	1.57	1.86	2.15	2.55	+ 15
+ 10					0.78	0.78	0.79	0.80	0.83	0.95	1.10	1.28	1.51	1.78	2.06	2.44	+ 10
+ 5						0.75	0.76	0.77	0.80	0.91	1.06	1.23	1.45	1.71	1.98	2.34	+ 5
0							0.73	0.74	0.77	0.88	1.02	1.19	1.39	1.65	1.90	2.25	0
- 5								0.71	0.74	0.85	0.98	1.14	1.34	1.58	1.83	2.17	- 5
- 10									0.72	0.82	0.95	1.10	1.30	1.53	1.77	2.09	- 10
Correction factor $K_{\Delta p}$																	
Δp (bar)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	8	9	Δp (bar)
$K_{\Delta p}$	4.25	3.00	2.46	2.13	1.90	1.74	1.61	1.50	1.42	1.35	1.28	1.23	1.18	1.14	1.06	1.00	$K_{\Delta p}$
Δp (bar)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Δp (bar)
$K_{\Delta p}$	0.95	0.91	0.87	0.83	0.80	0.78	0.75	0.73	0.71	0.69	0.67	0.66	0.64	0.63	0.61	0.60	$K_{\Delta p}$

Liquid temperature entering valve °C	R407C Correction factor K_t Evaporating temperature °C																Liquid temperature entering valve °C
			+20	+15	+10	+5	0	-5	-10	-15	-20	-25					
+ 55			1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.63	1.98	2.42					+ 55
+ 50			1.13	1.15	1.17	1.19	1.22	1.24	1.27	1.48	1.79	2.18					+ 50
+ 45			1.05	1.06	1.08	1.10	1.12	1.14	1.17	1.35	1.64	2.00					+ 45
+ 40			0.98	0.99	1.01	1.02	1.04	1.06	1.08	1.25	1.52	1.84					+ 40
+ 35			0.92	0.93	0.94	0.96	0.98	0.99	1.01	1.17	1.41	1.71					+ 35
+ 30			0.87	0.88	0.89	0.90	0.92	0.93	0.95	1.10	1.32	1.60					+ 30
+ 25			0.82	0.83	0.84	0.85	0.87	0.88	0.90	1.03	1.25	1.51					+ 25
+ 20			0.78	0.79	0.80	0.81	0.82	0.84	0.85	0.98	1.18	1.43					+ 20
+ 15				0.75	0.76	0.77	0.78	0.80	0.81	0.93	1.12	1.35					+ 15
+ 10					0.73	0.74	0.75	0.76	0.77	0.89	1.07	1.29					+ 10
+ 5						0.71	0.72	0.73	0.74	0.85	1.02	1.23					+ 5
0							0.69	0.70	0.71	0.81	0.98	1.18					0
Correction factor $K_{\Delta p}$																	
Δp (bar)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	8	9	Δp (bar)
$K_{\Delta p}$	4.78	3.33	2.72	2.36	2.11	1.92	1.78	1.67	1.57	1.49	1.42	1.36	1.31	1.26	1.18	1.11	$K_{\Delta p}$
Δp (bar)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Δp (bar)
$K_{\Delta p}$	1.05	1.01	0.96	0.92	0.89	0.86	0.83	0.81	0.79	0.76	0.75	0.73	0.71	0.70	0.68	0.67	$K_{\Delta p}$

Liquid temperature entering valve °C	**R134a**																Liquid temperature entering valve °C
			Correction factor K_t Evaporating temperature °C														
			+20	+ 15	+10	+5	0	-5	-10	-15	-20	-25					
+ 60			1.27	1.30	1.33	1.36	1.40	1.44	1.48	1.75	2.08	2.46					+ 60
+ 55			1.18	1.21	1.23	1.26	1.29	1.33	1.36	1.60	1.90	2.25					+ 55
+50			1.10	1.13	1.15	1.17	1.20	1.23	1.26	1.48	1.76	2.07					+ 50
+ 45			1.04	1.06	1.08	1.10	1.12	1.15	1.17	1.38	1.63	1.92					+ 45
+ 40			0.98	0.99	1.01	1.03	1.05	1.08	1.10	1.29	1.52	1.79					+ 40
+ 35			0.92	0.94	0.96	0.97	0.99	1.01	1.03	1.21	1.43	1.68					+ 35
+ 30			0.88	0.89	0.91	0.92	0.94	0.96	0.98	1.14	1.35	1.58					+ 30
+ 25			0.83	0.85	0.86	0.87	0.89	0.91	0.92	1.08	1.27	1.49					+ 25
+ 20			0.80	0.81	0.82	0.83	0.85	0.89	0.88	1.02	1.21	1.41					+ 20
+ 15				0.77	0.78	0.79	0.81	0.82	0.84	0.97	1.15	1.34					+ 15
+ 10					0.75	0.76	0.77	0.78	0.80	0.93	1.09	1.28					+ 10
+ 5						0.73	0.74	0.75	0.76	0.89	1.04	1.22					+ 5
0							0.71	0.72	0.73	0.85	1.00	1.17					0
- 5								0.69	0.70	0.82	0.96	1.12					- 5
- 10									0.68	0.79	0.92	1.07					- 10
Correction factor $K_{\Delta p}$																	
Δp (bar)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	Δp (bar)
$K_{\Delta p}$	3.50	2.48	2.02	1.75	1.57	1.43	1.32	1.24	1.17	1.11	1.06	1.01	0.97	0.94	0.90	0.88	$K_{\Delta p}$
Δp (bar)	8.5	9	9.5	10	10.5	11	11.5	12	13	14	15	16	17	18	19	20	Δp (bar)
$K_{\Delta p}$	0.85	0.83	0.80	0.78	0.76	0.75	0.73	0.72	0.69	0.66	0.64	0.62	0.60	0.58	0.57	0.55	$K_{\Delta p}$

Liquid temperature entering valve °C	**R410A**																Liquid temperature entering valve °C
					Correction factor K_t Evaporating temperature °C												
					+ 15	+10	+5	0	-5	-10	-15	-20	-25	-30	-35	-40	
+ 60					1,50	1,51	1,53	1,54	1,57	1,59	1,85	2,16	2,55	3,03	3,64	4,42	+ 60
+ 55					1,32	1,33	1,35	1,36	1,38	1,40	1,62	1,89	2,23	2,65	3,17	3,84	+ 55
+ 50					1,20	1,20	1,21	1,23	1,24	1,26	1,46	1,70	2,00	2,37	2,83	3,42	+ 50
+ 45					1,09	1,10	1,11	1,12	1,13	1,15	1,33	1,55	1,82	2,15	2,57	3,10	+ 45
+ 40					1,01	1,02	1,03	1,04	1,05	1,06	1,22	1,43	1,67	1,98	2,36	2,84	+ 40
+ 35					0,94	0,95	0,96	0,97	0,98	0,99	1,14	1,32	1,55	1,83	2,18	2,63	+ 35
+ 30					0,89	0,89	0,90	0,91	0,91	0,92	1,06	1,24	1,45	1,71	2,04	2,45	+ 30
+ 25					0,84	0,84	0,85	0,85	0,86	0,87	1,00	1,16	1,36	1,61	1,91	2,30	+ 25
+ 20					0,79	0,80	0,80	0,81	0,81	0,82	0,95	1,10	1,28	1,51	1,80	2,16	+ 20
Correction factor $K_{\Delta p}$																	
Δp (bar)	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	8	9	Δp (bar)
$K_{\Delta p}$	5,29	3,74	3,05	2,65	2,37	2,16	2,00	1,87	1,76	1,67	1,60	1,53	1,47	1,41	1,32	1,25	$K_{\Delta p}$
Δp (bar)	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Δp (bar)
$K_{\Delta p}$	1,18	1,13	1,08	1,04	1,00	0,97	0,94	0,91	0,88	0,86	0,84	0,82	0,80	0,78	0,76	0,75	$K_{\Delta p}$

Technical data

Maximum working pressure TX6-H/M/N.. TX6-Z12/13/14/15/16/17	 PS: 31 bar PS: 42 bar
Compatibility	CFC, HCFC, HFC. Mineral and POE lubricants.
Fluid group	II
Medium temperature range TS	-45 to 65°C
Charges	CFC free

CE-Marking according to PED:	Not required
Seat leakage	≤ 1% nominal capacity
Connection	ODF copper
Power element	Laser welding, stainless steel
Label	Pin printing

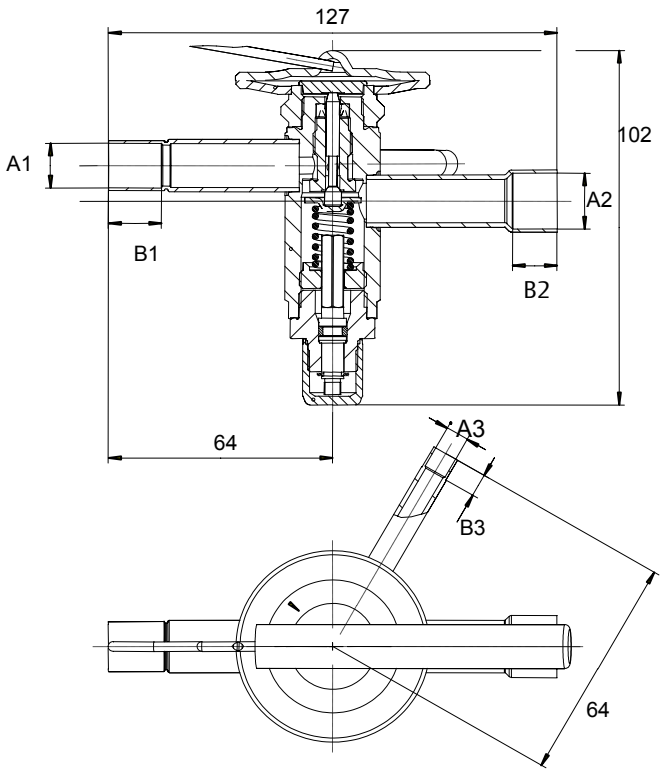
Charge	Refrigerant	Recommended evaporating temperature range °C	Maximum bulb temperature °C
N0	**R 407C**	-25 to +20	71
H0	**R 22**	-45 to +20	71
M0	**R 134a**	-25 to +30	88
N1. MOP 6.9 bar	**R 407C**	-25 to +14	120
H1. MOP 6.9 bar	**R 22**	-45 to +12	120
M1. MOP 3.8 bar	**R 134a**	-25 to +10	120
Z1 MOP 12.1 bar	**R 410A**	-45 to +14	120

Shipping weight and pack quantity TX6

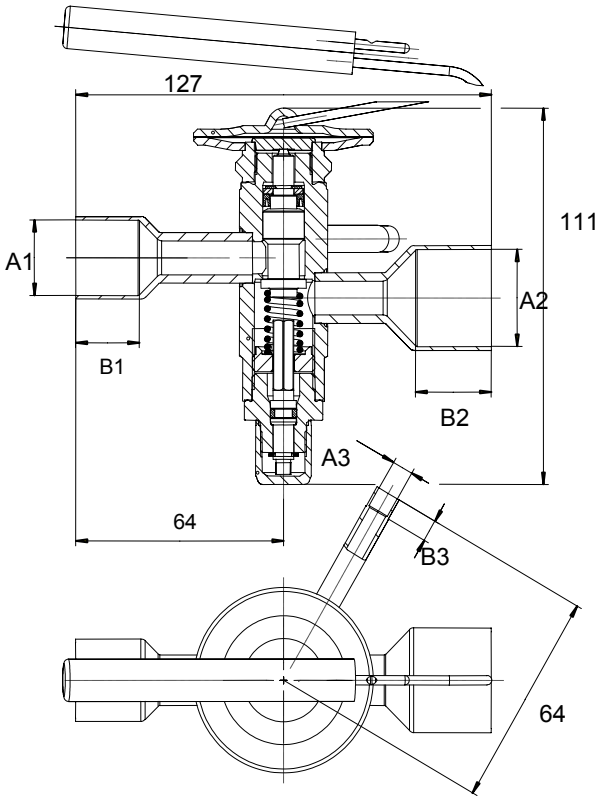
Pack quantity	12 pcs
Shipping weight	0.65 kg (individual)

Dimensions

TX6-….2/3



TX6-….4/5/6/



Type	A1 ∅	B1 mm	A2 ∅	B2 mm	A3 ∅	B3 mm	Capillary tube mm	Bulb size	
								Diameter mm	Length mm
TX6-…2	1/2” & 12 mm	9	5/8” & 16 mm	13	1/4” & 6 mm	8	1500	13 (R410A: 19,2)	89 (R410A: 59)
TX6-…3	1/2” & 12 mm	9	5/8” & 16 mm	13	1/4” & 6 mm				
TX6-…4	5/8” & 16 mm	13	7/8” & 22 mm	19	1/4” & 6 mm				
TX6-…5	5/8” & 16 mm	13	7/8” & 22 mm	19	1/4” & 6 mm				
TX6-…6	7/8” & 22 mm	19	1-1/8” & 28 mm	23	1/4” & 6 mm				
TX6-…7	7/8” & 22 mm	19	1-1/8” & 28 mm	23	1/4” & 6 mm				

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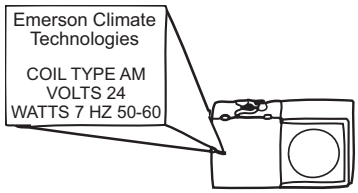
UK & Ireland	+44 (0)1 189 838 000	+44 (0)1 189 838 001

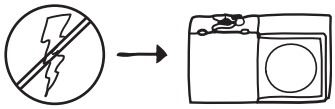
ASC, ASC2, AM, AH, DM, EB, EM, MM, RM Coils

GENERAL INSTALLATION

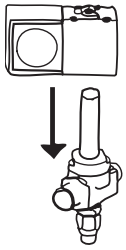
1. Verify selection of proper coil type, coil voltage and frequency. This information appears on coil nametag.



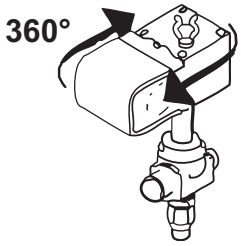
2. **Always disconnect electrical power source.**



3. Install the coil on the enclosing tube of the valve.

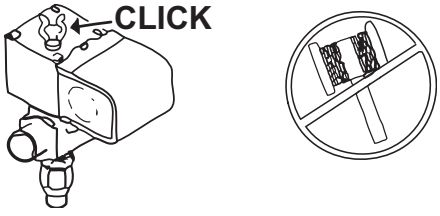


4. Coil may be rotated 360° for easy wiring. It is recommended that coil lead connections be soldered on D.C. and 24V/50-60 HZ.

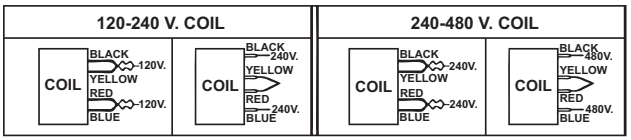


5. Press firmly to ensure coil is secured.

Warning: To avoid any damage to the enclosing tube, use your hands to secure the coil, do not use a hammer or other kind of tool.



6. Dual Voltage Wiring Diagram



INSTALLATION OF ASC OR ASC2 COILS

1. Install coil so that electrical connections are closer to the top of the enclosing tube.
2. Use metal snap cap X-13740-1 and press on until you hear it click into place.
3. Attach electric connector (DIN PLUG) onto coil and tighten screw until snug.

INSTALLATION OF RM COILS

1. Install coil on top of the enclosing tube.
2. Attach lockwasher and screw to top and secure tightly.

WARNING

A. Caution: Failure to attach ground wire to grounding lug violates certain electrical codes and creates the possibility of shock hazard.
B. Caution: Omission of conduit cover locking screw violates certain electrical codes and could cause cover to come off exposing "live" (energized) wires with resulting possibility of fire hazard and/or personal injury.

REMOVE

1. Verify selection of proper coil type, coil voltage and frequency.
2. Before removing coil from valve, **always disconnect electrical power source**. Failure to do so will cause a good coil to burn out and possible personal injury or property damage.
3. Remove old coil.

EX4 / EX5 / EX6 / EX7 / EX8
Electrical Control Valves
Technical Data

ALCO Controls **EX4 / EX5 / EX6 / EX7 / EX8** are stepper motor driven valves for precise control of refrigerant mass flow in air conditioning, refrigeration, heat pumps, close control, and industrial process cooling applications.

The Control Valves can be used as thermo-expansion duty, liquid injection duty, hot gas bypass, evaporator pressure regulator, crankcase pressure regulator, head pressure regulator, or liquid level control.

This data sheet describes only the performance of the valves. Operation of required controllers, driver boards and sensors are part of other documentations (see page 29).

EX4 / EX5 / EX6 (Uni-flow/Bi-flow)

EX7 (Uni-flow/Bi-flow)

EX8 (Uni-flow)

Features

- Multifunction as expansion valves, hot gas bypass, suction gas throttling, head pressure, liquid level actuator etc.
- Fully hermetic design (no thread joints between valve body and motor compartment)
- Stepper motor driven
- Very fast full stroke time (1.5 sec. for EX4/5/6, 3.2 sec. for EX7 and 5.2 sec. for EX8)
- High resolution and excellent repeatability
- Bi-flow versions for heat pump applications
- Positive shut-off function to eliminate the use of an additional solenoid valve
- Linear flow capacity
- Extremely wide capacity range (10 … 100%)
- Continuous modulation of mass flow, no stress (liquid hammering) in the refrigeration circuit
- Direct coupling of motor and valve for high reliability (no gear mechanism)
- Ceramic slide and port for accurate flow and minimal wear
- Balanced force design
- Corrosion resistant stainless steel body
- Europe patent No. 0743476, USA patent No. 5735501, Japan patent No. 28225789
- Compatible with all CFCs, HCFCs and HFCs

Selection table

Type	Part Code Nr.	Flow pattern	Capacity range	Inlet connection	Outlet connection	Electrical connection
EX4-I21	800 615	Uni-flow	10 … 100%	3/8” ODF	5/8” ODF	M12 plug
EX4-M21	800 616			10 mm ODF	16 mm ODF	
EX5-U21	800 618			5/8” (16 mm) ODF	7/8” (22 mm) ODF	
EX6-I21	800 620			7/8” ODF	1-1/8” ODF	
EX6-M21	800 621			22 mm ODF	28 mm ODF	
EX7-I21	800 624			1-1/8” (28 mm) ODF	1-3/8” (35 mm) ODF	
EX7-M21	800 625			1-1/8” (28 mm) ODF	1-3/8” (35 mm) ODF	
EX8-M21	801 964			42 mm ODF	42 mm ODF	DIN Plug
EX8-U21	801 970			1-3/8” (35 mm) ODF	1-3/8” (35 mm) ODF	DIN Plug
EX4-U31	800 617	Bi-flow (Heat pump)		5/8” (16 mm) ODF	5/8” (16 mm) ODF	M12 plug
EX5-U31	800 619			7/8” (22 mm) ODF	7/8” (22 mm) ODF	
EX6-I31	800 622			1-1/8” ODF	1-1/8” ODF	
EX6-M31	800 623			28 mm ODF	28 mm ODF	
EX7-U31	800 626			1-3/8” (35 mm) ODF	1-3/8” (35 mm) ODF	

EX4/5/6/7 is delivered without cable/connector assembly (order separately). EX8 is delivered with electrical DIN plug.

Cable and connector assembly for EX4 / EX5 / EX6 /EX7

Type	Part Code Nr.	Temperature Range	Length	Connector type to valve	Connector type to driver board or controller	Illustration
EX5-N15	804 650	-25 … +80°C	1.5 m	M12	Loose wires for EXD-S / -U / -C and EC3-33x	
EX5-N30	804 651		3.0 m			
EX5-N60	804 652		6.0 m			
EX5-L60	804 655	-50 …+80°C	6.0 m	M12, low temp.		
EX5-C15	804 656	-25 … +80°C	1.5 m	M12	Phoenix type, crimp connection for Alco EC3 controller	
EX5-C30	804 657		3.0 m			
EX5-C60	804 658		6.0 m			

Introduction

Thermostatic expansion valves and mechanical regulator valves have been used in the refrigeration and air conditioning industry to control superheat and refrigerant mass flow since its very beginning. As today's systems require improved energy efficiency, tighter temperature control, wider range of operating conditions and incorporate new features like remote monitoring and diagnostics, the application of electronically operated valves becomes mandatory. Only they offer the controls performance necessary to meet these needs.

As more new refrigerants appear on the market requiring an ever increasing number of different charges and settings for thermostatic expansion valves, electrical control valves can solve this problem too.

ALCO electrical control valves are the solution for the challenges above. The latest technology and more than 80 years of experience in design and production of flow controls including Thermo® expansion valves have been incorporated in the design of the EX4, EX5, EX6, EX7 and EX8.

Construction

EX4/EX5/EX6/EX7/EX8 consist of two main internal assemblies, the valve and the stepper motor. The stepper motor is connected directly to the slide and cage assembly of the valve. Similar to the technology used in compressors, the motor is exposed to refrigerant and lubricant and the materials used are identical. The housing of the motor and valve assembly is fully hermetic, utilising exclusively brazing and welding technologies and eliminating all gaskets.

This design offers several technical advantages. The motor is direct coupled to the valve assembly for easy and reliable movement of the valve slide, no need for any other seals and eliminating the use of bellows and diaphragms which could be subject to lifetime limitations and leaks.

Four electrical pins connect the motor to the outside. These pins are applied to the housing using melting-glass process technology. The EX4/5/6/7 pins require a M12 electrical connector. EX8 is supplied with DIN electrical plug.

The complete housing of the ECVs is made from stainless steel. EX8 is equipped with rotalock connections.

Unlike to mechanical expansion valves, EX4/5/6/7/8 are equipped with ceramic slide port.

Features:

- Wide range regulation (10 … 100%) with one slide orifice for each valve
- Linear characteristic over entire capacity range
- Positive shut-off

Guidelines for selection of electrical control valves

The following guideline should be taken in to the consideration in order to obtain full advantages of ECV:

- Published capacities are maximum. There are no reserve capacities.
- Larger size of valve leads to shorter pull down period and shorter travel time i.e. faster respond. For example, EX7 has maximum 3.2 seconds travel time. The valve has approximately 1.6 seconds travel time at 50% capacity operation.

ALCO Selection Tool

For easy and quick selection of Electrical Control Valves an Excel based selection tool can be ordered from the ALCO sales offices, or use the quick selection tables mentioned in this datasheet.

Example:

System with R407C having two different operating conditions:

A) 110 kW capacity at +4°C/+50°C with two stages compressor at 50%/100% capacity

B) 137 kW at +4°C/+30°C with two stages compressor at 50%/100% capacity

EX6 with 126 kW covers condition A, however is not sufficient to cover condition B. It is recommended to select the larger valve EX7 which offers 337 kW at condition A and 293 kW at condition B.

Condition A:

$$\text{Full load ratio} = \frac{110}{337} = 33\%$$

$$\text{Partial load ratio} = \frac{(110/2)}{337} = 16\%$$

Condition B:

$$\text{Full load ratio} = \frac{137}{293} = 47\%$$

$$\text{Partial load ratio} = \frac{(137/2)}{293} = 23\%$$

The capacity ratios of system to valve are in all conditions higher than 10%. It is recommended to use EX7 rather EX6.

