HydroThrift

HYDROTHRIFT CORPORATION

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HYDROTHRIFT CORPORATION

GERLING & ASSOCIATES
CA+20

Custom Mobile Heating, Ventilation, and Air Conditioning System
Operator Manual –Table of Contents

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Gerling & Associates
Model CA+20

Custom Mobile Heating, Ventilation, Air Conditioning System

Performance Summary

The HydroThrift Model CA+20 consists of two independent, heating, ventilation and air conditioning (HVAC) units mounted side-by-side. Each unit includes a 10-ton air conditioning system capable of operating at ambient temperatures from –20 °F to 115 °F, a 20 kW electric resistance heating element, and a 3,500 CFM blower. The air conditioning system is designed to operate the compressor continuously by alternating between 100% air-cooling and 100% bypass-cooling according to thermostat requirements.

Electrical Requirements

Power:	208 Volt / 3 Phase / 60 Hz
Full Load Amps:	64 Amps / Unit*
Recommended Fuse/Breaker Size:	90 Amps / Unit *

*Note: Values are for One Unit, Two Units Exist.

Unit Startup, Shutdown, and Operation Procedures

Before connecting power, verify panel disconnects and thermostats are OFF. After connecting electrical power, turn disconnect ON. Check for low airflow at register(s) or observe blower rotation to verify proper three-phase power hookup. If blower rotation is incorrect, switch two wires on unit feeder circuit and repeat check.

Locate and set the thermostats such that return air temperatures for air conditioning mode are between 70 °F and 85 °F and heating mode are less than 85 °F.

When possible, power the units ON and allow the blower to circulate air for 10 minutes prior to starting the air conditioner. This is particularly important if starting temperatures are below 70 °F to allow the refrigerant oil heaters and receivers to warm prior to operation. For cold days, the heater can be started immediately by switching the thermostat to HEAT. When heating is no longer required and the CA+20 has been powered for 10 minutes, the thermostat can be switched to COOL.

For shutdown, turn the thermostats OFF. Wait two minutes for the compressor and condenser to stop operating before powering the units OFF.

The installation may include an optional blower switch. The blower must be switched ON for HEAT or COOL to operate. The blower must remain on for two minutes after switching from COOL to OFF.

WARNING: DO NOT OPERATE WITH CABINET DOORS OPEN!

Component and Performance Specifications

Model:	CA+20
Number of Systems:	One (1)
Number of Units:	Two (2) – Right and Left

Ventilation / Unit

Blower:	Comefri ATLI 12-12 RA
Airflow:	3,500 CFM
External SP:	0.75" wc
Blower SP:	2.10" wc
Blower TP:	2.46" wc
RPM:	1185 RPM
Blower BHP:	2.38 HP
Motor:	Baldor HM3161A 1725 RPM 3 HP ODP ATO
Belt:	AX47
Tension:	0.25" Deflection @ 4.0 lb (New) / 3.3 lb (Retension)
Filters:	Two Precisionaire Pre Pleat HV 1x20x25

Heating / Unit

Heater:	Thermolec MD13-4918 Open Coil with 20KW Element
Safeties:	Differential Pressure Switch Automatic and Manual Reset Temp Switches
Heat:	20 kW
Temperature Rise:	18 °F

Air Conditioning / Unit

Refrigerant:	33 lbs R-22
Compressor:	Copeland Scroll ZR12M3-TWC-961
Refrigerant Oil:	Mineral
Evaporator:	25"x36" 6 Row/20 TH/8 FPI (See Coil Specifications)
Condenser:	42.5"x36" 6 Row/34 TH/12 FPI (See Coil Specifications)
Condenser Fan:	Aerovent 24L425-DDPRC-1750-1 1/2
Condenser Fan Airflow:	5,500 CFM
Condenser Fan SP:	0.87" wc
Condenser Fan BHP:	1.43 HP
Condenser Fan Speed:	1750 RPM
Condenser Fan Motor:	Westinghouse DT1/54 1750 RPM 1.5 HP ODP
Low Ambient Control:	Condenser Fan VFD <150 psi Fan Off with +17 psi differential to On 167 to 250 psi, Fan Speed Increases from 292 to 1750 RPM >250 psi Fan On 1750 RPM
Receiver:	16 lb 450 psi
Safeties:	Air Flow Pressure Switch, Low Pressure, High Pressure, Compressor Discharge Temp, Compressor Overload, Coil Icing Freeze Protection
Low Pressure Switch:	Automatic Reset 15 psi Cut Out, 30 psi Cut In
High Pressure Switches:	Manual Reset 400 psi Cut Out

Component and Performance Specifications (Continued)

Air Conditioning Components / Unit

Condenser Check Valve:	Superior 804A-14ST
Receiver Hot Gas Bypass Valve:	Sporlan ORD-4-35
Receiver Safety Relief Valve	Superior 3002A 450 psi
Liquid Line Filter:	Sporlan C-607-S
Liquid Line Solenoid:	Sporlan E19S270
Coil:	Sporlan MKC-2 208V (PN 311554)
Sight Glass And Moisture Indicator:	Sporlan SA-17S
Evaporator Thermostatic Expansion Valve:	Sporlan OVE-15-GA
Hot Gas Bypass Valve:	Sporlan SHGBE-8-0/100
Coil:	Sporlan MKC-1 208V (PN 310195)
DSH Liquid Line Solenoid Valve:	Sporlan E6S140
Coil:	Sporlan MKC-1 208V (PN 310195)
DSH Thermostatic Expansion Valve:	Sporlan SVE-2-L1
Hot Gas Isolation Valve:	Superior 587WAS-14ST
Suction Filter:	Sporlan SF-4811-T
Dual Pressure Control:	Johnson Controls P170SA-1C
Coil Icing Temperature Sensor:	Kele ST-R24S
Head Pressure Transmitter:	Dwyer 626-14-CH-P1-E5-S1 (0-500 psi, 4-20 mA)
Discharge Pressure Gauge (0-600 psi)	Weiss Instrument 84160
Suction Pressure Gauge (30" Hg-0-150 psi)	Weiss Instrument 84210

Structural

Material:	1.25x1.25x16 Gauge Carbon Steel
Drip Pan:	Stainless Steel
Unit Divider Sheet	Galvanized Steel
Insulation:	¾" Armaflex Sheet

Electrical Components

Disconnect	Allen Bradley 194E-E100-1753-6N
Compressor Contactor	Allen Bradley 100-C43H10
Ventilation Blower Contactor	Allen Bradley 100-C12H10
Heater Contactor	Allen Bradley 100-C30J10
Condenser Fan VFD	AC Tech SF215
Programmable Relay with Display	Moeller 820-DC-RC V04 or Later
Control Power and Crankcase Heater Fuse	Ferraz Shawmut ATMR-3
24V DC Power Supply	Weidmuller 9928890024

Programmable Relay Operation Guide

The HydroThrift Model CA+20 controls utilize a Moeller 820-DC-RC smart relay to execute the heating, cooling, and ventilation control logic. The Moeller 820-DC-RC is mounted inside the electrical enclosure and features a LCD panel for display of the chiller operational data and, when necessary, alarm and troubleshooting information.

In normal operation, the Moeller LCD cycles between displaying 1) operational hours for the blower, compressor, and heater and 2) condenser head pressure, VFD condenser fan speed (0-100%), and coil icing thermistor temperature. If an alarm condition exists, additional screen(s) will be displayed for the following problems:

- Check blower and/or air flow switch – The controller is getting a signal that the blower should be operating but the air flow switch is not providing a confirming signal. Troubleshooting: Check blower contactor, blower motor, belt, blower, air flow probe tubing, and air flow switch.
- Heater tstat safety tripped – The automatic and/or manual reset heater safety switches have tripped. Reset the manual reset heater safety switch and inspect heater. Verify air flow exists.
- Refrigerant high pressure tripped – Locate the low and high pressure switches near the compressor. Reset the high pressure switch. Check the condenser coil and fan for air flow blockage, check condenser fan, fan motor, variable frequency drive, and condenser head pressure temperature transmitter.
- Refrigerant low pressure tripped – Check liquid line solenoid valve is opening. Observe sight glass. Check for refrigerant leaks. System may be low on refrigerant. Evacuate system, repair any leaks, and charge with 33 lbs of R-22.
- Coil freezing, check air filter – This error may be displayed if the system is operated with the enclosure doors are open and inadequate air flow across the evaporator coil exists. Of course, the doors must be open to view the LCD. When this occurs, the system will avoid icing by operating in bypass model. Check the air flow filter and ignore this error....unless it is observed from a remote Vision terminal.
- Compressor internal OL tripped – The compressor protection module has stopped the compressor indicating several serious problems might exist. A refrigeration technician and/or HydroThrift should be contacted to check compressor operation, return gas temperature/superheat, suction pressure, and hot gas bypass desuperheating.
- Condenser pressure transmitter (tx) failed – The condenser head pressure transmitter has failed or is providing a signal outside of normal ranges. When this error is detected, the condenser fan will operate at full speed. If the transmitter is intermittent, disconnect and electrically tape each wire to prevent erroneous signals. Replace the pressure transmitter. NOTE: Disconnect the hose at the opposite end from the transmitter first. A service valve exists at the brazed copper fitting to ease maintenance requirements.
- Check VFD for fault – The variable frequency drive for the condenser fan motor is controlled by the Moeller controller. This error indicates the fan should be running but a feedback signal is absent. Check the VFD display for error messages and refer to the AC Tech section of this manual for troubleshooting help.

Programmable Relay Maintenance Mode

With the thermostat controls switched OFF (heater and compressor off), the Moeller controller has two maintenance mode functions to support common troubleshooting. To enter maintenance mode, press and hold the left arrow button for at least three seconds. The display will change and indicate Maintenance Mode. Following the displayed instructions, press up or down to select testing the solenoid valves or the variable frequency drive (VFD) or press the right button to end maintenance mode.

NOTE: While in maintenance mode, subsequent thermostat control signals will be ignored. End maintenance mode or cycle power off/on to reset the controller.

If the valve test is selected, all three solenoid valves can be cycled open or closed. The valves will be closed, if the display indicates to push the up arrow to open them. The valves will be open, if the display indicates to push the down arrow to close them. Press the right button at any time to end the test and maintenance mode.

If the VFD test is selected, the up and down arrow keys can be used to increase or decrease the VFD signal in 10% steps. Note that the VFD will display the speed in Hertz so (% speed) x 60 = VFD display. The VFD feedback signal will be displayed on the Moeller LCD in %. Of course, the fan rotation should also be observed. Press the right button at any time to stop the fan and end the test and maintenance mode.

Support

For all maintenance and support questions, contact HydroThrift at 330-837-5141.

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G- Force Mobile HVAC units may be equipped with the G-Force Vision Display. The following two (2) pages reference this equipment.

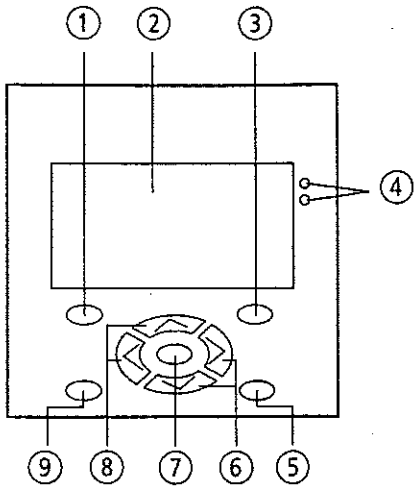
If your equipment does not include the G-Force Vision, please disregard this information.

G-FORCE

VISION

Operating Instructions

Display and operating unit



① DEL button
② Graphic display
③ ALT button
④ LEDs for signalling
⑤ Mode button
⑥ Right, down cursor buttons
⑦ OK button
⑧ Left, up cursor buttons
⑨ ESC button

1. Click OK to start unit as display indicates

   A. Street side unit starts first, followed by curb side

2. To stop unit, press DEL button twice

3. To change temperature settings on street and curb side units:

   A. Press ALT button

   B. Press OK button – shaded cursor will flash on street side temperature

   C. Press OK button – single digit will flash on street side temperature
      1. Press "up cursor" button to increase temperature setting
      2. Press "down cursor" button to decrease temperature setting

   D. Press OK button to accept desired temperature setting

   E. Press OK button – shaded cursor will flash on Curb Side temperature

   F. Press OK button – single digit will flash on Curb Side temperature
      1. Press "up cursor" button to increase temperature setting
      2. Press "down cursor" button to decrease temperature setting

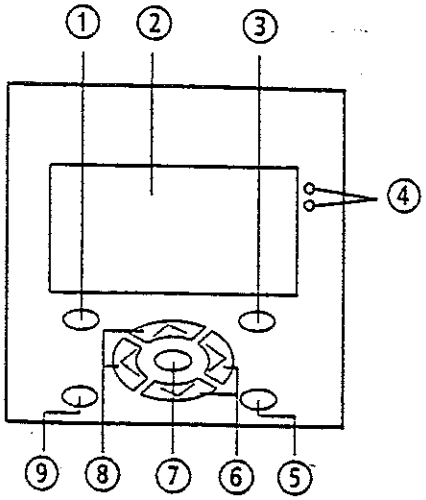
4. Press ESC button to return to Main Menu

5. Press "left cursor" or "right cursor" button to view Information and Alarm screens.

6. Press ESC button to return to Main Menu

G-Force Vision Advance Setup

Display and operating unit



1. DEL button
2. Graphic display
3. ALT button
4. LEDs for signaling (RED – ALARM)
5. Mode button
6. Right, down cursor buttons
7. OK button
8. Left, up cursor buttons
9. ESC button

DEVICE OVERVIEW

Device Mode Configurations

1. Automatic – unit will heat or cool based on temperature set points (unit starts in automatic mode).
2. Manual – Vent : Blower only operates
3. Manual – Heat : Heater only operates
4. Manual – Cool : Cooling only operates
5. Off : Unit disabled
6. Remote : Remote thermostat

ADVANCE SETUP

Parameter Changes in Advance Setup:

1. T'stat differential
2. Mode configuration
3. Override airflow switch
4. Override coil Freezestat
5. Override high pressure transmitter

Procedure for Accessing Advance Setup from Main Menu:

1. Press ALT button twice – graphic display will read: WARNING <ALT> AGAIN BOTH UNITS OFF FOR ADVANCE SETUP
2. Press ALT button – both units will shut down.
   - A. Graphic display will read: STREET SETUP
MODE: OFF
T'STAT DIFF. 2 F
   - B. Press OK button to enable differential change.
   - C. Press OK button – differential figure will flash
   - D. Press up cursor or down cursor button to make desired change
   - E. Press ESC button to exit T'stat differential
   - F. Press ALT button to enter Mode Change *
   - G. Pressing ALT button will change to all other modes
   - H. Press right cursor button to CURB SETUP
   - I. Press ALT button to change modes
   - J. Press right cursor button to display all possible overrides and follow graphic display instructions to alter.
   - K. Press ESC to return to Main Menu.

*NOTE: Mode must be change from OFF to AUTOMATIC or units will not cool or heat.

Fan Installation, Operation & Maintenance

Centrifugal Fans - Installation Operating and Maintenance Manual

Fan Installation, Operation & Maintenance

Centrifugal Fans - Installation Operating and Maintenance Manual

All Comefri Fans are manufactured according to our Quality Assurance System, in accordance with UNI-EN 29001 (ISO 9001); since 1987 our Quality System is certified by BSI (certificate no. FM-1403). All fans are balanced and tested before leaving the factory.

This document contains information on proper storage, installation, operation and maintenance. This publication will help you avoid some common problem with your fan. Failure to comply with proper installation procedures may void the warranty. The technical data and the permissible limits are to clearly listed on fan plate. Before you make changes in performance be sure to consult performance catalogue or contact Comefri USA.

Receiving and Handling

Each fan is carefully checked before shipment. When receiving a fan it is necessary to verify that is has not been damaged during the transport, especially the rotating and the electric parts. In case of damage, immediately document the damage on the delivery notes and contact the delivery company. Comefri will not take any responsibility for the transport and the handling of the fan at the customer's premises. The handling of the fan requires adequate care and lifting tools according to the weight and packaging of the fan (when moving the fan by crane, four lifting point have to be provided). Special care must is to be taken to ensure that the fan will never be lifted by the shaft ends, motor transport eyes, bearing supports and inlet or outlet flanges. Fixing points of the fans are the base frame, housing frames or lifting eyes, if available.

Note: That any improper handling, even though it may not damage the fan, often produces a need to re-balance the impeller.

Storage

Adequate storage must be provided to protect the fan from dirt and moisture. Do not use plastic sheets, as they will promote condensation and rust, especially in hot and humid environments. Most problems during storage are caused by moisture getting into the bearings. If the fan needs to be stored completely fill bearing with the recommended grease. This will remove all air pockets and avoid puddle corrosion. Rotate wheel while adding the grease to insure complete coverage. Reduce the belt tension on belt driven fans. This will reduce the load on the bearings, minimizing the potential for problems. Indoor storage is recommended. Store in a dry, clean area. If outdoor storage is necessary here are a few tips to maintain a good working condition of the fan.

- Coat the shaft with grease or a rust preventative compound.
- Wrap bearings for weather protection.
- Cover the inlet and outlet to prevent the accumulation of dirt and moisture in the housing.
- Periodically rotate the wheel
- Periodically inspect the unit to prevent damaging conditions.
- Add grease to the outside of the bearing seals

Important

On fan startup make sure to purge extra grease form the bearings. With split bearings, the caps can be removed prior to startup to remove excess grease.

Fan Foundations

Many fan problems are caused by a poorly designed foundation. The structure support must be strong enough to hold the weight of the fan and the loads created by it's running. If a base is designed well it will keep vibration levels low.

The best foundation for mounting a fan is a flat, reinforced concrete pad. This should weight at least 2 to 3 times the fan and motor. This foundation should extend at least 6 inches from the fan. The weight of the pad will ensure low vibrations. The natural frequency of concrete is usually very high, which avoids resonance problems.

The use of "T" or "J" bolts will provide a strong, rigid connection to the pad. A bolt sleeve should be use that is 2 to 2 ½ the diameter to avoid alignment problems. When using this type of anchor they should be size as large as possible.

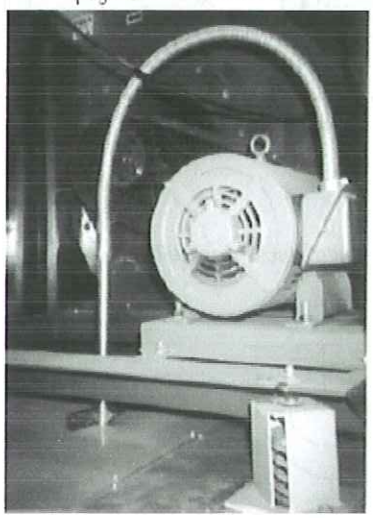
After the fan is mounted the pad level the fan using stainless steel shims. Then fill in the gap under the pad and the bolt sleeve with masonry grout. Then double check all anchor bolts to ensure they have not loosened.

Vibration Isolation Base

Isolators are use to prevent vibration and noise from being transferred to the surrounding structure. Bases must have sufficient rigidity to resist belt pull and prevent drive distortion which can lead to excessive belt and bearing wear.

Isolators, when properly selected, reduce vibration forces transmitted to the structure by approximately 95%. This much reduction reduces the likelihood of having a resonance in the support structure. There will always be a certain amount of vibration when operating centrifugal fans. If the vibration is extreme it can cause mechanical and structural failure. Figure 1 is a photograph of a fan and motor mounted on a structural steel base supported by spring vibration isolators.

Figure 1. Fan mounted on a structural steel base with spring vibration isolators



Installation

Installation is only to be carried out by trained personnel in observance of these Operating Instructions. By choosing the fan you must consider the type of installation. Particular attention must be paid to fans, which have to be installed in atmosphere with humidity and critic temperatures. The fans must be firmly fixed on a foundation or steel base frames. The fixing must be made avoiding any stress or deformation at the supporting structure. No forces or vibrations must be transferred to the supporting structure.

Duct Connections

It is important to design proper ducting to be able to keep your catalog performance. If ducting is a poor design it will result in losses this is called a "system effect". Be sure your fan conforms to the following guidelines.

Inlet Connections

Inlet spin is caused from improper ducting on the inlet of the fan housing. This will lower your performace. The change in performace is directly realated to the amount of the spin. The best solution is proper duct design and airflow patterns. This is showen in Figure 2. Installing elbows or duct turns to close to the fan inlet will also effect your performance. If the elbow is to close to the fan inlet you will have uneven flow into the fan. Allowing at least one wheel diameter from the fan will give you proper flow, as shown in Figure 3. In an applcation were the inlet is unducted there should be a least one wheel diameter of free space on the inlet side(s). Shown in figure 4.

Outlet Connections

On the fan outlet you should have at least 3 wheel diameters of straight duct before turning. Also to avoid duct trubulace the first elbow should be inline with the rotation of the fan. This is shown in Figure 5. For more information on system effects and methods for estimating their effect on performance, see AMCA Publication 201.

Fans that are mounted on vibration isolators will require a flex connector. This is used to avoid the transferring of vibration and sound into your system. Improperly mounted flex connector will also cause a system effect in figure 6A and 6B will illustrate the correct and incorrect installation of the flex a connection.

Figure 2 – Inlet Spin reduction

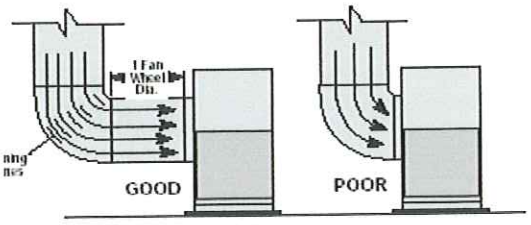


Figure 3 – Inlet elbows

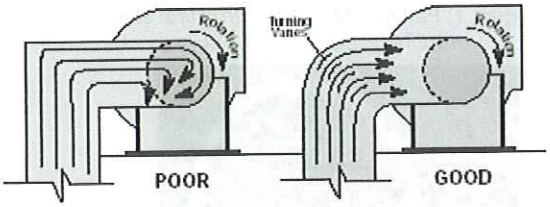


Figure 4 – Free inlet requirements

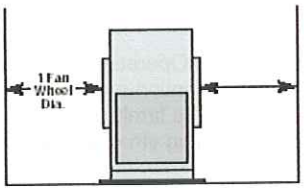


Figure 5 – Proper outlet ducting and elbow turn.

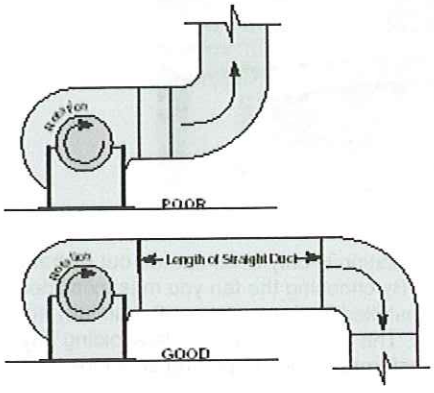
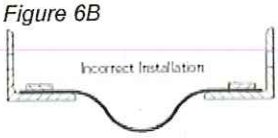


Figure 6A.

Figure 6B



Electrical wiring
The connection of the motor terminal box must be made in accordance with the information given by the motor manufacturer. The motor must be protected against overloading and particular care is required when using motors with explosion protection or provided with thermostats. Damages due to insufficient motor protection will void manufacturer's guarantee and warrantees.

Startup & Safety checks
Pay particular attention to safety. Be sure to lock off electrical power before working on any fan. Do not assume that because the factory tightened the fasteners and aligned the belt drives or couplings at the factory that they still will be tight and/or aligned when starting the fan at the jobsite. Fasteners can loosen during shipment and handling, and parts can move out of alignment. The fan should be switched on briefly to check the direction of rotation of the impeller, which should correspond to the one indicated by the arrow. Should the motor run in the wrong direction, interchange any two of the three electrical leads. Changing internal connections, as described on the motor label or wiring diagram, can reverse single-phase motors. Always observe the electrical safety instructions.

On belt drive fan proper alignment is crucial for belt life and to maintain correct belt tension. Figure. 7 shows the proper alignment. The following is a pre-start checklist that should be followed before starting any fan.

Pre-Start Check List

- ❑ Make sure electrical power is locked out.
- ❑ Check all nuts, bolts, and setscrews are tightened.
- ❑ That all electrical and system connections are properly made and tightened.
- ❑ Check power settings for voltage they must be checked against the motor plate.
- ❑ Check bearing lubrication.
- ❑ Check the ducts and the fan for foreign bodies (tools, small components, etc.)
- ❑ Wheel and assembly turns freely with on rubbing.
- ❑ Drives are tightened, properly aligned and tensioned.
- ❑ Make sure you are connected to the proper voltage.
- ❑ Motor is grounded.
- ❑ All leads are insulated.
- ❑ "Bump the Assembly" turn it on then off quickly.
- ❑ Check rotation.
- ❑ Stop fan - Check fan and assembly after first 30 min., 8 hrs and 24 hrs. for loose bolt, motor mount, drive alignment and tension.

Proper belt tension is important for long belt life. Too much tension will will place excessive loads on the belts and bearing causing permature failure. Not enough tension will cause belts to slip. This will generate unwanted heat and cut belt life in half. Use a belt tension tool to check if you have the correct tention. Belt tensioning gauges when the force required to deflect the belt the specified amount falls within the specified range. If a belt-tensioning gauge is not available, re-tension the belts just tight enough so that they do not squeal when starting the fan. A short "chirp" is acceptable; a squeal lasting several seconds or longer is not. Before starting the fan after tensioning the belts, recheck the alignment and realign the sheaves if necessary. New belts may stretch a little at first, so recheck belt tension after a few days of operation. A quick rule of thumb is the belt deflection should be about .25 inch per 12 inches of center distance. This is shown in figure 8.

Figure 7. Sheave & belt alignments

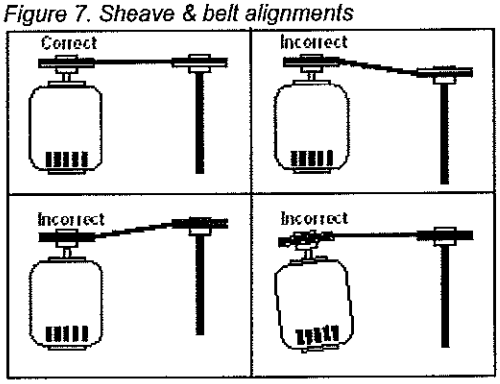
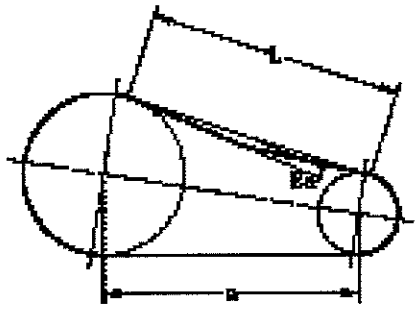


Figure 8. Belt Tensioning



Bearing Lubrication

The most common cause of fan problem is inadequate lubrication of the bearings. Causes of bearing failure do to lubrication can be due to over lubrication, under lubrication, or the use of the wrong lubricant. The intervals of relubrication will vary do to bearing size, speed, the air stream around the bearing, and ambient temperature. Higher Temperatures will tend to break down the grease more rapidly so more frequent lubrication is required. Bearing operating temperatures over 150°F will need to use a special high temperature grease.

Figure 9. Suggested brands & types of grease

Supplier	Type	Base	Temperature Range (Min - Max)
FINA	Marson HTL 2	Litium	-22°F / 248°F
SHELL	Alvania Fett 2	Litium	-4°F / 266°F
ESSO	Beacon 2	Litium	-4°F / 266°F
MOBIL	Mobilux EP2	Litium	-22°F / 266°F

Figure 10. Suggested greasing intervals

	Intervals of lubrication (By Months)											Amount of grease to be added. (In OZ.)
Speed (RPM)	500	1000	1500	2000	2500	3000	3500	4000	4250	4500	5000	
Shaft Dia.												
3/4" thur 1 3/16"	6	6	6	5	5	4	3	3	3	2	1	.25 Oz. to .50 Oz.
1 7/16" thur 1 15/16"	6	6	5	5	4	3	2	1				.50 Oz. to .75 Oz.
2" thur 2 3/16"	6	6	5	4	3	1	1					.75 Oz. to 1.0 Oz.
2 7/16" thur 2 15/16"	6	5	4	3	2	1						1.0 Oz. to 1.50 Oz.

Fan housing and impeller

Depending on the type of transported media, wear and dirt can be expected inside the housing and on the impeller (corrosion, abrasions, stacked materials). Regular inspection and cleaning must take place. The interval between them is to be fixed by the operator on accordance with individual operating conditions.

No high-pressure cleaners (steam rod cleaners) are to be used.

Over time fan vibrations may gradually increase due to wear of bearings, belts, or a build-up of material on the wheel. By periodically taking vibrations reading many unscheduled shutdowns can be avoided. Using vibration spectra will help you detect where the added vibration is coming from. If vibration levels have reach a shutdown level here is a checklist to help get your fan running.

- ❑ Review the pre-startup checklist.
- ❑ Check the surrounding area the vibration may not be coming from the fan.
- ❑ Clean the housing and wheel.
- ❑ Check the bearings, belt(s), sheaves, and motor for wear.
- ❑ Check the foundation for cracks and loose bolts
- ❑ Trim balance the fan

Comefri declines any responsibility for damages and inconveniences, which can be sustained as direct or indirect consequences of methods, procedures and applications in contradiction or in not full correspondence with the instructions given by this document. Comefri reserves the right to modify and update this document without any duty to give notice to the previous Users. For any further information and clarification concerning the above contents, contact Comefri USA.

Technical sheet

comefri

	3500 CFM	Elevation	0 ft
Stat. Pressure	1.86 In.W.G.	Temperature	70.0 °F
Ducted outlet		Density	0.075 lb/cu.ft

Selected model: ATLI 12 - 12 R

Moment of inertia lb ft²	RPM max 1/min	BHP max BHP	Ø Shaft Inches
3.37	1905	5.00	1"

Operating data:

o.v. ft/min	ptot In.W.G.	pstat In.W.G.	pdyn In.W.G.	tip speed ft/min	RPM 1/min	η stat. %	fan BHP BHP	P min BHP
2415.3	2.22	1.86	0.36	3745.9	1118	56.9	1.80	2.17

Total Sound Power Level Lw4 inside the outlet duct, per octave band:

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw4 tot [db]
Lwoct4 [dB]	86	80	78	76	77	72	69	62	88

Total Sound Power Level LwA4 (filter A) inside the outlet duct, per octave band:

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA4 tot[dbA]
LwA4 oct [dBA]	60	64	70	73	77	73	70	61	81

...l Sound Power Level Lw6d outside the termination of the outlet duct, per octave band:

....[Hz]	63	125	250	500	1.000	2.000	4.000	8.000	Lw6d tot[dB]
Lwoct6d [dB]	74	73	75	76	77	72	69	62	83

Total Sound Power Level LwA6d (filter A) outside the termination of the outlet duct, per octave band:

fm [Hz]	63	125	250	500	1.000	2.000	4.000	8.000	LwA6d tot[dBA]
LwA6d oct [dBA]	48	57	67	73	77	73	70	61	81

LwA4 tot [dBA] = LwA6d tot [dBA] = LwA7 tot [dBA]

Power rating (BHP) does not include drive losses

Performance ratings do not include the effects of appurtenances in the airstream.

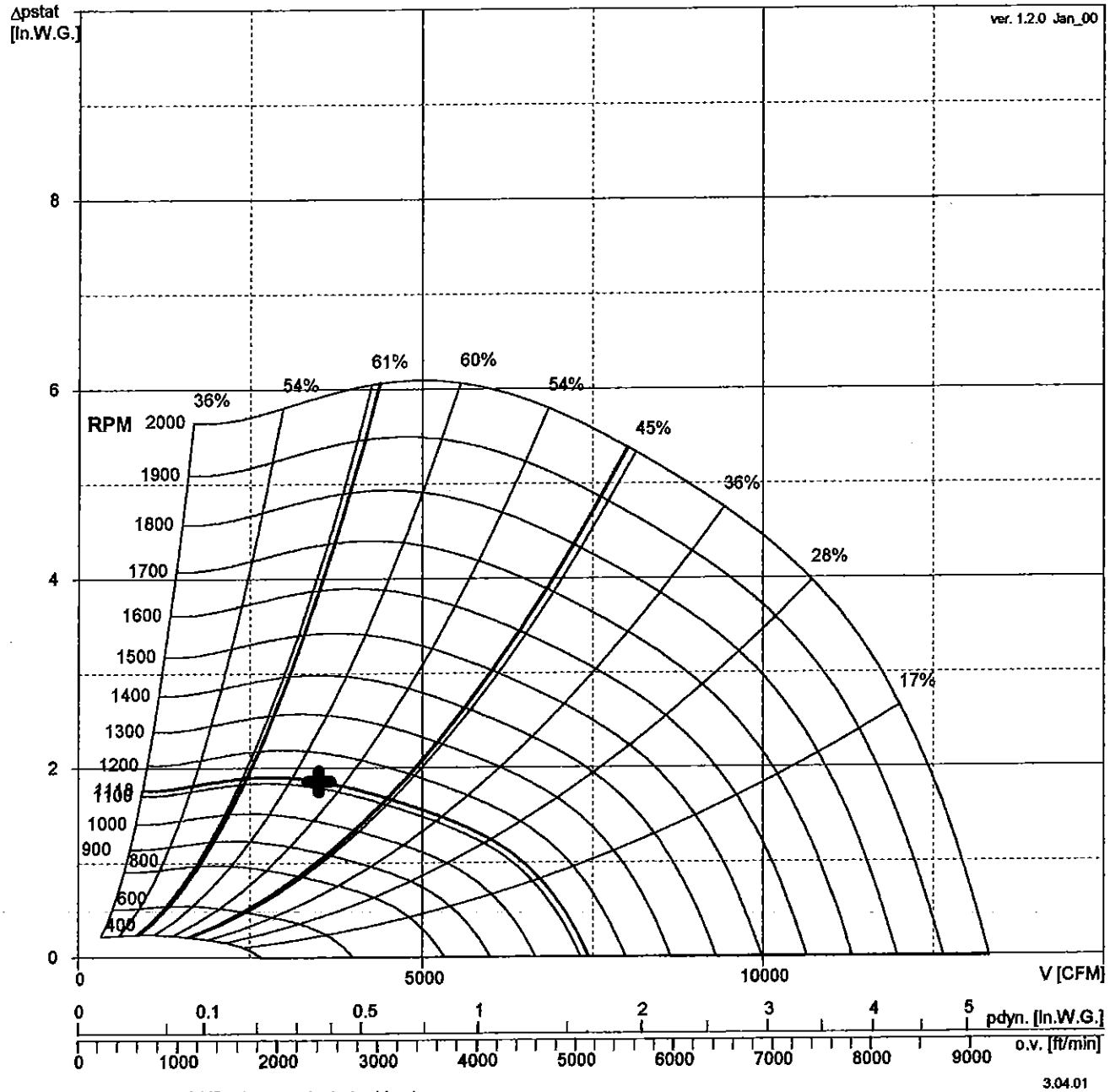
comefri

Model/size:	ATLI 12 - 12
Max fan rev.:	1905 RPM
Max. fan abs. BHP:	5.0 BHP
Moment of inertia:	3.37 lb ft²

Fan working condition: Free inlet- Ducted outlet

Volume:	3500 CFM
Stat. pressure:	1.86 In.W.G.
Abs. shaft fan BHP:	1.80 BHP
Stat. Efficiency:	56.9 %
Temperature:	70.0 °F
Elevation	0 ft

Fan curves plotted for air density : 0.075 lb/cu.ft
Fan plot condition: ATLI 12 - 12 R Free inlet- Ducted outlet



Power rating (BHP) does not include drive losses
Performance ratings do not include the effects of appurtenances in the airstream.