EX4/EX5/EX6/EX7/EX8 nominal and extended capacities as expansion valves and liquid injection valves

Nominal Capacities (10% … 100%), kW

Valve Type	R 407C	R 22	R 134a	R 404A	R 410A	R 23	R 124	R 744
EX4	2 ... 17.4	2 ... 16.5	1 ... 12.8	1 ... 11.5	2 ... 19.3	2 ... 17.8	1 ... 9.2	3 ... 33.5
EX5	5 ... 53	5 ... 50	4 ... 39	4 ... 35	6 ... 58	5 ... 54	3 ... 28	10 ... 102
EX6	15 ... 126	15 ... 120	10 ... 93	10 ... 84	15 ... 140	13 ... 130	7 ... 67	24 ... 244
EX7	35 ... 347	35 ... 330	25 ... 255	25 ... 230	40 ... 385	-	-	70 ... 670
EX8	100 ... 925	90 ... 880	70 ... 680	60 ... 613	100 ... 1027	-	-	180 ... 1789

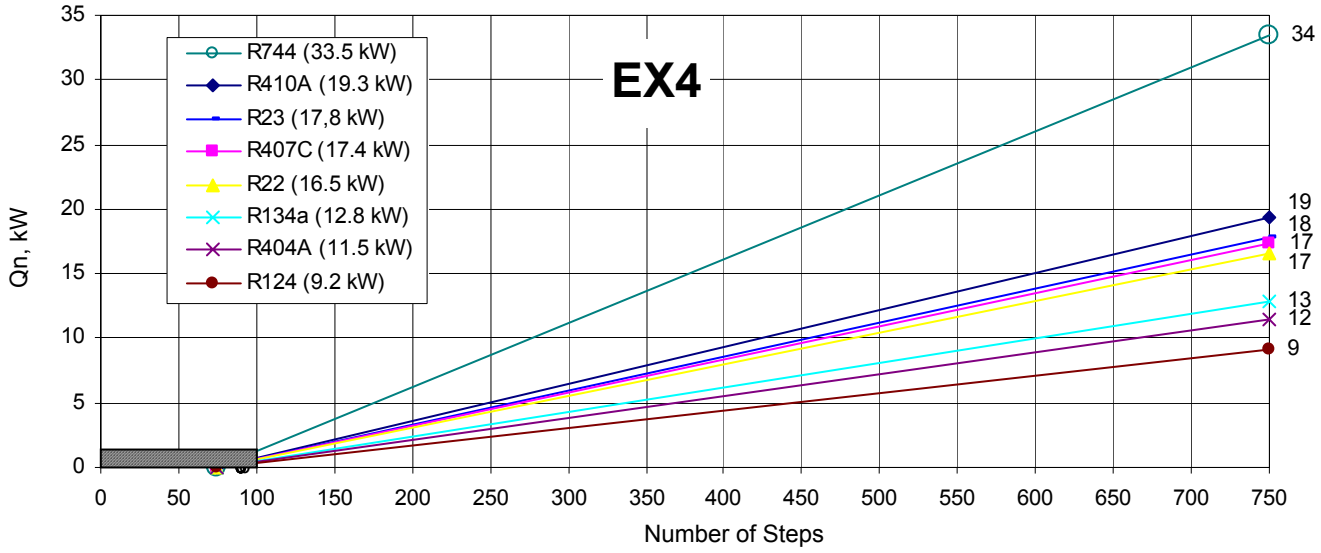
The nominal capacity (Qn) is based on the following conditions:

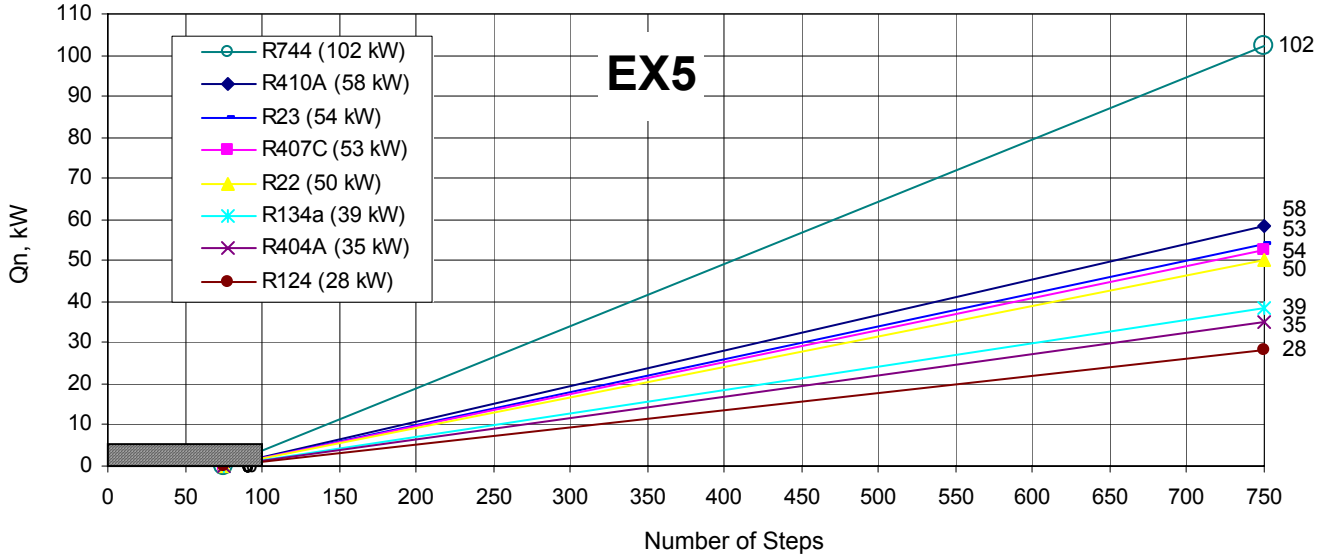
Refrigerant	Evaporating temperature	Condensing temperature	Subcooling
R 22, R 134a, R 404A, R 410A	+4°C	+38°C	1K
R 407C	+4°C dew point	+38°C bubble / +43°C dew point	1K
R 124	+20°C	+80°C	1K
R 23	-60°C	-25°C	1K
R 744	-40°C	-10°C	1K

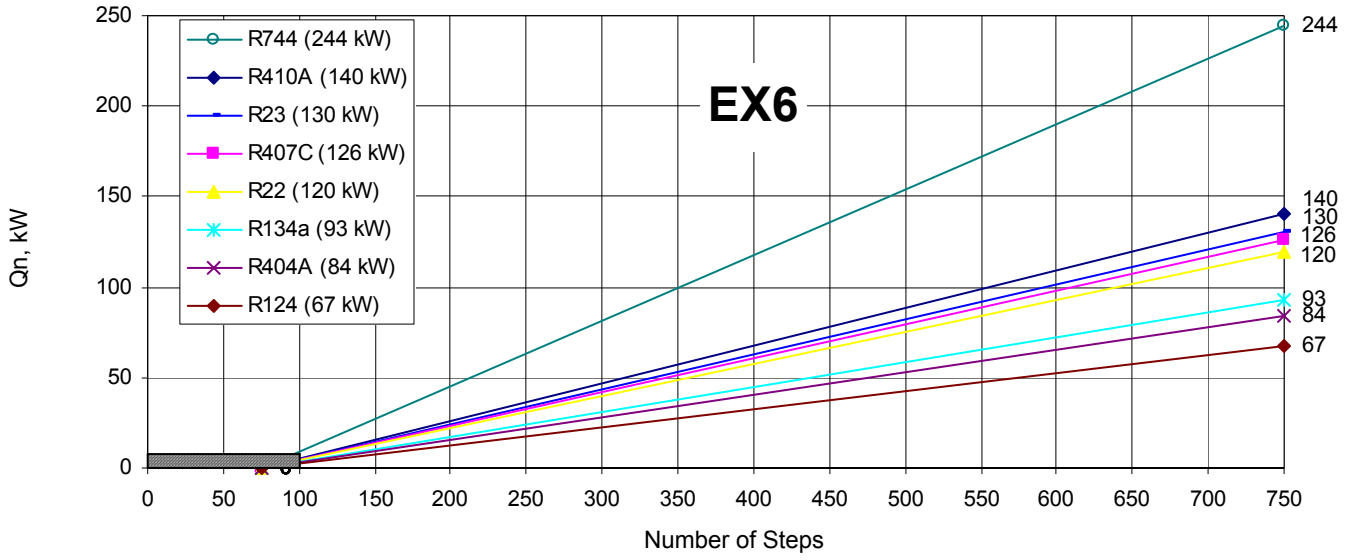
Overview of working pressure regardless of applied refrigerant type

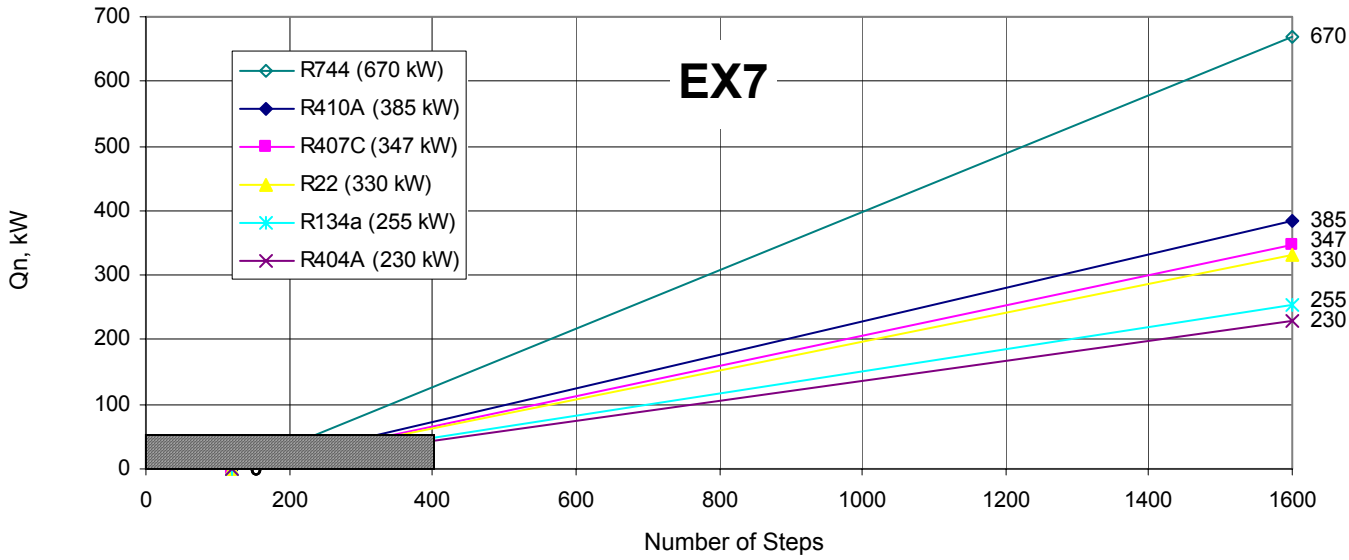
Valve type	Flow pattern	Maximum working pressure PS	Factory test pressure PT
EX4, EX5, EX6, EX7	Uni-flow/Bi-flow	45 bar	49.5 bar
EX8	Uni-flow	35 bar	38.5 bar

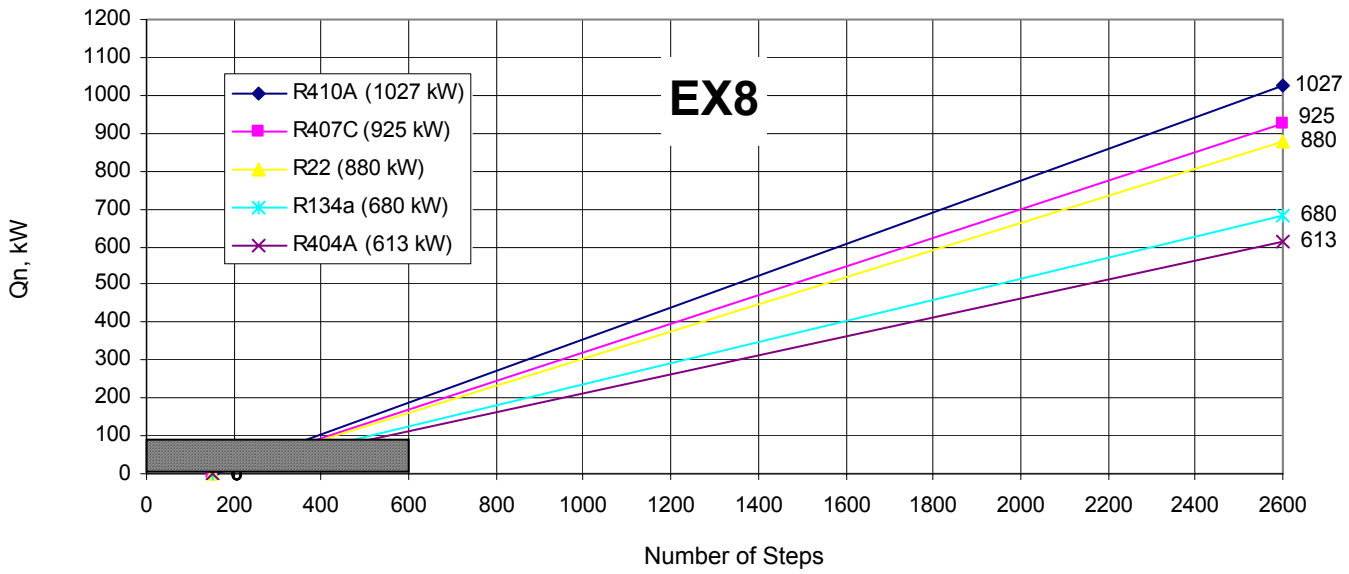
Capacity Diagrams (kW)






EX6
R744 (244 kW)
R410A (140 kW)
R23 (130 kW)
R407C (126 kW)
R22 (120 kW)
R134a (93 kW)
R404A (84 kW)
R124 (67 kW)
Qn, kW
Number of Steps
244
140
130
126
120
93
84
67


EX7
R744 (670 kW)
R410A (385 kW)
R407C (347 kW)
R22 (330 kW)
R134a (255 kW)
R404A (230 kW)
Qn, kW
Number of Steps
670
385
347
330
255
230


EX8
R410A (1027 kW)
R407C (925 kW)
R22 (880 kW)
R134a (680 kW)
R404A (613 kW)
Qn, kW
Number of Steps
1027
925
880
680
613

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **1.5 bar pressure drop** through liquid line:

Condensing temperature °C	Extended capacity kW R 410A Evaporating temperature °C													Valve Type
	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	17	17	18	18	18	18	18	18	18	18	17	17	17	EX4
	51	52	53	54	54	54	54	54	53	53	52	51	50	EX5
	123	126	129	130	131	131	131	130	129	127	125	123	120	EX6
	339	348	354	358	360	361	360	358	354	350	344	338	331	EX7
	-	-	-	-	-	-	-	-	-	-	-	-	-	EX8
55	18	18	19	19	19	19	19	19	19	19	19	18	18	EX4
	53	55	56	57	57	58	58	58	57	57	56	55	54	EX5
	127	132	135	137	138	139	139	139	138	137	135	133	131	EX6
	350	362	370	377	381	383	383	382	380	377	372	366	360	EX7
	935	965	988	1005	1016	1021	1023	1020	1014	1005	992	978	961	EX8
50	18	18	19	19	20	20	20	20	20	20	20	19	19	EX4
	53	55	57	58	59	60	60	60	60	59	59	58	57	EX5
	128	133	137	140	142	144	145	145	144	143	142	140	138	EX6
	351	366	377	386	392	396	398	398	397	394	391	386	380	EX7
	936	975	1006	1029	1045	1056	1061	1062	1059	1052	1043	1030	1015	EX8
45	17	18	19	19	20	20	20	20	20	20	20	20	20	EX4
	52	54	57	58	60	60	61	61	61	61	61	60	59	EX5
	124	131	136	141	144	146	147	148	148	147	146	145	143	EX6
	342	361	375	387	395	401	405	407	407	405	403	399	394	EX7
	913	962	1001	1031	1054	1070	1080	1085	1085	1082	1075	1064	1052	EX8
40	16	17	18	19	20	20	20	21	21	21	21	20	20	EX4
	49	52	55	57	59	60	61	62	62	62	62	61	61	EX5
	118	126	133	138	142	145	147	149	149	149	149	148	146	EX6
	324	348	366	381	392	400	406	409	411	411	409	406	402	EX7
	864	927	977	1015	1045	1067	1082	1091	1095	1095	1091	1084	1073	EX8
35	15	16	18	18	19	20	20	20	21	21	21	20	20	EX4
	45	49	53	55	58	59	60	61	62	62	62	62	61	EX5
	108	118	127	134	139	143	146	148	149	149	149	149	148	EX6
	296	326	349	368	382	393	401	406	409	411	410	409	406	EX7
	789	869	932	981	1019	1048	1069	1083	1092	1095	1095	1090	1082	EX8
30	13	15	16	17	18	19	20	20	20	20	20	20	20	EX4
	38	44	49	52	55	57	59	60	61	61	61	61	61	EX5
	93	107	118	126	133	138	142	145	147	148	148	148	147	EX6
	255	294	325	348	366	380	390	398	403	406	407	406	405	EX7
	680	786	866	928	976	1013	1041	1061	1075	1083	1086	1084	1079	EX8
25	10	13	15	16	17	18	19	19	20	20	20	20	20	EX4
	29	38	44	48	52	54	56	58	59	60	60	60	60	EX5
	71	91	106	117	125	131	136	140	143	144	145	146	145	EX6
	195	251	291	321	344	361	375	385	392	397	399	400	399	EX7
	520	669	775	855	916	964	1000	1027	1046	1058	1065	1067	1065	EX8
20	4	9	12	14	16	17	18	18	19	19	19	20	20	EX4
	13	28	37	43	47	51	53	55	57	58	58	59	59	EX5
	31	68	89	103	114	122	129	133	137	139	141	142	142	EX6
	84	188	244	284	314	337	354	367	377	383	388	390	390	EX7
	225	501	652	758	837	898	944	979	1005	1023	1034	1040	1042	EX8
15		3	9	12	14	15	16	17	18	18	19	19	19	EX4
		10	27	36	42	46	49	52	54	55	56	57	57	EX5
		23	65	86	100	111	119	125	130	133	135	137	137	EX6
		64	178	236	276	305	327	344	357	366	372	376	378	EX7
		172	475	629	735	813	873	917	951	976	992	1003	1008	EX8
10			1	8	11	13	15	16	17	17	18	18	18	EX4
			4	25	34	40	44	47	50	52	53	54	55	EX5
			10	60	82	96	107	115	121	125	128	130	132	EX6
			28	166	225	265	294	315	332	344	352	358	362	EX7
			76	443	600	706	783	841	885	917	940	956	965	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **1.5 bar pressure drop** through liquid line:

Condensing temperature		Extended capacity kW													Valve
Dew point	Bubble point	R 407C				Evaporating temperature °C (Dew point)									Type
°C	°C	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
64	60	16	17	17	17	17	17	16	16	16	15	15	15	14	EX4
		50	51	51	51	51	50	50	49	48	47	46	45	43	EX5
		119	120	121	121	121	119	118	116	114	112	109	106	103	EX6
		328	332	333	333	332	329	325	320	314	308	301	293	285	EX7
		874	884	889	889	885	877	867	854	838	821	802	781	759	EX8
59	55	17	17	17	17	17	17	17	17	16	16	16	15	15	EX4
		50	51	52	52	52	52	51	51	50	49	48	47	46	EX5
		120	122	123	124	124	123	122	121	119	117	114	112	109	EX6
		330	336	339	341	341	339	336	332	328	322	315	308	301	EX7
		879	895	904	909	908	904	897	886	873	858	840	821	801	EX8
54	50	16	17	17	17	17	17	17	17	17	17	16	16	16	EX4
		50	51	52	52	53	53	52	52	51	51	50	49	48	EX5
		118	121	123	125	125	125	125	123	122	120	118	116	113	EX6
		326	334	340	343	345	345	343	340	336	331	325	319	312	EX7
		869	891	906	915	919	919	914	907	896	883	868	851	832	EX8
50	45	16	16	17	17	17	17	17	17	17	17	17	16	16	EX4
		48	50	51	52	53	53	53	52	52	51	51	50	49	EX5
		115	119	122	124	125	125	125	125	124	122	120	118	116	EX6
		316	327	336	341	344	346	345	344	341	337	332	326	320	EX7
		843	873	894	909	918	921	920	916	908	897	884	869	853	EX8
45	40	15	16	16	17	17	17	17	17	17	17	17	17	16	EX4
		46	48	50	51	52	52	52	52	52	52	51	50	49	EX5
		109	114	118	121	123	124	125	125	124	123	121	120	118	EX6
		300	315	326	334	339	342	344	343	341	338	334	330	324	EX7
		801	840	870	891	905	913	916	915	910	902	891	878	864	EX8
40	35	14	15	16	16	17	17	17	17	17	17	17	17	16	EX4
		42	45	48	49	50	51	52	52	52	51	51	50	50	EX5
		101	108	113	117	120	122	123	123	123	122	121	120	118	EX6
		278	297	312	323	330	335	338	339	338	337	334	330	325	EX7
		742	793	832	860	880	894	901	904	902	897	889	879	866	EX8
35	30	12	14	15	15	16	16	16	17	17	17	17	16	16	EX4
		38	42	45	47	48	49	50	51	51	51	50	50	49	EX5
		90	99	106	111	115	118	119	120	121	120	120	119	117	EX6
		248	273	292	306	317	324	329	331	332	331	329	326	323	EX7
		661	729	779	817	844	864	876	883	885	884	878	870	860	EX8
30	25	10	12	13	14	15	15	16	16	16	16	16	16	16	EX4
		32	37	41	44	46	47	48	49	49	49	49	49	48	EX5
		75	88	97	103	108	112	115	116	117	117	117	116	115	EX6
		207	241	266	285	299	309	316	320	322	323	322	320	317	EX7
		552	644	710	760	796	823	841	853	860	861	859	854	846	EX8
26	20	7	10	12	13	14	14	15	15	16	16	16	16	15	EX4
		23	30	36	39	42	44	46	47	47	48	48	48	47	EX5
		54	72	85	94	100	105	108	111	112	113	113	113	112	EX6
		148	199	233	258	276	289	299	305	309	312	312	311	309	EX7
		395	530	621	687	735	770	796	814	825	831	832	829	824	EX8
21	15		7	9	11	12	13	14	14	15	15	15	15	15	EX4
			21	29	34	38	40	42	44	45	45	46	46	46	EX5
			50	69	81	90	96	101	104	106	108	108	109	108	EX6
			137	189	223	247	265	277	287	293	297	299	299	298	EX7
			365	503	594	658	705	740	764	781	791	796	797	795	EX8
16	10			6	9	11	12	13	13	14	14	14	14	14	EX4
				19	27	32	36	38	40	42	43	43	43	43	EX5
				45	64	76	85	91	96	99	101	103	103	103	EX6
				123	176	210	234	251	264	273	279	282	284	284	EX7
				329	470	561	624	670	704	727	743	753	757	758	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **1.5 bar pressure drop** through liquid line:

Condensing temperature	R 22	Extended capacity kW												Valve Type
	Evaporating temperature °C													
°C	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	17	17	18	18	18	18	18	18	18	17	17	17	17	EX4
	51	52	53	54	54	54	54	54	53	53	52	52	51	EX5
	123	126	128	129	130	130	130	129	128	127	126	124	122	EX6
	337	345	351	355	357	358	357	356	353	350	345	340	335	EX7
	900	921	936	946	952	954	953	948	941	932	921	908	893	EX8
55	16	17	17	18	18	18	18	18	18	18	17	17	17	EX4
	50	51	52	53	54	54	54	54	54	53	53	52	52	EX5
	119	123	126	128	129	130	130	130	129	128	127	126	124	EX6
	328	339	346	352	355	357	358	357	356	353	350	345	340	EX7
	876	903	923	938	948	953	955	953	949	941	932	921	908	EX8
50	16	16	17	17	18	18	18	18	18	18	18	17	17	EX4
	48	50	51	52	53	54	54	54	54	54	53	53	52	EX5
	114	119	123	125	127	129	129	129	129	128	127	126	125	EX6
	314	327	337	345	350	354	355	356	355	353	351	347	343	EX7
	838	873	899	919	933	943	948	949	947	942	935	925	914	EX8
45	15	16	16	17	17	17	17	18	18	18	17	17	17	EX4
	45	47	49	51	52	52	53	53	53	53	53	52	52	EX5
	107	113	118	121	124	126	127	128	128	127	127	126	124	EX6
	295	311	324	334	341	346	349	351	351	350	348	346	342	EX7
	787	830	864	890	909	923	932	936	937	934	929	922	912	EX8
40	13	15	15	16	16	17	17	17	17	17	17	17	17	EX4
	41	44	46	48	50	51	52	52	52	52	52	52	51	EX5
	98	106	111	116	119	122	124	125	125	125	125	124	123	EX6
	270	290	306	319	328	335	340	343	345	345	344	342	339	EX7
	719	774	817	850	875	894	907	915	919	919	916	911	903	EX8
35	12	13	14	15	16	16	16	17	17	17	17	17	17	EX4
	36	40	43	45	47	49	50	50	51	51	51	51	50	EX5
	86	96	103	109	113	117	119	121	122	122	122	122	121	EX6
	237	264	284	300	312	321	327	332	335	336	336	335	333	EX7
	632	703	757	799	831	856	873	885	893	896	896	893	888	EX8
30	10	11	13	14	15	15	16	16	16	16	16	16	16	EX4
	29	35	39	42	44	46	47	48	49	49	49	49	49	EX5
	70	83	93	100	106	110	113	116	117	118	118	118	118	EX6
	194	229	256	276	291	303	312	318	322	325	326	326	324	EX7
	516	611	682	735	776	808	831	848	859	866	869	868	865	EX8
25	7	9	11	12	13	14	15	15	15	16	16	16	16	EX4
	20	28	33	37	40	43	44	46	46	47	47	48	48	EX5
	47	67	80	90	97	102	106	109	112	113	114	114	114	EX6
	130	184	220	246	266	281	292	301	307	311	313	314	314	EX7
	347	491	587	656	709	749	779	802	818	829	835	837	836	EX8
20		6	9	10	12	13	13	14	14	15	15	15	15	EX4
		18	26	32	36	39	41	42	44	45	45	45	46	EX5
		43	63	76	85	93	98	102	105	107	108	109	109	EX6
		117	173	209	235	254	269	280	288	294	298	300	300	EX7
		312	461	557	627	678	718	747	768	784	793	799	801	EX8
15			5	8	10	11	12	13	13	14	14	14	14	EX4
			15	24	30	34	37	39	40	42	42	43	43	EX5
			37	58	71	81	88	93	97	100	102	103	104	EX6
			101	160	196	222	241	256	266	274	279	283	285	EX7
			269	426	524	593	644	682	710	731	745	754	759	EX8
10				4	7	9	10	11	12	13	13	13	13	EX4
				12	22	28	31	34	36	38	39	40	40	EX5
				29	53	66	76	82	87	91	94	96	97	EX6
				80	145	182	208	227	241	251	258	263	267	EX7
				214	386	485	554	604	642	669	689	702	711	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **1.5 bar pressure drop** through liquid line:

Condensing temperature	R 134a	Extended capacity kW												Valve Type
		Evaporating temperature °C												
°C	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	13	13	13	13	13	13	12	12	12	12	11	11	11	EX4
	39	39	39	39	39	39	38	37	36	35	34	33	32	EX5
	93	94	94	94	93	92	90	89	87	84	82	79	77	EX6
	255	257	258	257	255	252	248	243	237	231	224	217	210	EX7
	679	686	688	686	680	672	661	648	633	616	598	580	560	EX8
55	12	13	13	13	13	13	13	12	12	12	12	11	11	EX4
	38	39	39	39	39	39	38	38	37	36	35	34	33	EX5
	91	92	93	94	93	93	92	90	88	86	84	82	80	EX6
	249	253	256	257	256	254	251	247	242	237	231	225	218	EX7
	663	676	683	685	683	678	670	659	647	632	616	599	582	EX8
50	12	12	13	13	13	13	13	12	12	12	12	12	11	EX4
	36	38	38	39	39	39	38	38	37	37	36	35	34	EX5
	87	90	91	92	93	92	92	91	89	88	86	84	81	EX6
	238	246	250	253	254	253	251	249	245	240	235	229	223	EX7
	636	655	668	675	677	676	671	663	653	640	627	611	595	EX8
45	11	12	12	12	12	13	12	12	12	12	12	12	11	EX4
	34	36	37	38	38	38	38	38	37	37	36	35	35	EX5
	81	85	88	90	91	91	91	90	89	88	86	84	82	EX6
	223	234	241	246	248	249	249	247	244	240	236	231	226	EX7
	595	623	642	655	662	664	663	658	651	641	629	616	602	EX8
40	10	11	11	12	12	12	12	12	12	12	12	12	11	EX4
	31	33	35	36	37	37	37	37	37	36	36	35	34	EX5
	74	79	83	85	87	88	89	88	88	87	85	84	82	EX6
	202	217	227	234	239	242	243	242	240	238	234	230	225	EX7
	539	578	606	625	638	645	647	646	641	634	625	614	601	EX8
35	9	10	10	11	11	12	12	12	12	12	12	11	11	EX4
	27	30	32	34	35	35	36	36	36	36	35	35	34	EX5
	63	71	76	80	83	84	85	86	85	85	84	83	81	EX6
	173	194	209	219	226	231	234	235	234	232	230	227	223	EX7
	463	517	556	584	604	616	623	625	624	620	613	604	594	EX8
30	7	8	9	10	11	11	11	11	11	11	11	11	11	EX4
	20	25	28	30	32	33	34	34	34	34	34	34	33	EX5
	49	60	67	73	76	79	81	82	82	82	81	80	79	EX6
	133	164	184	199	210	217	221	224	225	224	223	221	217	EX7
	356	436	492	531	559	578	590	597	600	599	595	588	580	EX8
25	3	6	8	9	9	10	10	11	11	11	11	11	11	EX4
	10	18	23	26	29	30	31	32	33	33	33	32	32	EX5
	23	44	55	63	69	72	75	77	78	78	78	77	76	EX6
	63	121	152	173	188	198	206	210	213	214	213	212	210	EX7
	169	322	406	462	501	529	548	560	567	570	569	565	559	EX8
20		2	5	7	8	9	9	10	10	10	10	10	10	EX4
		5	16	21	25	27	28	29	30	31	31	31	31	EX5
		12	38	51	58	64	68	70	72	73	73	73	73	EX6
		34	105	139	160	175	186	193	197	200	201	201	199	EX7
		90	281	370	427	467	495	514	526	533	536	535	532	EX8
15				4	6	7	8	9	9	9	9	9	9	EX4
				13	19	22	25	26	27	28	28	29	29	EX5
				32	45	53	59	62	65	67	68	68	68	EX6
				87	123	145	161	171	178	183	186	187	187	EX7
				231	328	388	428	456	475	488	495	498	498	EX8
10					3	5	6	7	8	8	8	9	9	EX4
					9	16	20	22	24	25	26	26	26	EX5
					22	38	47	52	56	59	61	62	62	EX6
					61	104	128	144	155	162	167	170	171	EX7
					162	277	341	384	413	432	445	452	455	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **1.5 bar pressure drop** through liquid line:

Condensing temperature	R 404A / R 507				Extended capacity kW									Valve Type
	Evaporating temperature °C													
°C	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	9	9	9	9	9	9	9	8	8	8	7	7	6	EX4
	28	28	28	28	28	27	26	25	24	23	22	21	20	EX5
	68	68	68	67	66	65	63	61	58	56	53	50	47	EX6
	186	187	186	184	181	177	172	166	160	153	145	137	129	EX7
	495	498	496	491	482	471	458	443	425	407	387	366	344	EX8
55	10	10	10	10	10	10	10	9	9	9	8	8	8	EX4
	30	31	31	31	30	30	29	29	28	27	26	25	23	EX5
	72	73	74	74	73	72	70	69	67	64	62	59	56	EX6
	198	201	202	202	200	197	193	188	182	176	169	162	154	EX7
	527	535	538	537	533	525	514	501	486	470	451	432	411	EX8
50	10	10	11	11	11	11	10	10	10	10	9	9	9	EX4
	31	32	32	32	32	32	32	31	30	30	29	28	27	EX5
	74	76	77	78	78	77	76	75	73	71	69	66	64	EX6
	203	208	211	213	213	211	208	204	200	194	188	181	174	EX7
	541	555	564	567	567	562	555	545	532	518	501	484	465	EX8
45	10	10	11	11	11	11	11	11	11	10	10	10	9	EX4
	31	32	33	33	33	33	33	33	32	32	31	30	29	EX5
	74	77	79	80	80	80	80	79	78	76	74	72	69	EX6
	201	210	215	219	220	220	219	216	212	208	202	196	190	EX7
	537	559	574	583	587	586	582	575	566	553	539	524	506	EX8
40	10	10	11	11	11	11	11	11	11	11	11	10	10	EX4
	29	31	33	33	34	34	34	34	34	33	32	32	31	EX5
	71	75	78	80	81	82	82	81	81	79	78	76	74	EX6
	193	205	214	219	223	225	225	223	221	217	213	208	202	EX7
	515	547	570	585	594	598	598	595	588	578	567	553	538	EX8
35	9	10	10	11	11	11	11	11	11	11	11	11	11	EX4
	27	30	31	33	34	34	34	34	34	34	33	33	32	EX5
	65	71	75	79	81	82	83	83	82	81	80	79	77	EX6
	178	195	207	215	221	225	226	226	225	223	219	215	210	EX7
	474	519	551	574	590	599	603	604	600	594	585	573	560	EX8
30	8	9	10	10	11	11	11	11	11	11	11	11	11	EX4
	23	27	30	31	33	34	34	34	34	34	34	33	33	EX5
	56	65	71	75	78	81	82	83	83	82	81	80	79	EX6
	153	177	194	206	215	221	224	226	226	225	223	219	215	EX7
	409	472	517	550	573	588	598	603	603	600	593	584	573	EX8
25	6	8	9	10	10	11	11	11	11	11	11	11	11	EX4
	17	23	27	29	31	32	33	34	34	34	34	34	33	EX5
	42	55	64	70	74	78	80	81	82	82	81	80	79	EX6
	114	150	174	191	204	213	218	222	224	224	223	220	217	EX7
	305	400	465	510	543	566	582	592	596	597	593	587	579	EX8
20	1	5	7	8	9	10	10	11	11	11	11	11	11	EX4
	3	16	22	26	28	30	32	33	33	33	33	33	33	EX5
	8	40	53	62	68	73	76	78	80	80	80	80	79	EX6
	21	108	146	170	187	200	208	214	218	219	220	218	216	EX7
	56	289	388	453	499	532	555	571	580	585	585	582	576	EX8
15			5	7	8	9	10	10	10	11	11	11	11	EX4
			15	21	25	28	29	31	32	32	32	33	32	EX5
			37	51	60	66	71	74	76	77	78	78	78	EX6
			101	139	164	181	194	202	208	212	213	214	213	EX7
			268	371	437	484	516	540	555	564	569	569	566	EX8
10				5	7	8	9	9	10	10	10	10	10	EX4
				14	20	24	26	28	30	31	31	31	31	EX5
				33	48	57	64	68	71	73	75	75	75	EX6
				91	131	156	174	186	195	201	204	206	206	EX7
				242	350	417	464	496	519	535	544	548	549	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering 1.5 bar pressure drop through liquid line:

Condensing temperature °C	R 23 Extended capacity kW, Evaporating temperature °C												Valve Type
	-45	-50	-55	-60	-65	-70	-75	-80	-85	-90	-95	-100	
-10	17	18	19	19	19	19	19	19	19	19	19	18	EX4
	53	55	56	57	58	58	58	58	58	57	57	56	EX5
	127	132	135	138	139	140	140	140	139	138	137	135	EX6
-15	16	17	18	18	19	19	19	19	19	19	18	18	EX4
	50	52	54	55	56	57	57	57	57	57	56	55	EX5
	119	125	130	133	135	137	137	137	137	136	135	134	EX6
-20	15	16	17	17	18	18	18	18	18	18	18	18	EX4
	45	48	51	53	54	55	55	55	55	55	55	54	EX5
	109	117	122	127	130	132	133	134	133	133	132	131	EX6
-25	13	14	15	16	17	17	17	18	18	18	18	17	EX4
	40	44	47	49	51	52	53	53	53	53	53	53	EX5
	96	106	113	118	122	125	127	128	129	128	128	127	EX6
-30	11	13	14	15	16	16	16	17	17	17	17	17	EX4
	33	38	42	45	47	49	50	51	51	51	51	51	EX5
	78	92	101	108	114	117	120	122	122	123	123	122	EX6
-35	7	10	12	13	14	15	15	16	16	16	16	16	EX4
	22	30	36	40	43	45	46	47	48	48	48	48	EX5
	53	73	86	96	103	108	111	114	115	116	116	116	EX6
-40		6	9	11	12	13	14	14	15	15	15	15	EX4
		19	28	33	37	40	42	43	44	45	45	45	EX5
		46	67	80	90	96	101	104	106	108	108	108	EX6
-45			5	8	10	11	12	13	13	13	14	14	EX4
			15	25	30	34	37	39	40	41	41	41	EX5
			37	60	73	82	88	93	96	98	99	100	EX6

Condensing temperature °C	R 124 Extended capacity kW, Evaporating temperature °C							Valve Type
	30	25	20	15	10	5	0	
100	7	7	7	6	6	6	5	EX4
	22	21	20	19	18	17	16	EX5
	53	51	49	47	44	42	39	EX6
95	8	8	7	7	7	7	6	EX4
	24	23	23	22	21	20	19	EX5
	57	56	54	52	50	47	45	EX6
90	8	8	8	8	7	7	7	EX4
	25	25	24	24	23	22	21	EX5
	61	59	58	56	54	52	50	EX6
85	9	9	8	8	8	8	7	EX4
	26	26	25	25	24	23	23	EX5
	63	62	61	60	58	56	54	EX6
80	9	9	9	8	8	8	8	EX4
	27	27	26	26	25	25	24	EX5
	64	63	63	62	61	59	57	EX6
75	9	9	9	9	9	8	8	EX4
	27	27	27	26	26	25	25	EX5
	64	64	64	63	62	61	60	EX6
70	9	9	9	9	9	9	8	EX4
	26	26	27	27	26	26	25	EX5
	62	63	64	63	63	62	61	EX6
65	8	8	9	9	9	9	8	EX4
	25	26	26	26	26	26	26	EX5
	60	61	62	63	63	62	62	EX6
60	8	8	8	8	8	8	8	EX4
	23	24	25	26	26	26	26	EX5
	56	58	60	61	62	62	61	EX6

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering 1.5 bar pressure drop through liquid line:

Condensing temperature °C	R 744 Extended capacity kW Evaporating temperature °C													Valve Type
	8	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	
10	5	12	18	22	26	29	31	33	34	35	36	37	38	EX4
	15	36	55	68	79	87	94	99	104	108	110	113	114	EX5
	36	86	132	164	189	208	225	238	249	257	264	269	273	EX6
	99	237	362	450	518	572	617	653	683	707	726	740	750	EX7
	-	-	-	-	-	-	-	-	-	-	-	-	-	EX8
5			12	19	23	27	29	32	33	35	36	37	38	EX4
			37	57	71	81	90	96	102	106	110	113	115	EX5
			89	137	170	195	215	231	244	254	263	269	274	EX6
			244	376	466	535	589	634	670	699	722	739	753	EX7
			-	-	-	-	-	-	-	-	-	-	-	EX8
0				12	19	24	27	30	32	34	35	36	37	EX4
				38	58	72	83	91	98	103	107	111	113	EX5
				90	139	173	198	218	234	247	257	265	271	EX6
				247	383	475	544	598	642	677	705	727	744	EX7
				659	1023	1267	1452	1598	1715	1809	1883	1942	1987	EX8
-5					12	19	24	27	30	32	34	35	36	EX4
					37	59	73	83	91	98	103	107	110	EX5
					89	140	174	199	219	234	247	257	264	EX6
					245	385	477	547	601	644	678	705	725	EX7
					654	1028	1275	1460	1604	1718	1809	1881	1937	EX8
-10						12	19	24	27	30	32	34	35	EX4
						36	58	72	83	91	97	102	106	EX5
						87	139	173	198	217	233	245	254	EX6
						239	382	475	544	597	639	671	697	EX7
						639	1021	1269	1452	1594	1705	1793	1861	EX8
-15							11	19	23	27	29	31	33	EX4
							35	57	71	82	89	96	100	EX5
							84	137	171	195	214	229	240	EX6
							229	376	468	536	588	628	660	EX7
							613	1003	1250	1431	1570	1677	1761	EX8
-20								11	18	23	26	29	31	EX4
								33	56	70	80	87	93	EX5
								79	133	166	191	209	223	EX6
								216	365	457	523	574	613	EX7
								576	974	1220	1398	1532	1636	EX8
-25									10	18	22	25	28	EX4
									30	53	67	77	85	EX5
									72	128	161	185	202	EX6
									198	350	442	507	556	EX7
									528	935	1179	1353	1483	EX8
-30										9	17	21	24	EX4
										27	51	64	74	EX5
										64	121	154	177	EX6
										175	332	423	486	EX7
										466	887	1129	1298	EX8
-35											7	16	20	EX4
											22	47	61	EX5
											53	113	146	EX6
											145	310	400	EX7
											386	828	1068	EX8
-40												5	14	EX4
												16	43	EX5
												37	103	EX6
												103	284	EX7
												275	759	EX8

EX4/EX5/EX6/EX7/EX8 Nominal and extended capacities as hot gas bypass regulator

Nominal Capacities, kW

Valve Type	Kv, m^3/h	R 22/R 407C	R 134a	R 404A/R 507
EX4	0.21	4.9	3.4	4.6
EX5	0.68	16	11	15
EX6	1.57	37	26	35
EX7	5.58	131	92	126
EX8	16.95	399	278	382

Nominal capacities at +4°C, +38°C bubble point for all refrigerants (+43°C dew point for R407C).
Remarks: EX4, EX5, EX6, EX7 and EX8 must be installed with motor downward in hot gas line applications.
This insures the valve life expectancy.

Extended capacities, kW

Liquid / Condensing temperature °C	R 22 / R 407C	R 134a	R 404A / R 507	Valve type
60 bubble point for all refrigerants (64 dew point for R407C)	7	4.9	5.8	EX4
	23	16	19	EX5
	54	38	45	EX6
	191	135	161	EX7
	581	411	488	EX8
50 bubble point for all refrigerants (54 dew point for R407C)	6.1	4.3	5.5	EX4
	20	14	18	EX5
	46	32	41	EX6
	163	115	147	EX7
	495	348	447	EX8
40 bubble point for all refrigerants (45 dew point for R407C)	4.9	3.7	4.9	EX4
	16	12	16	EX5
	38	27	36	EX6
	136	95	130	EX7
	414	289	394	EX8
30 bubble point for all refrigerants (35 dew point for R407C)	4.3	2.8	4	EX4
	14	9	13	EX5
	32	22	31	EX6
	112	78	111	EX7
	340	236	336	EX8

EX6/EX7/EX8 Nominal and extended capacities as suction pressure regulator (evaporator or crankcase)

Nominal Capacities, kW

Valve Type	Kv, m^3/h	R 407C	R 22	R 134a	R 404A
EX6	1.57	3.9	4.1	3.1	3.5
EX7	5.58	14	15	11	13
EX8	16.95	42	45	34	38

Nominal capacities at +4°C, +38°C bubble point for all refrigerants (+43°C dew point for R407C) and 0.15 bar pressure drop.
Remarks: EX4, EX5, EX6, EX7 and EX8 must be installed with motor downward in suction line applications.
This insures the valve life expectancy.

Multiply above nominal capacities by following factors to obtain capacities at different pressure drops:

ΔP, bar	0.10	0.15	0.20	0.30
Correction factor	0.82	1.00	1.15	1.41

Example:
EX6 provides 3.5 kW at 0.15 bar pressure drop with R404A: 3.5*1.41 = 4.9 kW capacity at 0.3 bar pressure drop.

Extended capacities in kW, suction pressure regulator duty

Condensing temperature °C	Extended capacity kW R 22 Evaporating temperature °C 10	5	0	-10	-20	-30	-40	Valve Type
60	4	3	3	3	2	2	1	EX6
	13	12	11	9	7	5	4	EX7
	41	37	34	27	22	17	12	EX8
50	4	4	3	3	2	2	1	EX6
	15	13	12	10	8	6	5	EX7
	45	41	37	30	24	19	14	EX8
40	5	4	4	3	2	2	1	EX6
	16	15	13	11	9	7	5	EX7
	49	45	41	33	27	21	15	EX8
30	5	4	4	3	3	2	2	EX6
	17	16	14	12	9	7	5	EX7
	53	48	44	36	29	22	16	EX8
20	5	5	4	4	3	2	2	EX6
	19	17	15	13	10	8	6	EX7
	56	52	47	39	31	24	18	EX8

Condensing temperature Dew point °C	Bubble point °C	Extended capacity kW R 407C Evaporating temperature °C 10	5	0	-10	-20	Valve Type
64	60	3	3	3	2	2	EX6
		12	11	10	8	6	EX7
		36	33	29	23	18	EX8
54	50	4	3	3	2	2	EX6
		14	12	11	9	7	EX7
		41	37	34	27	21	EX8
45	40	4	4	3	3	2	EX6
		15	14	12	10	8	EX7
		46	42	38	30	23	EX8
35	30	5	4	4	3	2	EX6
		17	15	14	11	9	EX7
		51	46	41	33	26	EX8
26	20	5	5	4	3	3	EX6
		18	16	15	12	9	EX7
		55	50	45	36	28	EX8

Extended capacities in kW, suction pressure regulator duty

Condensing temperature °C	R 134a	Extended capacity kW Evaporating temperature °C					Valve Type
		10	5	0	-10	-20	
60		3	2	2	2	1	EX6
		10	9	8	6	4	EX7
		30	27	24	18	13	EX8
50		3	3	2	2	1	EX6
		11	10	9	7	5	EX7
		34	30	27	21	15	EX8
40		3	3	3	2	2	EX6
		12	11	10	8	6	EX7
		38	34	30	23	17	EX8
30		4	3	3	2	2	EX6
		14	12	11	8	6	EX7
		41	37	33	26	19	EX8
20		4	4	3	3	2	EX6
		15	13	12	9	7	EX7
		45	40	36	28	21	EX8

Condensing temperature °C	R 404A / R507	Extended capacity kW Evaporating temperature °C						Valve Type
	10	5	0	-10	-20	-30	-40	
60	3	2	2	2	1	1	1	EX6
	9	8	8	6	4	3	2	EX7
	29	26	23	18	13	10	7	EX8
50	3	3	3	2	2	1	1	EX6
	12	11	9	7	6	4	3	EX7
	36	32	29	23	18	13	9	EX8
40	4	3	3	3	2	1	1	EX6
	14	12	11	9	7	5	4	EX7
	42	38	34	27	21	16	12	EX8
30	4	4	4	3	2	2	1	EX6
	16	14	13	10	8	6	5	EX7
	48	43	39	31	25	19	14	EX8
20	5	4	4	3	3	2	1	EX6
	17	16	14	12	9	7	5	EX7
	53	48	44	35	28	21	16	EX8

EX5/EX6/EX7/EX8 Nominal and extended capacities as condensing pressure regulator and liquid duty

Nominal Capacities, kW

Valve Type	Kv, m^3/h	R 407C	R 22	R 134a	R 404A
EX5	0.68	18	20	18	13
EX6	1.57	43	46	42	30
EX7	5.58	153	162	151	106
EX8	16.95	463	491	458	323

Nominal capacities at +4°C, +38°C bubble point for all refrigerants (+43°C dew point for R407C) and 0,35 bar pressure drop.
Multiply above nominal capacities by following factors to obtain capacities at different pressure drops.