BALDOR®

Integral Horsepower
AC Induction Motors
ODP, WPI, WPII Enclosure
TEFC Enclosure
Explosion Proof

Installation & Operating Manual

12/03 **MN400**

Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

1. Baldor Electric motors are warranted for a period of one (1) year, from date of shipment from the factory or factory warehouse against defects in material and workmanship. To allow for stocking and/or fabrication period and to provide one year of actual service, the warranty period is extended for an additional period of six (6) months for a total of eighteen (18) months from the original date of shipment from the factory or factory warehouse stock. In no case will the warranty period be extended for a longer period. Baldor extends this limited warranty to each buyer of the electric motor for the purpose of resale and to the original purchaser for use.
2. Baldor will, at its option repair or replace a motor which fails due to defects in material or workmanship during the warranty period if:
   a. the purchaser presents the defective motor at or ships it prepaid to, the Baldor plant in Fort Smith, Arkansas or one of the Baldor Authorized Service Centers and
   b. the purchaser gives written notification concerning the motor and the claimed defect including the date purchased, the task performed by the Baldor motor and the problem encountered.
3. Baldor will not pay the cost of removal of any electric motor from any equipment, the cost of delivery to Fort Smith, Arkansas or a Baldor Authorized Service Center, or the cost of any incidental or consequential damages resulting from the claimed defects. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply to you.) Any implied warranty given by laws shall be limited to the duration of the warranty period hereunder. (Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.)
4. Baldor Authorized Service Centers, when convinced to their satisfaction that a Baldor motor developed defects in material or workmanship within the warranty period, are authorized to proceed with the required repairs to fulfill Baldor's warranty when the cost of such repairs to be paid by Baldor does not exceed Baldor's warranty repair allowance. Baldor will not pay overtime premium repair charges without prior written authorization.
5. The cost of warranty repairs made by centers other than Baldor Authorized Service Centers **WILL NOT** be paid unless first authorized in writing by Baldor.
6. Claims by a purchaser that a motor is defective even when a failure results within one hour after being placed into service are not always justified. Therefore, Baldor Authorized Service Centers must determine from the condition of the motor as delivered to the center whether or not the motor is defective. If in the opinion of a Baldor Authorized Service Center, a motor did not fail as a result of defects in material or workmanship, the center is to proceed with repairs only if the purchaser agrees to pay for such repairs. If the decision is in dispute, the purchaser should still pay for the repairs and submit the paid invoice and the Authorized Service Center's signed service report to Baldor for further consideration.
7. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

   Note that **Baldor Super-E® Premium Efficiency** electric motors are warranted for a period of three (3) years. **Baldor IEEE 841** electric motors are warranted for a period of five (5) years.
   All other terms and conditions of the Limited Warranty statement apply.

Safety Notice:

This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

WARNING: **Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.**

WARNING: **Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.**

WARNING: **This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.**

WARNING: **Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.**

WARNING: **Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.**

WARNING: **Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.**

WARNING: **Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.**

WARNING: **Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.**

WARNING: **Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.**

WARNING: **Do not use these motors in the presence of flammable or combustible vapors or dust. These motors are not designed for atmospheric conditions that require explosion proof operation.**

Safety Notice Continued

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate.**

Specific service conditions for these motors are defined in NEC 70-599.

WARNING: **UL rated motors must only be serviced by authorized Baldor Service Centers if these motors are to be returned to a flammable and/or explosive atmosphere.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load from the motor shaft before moving the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG-1 and MG-2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Storage

If the motor is not put into service immediately, the motor must be stored in a clean, dry and warm location. Several precautionary steps must be performed to avoid motor damage during storage.

1. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
2. Do not lubricate bearings during storage. Motor bearings are packed with grease at the factory. Excessive grease can damage insulation quality.
3. Rotate motor shaft at least 10 turns every two months during storage (more frequently if possible). This will prevent bearing damage due to storage.
4. If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motors' space heater (if available) while the motor is in storage.

Unpacking

Each Baldor motor is packaged for ease of handling and to prevent entry of contaminants.

1. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.
2. When the motor has reached room temperature, remove all protective wrapping material from the motor.

Handling

The motor should be lifted using the lifting lugs or eye bolts provided.

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. When lifting a WPII (weatherproof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only. A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.
3. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation. Do not lift using the motor lugs or eye bolts provided.

   If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Section 2
Installation & Operation

Overview

Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location

The motor should be installed in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance. Be sure to allow clearance for ventilation and access for cleaning, repair, service and inspections. Ventilation is extremely important. Be sure the area for ventilation is not obstructed. Obstructions will limit the free passage of air. Motors get warm and the heat must be dissipated to prevent damage.

These motors are not designed for atmospheric conditions that require explosion proof operation. They must NOT be used in the presence of flammable or combustible vapors or dust.

1. ODP motors are suitable only for indoor applications.
2. TEFC and WPII motors are suitable for indoor or outdoor standard service applications.

Mounting

The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment

Accurate alignment of the motor with the driven equipment is extremely important.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.
4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

Caution: Do not over tension belts.

5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting

After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

Power Connection

Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices.

Conduit Box

For ease of making connections, an oversize conduit box is provided. The box can be rotated 360° in 90° increments. Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

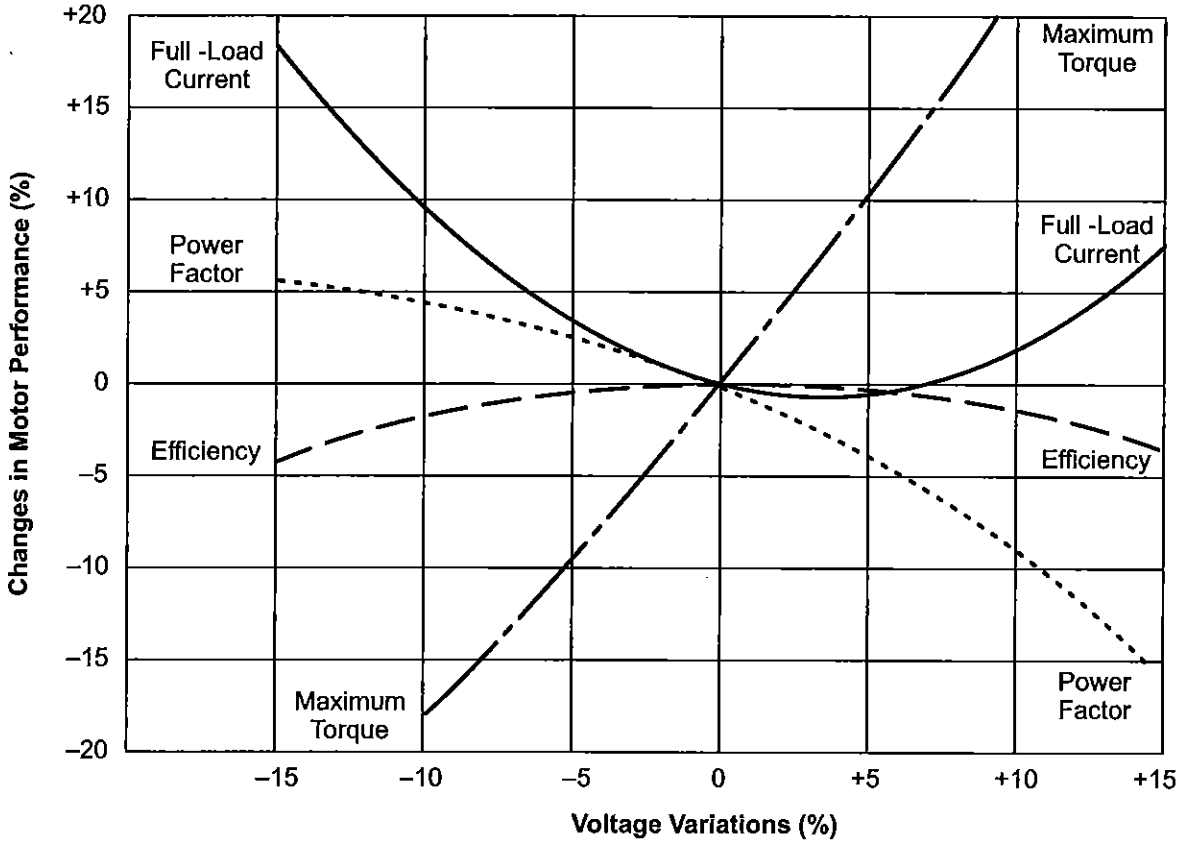
AC Power

Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-1.

Figure 2-1 Motor Performance VS Voltage Variations



First Time Start Up

Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity with a Megger.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up

This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts

Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor distributor or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: **UL rated motors must only be serviced by authorized Baldor Service Centers if these motors are to be returned to a flammable and/or explosive atmosphere.**

General Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: **Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.**

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Lubrication & Bearings

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease

A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is Polyrex EM (Exxon Mobil).

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

– Maximum operating temperature for standard motors = 110° C.
– Shut–down temperature in case of a malfunction = 115° C.

Lubrication Intervals

Recommended lubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2 and 3-3.

Table 3-1 Lubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)			3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)			* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)			*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Lubrication intervals are for ball bearings. For roller bearings, divide the listed lubrication interval by 2.

** For 6205 and 6806 bearings. For 6807 bearings, consult oil mist lubrication (MN401).
Relubrication interval for 6205 bearing bearing is 1550Hrs. (using grease lubrication).
Relubrication interval for 6806 bearing bearing is 720Hrs. (using grease lubrication).

Table 3-2 Service Conditions

Severity of Service	Ambient Temperature Maximum	Atmospheric Contamination	Type of Bearing
Standard	40° C	Clean, Little Corrosion	Deep Groove Ball Bearing
Severe	50° C	Moderate dirt, Corrosion	Ball Thrust, Roller
Extreme	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion	All Bearings
Low Temperature	<–30° C **		

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Lubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)					
	Bearing	OD D mm	Width B mm	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
					in^3	tea-spoon
Up to 210 incl. (132)	6307	80	21	0.30 (8.4)	0.6	2.0
Over 210 to 280 incl. (180)	6311	120	29	0.61 (17)	1.2	3.9
Over 280 to 360 incl. (225)	6313	140	33	0.81 (23)	1.5	5.2
Over 360 to 449 incl. (280)	6319	200	45	2.12 (60)	4.1	13.4
Over 5000 to 5800 incl. (355)	6328	300	62	4.70 (130)	9.2	30.0
Over 360 to 449 incl. (280)	NU319	200	45	2.12 (60)	4.1	13.4
Over 5000 to 5800 incl. (355)	NU328	300	62	4.70 (130)	9.2	30.0
Spindle Motors						
76 Frame	6207	72	17	0.22 (6.1)	0.44	1.4
77 Frame	6210	90	20	0.32 (9.0)	0.64	2.1
80 Frame	6213	120	23	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Lubrication Procedure

Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

With Grease Outlet Plug

1. Clean all grease fittings.
2. Remove grease outlet plug.
3. If motor is stopped, add the recommended amount of grease.

   If motor is to be greased while running, a slightly greater quantity of grease will have to be added. Add grease slowly until new grease appears at shaft hole in the endplate or purge outlet plug.
4. Re-install grease outlet plug.

Without Grease Outlet Plug

1. Clean the grease fitting.
2. Add recommended amount of grease to bearing (see Table 3-4).

Sample Lubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-3 lists a multiplier value of 0.5 for Severe conditions.
4. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Accessories

The following is a partial list of accessories available from Baldor. Contact your Baldor distributor for availability and pricing information.

Note: Space heaters and RTD's are standard on some motors.

Bearing RTD
RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor bearing during operation.

Bearing Thermocouples
Used to measure or monitor bearing temperatures.

Bearing Thermostat
Temperature device that activates when bearing temperatures are excessive. Used with an external circuit to warn of excessive bearing temperature or to shut down a motor.

Conduit Boxes
Optional conduit boxes are available in various sizes to accommodate accessory devices.

Cord & Plug Assembly
Adds a line cord and plug for portable applications.

Drains and Breathers
Stainless steel drains with separate breathers are available.

Drip Covers
Designed for use when motor is mounted in a vertical position. Contact your Baldor distributor to confirm that the motor is designed for vertical mounting.

Fan Cover & Lint Screen
To prevent build-up of debris on the cooling fan.

Nameplate
Additional stainless steel nameplates are available.

Roller Bearings
Recommended for belt drive applications with a speed of 1800 RPM or less.

Rotation Arrow Labels
Rotation arrows are supplied on motors designed to operate in one direction only. Additional rotation arrows are available.

Space Heater
Added to prevent condensation of moisture within the motor enclosure during periods of shut down or storage.

Stainless Hardware
Stainless steel hardware is available. Standard hardware is corrosion resistant zinc plated steel.

Winding RTD
RTD (Resistance Temperature Detector) devices are used to measure or monitor the temperature of the motor winding during operation.

Winding Thermocouples
Used to measure or monitor winding temperatures.

Winding Thermostat
Temperature device that activates when winding temperatures are excessive. Used with an external circuit to warn of excessive winding temperature or to shut down a motor.

Note: On some motors, leads for accessory devices are brought out to a separate conduit box located on the side of the motor housing (unless otherwise specified).

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten "Thru Bolts".
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs – Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod–Express.
• When Class H temperatures are used, consider bearing temperatures and lubrication requirements.

Bearing RTDs – Temperature Limit In OC with 40°C Max Ambient

Bearing Type Oil or Grease	Anti–Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:
– Texaco Polystar
– Rykon Premium #2
– Chevron SRI #2

See the motor nameplate for replacement grease or oil recomendation. Contact Baldor application engineering for special lubricants or further clarifications.

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Montréal, Québec, Canada H4R 1L1

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Electric Heating and Controls

Installation, Operating and Maintenance Instructions for THERMOLEC electric heaters - type FC & SC - (or tubular FT & ST).

1- Mechanical Installation of THERMOLEC heaters.

1.1 Handling.

1. Remove the shipping covers just before installation.
2. Inspect the heater carefully and report any damage to the manufacturer.

DO NOT INSTALL A DAMAGED HEATER.

1.2 Installation.

Heater Position

1.2.1 The axis of the duct must always be perpendicular to the face of the heater.
1.2.2 The heating elements must always be installed horizontally.

Model SC or ST (Slip-in type) (Please see drawings page 4).

1.2.3 Cut an opening in the side of the duct.
1.2.4 Slip the heater into the duct until the hole is completely covered by flanges around the heater.
1.2.5 Fasten the heater to the duct with sheet metal screws and seal openings with a suitable sealing compound.
1.2.6 If the heater is heavy, use additional hangers to support the heater.

Model FC or FT (Flanged type) (Please see drawings page 4).

1.2.7 Flange both ends of the duct outwards on three sides to match the heater's flanges.

1.2.8 Fasten the heater to the duct with sheet metal screws. (For heavy heaters, use nuts and bolts and additional hangers to support the heater).
1.2.9 Seal openings with a suitable sealing compound.

1.2.10 Spacing Requirements to obtain Optimal Operating Conditions (Please see drawings page 4).

- 24 inches between the heater and filter frames.
  - ** inches between the heater and elbows in the duct.
  - ** inches between the heater and branches in the duct.
  - ** inches between the heater and sharp transitions of the duct.
  - ** = minimum distance = the largest of two dimensions (W or H) up to 48".

Examples:	heater of 12" x 12"	minimum distance 12".
	heater of 30" x 12"	minimum distance 30".
	Heater of 60" x 30"	minimum distance 48".

- 48 inches between the heater and a double outlet fan, (except with split duct design)
- 24 inches between the heater and access doors or diffusers, (except if a metal screen is supplied with the heater.
- 1 inch between the duct at the outlet side and combustible materials for a length of 72", (for vertical ducts only).

- For the flanged type, 24 inches between the control box cover and obstructions to allow space for installation and service.
- For the slip-in type, width of the duct (dimension W) + depth of the control box + ten (10) inches between the control box cover and obstructions to allow slipping the heater out the duct and to allow safe servicing.

12.12 **Important Notes**

- Do not install a duct heater in a vertical duct directly above a ceiling diffuser or an opening in the ceiling.
- Do not install standard heaters outdoors. Order a heater with weatherproof control box instead.
- Do not install spray humidifiers upstream of duct. Install it downstream instead.
- Do not cover the control box with thermal insulating materials.
- Use special air intake louvers of weatherproof construction for preheat duct heaters to avoid intake of water or snow particles.

Make sure that motorized damper blades are not blocked with snow or dirt. Inspect the dampers regularly to ensure a suitable airflow.

2- Electrical Installation of THERMOLEC heaters.

2.1 **Disconnect all power sources** before opening the control box and working within.

2.2 **Read the nameplate carefully** and consult wiring diagram before starting to wire.

2.3 **Supply wires:**
Use only wires suitable for 75°C. Wires shall be sized according to the Canadian Electrical Code requirements. All wires must be brought in through knock-outs.

2.4 **Disconnecting means:**
Install a disconnect switch close to the heater according to the code unless a disconnect switch is already built into the heater.

2.5 **Control circuit wiring:** Use class 2 wiring for control circuit connections to the duct heater.

2.6 **Magnetic contactors:**
If magnetic contactors are mounted outside of the duct heater, use only contactors approved for:

- 250,000 operations when controlled by auto-reset thermal cut-out (A) and by other switching devices in series with this cut-out (thermostat, step controller, air flow switch, etc.).
- 100, 000 operations when controlled by auto-reset thermal cut-out (A) alone.
- 100,000 operations when controlled by auto-reset thermal cut-out (A) plus manual reset cut-out in series.(A&M).
- 6,000 operations when controlled by manual reset cut-out (M) alone.

2.7 **External Controls ratings:**
Rating of external control devices shall be suitable for handling the VA ratings as marked on the nameplate, otherwise, a back-up relay must be used.

2.8 **Air Flow Interlock:**
Heaters are generally supplied with one extra terminal marked (1) for fan interlock or air sensing device connection. Remove jumper between terminals I and C before connecting the fan interlock, Select a suitable air flow sensing device of the differential pressure sensing type, with snap acting contacts. A slow make, slow brake device may cause undue cycling and in some instances chattering of the contactors. When fresh air dampers are used, make sure the heater is properly interlocked to prevent it from being energized before the damper is fully open.

3- Operating THERMOLEC Heaters.

3.1 **Minimum air flow.**
Ensure that sufficient air flow as marked on the nameplate is passing through the heater. Air flow should be evenly distributed across the entire face of the heater. Use air turning vane at duct elbows and splitter damper at duct branch-offs to streamline the air flow in the heater. Use suitable air flow sensing device or interlock the heater with fan. An insufficient air flow will lead to the opening of the auto-reset thermal cut-out or damage to the heating elements.

3.2 **Warning.**
The air flowing through the duct where the heater is installed shall not contain any combustible particles, nor any flammable vapor or gas.

3.3 **Air Temperature.**
The air temperature should not exceed 27°C (81°F) at the heater inlet and 66°C (151°F) at the outlet.

3.4 Minimum static pressure and air direction.

The heater is protected by a differential pressure switch. To keep the contact of this switch closed, it is necessary to maintain a minimum total pressure of 0,07 inches of water for a constant flow.
Unless otherwise specified, all **Thermolec** heaters operate horizontally or vertically with the airflow in either direction. This unique feature allows the contractor maximum flexibility in installation and avoidance of problems.
(Please see drawings page 4)

3.5 Manual-reset thermal cut-out

This protection device is standard on all heaters of less than 300V and 30 KW and is optional on all other heaters. Please check the auto-reset thermal cut-out BEFORE re-setting the manual thermal cut-out. If any defest has been detected in the auto-reset thermal cut-out, it will be necessary to replace it before re-setting the manual-reset thermal cut-out.

4- Maintenance.

All **THERMOLEC** heaters have been designed to operate long term without problems. Those responsible for equipment and maintenance should be aware of the following suggestions.,

4.1 Visual Inspection.

THERMOLEC strongly recommends a periodic inspection. This precautionary step will help to keep your installations operating well. Note these eventual first signs of problems: Accumulation of dust on the heating elements, signs of overheating on the heater frame, traces of water or rust on the control box

4.2 Electrical Inspection.

Two weeks after startup , all electric connections to contactors should be checked and tightened up. Before each heating season, check the resistance between the heating elements and ground.
It is also recommended to check the electrical connections to heating elements, magnetic contactors, and main power lugs. This inspection is recommended monthly during the first four months of operation. After that, two inspections per heating season are sufficient

4.3 What are the checkpoints?

- Check all fuses;
- Check the resistance to ground for each circuit;
- Check the resistance phase to phase for each circuit;
- Check the tightening of connections at all contactors and heating elements;
- Check all contactors.

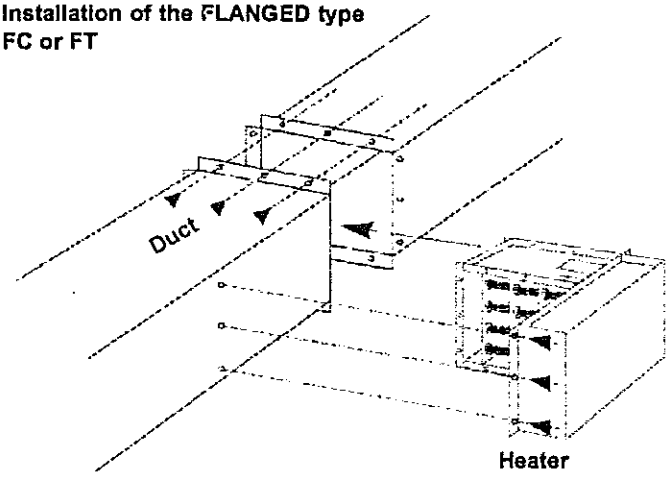
4.4 Off-season maintenance

Where tubular heating elements are used, THERMOLEC strongly recommends that you start the heating system from time to time. This precaution will prevent moisture from percolating through the terminal gaskets into the heating element and accumulating in the insulating powder.

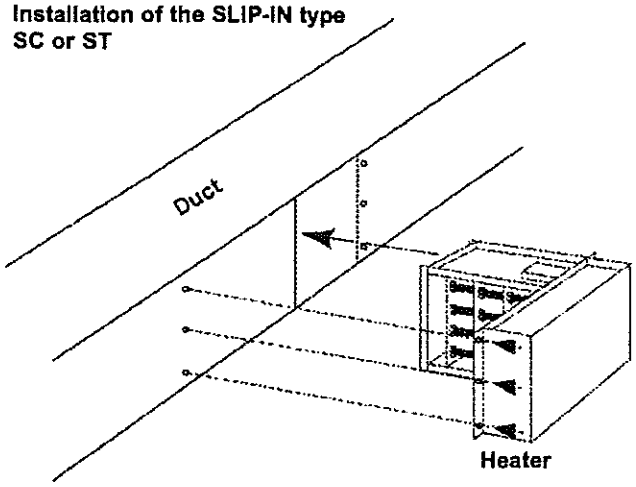
Should a heater be shut off for a long period, we recommend that you check carefully the resistance to ground for each circuit. It is important not to power a heater when too a low resistance to ground has been measured. It is also recommended to pay attention to any other heater operating in normal conditions.

Control components such as step controllers or modulating valves (SCR) should be maintained and checked according to respective manufacturers instructions. Any defective components should be replaced only with identical origin parts.

Installation of the FLANGED type
FC or FT

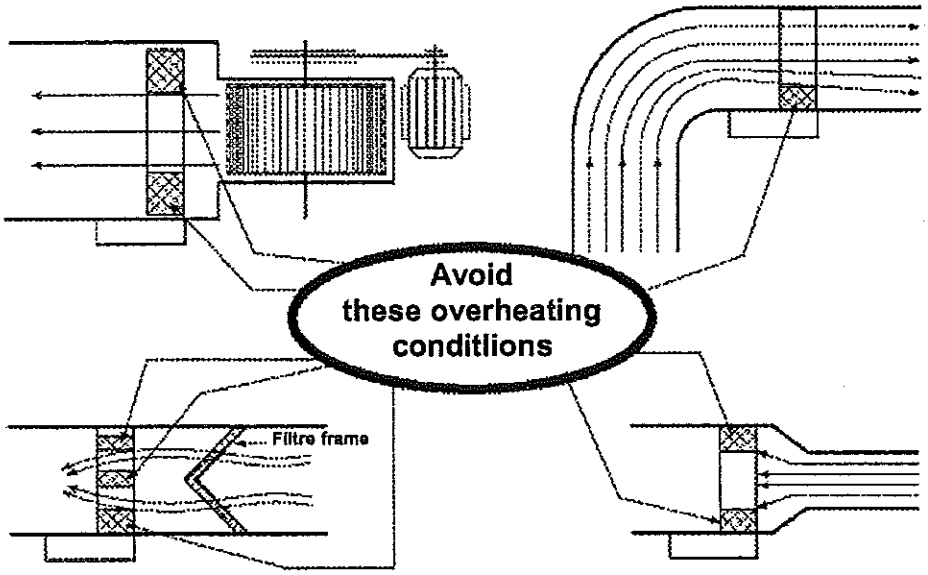


Installation of the SLIP-IN type
SC or ST



Heater too close to a fan

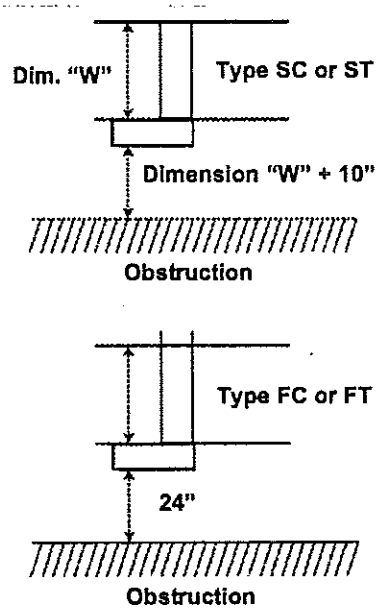
Heater too close to an elbow



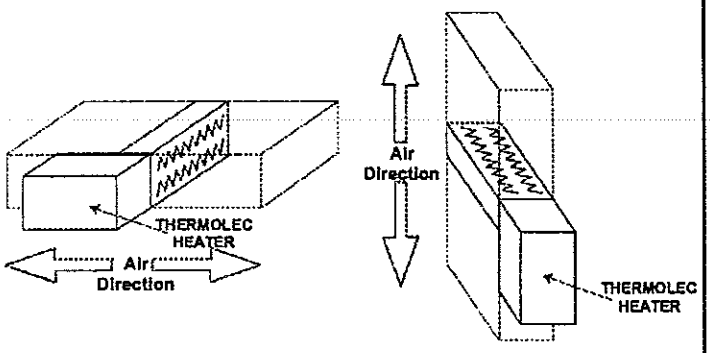
Heater too close to a filter

Heater too close to a transition

Minimum recommended distance for safety and service



Universal mounting of Thermolec heaters



Warranty

1 - **THERMOLEC LTD** guarantees it's heater resistance elements against any defect in workmanship and material for a period of two years and other built-in components for a period of one year, starting from the date of shipment from it's factory.

2 - **THERMOLEC LTD** will repair or replace without charge, in its factory or in the field at its own discretion, the heater or part, which upon manufacturer examination, is considered to be defective.

3 - Misuse of this product, or repairs made by others without **THERMOLEC LTD's** authorization, will void this warranty.

4 - **THERMOLEC LTD** shall not be held responsible for damage or delay and shall not be held liable for any charges resulting from the removal or replacement of the allegedly defective heater.

5 - **THERMOLEC LTD** shall not be held responsible for any incidental or consequential damage or delay due to workmanship or material. No additional charge will be accepted for repair, replacement or modification if prior written authorization was not obtained from **THERMOLEC LTD.**

6 - Any control device or accessory, supplied with the heater, to be mounted or connected remotely, will only be guaranteed by the manufacturer per conditions stated in paragraph 5.

INSTALLATION DE LA SONDE DE L'INTERRUPTEUR À PRESSION DIFFÉRENTIELLE.

1. Percer un trou de 3/8" diam. dans la gaine, à 9" du serpentin électrique.
2. Insérer la jauge de pression et la fixer par la base à la gaine, avec deux vis à métal.

IMPORTANT

a) La flèche doit suivre le sens de la circulation d'air lorsque le serpentin est placé **après** le ventilateur; elle doit indiquer le sens contraire lorsque le serpentin est placé **avant** le ventilateur.

b) La jauge peut être placée d'un côté ou de l'autre du serpentin sans affecter l'efficacité de l'interrupteur.

3. **Les connexions**

a) **Installation à air pulsé** (serpentin **après** le ventilateur).

Brancher une extrémité du tuyau de caoutchouc à la connexion marquée "haute". Laisser l'autre extrémité, marquée "basse" ouverte à l'atmosphère* (voir l'illustration).

b) **Installation à air aspiré** (serpentin **avant** le ventilateur).

Brancher le tuyau à la connexion marquée basse. Laisser l'autre extrémité, marquée "haute" ouverte à l'atmosphère*.

4. Pour les serpentins Rapidel, la jauge doit toujours être placée après le ventilateur.
5. L'interrupteur est ajusté à son point le plus sensible par le manufacturier. En cas de pression insuffisante pour l'enclenchement de l'interrupteur, placer la jauge plus près du ventilateur, en utilisant un tuyau plus long.

IMPORTANT

* En cas d'installation du serpentin et de sa boîte de contrôle à l'intérieur de l'appareil de ventilation, il faut faire les raccords supplémentaires à l'atmosphère.

INSTALLATION INSTRUCTIONS FOR PRESSURE DIFFERENTIAL SWITCH PROBE.

1. Drill a hole 3/8" diam. in the duct 9" away from the duct heater.
2. Insert the probe and fasten base to the duct using two sheet metal screws.

IMPORTANT:

a) The arrow should indicate the air flow for a blow thru system and the opposite is applicable for a draw thru system.

b) The probe can be inserted either side of the heater without affecting the P.D. Switch performance.

3) **Connections**

a) **For blow-thru systems**

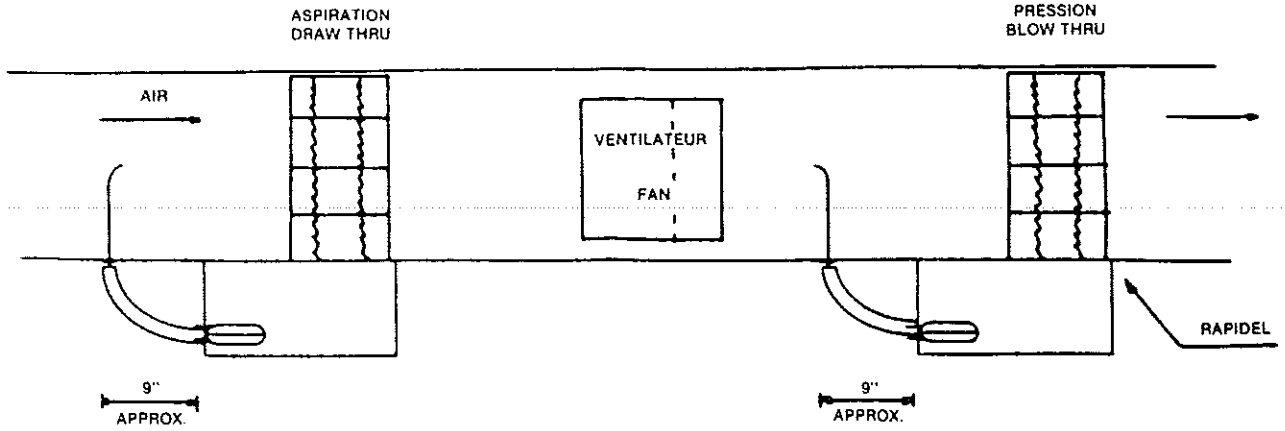
Connect one end of the rubber hose to the probe and the other to the "high" connection of the P.D. Switch. Leave the "low" connection open to atmosphere*. Refer to Fig.

b) **For draw-thru systems**

Connect the rubber hose to the "low" connection on the P.D. Switch. Leave the "high" connection open to atmosphere*.

4. For a Rapidel heater the probe should always be inserted after the fan.
5. The P.D. Switch is factory adjusted to its lower setting; however if pressure is not enough to activate the P.D. Switch, locate the probe closer to the fan using longer tubing.

* **IMPORTANT:** In cases where the heater and its control box are both enclosed in an air handling unit make additional connection to atmosphere.



Pre Pleat HV

High Velocity and Gas Turbine Pleat

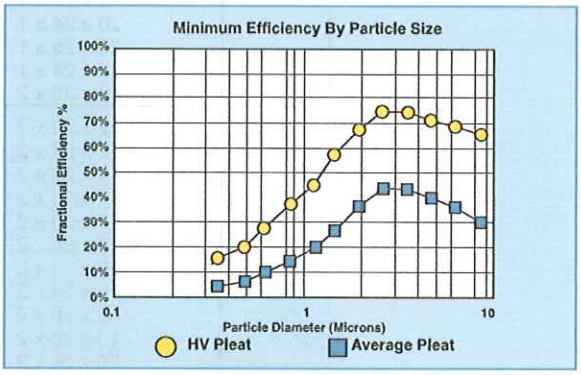
General

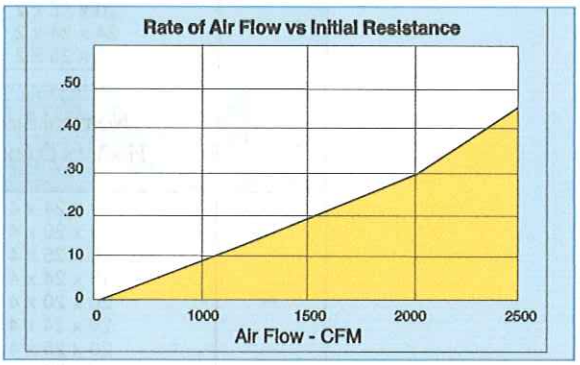
The Pre Pleat HV pleated filter from Flanders is designed to operate in high velocity and turbulent air applications where standard pleated filters have a tendency to fail.

They are ideal for gas turbine and rotary machinery equipment or any area requiring a pleated filter to operate under demanding use.

Construction

A heavy-duty die-cut moisture resistant frame encloses the media pack. The media is manufactured of 100% electrostatically charged synthetic fibers that attract and hold airborne particulate contaminants. The media is bonded to a zinc coated, 1-1/4" mesh expanded metal backing which is substantially heavier than standard metal backing. These features result in a more efficient, durable and reliable product.





Important Features

- Moisture resistant die-cut frame
- Heavy gauge metal backing for exceptional strength
- 1", 2", 4" depths
- Special sizes available
- MERV 8 rating, per ASHRAE Standard 52.2

Nominal Depth (inch)	Nominal Size H x W x D (inch)	300 fpm		500 fpm		Media Area sq. ft.
		cfm	PD	cfm	PD	
1	10 x 10 x 1	210	0.15	347	0.38	1.6
	10 x 20 x 1	417	0.15	694	0.38	3.2
	12 x 20 x 1	500	0.15	833	0.38	3.8
	12 x 24 x 1	600	0.15	1000	0.38	4.5
	14 x 20 x 1	583	0.15	972	0.38	4.5
	14 x 25 x 1	729	0.15	1215	0.38	5.3
	15 x 20 x 1	625	0.15	1042	0.38	4.8
	16 x 20 x 1	667	0.15	1110	0.38	4.8
	16 x 25 x 1	834	0.15	1390	0.38	6.1
	20 x 20 x 1	834	0.15	1390	0.38	6.1
	18 x 24 x 1	900	0.15	1500	0.38	6.9
	18 x 25 x 1	945	0.15	1575	0.38	7.2
	20 x 24 x 1	1000	0.15	1667	0.38	7.7
	20 x 25 x 1	1042	0.15	1735	0.38	7.6
	24 x 24 x 1	1200	0.15	2000	0.38	8.9
	10 x 20 x 2	417	0.13	694	0.29	6.4
2	12 x 20 x 2	500	0.13	833	0.29	7.7
	12 x 24 x 2	600	0.13	1000	0.29	8.7
	14 x 20 x 2	583	0.13	972	0.29	8.9
	14 x 25 x 2	729	0.13	1215	0.29	11.2
	15 x 20 x 2	625	0.13	1042	0.29	9.6
	16 x 20 x 2	667	0.13	1110	0.29	10.0
	16 x 25 x 2	834	0.13	1390	0.29	12.4
	18 x 24 x 2	900	0.13	1500	0.29	13.8
	18 x 25 x 2	938	0.13	1563	0.29	14.4
	20 x 20 x 2	834	0.13	1390	0.29	12.4
	20 x 24 x 2	1000	0.13	1667	0.29	15.3
	20 x 25 x 2	1042	0.13	1735	0.29	15.5
	24 x 24 x 2	1200	0.13	2000	0.29	17.8
	25 x 25 x 2	1300	0.13	2170	0.29	19.2

Depth	Nominal Size H x W x D (inch)	300 fpm		625 fpm		Media Area (sq. ft)
		cfm	PD	cfm	PD	
4	12 x 24 x 4	600	0.10	1250	0.35	14.0
	16 x 20 x 4	667	0.10	1390	0.35	15.5
	16 x 25 x 4	834	0.10	1735	0.35	19.6
	18 x 24 x 4	900	0.10	1500	0.35	21.9
	20 x 20 x 4	834	0.10	1735	0.35	19.6
	20 x 24 x 4	1000	0.10	1667	0.35	24.3
	20 x 25 x 4	1042	0.10	2170	0.35	24.0
	24 x 24 x 4	1200	0.10	2500	0.35	28.0
	25 x 29 x 4	1500	0.10	3100	0.35	34.0
	28 x 30 x 4	1680	0.10	3500	0.35	39.0

Performance values stated may be averages typical of the products listed.
Contact factory for actual performance test reports on specific products.