ΔP, bar	0.15	0.20	0.35
Correction factor	0.65	0.76	1.00

Extended capacities, kW

Condensing temperature °C	R 22 Extended capacity kW, Evaporating temperature °C: 10	0	-10	-20	-30	-40	Valve Type
60	15	15	15	14	14	13	EX5
	36	35	34	33	32	30	EX6
	128	124	120	116	112	108	EX7
	387	377	365	353	341	328	EX8
50	17	17	16	17	16	15	EX5
	41	40	36	39	36	35	EX6
	144	141	129	137	129	124	EX7
	439	428	391	416	391	377	EX8
40	19	19	19	18	17	17	EX5
	45	44	43	42	41	39	EX6
	161	157	153	149	145	140	EX7
	488	477	465	453	439	426	EX8
30	21	21	20	20	19	19	EX5
	50	49	48	46	45	44	EX6
	177	173	169	165	160	156	EX7
	536	525	513	500	486	472	EX8
20	23	23	22	22	21	21	EX5
	54	53	52	51	49	48	EX6
	192	188	184	180	175	171	EX7
	584	572	560	547	533	519	EX8

Condensing temperature °C	R 134a Extended capacity kW, Evaporating temperature °C: 10	0	-10	-20	-30	-40	Valve Type
60	14	13	13	12			EX5
	32	31	29	27			EX6
	115	109	104	98			EX7
	350	332	315	296			EX8
50	16	15	15	14			EX5
	37	36	34	32			EX6
	133	127	121	115			EX7
	405	387	369	350			EX8
40	18	18	17	16			EX5
	42	41	39	37			EX6
	151	145	139	133			EX7
	458	440	422	403			EX8
30	20	20	19	18			EX5
	47	46	44	42			EX6
	168	162	156	150			EX7
	512	493	474	455			EX8
20	22	22	21	20			EX5
	52	51	49	47			EX6
	186	180	173	167			EX7
	564	546	526	507			EX8

Extended capacities in kW, condensing pressure and liquid regulator

Condensing temperature °C	R 404A/R 507 Extended capacity kW Evaporating temperature °C 10	0	-10	-20	-30	-40	Valve Type
60	8	8	7	6	6	5	EX5
	19	17	16	15	13	12	EX6
	66	62	58	53	48	43	EX7
	202	189	175	160	146	130	EX8
50	11	10	9	9	8	8	EX5
	24	23	22	20	19	17	EX6
	87	82	78	73	67	62	EX7
	264	250	236	220	205	189	EX8
40	13	12	12	11	10	10	EX5
	30	28	27	26	24	23	EX6
	106	101	96	91	85	80	EX7
	321	306	291	276	260	243	EX8
30	15	14	14	13	12	12	EX5
	35	33	32	30	29	27	EX6
	123	119	114	108	103	97	EX7
	375	360	345	329	312	295	EX8
20	17	16	16	15	14	14	EX5
	40	38	37	35	34	32	EX6
	141	136	131	125	120	114	EX7
	427	412	397	380	363	346	EX8

Condensing temperature Dew point °C	Bubble point °C	R 407C Extended capacity kW Evaporating temperature °C 10	0	-10	-20	Valve Type
64	60	14	13	12	12	EX5
		32	30	29	28	EX6
		112	108	103	98	EX7
		340	327	313	298	EX8
54	50	16	15	15	14	EX5
		37	36	35	33	EX6
		132	128	123	118	EX7
		402	388	373	358	EX8
45	40	18	18	17	17	EX5
		43	41	40	38	EX6
		152	147	142	137	EX7
		460	446	431	415	EX8
35	30	21	20	19	19	EX5
		48	47	45	44	EX6
		170	166	160	155	EX7
		517	503	487	471	EX8
26	20	23	22	22	21	EX5
		53	52	50	49	EX6
		189	184	179	173	EX7
		573	558	543	526	EX8

EX6/EX7/EX8 Nominal and extended capacities for hot gas flow such as heat reclaim application

Nominal Capacities, kW

Valve Type	Kv, m^3/h	R 22 / R 407C	R 134a	R 404A/R 507	R 410A
EX6	1.57	11	9	10	13
EX7	5.58	39	33	36	47
EX8	16.95	119	101	108	144

Nominal capacities are at 0.5 bar pressure drops, +4°C evaporating temperature, +38°C bubble point for all refrigerants (+43°C dew point for R407C) and 0.8 isentropic efficiency of compressor. For other conditions, page 17-20.

Remarks: EX6/EX7/EX8 must be installed with motor downward in hot gas line applications. This insures the valve life expectancy.

Extended capacities, kW

Condensing temperature °C	Pressure drop bar	R 404A Extended capacity kW Evaporating temperature °C 15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	Valve Type
60	0.1	4	4	4	4	4	3	3	3	3	3	3	2	2	EX6
		15	14	14	13	13	12	11	11	10	10	9	8	8	EX7
		45	43	42	40	38	36	35	33	31	29	27	25	23	EX8
	0.5	9	9	8	8	8	7	7	7	6	6	6	5	5	EX6
		32	31	30	29	28	26	25	24	22	21	20	18	17	EX7
		99	95	92	88	84	80	76	72	68	64	60	56	52	EX8
	1	13	12	12	11	11	10	10	9	9	8	8	7	7	EX6
		45	44	42	40	39	37	35	33	31	29	27	26	24	EX7
		137	132	127	122	117	112	106	101	95	89	84	78	72	EX8
50	0,1	5	4	4	4	4	4	4	4	3	3	3	3	3	EX6
		16	16	15	15	14	14	13	13	12	11	11	10	10	EX7
		49	47	46	44	43	41	40	38	36	35	33	31	30	EX8
	0.5	10	10	9	9	9	8	8	8	7	7	7	6	6	EX6
		35	34	33	32	31	30	29	28	26	25	24	23	22	EX7
		107	104	101	98	95	91	88	84	80	77	73	69	65	EX8
	1	14	13	13	13	12	12	11	11	10	10	9	9	8	EX6
		49	48	46	45	43	42	40	38	37	35	33	32	30	EX7
		149	145	141	136	131	127	122	117	112	107	102	96	91	EX8
40	0.1	5	4	4	4	4	4	4	4	4	3	3	3	3	EX6
		16	16	16	15	15	14	14	13	13	12	12	11	11	EX7
		50	49	47	46	45	43	42	40	39	37	36	34	33	EX8
	0.5	10	10	10	9	9	9	9	8	8	8	7	7	7	EX6
		36	35	34	33	32	31	30	29	28	27	26	25	24	EX7
		109	107	104	101	98	95	92	89	86	83	79	76	73	EX8
	1	14	14	13	13	13	12	12	11	11	11	10	10	9	EX6
		50	49	48	46	45	44	42	41	39	38	36	35	33	EX7
		152	148	144	140	136	132	128	124	119	115	110	105	101	EX8
30	0.1	5	4	4	4	4	4	4	4	4	4	3	3	3	EX6
		16	16	15	15	15	14	14	13	13	13	12	12	11	EX7
		49	48	47	46	45	43	42	41	40	38	37	36	34	EX8
	0.5	10	10	10	9	9	9	9	8	8	8	8	7	7	EX6
		35	35	34	33	32	31	31	30	29	28	27	26	25	EX7
		108	105	103	101	98	95	93	90	87	84	81	78	76	EX8
	1	14	13	13	13	13	12	12	12	11	11	10	10	10	EX6
		49	48	47	46	45	43	42	41	40	38	37	36	34	EX7
		149	146	142	139	135	132	128	124	120	117	113	109	104	EX8

Extended capacities kW, hot gas flow such as heat reclaim applications

Condensing temperature °C	Pressure drop bar	Extended capacity kW R 134a Evaporating temperature °C													Valve Type
		15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	0.1	5	5	4	4	4	4	4	4	4	3	3	3	3	EX6
		16	16	16	15	15	14	14	13	13	12	12	11	10	EX7
		50	49	47	46	44	43	41	40	38	37	35	33	32	EX8
	0.5	10	10	10	9	9	9	8	8	8	7	7	7	6	EX6
		36	35	34	33	32	31	30	29	28	26	25	24	23	EX7
		110	107	104	101	97	94	91	87	84	80	77	74	70	EX8
	1	14	14	13	13	12	12	12	11	11	10	10	9	9	EX6
		50	49	47	46	44	43	41	40	38	37	35	34	32	EX7
		152	148	144	139	135	130	126	121	116	112	107	102	97	EX8
50	0,1	5	4	4	4	4	4	4	4	4	3	3	3	3	EX6
		16	16	15	15	14	14	14	13	13	12	12	11	11	EX7
		49	48	47	45	44	43	41	40	39	37	36	35	33	EX8
	0.5	10	10	9	9	9	9	8	8	8	8	7	7	7	EX6
		35	35	34	33	32	31	30	29	28	27	26	25	24	EX7
		108	105	102	99	97	94	91	88	85	82	79	76	73	EX8
	1	14	13	13	13	12	12	12	11	11	10	10	10	9	EX6
		49	48	46	45	44	43	41	40	39	37	36	34	33	EX7
		148	145	141	137	133	129	125	121	117	113	109	105	100	EX8
40	0.1	4	4	4	4	4	4	4	4	4	3	3	3	3	EX6
		16	15	15	14	14	14	13	13	13	12	12	11	11	EX7
		47	46	45	44	43	42	40	39	38	37	36	34	33	EX8
	0.5	10	9	9	9	9	8	8	8	8	7	7	7	7	EX6
		34	33	32	32	31	30	29	28	27	26	26	25	24	EX7
		103	100	98	96	93	91	88	86	83	80	78	75	73	EX8
	1	13	13	12	12	12	12	11	11	11	10	10	10	9	EX6
		46	45	44	43	42	41	40	39	38	36	35	34	33	EX7
		141	138	134	131	128	124	121	117	114	110	107	103	100	EX8
30	0.1	4	4	4	4	4	4	4	3	3	3	3	3	3	EX6
		15	14	14	14	13	13	13	12	12	12	11	11	11	EX7
		44	43	42	42	41	40	39	38	37	35	34	33	32	EX8
	0.5	9	9	9	8	8	8	8	8	7	7	7	7	6	EX6
		32	31	30	30	29	28	28	27	26	25	25	24	23	EX7
		96	94	92	90	88	86	84	81	79	77	75	72	70	EX8
	1	12	12	12	11	11	11	11	10	10	10	9	9	9	EX6
		43	42	41	40	39	38	37	36	35	34	33	32	31	EX7
		130	128	125	122	119	117	114	111	108	105	102	98	95	EX8

Extended capacities kW, hot gas flow such as heat reclaim applications

Condensing temperature °C	Pressure drop bar	R 22 / R 407C* Extended capacity kW Evaporating temperature °C													Valve Type
		15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	0.1	6	5	5	5	5	5	5	5	4	4	4	4	4	EX6
		20	19	19	18	18	17	17	16	16	15	15	14	14	EX7
		59	58	57	55	54	53	51	50	48	47	45	44	42	EX8
	0.5	12	12	12	11	11	11	10	10	10	10	9	9	9	EX6
		43	42	41	40	39	38	37	36	35	34	33	32	31	EX7
		131	129	126	123	119	116	113	110	107	103	100	97	94	EX8
	1	17	17	16	16	15	15	15	14	14	13	13	13	12	EX6
		60	59	58	56	55	53	52	51	49	48	46	45	43	EX7
		183	179	175	171	167	162	158	154	149	145	140	135	131	EX8
50	0,1	5	5	5	5	5	5	5	5	4	4	4	4	4	EX6
		19	19	18	18	17	17	17	16	16	15	15	14	14	EX7
		58	57	56	54	53	52	51	49	48	47	45	44	42	EX8
	0.5	12	12	11	11	11	11	10	10	10	10	9	9	9	EX6
		42	41	40	40	39	38	37	36	35	34	33	32	31	EX7
		128	126	123	120	117	115	112	109	106	103	100	97	94	EX8
	1	17	16	16	15	15	15	14	14	14	13	13	13	12	EX6
		59	57	56	55	54	52	51	50	49	47	46	44	43	EX7
		178	175	171	167	163	159	155	151	147	143	139	135	131	EX8
40	0.1	5	5	5	5	5	5	5	4	4	4	4	4	4	EX6
		18	18	18	17	17	16	16	16	15	15	15	14	14	EX7
		56	55	54	52	51	50	49	48	47	45	44	43	42	EX8
	0.5	11	11	11	11	10	10	10	10	9	9	9	9	8	EX6
		40	40	39	38	37	36	35	35	34	33	32	31	30	EX7
		123	120	118	115	113	110	108	105	103	100	97	94	92	EX8
	1	16	15	15	15	14	14	14	14	13	13	12	12	12	EX6
		56	55	54	53	52	50	49	48	47	46	44	43	42	EX7
		170	167	163	160	157	153	149	146	142	139	135	131	127	EX8
30	0.1	5	5	5	5	4	4	4	4	4	4	4	4	4	EX6
		17	17	17	16	16	16	15	15	15	14	14	14	13	EX7
		53	52	51	50	49	48	46	45	44	43	42	41	40	EX8
	0.5	11	10	10	10	10	10	9	9	9	9	9	8	8	EX6
		38	37	37	36	35	34	34	33	32	31	30	30	29	EX7
		115	113	111	109	107	104	102	100	97	95	93	90	88	EX8
	1	15	14	14	14	14	13	13	13	12	12	12	12	11	EX6
		52	51	50	49	48	47	46	45	44	43	42	41	40	EX7
		159	156	153	150	147	144	141	138	134	131	128	124	121	EX8

***) Condensing temperatures R 407C:**

The relation between bubble points and dew points is as follows:

Dew point °C	Bubble point °C
64	**60**
54	**50**
45	**40**
35	**30**

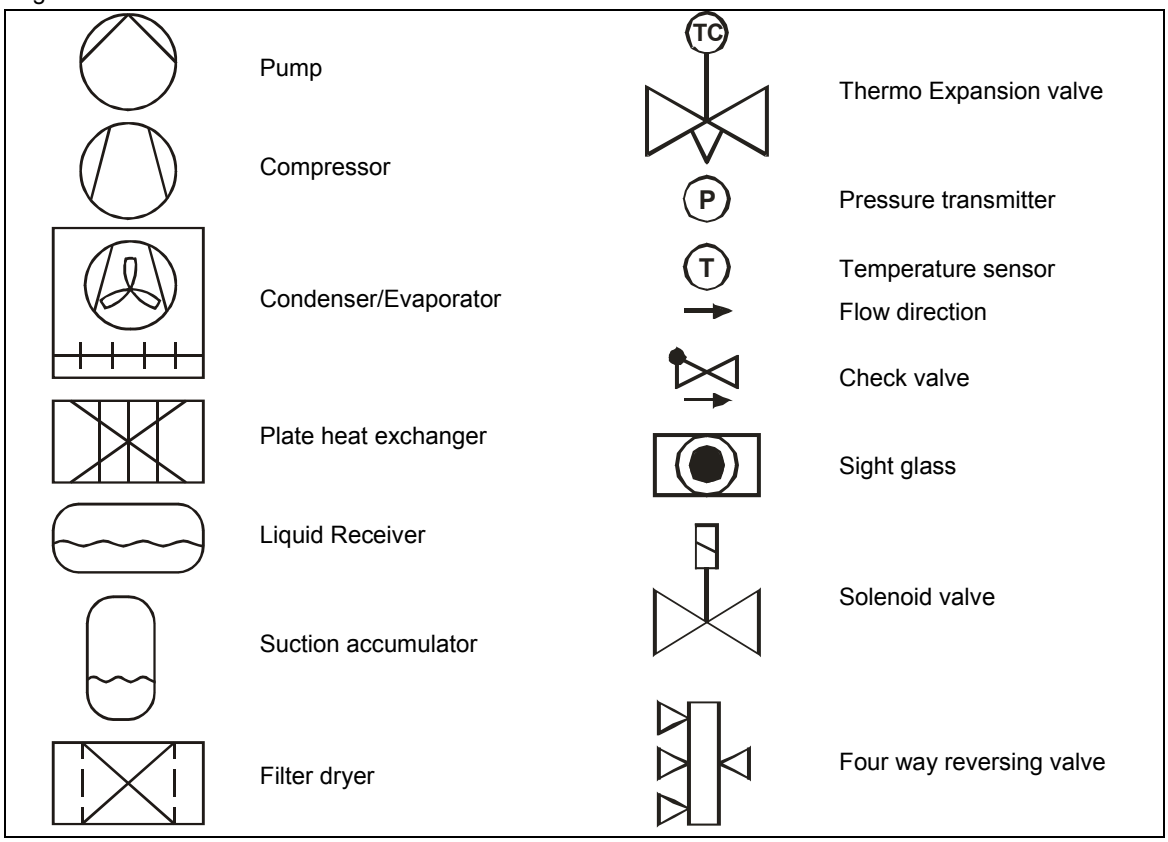
Extended capacities kW, hot gas flow such as heat reclaim applications

Condensing temperature °C	Pressure drop bar	Extended capacity kW R 410A Evaporating temperature °C													Valve Type
		15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	
60	0.1	6	6	6	6	5	5	5	5	5	5	4	4	4	EX6
		21	21	20	20	19	19	18	18	17	16	16	15	15	EX7
		64	63	62	60	58	57	55	53	52	50	48	46	44	EX8
	0.5	13	13	13	12	12	12	11	11	11	10	10	10	9	EX6
		47	46	45	44	43	41	40	39	38	36	35	34	32	EX7
		143	140	137	133	130	126	122	118	115	111	107	103	99	EX8
	1	19	18	18	17	17	16	16	15	15	14	14	13	13	EX6
		66	64	63	61	60	58	56	55	53	51	49	47	46	EX7
		200	196	191	186	182	177	171	166	161	155	150	144	138	EX8
50	0,1	6	6	6	6	6	6	5	5	5	5	5	5	4	EX6
		22	22	21	21	20	20	19	19	18	18	17	17	16	EX7
		67	66	65	63	62	60	59	57	55	54	52	50	48	EX8
	0.5	14	14	13	13	13	12	12	12	11	11	11	10	10	EX6
		49	48	47	46	45	44	43	42	40	39	38	37	35	EX7
		149	146	143	140	137	133	130	126	123	119	115	111	108	EX8
	1	19	19	19	18	18	17	17	16	16	15	15	14	14	EX6
		69	67	66	64	63	61	60	58	57	55	53	51	50	EX7
		209	204	200	196	191	186	182	177	172	167	161	156	151	EX8
40	0.1	6	6	6	6	6	6	5	5	5	5	5	5	5	EX6
		22	22	21	21	20	20	19	19	18	18	17	17	16	EX7
		67	66	65	63	62	60	59	58	56	54	53	51	50	EX8
	0.5	14	13	13	13	13	12	12	12	11	11	11	11	10	EX6
		49	48	47	46	45	44	43	42	41	40	39	37	36	EX7
		148	146	143	140	137	134	131	127	124	121	117	114	110	EX8
	1	19	19	18	18	18	17	17	16	16	16	15	15	14	EX6
		68	67	66	64	63	61	60	59	57	55	54	52	51	EX7
		207	203	199	195	191	187	182	178	173	168	164	159	154	EX8
30	0.1	6	6	6	6	6	5	5	5	5	5	5	5	5	EX6
		21	21	21	20	20	19	19	19	18	18	17	17	16	EX7
		65	64	63	61	60	59	58	56	55	53	52	51	49	EX8
	0.5	13	13	13	13	12	12	12	12	11	11	11	10	10	EX6
		47	46	45	45	44	43	42	41	40	39	38	37	36	EX7
		143	141	138	135	133	130	127	124	121	118	115	112	109	EX8
	1	18	18	18	17	17	17	16	16	16	15	15	14	14	EX6
		65	64	63	62	61	60	58	57	56	54	53	51	50	EX7
		199	195	192	188	185	181	177	173	169	165	160	156	152	EX8

Application of control valves in systems

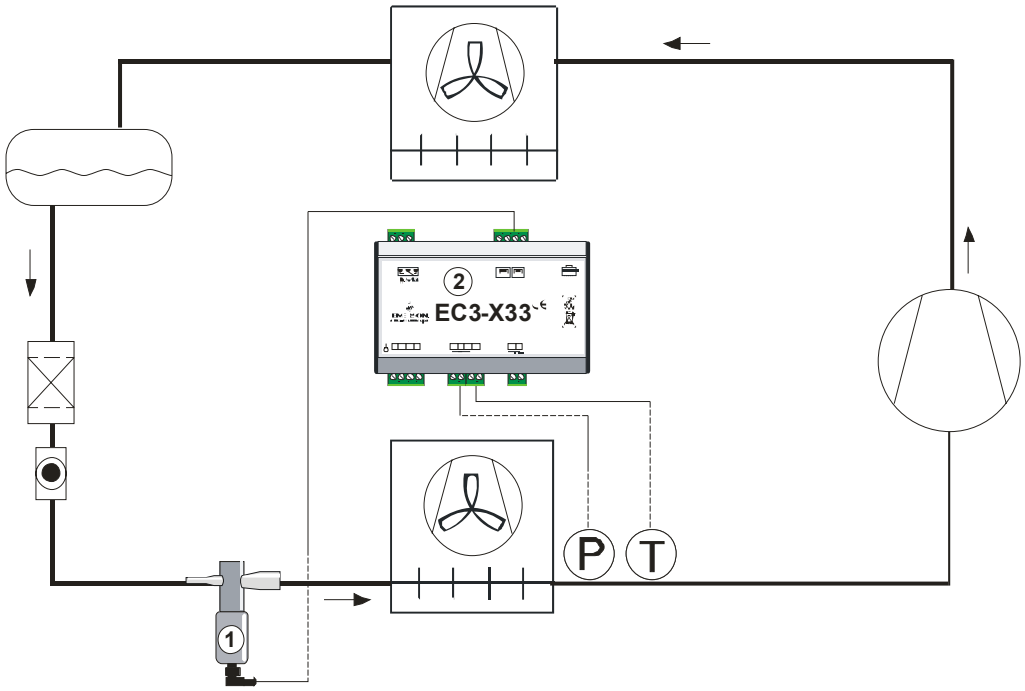
The following schematics show the arrangement of integrated valves for different applications.

Legends:



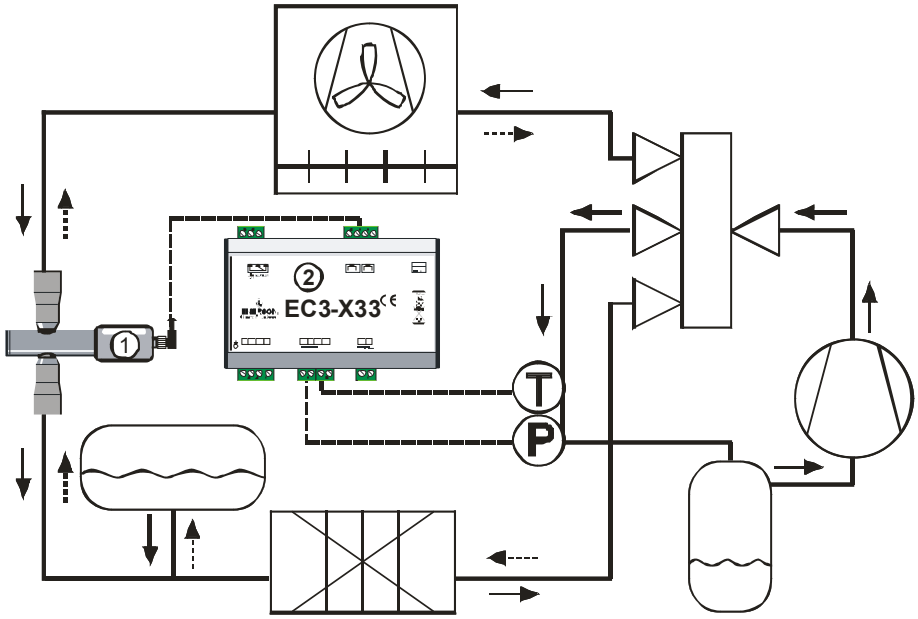
Overview applications:

Application 1: Expansion valve in cooling system



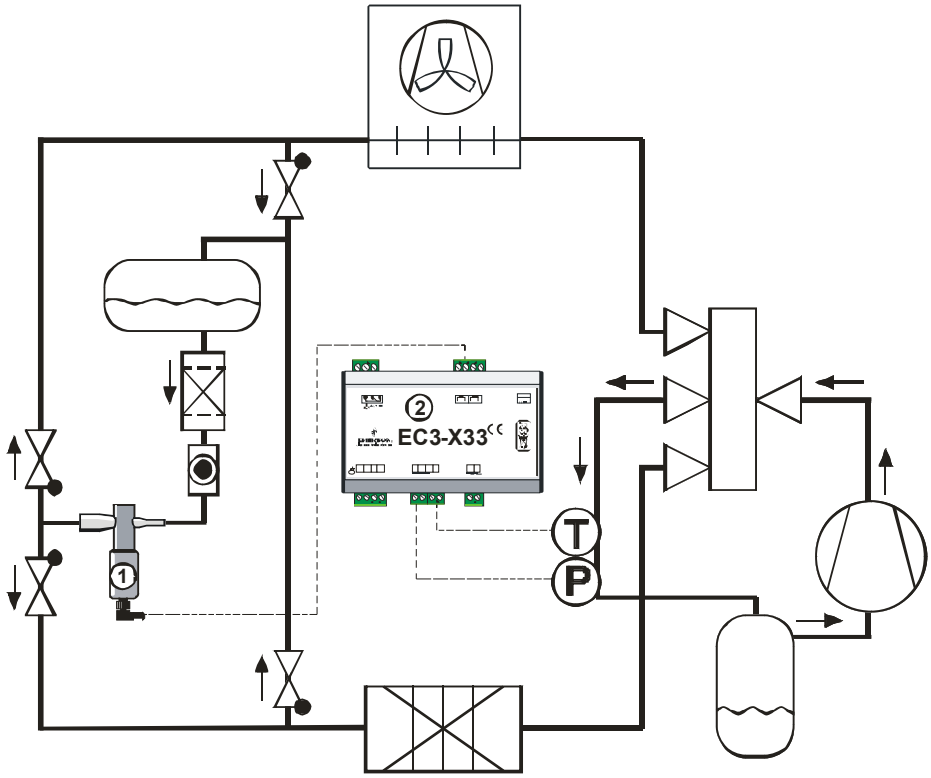
(1) = Expansion Valve
(2) = Superheat controller EC3-X33