Guide Specifications

1.0 General

1.1 High velocity Pre Pleat HV extended surface pleated filter as manufactured by Flanders.

1.2 Filter sizes and capacities shall be as scheduled on the drawings.

2.0 Filter Construction

2.1 Filter media shall be manufactured of 100% electrostatically charged synthetic fibers and bonded to a corrosion-resistant expanded metal backing.

2.2 The frame shall be moisture resistant board with diagonal and horizontal support members on the upstream and downstream sides.

3.0 Performance

3.1 Initial and final resistance shall not exceed the scheduled values.

3.2 Media area must be equal to that of the specified filter.

3.3 The minimum efficiency shall be a MERV 8 rating per ASHRAE Standard 52.2 and 50% dust spot efficiency per ASHRAE Standard 52.1.

3.4 The manufacturer shall guarantee performance as stated in the literature within tolerances as outlined in Section 7.4 of ARI Standard 850.

Application Engineering Bulletin
AE 1316

Issued June 6, 2001

Application Guidelines For ZR90K3 to ZR19M3 and ZR250KC to ZR300KC Copeland Scroll™ Compressors

Introduction

This bulletin describes the operating characteristics, design features, and application requirements for 7.5 to 25 HP R22 and R407C Copeland Scroll Compressors. Typical model numbers are ZR90K3-TWC, ZR16M3-TW7 and ZR300KC-TWD. For additional information on this and other products, please refer to the "On-line Product Information" accessible from the Copeland website at www.copeland-corp.com. Operating principles of the Copeland Scroll are described in Copeland Application Engineering Bulletin 4-1312. Several operating characteristics and design features are described below that differ from those of smaller Copeland Scroll compressor models.

The Large Copeland Scroll compressor is designed for air conditioning and heat pump usage but will work well in other applications that correspond to its operating requirements and envelope. **(See operating envelope Figure 2)**. The 7.5 to 25 HP compressors are characterized by the pilot duty motor protection system that uses internal sensors and an external electronic module to protect the compressor against motor overheating and excessive discharge temperature.

Application Considerations

The Copeland Scroll has a number of application characteristics which are different from those of the traditional reciprocating compressor. These are detailed below.

Compressor Handling

It is recommended that the plugs in the compressor line connections be left in place until the compressor is set into the unit. This reduces the chance of contaminants and moisture getting into the compressor especially if the compressor is charged with the more hygroscopic POE oil. If the compressor has two lifting tabs, **both** must be used for lifting. Either connection plug may be removed first, but pulling the discharge connection plug first will allow the escaping dry air pressure inside the compressor to possibly spray the operator with oil. The copper coated steel tubes must be wiped clean of oil before brazing (see **Figure 5**). No object (e.g. a swaging tool) should be inserted deeper than two inches (51 mm) into the suction tube or it might damage the suction screen.

IPR Valve

The 7.5 to 25 HP Copeland Scroll Compressors do not have internal pressure relief valves. To ensure safe operation, a high pressure control set no higher than 425 psig (30 kg/cm2) must be used in all applications.

Safety Controls

High Pressure Control: Because these compressors do not have an internal pressure relief valve, a high pressure control with a maximum cut out setting of 425 psig (30 kg/cm2) **must be used** in the system. The high pressure control should have a manual reset feature for the highest level of system protection.

Low Pressure Control: A low pressure control **is highly recommended** for loss of charge protection. A cut-out setting no lower than 25 psig (2 kg/cm2) for air conditioning and 7 psig (0.5 kg/cm2) for heat pumps is recommended. Even though these compressors have an internal discharge temperature sensor, loss of system charge etc. will result in overheating and recycling of the motor protector. Prolonged operation in this manner could result in oil pump out and eventual bearing failure.

Operation near 7 psig (-25°F or –32°C saturated suction temperature) is clearly outside the approved operating envelope shown in **Figure 2**. However, heat pumps in some geographical areas have to operate in this range because of the low ambient temperatures. This is acceptable as long as the condensing temperature is not above 90°F (32°C) and the resulting discharge temperature is below 275°F (135°C). Some liquid floodback to the compressor under these conditions can help keep the discharge temperature under control. Certain conditions may allow even the 7 psig (0.5 kg/

cm2) low pressure control to cause nuisance trips. These could be temporary suction blockage during reversing valve operation; or lack of liquid pressure available to the metering device upon startup in heating. For this reason the low pressure control can be moved to the liquid line where it won't be subjected to momentary low suction pressures that can cause nuisance trips. An alternative is to keep the low pressure control in the suction line and provide a 60-second (maximum) low pressure time delay that ignores a signal from the low pressure control and allows the compressor to continue operating.

The low pressure cutout, if installed in the suction line, can provide additional protection against a TXV failed in the closed position, outdoor fan failure in heating, a closed liquid line or suction line service valve, or a blocked liquid line screen, filter, orifice, or TXV. All of these may starve the compressor for refrigerant and may result in compressor failure. The low pressure cut-out should have a manual reset feature for the highest level of system protection.

Motor Protection Module: The motor protection system consists of an external electronic control module connected to a chain of four thermistors embedded in the motor winding with a fifth thermistor located at the internal scroll discharge port. The module will trip and remain off for 30 minutes if either the motor or discharge temperature exceeds a preset point. Note: Turning off power to the module will reset it immediately. The module has a 30 minute time delay to allow the scrolls to cool down after the discharge temperature limit has been reached. Restarting the compressor sooner will cause a destructive temperature build up in the scrolls. For this reason module power must never be switched with the control circuit voltage. Since the compressor is dependent upon the contactor to disconnect it from power in case of a fault the contactor must be selected in accordance with AE Bulletin 10-1244. The contactor must meet both the Copeland Rated Load Amps (RLA) and Locked Rotor Amps (LRA) specified for the compressor.

Protector Specification:

Models	071-0520-04	071-0520-05
Voltage	24 V	120/240 V
Control Rating	60 VA	300/375 VA
	25 A Inrush	25/15 A Inrush
Normal PTC resistance:	250 to 2250 Ohms	
Trip resistance:	>4500 Ohm +/- 20%	
Reset resistance:	<2750 Ohms	
Module time out:	30 minutes +/- 5 minutes	
Low Voltage Sensing:	None	
Phase Monitor:	No	

See "Solid State Module Field Trouble Shooting" at the end of this bulletin. It may take as long as two hours for the motor to cool down before the protector will reset. If current monitoring to the compressor is available, the system controller can take advantage of the compressor protector operation. The controller can be designed to lock out the compressor if current draw is not coincident with a signal for the unit to run, implying that the compressor has shut off on its protector. This will prevent unnecessary compressor cycling on a fault condition until corrective action can be taken. The same logic can be applied using voltage monitoring across the contacts M1 and M2 of the protector module as well as those of other safety devices to detect a trip in place of current monitoring if this is more convenient.

Accumulators

Due to the Copeland Scroll's inherent ability to handle liquid refrigerant in flooded start and defrost cycle operation, an accumulator may not be required for durability in most systems, especially those systems designed with thermostatic expansion valves. However, large volumes of liquid refrigerant which repeatedly flood back to the compressor during normal off cycles or excessive liquid refrigerant floodback during defrost or varying loads, no matter what the system charge is, can dilute the oil. As a result, bearings are inadequately lubricated and wear may occur. To test for these conditions see the section entitled EXCESSIVE LIQUID FLOODBACK TESTS at the end of this bulletin. If an accumulator must be used, an oil return orifice size in the range of 0.070 - 0.090 inches (1.8 – 2.3 mm) is recommended. A large-area protective screen no finer than 30 x 30 mesh (0.6 mm openings) is required to protect this small orifice from plugging with system debris. Tests have shown that a small screen with a fine mesh can easily become plugged causing oil starvation to the compressor bearings. Accumulators are a standard item in air to air heat pumps and are used even when a thermostatic expansion valve is used to meter refrigerant in the heating mode. During low ambient conditions, the oil returning from the outdoor coil will be very viscous and difficult to return through the accumulator if the expansion valve is working properly by maintaining superheat. To prevent slow oil return it may be possible to remove the accumulator from systems that use expansion valves in heating. To determine if the accumulator can be removed, a defrost test must be run at an outdoor ambient of around 30°F (-1° C) in a high humidity environment. This is to ensure that excessive liquid does not flood back to the compressor during reversing valve operation, especially when coming out of defrost. Excessive flood back

occurs when the sump temperature drops below the safe operation line shown in **Figure 1** for more than 10 seconds.

Screens

The use of screens finer than 30 x 30 mesh (0.6 mm openings) anywhere in the system is not recommended. Field experience has shown that finer mesh screens used to protect thermal expansion valves, capillary tubes, or accumulators can become temporarily or permanently plugged with normal system debris and block the flow of either oil or refrigerant to the compressor. Such blockage can result in compressor failure.

Crankcase Heaters

Table 4 lists crankcase heaters required for these compressors when the system charge exceeds that shown in **Table 6**. The crankcase heater must be mounted below the oil removal valve located on the bottom shell. **The crankcase heater must remain energized during compressor off cycles.** If the crankcase heaters require a conduit, one possible solution is to use a conduit adapter box shown in **Table 4** and **Figure 4**.

The initial start in the field is a very critical period for any compressor because all load bearing surfaces are new and require a short break-in period to carry high loads under adverse conditions. **The crankcase heater must be turned on a minimum of 12 hours prior to starting the compressor**. This will prevent oil dilution and bearing stress on initial start up. If it is not feasible to turn on the crankcase heater 12 hours in advance of starting the compressor, then use one of the techniques listed below to prevent possible flooded-start damage to the compressor: 1) Direct a 500 watt heat lamp or other safe heat source **(do not use torch)** at the lower shell of the compressor for approximately 30 minutes to boil off any liquid refrigerant prior to starting; or 2) Bump start the compressor by manually energizing the compressor contactor for about one second. Wait five seconds and again manually energize compressor for one second. Repeat this cycle several times until the liquid in the shell has been boiled off and the compressor can be safely started and run continuously.

Pumpdown Cycle

Recycling pumpdown for control of refrigerant migration may be used instead of, or in conjunction with, a crankcase heater when the compressor is located so that cold air blowing over the compressor makes the crankcase heater ineffective. The compressor discharge check valve is designed for low leak back and will allow the use of recycling pump down without the addition of an external check valve. The low pressure control cut-in and cut-out settings have to be reviewed since a relatively large volume of gas will re-expand from the high side of the compressor into the low side on shut down. A one time pump down at the end of a run cycle is not recommended since refrigerant can still migrate into the compressor after a long shut down. If a one time pump down is used a crankcase heater must be installed.

Minimum Run Time

There is no set answer to how often scroll compressors can be started and stopped in an hour, since it is highly dependent on system configuration. There is no minimum off time, because the scrolls start unloaded, even if the system has unbalanced pressures. The most critical consideration is the **minimum run time required to return oil to the compressor after startup.** This is easily determined since these compressors are equipped with a sight glass. The minimum on time becomes the time required for oil lost on compressor startup to return to the compressor sump and restore a normal level in the sight glass. Cycling the compressor for a shorter time than this, for instance to maintain very tight temperature control, can result in progressive loss of oil and damage to the compressor. See Application Engineering Bulletin 17-1262 for more information on preventing compressor short cycling.

Reversing Valves

Since Copeland Scroll compressors have a very high volumetric efficiency, their displacements are lower than those of comparable capacity reciprocating compressors. As a result, Copeland recommends that the capacity rating on reversing valves be no more than 2 times the nominal capacity of the compressor with which it will be used. This will ensure proper operation of the reversing valve under all operating conditions.

The reversing valve solenoid should be wired so that the valve does not reverse when the system is shut off by the operating thermostat in the heating or cooling mode. If the valve is allowed to reverse at system shutoff, suction and discharge pressures are reversed to the compressor. This results in pressures equalizing through the compressor which can cause the compressor to slowly rotate until the pressures equalize. This condition does not affect compressor durability but can cause unexpected sound after the compressor is turned off.

Low Ambient Cut-Out

Low ambient cut-outs are not required to limit heat pump operation. However, the discharge temperature must be limited to 275°F (135°C) or below. Otherwise, the internal discharge sensor may trip the motor protection.

Oil Type and Oil Removal

In HCFC R-22 applications mineral oil is used in the compressors. 3GS oil may be used if the addition of oil in the field is required. Polyol ester lubricants must be

used with HFC refrigerants (R134a, R407C, etc.). Compressors using polyol ester oil are identified with an "E" in the model number. An example is the ZR12ME-TWD. Copeland Ultra 22 CC should be used if additional POE oil is needed in the field. Mobil Arctic EAL22CC or ICI Emkarate RL32CF oil may be used to recharge these compressors if Ultra 22 is not available.

When a compressor is exchanged in the field it is possible that a major portion of the oil from the replaced compressor may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage. To remove this excess oil, an access valve has been added to the lower shell of the compressor. The compressor should be run for 10 minutes, shut down and the access valve opened until oil is between ¼ to 1/3 of the sight glass. This operation should be repeated at least twice to make sure the proper oil level has been achieved. In tandem applications where sight glasses are not available, a Schrader valve may be added to the lower portion of the common oil/gas and equalization line. The compressor should then be run for 10 minutes, shut down and the access valve opened until no oil flows. This should be repeated twice to make sure that the proper oil level has been achieved.

Shutoff Sound

Since Copeland Scroll compressors are also excellent gas expanders, they may run backward for a brief period at shutoff as the internal pressures equalize. A low mass, disc-type check valve in the discharge tube of the compressor prevents the compressor from running backward for more than a second. This momentary reversal of direction of the scrolls has no effect on compressor durability and is entirely normal. Development testing should include a review of the shutoff sound for acceptability in a particular system.

Discharge Mufflers

Flow through Copeland Scroll Compressors is semi-continuous with relatively low pulsation. External mufflers, where they are normally applied to piston compressors today, may not be required for Copeland Scroll. Because of variability between systems, however, individual system tests should be performed to verify acceptability of sound performance. When no testing is performed, mufflers are recommended in heat pumps. A hollow shell muffler will work quite well. The muffler should be located a minimum of six inches (15 cm) to a maximum of 18 inches (46 cm) from the compressor for most effective operation. The further the muffler is placed from the compressor within these ranges, the more effective it may be. If adequate attenuation is not achieved, use a muffler with a larger cross-sectional area to inlet-area ratio. The ratio should be a minimum of 20:1 with a 30:1 ratio recommended. The muffler should be from four to six inches (10-15 cm) long.

Air Conditioning System Suction Line Noise and Vibration

Copeland Scroll compressors inherently have low sound and vibration characteristics. However, the sound and vibration characteristics differ in some respects from those of reciprocating compressors. In rare instances, these could result in unexpected sound complaints.

One vibration characteristic of the scroll compressor may result in a low level "beat" frequency that may be detected as noise coming along the suction line into the building under some conditions. Elimination of the "beat" can be achieved by attenuating the contributing frequency. The most important frequency to avoid is the power supply line frequency for three phase compressors. See **Table 3** for common combinations of design configurations. The scroll compressor makes both a rocking and torsional motion, and enough flexibility must be provided in the suction line to prevent vibration transmission into any lines attached to the unit. In a split system the most important goal is to ensure minimal vibration in all directions at the service valve to avoid transmitting vibrations to the structure to which the lines are fastened.

A second difference of the Copeland Scroll is that under some conditions the normal rotational starting motion of the compressor can transmit an "impact" noise along the suction line. This may be particularly pronounced in three phase models due to their inherently higher starting torque. This phenomenon, like the one described previously, also results from the lack of internal suspension, and can be easily avoided by using standard suction line isolation techniques as described in **Table 3.**

The sound phenomena described above are not usually associated with heat pump systems because of the isolation and attenuation provided by the reversing valve and tubing bends.

Electrical Connections

The orientation of the electrical connections on the Copeland Scroll compressors is shown in **Figure 3** and is also shown on the wiring diagram inside the terminal box cover. The screw terminals used on this compressor should be fastened with a torque of 21 to 23 in-lb (2.5 to 2.6 Nm).

Deep Vacuum Operation

Copeland Scroll compressors (as with any refrigerant compressor) **should never be used to evacuate a refrigeration or air conditioning system.** The scroll compressor can be used to pump down refrigerant in a unit as long as the pressures remain within the operating envelope shown in **Figure 2**. Low suction pressures will result in overheating of the scrolls and permanent damage to the compressor drive bearing. (See Application Engineering Bulletin 24-1105 for proper system evacuation procedures.)

Nomenclature

The model numbers of the Copeland Scroll compressors include the approximate nominal 60 HZ capacity at ARI rating conditions. An example would be the ZR90K3-TWD, which has approximately 90,000 Btu/hr cooling capacity at the ARI high temperature air conditioning rating point when operated on 60 Hz. The letter "K" in the 5th place of the model number indicates that the number preceding it is to be multiplied by 1000, "M" by 10,000. Note that the same compressor will have approximately 5/6 of this capacity or 75000 Btu/hr when operated on 50 Hz current. Please refer to the file "Nomenclature" found in "Online Product Information" on the Copeland Web page for details pertaining to other information contained in the model number.

Shell Temperature

Certain types of system failures, such as condenser or evaporator fan blockage or loss of charge, may cause the top shell and discharge line to briefly but repeatedly reach temperatures above 350°F (177°C) as the compressor cycles on its internal protection devices. Care must be taken to ensure that wiring or other materials, which could be damaged by these temperatures, do not come in contact with these potentially hot areas.

Suction and Discharge Fittings

The compressors are available with stub tube or a combination Rotalock connection and flanged connection. The stub tube version has copper plated steel suction and discharge fittings. These fittings are far more rugged than copper fittings used on other compressors. Due to the different thermal properties of steel and copper, brazing procedures may have to be changed from those commonly used. See **Figure 5** for assembly line and field brazing procedures. **Table 5** contains torque values for those compressors with valve connections.

Rotation Direction of Three Phase Scroll Compressors

Scroll compressors, like several other types of compressors, will only compress in one rotational direction. Direction of rotation is not an issue with single phase compressors since they will always start and run in the proper direction. Three phase compressors will rotate in either direction depending upon phasing of the power. Since there is a 50-50 chance of connecting power in such a way as to cause rotation in the reverse direction, **it is important to include notices and instructions in appropriate locations on the equipment to ensure proper rotation direction when the system is installed and operated.** Verification of proper rotation direction is made by observing that suction pressure drops and discharge pressure rises when the compressor is energized. Reverse rotation of the scroll compressor also results in substantially reduced current draw compared to specification sheet values.

There is no negative impact on durability caused by operating three phase Copeland Scroll compressors in the reversed direction for a short period of time (under one hour) but oil may be lost. Oil loss can be prevented during reverse rotation if the tubing is routed at least six inches (15 cm) above the compressor. After several minutes of operation in reverse, the compressor's protection system will trip. If allowed to repeatedly restart and run in reverse without correcting the situation, the compressor will be permanently damaged.

All three phase scroll compressors are identically wired internally. Therefore, once the correct phasing is determined for a specific system or installation, connecting properly phased power leads to the identified compressor terminals will insure proper rotation direction.

Brief Power Interruptions

No time delay is required on three phase models to prevent reverse rotation due to power interruptions. The torque of the motor is strong enough to assure proper rotation under all starting circumstances.

Assembly Line Brazing Procedure

Figure 5 discusses the proper procedures for brazing the suction and discharge lines to a scroll compressor. **It is important to flow nitrogen through the system while brazing all joints during the system assembly process.** Nitrogen displaces the air and prevents the formation of copper oxides in the system. If allowed to form, the copper oxide flakes can later be swept through the system and block screens such as those protecting capillary tubes, thermal expansion valves, and accumulator oil return holes. The blockage – whether it be of oil or refrigerant – is capable of doing damage resulting in compressor failure.

Assembly Line System Charging Procedure

Because scrolls have discharge check valves, systems should be charged on both the high and low side simultaneously to assure refrigerant pressure is present in the compressor before it is Hi-Pot tested or operated. The majority of the charge should be placed in the high side of the system to prevent Hi-Pot failures and bearing washout during first-time start on the assembly line. It is best to charge only vapor into the low side of the system.

Do not operate compressor without enough system charge to maintain at least 7 psig (0.5 kg/cm2) suction pressure. Do not operate with a restricted suction. Do not operate with the low pressure cut-out jumpered.

Allowing pressure to drop below 7 psig (0.5 kg/cm2) for more than a few seconds may overheat scrolls and cause early drive bearing damage. Do not use compressor to test opening setpoint of high pressure cutout. Bearings are susceptible to damage before they have had several hours of normal running for proper break in.

"Hipot" (AC High Potential) Testing

Copeland Scroll compressors are configured with the motor down and the pumping components at the top of the shell. As a result, the motor can be immersed in refrigerant to a greater extent than hermetic reciprocating compressors when liquid refrigerant is present in the shell. In this respect, the scroll is more like semi-hermetic compressors which can have horizontal motors partially submerged in oil and refrigerant. When Copeland Scroll compressors are Hipot tested with liquid refrigerant in the shell, they can show higher levels of leakage current than compressors with the motor on top. This phenomenon can occur with any compressor when the motor is immersed in refrigerant. The level of current leakage does not present any safety issue. If uncertainty exists as to the source of the current leakage, test the system with a resistance meter. If the resistance reading does not show a direct short to ground, lower the current leakage reading by operating the system for a brief period of time to redistribute the refrigerant to a more normal configuration and Hi-Pot the system again. See AE Bulletin 4-1294 for Megohm testing recommendations. Under no circumstances should the Hipot test be performed while the compressor is under a vacuum. The solid state module and sensors are delicate electronic components and can easily be damaged by high voltage. Under no circumstances should a high potential test be made of the sensors with the sensor leads attached to the module. If the sensors need to be high potential tested, remove the leads from the module and short them together. Apply a maximum of 600 volts to the sensor leads during this test.

Unbrazing System Components

Caution! Before opening a system it is important to remove all refrigerant from both the high and low side. If the refrigerant charge is removed from a scroll-equipped unit by bleeding the high side only, it is possible for the scrolls to seal, preventing pressure equalization through the compressor. This may leave the low side shell and suction line tubing pressurized. If a brazing torch is then applied to the low side while the low side shell and suction line contains pressure, the pressurized refrigerant and oil mixture could ignite when it escapes and contacts the brazing flame. To prevent this occurrence, **it is important to check both the high and low side with manifold gauges before unbrazing.** Instructions should be provided in appropriate product literature and assembly (line repair) areas. If compressor removal is required, the compressor should be cut out of system rather than unbrazed. See **Figure 5** for proper compressor removal procedure.

Copeland Scroll Functional Check

A functional compressor test with the suction service valve closed to check how low the compressor will pull suction pressure is not a good indication of how well a compressor is performing. **Such a test will damage a scroll compressor.** The following diagnostic procedure should be used to evaluate whether a Copeland Scroll compressor is working properly.

1. Proper voltage to the unit should be verified.
2. The normal checks of motor winding continuity and short to ground should be made to determine if an internal motor short or ground fault has developed. If the protector has opened, the compressor must be allowed to cool sufficiently to allow it to reset.
3. Proper indoor and outdoor blower/fan operation should be verified.
4. With service gauges connected to suction and discharge pressure fittings, turn on the compressor. If suction pressure falls below normal levels, the system is either low on charge or there is a flow blockage in the system.
5. If suction pressure does not drop and discharge pressure does not rise to normal levels, reverse any two of the compressor power leads and reapply power to make sure compressor was not wired to run in reverse direction. If pressures still do not move to normal values, either the reversing valve (if so equipped) or the compressor is faulty. Reconnect the compressor leads as originally configured and use normal diagnostic procedures to check operation of the reversing valve.
6. To test if the compressor is pumping properly, the compressor current draw must be compared to published compressor performance curves using the operating pressures and voltage of the system. If the average measured current deviates more than ±15% from published values, a faulty compressor may be indicated. A current imbalance exceeding 15% of the average on the three phases may indicate a voltage imbalance and should be investigated further. A more comprehensive trouble-shooting sequence for compressors and systems can be found in Section H of the Copeland Electrical Handbook.
7. **Before replacing or returning a compressor:** Be certain that the compressor is actually defective. As a minimum, recheck a compressor returned from the field in the shop or depot for Hipot, winding resistance, and ability to start before returning.

More than one-third of compressors returned to Copeland for warranty analysis are determined to have nothing found wrong. They were mis-diagnosed in the field as being defective. Replacing working compressors unnecessarily costs everyone.

Tandem Operation

The 7.5 to 25 HP models are designed so that the compressors may be piped together for parallel tandem operation offering two steps of modulation. Either one or both compressors can run, depending upon the capacity requirement. A discharge and suction manifold provide a single point discharge and suction line connection. An oil equalization tube is installed between the compressors to ensure that oil is distributed equally. The compressors are mounted directly on two steel rails. This rigid mounting keeps the interconnecting tubing stresses to a minimum. The tandem assembly should be mounted on rubber isolating grommets to the unit basepan. Both compressors must be at the same level to prevent oil from migrating to the lowest compressor through the oil equalization line.

Handling: See handling instruction label on tandem. The tandem must be lifted so that the lifting chains go straight up from the hanger tabs. If the tandem is hoisted from a single point so that the chain makes a "V " the mounting rails will bend and possibly collapse.

The individual compressors that make up the tandem are wired independently using the electrical values of the single compressors. It is recommended that compressors be wired to change lead/lag position. This will ensure equal run time for both compressors, thereby increasing reliability.

Table 4 lists crankcase heaters that must be mounted on each compressor when the system charge exceeds that shown in **Table 6** by 20%.The crankcase heater must be located below the oil removal spud. See previous section on Crankcase Heaters.

Pumpdown may be used instead of or in conjunction with crankcase heaters. See previous section on Pumpdown.

Compressor Replacement

In the case of a motor burn, the majority of contaminated oil will be removed with the compressor. The rest of the oil is cleaned through use of suction and liquid line filter dryers. A 100% activated alumina suction filter drier is recommended but must be removed after 72 hours. See Application Engineering Bulletin 24-1105 for clean up procedures and AE Bulletin 11-1297 for liquid line filter-drier recommendations. **It is highly recommended that the suction accumulator be replaced if the system contains one.** This is because the accumulator oil return orifice or screen may be plugged with debris or may become plugged shortly after a compressor failure. This will result in starvation of oil to the replacement compressor and a second failure.

When a single compressor or tandem is exchanged in the field it is possible that a major portion of the oil may still be in the system. While this may not affect the reliability of the replacement compressor, the extra oil will add to rotor drag and increase power usage. See previous section on **Oil Type and Oil Removal.**

See **Table 5** for Rotalock valve, flange fitting, sight glass, and mounting bolt torque values.

Start-up of a New or Replacement Compressor

It is good service practice, when charging a system, to charge liquid refrigerant into the high side only and charge the low side of the system with vapor only. It is not good for any compressor to have liquid refrigerant dumped from a refrigerant cylinder into the crankcase of the compressor. **Do not start the compressor while the system is in a deep vacuum.** Internal arcing may occur when a scroll compressor is started in a vacuum.

Do not operate compressor without enough system charge to maintain at least 7 psig (0.5 kg/cm2) suction pressure. Do not operate with a restricted suction. Do not operate with the low pressure cut-out jumpered.

A minimum suction pressure of 25 psig (1.75 kg/cm2) must be maintained during charging. Allowing pressure to drop below 7 psig (0.5 kg/cm2) for more than a few seconds may overheat scrolls and cause early drive bearing damage. Never install a system in the field and leave it unattended when it has no charge, a holding charge, or with the service valves closed without securely locking out the system. This will prevent unauthorized personnel from accidentally operating the system and potentially ruining the compressor by operating with no refrigerant flow.

Excessive Liquid Floodback Tests

The following tests are for those system configurations and charge levels identified in **Table 1** that need special testing to verify exemption from need of an accumulator. **Figure 1** applies only during floodback, not when the suction gas is superheated, and must be used to determine the effectiveness of an accumulator. The compressor sump temperature during any unit test where flood back occurs must remain within the "safe zone" shown in **Figure 1.**

To test for excessive continuous liquid refrigerant flood back, it is necessary to operate the system in a test room at conditions where steady state floodback may occur (low ambient heating operation). Thermocouples should be attached with glue or solder to the center of the bottom shell and to the suction and discharge lines approximately 6 inches (15 cm from the

shell). These thermocouples should be insulated from the ambient air with Permagum® or other thermal insulation to be able to record true shell and line temperatures. If the system is designed to be field charged, it should be overcharged by 15% in this test to simulate overcharging commonly found in field installations.

The system should be operated at an indoor temperature of 70°F (21°C) and outdoor temperature extremes (0°F or -18°C or lower in heating) to produce floodback conditions. The compressor suction and discharge pressures and temperatures as well as the sump temperature should be recorded. The system should be allowed to frost up for several hours (disabling the defrost control and spraying water on the outdoor coil may be necessary) to cause the saturated suction temperature to fall to below -10°F (-23°C). The compressor sump temperature must remain above the sump temperature shown in **Figure 1** or design changes must be made to reduce the amount of floodback. If an accumulator is used, an oil return orifice size of 0.070 - 0.090 inches (1.8 – 2.3 mm) is recommended. (See information on Accumulators in Application Considerations and also Copeland Application Engineering bulletin 11-1247). Increasing indoor coil volume, increasing outdoor air flow, reducing refrigerant charge, decreasing capillary or orifice diameter, and adding a charge compensator can also be used to reduce excessive continuous liquid refrigerant floodback.

To test for **repeated excessive liquid floodback** during normal system off-cycles, perform the **"Field Application Test".** Obtain a sample compressor with a side sight tube to measure liquid level in the compressor. Set the system up in a configuration with the indoor unit elevated several feet above the outdoor unit with 25 feet (8 m) of connecting tubing and no traps between the indoor and outdoor units. If the system is designed to be field charged, the system should be overcharged by 15% in this test to simulate overcharging commonly found in field installations. Operate the system in the cooling mode at the outdoor ambients, on/off cycle times, and number of cycles specified in **Table 1.** Record the height of the liquid in the compressor at the start of each on cycle, any protector trips, or any compressor stalls during each test. Review the results with Copeland Application Engineering to determine if an accumulator is required for the application. The criteria for pass/fail is whether the liquid level is above the compressor suction connection. Liquid levels higher than these allow any compressor oil floating on top of the refrigerant to be ingested by the scrolls and pumped out of the compressor on startup, a hazardous situation.

Field Trouble Shooting Solid State Module Part Number 071-0520-XX

The module used in the 7.5 to 25 HP scroll compressor works in conjunction with a thermistor chain inside the scroll compressor to protect against excessive motor and discharge gas temperature. A problem in either area will cause the module to interrupt the control circuit (open M1 & M2) for 30 minutes +/- 5 minutes. Follow the steps listed below to trouble shoot the module in the field. See wiring diagram below or on terminal box cover.

1. De-energize control circuit and module power. Remove the control circuit wires from the module (Terminals M1 & M2). Connect a jumper across these "control circuit" wires. This will bypass the "control contact" of the module.

   CAUTION: THE MOTOR PROTECTION SYSTEM WITHIN THE COMPRESSOR IS NOW BYPASSED. USE THIS CONFIGURATION TO TEMPORARILY TEST MODULE ONLY !

2. Re-energize the control circuit and module power.

   If the compressor will not operate with the jumper installed, then the problem is external to the solid state protection system.

   If the compressor operates with the module bypassed but will not operate when the module is reconnected, then the control circuit relay in the module is open. The thermistor protection chain now needs to be tested to determine if the module's control circuit relay is open due to excessive internal temperatures or a faulty component.

3. Check the thermistor protection chain located in the compressor as follows:

   De-energize control circuit and module power. Remove the sensor leads from the module (S1 & S2). Measure the resistance of the thermistor protection chain through these sensor leads with an ohmmeter.

   CAUTION ! Use an Ohmmeter with a maximum of 9 volts to check the sensor chain. The sensor chain is sensitive and easily damaged; no attempt should be made to check continuity through it with anything other than an ohmmeter. The application of any external voltage to the sensor chain may cause damage requiring the replacement of the compressor.

The diagnosis of this resistance reading is as follows:

- 250 to 2250 ohms – Normal operating range
- 2750 ohms or greater – Compressor overheated - Allow time to cool

- zero resistance – Shorted sensor circuit – Replace the compressor
- infinite resistance – Open sensor circuit – Replace the compressor

If the resistance reading is abnormal, remove the sensor connector plug from the compressor and measure the resistance at the sensor fusite pins. This will determine if the abnormal reading was due to a faulty connector or the thermistors.

On initial start-up, and after any module trip, the resistance of the sensor chain must be below the module reset point before the module circuit will close. Reset values are 2250-3000 ohms.

4. If the sensor chain has a resistance that is below 2250 ohms, and the compressor will run with the control circuit bypassed, but will not run when connected properly, the solid state module is defective and should be replaced. The replacement module must have the same supply voltage rating as the original module.

Notes: The module has a 30-minute time out after a trip. Interrupting the module power for 1 second or longer will reset the module.

The voltage should be disconnected between tests in order to avoid short circuits and accidental arcing of contacts. The function of the module should be checked each time there is an open fuse or breaker trip to insure that the module contacts did not stick.

Fig. 1
Oil Dilution Chart

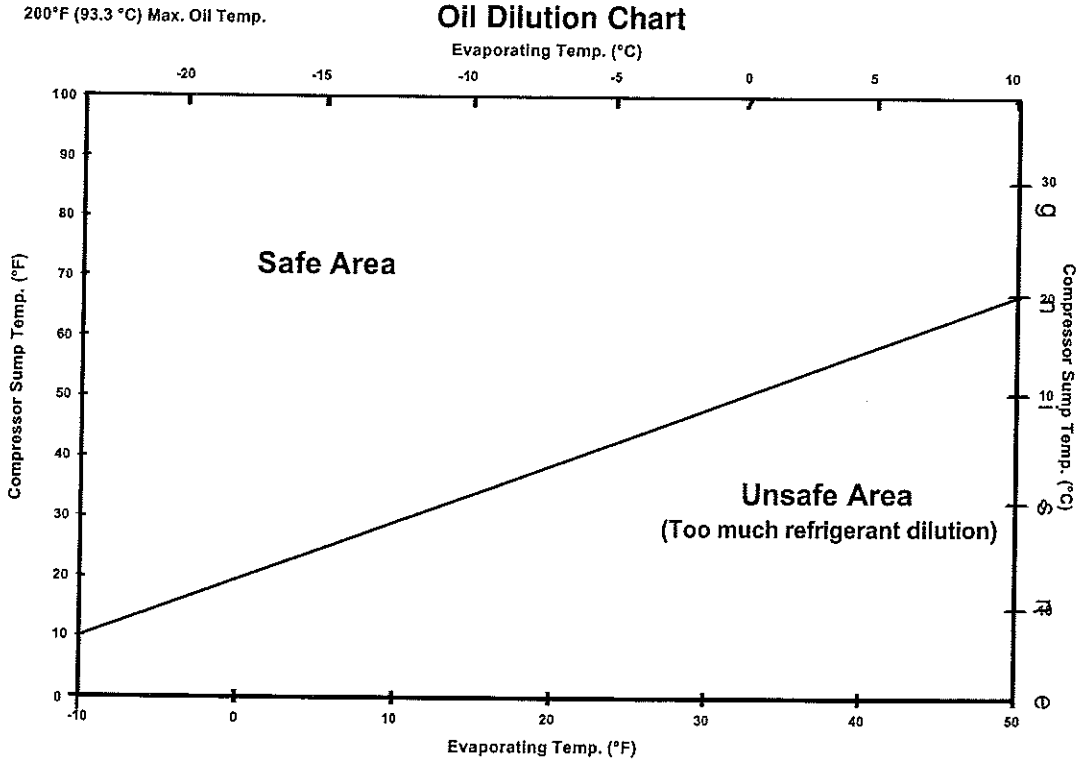
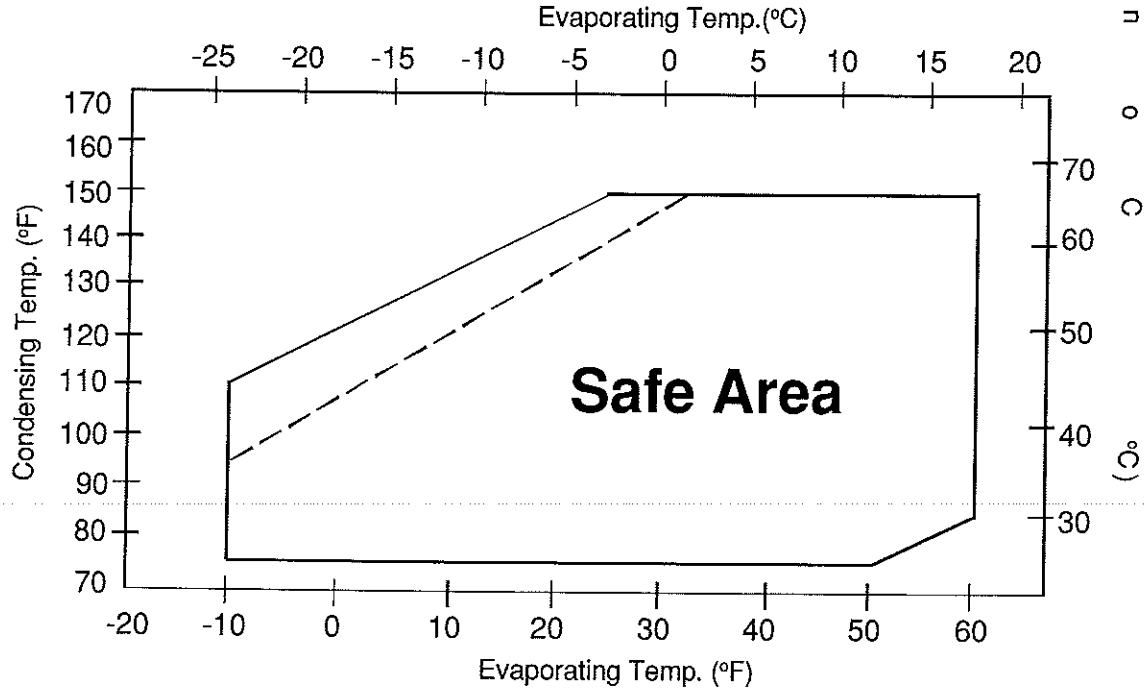


Fig. 2
R22 & R407C Scroll Operating Envelope



Full operating envelope is for ZR90K3E toZR19M3E and ZR250KCE and ZR300KCE with R407C at dewpoint. Dashed line indicates reduced operating envelope required for ZR90K3 to ZR19M3 and ZR250KC to ZR300KC with R22.

Fig. 3

Wiring Diagram

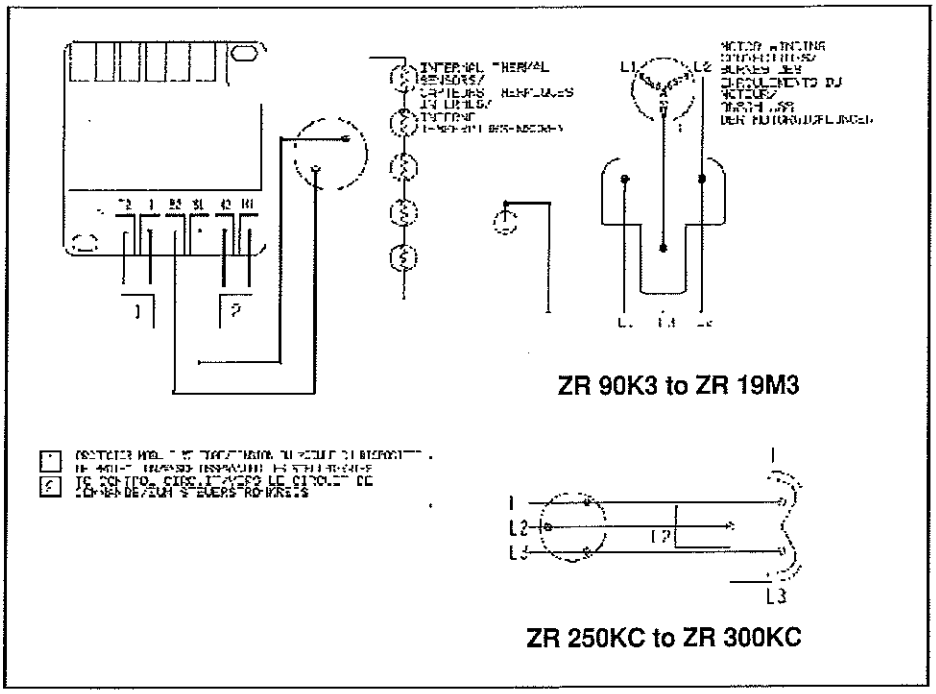


Fig. 4

Crankcase Heater Conduit Box Drawing

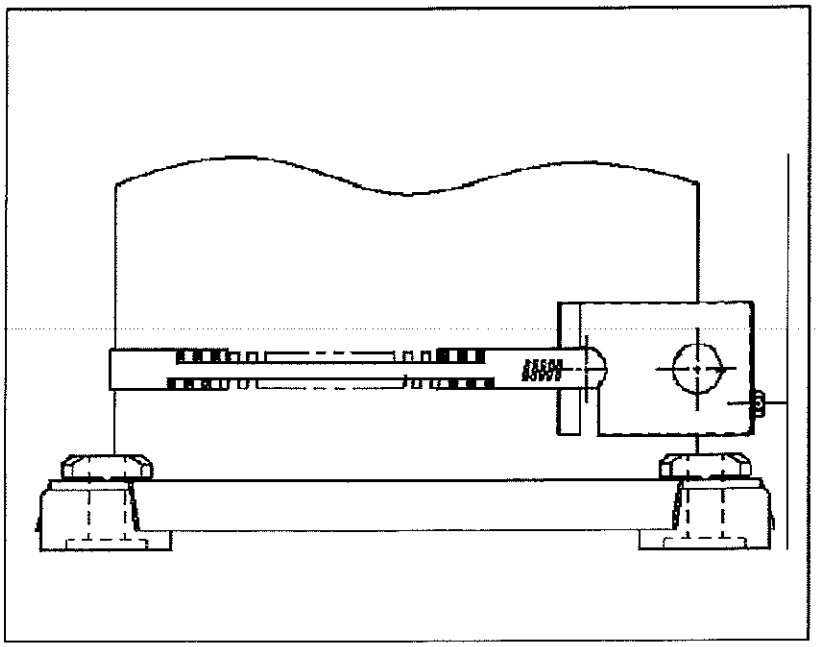
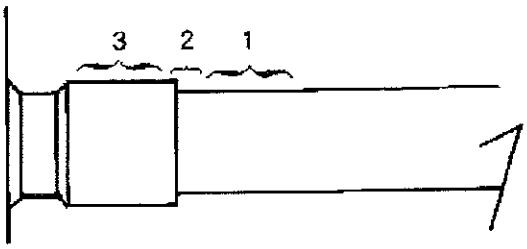


Fig. 5
Brazing instructions



New Installations

- The copper-coated steel tubes on scroll compressors can be brazed in approximately the same manner as any copper tube.
- Recommended brazing materials: Any silfos material is recommended, preferably with a minimum of 5% silver. However, 0% silver is acceptable.
- Be sure both tube fitting I.D. and O.D. are clean prior to assembly. If oil film is present wipe with denatured alcohol, Dichloro-Trifluoroethane or other suitable solvent.
- Using a double-tipped torch apply heat in Area 1. As tube approaches brazing temperature, move torch flame to Area 2.
- Heat Area 2 until braze temperature is attained, moving torch up and down and rotating around tube as necessary to heat tube evenly. Add braze material to the joint while moving torch around joint to flow braze material around circumference.
- After braze material flows around joint, move torch to heat Area 3. This will draw the braze material down into the joint. The time spent heating Area 3 should be minimal.
- As with any brazed joint, overheating may be detrimental to the final result.

Field Service

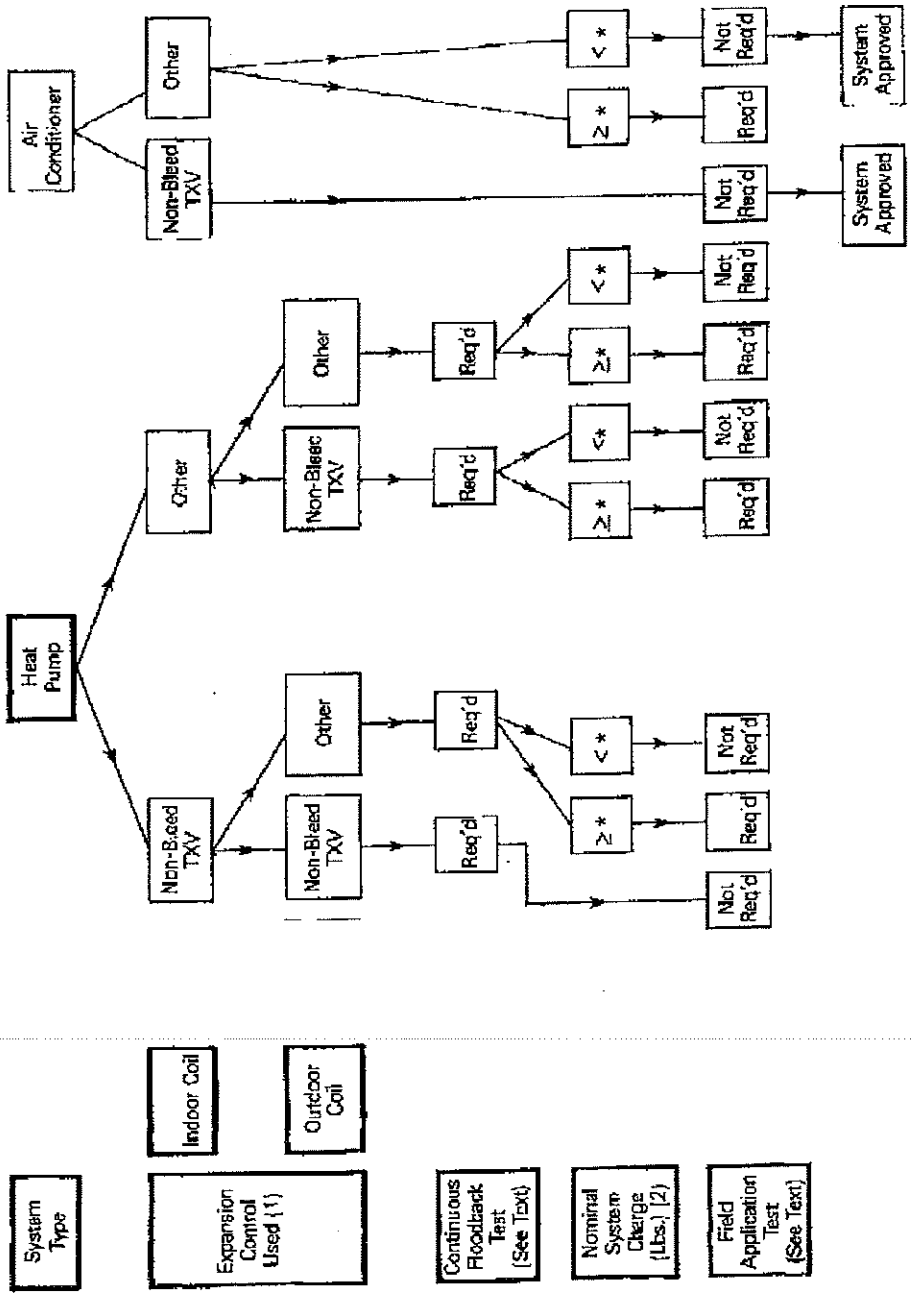
- To disconnect: Reclaim refrigerant from both the high and low side of the system. Cut tubing near compressor
- To reconnect:
  - Recommended brazing materials: Silfos with minimum 5% silver or silver braze material with flux.
  - Insert tubing stubs into fitting and connect to the system with tubing connectors.
  - Follow **New Installation** brazing instructions.

Table 1
Field Application Test

Operate the system as it would be operated in an actual field installation, cycling the unit on and off for the times indicated at each ambient.

Outdoor Ambient (°F)	85°F (29°C)	95°F (35°C)	105°F (40°C)
System On-Time (Minutes)	7	14	54
System Off-Time (Minutes)	13	8	6
Number of On/Off Cycles	5	5	4

Scroll Compressor Application Diagram



(1) "Other" includes bleed-type TXVs, capillary tubes, and fixed orifices.
(2) "Nominal System Charge" is defined as the design charge for a system.
* See text for crankcase heater or pump down requirements if system charge exceeds Compressor refrigerant charge limit in **Table 6**.

Piping Configuration to Reduce Vibration Transmission

Recommended Configuration

Component	Description
Tubing configuration ...	shock loop
Service valves	"angled valves" rigidly attached to the unit preferably to base pan.
Suction muffler	not required

Alternate Configuration

Component	Description
Tubing configuration ...	shock loop
Service valve	"straight-through" valve or line not attached to unit.
Suction muffler	may be required to add mass to the suction line to shift line resonance away from excitation frequencies.

Table 4
Crankcase Heater Table

Copeland Models:	Copeland Part #:	Tutco Part #:	Volts:	Watts:	Lead Length:	Conduit Box
ZR90K3 - ZR19M3	018-0036-01	02-7150-02	120	70	26" (66cm)	998-7015-00
	018-0036-00	02-7150-00	240	70	26" (66cm)	
	018-0036-02	02-7150-03	480	70	26" (66cm)	
	018-0036-03	02-7150-06	575	60	26" (66cm)	
ZR300KC	018-0056-01	02-6331-00	240	150	28" (71 cm)	TBD
	018-0056-00	02-6331-03	480	150	28" (71 cm)	
	018-0056-02	02-6331-02	120	150	28" (71 cm)	
	018-0056-03	02-6331-06	575	150	28" (71 cm)	
ZR250KC		02-6333-00	240	120	28" (71 cm)	TBD
		02-6333-03	480	120	28" (71 cm)	
		02-6333-02	120	120	28" (71 cm)	
		02-6333-06	575	120	28" (71 cm)	

Table 5
Torque Values

	Torque	
	Foot-Pound	Newton-Meter
Rotalock 3/4"-16UN	30 - 37	40 - 50
Rotalock 1-1/4"-12UN	74 - 81	100-110
Rotalock 1-3/4"-12UN	125 - 133	170-180
Rotalock 2-1/4"-12UN	140 - 148	190-200
Flange w. M16 bolts	75 - 83	102 - 113
Sight Glass	18 - 19	25 - 25.5
Mounting Bolts 5/16", M 9	20 max.	27 max.

Table 6
Refrigerant Charge Limits

	LBS.	KG
ZR90K3 to ZR19M3	17	7.7
ZR250KC	25	11.3
ZR300KC	30	13.6

RATING CONDITIONS
20 °F Superheat
10 °F Subcooling
95 °F Ambient Air Over

60 Hz Operation

AIR CONDITIONING

ZR12M3-TWC
HCFC-22
COPELAND SCROLL™
TWC 208/230-3-60

Condensing Temperature °F (Sat Dew Pt Pressure, psig) — **Evaporating Temperature °F (Sat Dew Pt Pressure, psig)**

		-10(16)	0(24)	10(33)	20(43)	30(55)	40(68)	45(76)	50(84)	55(93)
150 (381)	C						96000	106000	117000	129000
	P						13800	13800	13800	13800
	A						38.8	38.9	38.9	39
	M						1620	1770	1940	2120
	E						7	7.7	8.5	9.3
	%						62.2	64.1	65.9	67.4
140 (337)	C					84000	104000	114000	126000	139000
	P					12300	12300	12300	12300	12300
	A					35.6	35.7	35.7	35.7	35.7
	M					1360	1650	1810	1980	2160
	E					6.8	8.4	9.3	10.2	11.2
	%					61	65.2	67	68.5	69.7
130 (297)	C				72500	90500	111000	122000	135000	148000
	P				10900	11000	11000	11000	11000	11000
	A				32.8	32.9	32.9	32.9	32.9	32.9
	M				1130	1390	1680	1840	2010	2190
	E				6.6	8.2	10.1	11.1	12.3	13.5
	%				59.1	63.9	67.7	69.2	70.3	71
120 (260)	C			61000	77500	96500	118000	130000	143000	157000
	P			9750	9800	9850	9800	9800	9750	9750
	A			30.4	30.5	30.6	30.5	30.5	30.5	30.5
	M			915	1150	1410	1700	1870	2040	2220
	E			6.3	7.9	9.8	12.1	13.3	14.7	16.1
	%			56.4	61.9	66.3	69.5	70.5	71	71.1
110 (226)	C		49900	65000	82500	102000	125000	138000	152000	166000
	P		8600	8700	8750	8750	8700	8700	8700	8700
	A		28.3	28.5	28.6	28.5	28.5	28.4	28.4	28.4
	M		730	940	1170	1430	1730	1890	2060	2250
	E		5.8	7.5	9.4	11.7	14.4	15.8	17.4	19.2
	%		52.7	59.2	64.2	67.9	70	70.3	70.1	69.2
100 (196)	C	39500	53500	69500	87500	108000	132000	145000	160000	175000
	P	7600	7700	7800	7800	7800	7750	7750	7750	7750
	A	26.4	26.7	26.8	26.8	26.8	26.7	26.7	26.7	26.8
	M	560	750	955	1180	1450	1740	1910	2080	2270
	E	5.2	6.9	8.9	11.2	13.9	17	18.7	20.6	22.6
	%	48	55.6	61.4	65.7	68.4	69	68.4	67	64.8
90 (168)	C	42800	57000	73000	92000	113000	138000	152000	167000	183000
	P	6800	6900	6950	6950	6900	6900	6900	6950	6950
	A	25.1	25.3	25.4	25.3	25.3	25.3	25.3	25.4	25.4
	M	580	765	965	1200	1460	1760	1920	2100	2290
	E	6.3	8.3	10.6	13.2	16.4	20	22	24.1	26.4
	%	51.1	57.9	62.9	66.1	67.3	65.9	64	61.2	57.4
80 (144)	C	45800	60000	76500	96000	118000	144000	159000	174000	191000
	P	6050	6100	6150	6150	6150	6150	6200	6250	6300
	A	23.9	24.1	24.1	24.1	24.1	24.1	24.2	24.3	24.4
	M	600	775	975	1200	1460	1770	1930	2110	2300
	E	7.6	9.8	12.5	15.6	19.2	23.4	25.7	28	30.4
	%	53.7	59.4	63.3	65.1	64.3	60.1	56.6	51.8	46.1

NON-STANDARD CONDITIONS: Nominal Performance Values (±10%) based on 72 hours run-in. Subject to change without notice.
C:Capacity(Btu/hr), P:Power(Watts), A:Current(Amps), M:Mass Flow(lbs/hr), E:EER(Btu/Watt-hr), %:Isentropic Efficiency(%)

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Autogenerated Compressor Performance

EMERSON. Climate Technologies

Copeland

ZR12M3-TWC

AC: Air Conditioning
Refrigerant: 22
Voltage: TWC 208/230-3-60

Rating Conditions
65.9 Return Gas (F)
10 Sub Cool (F)
20 Compressor Super Heat (F)
95 Ambient Temperature (F)

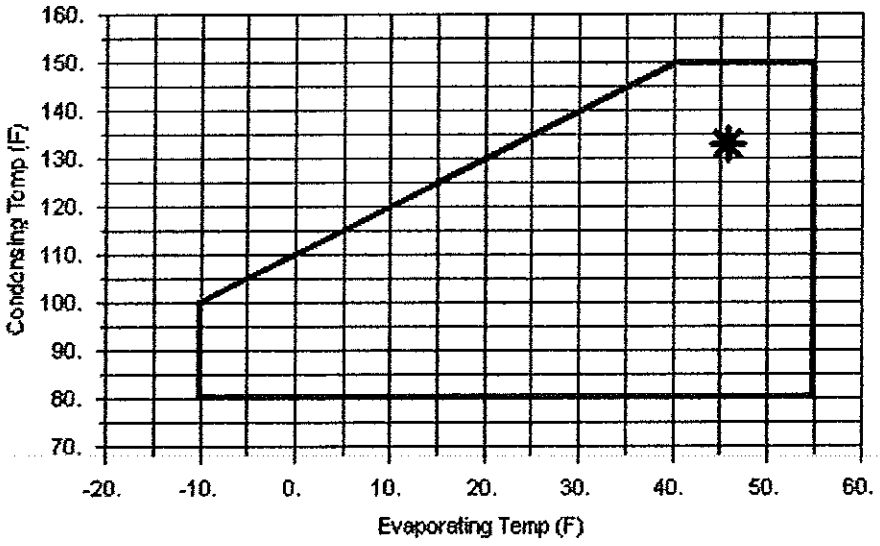
Production Status: Available for sale to all U.S. customers. Please check with your local Copeland representative for international availability.

Evap Temp (F) = 45.9
Cond Temp (F) = 133
Capacity (Btu/hr) = 122000
Power (Watts) = 11400
Current (Amps) = 33.7
Mass Flow (lbs/hr) = 1860
EER (Btu/W-hr) = 10.7
Isentropic Efficiency = 68.9

RLA = 38.6
Half Winding RLA =
LoLRA =
HiLRA = 278
Half Winding LRA =
Max Operating Current = 39.4

Evaporator Superheat (F) = 20, Net Refrig Effect (Btu/hr) = 122000

Operating Map



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Printed 3/3/2005

HydroThrift

1301 Sanders Avenue, SW
P.O. Box 1037
Massillon, OH 44648-1037

Phone: 330-837-5141
Fax: 330-837-0558
E-mail: www.hydrothrift.com

CA+20 Coil Specifications

EVAPORATOR

A.	Air Flow	3,500 CFM
B.	Entering Pressure	14.696 psia
C.	Entering Temp Dry Bulb / Wet Bulb	78.0 / 67.0 °F
D.	Leaving Temp Dry Bulb / Wet Bulb	57.6 / 56.2 °F
E.	Heat Load	120,200 Btu/hr
F.	Refrigerant	R-22
G.	Refrigerant Saturated Suction Temp	45.0 °F
H.	Refrigerant Liquid Temp	120.0 °F
I.	Fin Height	25 inches
J.	Fin Length	36 inches
K.	Fin Spacing	8 fins/inch
L.	Fin Material	Aluminum
M.	Tube Material	Copper
N.	Air Side Pressure Drop	0.66 in wc

CONDENSER WITH SUBCOOLING CIRCUIT

A.	Air Flow	5,500 CFM
B.	Entering Pressure	14.696 psia
C.	Entering Temp Dry Bulb	100.8 °F
D.	Refrigerant Condensing Temp	133 °F
E.	Condensing Duty	159,000 Btu/hr
F.	Subcooled Liquid Exit Temp	112 °F
G.	Fin Height	42.5 inches
H.	Fin Length	36 inches
I.	Fin Spacing	12 fins/inch
J.	Fin Material	Aluminum
K.	Tube Material	Copper
L.	Air Side Pressure Drop	0.64 in wc

HydroThrift

1301 Sanders Avenue, SW P.O. Box 1037
Massillon, OH 44648-1037
330.837.5141 fax 330.837.0558

BLOWER FAN – OPERATING INSTRUCTIONS

- User must avoid improper use of fan.
- User must contact manufacturer of "abnormal" operating conditions.
- Fan installation and maintenance must be carried out by technically competent personnel.
- Fan cannot operate beyond limits of the plate entitled "Technical Data".
- It is the user's responsibility to ensure fan operates safely, taking all necessary prevention precautions.
- It is the user's responsibility to regulate noise level, using an adequate device respecting norms currently in effect.
- Installation and operation of anti-spark execution fans must conform to norms of respective country (ref: Cometri VDMA 241 69).
- When moving fans, appropriate means of support must be used; fans in cardboard boxes must be lifted from the base of the box.
- When storing fans in cardboard boxes, stacking limits must be respected (ie., sizes 7-12: max. 4 units; sizes 15-18; max. 3 units).

FOR FIRST TIME FAN OPERATION, THE USER MUST:

- Ensure that moving parts are not in contact with stationary parts.
- Ensure that all main accident prevention precautions have been taken (eg., keeping one's
- distance from moving parts).
- Ensure impeller's rotation direction corresponds to the direction of arrow found on the fan casing.
- Check all bolts within first 500 hours of operation, ensuring they have been tightened to guarantee stability in assembled components.
- Verify there are no operating abnormalities, such as excessive vibration or noise. **In these instances, it is necessary to stop the fan IMMEDIATELY.**

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General Installation, Operation and Maintenance Instructions For Aerovent Products

Introduction

This manual has been prepared to guide the users of Aerovent equipment in the proper installation, operation and maintenance procedures to insure maximum equipment life and trouble-free operation.

Receiving

Products leaving the assembly plant have been inspected and are in satisfactory operating condition. The carrier assumes full responsibility for material from the time it leaves the plant until it is delivered to the user. Therefore, material should be inspected for damage immediately so that any damage claims against the carrier can be made before acceptance of the shipment. No equipment is to be returned without an authorized returned goods tag.

Handling

All products must be handled with extreme care to avoid misalignment of rotating components. Never lift a unit assembly by using the shaft, drive sheaves, wheel or motor as a point of attachment. If it is apparent that slings will not clear a portion of the product being hoisted, a spreader should be used to avoid damage.

Initial Operation

All Aerovent fans are lubricated at the factory and have been given a run-in test before shipment. Read carefully all installation and maintenance manuals before following the startup check list.

Safety Precautions

Any piece of machinery should be treated with respect and not overconfidence. Overconfidence usually leads to carelessness and carelessness leads to injury. Following is a list of DO's and DO NOT's:

DO

1. Make sure the unit is stopped and electrical power is locked out before putting hands into the inlet or outlet openings or near the belt drive. A warning sign on the START SWITCH cautioning not to start is recommended when the unit is being serviced.
2. Follow maintenance instructions.

DO NOT

1. Put hands near or allow loose or hanging clothing to be near belts or sheaves while the unit is running.
2. Put hands into inlet or outlet while the unit is running. It is sometimes difficult to tell whether or not a fan is running . . . be sure it is not running and cannot be operated before any inspection.

Startup Checklist

1. Inspect the equipment for any shipping damage. Remove any foreign material such as tags or packing from any moving parts or from within the fan housing.
2. Compare the voltage, hertz, and phase stamped on the motor with the current characteristics of the line to which the motor is to be connected.
3. Lock out the power source at the disconnect switch.
4. Turn motor, drive, and propeller by hand to see that no misalignment has taken place in shipment. Check V-belt drive for proper alignment and belt tension.
5. Check all bolts, screws and fasteners and tighten if necessary. Make certain all set screws, locking collars and bearing mounting bolts are secure.
6. Secure and check clearance of access doors, belt guards and inlet and outlet guards.
7. If equipped with dampers, check for correct linkage operation. Make sure that the operator opens or closes these control devices to the proper positions.
8. Jog the fan electrically and note the rotation. Reverse two electrical leads, if necessary, to obtain proper rotation as marked with rotation arrow on fan. Do not allow the propeller to run backwards except momentarily.
9. **Centrifugal Fans:** Close dampers as required for adequate system resistance to prevent the motor from overloading.

CAUTION: With fans that use the forward-curve or radial type of wheel, it is possible to overload the motor if the fan is operated at a lower static pressure than that which the fan is rated. Check the catalog rating of the fan for proper speed and resistance.

10. Start the fan and observe its operation.
11. Take a motor amp reading and compare with the amp rating on the motor. (The actual running amps should not exceed motor nameplate amps x service factor, exceptions may be taken for air over motors.)

Fan Balance

Fan propellers are statically and dynamically balanced within acceptable tolerances at the factory. Damage in shipping and handling or poor installation of the unit may upset the unit balance. A propeller that is not properly balanced can lead to excessive vibration causing undue wear on the entire unit. It is recommended that after installation a vibration test be made on the fan by an experienced technician.

CAUTION: For units furnished less final drive compo-

©2000 Aerovent

nents at customer request, the addition of drive components in the field can create critical vibration modes. Aerovent strongly recommends a final unit balance procedure after all rotating components are installed. Failure to do so voids Aerovent's warranty.

All Aerovent fan assemblies are factory balanced to quality grade G6.3 (mm/sec., vel.) in accordance with ISO 1940-1973 standards. Selected values of fan RPM and corresponding total displacement (mils-peak to peak) and peak velocity (in./sec.) for quality grade G6.3 are charted below.

Fan RPM	Total Displacement (Mils-Peak-To-Peak)	Peak Velocity (In./Sec.)
3600	0.66	0.124
1800	1.32	0.124
1200	1.97	0.124
900	2.63	0.124
700	3.38	0.124

Vibration measurements, when possible, should be taken at each fan shaft bearing in two planes perpendicular to the axis of rotation (planes to have 90 degree interval), and one measurement parallel to the axis of rotation. On direct drive units, the perpendicular measurements will be taken at each end of the motor casing, taking care not to take measurements on the fan shroud on TEFC motors. The axial measurement can be taken on the motor foot or mounting base. In some cases, primarily on axial flow units, it will not be possible to take measurements at the bearings or motor. On these units, the measurements should be taken on the inner shell near the bearings. If this is not possible, then take the readings on the outer shell near the bearing locations.

If vibration is excessive, shut down the fan and determine the cause.

Common Causes of Excessive Vibration

1. Support structure not sufficiently rigid or level. Vibration amplified by resonance in ductwork or support structure.
2. V-belt drive misalignment. Belt tension is too tight or too loose.
3. Bearing locking collar or mounting bolts loose. Propeller set screw loose.
4. Material accumulation on propeller.
5. **Centrifugal Fans:** Wheel rubbing on inlet cone.

Motors

Most integral horsepower totally-enclosed motors have drain plugs in the end bells for drainage of condensation. On all roof ventilators, the bottom or lower plug has been removed for continuous drainage.

All other style fans are shipped with the drain plugs installed. The user should remove the proper drain plug. For horizontally mounted units with the motor in the airstream, remove the downstream drain plug. For vertically mounted units, remove the bottom or lower drain plug.

With motors supplied by the user, drain plugs may not have been provided. Check with the motor manufacturer regarding drainage and condensation.

Lubrication Instructions for Ball Bearing Motors

Grease-lubricated bearings, as furnished, are adequate for a long period of operation without relubrication. A good maintenance schedule for regreasing will vary widely depending on motor size, speed and environment.

The table below suggests relubrication intervals for motors on normal, steady running, light duty indoor loads in relatively clean atmosphere at 40°C (105°F) ambient temperature or less. Fractional horsepower motors follow a schedule similar to that shown under frames 143T to 215T.

Motor Lubrication Intervals

TYPE OF ENCLOSURE	INSULATION	FRAME SIZE		
		143T-215T	254T-326T	364T-449T
Open-DP	B	2 yrs.	18 mos.	1 yr.
Enclosed-FC Open-DP	B F	18 mos.	1 yr.	9 mos.
Enclosed-NV Enclosed-FC Open-DP Enclosed-Lint Free-FC	B F H B	1 yr.	9 mos.	6 mos.
Enclosed-NV Enclosed-FC Enclosed-Lint Free-FC	F H F	9 mos.	6 mos.	3 mos.

NOTE: For motors over 1800 RPM, use ½ of tabled period. For heavy duty, dusty locations, use ½ of tabled period. For severe-duty high vibration/shock, use ⅓ of tabled period.

VOLUME - REFERENCE TABLE

SHAFT DIAMETER (AT FACE OF BRACKET)	AMOUNT OF GREASE TO ADD
¾" to 1¼"	1/8 cu. in. or 0.1 oz.
1¼" to 1⅞"	1/4 cu. in. or 0.2 oz.
1⅞" to 2⅜"	3/4 cu. in. or 0.6 oz.
2⅜" to 3⅜"	2 cu. in. or 1.6 oz.

Motors with no provision for lubrication are equipped with sealed bearings and require no maintenance. Motors mounted in inaccessible locations are provided with extended grease lines to facilitate lubrication if provisions for lubrication are provided. The bearings are equipped with relief fittings to prevent over-lubrication. The grease lines are filled with lubricant at the factory.

Procedure for Relubrication

1. Stop motor.
2. Remove grease relief plugs in bearing housings.
3. Grease with hand gun until new grease appears at relief hole.
4. Run motor for ten (10) minutes before replacing relief plugs.

CAUTION: Do not over-lubricate. This is a major cause of bearing and motor failure. Make sure dirt and contaminants are not introduced when adding grease.

Type of Grease

Lubricate with the following greases or their equivalent:

Amoco Rykon Premium #2
Chevron BRB-2 – Standard Oil or Calif.
SRI-2 – Standard Oil Company
Alvania #2 – Shell Oil Company

For motors lubricated with special greases, check lubrication tag on motor.

Lubrication Instructions for Fan Ball Bearings

Bearings and grease lines on belt driven fans are lubricated in assembly. When lubrication is required, add grease slowly while the shaft is rotating until grease comes rapidly out of the seal.

For extreme conditions, lubricate according to experience. For normal conditions, lubricate the bearings with Rykon Premium Grease No. 2 EP or an equivalent.

Bearings and grease lines on axial fans that are ordered for high moisture or above normal temperatures have been lubricated with a special lubricant, Plastilube #2. Lubricate at regular intervals with Plastilube #2 as indicated in the special lubrication chart listed below. Plastilube #2 is available from Sulflo, Inc. 1158 Erie Avenue, North Tonowanda, New York 14120.

Special Lubrication Frequency For High Temperature and High Moisture

AIRSTREAM TEMPERATURE	HOURS
TO 250°F	4500
TO 350°F	1500
TO 500°F	1000
WET ATMOSPHERE AT ROOM TEMPERATURE	1000 TO 1500

Storage of Equipment

Fan Bearings

Since bearings tend to "breathe" on equipment stored in areas with other than a constant temperature, moisture will condense internally. Therefore, it is necessary to keep the bearings completely full of grease and periodically rotated to make certain that all internal parts are coated with grease. Even a full bearing will eventually pick up moisture and, therefore, must be periodically purged with new grease.

Grease should be purged from the bearings to remove condensed moisture, and the fan wheel rotated by hand every thirty (30) days. This practice should be done more often if weather is severe or if there is a wide variation in temperature.

CAUTION IN PURGING: The fan should be rotated while greasing and high pressure pneumatic greasers should be avoided. See "Lubrication Instructions for Fan Ball Bearings."

To rotate the fan, follow the procedure listed below:

The blade marked number 1 should be rotated to top center. The blade number and date should be recorded in a log book which is to be stored in a protective pouch attached to the fan. During storage, the fan propeller should be rotated by hand at least ten (10) revolutions every thirty (30) days to circulate the lubricant in the bearings in the motor or on the fan shaft. After the tenth revolution, stop with a blade at top center which is not the same one as is listed for the previous date in the log book.

Fans which are V-belt driven should be prepared for storage as follows:

Carefully remove the belts, coil them (without kinks) in matched sets and place them in a heavy carton. Mark the carton with fan identification and store the carton in a dry, well-ventilated area. Belts must not be left exposed to sunlight or subjected to storage ambient conditions exceeding 85°F, 70% relative humidity. Belts which show signs of deterioration should be replaced prior to startup. Before reinstalling belts, review the section on "Belt Tension."

NOTE: Procedures for storage of Aerovent equipment as outlined above are intended as a general guide only. Storage conditions will vary depending on the location. Common sense and practical experience should determine to what extent the above procedures will be followed.

Motors

Motors must be stored under cover in a clean, dry, vibration-free location. Remove sufficient packaging material to allow circulation of air around the motor. Maintain the temperature of the windings a few degrees above that of the surrounding air to protect against condensation. If the motor is equipped with internal heaters, the heaters should be energized throughout the storage period to prevent this condensation. If the motor does not have internal heaters, this can be accomplished using any other safe, reliable method of heating. Measure and record the ambient air temperature and winding temperature monthly.

In the event that the motor is not equipped with internal heaters and space heating equipment is unavailable, wrap the motor as tightly as possible with heavy duty polyethylene. Enclose bags of desiccant (such as sil-

Lubrication Frequency for Horizontal Shaft Installations (see Note ① for vertical shaft installations)

SHAFT SIZE (INCHES)	LUBRICATION FREQUENCY ① OPERATING SPEED (RPM)									
	500	1000	1500	2000	2500	3000	3500	4000	4500	5000
	RELUBRICATION CYCLE (MONTHS)									
1/2 – 1	6	6	6	6	6	6	4	4	2	2
1 1/16 – 1 7/16	6	6	6	6	6	6	4	4	2	1
1 1/2 – 1 3/4	6	6	6	4	4	2	2	2	1	1
1 7/8 – 2 3/16	6	6	4	4	2	2	1	1	1	
2 1/4 – 2 7/16	6	4	4	2	2	1	1	1		
2 1/2 – 3	6	4	4	2	1	1	1			
3 7/16 – 3 1/2	6	4	2	1	1	1				
3 15/16 – 4	6	4	2	1	1					

NOTES: ① Reduce this lubrication frequency schedule by half for vertical shaft installations.
② Consult manufacturer for specific recommendations.

icagel) with the motor to minimize moisture problems. Check the desiccant regularly and replace it periodically as dictated by climate requirements.