Application 2: Bi-Flow expansion valve in heat pump (except EX8)



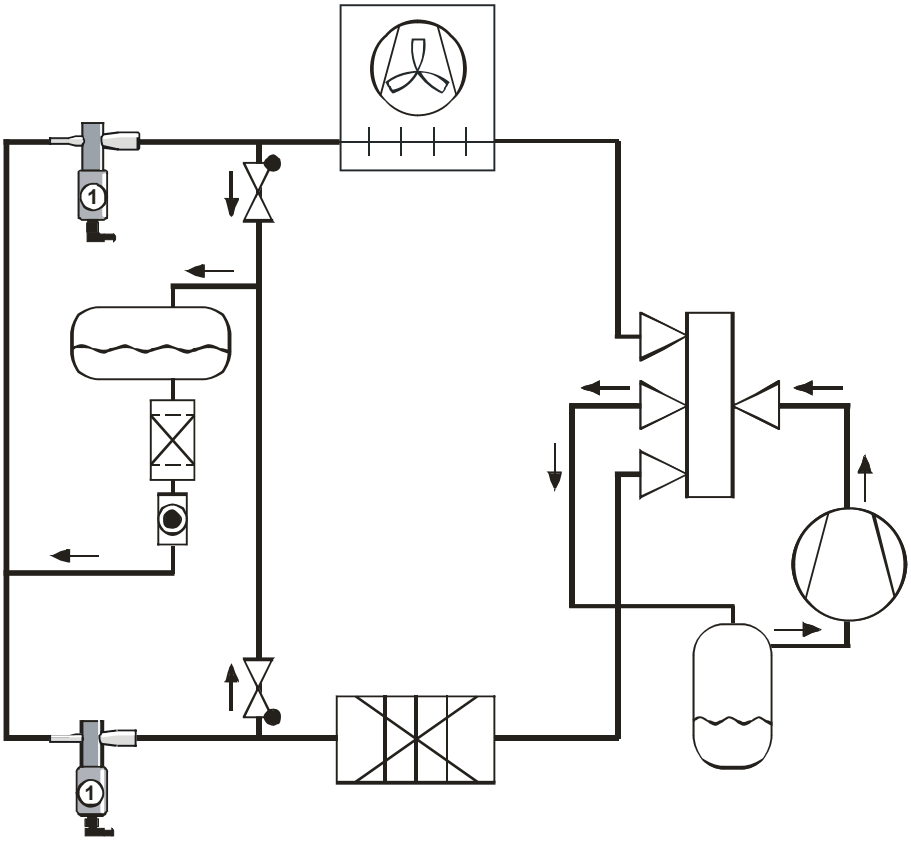
(1) = Bi-Flow Expansion Valve
(2) = Superheat controller EC3-X33

Application 3: Expansion valve in heat pump (one valve)



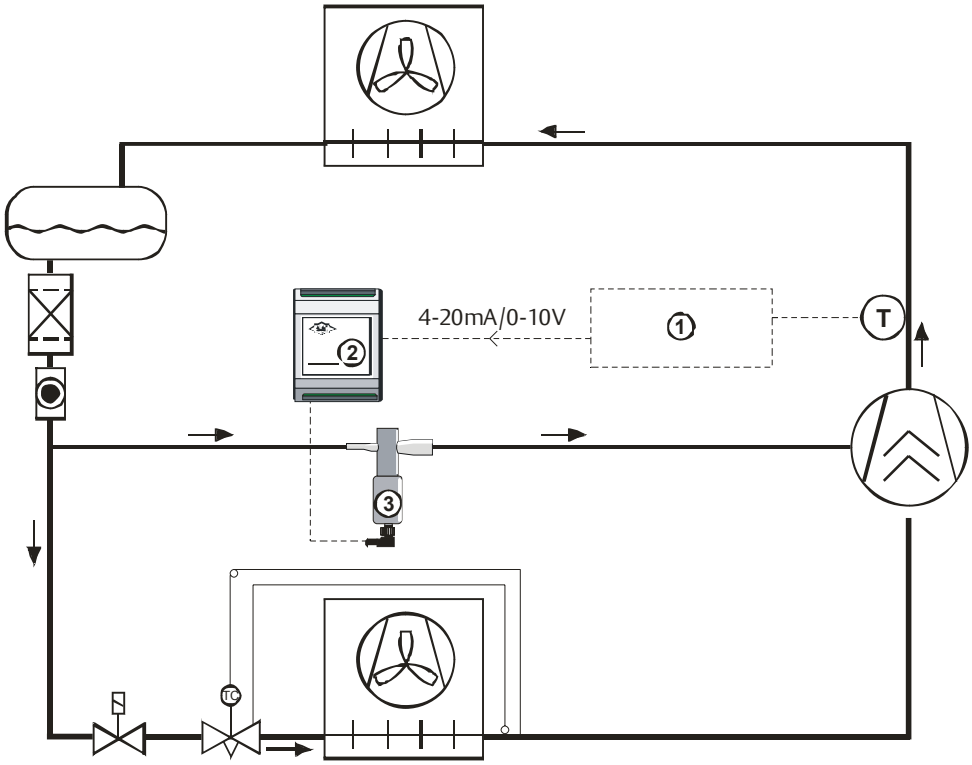
(1) = Expansion Valve
(2) = Superheat controller EC3-X33

Application 4: Expansion valve in heat pump (two valves)



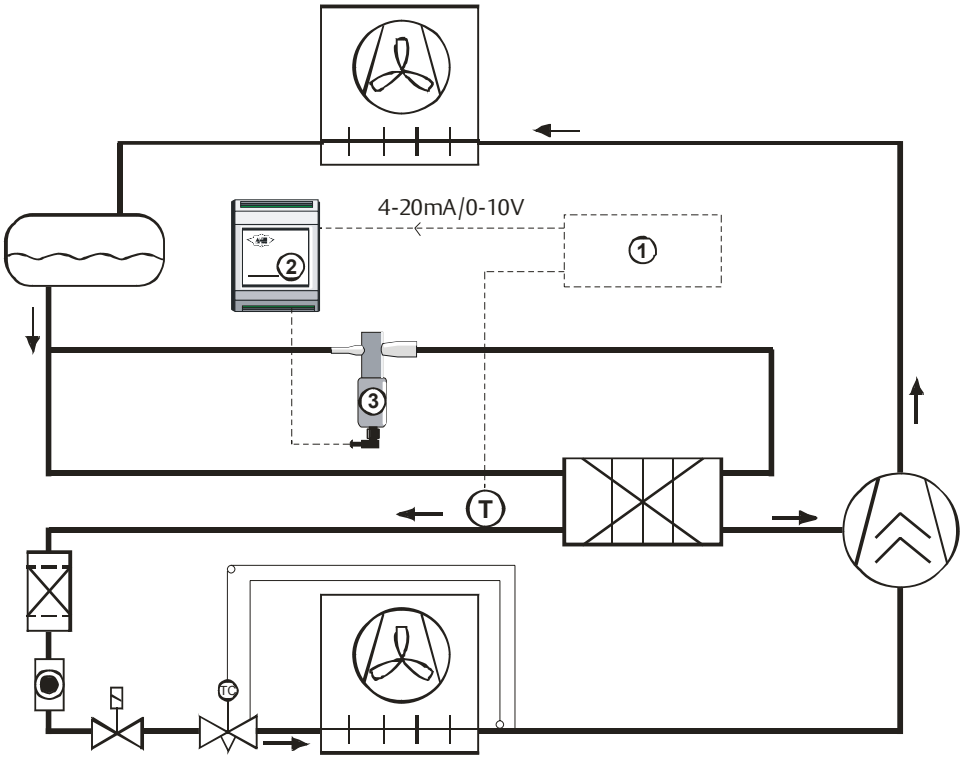
(1) = Expansion Valve, heating mode
(2) = Expansion Valve, cooling mode

Application 5: Expansion valve as liquid injection valve for desuperheating



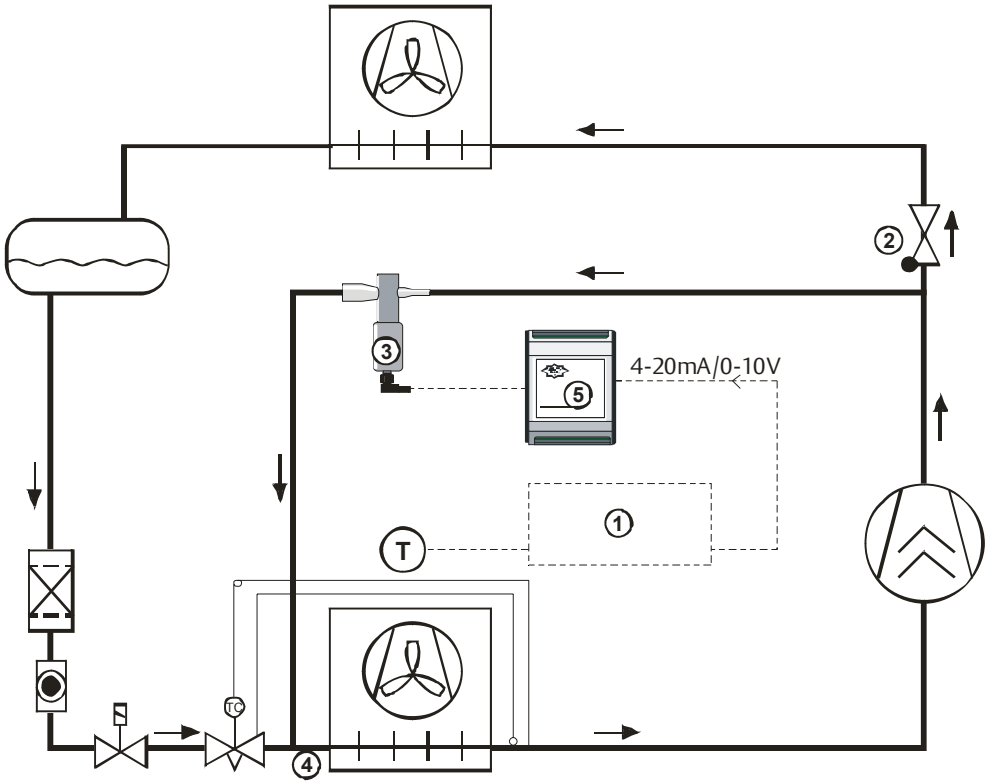
(1) = Temperature Controller
(2) = Stepper motor driver EXD-U00
(3) = Electrical Control Valve

Application 6: Expansion valve as liquid injection valve for subcooling



(1) = Temperature Controller
(2) = Stepper motor driver EXD-U00
(3) = Electrical Control Valve

Application 7: Capacity control by means of hot gas bypass



Remarks:

(1) = Temperature Controller

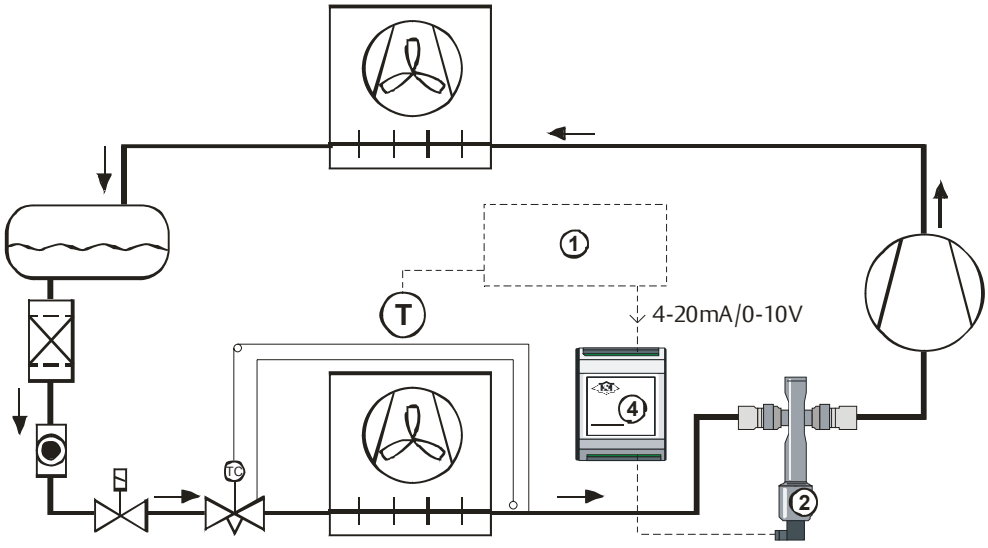
(2) = Check Valve: It is important to install a check valve just after T-connection as shown. Check valve will not allow return of liquid refrigerant from condenser through electrical control valve in to the evaporator during power interruption to system.

(3) = Hot gas bypass valve must be installed with motor downward. This insures the valve life expectancy.

(4) = Liquid Distributor must be selected properly for hot gas mass flow.

(5) = Stepper motor driver EXD-U00

Application 8: Capacity control by means of suction pressure throttling



Remarks:

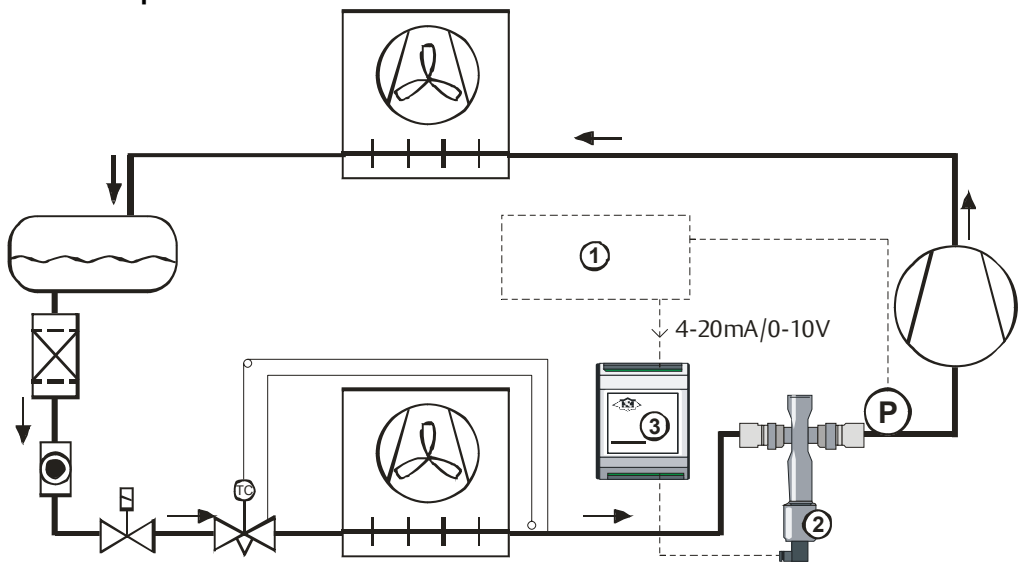
(1) = Temperature Controller

(2) = Evaporator temperature regulator. EX6, EX7 and EX8 must be installed with motor downward in suction line applications. This insures the valve life expectancy.

(3) This application may require additional liquid injection to suction line for desuperheating of compressor by means of suction line superheat control or discharge line temperature control. Please consult Alco Controls for more details.

(4) = Stepper motor driver EXD-U00

Application 9: Crankcase pressure control



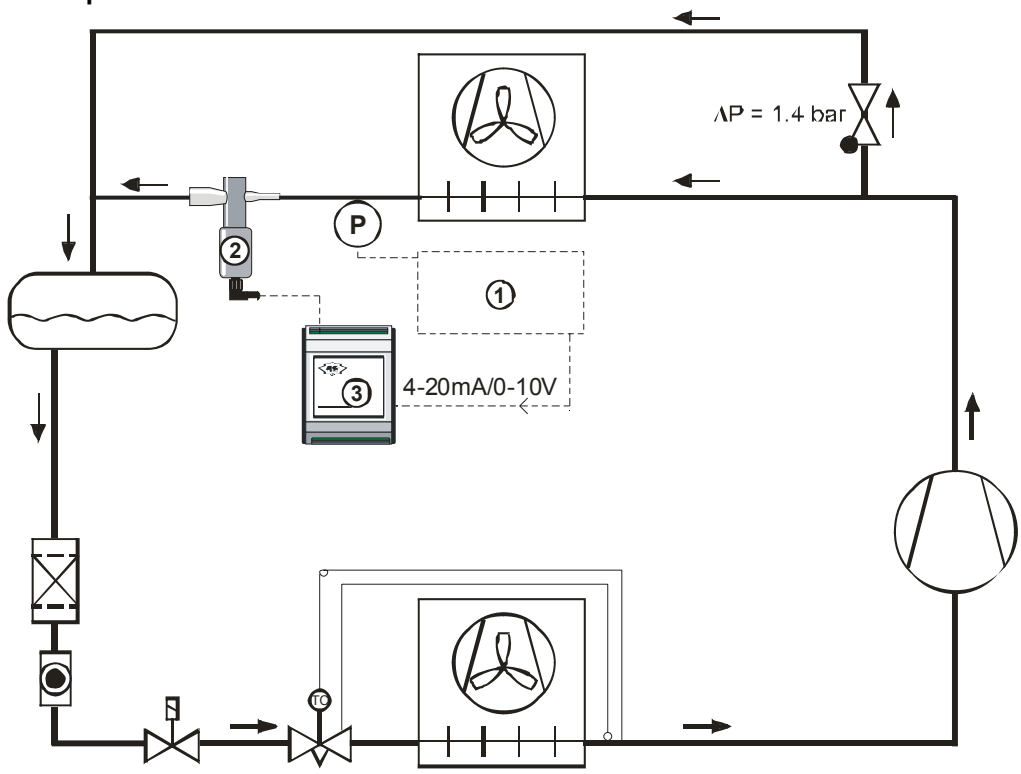
Remarks:

(1) = Pressure Controller

(2) = Crankcase pressure regulator. ECVs must be installed with motor downward in suction line applications. This insures the valve life expectancy.

(3) = Stepper motor driver EXD-U00

Application 10: Head pressure control

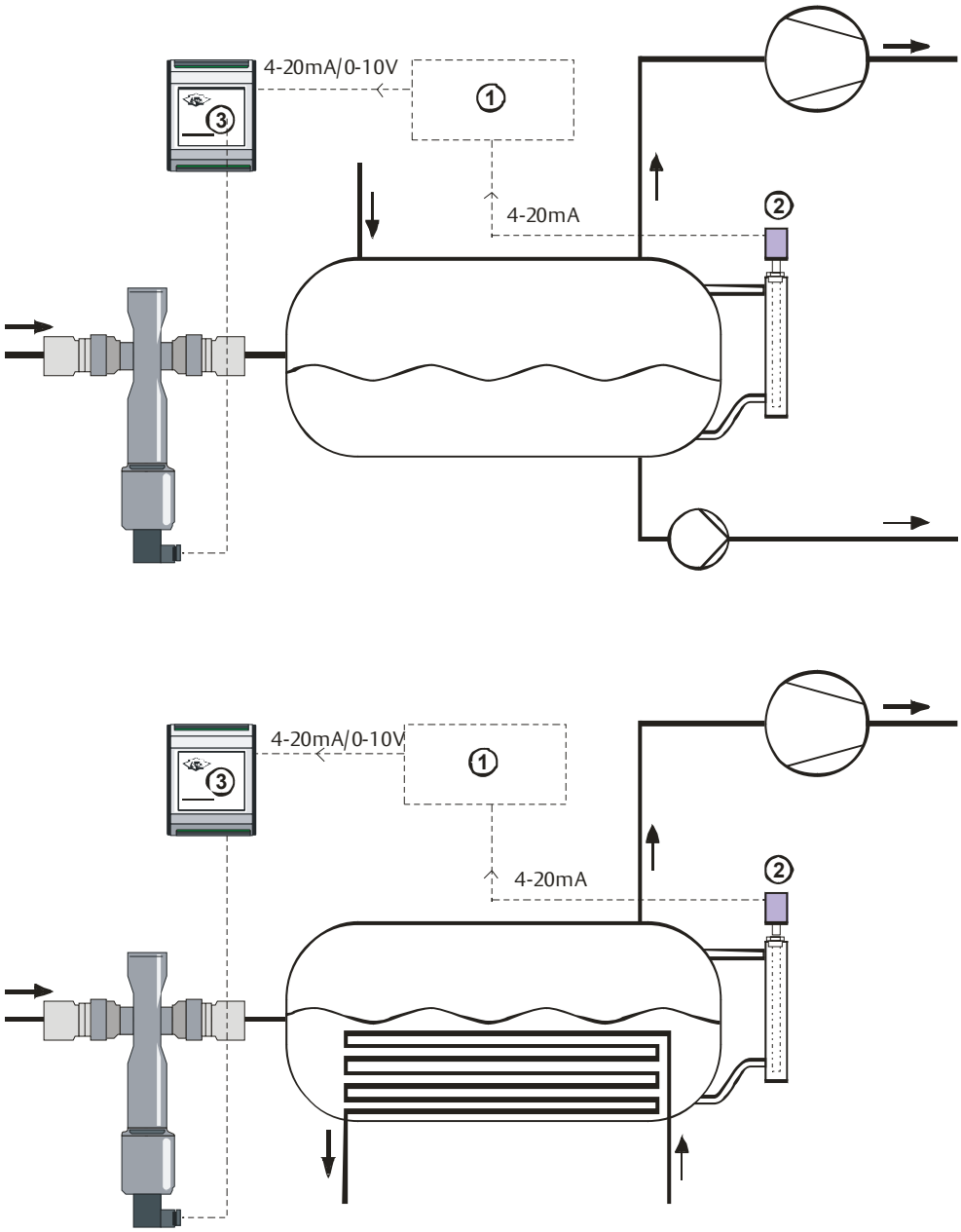


(1) = Pressure Controller

(2) = Condensing pressure regulator

(3) = Stepper motor driver EXD-U00

Application 11: Liquid level control



(1) = Level Controller
(2) = Liquid level sensor
(3) = Stepper motor driver EXD-U00
Note: ECVs are not released for use with ammonia.

Driver and controller

In contrary to thermo-expansion and regulator valves, stepper motor driven valves are not self operated actuators and require:

- a stepper motor driver which generates the digital pulse sequence needed to move the stepper motor in clockwise or counter clockwise direction
- an algorithm which determines the opening of the valve as a function of system parameters and conditions.

Alco Controls offers several solutions for this task:

EC3-X33 Superheat controller as stand alone for all applications and **EC3-X32 Superheat controller** for use in TCP/IP networks. The modules contain all required algorithms for full operation of ALCO ECVs. For further details please refer to EC3X33 or EC3X32 technical data sheet.

EC3-33x Cold Room Controller is a digital temperature controller primary for refrigeration applications such as cold rooms. It features temperature control, superheat control and defrost, compressor and fan management where applicable. For further details please refer to EC33x technical data sheet.

EXD-U Universal driver is a stepper motor driver which uses an analogue input signal to define the valve opening. It enables the operation of EX4/EX5/EX6/EX7/EX8 as:

- Electronic expansion valve
- Capacity control by means of hot gas bypass or evaporating pressure regulator
- Crankcase pressure regulator
- Condenser pressure regulator
- Liquid level actuator
- Liquid injection valve

The input signal for the driver module can be 4…20mA or 0…10V. The output pulses provide the proportional opening/closing of EX4/EX5/EX6/EX7/EX8 and consequently the control of liquid or vapour refrigerant mass flow. The universal driver module can be connected to any controller which provides the analogue signal. This gives system manufacturers the extreme flexibility to use any desired controller in conjunction with the universal driver module to achieve different functionality. For further details please refer to EXD-U technical data sheet.

The patented valve control module **VCM** is a hybrid integrated circuit, which provides the superheat algorithm and the stepper motor driver to those customers, who want to integrate the valve control into their own system controller. This solution is mainly for OEMs having serial mass production systems.

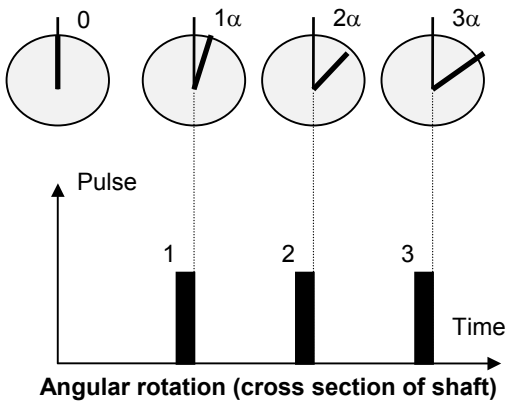
The following information is for those customers who want to develop their own driver/controller/algorithms:

Function

1) Motor

A 2-phase bipolar stepper motor drives the EX4/5/6/7/8. This motor follows the basic operating characteristics of any stepper motor i.e. the motor will be held in position unless current pulses from a driver board initiate rotation in either direction. The direction of the rotation depends on the phase relationship of the current pulses, the amount of rotation is dependent on the number of pulses. One pulse will drive the motor one step i.e. the rotor will move by α=1.8°. Successive pulses will lead to continuous rotation.

The drive shaft of the rotor is connected to a spindle which transforms the rotation into linear motion of the valve slide.



Angular rotation (cross section of shaft)

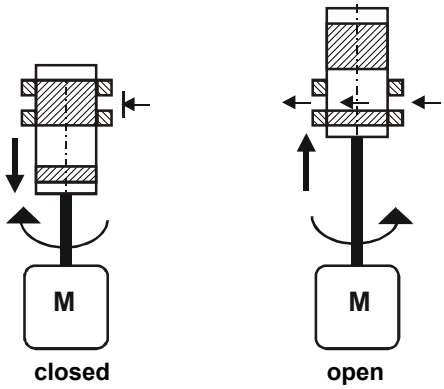
2) Valve

The gate type valve is optimised to provide a wide range of capacity with a linear relation between flow and positioning of the valve (capacity vs. number of steps). Slide and ports are made from ceramic for precise flow characteristics, high resolution and infinite life.

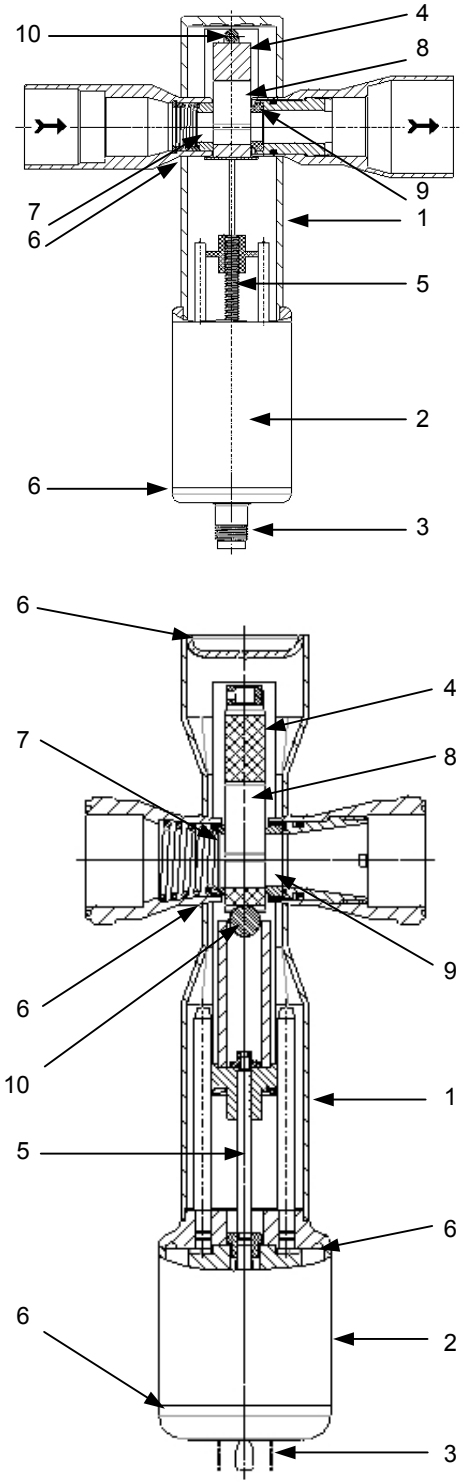
The compliant slide eliminates undesirable horizontal forces caused by differential pressure (across the valve) to the cage assembly and shaft of stepper motor. The internal design of the EX4/5/6/7/8 is patented.

Total valve travel is 750 full steps for EX4/5/6, 1600 steps for EX7 and 2600 steps for EX8.

A mechanical stop in the fully closed position of the valve acts as reference point. The controller is reset by driving the valve towards the fully closed position against the mechanical stop. By overdriving the valve i.e. applying more than the full number of steps, it can be assured that the reference point is correct.



closed **open**



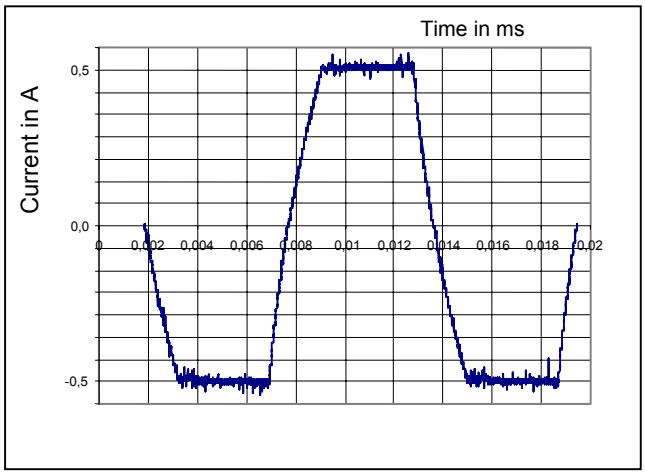
1 Stainless steel body
2 Stepper motor
3 Electrical connector
4 Cage assembly
5 Shaft
6 Welding and/or brazing
7 Ceramic inlet port
8 Ceramic slide
9 Ceramic outlet port
10 Brass ball

3) Driving of stepper motor

There are many different options to drive stepper motors like the one used in the EX4/5/6/7/8. Alco Controls stepper motors need a driver board with chopper drive function (constant current), an interface and a controller.

Chopper drive (constant current)

The stepper motor of EX4/5/6/7/8 is a bipolar, 2-phase permanent-magnet motor and operates with constant DC current in each phase. A driver board with chopper drive function feeds a DC current as indicated below to the windings of the stepper motor.



4) Design of customised driver board

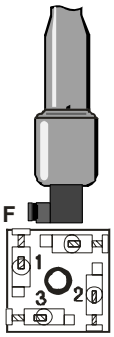
A suitable driver board must be selected according to the electrical data of the stepper motor and based on the following requirements:

- Electrical output (four-stage switching sequence, see next page)
- The EX4/5/6/7/8 should be operated in full step mode.
- Stepping rate: 500Hz for EX4/5/6/7/8
- Chopper function, current:

Current	EX4/5/6	EX7	EX8
Operating	500 mA	750 mA	800 mA
Holding	100 mA	250 mA	500 mA

Sequence for driving of stepper motor and valve

Direction	Reverse direction	Number of steps	Identification code of pins for electrical connections to third party drivers/controllers			
			A	B	C	D
			Current direction			
Valve is opening ↓	Valve is closing ↑	Step 1	+	-	+	-
		Step 2	-	+	+	-
		Step 3	-	+	-	+
		Step 4	+	-	-	+
		Remark	The sequence is repeated from step 5 to 8 similar to step 1 to 4			
		Step 5	+	-	+	-
		Step 6	-	+	+	-
		Step 7	-	+	-	+
		Step 8	+	-	-	+
		Remark	The sequence is repeated from step 9 to 12 similar to step 1 to 4			
↓	↓	↓	↓			

EX4/EX5/EX6/EX7/EX8 identification code of pins for electrical connection to third party drivers/controllers	**DIN plug for EX8** 	**M12 plug and cable assembly (EX5-xxx) for EX4/EX5/EX6/EX7** 
	Plug terminal numbers	**Cable, wire colour**
A	1	White
B	3	Black
C	-/4	Blue
D	2	Brown

Technical data

CE marking EX4/EX5: EX6/EX7/EX8:	 not required required, Cat I, Module A
Compatibility (not released for use with inflammable refrigerants)	CFCs, HCFCs, HFCs, mineral and POE lubricants
MOPD (maximum operating pressure differential)	EX4/EX5/EX6/EX7: 33 bar EX8: 25 bar
Max. working pressure, PS	EX4/EX5/EX6/EX7: 45 bar EX8: 35 bar
Temperature range: Refrigerant Ambient	 TS: -50 to +100°C (at motor) -40 to +55°C
Salt spray test	non-corrosion stainless steel body
Humidity	5 to 95% r.H.
Connections	EX4/EX5/EX6/EX7: ODF stainless steel fittings EX8: Rotalock with ODF, plated fittings

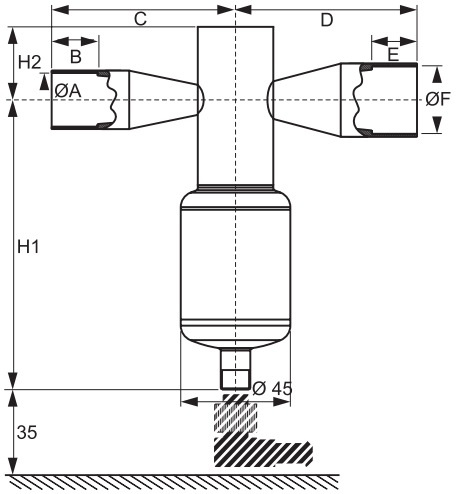
Protection accordance to IEC 529, DIN 40050	EX4/5/6/7: IP68 with Alco supplied cable connector assembly EX8: IP65 with DIN plug
Vibration for non-connected and fastened valve	4g (0 to 1000 Hz, 1 octave /min.)
Shock	20g at 11 ms 80g at 1 ms
Net weight (kg)	0.5 kg (EX4), 0.52 kg (EX5), 0.60 kg (EX6), 1.8 kg (EX7), 2.5 kg (EX8)
Accessories	See table on page 2
Package and delivery (individual)	EX4/5/6/7: without electrical connector EX8: with DIN plug and a pair of rotalock connections
External leakage	≤ 3 gram / year
Seat leakage	Positive shut-off as solenoid valve

Electrical data

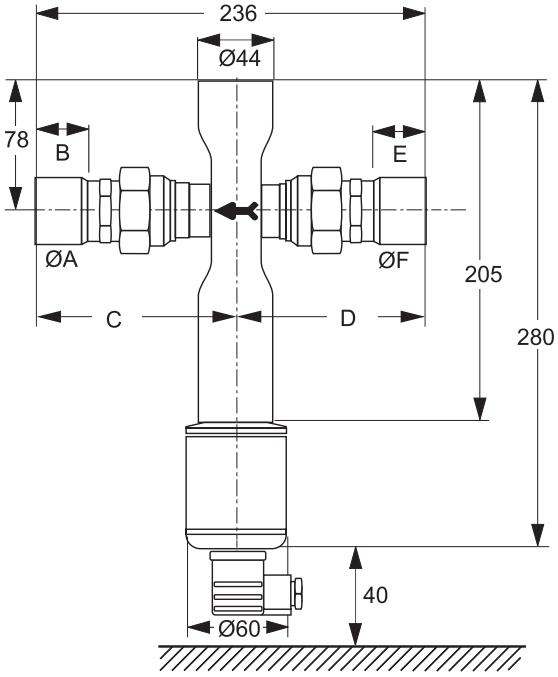
Stepper motor type	Bi-polar, phase current by chopper control (constant current)
Electrical connection	4 pin terminal via plug
Reccom. driver supply voltg.	24 VDC (nominal)
Driver supply voltage range	18 … 36 VDC
Phase current, operating	EX4/EX5/EX6: 500mA max, -10% EX7: 750mA ±10% EX8: 800mA ±10%
Holding current	EX4/EX5/EX6: 100mA EX7: 250mA EX8: 500mA
Nominal input power per phase	EX4/EX5/EX6: 3.5W EX7/EX8: 5W

Phase inductance	EX4/EX5/EX6: 30 mH ± 25% EX7: 20 mH ± 25% EX8: 22 mH ± 25%
Step mode	2 phase full step
Step angle	1.8° per step ± 8%
Total number of steps	EX4/EX5/EX6: 750 full steps EX7: 1600 full steps EX8: 2600 full steps
Stepping rate	500Hz
Winding resistance per phase	EX4/EX5/EX6: 13Ohm ±10% EX7: 8Ohm ±10% EX8: 6Ohm ±10%
Full travel time	EX4/EX5/EX6: 1.5 seconds EX7: 3.2 seconds EX8: 5.2 seconds
Reference position	Mechanical stop at fully close position

Dimensions EX4 / EX5 / EX6 / EX7



Dimensions EX8



Valve Type	Ø A x Ø F (ODF)	B	C	D	E	H1	H2
EX4-I21	3/8" x 5/8"	8	45	55	11	113	25
EX4-M21	10 x 16 mm	8	45	55	11	113	25
EX4-U31	16 x 16 mm (5/8" x 5/8")	11	55	55	11	113	25
EX5-U21	5/8" x 7/8" (16 x 22mm)	11	55	65	16	113	25
EX5-U31	7/8" x 7/8" (22 x 22mm)	16	65	65	16	113	25
EX6-I21	7/8" x 1-1/8"	16	65	75	19	113	25
EX6-M21	22 x 28 mm	16	65	75	19	113	25
EX6-I31	1-1/8" x 1-1/8"	19	75	75	19	113	25
EX6-M31	28 x 28 mm	19	75	75	19	113	25
EX7-I21	1-1/8" x 1-3/8"	20	77.5	82.5	23	157	42
EX7-M21	28 x 35 mm	20	77.5	82.5	23	157	42
EX7-U31	1-3/8 x 1-3/8 (35 x 35mm)	23	82.5	82.5	23	157	42
EX8-M21	42 x 42	25	119	117	25		78
EX8-U21	1-3/8 x 1-3/8 (35 x 35mm)	25	119	117	25		78

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EC3-D7x Digital Superheat Controller
EC3-D72 with TCP/IP communication capability

Operating Instructions

GB

Description

EC3-D7x is the superheat controller with TCP/IP connection for stepper motor driven Alco Electrical Control Valves EX4...EX6 and is optimized to operate with the Copeland Digital Scroll series utilising a 0-10V input from a third party controller. The controller synchronises the PWM digital compressor solenoid valve with the superheat controlled by the electrical control valve; EX series. The EC3-D73 has the same functionality but can only be set-up via the ECD-002 display. It has no external communication functionality.

Note: This document contains short form instructions for experienced users.

⚠ Safety instructions:

- **Read installation instructions thoroughly. Failure to comply can result in device failure, system damage or personal injury.**
- **The product is intended for use by persons having the appropriate knowledge and skills.**
- **Disconnect all voltages from system before installation.**
- **Do not operate system before all cable connections are completed.**
- **Comply with local electrical regulations when wiring.**

Note: The EC3-D7x series contains a lead, acid gel rechargeable battery. The battery must NOT be disposed of with other commercial waste. Instead, it is the user's responsibility to pass it to a designated collection point for the safe recycling of batteries (harmonised directive 98/101/EEC). For further information contact your local environmental recycling centre.

Technical data

Power supply	24VAC ±10%; 50/60Hz; 1A
Power consumption	25VA max. including EX4 … EX6
Plug-in connector	Removable screw terminals wire size 0,14 .. 1,5 mm^2
Grounding	6,3 mm spade earth connector
Protection class	IP20
COM, TCP/IP connection	RJ45 Ethernet
Connection to optional local ECD-002	ECC-Nxx or CAT5 cable with RJ45 connectors
Digital Input; Cooling demand	0/24VAC/DC for stop/start function. EX valve closes during stop command. Typically thermostat or third party controller.
Digital Input; Comp2 running	0/24VAC/DC typically connected to auxiliary connection. EX valve control loop remains active when input is 24V and the digital scroll is idle.
NTC input; Coil-out temperature sensor	Emerson temperature sensor ECN-N60 or ECN-P60
4-20 mA Analog input	Emerson PT4-07M / PT4-18M / PT4-30M
4-20 mA Analog output Deviation from input signal	For connection to any 3rd party controller with 12/24VDC power supply and appropriate burden ±8% max
Output alarm relay (If L2 = 1) Activated: Deactivated:	SPDT contact 24V AC/DC, 2 Amp inductive load During normal operation (no alarm condition) During alarm condition or power supply is OFF
Output pump down relay (If L2 = 1) Activated: Deactivated:	SPDT contact 24V AC/DC, 2 Amp inductive load During normal operation All other conditions
⚠ If the output relays are not utilized, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure.	
Output Digital Scroll t Triac	24V or 230V AC output to activate PWM valve on Digital Scroll
Stepper motor output for EX4…EX6	Maximum current 0.6A with nominal 24VDC operating voltage
Ambient temperature range	0 … 60°C 1 … 25°C (for best battery life time) > 35°C battery life time < 2 years
⚠ In order to provide system protection in the event of power loss, it is recommended to change the battery annually.	

Mounting

The EC3-D7x is designed to be mounted onto a standard DIN rail.

Electrical installation

- Refer to the electrical wiring diagram for electrical connections.
- Do not apply voltage to the controller before completion of wiring.
- Ground the metal housing with a 6.3mm spade connector.
- **Important:** Keep controller and sensor wiring well separated from mains wiring. Minimum recommended distance 30mm.

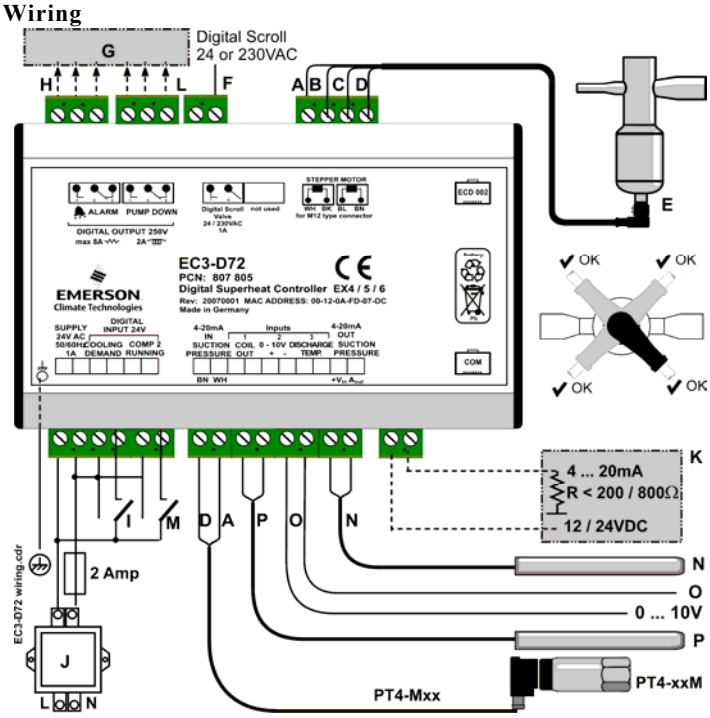
Warning: Use a class II category transformer for 24VAC power supply. Do not ground the 24VAC lines. We recommend using individual transformers for EC3 controller and for 3rd party controllers to avoid possible interference or grounding problems in the power supply. Connecting any EC3 inputs to mains voltage will permanently damage the EC3.

Digital input status is dependant to operation of compressor/0-10V input

System Operating condition	Digital Inputs	0-10V input from third party controller
Comp. 1 & Comp.2 in stop mode	"Cooling demand" open (0V) "Comp 2 Running" open (0V)	ECV remains closed irrespective of voltage input value
Comp. 1 in run & Comp.2 in stop mode)	"Cooling demand" closed (24V) / "Comp 2 Running" open (0V)	ECV active Input =0V: digital valve capacity at 10% default capacity. When the digital comp. is in by-pass the ECV will: Close when capacity is <70% Be inhibited when the capacity is >70%
Comp 1 & Comp. 2 in run mode	"Cooling demand" closed (24V) / "Comp 2 Running" closed (24V)	ECV active The ECV will always modulate even when the digital compressor is in by-pass mode.
Comp.1 in stop and Comp. 2 in run mode starts	"Cooling demand" open (0V) / "Comp 2 Running" closed (24V)	ECV remains closed irrespective of voltage input value

Digital comp. should always be regarded as base load; compressor 1

Wiring



A: White wire **B**: Black wire
C: Blue wire **D**: Brown wire
E: M12 Plug cable assembly EX5-Nxx for connection to EX4/EX5/EX6
F: 24V/230V Triac output to PWM Digital Scroll valve
G: Remote control panel, system controller
H: Alarm relay, dry contact. Relay coil is not energised at Alarm or power off

⚠ The use of the relay is essential to protect the system in case of power failure if the communications interface or the ECD-002 are not utilized..

I: Digital input 1: "Cooling demand" (Digital compressor run: (0V/open = Stop; 24V/closed = Control Start;)
J: Transformer Class II, 24VAC secondary / 25VA min. Model ECT-323
K: Third party controller (can use the suction pressure (4-20mA) analog output signal from EC3)
L: Pump down relay, dry contact. Relay is energized during normal operation.
M: Digital input 2: "Comp. 2 running" (0V/open = Comp2 stop; 24V/closed = Comp2 running
N: Discharge Temp. Sensor
O: 0-10V Digital Scroll capacity demand signal from system controller
P: ECN-N60 Coil out sensor

Preparation for Start-up:

- Vacuum the entire refrigeration circuit.

Warning: Alco Electrical Control Valves EX4...EX6 are delivered at half open position. Do not charge system before closure of valve.

- Apply supply voltage 24V to EC3 while the cooling demand digital input is 0V (open). The valve will be driven to close position.
- After closure of valve, start to charge the system with refrigerant.

Possibilities of connecting EC3-D72 to a network or PC

A **TCP/IP Controller Readme** file is available on the www.emersonclimate.eu website to provide detailed information about TCP/IP Ethernet connectivity. Please refer to this file if you need information beyond the contents of this instruction sheet.

1) Connect the EC3-D72 using the optional ECC-Nxx cable assembly or a standard CAT5 network cable with RJ45 plugs assembly to a network or router that enables the controller to receive a dynamic TCP/IP address or

2) Connect the EC3-D72 to a computer using a crossover cable plugged directly into the Ethernet port. In this case, the TCP/IP address of the computer must be manually modified to be compatible with the default address of the controller. Refer to the TCP/IP Controller-Readme file for more details.

Setting and visualising Data: WebPages (recommended method)

Important: Make sure that cooling demand input is 0V (open). Turn the power supply ON.

Four parameters i.e. refrigerant type (u0), pressure sensor type (uP), valve type (ut) and control mode can be set only when cooling demand digital input is open (0V) and the power supply is ON (24V). This feature is for added safety to prevent accidental damage of compressors and other system components. All other parameters can be modified at any time.

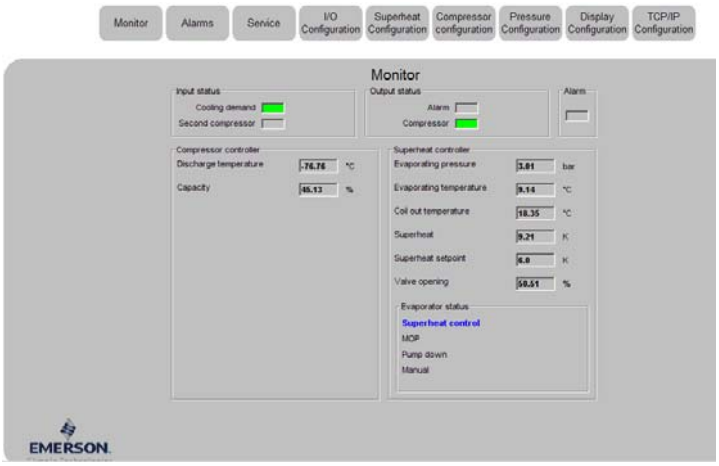
The EC3-D72 has a TCP/IP Ethernet communication interface enabling the controller to be directly connected to a network or a PC via the standard Ethernet port. The EC3-D72 controller has embedded WebPages to enable the user to visualise the parameter lists using real text labels.

To view WebPages on the PC, a standard WebBrowser like Internet Explorer® or Mozilla Firefox and JRE Java Runtime Environment is needed. JRE can be downloaded at no charge from the www.java.com website.

Open the Internet browser program on the computer and, if EC3-D72 is connected directly to PC with a crossover cable enter the default TCP/IP address of the controller **(192.168.1.101)** into the address line, or the dynamic address from the DHCP server from network/Router. Refer to the TCP/IP Controller-Readme file if a specific port is required.

It is possible to identify the dynamic TCP/IP address assigned by DHCP of the Router or network, refer to the TCP/IP Controller-Readme file.

After a few moments, the default monitoring page should be displayed. If the browser does not open the default page or display active data, the user should check the Internet browser "Option" configuration. Refer to the TCP/IP Controller-Readme file.