To prevent rusting of bearing parts, the rotor must be rotated at regular intervals (30 days) to assure these parts are well covered with oil or grease.

Prior to energizing the motor, it is to be inspected and meggered by a motor manufacturer's field service engineer. The charges for this service to the customer will be in accordance with the manufacturer's published service rates in effect at the time of the inspection.

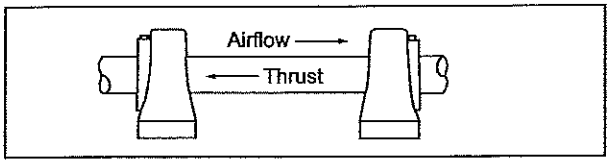
In addition, it is strongly recommended that the motor manufacturer be contacted for specific long-term storage instructions.

Fan Bearing Replacement Procedure

It is important to follow the assembly and alignment procedure when making an installation of replacement bearings. Inspect the shaft for wear at the bearing mounting positions. Shaft diameter should not be undersized more than commercial ground and polished tolerances. Excessive undersizing will result in rapid wear.

1. Place new bearings loosely on the shaft. Locking collars may be located on either end of the bearings for ease of installation. The illustration shows one locking collar on the drive end and one locking collar on the fan end which is typical for a tubeaxial type fan. A typical SWSI centrifugal fan would have both collars mounted on the sheave side of the bearings. Drop the mounting bolts in place, snug them and adjust the position of the shaft with proper spacing at either end.
2. Center both ends of the shaft in the housing of tubeaxial fans using the propeller as a guide. On centrifugal fans, the shaft is positioned 90° to the scroll side with the wheel inlet centered in the scroll inlet. Use the clearance in the mounting holes for horizontal adjustment and shims, if necessary, for vertical adjustment.

Figure 1. Two Bearing Drive



3. Tighten the bearings to the base plate and check the position of the shaft again. Before tightening the locking collars, be sure the shaft and bearings are in proper alignment. The shaft should slide freely end to end.
4. Tighten the eccentric cam locking collar of the bearing at the propeller/wheel end. (The locking collar design provides a positive lock of the wide inner ring bearing to the shaft. To tighten, turn the locking collar in the direction of shaft rotation to the lock position, then tighten the collar set screw.) Repeat this procedure for the sheave end locking collar on DWDI and open wheel centrifugals. For other fan types, proceed to Step 5.
5. Axial flow propellers and single inlet centrifugal wheels with back plates exert an air thrust toward the fan inlet. To help balance the bearing loading, we allow the fan end bearing (belt driven units) to carry the majority of this thrust loading while the sheave end bearing carries most of the radial load. (Direct coupled units would be just the opposite.) To accomplish this, grasp the sheave end of the shaft and pull or push on it toward the fan inlet. At the same time, tap the locking collar of the sheave end bearing (fan end on direct coupled units) in the opposite direction with a soft mallet.
6. The final step is to tighten the sheave end bearing eccentric cam locking collar while maintaining constant pressure on the shaft toward the fan inlet.

For special heavy duty bearings, a spring locking collar is used. The two knurled cup-point set screws extend through the inner ring of the bearing and lock firmly onto the shaft. Tighten the propeller end collar first, then take hold of the sheave end of the shaft, pull and then tighten the locking collar. The locking collar is tightened by using the two set screws mentioned above.

Replacing Fan Belts

Worn belts may be easily replaced without removing the fan from the system.

1. Loosen the motor hold-down bolts and move the motor toward the fan. (This is done by turning a jackscrew which is a part of the motor base on models having larger motors.) The belt may be slipped off the motor sheave and then easily removed from the sheave on the propeller shaft.
2. Check the numbers on the belt and make the replacement with a belt having the same length and section.
3. Adjust the motor outward to tighten the belt (see instructions on belt tension, below) and tighten the motor hold-down bolts. Be sure that the motor is not cocked at an angle and that the end face of the motor sheave is parallel to the end face of the driven sheave.

Belt Tension Procedure

Belt tension is very important to the proper operation of a fan and to the service life of a V-belt drive. A new fan will be received with its belts properly adjusted; however, all V-belts stretch in the first few hours of operation. It is necessary to readjust the belt tension after eight hours of running. After 100 hours the belts should again be adjusted. Thereafter, periodic inspection is recommended so belts may be adjusted or replaced when necessary.

1. To adjust the belts, loosen the motor hold-down bolts. Tighten the belt using the motor base adjusting screw until the belt appears to be taut. You should be able to deflect the belt slightly by squeezing the two sides between thumb and forefinger and the belt should snap back into position when released.
2. Retighten the motor hold-down bolts and start the fan. If the belt screeches on startup it is too loose and should be tightened further.
3. Allow the fan to run for a while, stop the fan, and check the temperature of the sheave with your hand. If the sheave is too hot to touch, the belt is probably too tight.

V-belt drives on Aerovent fans are purposely sized to handle considerably more load than would be necessary for normal drive design. This is done to prolong the life of the drive and provide for minimum maintenance. Belts should be replaced when they have obviously become worn, even though they are still operating. A badly worn belt will also cause undue wear of the sheave. Replace belts when they show definite signs of wear; otherwise the sheaves will become worn to the point where they also must be replaced. Never put new belts on a badly worn sheave. This will reduce the capacity of the drive and cause excessive belt wear.

Most Aerovent fans are provided with an adjusting screw as a part of the motor base for easy setting of belt tension. However, small fans or fans using small horsepower motors may have only a slotted base plate. When the belt tension is adjusted by moving a motor on a slotted base, be sure to block the motor tightly and squarely before tightening the hold-down bolts, keeping the motor sheave in line with the belt. The motor sheave must be parallel to and in line with the fan sheave.

When you make replacement of belts on a multigroove drive, be sure they are used in a matched set. If you are not sure the belts are matched, observe them in operation. The tight side should be perfectly straight and the belts should run smoothly and in line. The slack side should bow out and also be in line. If one of the belts extends out considerably farther than another, it is an indication that the belts are not matched and should be changed. If there is only a slight difference, the normal stretching in the first hours of operation will equalize the belt lengths and the belts will be well matched.

Adjusting Variable Pitch Sheaves

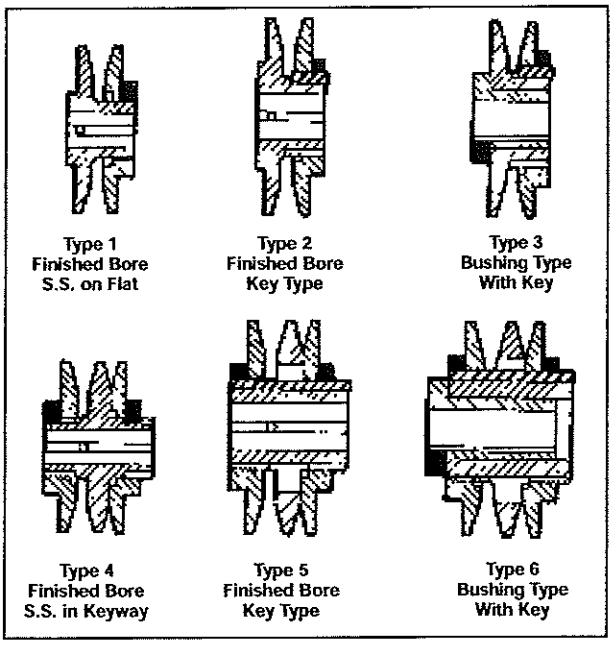
Many Aerovent belt driven fans are furnished with variable-pitch motor sheaves. Sheaves may be adjusted for lower fan speeds without concern of overloading motors. When adjusting sheaves to increase the fan speed, check the motor current to be sure the motor is not overloaded. Keep the motor current within the nameplate and service factor ratings.

The sheaves used are easily adjusted. They come in various styles, depending upon the size drive and motor shaft. They are all fitted with hollow head knurled point safety set screws.

The following steps should be taken to adjust the pitch diameter.

1. Release belt tension and remove the belt or belts from the sheave.
2. Loosen the set screw and remove the key holding the adjustable half of the groove (keys used on styles 2, 3, 5 and 6 only). With styles 3 and 6, it may be necessary to remove the sheave from the shaft to remove the key.
3. Rotate the adjustable half of the sheave out for a smaller pitch diameter (decreased speed) or in for a larger pitch diameter (increased speed). Each one-half turn will change the pitch diameter one-tenth of an inch. Adjust two-groove sheaves the same amount on each groove. 4L or A belts will operate satisfactorily with the sheave fully closed to a maximum of five full turns open. 5L or B belts will operate satisfactorily with the sheave one full turn open to a maximum of six full turns open. (This will insure full contact of the sheave in the groove.)
4. Replace the key and tighten the set screw to lock the sheave half in position.
5. Replace the belts and tighten to the proper tension. If an extreme amount of adjustment has been made, it may be necessary to replace belts with another length.

Figure 2. Types of Sheaves

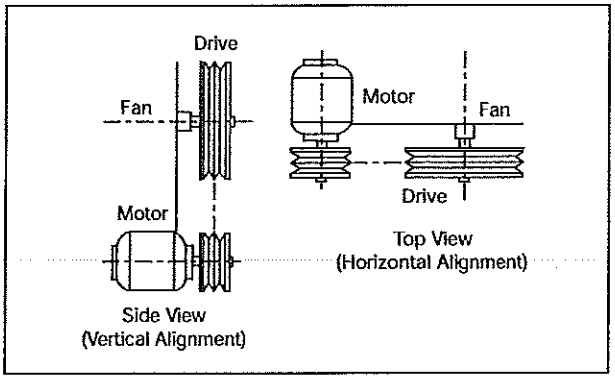


V-Belt Drive Alignment

Proper alignment and balance of the V-belt is as important as a well-balanced propeller. To insure smooth fan operation, the following should be checked:

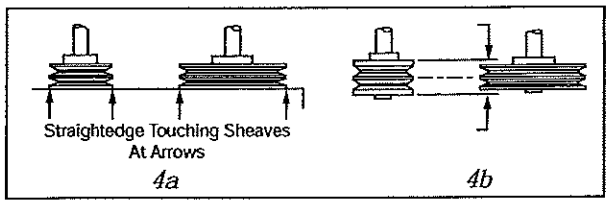
1. The fan and motor sheaves must be in axial alignment. Shafts are parallel in both the vertical and horizontal planes (Figure 3).

Figure 3. Fan and Motor Sheave Axial Alignment



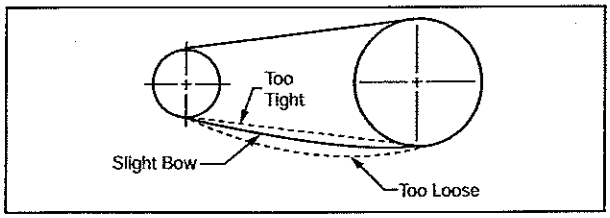
2. The fan motor sheave must be in radial alignment. When sheaves are of equal width, align with a straightedge (Figure 4a). When sheaves are of unequal width, align the center of the sheaves (Figure 4b).

Figure 4. Sheave Alignment



3. Sheaves must have no noticeable eccentricity.
4. Belts must have the proper tension. Belts either too loose or too tight cause vibration and excessive wear (Figure 5). See instructions for belt tension adjustment procedure.
5. After proper installation of drives, recheck the complete assembly for smoothness of operation.

Figure 5. Proper Belt Tension



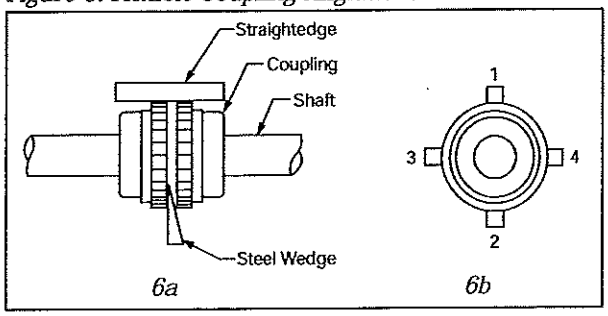
Flexible Couplings

Direct-coupled fans, which are received factory assembled, on a common base plate, are accurately aligned before shipment. However, base plates are flexible to some extent and therefore must not be relied upon to maintain the factory alignment. Realignment is necessary after the fan has been leveled, grouted, and the foundation bolts tightened. Also, check the lubricant, where applicable, following the manufacturer's recommendations for the type and amount of lubricant.

For field installation, the coupling should be mounted as follows:

1. Remove dirt or rust from fan and motor shafts and coat with grease or oil for ease of mounting.
2. Check fan and fan shaft alignment, making sure that the bearings are secure. Mount the fan shaft coupling half flush to the end of the shaft and secure.
3. Mount the motor shaft coupling half flush to the end of the shaft and secure.
4. Move the motor into position, with the coupling faces separated by the coupling manufacturer's specified gap.
5. With a straightedge, tapered wedge, or a feeler gauge, check for parallel and angular alignment (Figure 6a).
6. Align the shafts until a straightedge appears to be parallel to the shafts. Repeat at three additional points at approximately 90° from each other (Figure 6b). Recheck the hub separation gap.
7. For more accurate alignment, use a dial indicator clamped on one hub. With the dial button resting on the other hub, rotate the hub on which the indicator is clamped and observe the indicator reading. Take readings at four locations, 90° apart. With correct alignment, the faces of the couplings should be parallel within 0.002".
8. Once proper alignment is assured, secure the motor, examine the alignment, complete the assembly, and lubricate the coupling (when required) before putting the unit into operation.

Figure 6. Flexible Coupling Alignment



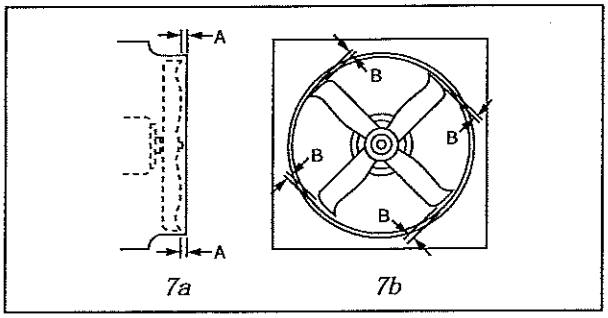
Propeller/Wheel Alignment

Fans, which are received factory assembled, have the propellers already aligned and in place before shipment. However, fans being flexible to some extent are sometimes subject to movement during shipment. To insure smooth operation and proper performance, the following propeller alignment should be checked before putting a fan into operation.

Propeller Fan Alignment

The fan shaft should be centered and parallel to the fan casing. Center by checking gap (B) between the propeller tip and the fan casing. Repeat at three additional points at approximately 90° from each other (Figure 7b). Parallelism can be observed by measuring the axial distance (A) from one blade to the end of the fan casing at four points at approximately 90° from each other (Figure 7a).

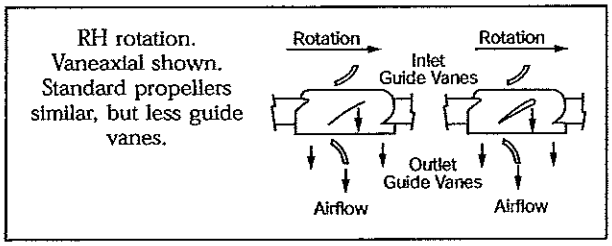
Figure 7. Propeller Fan Alignment



Do not confuse parallelism with blade track (axial deviation of one blade to another). Blade track can be checked by measuring the axial distance from one point on the fan casing to the same point on each blade as it passes by. (Some blades are mistracked for balancing.)

While checking the propeller alignment, it is good practice to check its rotation. Normally the fan rotation is marked by arrows on both the propeller and the fan casing. If omitted, obliterated, or misapplied, check for proper rotation as in Figure 8.

Figure 8. Checking for Proper Rotation

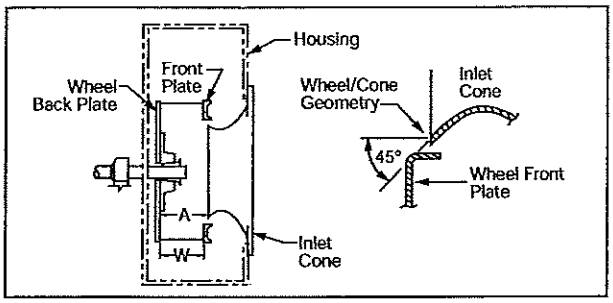


Centrifugal Fan Alignment

The fan shaft should be approximately centered in the clearance hole in the fan housing and perpendicular to the housing sides.

Adjust the clearance by moving the wheel axially on the shaft. The following table indicates the correct measurements for positioning the BI and BIA wheels. Proper positioning is important in attaining correct fan performance, particularly on the BI and BIA wheels.

Type BI & BIA (SWSI Units)



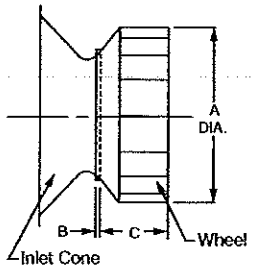
SIZE	A	W*
12	$4^{11}/_{16}$	$4^{7}/_{16}$
14	$5^{9}/_{32}$	$5^{1}/_{32}$
16	$5^{29}/_{32}$	$5^{21}/_{32}$
18	$6^{23}/_{32}$	$6^{3}/_{8}$
20	$7^{7}/_{16}$	$7^{1}/_{16}$
22	$8^{5}/_{16}$	$7^{15}/_{16}$
25	$9^{5}/_{16}$	$8^{15}/_{16}$
28	$10^{17}/_{32}$	$10^{1}/_{16}$
32	$11^{27}/_{32}$	$11^{11}/_{32}$

SIZE	A	W*
35	$13^{15}/_{16}$	$12^{3}/_{4}$
39	$14^{27}/_{32}$	$14^{3}/_{16}$
44	$16^{9}/_{16}$	$15^{7}/_{8}$
49	$18^{9}/_{16}$	$17^{23}/_{32}$
55	$20^{7}/_{8}$	$19^{27}/_{32}$
63	$23^{3}/_{4}$	$22^{11}/_{16}$
71	$26^{19}/_{32}$	$25^{1}/_{2}$
79	$29^{5}/_{8}$	$28^{11}/_{32}$

* = 100% Wheel Width

"A" dimension (inside edge of inlet cone to inside face of wheel backplate) must be held. This dimension is critical to fan performance. "A" dimension shown is based on 100% wheel width "W" and must be adjusted if the wheel furnished is other than 100% full width.

Type BIUB



SIZE	A	B	C
12	12.25	0.32	4.28
14	13.50	0.34	4.84
15	15.00	0.38	5.38
16	16.50	0.44	5.81
18	18.25	0.56	6.44
20	20.00	0.63	7.00
22	22.25	0.69	7.84
24	24.50	0.75	8.63
27	27.00	0.88	9.47
30	30.00	0.97	10.56
33	33.00	1.06	11.63
36	36.50	1.10	13.03

Type BW, OW, PB & HPB

These radial blade wheels do not require precise positioning to attain the correct performance. The important thing is to centrally locate these wheels axially within the housing to insure adequate running clearance and to maintain concentricity with the fan inlet.

Type AW

These wheels require a special inlet on the housing which must extend into the wheel inlet flange to perform properly. Other than maintaining a minimum ¼" overlap, adequate running clearance and concentricity are all that is required.

Type FC

The forward curve blower employs a shallow venturi in the housing to guide the air into the wheel. The depth of this venturi is approximately one-tenth the wheel diameter. Clearance between the wheel and venturi should be the smallest allowable and still maintain normal running clearance. This axial separation is approximately ¼" and should be measured at four points approximately 90° apart.

Installation Instructions for Propellers Equipped with Browning Malleable Iron Split Taper Bushings

Many Aerovent fans are furnished with split taper bushings for mounting the propeller to the shaft. When properly assembled, the bushings grip the hub with positive clamping action.

1. The bushing barrel and the bore of the propeller are tapered. This assures concentric mounting and a true running propeller.
2. Capscrews, when tightened, lock the bushing in the propeller. Use special plated capscrews threaded full length furnished by Aerovent.
3. The bushing is split so that when the locking capscrews force the bushing into the tapered bore, the bushing grips the shaft with a positive clamping fit. This will withstand vibration and punishing loads without being loosened.
4. The propeller and bushing assembly is keyed to the shaft and held in place by compression. This gives added driving strength.

   Before assembly, be sure that the shaft and keyway are clean and smooth. Check the key size with both the shaft and bushing keyways.
5. To assemble, put the capscrews through the clearance holes in the bushing and put the bushing loosely into the propeller. Do not press or drive. Start the capscrews by hand, turning them just enough to engage the threads in the tapped holes on the propeller. Do not use a wrench at this time. The bushing should be loose enough in the propeller to move slightly. Slide the propeller and bushing assembly onto the shaft, making allowance for end play of the shaft to prevent rubbing. Install the key into the keyway. Do not force the propeller and bushing onto the shaft. If it does not go on easily, check the shaft, bushing and key sizes once again.

Capscrew Torque Values

BUSHING NO.	DIAMETER	LENGTH (IN.)	TORQUE FT. LBS.
H	1/4-20	1 1/4	7 1/2
P-1	5/16-18	1 1/2	13
P-2	5/16-18	1 3/4	13
Q-2	3/8-16	2 1/2	24
R-2	3/8-16	3	24

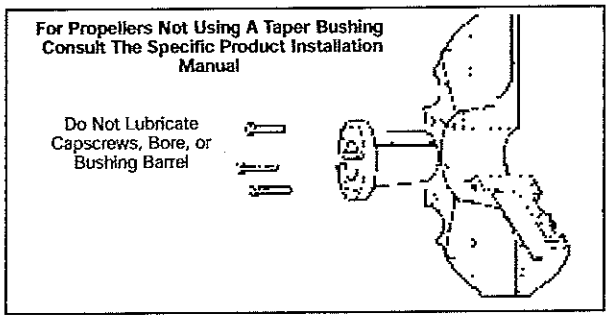
Tighten the capscrews progressively with a wrench. Do this evenly as in mounting an automobile wheel. Tighten each capscrew part of a turn successively until all are tight. These capscrews force the taper bushing into the hub which in turn compresses the bushing onto the shaft. This makes a positive clamping fit. The torque must not exceed that shown in the table above.

WARNING: Do not attempt to pull the bushing flange flush with the hub end. There should be a clearance which varies approximately 3/16" to 1/4" with the bushing size when tightened. (Note, this is not a locating dimension.)

Removing Propeller Assembly from Shaft (see Figure 9)

1. Remove all capscrews from the propeller and hub assembly.
2. Start capscrews into the threaded holes in the bushing flange.
3. Tighten each bolt successively part of a turn to force the propeller off the bushing. This forces the bushing loose from the propeller and releases the compression so that the entire assembly will slide from the shaft.
4. Pull the bushing off the shaft. If the assembly has been in place some time, it may be necessary to use a wheel puller to remove the bushing. Never use a wheel puller on the propeller.

Figure 9. Removing Propeller Assembly



Typical Motor Current and Starter Size

Amperes shown in the table below are nominal and were used for sizing of the starters only. These values are **not** to be used for sizing heaters or other overload protection. Consult the motor nameplate for the correct motor current and refer this to the heater size chart for the particular starters used.

NOTE: When sizing overload heaters, conditions under which the starters will operate must be considered. Enclosed starters should have heaters one size larger than open starters. Where enclosures are subjected to external heat, such as radiant heat from the sun or heat accumulation under a roof, it may be necessary to increase the size even more. Experience with the operating conditions and measurement of the actual line current will aid in proper sizing of heaters.

Typical Motor Current and Starter Size

HP	THREE PHASE						SINGLE PHASE			
	230V		460V		575V		115V		230V	
	AMPS	STARTER	AMPS	STARTER	AMPS	STARTER	AMPS	STARTER	AMPS	STARTER
1/4		00		00		00	5.8	00	2.9	00
1/3	1.7	00	0.9	00		00	7.2	00	3.6	00
1/2	2.0	00	1.0	00	0.8	00	9.8	0	4.9	00
3/4	2.8	00	1.4	00	1.1	00	13.6	0	6.9	00
1	3.5	00	1.8	00	1.4	00	16.0	0	8.0	00
1 1/2	5.0	00	2.5	00	2.0	00	20.0	1	10.0	0
2	6.5	0	3.3	00	2.6	00	24.0	1	12.0	0
3	9.0	0	4.5	0	4.0	0	34.0	1	17.0	1
5	15.0	1	7.5	0	6.0	0			28.0	1
7 1/2	22.0	1	11.0	1	9.0	1			40.0	2
10	27.0	2	14.0	1	11.0	1			50.0	3
15	40.0	2	20.0	2	16.0	2				
20	52.0	3	26.0	2	21.0	2				
25	64.0	3	32.0	2	26.0	2				

For larger motor sizes, refer to National Electric Code.

Aerovent

A Twin City Fan Company

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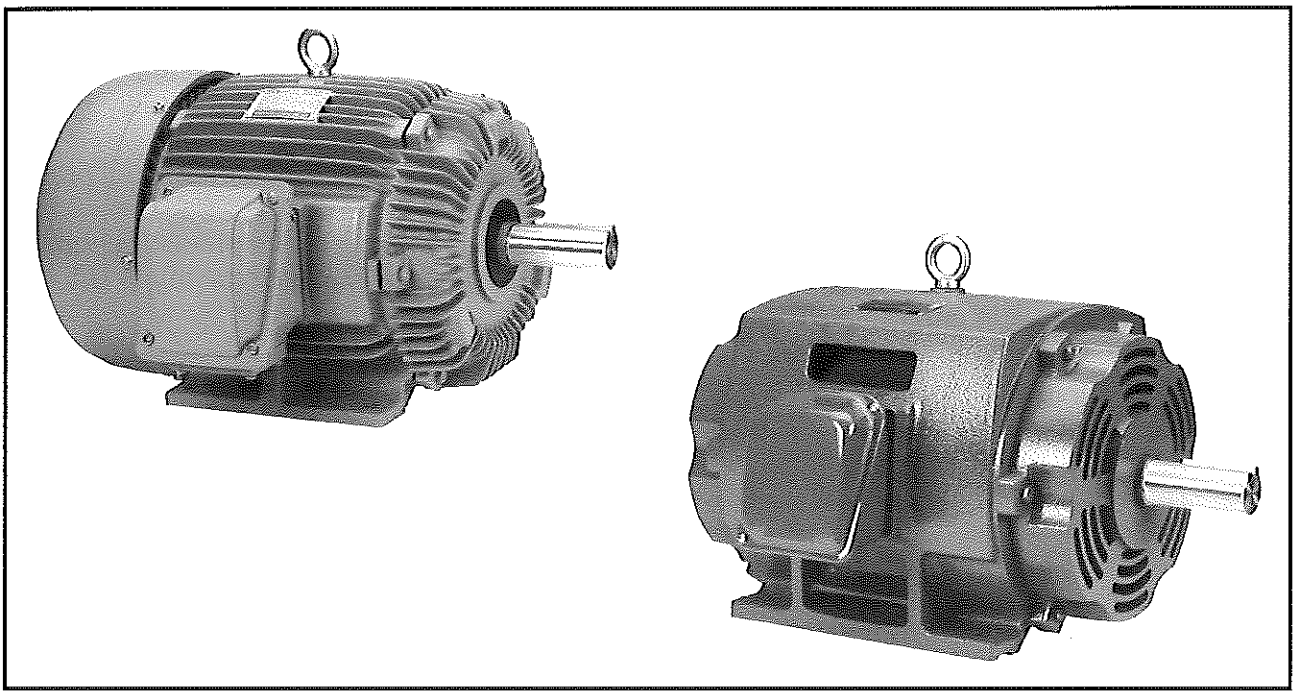
ISO 9001 CERTIFIED

TECO–Westinghouse

INSTALLATION AND MAINTENANCE INSTRUCTIONS FOR THREE PHASE INDUCTION MOTORS

Frames 143T - 449TZ



RECEIVING

1. Check nameplate data.
2. Check whether any damage has occurred during transportation.
3. After removal of shaft clamp, turn shaft by hand to check that it turns freely.
4. If motor is to be reshipped (alone or installed to another piece of equipment) the shaft must again be clamped to prevent axial movement.
   Note: Remove the bearing clamp before turning the shaft on 284T-449TZ frame motors.

WARNING
THE FOLLOWING SAFETY PRECAUTIONS MUST BE OBSERVED:

1. Electric rotating machinery and high voltage can cause serious or fatal injury if improperly installed, operated or maintained. Responsible personnel should be familiarized with NEMA MG2; Safety Standards for Construction and Guide Selection. Installation and Use of Electric Motors and Generators; National Electric Code and all local safety requirements.
2. When servicing, all power sources to the motor and to the accessory devices should be de-energized and disconnected and all rotating parts should be at standstill.
3. Lifting means, when supplied, are intended for lifting the motor only. When two lifting devices are supplied with the motor a dual chain must be used.
4. Suitable protection must be used when working near machinery with high noise levels.
5. Safeguard or protective devices must not be by-passed or rendered inoperative.
6. The frame of this machine must be grounded in accordance with the National Electric Code and applicable local codes.
7. A suitable enclosure should be provided to prevent access to the motor by other than authorized personnel. Extra caution should be observed around motors that are automatically or have automatic re-setting relays as they may restart unexpectedly.
8. Shaft key must be fully captive or removed before motor is started.
9. Provide proper safeguards for personnel against possible failure of motor-mounted brake, particularly on applications involving overhauling loads.
10. Explosion proof motors are constructed to comply with the label service procedure manual, repair of these motors must be made by TECO-Westinghouse Motor Company or U/L listed service center in order to maintain U/L listing.

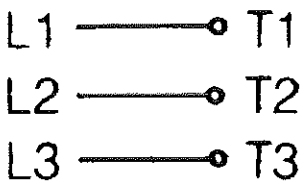
LOCATION

1. Drip-proof motors are intended for use where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. Totally enclosed motors may be installed where dirt, moisture, or dust are present and in outdoor locations.
3. Explosion-proof motors are built for use in hazardous locations as indicated by Underwriters' label on the motor.
4. Chemical duty enclosed motors are designed for installation in high corrosion or excessive moisture locations.
   Note: in all cases, no surrounding structure should obstruct normal flow or ventilating air through or over the motor.

POWER SUPPLY & CONNECTIONS

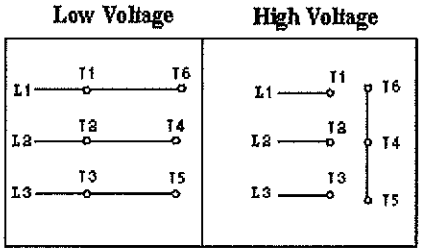
1. Wiring of motor and control, overload protection and grounding should be in accordance with National Electrical Code and all local safety requirements.
2. Nameplate voltage and frequency should agree with power supply. Motor will operate satisfactorily on line voltage within ±10% of nameplate voltage; or frequency with ±5% and with a combined variation not to exceed ±10%. 230-volt motors can be used on 208-volt network systems, but with slightly modified performance characteristics as shown on the nameplate.
3. Dual voltage and single voltage motors can be connected for the desired voltage by following connection diagram shown on the nameplate or inside of the conduit box.
4. All Explosion Proof motors have Temperature Limiting Devices in the motor enclosure to prevent excessive external surface temperature of the motor in accordance with U/L standards. Terminals of thermal protectors (P1 & P2) should be connected to the motor control equipment, according to the connection diagram inside of the conduit box.
5. Standard connection diagram for three phase, not thermally protected, dual rotation motors are shown in diagrams A through E.
   (Note: To change rotation, Interchange any two line leads)

A. 3 Lead, Single Voltage

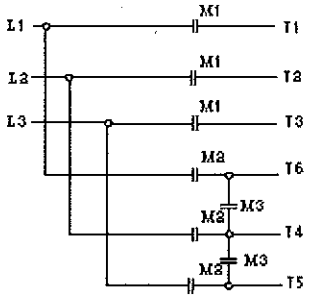


B. 6 Lead, Dual Voltage & Voltage Ration 1 to 3

B-1 Across the Line Start & Run



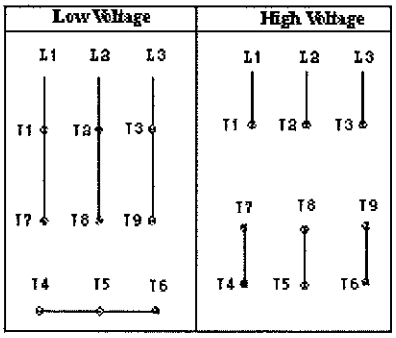
B-2 Wye Start & Delta Run
(Low Voltage only)



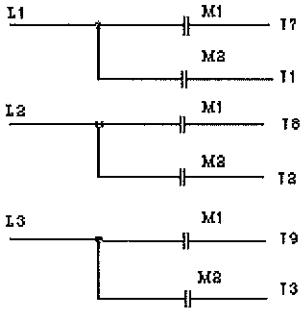
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

C. 9 Leads; Dual Voltage & Voltage Ratio 1 to 2, Wye Connected

C-1 Across the Line Start & Run



C-2 Part Winding Start
(Low Voltage only)

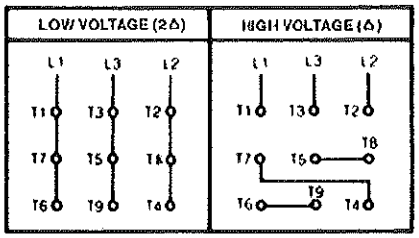


	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE

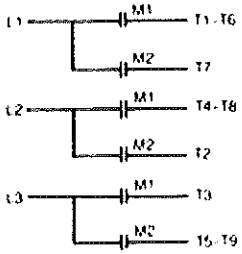
Tie (T4-T5-T6) Together

D. 9 Leads; Dual Voltage & Voltage Ration 1 to 2, Delta Connected

D-1 Across the Line Start & Run



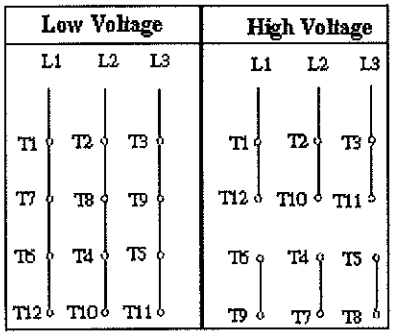
D-2 Part Winding Start
(Low Voltage only)



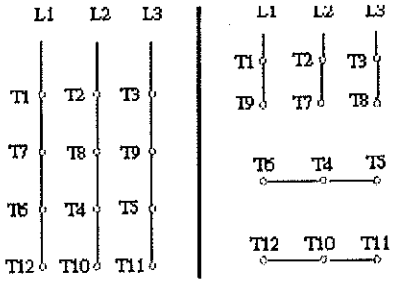
	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE

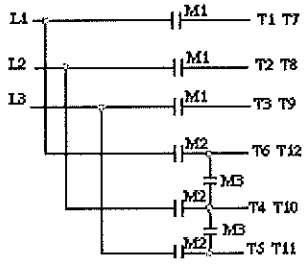
E. 12 Leads, Dual Voltage

E-1 Across the Line Start & Run



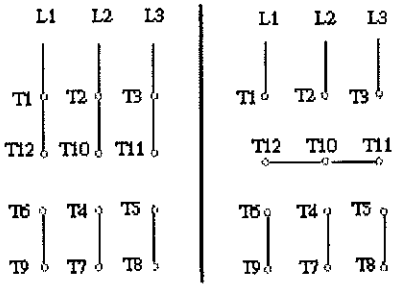
E-2-1 Wye Start & Delta Run (Low Voltage only)

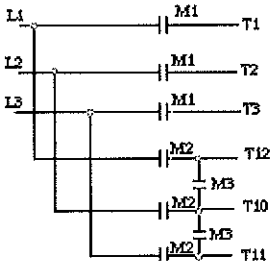




	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

E-2-2 Wye Start & Delta Run (High Voltage only)

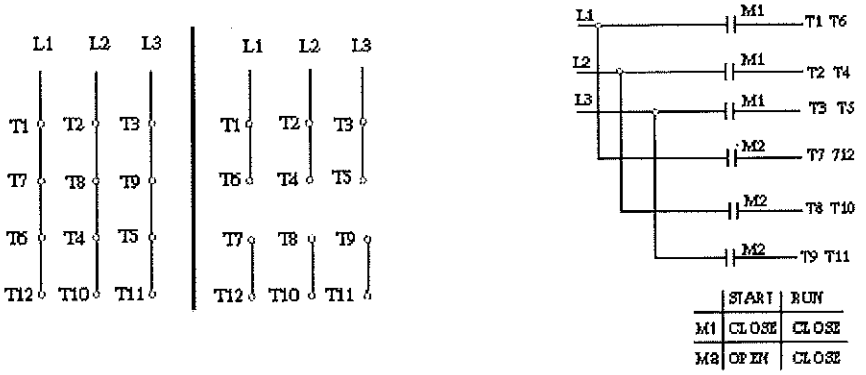




	START	RUN
M1	CLOSE	CLOSE
M2	OPEN	CLOSE
M3	CLOSE	OPEN

T1: Together (T4-T7); (T5-T8); (T6-T9)

E-3 Part Winding Start (Low Voltage only)



*Important: For Part Winding Start, M2 contactor should be closed within two (2) seconds after M1 contactor is closed.
Only 4 pole and above (e.g., 6P, 8P…) motors are satisfactory for Part Winding Start at low voltage.

START UP

1. Disconnect load and start motor. Check direction of rotation. If rotation must be changed, ALLOW THE MOTOR TO STOP COMPLETLEY. Interchange any two leads of a three-phase motor.
2. Connect load. The motor should start quickly and run smoothly. If no, shut power off at once. Recheck the assembly including all connections before restarting.
3. If excessive vibration is noted, check for loose mounting bolts too flexible motor support structure or transmitted vibration from adjacent machinery. Periodic vibration checks should be made; foundations often settle.
4. Operate under load for short period of time and check operating current against nameplate.

TESTING

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, it is best to check the insulation resistance of the stator winding with a megometer. Depending on the length and conditions of storage it may be necessary to regrease or change rusted bearings.
If the resistance is lower than one megohm the windings should be dried in one of the following two ways:

1. Bake in oven at temperatures not exceeding 194°F until insulation resistance becomes constant.
2. With rotor locked, apply low voltage and gradually increase the current through windings until temperature measured with a thermometer reaches 194°F. Do not exceed this temperature.

MAINTENANCE

INSPECTION
Inspect motor at regular intervals. Keep motor clean and ventilation openings clear.

LUBRICATION
1. Frame 143T-256T: Double shielded and pre-lubricated ball-bearing motors without grease fittings and don't need relubrication, except on MAX-E1® and MAX-E2® products which have regreasable features.
2. Frames 280TS, 320-449TZ(TS): Motors having grease fittings and grease discharge devices at brackets. Motors are shipped with grease for initial running. It is necessary to relubricate anti-friction bearing motors periodically, depending on size and type of service. See Table 2 to provide maximum bearing life. Excessive or too frequent lubrication may damage the motor.

TABLE 2

Horsepower	Standard Conditions	Severe Conditions	Extreme Conditions
1 Thru 30 Hp, 1800 rpm and below	7 years	3 years	180 days
40 Thru 75 Hp, 1800 rpm and below	210 days	70 days	30 days
100 Thru 150 Hp, 1800 rpm and below	90 days	30 days	15 days
1 Thru 20 Hp, 3600 rpm	5 years	2 years	90 days
25 Thru 75 Hp, 3600 rpm	180 days	60 days	30 days
100 Thru 150 Hp, 3600 rpm	90 days	30 days	15 days

Note:
A. Standard conditions: 8 hours operation per day, normal or light loading, clear and 40°C ambient conditions.
B. Severe conditions: 24-hour operation per day or light shock loading, vibration or in dirty or dusty conditions.
C. Extreme conditions: With heavy shock loading or vibration or dusty conditions.
D. For double shielded bearings, above data (lubrication frequency) means that the bearing must be replaced.

3. Be sure fittings are clean and free from dirt. Using a low-pressure grease gun, pump in the recommended grease until new grease appears at grease discharge hole.
4. Use the ALVANIA R3 grease or equivalent lithium based grease unless special grease is specified on the nameplate.
5. If relubrication is to be performed with the motor running, stay clear of rotating parts. After regreasing, allow the motor to run for ten to thirty minutes.

RENEWAL PARTS
1. Use only genuine TECO-Westinghouse renewal parts or as recommended by TECO-Westinghouse Motor Company.
2. When you order renewal parts please specify complete information to TECO-Westinghouse office/agent such as type, frame no., poles, horsepower, voltage, series no., quantity, etc.

AC Tech

member of the **Lenze** Group

Drive for Global Excellence

SCF Series

Installation and Operation Manual

TABLE OF CONTENTS

1.0 GENERAL

1.1 PRODUCTS COVERED IN THIS MANUAL

This manual covers the AC Tech SCF Series Variable Frequency Drive.

1.2 PRODUCT CHANGES

AC Technology Corporation reserves the right to discontinue or make modifications to the design of its products without prior notice, and holds no obligation to make modifications to products sold previously. AC Technology Corporation also holds no liability for losses of any kind which may result from this action. Instruction manuals with the most up-to-date information are available for download from the AC Tech website (www.actechdrives.com).

1.3 WARRANTY

AC Technology Corporation warrants the SCF Series AC motor control to be free of defects in material and workmanship for a period of twelve months from the date of sale to the user, or eighteen months from the date of shipment, which ever occurs first. If an SCF motor control, under normal use, becomes defective within the stated warranty time period, contact AC Technology's Service Department for instructions on obtaining a warranty replacement unit. AC Technology Corporation reserves the right to make the final determination as to the validity of a warranty claim, and sole obligation is to repair or replace only components which have been rendered defective due to faulty material or workmanship. No warranty claim will be accepted for components which have been damaged due to mishandling, improper installation, unauthorized repair and/or alteration of the product, operation in excess of design specifications or other misuse, or improper maintenance. AC Technology Corporation makes no warranty that its products are compatible with any other equipment, or to any specific application, to which they may be applied and shall not be held liable for any other consequential damage or injury arising from the use of its products.

This warranty is in lieu of all other warranties, expressed or implied. No other person, firm or corporation is authorized to assume, for AC Technology Corporation, any other liability in connection with the demonstration or sale of its products.

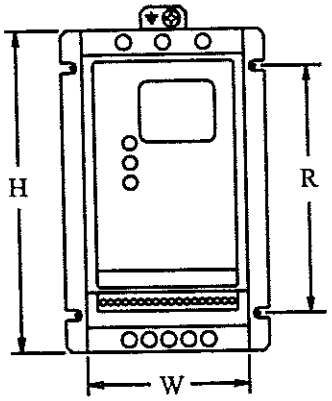
1.4 RECEIVING

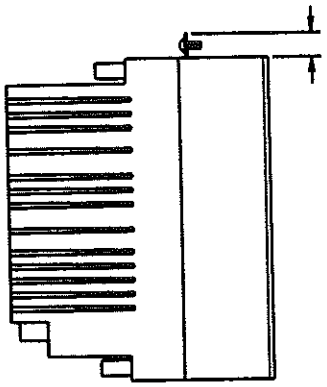
Inspect all cartons for damage which may have occurred during shipping. Carefully unpack equipment and inspect thoroughly for damage or shortage. Report any damage to carrier and/or shortages to supplier. All major components and connections should be examined for damage and tightness, with special attention given to PC boards, plugs, knobs and switches.

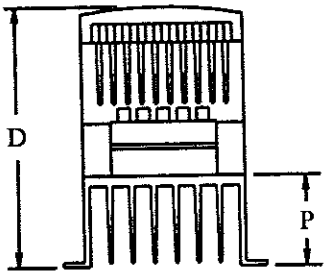
1.5 CUSTOMER MODIFICATION

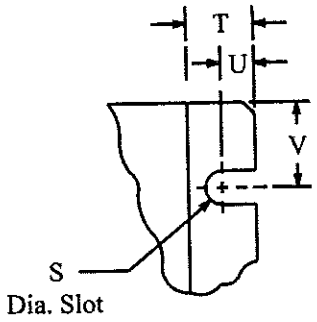
AC Technology Corporation, its sales representatives and distributors, welcome the opportunity to assist our customers in applying our products. Many customizing options are available to aid in this function. AC Technology Corporation cannot assume responsibility for any modifications not authorized by its engineering department.

2.0 SCF DIMENSIONS









Mounting Tab Detail

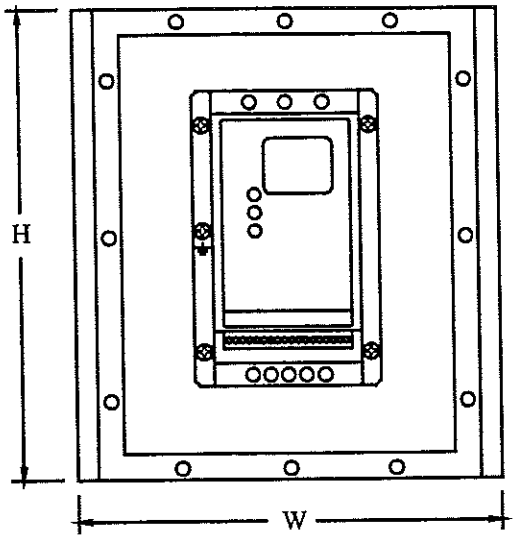
If R < 6.30" (160)
S = 0.19" (5)
T = 0.38" (10)
U = 0.18" (5)
V = 0.66" (17)

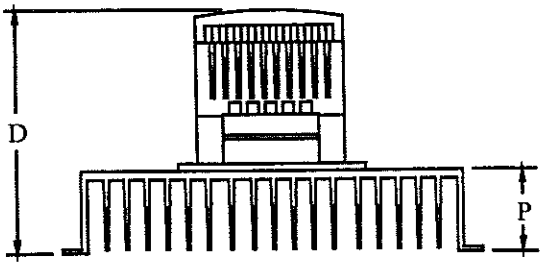
If R = 6.30" (160)
S = 0.28" (7)
T = 0.50" (13)
U = 0.24" (6)
V = 0.90" (23)

HP	kW	INPUT VOLTAGE	MODEL	H	W	D	P	R
0.25	0.18	208/240	SF203Y	5.75 (146)	2.88 (73)	3.94 (100)	0.80 (20)	4.37 (111)
0.5	0.37	208/240	SF205Y	5.75 (146)	2.88 (73)	3.94 (100)	0.80 (20)	4.37 (111)
		400/480	SF405	5.75 (146)	2.88 (73)	3.94 (100)	0.80 (20)	4.37 (111)
1	0.75	208/240	SF210Y	5.75 (146)	2.88 (73)	4.74 (120)	1.60 (41)	4.37 (111)
		208/240	SF210	5.75 (146)	2.88 (73)	4.74 (120)	1.60 (41)	4.37 (111)
		400/480	SF410	5.75 (146)	2.88 (73)	4.74 (120)	1.60 (41)	4.37 (111)
		480/590	SF510	5.75 (146)	2.88 (73)	4.74 (120)	1.60 (41)	4.37 (111)
1.5	1.1	208/240	SF215Y	5.75 (146)	3.76 (96)	5.24 (133)	1.90 (48)	4.37 (111)
		208/240	SF215	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	4.37 (111)
		400/480	SF415	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	4.37 (111)
2	1.5	208/240	SF220Y	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	4.37 (111)
		208/240	SF220	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	3.06 (78)
		400/480	SF420	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	4.37 (111)
		480/590	SF520	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	4.37 (111)

HP	kW	INPUT VOLTAGE	MODEL	H	W	D	P	R
3	2.2	208/240	SF230Y	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	3.25 (83)
		208/240	SF230	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	3.06 (78)
		400/480	SF430	5.75 (146)	2.88 (73)	5.74 (146)	2.60 (66)	3.06 (78)
		480/590	SF530	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	4.37 (111)
5	3.7	208/240	SF250Y	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
		208/240	SF250	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	3.25 (83)
		400/480	SF450	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	3.25 (83)
		480/590	SF550	5.75 (146)	3.76 (96)	6.74 (171)	3.40 (86)	3.25 (83)
7.5	5.5	208/240	SF275	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
		400/480	SF475	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
		480/590	SF575	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
10	7.5	208/240	SF2100	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
		400/480	SF4100	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
		480/590	SF5100	7.75 (197)	5.02 (128)	7.18 (182)	3.40 (86)	4.81 (122)
15	11	208/240	SF2150	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
		400/480	SF4150	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
		480/590	SF5150	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
20	15	208/240	SF2200	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
		400/480	SF4200	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
		480/590	SF5200	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
25	18.5	400/480	SF4250	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
		480/590	SF5250	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)
30	22	400/480	SF4300	9.75 (248)	6.68 (170)	8.00 (203)	3.60 (91)	6.30 (160)

2.1 SCF THROUGH-HOLE MOUNT DIMENSIONS





HP	kW	INPUT VOLTAGE	MODEL	H	W	D	P
1	0.75	208/240	SF210YF	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		208/240	SF210F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		400/480	SF410F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		480/590	SF510F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
1.5	1.1	208/240	SF215YF	7.72 (196)	6.80 (173)	4.75 (121)	1.20 (30)
		208/240	SF215F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		400/480	SF415F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
2	1.5	208/240	SF220YF	7.72 (196)	6.80 (173)	4.75 (121)	1.20 (30)
		208/240	SF220F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		400/480	SF420F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
		480/590	SF520F	7.72 (196)	6.80 (173)	4.55 (116)	1.20 (30)
3	2.2	208/240	SF230YF	7.72 (196)	8.54 (217)	5.30 (135)	1.75 (44)
		208/240	SF230F	7.72 (196)	8.54 (217)	5.10 (130)	1.75 (44)
		400/480	SF430F	7.72 (196)	8.54 (217)	5.10 (130)	1.75 (44)
		480/590	SF530F	7.72 (196)	8.54 (217)	5.30 (135)	1.75 (44)
5	3.7	208/240	SF250YF	9.59 (244)	11.14 (283)	7.65 (194)	3.60 (91)
		208/240	SF250F	7.72 (196)	8.54 (217)	6.30 (160)	2.75 (70)
		400/480	SF450F	7.72 (196)	8.54 (217)	6.30 (160)	2.75 (70)
		480/590	SF550F	7.72 (196)	8.54 (217)	6.30 (160)	2.75 (70)
7.5	5.5	208/240	SF275F	11.59 (294)	11.14 (283)	7.65 (194)	3.60 (91)
		400/480	SF475F	9.59 (244)	11.14 (283)	7.65 (194)	3.60 (91)
		480/590	SF575F	9.59 (244)	11.14 (283)	7.65 (194)	3.60 (91)

HP	kW	INPUT VOLTAGE	MODEL	H	W	D	P
10	7.5	208/240	SF2100F	15.59 (396)	11.14 (283)	7.65 (194)	3.60 (91)
		400/480	SF4100F	11.59 (294)	11.14 (283)	7.65 (194)	3.60 (91)
		480/590	SF5100F	11.59 (294)	11.14 (283)	7.65 (194)	3.60 (91)
15	11	208/240	SF2150F	18.09 (459)	11.14 (283)	8.29 (211)	3.60 (91)
		400/480	SF4150F	15.59 (396)	11.14 (283)	8.29 (211)	3.60 (91)
		480/590	SF5150F	15.59 (396)	11.14 (283)	8.29 (211)	3.60 (91)
20	15	400/480	SF4200F	18.09 (459)	11.14 (283)	8.29 (211)	3.60 (91)
		480/590	SF5200F	18.09 (459)	11.14 (283)	8.29 (211)	3.60 (91)
25	18.5	400/480	SF4250F	28.50 (724)	10.34 (263)	8.39 (213)	3.70 (94)
		480/590	SF5250F	28.50 (724)	10.34 (263)	8.39 (213)	3.70 (94)

NOTE: Refer to Appendix A for mounting template dimensions for the Through-hole Mount option.

3.0 SCF SPECIFICATIONS

Storage Temperature	-20° to 70° C
Ambient Operating Temperature	0° to 50° C (up to 6 kHz carrier, derate above 6 kHz)
Ambient Humidity	< 95% (non-condensing)
Maximum Altitude	3300 ft (1000 m) above sea level (without derating)
Input Line Voltages	208/240 Vac, 400/480 Vac, 480/590 Vac
Input Voltage Tolerance	+10%, -15%
Input Frequency Tolerance	48 to 62 Hz
Output Wave Form	Sine Coded PWM
Output Frequency	0 - 240 Hz (consult factory for higher output frequencies)
Carrier Frequency	4 kHz to 10 kHz
Service Factor	1.00 (up to 6 kHz carrier, derate above 6 kHz)
Efficiency	Up to 98%
Power Factor (displacement)	0.96 or better
Overload Current Capacity	150% for 60 seconds, 180% for 30 seconds
Speed Reference Follower	0-10 VDC, 4-20 mA
Control Voltage	15 VDC
Power Supply for Auxiliary Relays	50 mA at 12 VDC
Analog Outputs	0 - 10 VDC or 2 - 10 VDC: Proportional to frequency or load
Digital Outputs	Open-collector outputs: 50 mA at 30 VDC

4.0 SCF MODEL DESIGNATION CODE

The SCF model number gives a full description of the basic drive unit (see example below).

EXAMPLE: SF210Y (SCF Series, 208/240 Vac, 1 HP, single or three phase input)

SF	2	10	Y		

Series:

SF = SCF Series Variable Speed AC Motor Drive

Input Voltage:

2 = 208/240 Vac (For 208, 230, and 240 Vac; 50 or 60 Hz)
4 = 400/480 Vac (For 380, 415, 440, 460 and 480 Vac; 50 or 60 Hz)
5 = 480/590 Vac (For 440, 460, 480, 575 and 600 Vac; 50 or 60 Hz)

Rating:

03 = ¼ HP (0.20 kW)	30 = 3 HP (2.2 kW)	200 = 20 HP (15 kW)
05 = ½ HP (0.37 kW)	50 = 5 HP (4.0 kW)	250 = 25 HP (18.5 kW)
10 = 1 HP (0.75 kW)	75 = 7½ HP (5.5 kW)	300 = 30 HP (22 kW)
15 = 1½ HP (1.1 kW)	100 = 10 HP (7.5 kW)	
20 = 2 HP (1.5 kW)	150 = 15 HP (11 kW)	

Input Phase:

Y = Single or three phase input
No character indicates three phase input only

Mounting Style:

F = Through-hole mount with special heatsink
F1 = Through-hole mount without heatsink (customer supplies heatsink)
No character indicates panel or DIN rail mounting

Application Specific Options:

P = PI (setpoint control) software
V = High Frequency Output - up to 1000 Hz

5.0 SCF RATINGS

MODEL NUMBER (NOTE 1)	FOR MOTORS RATED HP	FOR MOTORS RATED kW	INPUT (50-60 Hz) INPUT PHASE	INPUT (50-60 Hz) CURRENT (AMPS)	INPUT (50-60 Hz) POWER (kVA)	OUTPUT CURRENT (AMPS)	HEAT LOSS (WATTS) (NOTE 5) STD	HEAT LOSS (WATTS) (NOTE 5) THRU
SF200Y SERIES (NOTE 2)			**208 / 240 Vac**			**0 - 200 / 230 Vac**	**STD**	**THRU**
SF203Y	0.25	0.20	1	3.6 / 3.2	0.76	1.6 / 1.4	19	N/A
SF203Y	0.25	0.20	3	1.9 / 1.7	0.71	1.6 / 1.4	19	N/A
SF205Y	0.5	0.37	1	5.4 / 4.7	1.2	2.5 / 2.2	26	N/A
SF205Y	0.5	0.37	3	3.1 / 2.7	1.1	2.5 / 2.2	26	N/A
SF210Y	1	0.75	1	10.6 / 9.2	2.2	4.8 / 4.2	49	18
SF210Y	1	0.75	3	5.8 / 5.1	2.1	4.8 / 4.2	49	18
SF215Y	1.5	1.1	1	13.9 / 12.0	2.9	6.9 / 6.0	82	23
SF215Y	1.5	1.1	3	8.0 / 6.9	2.9	6.9 / 6.0	82	23
SF220Y	2	1.5	1	14.8 / 12.9	3.1	7.8 / 6.8	86	26
SF220Y	2	1.5	3	9.1 / 7.9	3.2	7.8 / 6.8	86	26
SF230Y	3	2.2	1	19.7 / 17.1	4.1	11.0 / 9.6	130	29
SF230Y	3	2.2	3	12.4 / 10.8	4.4	11.0 / 9.6	130	29
SF250Y	5	3.7	1	29 / 26	6.1	17.5 / 15.2	212	40
SF250Y	5	3.7	3	19.6 / 17.1	7.1	17.5 / 15.2	212	40
SF200 SERIES (NOTE 2)			**208 / 240 Vac**			**0 - 200 / 230 Vac**		
SF210	1	0.75	3	5.8 / 5.1	2.1	4.8 / 4.2	41	11
SF215	1.5	1.1	3	8.0 / 6.9	2.9	6.9 / 6.0	69	13
SF220	2	1.5	3	9.1 / 7.9	3.3	7.8 / 6.8	78	15
SF230	3	2.2	3	12.4 / 10.8	4.5	11.0 / 9.6	117	20
SF250	5	3.7	3	19.6 / 17.1	7.1	17.5 / 15.2	187	22
SF275	7.5	5.5	3	28 / 25	10.3	25 / 22	286	31
SF2100	10	7.5	3	34 / 32	13.1	30 / 28	379	39
SF2150	15	11	3	54 / 48	20.0	48 / 42	476	51
SF2200	20	15	3	65 / 61	25.4	58 / 54	648	N/A

NOTE 1: See Section 3.0 for model number breakdown.

NOTE 2: The higher current ratings are for 208 Vac input and the lower current ratings are for 240 Vac input.

NOTE 5: STD = standard unit; THRU = through-hole mount unit. Values are worst-case (not typical) for 6kHz carrier frequency at full speed and full load.

MODEL NUMBER (NOTE 1)	FOR MOTORS RATED HP	kW	INPUT (50-60 Hz) INPUT PHASE	CURRENT (AMPS)	POWER (kVA)	OUTPUT CURRENT (AMPS)	HEAT LOSS (WATTS) (NOTE 5) STD	THRU
SF400 SERIES (NOTE 3)			**400 / 480 Vac**			**0 - 400 / 460 Vac**	**STD**	**THRU**
SF405	0.5	0.37	3	1.6 / 1.4	1.1	1.3 / 1.1	26	N/A
SF410	1	0.75	3	2.9 / 2.5	2.1	2.4 / 2.1	40	12
SF415	1.5	1.1	3	4.0 / 3.6	3.0	3.4 / 3.0	56	13
SF420	2	1.5	3	4.6 / 4.0	3.3	3.9 / 3.4	67	14
SF430	3	2.2	3	6.2 / 5.4	4.5	5.5 / 4.8	100	19
SF450	5	3.7	3	9.8 / 8.6	7.1	8.7 / 7.6	168	22
SF475	7.5	5.5	3	14.2 / 12.4	10.3	12.6 / 11.0	254	29
SF4100	10	7.5	3	18.1 / 15.8	13.1	16.1 / 14.0	310	37
SF4150	15	11	3	27 / 24	20.0	24 / 21	390	42
SF4200	20	15	3	35 / 31	25.8	31 / 27	530	57
SF4250	25	18.5	3	44 / 38	31.6	39 / 34	648	72
SF4300	30	22	3	52 / 45	37.4	46 / 40	770	N/A
SF500 SERIES (NOTE 4)			**480 / 590 Vac**			**0 - 460 / 575 Vac**		
SF510	1	0.75	3	2.2 / 2.0	1.9 / 2.0	1.9 / 1.7	40	12
SF520	2	1.5	3	4.0 / 3.5	3.3 / 3.6	3.4 / 3.0	67	13
SF530	3	2.2	3	4.7 / 4.7	3.9 / 4.8	4.2 / 4.2	100	14
SF550	5	3.7	3	7.4 / 7.4	6.1 / 7.5	6.6 / 6.6	168	19
SF575	7.5	5.5	3	11.2 / 11.2	9.3 / 11.4	9.9 / 9.9	254	29
SF5100	10	7.5	3	13.7 / 13.7	11.4 / 14.0	12.2 / 12.2	310	37
SF5150	15	11	3	22 / 22	18.3 / 22.5	19.0 / 19.0	390	42
SF5200	20	15	3	27 / 27	22.4 / 27.6	24 / 24	530	57
SF5250	25	18.5	3	31 / 31	25.8 / 31.7	27 / 27	648	72

NOTE 1: See Section 3.0 for model number breakdown.

NOTE 3: The higher current ratings are for 400 Vac input and the lower current ratings are for 480 Vac input.

NOTE 4: The higher current ratings are for 480 Vac input and the lower current ratings are for 590 Vac input.

NOTE 5: STD = standard unit; THRU = through-hole mount unit. Values are worst-case (not typical) for 6kHz carrier frequency at full speed and full load.

6.0 INSTALLATION

NOTE!

SCF drives are intended for inclusion within other equipment, by professional electrical installers. They are not intended for stand-alone operation.

WARNING!

DRIVES MUST NOT BE INSTALLED WHERE SUBJECTED TO ADVERSE ENVIRONMENTAL CONDITIONS SUCH AS: COMBUSTIBLE, OILY, OR HAZARDOUS VAPORS OR DUST; EXCESSIVE MOISTURE OR DIRT; VIBRATION; EXCESSIVE AMBIENT TEMPERATURES. CONSULT AC TECHNOLOGY FOR MORE INFORMATION ON THE SUITABILITY OF A DRIVE TO A PARTICULAR ENVIRONMENT.

SCF models are suitable for UL pollution degree 2 environment only, and MUST be installed in an electrical enclosure which will provide complete mechanical protection and will maintain the internal temperature within the drive's ambient operating temperature rating. All drive models MUST be mounted in a vertical position for proper heatsink cooling.

Maintain a minimum spacing around the drive of at least 1 inch (25 mm) on each side and 2 inches (50 mm) on the top and bottom for units rated up to 5 HP (3.7 kW). For units rated 7.5 - 30 HP (5.5 - 22 kW), maintain at least 2 inches (50 mm) on each side and 4 inches (100 mm) on the top and bottom. Allow more spacing if the drive is mounted next to other heat-producing equipment. Do not mount drives above other drives or heat producing equipment. Fans or blowers should be used to insure proper cooling in tight quarters.

In order to properly size an enclosure, the heat generated by the drive(s) must be known. Refer to the HEAT LOSS columns in Section 5.0 - SCF RATINGS. The STD column is for standard units, and the THRU column is for through-hole mount units (drives with the through-hole mount option still generate some heat inside the enclosure that must be taken into account). An enclosure manufacturer can then determine the required enclosure size based on the total heat generated inside the enclosure (from the drive(s) and other heat sources), the maximum allowable temperature inside the enclosure, the maximum ambient temperature outside the enclosure, and the enclosure properties.

The SCF Series is UL approved for solid state motor overload protection. Therefore, a separate thermal overload relay is not required for single motor applications.

6.1 INSTALLATION AFTER A LONG PERIOD OF STORAGE

WARNING!

Severe damage to the drive can result if it is operated after a long period of storage or inactivity without reforming the DC bus capacitors!

If input power has not been applied to the drive for a period of time exceeding three years (due to storage, etc), the electrolytic DC bus capacitors within the drive can change internally, resulting in excessive leakage current. This can result in premature failure of the capacitors if the drive is operated after such a long period of inactivity or storage.

In order to reform the capacitors and prepare the drive for operation after a long period of inactivity, apply input power to the drive for 8 hours prior to actually operating the motor.

6.2 EXPLOSION PROOF APPLICATIONS

Explosion proof motors that are not rated for inverter use lose their certification when used for variable speed. Due to the many areas of liability that may be encountered when dealing with these applications, the following statement of policy applies:

"AC Technology Corporation inverter products are sold with no warranty of fitness for a particular purpose or warranty of suitability for use with explosion proof motors. AC Technology Corporation accepts no responsibility for any direct, incidental or consequential loss, cost, or damage that may arise through the use of its AC inverter products in these applications. The purchaser expressly agrees to assume all risk of any loss, cost, or damage that may arise from such application."

7.0 INPUT AC POWER REQUIREMENTS

WARNING!

Hazard of electrical shock! Capacitors retain charge after power is removed. Disconnect incoming power and wait until the voltage between terminals B+ and B- is 0 VDC before servicing the drive.

The input voltage must match the nameplate voltage rating of the drive. Voltage fluctuation must not vary by greater than 10% overvoltage or 15% undervoltage.

NOTE: Drives with dual input voltage ratings must be programmed for the proper supply voltage (refer to Parameter 01 - LINE VOLTAGE SELECTION in Section 15.0 - DESCRIPTION OF PARAMETERS).

The drive is suitable for use on a circuit capable of delivering not more than 5,000 RMS symmetrical amperes at 5 HP (3.7 kW) and below, and 18,000 RMS symmetrical amperes at 7.5 - 25 HP (5.5 - 18.5 kW), at the drive's rated voltage.

If the kVA rating of the AC supply transformer is greater than 10 times the input kVA rating of the drive(s), an isolation transformer or 2-3% input line reactor must be added to the line side of the drive(s).

Three phase voltage imbalance must be less than 2.0% phase to phase. Excessive phase to phase imbalance can cause severe damage to the drive's power components.

Motor voltage should match line voltage in normal applications. The drive's maximum output voltage will equal the input voltage. Use extreme caution when using a motor with a voltage rating which is different from the input line voltage.

7.1 INPUT VOLTAGE RATINGS

SF200 Series drives are rated for 208/240 Vac, three phase, 50-60 Hz input. The drive will function with input voltages of 208 to 240 Vac (+ 10%, - 15%), at 48 to 62 Hz.

SF200Y Series drives are rated for 208/240 Vac, single or three phase, 50-60 Hz input. The drive will function with input voltage of 208 to 240 Vac (+10%, -15%), at 48 to 62 Hz.

SF400 Series drives are rated for 400/480 Vac three phase, 50-60 Hz input. The drive will function with input voltages of 400 to 480 Vac (+ 10%, - 15%), at 48 to 62 Hz.

SF500 Series drives are rated for 480/590 Vac, three phase, 50-60 Hz input, and will function with input voltages of 480 to 590 Vac (+ 10%, - 15%), at 48 to 62 Hz.

NOTE: Parameter 01 - LINE VOLTAGE SELECTION must be programmed according to the applied input voltage. See Section 15.0 - DESCRIPTION OF PARAMETERS.

7.2 INPUT FUSING AND DISCONNECT REQUIREMENTS

A circuit breaker or a disconnect switch with fuses must be provided in accordance with the National Electric Code (NEC) and all local codes. Refer to the following tables for proper fuse/circuit breaker ratings and wire sizes.

NOTE 1: Applicable national and local electrical codes take precedence over recommendations in the following tables.

INPUT FUSE & CIRCUIT BREAKER RATINGS							
208/240 Vac, 1 phase		208/240 Vac, 3 phase		400/480 Vac, 3 phase		480/590 Vac, 3 phase	
MODEL	RATING	MODEL	RATING	MODEL	RATING	MODEL	RATING
SF203Y	10 A	SF203Y	10A				
SF205Y	10 A	SF205Y	10 A	SF405	10 A		
SF210Y	15 A	SF210(Y)	10 A	SF410	10 A	SF510	10 A
SF215Y	20 A	SF215(Y)	12/10 A	SF415	10 A		
SF220Y	25/20 A	SF220(Y)	15/12 A	SF420	10 A	SF520	10 A
SF230Y	30/25 A	SF230(Y)	20/15 A	SF430	10 A	SF530	10 A
SF250Y	45/40 A	SF250(Y)	30/25 A	SF450	15 A	SF550	12 A
		SF275	45/40 A	SF475	20 A	SF575	20 A
		SF2100	50/50 A	SF4100	30/25 A	SF5100	20 A
		SF2150	80/75 A	SF4150	40/35 A	SF5150	30 A
		SF2200	100/90 A	SF4200	50/45 A	SF5200	40 A
				SF4250	70/60 A	SF5250	45 A
				SF4300	80/70 A		

NOTE 2: Use UL Class CC fast-acting, current limiting type fuses. Select fuses with low I^2T values, rated at 200,000 AIC. Recommended fuses are Bussman KTK-R, JJN, and JJS. Similar fuses with equivalent ratings by other manufacturers may also be acceptable.

WIRE SIZE REQUIREMENTS												
208/240 Vac, 1 phase			208/240 Vac, 3 phase			400/480 Vac, 3 phase			480/590 Vac, 3 phase		
MODEL	AWG	mm²	MODEL	AWG	mm²	MODEL	AWG	mm²	MODEL	AWG	mm²
SF203Y	14	1.5	SF203Y	14	1.5						
SF205Y	14	1.5	SF205Y	14	1.5	SF405	14	1.5			
SF210Y	14	1.5	SF210(Y)	14	1.5	SF410	14	1.5	SF510	14	1.5
SF215Y	12	2.5	SF215(Y)	14	1.5	SF415	14	1.5			
SF220Y	12	2.5	SF220(Y)	14	1.5	SF420	14	1.5	SF520	14	1.5
SF230Y	10	4.0	SF230(Y)	12	2.5	SF430	14	1.5	SF530	14	1.5
SF250Y	8	6.0	SF250(Y)	10	4.0	SF450	14	1.5	SF550	14	1.5
			SF275	8	6.0	SF475	12	2.5	SF575	14	1.5
			SF2100	8	10	SF4100	10	4.0	SF5100	12	2.5
			SF2150	6	16	SF4150	8	6.0	SF5150	10	4.0
			SF2200	4	25	SF4200	8	10	SF5200	8	6.0
						SF4250	6	16	SF5250	8	10
						SF4300	6	16			

8.0 POWER WIRING

WARNING!

Hazard of electrical shock! Capacitors retain charge after power is removed. Disconnect incoming power and wait until the voltage between terminals B+ and B- is 0 VDC before servicing the drive.

Note drive input and output current ratings and check applicable electrical codes for required wire type and size, grounding requirements, over-current protection, and incoming power disconnect, before wiring the drive. Size conservatively to minimize voltage drop.

Refer to Section 9.0 - SCF POWER WIRING DIAGRAM for information on torque and wire stripping requirements for power wiring.

Input fusing and a power disconnect switch or contactor MUST be wired in series with terminals L1, L2, and L3 for three phase input models. For 208/240 Vac single phase input models, use terminals L1 and L2. This disconnect must be used to power down the drive when servicing, or when the drive is not to be operated for a long period of time, but should not be used to start and stop the motor.

Repetitive cycling of a disconnect or input contactor (more than once every two minutes) may cause damage to the drive.

8.1 WIRING FOR SINGLE PHASE OR THREE PHASE INPUT

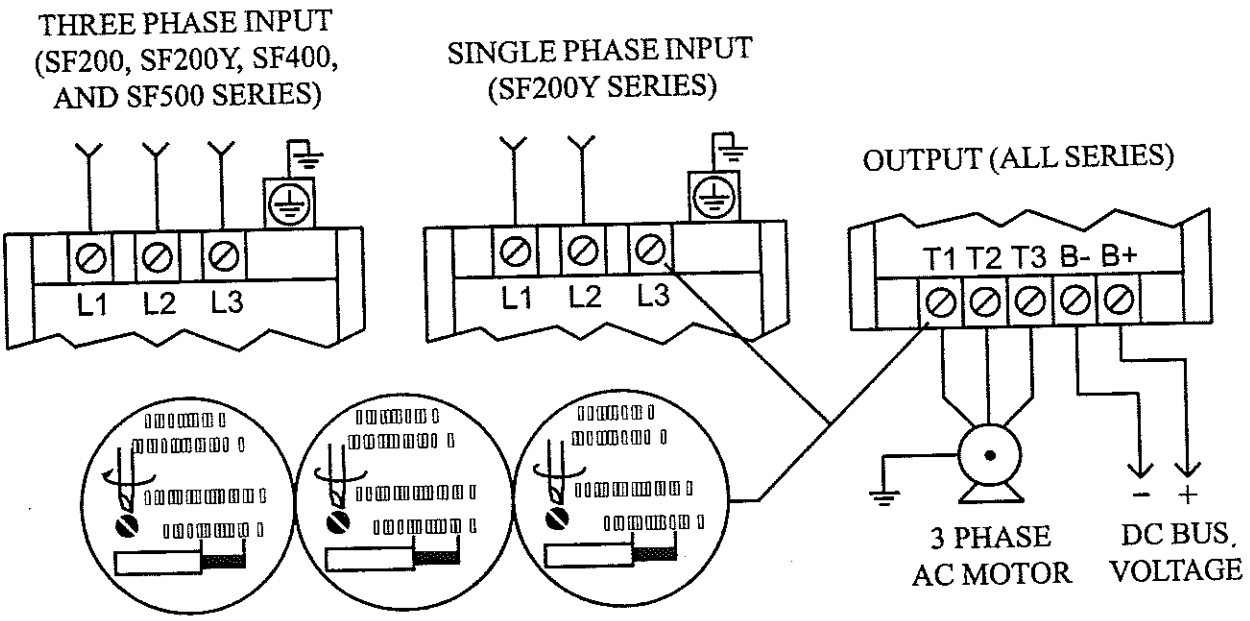
If the drive is rated for single and three phase input (SF200Y models), wire to terminals L1 and L2 for single phase input, or wire to terminals L1, L2, and L3 for three phase input.