The Monitoring and Alarm WebPages are read only and therefore it is not necessary to enter a username or password. A username and password will be requested upon the initial request to any of the other WebPages. The factory default settings are :

Username: "EmersonID" , Password: "12"

The default settings may be modified on the Display configuration page.

Press the tabs at the top of the Monitoring page with a left click of the mouse button to enter the respective Webpage.

The parameters will be visualised in real text together with the program code as defined in the parameter list below.

After the parameters have been modified, the complete list of settings can be saved to the memory of the computer and used later to upload into another controller. This can save a considerable amount of time when using multiple controllers and over a period of time, a library can be created containing the parameter lists for equipment for different applications.

It is also possible to display live graphical data from the controller. Superheat, evaporating pressure, coil-out temperature and evaporating temperature are available on a 10 minutes rolling chart. Refer to the TCP/IP Controller-Readme file for a complete description of the features available for the TCP/IP series of controllers.

Alternative procedure for parameter modification using ECD-002

Note: Some of the functions/parameters (manual control and TCP/IP configuration) cannot be modified when using ECD-002 comparing to a set-up by PC via TCP/IP. **Warning**: All alarms are disabled during manual control. We do not recommend unattended operation of system during manual control.

The parameters can be accessed via the 4-button keypad. The configuration parameters are protected by a numerical password. The default password is "**12**".

To select the parameter configuration:

- Press the **PRG** button for more than 5 seconds
  A flashing 0 is displayed
- Press ▲ or ▼ until the password is displayed (default 12).
  If the password was changed, select the new password
- Press **SEL** to confirm password
- Press ▲ or ▼ to show the code of the parameter that has to be changed;
- Press **SEL** to display the selected parameter value;
- Press ▲ or ▼ to increase or decrease the value;
- Press **SEL** to temporarily confirm the new value and display its code;

Repeat the procedure from the beginning "*press* ▲ or ▼ *to show...*"

To exit and save the new settings:
Press **PRG** to confirm the new values and exit the parameters modification procedure.

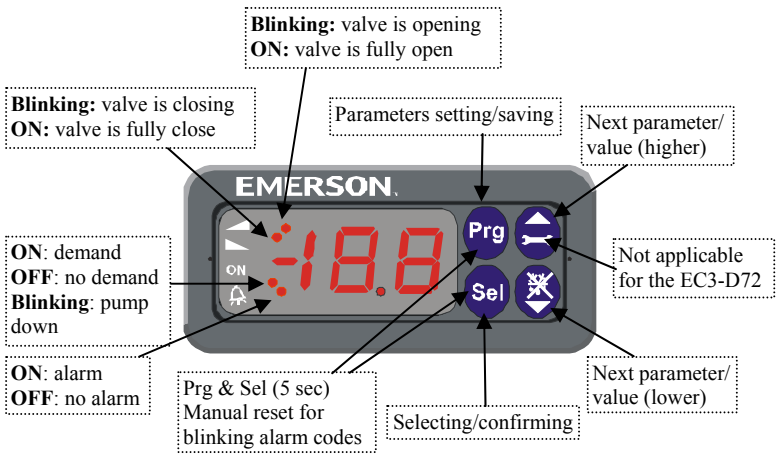
To exit without modifying any parameters:
Do not press any button for at least 60 seconds (TIME OUT).

Special Functions:

The Special Functions can be activated by:

- Press ▲ and ▼ together for more than 5 seconds.
  A flashing 0 is displayed.
- Press ▲ or ▼ until the password is displayed (default = 12).
  If password was changed, select the new password.
- Press **SEL** to confirm password
  A 0 is displayed and the Special Function mode is activated.
- Press ▲ or ▼ to select the function. The number of special functions is dynamic and controller dependent. See list below.
  0: Reset controller to factory settings (this action is possible only when digital input is 0V i.e. open)
  1: Displays the current TCP/IP address
  2: Assign temporary 192.168.1.101 as TCP/IP address if EC3-D72 has different address
- Press **SEL** to activate the function without leaving the special function mode.
- Press **PRG** to activate the function and leave the special function mode.

ECD-002 display/keypad unit (LEDs and button functions)



EC3-D7x Digital Superheat Controller
EC3-D72 with TCP/IP communication capability

Operating Instructions

GB

List of parameters in scrolling sequence by pressing button

Code	Parameter description and choices	Min	Max	Factory setting	Field setting
H5	Password	1	199	12	
u0	System refrigerant 0 = R22; 1 = R134a; 2 = R507; 3 = R404A; 4 = R407C; 5 = R410A; 6 = R124; 7 = R744 (subcritical application)	0	7	4	
uP	Installed pressure sensor type 0 = PT4-07M (for R22/R134a/R507/R404A/R407C/R124) 1 = PT4-18M (for R410A) 2 = PT4-30M (for R744, subcritical)	0	2	0	
ut	Installed valve type 1 = EX4; 2 = EX5; 3 = EX6	1	3	2	
uu	Start valve opening (%)	10	100	50	
u9	Start opening duration (second)	1	30	5	
uL	Low superheat alarm function 0 = disable (for flooded evaporator) 1 = enable auto reset 2 = enable manual reset Cut-out at 0.5K (if it maintains 1 min.); Cut-in immediately at 3K	0	2	1	
u5	Superheat set-point (K) If uL enabled (auto or manual) If uL disabled	 3 0.5	 30 30	 6 6	
u2	MOP function 0 = disable 1 = enable	0	1	1	
u3	MOP set-point (°C) saturation temperature Factory setting is according to selected refrigerant (u0): +13°C for R22 +15°C for R134a +7°C for R507 +7°C for R404A +15°C for R407C +15°C for R410A +50°C for R124 -5°C for R744	*	*	X	
┌┘5	Units conversion 0 = °C, K, bar 1 = °F, R, psig (Psig values are divided by 10. Example: Display 12.5 is 125 psig)	0	1	0	
┌┘1	Value to show 0 = Measured superheat (K) 1 = Measured evaporator pressure (bar) 2 = Valve opening (%) 3 = Measured coil-out temp. (°C) 4 = Calculated evaporating temperature (°C) from the pressure 5 = Compressor capacity in %	0	4	0	
u4	Superheat control mode 0 = Standard, 1 = Slow	0	1	0	
uH	High superheat alarm function 0 = disable, 1 = enable auto reset	0	1	0	
uA	High superheat alarm setpoint	16	40	30	
ud	High superheat alarm delay, min.	1	15	3	
P2	Freeze protection cut-out, °C	-40	40	0	
P3	Freeze protection cut-in, °C	-37	43	3	
P4	Freeze protection alarm function 0 = disable, 1 = enable auto-reset, 2 = enable manual reset	0	2	0	
P5	Freeze protection alarm delay, sec.	5	199	30	
P6	Pump-down function 0 = disable, 1 = enable auto-reset	0	1	0	
P7	Pump-down cut-out, barg	-0,5	18	0.5	
P8	Pump-down time delay, sec.	0	199	30	
P9	Low pressure alarm function 0 = disable, 1 = enable auto-reset, 2 = enable manual reset	0	2	0	
PA	Low pressure alarm cut-out, barg	-0,8	17,7	0	
Pb	Low pressure alarm delay, sec.	5	199	5	
Pd	Low pressure alarm cut-in, barg	-0,5	18	0.3	

Code	Parameter description and choices	Min	Max	Factory settings	Field settings
L2	Output logic 0: Alarm & pump down. = normal 1: Alarm = inverse, pump down. = normal 3: Alarm & pump down. = inverse 2: Alarm = normal, pump down. = inverse	0	3	1	
b1	Battery error management, when battery is defective, see below:	0	3	2	

value	Alarm display	Alarm relay	Valve	Reset possibility after recovery/replacement
0	-	-	Regulating	-
1	Ab	-	Regulating	-
2	Ab	Signalling	Fully close	Auto
3	Ab (blinking)	Signalling	Fully close	Manual

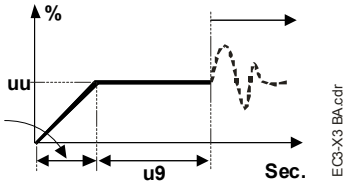
⚠ When setting b1 to option 0 or 1, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure.

/6	Show decimal point; 0=yes, 1 = no	0	1	0	
A6	Maximum discharge temperature; °C	100	140	130	
A7	Discharge temp. alarm delay; sec.	0	199	30	
F2	Minimum capacity; %	10	100	10	
F3	Maximum capacity; %	10	100	100	
F6	Scroll Valve, PWM cycle time; sec.	10	20	20	
t3	Monitor discharge temperature sensor 0 = no, 1 = Yes	0	1	0	
ru	0-10V input filtering; 0 = off, 1 = on	0	1		

*) Min. and Max. setting values are dependant to selected type of refrigerant.

Control (valve) start-up behaviour (Parameter uu and u9)

EX4/5/6 ≤ 1.5 seconds



Pump down function (if P6=1 and L2=1)

Cooling demand status	Alarm condition	Pump down relay
24V (ON)	NO	Activate
0V (OFF)	NO	Deactivate when pressure drops below P7 and after elapsed time P8
0V or 24V	YES	Deactivate instantaneously

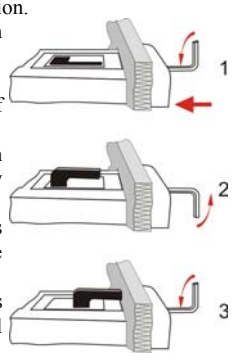
Start-up

Start the system and check the superheat and operating conditions. The EC3-D72 is fully functional without connected PC or keypad/display unit. ECD-002.

Mounting of ECD-002

ECD-002 can be installed at any time also during operation.

- ECD-002 can be mounted in panels with 71x29 mm cutout
- Push controller into panel cut-out.(1)
- Make sure that mounting lugs are flush with outside of controller housing
- Insert Allen key into front panel holes and turn clockwise. Mounting lugs will turn and gradually move towards panel (2)
- Turn Allen key until mounting lug barely touches panel. Then move other mounting lug to the same position (3)
- Tighten both sides very carefully until keypad is secured. Do not over tighten as mounting lugs will break easily.



Error/Alarm handling

Alarm code	Description	Related parameter	Alarm relay	Valve	What to do?	Requires manual reset after resolving alarm
E0	Pressure transmitter error	-	Signalling	Fully close	Check wiring connection and measure the signal 4 to 20 mA	No
E1	Coil-out temperature sensor error	-	Signalling	Fully close	Check wiring connection and measure the resistance of sensor 10,000ohms @ 25°C	No
E3	Discharge temp. sensor error	-	Signalling	Regulating	Check wiring connections and measure the resistance of the sensor. Also check the status of the I/O configuration (t3)	
AII	EX4…EX6 electrical connection error	-	Signalling	-	Check wiring connection and measure the resistance of winding Refer to EX series datasheet: EX58e35008	No

Alarm code	Description	Related parameter	Alarm relay	Valve	What to do?	Requires manual reset after resolving alarm
Ab	Battery error	b1: 1	-	Regulating	Battery potentially does not have enough charge to close valve in case of main power supply interruption. May occur temporarily with new controllers or after long storage but should disappear when battery is charged sufficiently (allow 10hrs). If Ab remains active even when battery is charged, battery may be defective and should be replaced. (Replacement kit: 807 790).	-
Ab		b1: 2	Signalling	Fully close		-
Ab blinking		b1: 3	Signalling	Fully close		Yes
AE blinking	Pump down action can not accomplished	P6: 1	Signalling	Already closed by Pumpdown command	Allocate the source, which does not let suction pressure drops below desired set-point	Yes
AF	Freeze protection	P4: 1	Signalling	Fully close Pumpdown deactivated	Check the system for cause of low pressure such as insufficient load on evaporator	No
AF blinking		P4: 2				Yes
AL	Low superheat (<0,5K)	uL: 1	Signalling	Fully close Pumpdown deactivated	Check wiring connection and operation of valve	No
AL blinking		uL: 2				Yes
AH	High superheat	uH: 1	Signalling	Fully close Pumpdown deactivated	Check the system	No
AP	Low pressure	P9: 1	Signalling	Fully close Pumpdown deactivated	Check the system for cause of low pressure such as refrigerant loss	No
AP blinking		P9: 2				Yes
dA	High discharge temp.	A6: alarm setpoint	Signalling	Fully close Pumpdown deactivated	Check the system	No Fixed differential = 10°C
Er	Data error display – out of range	-	-	-	Data send to the display is out of range. Check temperature and pressure sensor.	No

Note: When multiple alarms occur, the highest priority alarm is displayed until being cleared, then the next highest alarm is displayed until all alarms are cleared. Only then will parameters be shown again.

Message

--- No data to display
The display will show an "---" at start up and when no data is send to ECD-002

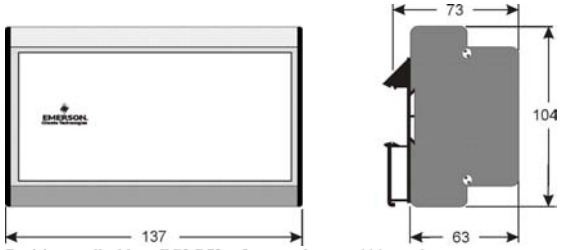
Checking system operating conditions using local display/keypad ECD-002

The data to be permanently shown on the display can be selected by the user (parameter ┌┘1). It is possible to temporarily display these values. However this function is not available in an alarm condition. The display will show for one second the numerical identifier of the data (see ┌┘1 parameter) and then the selected data. After 5 minutes, the display will return to the value selected by parameter ┌┘1.

Service / Troubleshooting

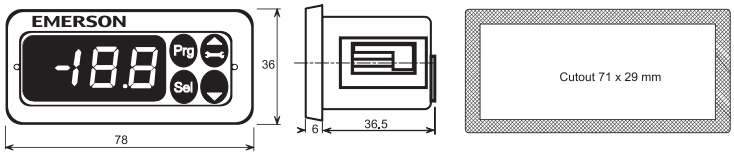
Symptom	Cause	Action
Operating superheat is several degrees higher or lower than set-point	Incorrect signal from pressure or temperature sensors	1- Check the sensors 2- Make sure ECN-N60 temperature sensor is used 3- For optimum accuracy, please use: PT4-07M for R22/R134a/R507/R404A/R407C/R124 PT4-18M for R410A PT4-30M for R744 4- Make sure the sensor cables are not installed along with other high voltage cables
Operating superheat is too low i.e. compressor wet running	1- Incorrect wiring of ECV 2- Defective sensors	1- Check the wiring 2- Check the sensor
Valve is not fully closed	1- The cooling demand digital input is ON (24V) 2- Wrong ECV selected.	1- Valve is shut off only when the digital input is turned off (0V) 2- Check the setting of parameter ut
Unstable superheat (hunting)	Evaporator is designed to operate at higher superheat	Increase the superheat set-point to a higher value; if system is stable, start to decreasing gradually checking each time for a stable control
Valve opens when EC3 commands to close and vice versa	Wrong wiring between EC3-D72 and valve	Check the wiring and obey the colour coding: white/black, blue/brown.
Superheat set-point is shifting after several months of uninterrupted operation or permanent jumper of 24V digital input	Stepper motor driven valves require synchronization	Do not apply permanent 24V digital input. Interrupt digital input once every week for 5 seconds if compressor never stops. This has the effect of referencing the valve to the fully closed position.

Dimensions EC3-D72/D73



Revision applicable to EC3-D72 software release =>114, rev 6

ECD-002



System 350™ A350P Electronic Proportional Plus Integral Temperature Control

The A350P is an electronic, proportional plus integral temperature control with analog 0 to 10 VDC and 0 to 20 mA outputs. The control is equipped with three user-selectable time integration constants and an adjustable throttling range of 2 to 30F° (1 to 17C°). Two models cover a setpoint range of -30 to 130°F (-35 to 55°C) and 90 to 250°F (32 to 121°C).

As are all System 350™ products, the A350P control is housed in a NEMA 1, high-impact plastic enclosure. The modular design provides easy, plug-together connections for quick installation and future expandability.

Figure 1: A350P Electronic Proportional Plus Integral Temperature Control

Features and Benefits

❑ **Modular Design**	Enables stage, display, and power modules to be purchased and installed as needed
❑ **Plug-Together Connectors and 35 mm DIN Rail Mounting**	Eliminates wiring between modules, which reduces installation costs
❑ **Two Models Cover a Wide Setpoint Range of -30 to 250°F (-35 to 121°C)**	Reduces inventory by encompassing temperature ranges required to support the majority of Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC/R) applications
❑ **Minimum Output Adjustable from 0 to 60%**	Tailors the output to the requirements of the controlled device; can be used to set minimum valve or damper position
❑ **Adjustable Throttling Range of 2 to 30F° (1 to 17C°)**	Enables the user to tune the system for optimum stable performance
❑ **Field-selectable Reverse or Direct Acting Mode**	Works in heating or cooling applications
❑ **Three User-Selectable Integration Time Constants**	Provides selection of the integration constant for applications requiring proportional plus integral control
❑ **Interchangeable Temperature Sensors**	Increase versatility and serviceability

Part No. 24-7664-192, Rev. F
Code No. LIT-930020

Application

The A350P Temperature Control can be used as a standalone device or in conjunction with plug-together accessory modules. The addition of S350 Stage Modules allows for the control of multiple stage HVAC/R applications. Typical application for the A350P includes:

- proportional heating control with staged direct expansion cooling
- simple temperature control for air handling units
- modulating damper actuators for mixed air control
- simple proportional mixed air control

A typical System 350 Temperature Control setup includes the following:

- A350P Temperature Control
- A99B Series Temperature Sensor
- Y350R Power Module (or 24 VAC Class 2 transformer)
- S350 Stage Modules
- D350 Digital Temperature Display Module

Operation

The A350P control operates on 24 VAC/VDC and provides two simultaneous analog outputs: 0 to 10 VDC and 0 to 20 mA. A cover-mounted, 10-segment Light-Emitting Diode (LED) bar graph indicates percentage of output.

Features include:

- adjustable setpoint
- adjustable minimum output
- adjustable throttling range (proportional band)
- selectable integration time constant
- selectable Reverse Acting (RA) or Direct Acting (DA) mode of operation

IMPORTANT:	All System 350 controls are designed for use **only** as operating controls. Where an operating control failure would result in personal injury and/or loss of property, it is the responsibility of the installer to add devices (safety, limit controls) or systems (alarm, supervisory systems) that protect against, or warn of, control failure.

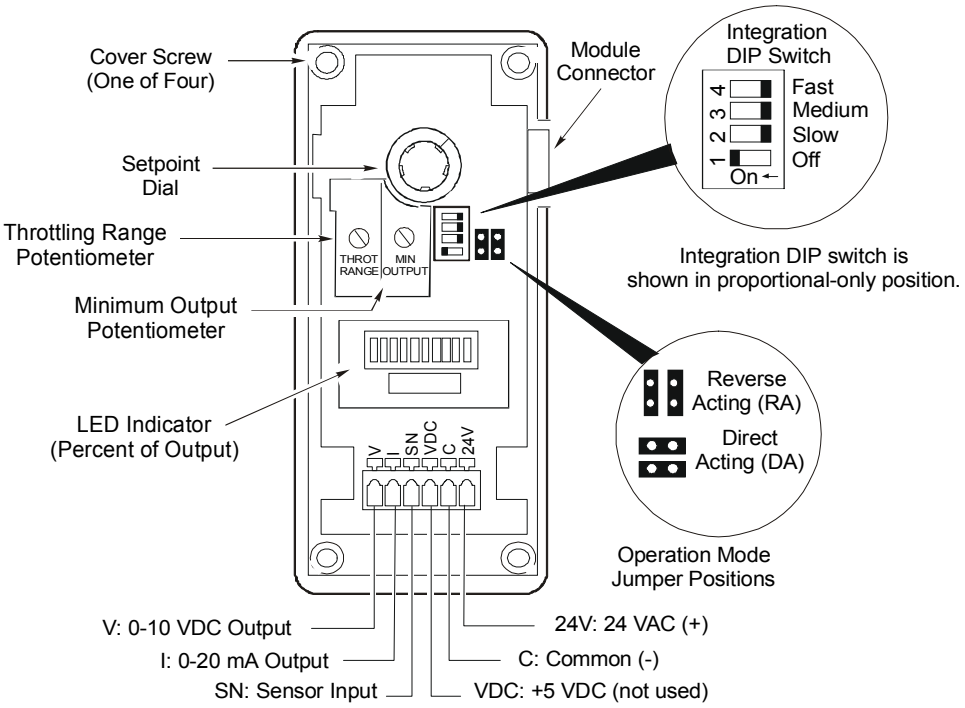


Figure 2: Interior View Showing A350P Control's Features

Minimum Output Adjustment

The minimum output adjustment sets the minimum voltage or milliampere output provided by the A350P control. It can be adjusted from 0 to 60% (0 to 6 VDC or 0 to 12 mA) of the output range.

Example:

A controlled device responding to a 4-20 mA output would require the minimum output to be adjusted to 20% or 4 mA. (See Figure 3.) The minimum output adjustment may also be used to set valves or dampers to minimum positions.

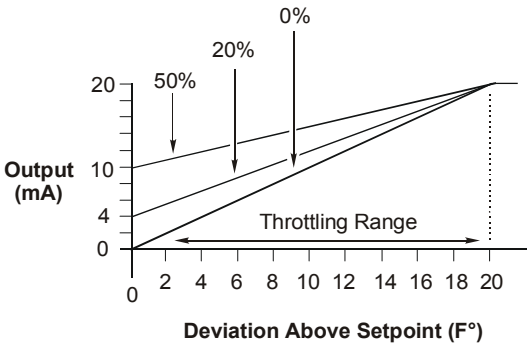


Figure 3: Output vs. Deviation from Setpoint for: Minimum Output = 0, 20, and 50%, Throttling Range = 20°F (DA)

Make the adjustment at the minimum output potentiometer marked as MIN OUTPUT. (See Figure 2.) For each 10% increase in output, the **next** bar on the LED indicator will light (only one bar is lit at any time).

Note: Before setting the minimum output potentiometer, verify that the control reads zero output (that is, no LEDs are lit).

Throttling Range (Proportional Band)

The throttling range is the range over which a control is active. Throttling range for the A350P control can be adjusted from 2 to 30F° (1 to 17C°). Make the adjustment at the throttling range potentiometer marked THROT RANGE (see Figure 2).

Integration Function

Proportional-only controls cannot hold a process at the exact setpoint. A proportional offset is always present because the control output is 0% at setpoint. Any load on the system will cause the control point to be offset from the setpoint. The greater the load on the system, the further the control point will be offset from the setpoint. (This is commonly referred to as proportional offset, and under maximum load this error will approach the throttling range.)

Some proportional-only controls are designed with their setpoint located midway through the proportional band to help compensate for this offset. This results in a plus/minus error from the setpoint rather than a single-ended error. Refer to Figure 4.

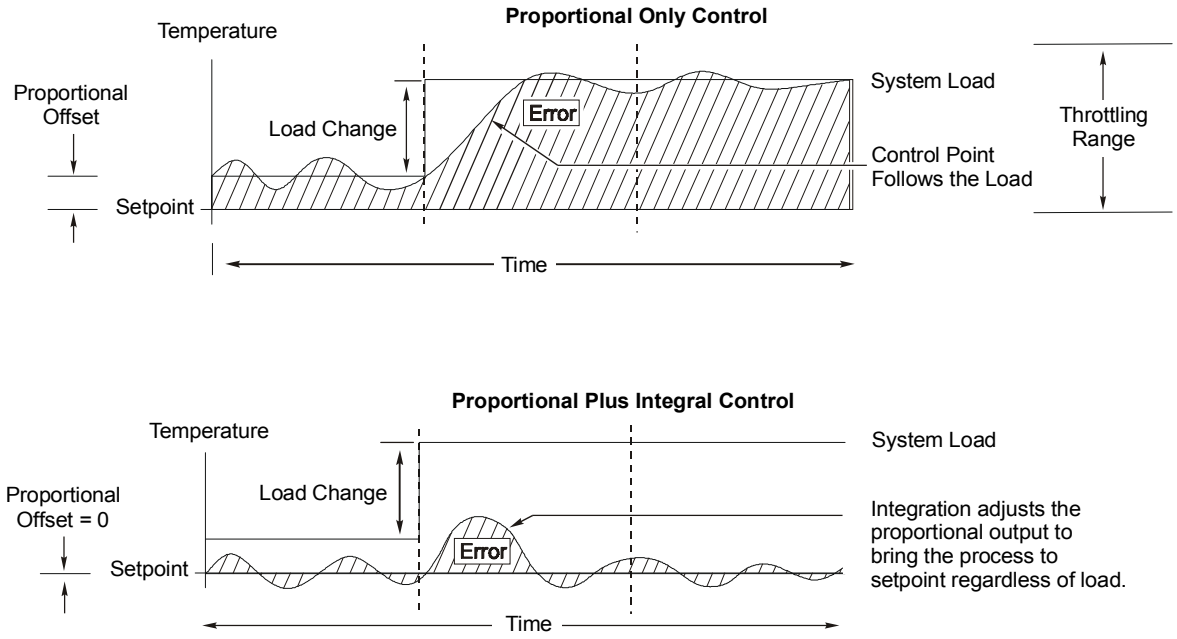


Figure 4: Comparison Between Proportional Only and Proportional Plus Integral Control

The A350P control has an integration feature that forces the control point to match the setpoint. Over time, the A350P will control the heating/cooling equipment to balance the system load at the control setpoint. (See Figure 4.)

On traditional proportional plus integral controls, the amount of correction will become too large if the system load exceeds the capacity of the equipment. When the actuated device (valve or damper) is fully open or closed and the setpoint still cannot be reached, the integration error continues to grow. The result is called *integral windup*.

The A350P control avoids *integral windup* with a patented circuit that puts a dynamic ceiling on the integrator. This resets the integration error when the sensor goes just above the setpoint plus the throttling range (in DA mode) or just below the setpoint minus the throttling range (in RA mode). This allows the process to recover from an out-of-range condition without a large overshoot.

The A350P control has three field-selectable integration constants and an off position. The integration DIP switch selects the integration constant. (See Figure 2 for location.)

The field-selectable integration constants include:

- **OFF: Switch 1 to On position, all others Off** provides proportional-only operation.

Note: In open-loop (without feedback) applications, select OFF (proportional-only) operation.

- **Slow (C3): Switch 2 to On position, all others Off** is the slowest integration constant (26 minute), and is suitable for most proportional plus integral applications. Slow is the recommended initial setting.
- **Medium (C2): Switch 3 to On position, all others Off** selects a 13-minute integration constant. If the rate of system recovery to setpoint is sluggish with the control set to slow, and if the system has enough capacity to drive the process to setpoint at a faster rate, the medium setting may be used.
- **Fast (C1): Switch 4 in On position, all others Off** is the fastest integration constant (6.5 minutes). Use fast only in instances where the rate of change at the sensor is extremely rapid and system capacity can compensate for that rapid change.

Reverse or Direct Acting Operation

With the operation jumpers in the Reverse Acting (RA) position, the analog output increases as the temperature drops below setpoint. (See Figure 5.)

With the operation jumpers in the Direct Acting (DA) position, the analog output will increase as the temperature rises above the setpoint.

Select the RA/DA mode by positioning the operation jumpers vertically or horizontally. (See Figure 2.) Position the operation jumpers vertically for RA and horizontally for DA.

The RA/DA operation jumpers are installed in the RA mode at the factory.

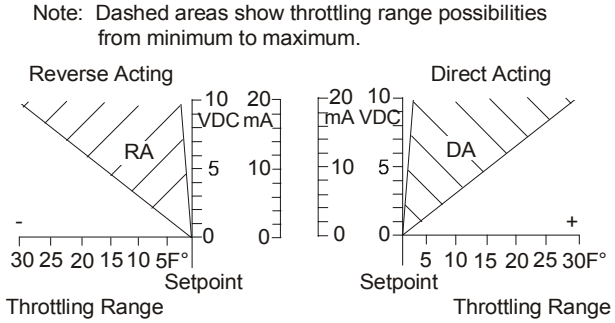


Figure 5: RA and DA Proportional Bands Shown in Proportional-Only Mode

Add-on Modules

The maximum number of add-on modules is listed in Table 1.

Table 1: Maximum Number of S350 Stage Modules per A350P

Power Source	Number of S350A or S350C Stage Modules Allowed	Number of S350A or S350C Modules (with One S350P) Allowed	Number of S350A or S350C Modules (with Two S350Ps) Allowed
Y350R	4	2	0
External Class 2 Transformer	9	8	7

S350A On-Off Stage Modules

S350A On-Off stage modules receive power, setpoint, and sensor input from the A350P control. S350A stage modules perform switching functions based on the control's setpoint and sensor information, as well as the offset and differential selected at the S350A stage module.

For more information on these modules, refer to the *System 350™ S350 Temperature, S351 Humidity, and S352 Pressure On/Off Stage Modules Product/Technical Bulletin (LIT-930080)*.

S350C Slave Stage Module

S350C slave stage modules receive power and sensor input from the A350P control. S350C slave stage modules perform switching functions based upon the control's sensor information, as well as the setpoint and differential selected at the S350C stage module.

For more information on these modules, refer to the *System 350™ S350C Temperature Slave Stage Module Product/Technical Bulletin (LIT-930084)*.

S350P Proportional Stage Modules

S350P proportional stage modules receive power, setpoint, and sensor input from the A350P control. The S350P stage module responds with an analog 0 to 10 VDC and 0 to 20 mA output signal. This is based upon the control's setpoint and sensor information, as well as the offset, throttling range, and minimum output selected at the S350P stage module.

For more information on these modules, refer to the *System 350™ S350P Proportional Plus Integral Temperature Stage Module Product/Technical Bulletin (LIT-930086)*.

Dimensions

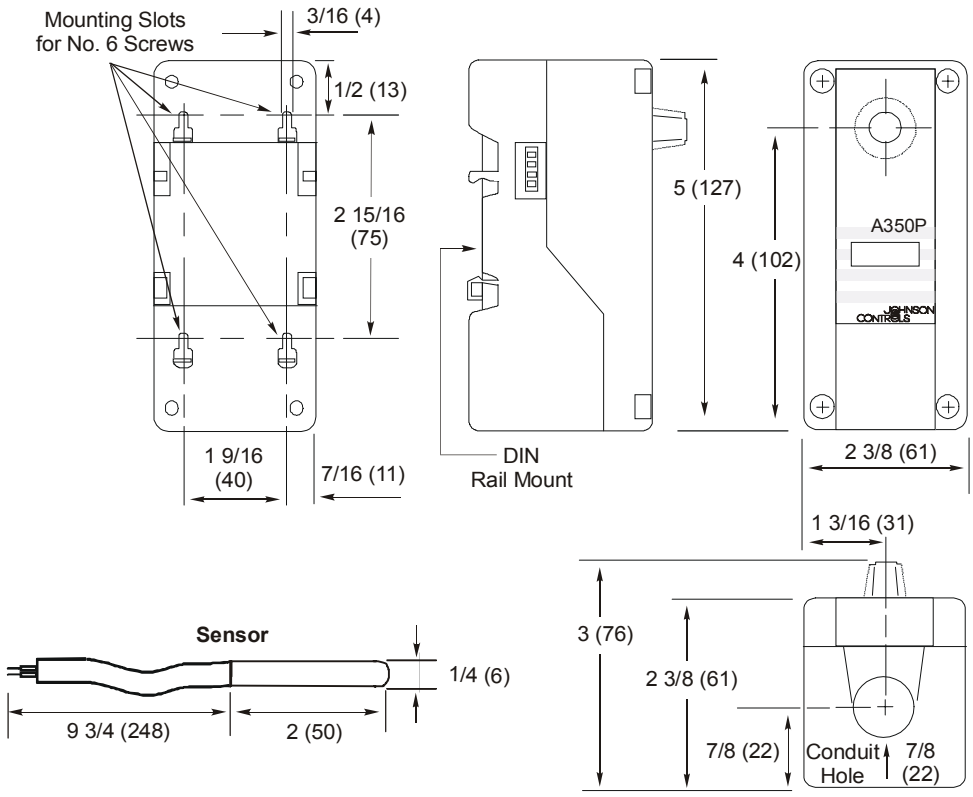


Figure 6: A350P Control and Sensor Dimensions, in. (mm)

Installation and Wiring

Celsius Scale Conversion

A Celsius scale throttling range decal is included with the A350P control. If the Celsius scale is desired:

1. Locate the throttling range and minimum output potentiometers on the main PC board. (See Figure 2.) Carefully remove the knobs and the existing decal.
2. Apply the Celsius scale decal in the same place as the original decal.
3. Rotate both knob stems completely counterclockwise (CCW).
4. Reinstall the potentiometer knobs so the arrows point to the minimum values.

The A350P Temperature Control is housed in a compact NEMA 1 plastic enclosure designed for standard 35 mm DIN rail mounting. Four key-slot mounting holes on the back of the control case are provided should surface mounting be required. If a Y350R is used, it should be mounted immediately to the right of the control. Any S350 modules would follow on the right, with the D350 being the last module mounted, also on the right.

Note: When mounting any System 350 module to rigid conduit, attach the hub to the conduit before securing the hub to the control enclosure.

WARNING: **Risk of Electrical Shock.** Disconnect power supply before making electrical connections to avoid possible electrical shock or equipment damage.

Wiring Terminals

Install all wiring to conform to the National Electrical Code and local regulations. For maximum electrical rating of control, refer to the label inside the control cover. Terminals will accept 12 to 26 AWG wire. Use only copper conductors.

1. Use a 1/8 in. (3 mm) flat-blade screwdriver to push the clamp arm down.
2. Insert the appropriate wire into the opening. Refer to Table 2 for terminal designations.
3. Release the clamp arm to secure the wire. See Figure 7.

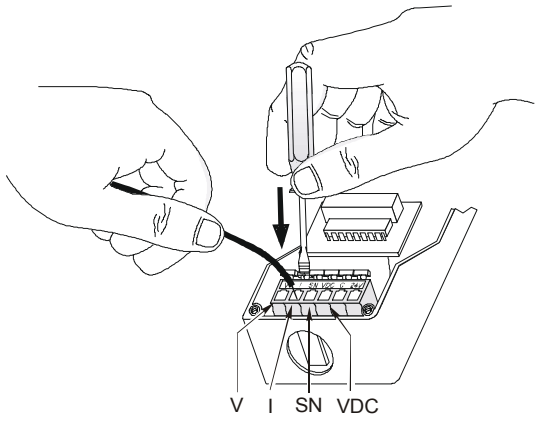


Figure 7: Cage Clamp Terminal Block

Table 2: Terminal Designations

Terminal	Description
V	0 to 10 VDC output
I	0 to 20 mA output
SN	Temperature sensor input
VDC	5 VDC power supply (not used)
C	Common for power supply, temperature sensor, and outputs
24V	24 Volts AC

Note: Output signals from the A350P control vary from 0 to 10 VDC and 0 to 20 mA. (Both outputs can be used simultaneously.) Connections can be made to both the V and I terminals, allowing the control to drive two outputs from the same RA or DA ramp simultaneously. This feature can be used to drive motor actuators of different types in a single application.

Sensor Connection

Shielded cable is not generally required for sensor wiring on runs of less than 50 feet. When using shielded cable, isolate and tape the shield at the sensor. Connect the shield to Terminal C on the A350P control.

Refer to Table 3 for the maximum recommended cable lengths for particular sizes of wire.

Table 3: Maximum Recommended Sensor Cable Lengths

Wire Gauge	Shielded Cable Length	
	Feet	Meters
14 AWG	800	244
16 AWG	500	152
18 AWG	310	94
20 AWG	200	61
22 AWG	124	38

- Various A99B Series Temperature Sensors and mounting hardware are available for use with A350P Series controls.

  The sensor must be connected to Terminals SN and C. (See Figure 2.) The sensors are not polarity sensitive.

- The sensor must be mounted so that it can accurately sense the temperature of the controlled medium.

Table 4: A350P Controls And Sensors

Control	Sensor Included Sensor Lead Length is 9-3/4 in. (0.25 m)
A350PS-1C	A99BB-25C; Range: -40 to 212°F (-40 to 100°C)
A350PS-1CM	A99BB-25C; Range: -40 to 212°F (-40 to 100°C)
A350PS-2C	A99BC-25; Range: -40 to 248°F (-40 to 120°C)
A350PS-2CM	A99BC-25; Range: -40 to 248°F (-40 to 120°C)
A350PT-1C	No Sensor Included
A350BA-2C	A99BC-25; Range: -40 to 248°F (-40 to 120°C)

- For more information regarding sensor options and installation, refer to the *A99B Series Temperature Sensors Product/Technical Bulletin (LIT-125186).*

Adjustments

Follow this procedure to set up the A350P control for the types of operation desired.

1. Remove its cover by loosening the four captive cover screws. (See Figure 2.)
2. Set the RA/DA operation jumpers to the desired mode of operation. Position the operation jumpers vertically for RA (Reverse Acting) or horizontally for DA (Direct Acting). (See Figure 2.)
3. Adjust the throttling range potentiometer to desired setting. Rotate Clockwise (CW) to increase the throttling range.

Notes: Included with the control is a Celsius scale throttling range decal. If the Celsius scale is desired, refer to the *Celsius Scale Conversion* section for decal installation instructions.

If the A350P is to be used in proportional plus integral control, the initial throttling range adjustment is seldom set below 6F° (3C°). A narrow proportional band used in conjunction with the integration may result in unstable control.

4. If minimum output is required, set the minimum output potentiometer (see Figure 2) to the desired position. The 10-segment front LED panel or a voltmeter can be used to read the minimum output. (The minimum setting for the **control** is designated by the 0 on the decal.)

Notes: Before adjusting the minimum output potentiometer, verify that the control reads zero output (that is, no LEDs are lit).

For each 10% increase in output, the **next** bar will light on the LED bar graph (only one bar is lit at anytime). In a milliampere application, each bar equals 2 mA. In a voltage application, each bar equals 1 VDC. (Refer to Figure 3.)

Example:

To set the control for a minimum output of 4 mA, turn the minimum output potentiometer clockwise until the second LED segment just lights.

5. Make sure the system is stable in the proportional mode before selecting integration. Refer to the *Checkout Procedure* section.
6. Reinstall the cover and secure in place with the four captive cover screws.
7. Adjust the setpoint dial to the desired setpoint.

   If using the D350 Display Module, press and hold the setpoint button on the D350 while rotating the setpoint dial.

Note: The control's setpoint is factory calibrated at midscale to a tolerance of ±1F° (0.6C°). The setpoint tolerance at the extreme ends of the setpoint scale may be ± 4F° (2.2C°). The D350 Display Module is unaffected by this tolerance shift. Use the D350 for the most accurate setpoint selection.

Checkout Procedure

Follow this procedure to verify the A350P control is connected and functioning properly.

1. Before applying power, make sure that the installation and wiring connections are according to job specifications.
2. Set up the system for proportional mode (Integration = OFF), and make any necessary adjustments to the setpoint, throttling range, and minimum output. Then select Reverse or Direct Acting mode.
3. After making adjustments and electrical connections, apply power to the system, and observe it for stable operation.
4. If integration is required, select the fast (C1), medium (C2), or slow (C3) integration constant. Slow is the recommended initial setting. (Refer to the *Integration Function* section.)
5. Put the system back into operation. If instability occurs, consider increasing the throttling range.

Troubleshooting

If the control system does not function properly, verify that the proper operation mode is selected on each module (DA or RA), and perform the following procedures to determine the cause of the problem:

1. Check for proper voltages on the A350P control.
   a. Connect a digital voltmeter (DVM) between Terminals 24V (+) and C (-) located on the A350P's terminal block. (See Figure 2.)

      If an external transformer is used, select AC volts on the DVM. Verify that the voltage is between 20 and 30 VAC.

      If a Y350R Power Module is used, select DC volts on the DVM. Verify that the voltage is between 16 and 38 VDC.

      If an external DC power supply is used, select DC volts on the DVM. Verify that the voltage is between 22 and 29 VDC.

   b. If the DVM reading is within the indicated voltage range, select DC volts on the DVM (DVM must be accurate to +/-0.01 VDC), and connect the (+) lead to Terminal VDC and the (-) lead to Terminal C.

      If the DVM voltage is between 4.9 and 5.1 VDC, proceed to Step 2.

      If the DVM voltage is above 5.1 VDC, replace the A350P.

   c. If the DVM voltage is below 4.9 VDC, check the control using the following procedure.

      Disconnect all loads from the A350P control. (If in Direct Acting mode with power on, the system will go to full output when the sensor is disconnected. Thus, ensure that any loads are disconnected *before* disconnecting the temperature sensor.)

      Disconnect the temperature sensor completely, and recheck the DVM voltage.

      If the DVM voltage rises to a value between 4.9 and 5.1 VDC, replace the sensor.

      If the DVM voltage is still below 4.9 VDC, replace the A350P control.

2. Check sensor for proper resistance at a given temperature. (The resistance across the sensor changes with the temperature of the sensor.)
   a. Disconnect power from the A350P control.
   b. Disconnect the sensor from the control and measure the resistance across sensor leads.
   c. When measuring the sensor's resistance, use an accurate thermometer to measure the temperature at the sensor.
   d. Refer to Figure 8 to determine the optimal resistance for the measured temperature.
   e. If the measured resistance varies substantially from the optimal resistance for that temperature, the sensor or wiring must be replaced.
   f. If the sensor's resistance conforms to the chart in Figure 8, reconnect the sensor to the control.
   g. Reconnect power to the control.

Note: The sensor reading indicated by the D350 may differ somewhat from thermometer readings due to sensor tolerances, time constants, thermometer accuracy, and other factors.

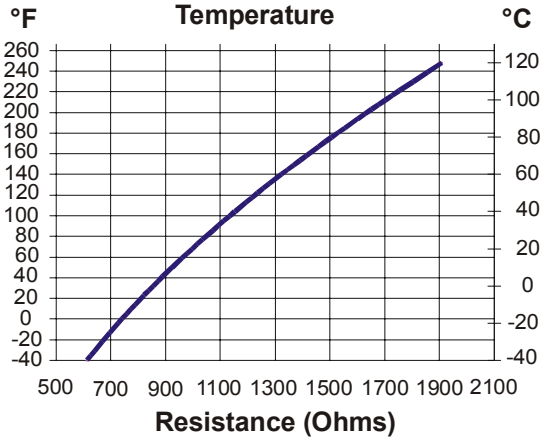


Figure 8: Temperature vs. Resistance Chart for the A99B Series Sensor

3. Check the A350P control for proper operation.

Note: Perform Steps 1 and 2 first.

a. Reconnect the sensor to the control and re-apply power.

b. Turn the throttling range and the minimum output to minimum by turning both potentiometers counterclockwise.

c. Switch off the integration.

d. Select the RA mode.

e. Connect the DVM (+) lead to the A350P control's Terminal SN and the (-) lead to Terminal C.

If the sensor voltage is less than 1.8 VDC on model A350PS-1C or less than 2.3 VDC on model A350PS-2C, go to Step 3g.

f. If the voltage is greater than 1.8 VDC on model A350PS 1C or greater than 2.3 VDC on model A350PS-2C, adjust the setpoint to 120°F (49°C) on model A350PS-1C or 240°F (116°C) on model A350PS-2C.

The output Terminal V should be less than 0.1 VDC, and all LEDs in the bar graph display should be off. If not, replace the A350P.

1. Adjust the minimum output to the maximum by turning the potentiometer CW. As the potentiometer is turned CW, the LEDs in the bar graph should turn on from left to right until the fifth or sixth bar is on. If not, replace the A350P control.

2. Adjust the minimum output to zero again, and select the DA mode.

3. If the right most LED in the bar graph is on (Terminal V = 10 VDC, Terminal I = 20 mA), go to Step 3h. If the LED is not on, replace the A350P.

g. If the sensor voltage is above 1.1 VDC on A350PS-1C or above 1.6 VDC on A350PS-2C, adjust the setpoint to match the actual temperature (T_S). The output Terminal V should be less than 0.1 VDC, and all LEDs in the bar graph should be off.

Note: Some tolerance error is present between the setpoint scale and the setpoint knob pointer. Refer to the *Adjustments* section.

1. Make sure the A350P control is in RA mode.

2. Increase the setpoint in increments of 2F° (1C°).

3. As the setpoint is increased, the control's Terminal V output voltage should go from 0 to 10 VDC, the Terminal I output current should go from 0 to 20 mA, and the LEDs should turn on, one at a time from left to right.

4. If the LEDs do not turn on and if the outputs of terminals V and I do not change as described above, replace the control.

h. Readjust the A350P control to the desired control settings.

Repairs and Replacement

Do not make field repairs or perform calibration. A99B Temperature Sensors and replacement controls are available through the nearest Johnson Controls representative. (See Tables 5 and 6 for ordering information.)

Ordering Information

Table 5: System 350 Products

Item	Product Code Number	Description
A350P Proportional Plus Integral Temperature Controls	A350PS-1C	Range: -30 to 130°F (-35 to 55°C) Throttling Range: 2 to 30 F° (1 to 17C°) (Includes the A99BC-25C Temperature Sensor)
	A350PS-2C	Range: 90 to 250°F (30 to 120°C) Throttling Range: 2 to 30 F° (1 to 17C°) (Includes the A99BC-25C Temperature Sensor)
	A350PT-1C	Range: -30 to 130°F (-35 to 55°C) Throttling Range: 2 to 30F° (1 to 17C°) (Sensor not included)
Display Modules	D350AA-1C D350BA-1C	Digital Temperature Display Module (Fahrenheit Scale) Digital Temperature Display Module (Celsius Scale)
On/Off Stage Modules	S350AA-1C S350AB-1C	Fahrenheit Scale Celsius Scale
Slave Stage Module	S350CC-1C	Dual Scale (°F and °C)
Proportional Stage Module	S350PQ-1C	Dual Scale (°F and °C)
Power Module	Y350R-1C	120 or 240 VAC, 50/60 Hz Input, Rectified Class 2, 24 VAC Output

Table 6: System 350 Accessories

Item	Product Code Number	Description
Wall Mount Plate	TE-6001-4	Includes sensor mounting clip
Cover	T-4000-2644	For wall mount plate
Mounting Clip	A99-CLP-1	Surface mounting clip for the A99B Temperature Sensor
Duct Mounting	TE-6001-1	Duct-mounting hardware with handy box
Duct Mounting	TE-6001-11	Duct-mounting hardware without handy box
Conduit Adaptor	ADP11A-600R	1/2 in. snap-fit EMT conduit adaptor (box of 10)
Immersion Well	WEL11A-601R	For liquid sensing applications
Sun Shield	SHL10A-603R	For use with outside sensors in sunny locations
DIN Rail Sections	BKT287-1R BKT287-2R	12 in. (0.3 m) long 39-1/3 in. (1.0 m) long
DIN Rail End Clamp	PLT344-1R	Consists of two end clamps
Cables for Remote Mounting of D350 Display Module	WHA29A-600R* WHA29A-603R WHA29A-604R	3 ft (0.9 m) 25 ft (7.6 m) 50 ft (15.2 m)

*WHA29A-600R may be used to daisy chain S350 modules together.

Specifications

Product	A350P Proportional Plus Time Integral Temperature Control	
Supply Voltage	Y350R Power Module:	Input: 120/240 VAC 50/60 Hz
		Output: 24 VDC, unfiltered, 10 VA
	External Source:	24 VAC, 50/60 Hz, Class 2 (20-30 VAC)
	Note: Only one supply voltage source may be used.	
Power Consumption	3.2 VA maximum	
Ambient Temperature	Operating:	-30 to 150°F (-34 to 66°C)
	Shipping:	-40 to 185°F (-40 to 85°C)
Humidity (all modules)	0 to 95% RH non-condensing; maximum dew point 85°F (29°C)	
Setpoint Adjustment Range	A350PS-1C:	-30 to 130°F (-35 to 55°C)
	A350PS-2C:	90 to 250°F (30 to 120°C)
	A350PT-1C:	-30 to 130°F (-35 to 55°C)
Throttling Adjustment Range	2 to 30F° (1 to 17C°)	
Analog Outputs	0 to 10 VDC (550 ohm load minimum) and 0 to 20 mA (600 ohm load maximum)	
Minimum Output	Adjustable from 0 to 60% of the output	
Output Indication	A ten segment LED bar graph indicates percentage of output.	
Control Action	Direct or reverse action is jumper selectable.	
Integration Constant	Four selectable rates: fast, medium, slow, and off	
Sensor	Replaceable positive temperature coefficient sensor	
	Reference resistance 1035 ohms at 77°F (25°C)	
Material	Case and cover:	NEMA 1 high-impact thermoplastic
Agency Listing	UL Listed, CCN XAPX, File E27734	
	UL Listed for Canada, CCN XAPX7, File E27734	

The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult Johnson Controls Application Engineering at (414) 274-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

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