If the drive is rated for three phase input, wire the input to terminals L1, L2, and L3.

All three power output wires, from terminals T1, T2, and T3 to the motor, must be kept tightly bundled and run in a separate conduit away from all other power and control wiring.

It is not recommended to install contactors or disconnect switches between the drive and motor. Operating such devices while the drive is running can potentially cause damage to the drive's power components. If such a device is required, it should only be operated when the drive is in a STOP state. If there is potential for the device to be opened while the drive is running, the drive must be programmed for COAST to stop (see Parameter 4 - STOP METHOD), and an auxiliary contact on the device must be interlocked with the drive's run circuit. This will give the drive a stop command at the same time the device opens, and will not allow the drive to start again until the device is closed.

9.0 SCF POWER WIRING DIAGRAM



WARNING!

Do not connect incoming AC power to output terminals T1, T2, or T3. Severe damage to the drive will result.

NOTES:

1. WIRE AND GROUND IN ACCORDANCE WITH NEC OR CEC, AND ALL APPLICABLE LOCAL CODES.
2. Motor wires MUST be run in a separate steel conduit away from control wiring and incoming AC power wiring.
3. Do not install contactors between the drive and the motor without consulting AC Technology for more information. Failure to do so may result in drive damage.
4. Use only UL and CSA listed and approved wire.
5. Minimum wire voltage ratings: 300 V for 208 and 240 Vac systems, and 600 V for 400, 480, and 590 Vac systems.
6. Wire gauge must be based on a minimum of 125% of the rated input/output current of the drive, and a minimum 75°C insulation rating. Use copper wire only.

10.0 CONTROL WIRING

10.1 CONTROL WIRING VS. POWER WIRING

External control wiring MUST be run in a separate conduit away from all other input and output power wiring. If control wiring is not kept separate from power wiring, electrical noise may be generated on the control wiring that will cause erratic drive behavior. Use twisted wires or shielded cable grounded at the drive chassis ONLY. Recommended control wire is Belden 8760 (2-wire) or 8770 (3-wire), or equivalent.

Strip off 0.20 to 0.25 inches (5 to 6 mm) of insulation for control wiring, and torque the terminals to 2 lb-in (0.2 Nm). Be careful not to overtorque the terminals, as this will cause damage to the terminal strip. This is not covered under warranty and can only be repaired by replacing the control board.

10.2 TB-2: CIRCUIT COMMON

The TB-2 terminals are used as circuit common for the start/stop, forward/reverse, input select, local/remote, analog input, and analog output functions. There are three TB-2 terminals available on the terminal strip, and they are all internally connected to each other on the main control board. If necessary TB-2 may be connected to chassis ground.

NOTE: TB-2 must be connected to chassis ground when using serial communications.

10.3 SURGE SUPPRESION ON RELAYS

Current and voltage surges and spikes in the coils of contactors, relays, solenoids, etc, near or connected to the drive, can cause erratic drive operation. Therefore, a snubber circuit should be used on coils associated with the drive. For AC coils, snubbers should consist of a resistor and a capacitor in series across the coil. For DC coils, a free-wheeling or flyback diode should be placed across the coil. Snubbers are typically available from the manufacturer of the device.

10.4 START/STOP CONTROL

There are various control schemes that allow for 2-wire and 3-wire Start/Stop circuits. Refer to the wiring diagrams in Section 11.0 - SCF CONTROL WIRING DIAGRAMS

10.5 SPEED REFERENCE SIGNALS

The drive allows for three analog speed reference inputs:

SPEED POT	Connect the wiper of a speed pot to terminal TB-5, and connect the high and low end leads to terminals TB-6 and TB-2, respectively. The speed pot can be 2.5kΩ up to 10kΩ.
0-10 VDC	Wire the positive to terminal TB-5 and the negative to terminal TB-2. TB-5 input impedance is 120 kilohms.
4-20 mA	Wire the positive to terminal TB-25 and the negative to terminal TB-2. TB-25 input impedance is 100 ohms.

10.6 SPEED REFERENCE SELECTION

If an analog speed reference input is used to control the drive speed, terminal TB-13A, 13B, or 13C (Parameter 10, 11, or 12) may be programmed as the input select for the desired analog input signal. When that TB-13 terminal is then closed to TB-2, the drive will follow the selected analog speed reference input.

If an analog speed reference input is not selected on the terminal strip using TB-13A, 13B, or 13C, speed control will default to STANDARD mode, which is governed by the setting of Parameter 05 - STANDARD SPEED SOURCE. The STANDARD SPEED SOURCE can be the ▲ and ▼ buttons on the front of the drive, PRESET SPEED #1 (Parameter 31), a 0-10 VDC signal, or a 4-20 mA signal.

0 - 10 VDC and 4 - 20 mA INPUT SIGNALS

TB-13A, TB-13B, and TB-13C can all be programmed to select a 0-10 VDC or 4-20 mA analog speed reference input.

PRESET SPEEDS

TB-13A can be programmed to select PRESET SPEED #1, TB-13B to select PRESET SPEED #2, and TB-13C to select PRESET SPEED #3. There are a total of seven preset speeds, which are activated by different combinations of contact closures between TB-13A, 13B, 13C and TB-2. Refer to Parameters 31-37 in Section 15.0 - DESCRIPTION OF PARAMETERS.

JOG

TB-13B can be programmed to select either JOG FORWARD or JOG REVERSE. The Jog speed is set by PRESET SPEED #2. Close TB-13B to TB-2 to JOG, and open the contact to STOP.

WARNING!

When operating in JOG mode, the STOP terminal (TB-1) and the STOP key (on the optional remote keypad) **WILL NOT** stop the drive. To stop the drive, remove the JOG command.

JOG REVERSE will operate the drive in reverse rotation even if ROTATION DIRECTION (Parameter 17) is set to FORWARD ONLY.

NOTE: If the drive is commanded to JOG while running, the drive will enter JOG mode and run at PRESET SPEED #2. When the JOG command is removed, the drive will STOP.

MOTOR OPERATED POT (MOP) / FLOATING POINT CONTROL

TB-13B and TB-13C are used for this function, which controls the drive speed using contacts wired to the terminal strip. Program TB-13B for DECREASE FREQ (05), and program TB-13C for INCREASE FREQ (05). Closing TB-13B to TB-2 will cause the speed setpoint to decrease until the contact is opened. Closing TB-13C to TB-2 will cause the speed setpoint to increase until the contact is opened. The INCREASE FREQ function will only operate while the drive is running.

NOTE: If TB-13A, TB-13B, and TB-13C are all programmed to select speed references, and two or three of the terminals are closed to TB-2, the higher terminal has priority and will override the others. For example, if TB-13A is programmed to select 0-10VDC, and TB-13C is programmed to select PRESET SPEED #3, closing both terminals to TB-2 will cause the drive to respond to PRESET SPEED #3, because TB-13C overrides TB-13A.

The exception to this is the MOP function, which requires the use of TB-13B and TB-13C. This leaves TB-13A to be used for some other function. If TB-13A is programmed for a speed reference, and TB-13A is closed to TB-2, TB-13A will override the MOP function.

10.7 ANALOG OUTPUT SIGNALS

Terminal TB-30 can provide a 0-10 VDC or a 2-10 VDC signal proportional to output frequency or load, and TB-31 can provide the same signals proportional to load only. The 2-10 VDC signal can be converted to a 4-20 mA signal using a resistor in series with the signal such that the total load resistance is 500 Ohms. Refer to Parameters 08 and 09 in Section 15.0 - DESCRIPTION OF PARAMETERS.

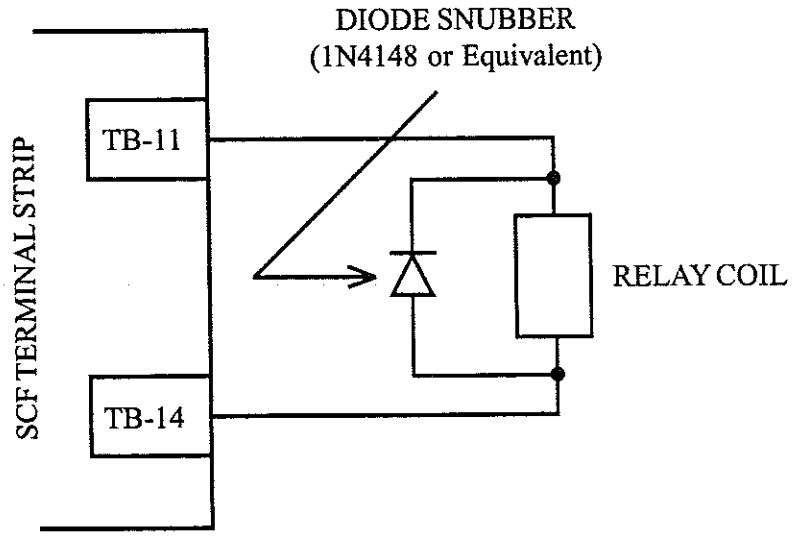
NOTE: These analog output signals cannot be used with "loop-powered" devices that derive power from a 4-20 mA signal.

10.8 DRIVE STATUS DIGITAL OUTPUTS

There are two open-collector outputs at terminals TB-14 and TB-15. The open-collector circuits are current-sinking types rated at 30 VDC and 50 mA maximum.

The open-collector outputs can be programmed to indicate any of the following: RUN, FAULT, INVERSE FAULT, FAULT LOCKOUT, AT SPEED, ABOVE PRESET SPEED #3, CURRENT LIMIT, AUTO SPEED MODE, and REVERSE. Refer to Parameters 06 and 13 in Section 15.0 - DESCRIPTION OF PARAMETERS.

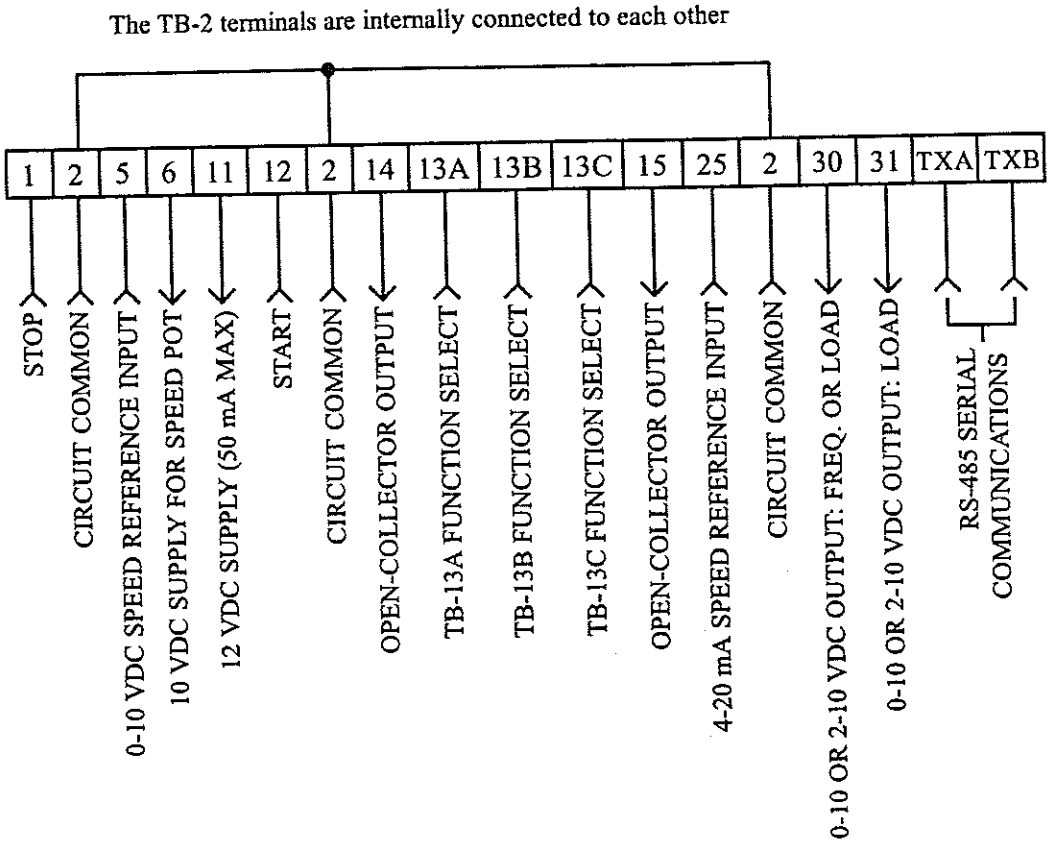
The diagram below illustrates how the 12 VDC power supply at TB-11 can be used with the open-collector output to drive an external relay:



11.0 SCF CONTROL WIRING DIAGRAMS

11.1 SCF TERMINAL STRIP

Shown below is the terminal strip on the main control board, along with a brief description of the function of each terminal.

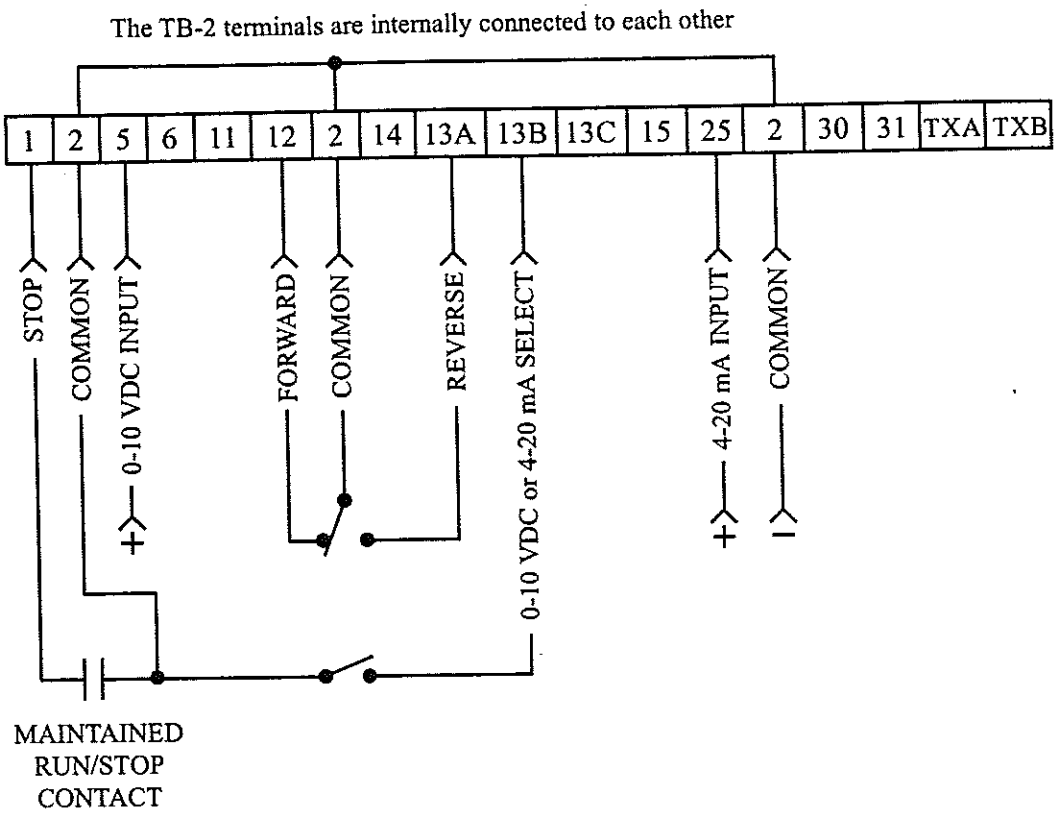


NOTE: The function of terminals TB-13A, TB-13B, TB-13C, TB-14, TB-15, TB-30, and TB-31 are dependent on the programming of certain parameters. Refer to Section 15.0 - DESCRIPTION OF PARAMETERS.

Additional information on operating the drive from the terminal strip can be found in Section 10.0. The following diagrams provide a quick reference to wire the drive for the most common configurations.

11.2 TWO-WIRE START/STOP CONTROL

Shown below is the wiring diagram for a typical two-wire start/stop control scheme, using one maintained contact (such as that from a PLC) for RUN and STOP commands.



NOTES:

1. Close TB-1 to TB-2 to RUN, and open TB-1 to TB-2 to STOP.

2. If reverse direction is also required, ROTATION DIRECTION (Parameter 17) must be set to FORWARD AND REVERSE (02), and TB-13A (Parameter 10) must be set to START REVERSE (06). **If reverse direction is not required, TB-12 must be wired directly to TB-2.**

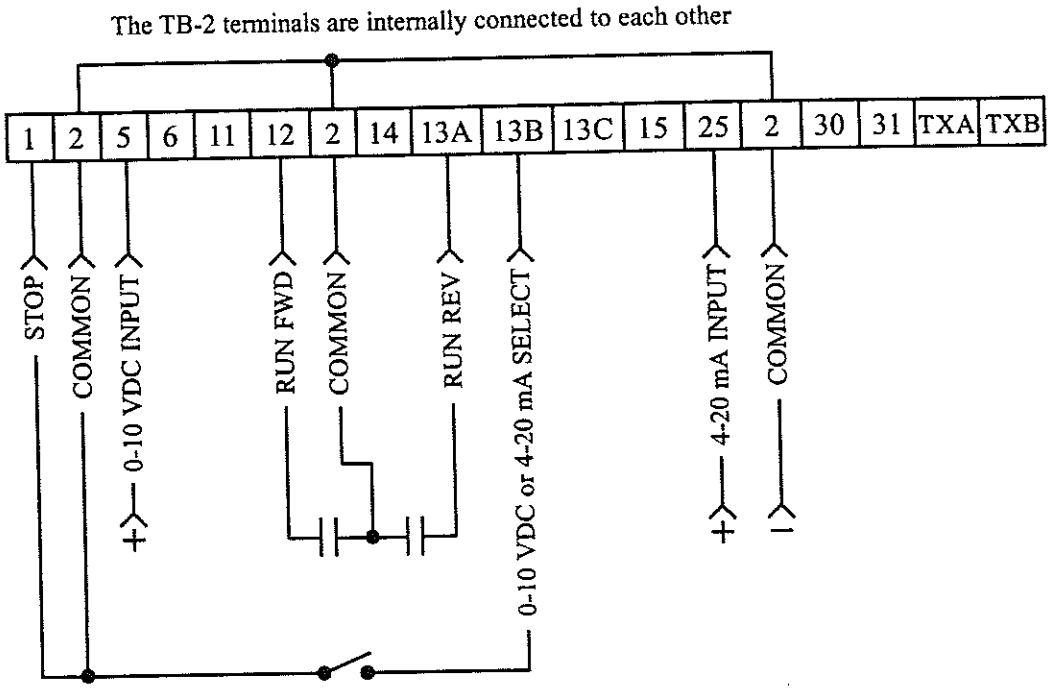
3. For 0-10 VDC or 4-20 mA speed control, use one of the following methods:

    1. Program one of the TB-13 terminals (13A, 13B, or 13C) for 0-10 VDC (02) or 4-20 mA (03). When that TB-13 terminal is closed to TB-2, the drive will respond to the selected speed reference signal. If that TB-13 terminal is not closed to TB-2, the drive will respond to the speed control source selected in Parameter 05 - STANDARD SPEED SOURCE. This method must be used if it is necessary to toggle between two speed sources.

    2. Program Parameter 05 - STANDARD SPEED SOURCE for 0-10 VDC (03) or 4-20 mA (04). This method is preferable if only one speed source is required, as this method leaves the TB-13 terminals free to be used for other functions.

11.3 ALTERNATE TWO-WIRE START/STOP CONTROL

Shown below is the wiring diagram for an alternate two-wire start/stop control scheme, using one maintained contact for RUN FORWARD and another maintained contact for RUN REVERSE.



NOTES:

1. For this control scheme, TB-13A MUST be set to RUN REVERSE (05), even if REVERSE direction is not required. Refer to Parameter 10 - TB13A FUNCTION.

2. Close TB-12 to TB-2 to RUN, and open TB-12 to TB-2 to STOP.

3. If reverse direction is also required, ROTATION DIRECTION (Parameter 17) must be set to FORWARD AND REVERSE (02). Close TB-13A to TB-2 to RUN in REVERSE, and open TB-13A to TB-2 to STOP. If TB-12 and TB-13A are closed to TB-2, the drive will STOP.

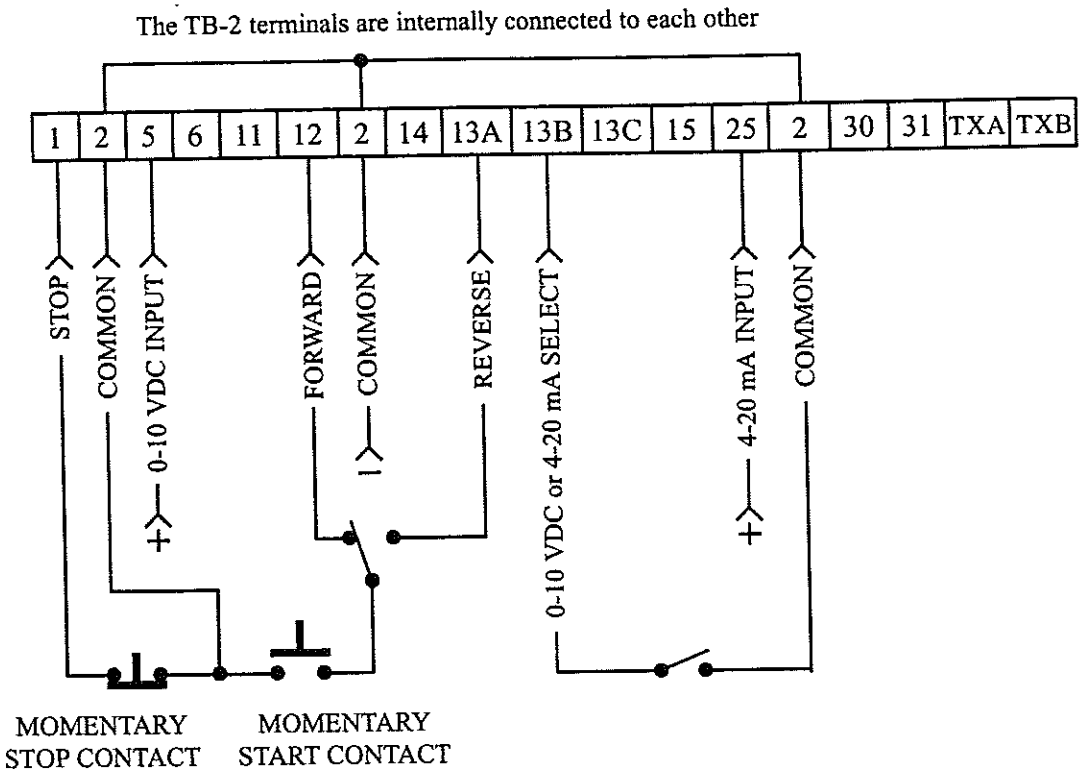
4. For 0-10 VDC or 4-20 mA speed control, use one of the following methods:

    1. Program one of the TB-13 terminals (13A, 13B, or 13C) for 0-10 VDC (02) or 4-20 mA (03). When that TB-13 terminal is closed to TB-2, the drive will respond to the selected speed reference signal. If that TB-13 terminal is not closed to TB-2, the drive will respond to the speed control source selected in Parameter 05 - STANDARD SPEED SOURCE. This method must be used if it is necessary to toggle between two speed sources.

    2. Program Parameter 05 - STANDARD SPEED SOURCE for 0-10 VDC (03) or 4-20 mA (04). This method is preferable if only one speed source is required, as this method leaves the TB-13 terminals free to be used for other functions.

11.4 THREE-WIRE START/STOP CONTROL

Shown below is the wiring diagram for a typical three-wire start/stop control scheme, using momentary contacts (such as pushbuttons) for START and STOP commands.



NOTES:

1. Momentarily close TB-12 to TB-2 to START the drive, and momentarily open TB-1 to TB-2 to STOP the drive.

2. If reverse direction is also required, ROTATION DIRECTION (Parameter 17) must be set to FORWARD AND REVERSE (02), and TB-13A (Parameter 10) must be set to START REVERSE (06). If the FWD/REV switch is changed while the drive is running, the drive will not change direction until the START button is pushed. **If reverse direction is not required, the other side of the START pushbutton must be wired directly to TB-12.**

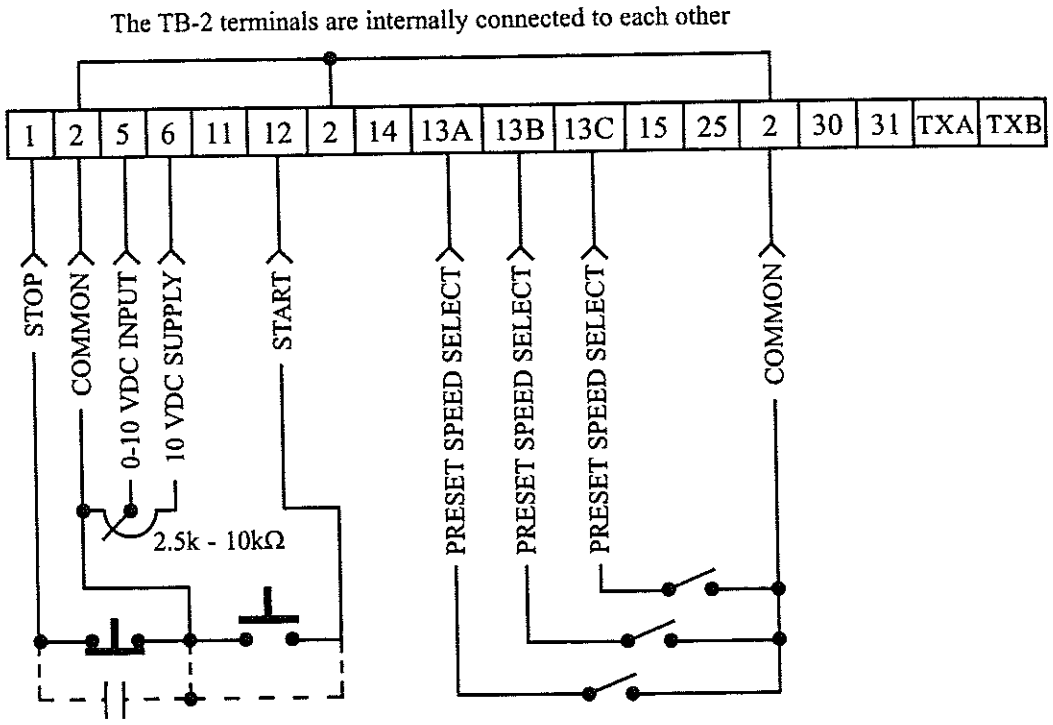
3. For 0-10 VDC or 4-20 mA speed control, use one of the following methods:

    1. Program one of the TB-13 terminals (13A, 13B, or 13C) for 0-10 VDC (02) or 4-20 mA (03). When that TB-13 terminal is closed to TB-2, the drive will respond to the selected speed reference signal. If that TB-13 terminal is not closed to TB-2, the drive will respond to the speed control source selected in Parameter 05 - STANDARD SPEED SOURCE. This method must be used if it is necessary to toggle between two speed sources.

    2. Program Parameter 05 - STANDARD SPEED SOURCE for 0-10 VDC (03) or 4-20 mA (04). This method is preferable if only one speed source is required, as this method leaves the TB-13 terminals free to be used for other functions.

11.5 SPEED POT AND PRESET SPEED CONTROL

Shown below is the wiring for SPEED POT and/or PRESET SPEED control, and either a two-wire or three-wire start/stop circuit:



NOTES:

1. Program the PRESET SPEEDS (Parameters 31-37) to the desired values.

2. Program TB-13A (Parameter 10) to PRESET SPEED #1 (04), TB-13B (Parameter 11) to PRESET SPEED #2 (04), and TB-13C (Parameter 12) to PRESET SPEED #3 (04). To select a preset speed, close the appropriate TB-13 terminal(s) to TB-2 (refer to Parameters 31-37 for the Preset Speed Activation table).

3. If reverse rotation is also required, TB-13A cannot be used as a PRESET SPEED SELECT. TB-13A must be programmed to select RUN REVERSE (05) or START REVERSE (06), leaving only TB-13B and TB-13C to select preset speeds.

4. For speed pot control, program Parameter 05 - STANDARD SPEED SOURCE for 0-10 VDC (03). If none of the preset speeds are selected (all of the TB-13 terminals are open), the drive will respond to the speed pot.

12.0 INITIAL POWER UP AND MOTOR ROTATION

WARNING!

DO NOT connect incoming AC power to output terminals T1, T2, and T3! Severe damage to the drive will result. Do not continuously cycle input power to the drive more than once every two minutes. Damage to the drive will result.

WARNING!

Hazard of electrical shock! Wait three minutes after disconnecting incoming power before servicing drive. Capacitors retain charge after power is removed.

WARNING!

Severe damage to the drive can result if it is operated after a long period of storage or inactivity without reforming the DC bus capacitors!

If input power has not been applied to the drive for a period of time exceeding three years (due to storage, etc), the electrolytic DC bus capacitors within the drive can change internally, resulting in excessive leakage current. This can result in premature failure of the capacitors if the drive is operated after such a long period of inactivity or storage.

In order to reform the capacitors and prepare the drive for operation after a long period of inactivity, apply input power to the drive for 8 hours prior to actually operating the motor.

Before attempting to operate the drive, motor, and driven equipment, be sure all procedures pertaining to installation and wiring have been properly followed.

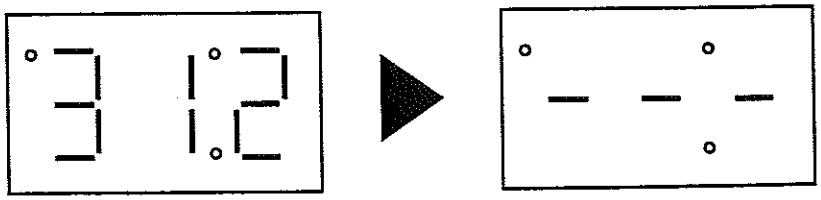
Disconnect the driven load from the motor. Verify that the drive input terminals (L1, L2, and L3) are wired to the proper input voltage per the nameplate rating of the drive.

Energize the incoming power line. The LED display will flash a three digit number (312 in the example below) that identifies the parameter version contained in the drive. The display should then read "- - -", which indicates that the drive is in a STOP condition. This is shown below:

Apply input power

Display flashes parameter version (300-399)

Display then reads "- - -"



Follow the procedure below to check the motor rotation. This procedure assumes that the drive has been powered up for the first time, and that none of the parameters have been changed.

1. Use the ▼ button to decrease the speed setpoint to 00.0 Hz. The left decimal point will illuminate as the speed setpoint is decreased. If the ▼ button is held down, the speed setpoint will decrease by tenths of Hz until the next whole Hz is reached, and then it will decrease by one Hz increments. Otherwise, each push of the ▼ button will decrease the speed setpoint by a tenth of a Hz.

   Once 00.0 Hz is reached, the display will toggle between "00.0" and "- - -", which indicates that the drive is in a STOP condition with a speed setpoint of 00.0 Hz.

2. Give the drive a START command. This can be done using one of several wiring methods described in Section 11.0 - SCF CONTROL WIRING DIAGRAMS. Once the START command is issued, the display will read "00.0", indicating that the drive is in a RUN condition with a speed setpoint of 00.0 Hz.

3. Use the ▲ button to increase the speed setpoint until the motor starts to rotate. The left decimal point will light as the speed setpoint is increased. If the ▲ button is held down, the speed setpoint will increase by tenths of Hz until the next whole Hz is reached, and then it will increase by one Hz increments. Otherwise, each push of the button will increase the speed setpoint by a tenth of a Hz.

4. If the motor is rotating in the wrong direction, give the drive a STOP command and remove power from the drive. Wait three minutes for the bus capacitors to discharge, and swap any two of the motor wires connected to T1, T2, and T3.

NOTE: The drive is phase insensitive with respect to incoming line voltage. This means that the drive will operate with any phase sequence of the incoming three phase voltage. Therefore, to change the motor rotation, the phases must be swapped at the drive output terminals or at the motor.

13.0 PROGRAMMING THE SCF DRIVE

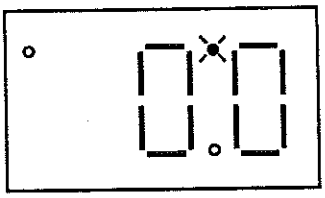
The drive may be programmed by one of three methods: using the three buttons and 3-digit LED display on the front of the drive, programming the Electronic Programming Module (EPM) using the optional EPM Programmer, and through a serial link using serial communications. This section describes programming the drive using the buttons and display, which are shown below:

To enter the PROGRAM mode to access the parameters, press the **Mode** button. This will activate the PASSWORD prompt (if the password has not been disabled). The display will read "00" and the upper right-hand decimal point will be blinking, as shown below:

Press **Mode**

Display reads "00"

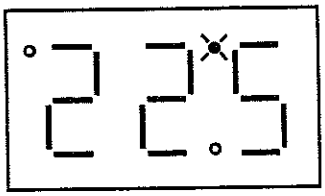
Upper right decimal point blinks



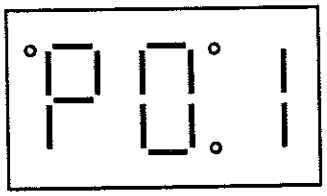
Use the ▲ and ▼ buttons to scroll to the password value (the factory default password is "225") and press the **Mode** button. Once the correct password value is entered, the display will read "P01", which indicates that the PROGRAM mode has been accessed at the beginning of the parameter menu (P01 is the first parameter). This is shown below:

Use ▲ and ▼ to scroll to the password value

Press **Mode** to enter password



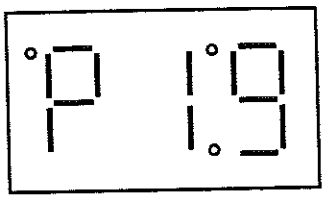
Parameter menu is accessed at the first parameter



NOTE: If the display flashes "Er", the password was incorrect, and the process to enter the password must be repeated.

Use the ▲ and ▼ buttons to scroll to the desired parameter number. In the example below, Parameter 19 is being displayed, which is the ACCELERATION TIME of the drive:

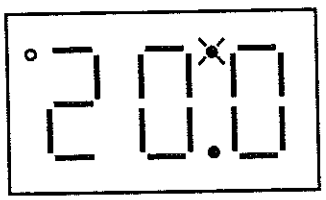
Use ▲ and ▼ to scroll to the desired parameter number (the example is Parameter 19 - ACCELERATION TIME)



Once the desired parameter number is found, press the **Mode** button to display the present parameter setting. The upper right-hand decimal point will begin blinking, indicating that the present parameter setting is being displayed, and that it can be changed by using the ▲ and ▼ buttons.

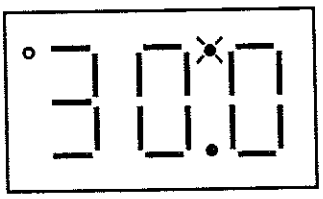
Press **Mode** to display present parameter setting (example setting is 20.0)

Upper right decimal point blinks



Use ▲ and ▼ to change setting (example setting changed to 30.0)

Press **Mode** to store new setting



Pressing the **Mode** will store the new setting and also exit the PROGRAM mode. To change another parameter, press the **Mode** key again to re-enter the PROGRAM mode (the parameter menu will be accessed at the parameter that was last viewed or changed before exiting). If the **Mode** key is pressed within two minutes of exiting the PROGRAM mode, the password is not required access the parameters. After two minutes, the password must be entered in order to access the parameters again.

13.1 SETTING VALUES IN TENTHS OF UNITS ABOVE 100

Parameter settings and the keypad speed command can always be adjusted in tenths of unit increments from 0.0 to 99.9. Above 100 however, values can be set in whole units or tenths of units, depending on the setting of Parameter 16 - UNITS EDITING.

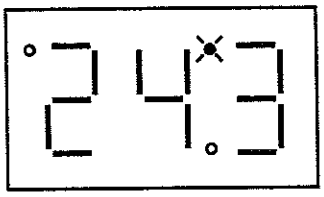
If Parameter 16 - UNITS EDITING is set to WHOLE UNITS (02), parameter values and the keypad speed command can only be adjusted by whole unit increments above 100. For example, Parameter 19 - ACCELERATION TIME could not be set to 243.7 seconds. It could only be set to 243 or 244 seconds. Likewise, the keypad speed command (set using the ▲ and ▼ buttons) could not be set to 113.4 Hz. It could only be set to 113 or 114 Hz.

If, however, Parameter 16 - UNITS EDITING is set to TENTHS OF UNITS (01), parameter values and the keypad speed command can be adjusted in tenths of unit increments up to a value of 1000 (above 1000, whole unit increments only). Each push of the ▲ or ▼ button will adjust the value by one tenth of a unit. If the ▲ or ▼ button is pressed and held, the value will increment by tenths of units until the next whole unit is reached, and then the value will increment by whole units.

When a value above 100 is being adjusted by tenths of units, the value is shifted to the left by one digit so that the tenths portion of the value can be displayed. This results in the first digit (reading from left to right) of the value disappearing from the display. Also, the lower decimal point will blink to indicate that the actual value is above 100. Once the value is no longer being adjusted, the value will shift back to the right and the tenths portion of the value will disappear.

In the example below, Parameter 19 - ACCELERATION TIME is presently set to 243.0 seconds, and is being increased to 243.7 seconds.

Go to Parameter 19 and press **Mode** to see present setting ("243" seconds)

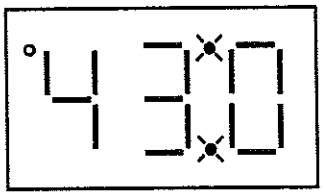


Upper right decimal point blinks

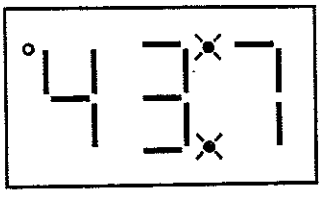
Press ▲ button to see tenths portion

Value shifts to the left ("2" disappears)

Upper right decimal point and lower decimal point blink



Press ▲ button to scroll up to "43.7"



Press **Mode** to store new value

13.2 ELECTRONIC PROGRAMMING MODULE (EPM)

Every SCF Series drive has an Electronic Programming Module (EPM) installed on the main control board. The EPM stores the user's parameter settings and special OEM default settings (if programmed). The EPM is removable, allowing it to be installed in another drive for quick set-up. For example, if a drive is being replaced with a new one, the EPM can be taken out of the first drive and installed in the new drive. Downtime is minimized because the new drive does not require programming - it is ready to run when the EPM is installed.

The SCF Series drive contains two or three sets of parameter values, depending on whether the drive has been programmed with optional OEM default settings. The first set of values is the factory default settings, which are permanently stored on the main control board and cannot be changed. The second set of values is the user settings, which are stored in the EPM. When the drive leaves the factory, the user settings are the same as the factory default settings, but the user settings can be changed to configure the drive for a particular application. The optional third set of values is the OEM default settings, which are also stored in the EPM. OEM default settings are typically used in cases where many drives are used for the same application, which requires that all of the drives have the same parameter settings. The OEM default settings cannot be changed without the optional EPM Programmer. The drive can be programmed to operate according to the user settings or the OEM default settings (see Parameter 48 in Section 15.0).

NOTE: The drive will not operate without the EPM installed. The drive will display "F1" if the EPM is missing or damaged.

WARNING!

Do not remove the EPM while power is applied to the drive. Damage to the EPM and/or drive may result.

An EPM Programmer is available as an option from AC Tech, which has the ability to quickly and easily program many SC Series drives for the same configuration. Once a "master" EPM is programmed with the desired parameter settings, the EPM Programmer can copy those settings to other EPMs, allowing many drives to be configured very quickly. Please consult the EPM Programmer Instruction Manual or contact the factory for more information.

If the OEM settings in the EPM become corrupted, the drive will operate normally, until an attempt is made to perform a RESET OEM using Parameter 48 - PROGRAM SELECTION. The drive will then flash "GF" to indicate that the OEM settings are no longer valid. This will require that the EPM be re-programmed using the optional EPM Programmer.

If the OEM settings and the user settings are both corrupted, the drive will display "GF" immediately and the drive will require a RESET 60 or RESET 50 using Parameter 48 - PROGRAM SELECTION. Once the RESET is performed, the parameters can then be programmed individually to match the OEM default settings. This will allow the drive to operate as if it were in OEM mode, even though it is actually operating in USER mode. Refer to Parameter 48 in Section 15.0 - DESCRIPTION OF PARAMETERS.

NOTE: The drive will also display "GF" if a RESET OEM or OPERATE WITH OEM SETTINGS is attempted when the drive is not equipped with the OEM default option.

14.0 PARAMETER MENU

NOTE: If the drive is equipped with the PI option, please refer to Appendix B for additional parameter information.

NO.	PARAMETER NAME	RANGE OF ADJUSTMENT	FACTORY DEFAULT (NOTE 1)
01	LINE VOLTAGE	HIGH (01), LOW (02)	HIGH (01)
02	CARRIER FREQUENCY	4kHz (01), 6 kHz (02), 8 kHz (03), 10 kHz (04)	6 kHz (02)
03	START METHOD	NORMAL (01), START ON POWER UP (02), START WITH DC BRAKE (03), AUTO RESTART WITH DC BRAKE (04), FLYING RESTART 1 (05), FLYING RESTART 2 (06), FLYING RESTART 3 (07)	NORMAL (01)
04	STOP METHOD	COAST (01), COAST WITH DC BRAKE (02), RAMP (03), RAMP WITH DC BRAKE (04)	COAST (01)
05	STANDARD SPEED SOURCE	KEYPAD (01), PRESET #1 (02), 0-10 VDC (03), 4-20 mA (04)	KEYPAD (01)
06 13	TB-14 OUTPUT TB-15 OUTPUT	NONE (01), RUN (02), FAULT (03), INVERSE FAULT (04), FAULT LOCKOUT (05), AT SET SPEED (06), ABOVE PRESET #3 (07), CURRENT LIMIT (08), AUTO SPEED (09), REVERSE (10)	NONE (01)
08	TB-30 OUTPUT	NONE (01), 0-10 VDC FREQ (02), 2-10 VDC FREQ (03), 0-10 VDC LOAD (04), 2-10 VDC LOAD (05)	NONE (01)
09	TB-31 OUTPUT	NONE (01), 0-10 VDC LOAD (02), 2-10 VDC LOAD (03), DYNAMIC BRAKING (04)	NONE (01)
10	TB-13A FUNCTION SELECT	NONE (01), 0-10 VDC (02), 4-20 mA (03), PRESET SPEED #1 (04), RUN REVERSE (05), START REVERSE (06), EXTERNAL FAULT (07), REMOTE KEYPAD (08), DB FAULT (09), AUXILIARY STOP (10), ACCEL/DECEL #2 (11)	NONE (01)
11	TB-13B FUNCTION SELECT	NONE (01), 0-10 VDC (02), 4-20 mA (03), PRESET SPEED #2 (04), DECREASE FREQ (05), JOG FORWARD (06), JOG REVERSE (07), AUXILIARY STOP (08)	NONE (01)

NOTE 1: Factory defaults are shown for a 60 Hz base frequency. See Parameter 48 for 50 Hz base frequency.

PARAMETER MENU (CONT'D)			
NO.	**PARAMETER NAME**	**RANGE OF ADUSTMENT**	**FACTORY DEFAULT** (NOTE 1)
12	TB-13C FUNCTION SELECT	NONE (01), 0-10 VDC (02), 4-20 mA (03), PRESET SPEED #3 (04), INCREASE FREQ (05), EXTERNAL FAULT (06), REMOTE KEYPAD (07), DB FAULT (08), ACCEL/DECEL #2 (09)	NONE (01)
13	TB-15 OUTPUT	(SEE PARAMETER 6 - TB-14 OUTPUT)	NONE (01)
14	CONTROL	TERMINAL STRIP ONLY (01), REMOTE KEYPAD ONLY (02), TERMINAL STRIP OR REMOTE KEYPAD (03)	TERMINAL STRIP ONLY (01)
15	SERIAL LINK	DISABLE (01), 9600, 8, N, 2 WITH TIMER (02), 9600, 8, N, 2 WITHOUT TIMER (03), 9600, 8, E, 1 WITH TIMER (04), 9600, 8, E, 1 WITHOUT TIMER (05), 9600, 8, O, 1 WITH TIMER (06), 9600, 8, O, 1 WITHOUT TIMER (07)	9600, 8, N, 2 WITH TIMER (02)
16	UNITS EDITING	TENTHS OF UNITS (01), WHOLE UNITS (02)	WHOLE UNITS (02)
17	ROTATION	FORWARD ONLY (01), FORWARD AND REVERSE (02)	FORWARD ONLY (01)
19	ACCELERATION TIME	0.1 - 3600.0 SEC	20.0 SEC
20	DECELERATION TIME	0.1 - 3600.0 SEC	20.0 SEC
21	DC BRAKE TIME	0.0 - 3600.0 SEC	0.0 SEC
22	DC BRAKE VOLTAGE	0.0 - 30.0 %	0.0 %
23	MINIMUM FREQUENCY	0.0 - MAXIMUM FREQUENCY	0.0 Hz
24	MAXIMUM FREQUENCY	MINIMUM FREQ - 240.0 Hz (NOTE 2)	60.0 Hz
25	CURRENT LIMIT	30 - 180 % (NOTE 3)	180%
26	MOTOR OVERLOAD	30 - 100 %	100%

NOTE 1: Factory defaults are shown for a 60 Hz base frequency. See Parameter 48 for 50 Hz base frequency.
NOTE 2: Maximum setting is 999.9 Hz on drives with High Output Frequency option. Consult the factory.
NOTE 3: If LINE VOLTAGE is set to LOW, maximum setting is 150%.

PARAMETER MENU (CONT'D)			
NO.	**PARAMETER NAME**	**RANGE OF ADJUSTMENT**	**FACTORY DEFAULT** (NOTE 1)
27	BASE FREQUENCY	25.0 - 500.0 Hz (NOTE 4)	60.0 Hz
28	FIXED BOOST	0.0 - 30.0 %	1.0 %
29	ACCEL BOOST	0.0 - 20.0 %	0.0 %
30	SLIP COMPENSATION	0.0 - 5.0 %	0.0 %
31-37	PRESET SPEEDS	0.0 - MAXIMUM FREQUENCY	0.0 Hz
38	SKIP BANDWIDTH	0.0 - 10.0 Hz	0.0 Hz
39	SPEED SCALING	0.0 - 6500.0	0.0
40	FREQUENCY SCALING	3.0 - 2000.0 Hz	60.0 Hz
41	LOAD SCALING	10 - 200 %	200 %
42	ACCEL/DECEL #2	0.1 - 3600.0 SEC	20.0 SEC
43	SERIAL ADDRESS	1 - 247	1
44	PASSWORD	000 - 999	225
47	CLEAR HISTORY	MAINTAIN (01), CLEAR (02)	MAINTAIN (01)
48	PROGRAM SELECTION	USER SETTINGS (01), OEM SETTINGS (02), RESET OEM (03), RESET 60 (04), RESET 50 (05), TRANSLATE (06)	USER SETTINGS (01)
50	FAULT HISTORY	(VIEW-ONLY)	(N/A)
51	SOFTWARE CODE	(VIEW-ONLY)	(N/A)
52	DC BUS VOLTAGE	(VIEW-ONLY)	(N/A)
53	MOTOR VOLTAGE	(VIEW-ONLY)	(N/A)
54	LOAD	(VIEW-ONLY)	(N/A)
55	0-10 VDC INPUT	(VIEW-ONLY)	(N/A)
56	4-20 mA INPUT	(VIEW-ONLY)	(N/A)
57	TB STRIP STATUS	(VIEW-ONLY)	(N/A)
58	KEYPAD STATUS	(VIEW-ONLY)	(N/A)
59	TB-30 OUTPUT	(VIEW-ONLY)	(N/A)
60	TB-31 OUTPUT	(VIEW-ONLY)	(N/A)

NOTE 1: Factory defaults are shown for a 60 Hz base frequency. See Parameter 48 for 50 Hz base frequency.
NOTE 4: Maximum setting is 1300.0 Hz (factory default is 999.9) on drives with High Output Frequency option. Consult the factory.

15.0 DESCRIPTION OF PARAMETERS

P01 LINE VOLTAGE SELECTION

This calibrates the drive for the actual applied input voltage, and can be set to HIGH (01) or LOW (02). Refer to the table below for the proper setting depending on the input voltage.

MODEL	RATED INPUT VOLTAGE	INPUT PHASE	APPLIED INPUT VOLTAGE	PARAMETER SETTING
SF200Y	208 / 240 Vac	1 or 3	220 - 240 Vac	HIGH (01)
		1 or 3	200 - 208 Vac	LOW (02)
SF200	208 / 240 Vac	3	220 - 240 Vac	HIGH (01)
		3	200 - 208 Vac	LOW (02)
SF400	400 / 480 Vac	3	440 - 480 Vac	HIGH (01)
		3	380 - 415 Vac	LOW (02)
SF500	480 / 590 Vac	3	575 - 600 Vac	HIGH (01)
		3	460 - 480 Vac	LOW (02)

NOTE: If this parameter is changed while the drive is running, the new value will not take effect until the drive is stopped.

P02 CARRIER FREQUENCY

This sets the switching rate of the output IGBT's. Increasing the carrier frequency will result in less audible motor noise. Available settings are: 4 kHz, 6 kHz, 8 kHz, and 10 kHz.

PARAMETER SETTING	CARRIER FREQUENCY	MAXIMUM OUTPUT FREQUENCY (NOTE 1)	AMBIENT OR OUTPUT DERATE (NOTE 2)
01	4 kHz	240.0 Hz (400.0 Hz)	50 C or 100%
02	6 kHz	240.0 Hz (600.0 Hz)	50 C or 100%
03	8 kHz	240.0 Hz (999.9 Hz)	43 C or 92%
04	10 kHz	240.0 Hz (999.9 Hz)	35 C or 82%

NOTE 1: For drives with the High Output Frequency option, the carrier frequency also determines the maximum output frequency (shown in parenthesis).

NOTE 2: The SCF drive is fully rated up to 6 kHz carrier frequency. If the 8 kHz or 10 kHz carrier frequency is selected, the drive's ambient temperature rating OR output current rating must be de-rated to the value shown in the table above.

NOTE 3: If this parameter is changed while the drive is running, the change will not take effect until the drive is stopped. Therefore, the allowable maximum frequency for drives with the High Output Frequency option (see NOTE 1) will not change if the carrier frequency is changed while the drive is running.

P03 START METHOD

WARNING!
Automatic starting of equipment may cause damage to equipment and/or injury to personnel! Automatic start should only be used on equipment that is inaccessible to personnel.

01 NORMAL: The drive will start when the appropriate contact is closed on the terminal strip, or by pressing the START key on the optional remote keypad. See Parameter 14.

02 START ON POWER UP: The drive will automatically start upon application of input power.

03 START WITH DC BRAKE: When a START command is given, the drive will apply DC BRAKE VOLTAGE (Parameter 22) for the duration of DC BRAKE TIME (Parameter 21) prior to starting the motor to ensure that the motor is not turning.

04 AUTO RESTART WITH DC BRAKING: Upon a START command, after a fault, or upon application of power, the drive will apply DC BRAKE VOLTAGE (Parameter 22) for the duration of DC BRAKE TIME (Parameter 21) prior to starting (or restarting) the motor.

05 FLYING RESTART 1: LOW performance. Slowest synchronization and lowest current level. This setting results in the smoothest synchronization.

06 FLYING RESTART 2: MEDIUM performance. Faster synchronization and higher current level. This setting allows faster synchronization while retaining smoothness.

07 FLYING RESTART 3: HIGH performance. Fastest synchronization and highest current level. This setting allows the fastest synchronization, but sacrifices smoothness.

The FLYING RESTART 1 - 3 settings allow the drive to start into a spinning load after a fault or upon application of input power. They differ in the time required to find the motor and the amount of current required to synchronize with it. The faster the drive attempts to find the motor, the more current is required.

When programmed for auto-restart, the drive will attempt three restarts after a fault. The interval between restart attempts is 15 seconds for setting 04, and 2 seconds for settings 05, 06 and 07. During the interval between restart attempts, the display will read "SP" to indicate Start Pending. If all three restart attempts fail, the drive will trip into FAULT LOCKOUT (displayed "LC") and require a manual reset. Refer to Section 16.0 - TROUBLESHOOTING.

NOTE: Settings 02 and 04 - 07 require a two-wire start/stop circuit to operate. The RUN contact must remain closed for the power-up start and auto-restart functions to operate.

P04 STOP METHOD

01 COAST TO STOP: When a STOP command is given, the drive shuts off the output to the motor, allowing it to coast freely to a stop.

02 COAST WITH DC BRAKE: When a stop command is given, the drive will activate DC braking (after a delay of up to 2 seconds, depending on frequency) to help decelerate the load. Refer to Parameters: 21 - DC BRAKE TIME, and 22 - DC BRAKE VOLTAGE.

03 RAMP TO STOP: When a stop command is given, the drive will decelerate the motor to a stop at the rate determined by Parameter 20 - DECELERATION TIME.

04 RAMP WITH DC BRAKE: When a stop command is given, the drive will decelerate the motor down to 0.2 Hz (at the rate set by Parameter 20 - DECELERATION TIME) and then activate DC braking according to the settings of Parameters 21 - DC BRAKE TIME and 22 - DC BRAKE VOLTAGE. This is used to bring the load to a final stop, as the motor may still be turning slightly after the drive stops.

P05 STANDARD SPEED SOURCE

This selects the speed reference source when the drive is in STANDARD speed mode. The following speed references can be selected:

01 KEYPAD: Use the ▲ and ▼ buttons to scroll to the desired speed.

02 PRESET SPEED #1: The drive will operate at the frequency set into Parameter 31.

03 0 - 10 VDC: The drive will respond to a 0-10 VDC signal wired to TB-2 and TB-5.

04 4 - 20 mA: The drive will respond to a 4-20 mA signal wired to TB-2 and TB-25.

P06 TB-14 OPEN COLLECTOR OUTPUT

This selects the status indication for the open-collector output at TB-14. The terms "open" and "close" refer to the state of the internal transistor that activates the circuit. When the transistor is "closed", TB-14 is at the same potential as TB-2, allowing current to flow.

01 NONE: Disables the open-collector output.

02 RUN: Closes upon a START command. Opens if the drive is in a STOP state, the drive faults, or input power is removed. DC braking is considered a STOP state.

03 FAULT: Closes if there is no fault condition. Opens if the drive faults, or input power is removed.

04 INVERSE FAULT: Closes if the drive faults. Opens if there is no fault condition.

05 FAULT LOCKOUT: Closes when input power is applied. Opens if three restart attempts are unsuccessful, or if input power is removed.

06 AT SET SPEED: Closes if the drive is within ± 0.5 Hz of the speed setpoint.

07 ABOVE PRESET SPEED #3: Closes if the output frequency exceeds the PRESET SPEED #3 setting. Opens if the output frequency is equal to or less than PRESET SPEED #3 (Parameter 33).

08 CURRENT LIMIT: Closes if the output current exceeds the CURRENT LIMIT setting. Opens if the output current is equal to or less than CURRENT LIMIT (see Parameter 25).

09 AUTOMATIC SPEED MODE: Closes if an AUTOMATIC (terminal strip) speed reference is active. Opens if a STANDARD (Parameter 5) speed reference is active.

10 REVERSE: Closes when reverse rotation is active. Opens when forward rotation is active. (see Parameter 17 - ROTATION DIRECTION).

P08 TB-30 ANALOG OUTPUT

Terminal TB-30 can be used as an analog output proportional to either output frequency or load. FREQUENCY SCALING (Parameter 40) or LOAD SCALING (Parameter 41) can be used to scale the output signal.

01 NONE
02 0-10 VDC FREQ
03 2-10 VDC FREQ
04 0-10 VDC LOAD
05 2-10 VDC LOAD

NOTE: The 2-10 VDC signal can be converted to a 4-20 mA signal by connecting a resistor in series with the signal such that the total load resistance is 500 Ohms. However, this output cannot be used with devices that derive power from a 4-20 mA signal.

P09 TB-31 ANALOG OUTPUT

Terminal TB-31 can be used as an analog output proportional to load, or as the control signal to activate the optional external Dynamic Braking module. LOAD SCALING (Parameter 41) can be used to scale the output signal when TB-31 is used as an analog output proportional to load.

01 NONE
02 0-10 VDC LOAD
03 2-10 VDC LOAD
04 DYNAMIC BRAKING: TB-31 becomes the "trigger" that activates the optional external Dynamic Braking module. Refer to the instructions included with the Dynamic Braking option.

NOTE: The 2-10 VDC signal can be converted to a 4-20 mA signal by connecting a resistor in series with the signal such that the total load resistance is 500 Ohms. However, this output cannot be used with devices that derive power from a 4-20 mA signal.

P10 TB-13A FUNCTION SELECT

This selects the function of terminal TB-13A. Closing TB-13A to TB-2 (or opening in the case of settings 7 and 10) activates the selected function. The following functions can be selected:

01 NONE: Disables the TB-13A function.

02 0-10 VDC: Selects a 0-10 VDC signal (at TB-5) as the AUTO speed reference input.

03 4-20 mA: Selects a 4-20 mA signal (at TB-25) as the AUTO speed reference input.

04 PRESET SPEED #1: Selects PRESET SPEED #1 as the AUTO speed reference. The drive will operate at the frequency programmed into Parameter 31.

05 RUN REVERSE: Close TB-13A to TB-2 to RUN in the reverse direction, and open to STOP. This setting forces TB-12 to act as RUN FWD, requiring a maintained contact to RUN in the forward direction. TB-1 must be closed to TB-2 for this function to operate.

06 START REVERSE: Momentarily close TB-13A to TB-2 to START the drive in the reverse direction. Momentarily open TB-1 to TB-2 to STOP. This setting forces TB-12 to act as START FWD, requiring a momentary contact to START in the forward direction.

07 EXTERNAL FAULT: Sets TB-13A as a normally closed external fault input. If TB-13A is open with respect to TB-2, the drive will fault.

08 REMOTE KEYPAD: Selects the optional remote keypad as the control source. Refer to Parameter 14 - CONTROL.

09 DB FAULT: Sets TB-13A as a dynamic braking fault input when using the optional dynamic braking module. When this input is activated by the dynamic braking module, the drive will trip into a "dF" fault and the motor will coast to a stop. Refer to the manual included with the Dynamic Braking option.

10 AUXILIARY STOP: When TB-13A is opened with respect to TB-2, the drive will decelerate to a STOP (even if STOP METHOD is set to COAST) at the rate set into Parameter 42 - ACCEL/ DECEL #2.

11 ACCEL/DECEL #2: Selects the acceleration and deceleration time programmed into Parameter 42 - ACCEL/DECEL #2.

NOTE: In order for the RUN REVERSE and START REVERSE functions to operate, Parameter 17 - ROTATION DIRECTION must be set to FORWARD AND REVERSE (02).

P11 TB-13B FUNCTION SELECT

This selects the function of terminal TB-13B. Closing TB-13B to TB-2 (or opening in the case of setting 08) activates the selected function. The following functions can be selected:

01 NONE: Disables the TB-13B function.

02 0-10 VDC: Selects a 0-10 VDC signal (at TB-5) as the AUTO speed reference input.

03 4-20 mA: Selects a 4-20 mA signal (at TB-25) as the AUTO speed reference input.

04 PRESET SPEED #2: Selects PRESET SPEED #2 as the AUTO speed reference. The drive will operate at the frequency programmed into Parameter 32.

05 DECREASE FREQUENCY: Decreases the speed setpoint when using the MOP function. Refer to Section 10.6.

06 JOG FORWARD: Jog in the forward direction. In this mode, the drive will JOG at the speed programmed into Parameter 32 - PRESET SPEED #2.

07 JOG REVERSE: Jog in the reverse direction. In this mode, the drive will JOG at the speed programmed into Parameter 32 - PRESET SPEED #2.

WARNING!

When operating in JOG mode, the STOP terminal (TB-1), the AUXILIARY STOP function (see setting 08), and the STOP key on the optional remote keypad **WILL NOT** stop the drive. To stop the drive, remove the JOG command.

JOG REVERSE will operate the drive in reverse rotation even if ROTATION DIRECTION (Parameter 17) is set to FORWARD ONLY.

08 AUXILIARY STOP: When TB-13B is opened with respect to TB-2, the drive will decelerate to a STOP (even if STOP METHOD is set to COAST) at the rate set into Parameter 42 - ACCEL/ DECEL #2.

NOTE: If the drive is commanded to JOG while running, the drive will enter JOG mode and run at PRESET SPEED #2. When the JOG command is removed, the drive will STOP.

P12 TB-13C FUNCTION SELECT

This selects the function of terminal TB-13C. Closing TB-13C to TB-2 (or opening in the case of setting 06) activates the selected function. The following functions can be selected:

01 NONE: Disables the TB-13C function.

02 0-10 VDC: Selects a 0-10 VDC signal (at TB-5) as the AUTO speed reference input.

03 4-20 mA: Selects a 4-20 mA signal (at TB-25) as the AUTO speed reference input.

04 PRESET SPEED #3: Selects PRESET SPEED #3 as the AUTO speed reference. The drive will operate at the frequency programmed into Parameter 33.

05 INCREASE FREQUENCY: Increases the speed setpoint when using the MOP function. Refer to Section 10.6.

06 EXTERNAL FAULT: Sets TB-13C as a normally closed external fault input. If TB-13C is open with respect to TB-2, the drive will fault.

07 REMOTE KEYPAD: Selects the optional remote keypad as the control source. Refer to Parameter 14 - CONTROL.

08 DB FAULT: Sets TB-13C as a dynamic braking fault input when using the optional dynamic braking module. When this input is activated by the dynamic braking module, the drive will trip into a "dF" fault and the motor will coast to a stop. Refer to the manual included with the Dynamic Braking option.

09 ACCEL/DECEL #2: Selects the acceleration and deceleration time programmed into Parameter 42 - ACCEL/DECEL #2.

P13 TB-15 OPEN COLLECTOR OUTPUT

This selects the status indication for the open-collector output at TB-15, and has the same selections as Parameter 6 - TB-14 OPEN COLLECTOR OUTPUT.

P14 CONTROL

This selects the source of START/STOP and direction commands.

01 TERMINAL STRIP ONLY: The drive will only respond to START/STOP and direction commands from the terminal strip.

02 REMOTE KEYPAD ONLY: The drive will only respond to START/STOP and direction commands from the optional remote keypad.

03 TERMINAL STRIP OR REMOTE KEYPAD: Terminal TB-13A or TB-13C can be used to select terminal strip control or remote keypad control. See Parameters 10 and 12.

NOTE: The STOP button on the optional remote keypad is always active as long as the serial link remains intact.

P15 SERIAL LINK

This parameter configures the drive for serial communications. The options are listed by baud rate, number of data bits, parity, number of stop bits, and whether the watchdog timer is enabled or disbabled.

The watchdog timer will stop the drive after 10 seconds of no serial activity to safeguard against a failed serial link. During set-up or troubleshooting, it may be useful to disable the watchdog timer, but is it not recommended to run normally without the watchdog timer.

WARNING!
Controlling the drive from the serial link without the watchdog timer could cause damage to equipment and/or injury to personnel!

01 DISABLED: Disables the serial link
02 9600, 8, N, 2 - ENABLED WITH TIMER
03 9600, 8, N, 2 - ENABLED WITHOUT TIMER
04 9600, 8, E, 1 - ENABLED WITH TIMER
05 9600, 8, E, 1 - ENABLED WITHOUT TIMER
06 9600, 8, O, 1 - ENABLED WITH TIMER
07 9600, 8, O, 1 - ENABLED WITHOUT TIMER

P16 UNITS EDITING

This allows parameter and keypad speed editing in whole units or tenths of units above 100. Below 100, the value can always be changed by tenths of units.

01 TENTHS OF UNITS: The value can always be changed by tenths of units (up to a value of 1000). If the ▲ or ▼ button is pressed and held, the value will change by tenths of units until the next whole unit is reached, and then the value will change by whole units. Refer to Section 13.1.

02 WHOLE UNITS: The value can be changed by tenths of units until 99.9 is reached. Above 99.9, the value will change in whole unit increments only. Below a value of 100, if the ▲ or ▼ button is pressed and held, the value will change by tenths of units until the next whole unit is reached, and then the value will change by whole units.

P17 ROTATION DIRECTION

01 FORWARD ONLY: The drive will only allow rotation in the forward direction. However, JOG REVERSE (see Parameter 11) will still operate even if FORWARD ONLY is selected.

02 FORWARD AND REVERSE: The drive will allow rotation in both directions.

P19 ACCELERATION TIME

This parameter sets the acceleration rate for all of the speed reference sources (keypad, speed pot, 4-20 mA, 0-10 VDC, jog, MOP, and preset speeds). This setting is the time to accelerate from 0 Hz to the BASE FREQUENCY (Parameter 27).

P20 DECELERATION TIME

This parameter sets the deceleration rate for all of the speed reference sources (keypad, speed pot, 4-20 mA, 0-10 VDC, jog, MOP, and preset speeds). This setting is the time to decelerate from BASE FREQUENCY to 0 Hz. If the drive is set for COAST TO STOP (setting 01 or 02 in Parameter 04), this parameter will have no effect when a STOP command is given.

P21 DC BRAKE TIME

This determines the length of time that the DC braking voltage is applied to the motor. The DC BRAKE TIME should be set to the lowest value that provides satisfactory operation in order to minimize motor heating.

P22 DC BRAKE VOLTAGE

This sets the magnitude of the DC braking voltage, in percentage of the nominal DC Bus voltage (DC Bus = input AC voltage X 1.414). The point at which the DC braking is activated depends on the selected STOP METHOD (Parameter 04):

If COAST WITH DC BRAKE is selected, the DC braking is activated after a time delay of up to 2 seconds, depending on the output frequency at the time of the STOP command. In this case, the DC braking is the only force acting to decelerate the load.

If RAMP WITH DC BRAKE is selected, braking is activated when the output frequency reaches 0.2 Hz. In this case, the drive decelerates the load to a near stop and the DC braking is used to bring the load to a final stop.

P23 MINIMUM FREQUENCY

This sets the minimum output frequency of the drive for all speed reference sources except the PRESET SPEEDS (Parameters 31-37).

When using a 0-10 VDC or 4-20 mA analog speed reference signal, this parameter also sets the drive speed that corresponds to the minimum analog input (0 VDC or 4 mA).

NOTE: If this parameter is changed while the drive is running, the new value will not take effect until the drive is stopped.

P24 MAXIMUM FREQUENCY

This sets the maximum output frequency of the drive for all speed reference sources, and is used with MINIMUM FREQUENCY (Parameter 23) to define the operating range of the drive.

When using a 0-10 VDC or 4-20 mA analog speed reference signal, this parameter also sets the drive speed that corresponds to the maximum analog input (10 VDC or 20 mA).

NOTE 1: On drives equipped with the High Output Frequency option, this parameter can be set up to 999.9 Hz.

NOTE 2: If this parameter is changed while the drive is running, the new value will not take effect until the drive is stopped.

P25 CURRENT LIMIT

This sets the maximum allowable output current of the drive. The maximum setting is either 180% or 150%, depending on whether LINE VOLTAGE SELECTION (Parameter 01) is set to HIGH or LOW.

The drive will enter current limit when the load demands more current than the CURRENT LIMIT setting. When this happens, the drive will reduce the output frequency in an attempt to reduce the output current. When the overload condition passes, the drive will accelerate the motor back up to the speed setpoint.

P26 MOTOR OVERLOAD

The SCF Series is UL approved for solid state motor overload protection, and therefore does not require a separate thermal overload relay for single motor applications.

The drive contains an adjustable thermal overload circuit that protects the motor from excessive overcurrent. This circuit allows the drive to deliver up to 150% current for one minute. If the overload circuit "times out", the drive will trip into an OVERLOAD fault (displayed as "PF").

MOTOR OVERLOAD should be set to the ratio (in percent) of the motor current rating to the drive current rating in order to properly protect the motor. See the example below.

Example: A 3 HP, 480 Vac drive with a 4.8 Amp rating is operating a 2 HP motor with a current rating of 3.4 Amps. Dividing the motor current rating by the drive current rating yields 71% (3.4 / 4.8 = 0.71 = 71%), so this parameter should be set to 71%.

P27 BASE FREQUENCY

The BASE FREQUENCY determines the V/Hz ratio by setting the output frequency at which the drive will output full voltage to the motor. In most cases, the BASE FREQUENCY should be set to match the motor's rated frequency.

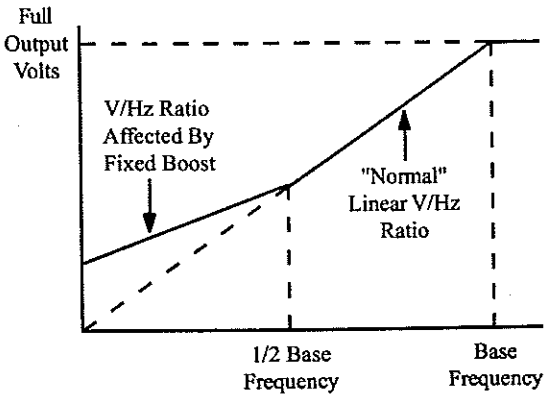
Example: A 460 Vac, 60 Hz motor requires a V/Hz ratio of 7.67 (460 V / 60 Hz = 7.67 V/Hz) to produce full torque. Setting the BASE FREQUENCY to 60 Hz causes the drive to output full voltage (460 Vac) at 60 Hz, which yields the required 7.67 V/Hz. Output voltage is proportional to output frequency, so the 7.67 V/Hz ratio is maintained from 0 - 60 Hz, allowing the motor to produce full torque from 2 Hz (below 2 Hz there is less torque due to slip) up to 60 Hz.

NOTE: If this parameter is changed while the drive is running, the new value will not take effect until the drive is stopped.

P28 FIXED BOOST

FIXED BOOST increases starting torque by increasing the output voltage when operating below half of the base frequency, which increases the V/Hz ratio (see diagram below). For better out-of-the-box performance, SCF Series drives are shipped with a setting that is different from the factory default, as seen in the table below. If a factory reset is performed, FIXED BOOST will default to 1.0 %.

HP	FACTORY SETTING	HP	FACTORY SETTING
0.25 - 1	5.3 %	10	2.4 %
1.5	4.4 %	15	2.2 %
2	4.4 %	20	2.0 %
3	3.6 %	25	1.8 %
5	3.0 %	30	1.6 %
7.5	2.7 %		



P29 ACCELERATION BOOST

ACCELERATION BOOST helps accelerate high-inertia loads. During acceleration, the output voltage is increased to increase motor torque. Once the motor reaches the new speed setpoint, the boost is turned off and the output voltage returns to the normal value.

P30 SLIP COMPENSATION

SLIP COMPENSATION is used to counteract changes in motor speed (slip) caused by changes in load. In a standard AC induction motor, the shaft speed decreases as load increases, and increases as load decreases. By increasing or decreasing the output frequency in response to an increasing or decreasing load, the slip is counteracted and speed is maintained. Most standard NEMA B motors have a 3% slip rating.

P31-P37 PRESET SPEED #1 - #7

Preset speeds are activated by contact closures between TB-2 and TB-13A, 13B, and 13C. The TB-13 terminals must be programmed as preset speed selects using Parameters 10-12.

NOTE 1: Preset speeds can operate below the frequency defined by the minimum frequency parameter (Parameter 23). The range of adjustment for the preset speeds is from 0 Hz to the maximum frequency (Parameter 24).

Refer to the table below for activation of the preset speeds using the TB-13 terminals.

SPEED #	TB - 13A	TB - 13B	TB - 13C
1	CLOSED	OPEN	OPEN
2	OPEN	CLOSED	OPEN
3	OPEN	OPEN	CLOSED
4	CLOSED	CLOSED	OPEN
5	CLOSED	OPEN	CLOSED
6	OPEN	CLOSED	CLOSED
7	CLOSED	CLOSED	CLOSED

NOTE 2: When a TB-13 terminal is programmed for a function other than a preset speed select, it is considered OPEN for the table above.

Preset Speed #6 and #7 can also be used as skip frequencies to restrict the drive from operating at frequencies that cause vibration in the system. See Parameter 38 below.

P38 SKIP BANDWIDTH

The SCF drive has two skip frequencies that can be used to lock out critical frequencies that cause mechanical resonance in the system. Once SKIP BANDWIDTH is set to a value other than 0.0 Hz, the skip frequencies are enabled. When the skip frequency function is enabled, PRESET SPEED #6 and #7 are used as the skip frequencies. SKIP BANDWIDTH sets the range above the skip frequencies that the drive will not operate within.

Example: The critical frequency is 23 Hz, and it is desired to skip a frequency range of 3 Hz above and below the critical frequency (therefore the skip range is 20 to 26 Hz). PRESET SPEED #6 or #7 would be set to 20 Hz, and the SKIP BANDWIDTH would be set to 6.0 Hz.

If the drive is running at a speed below the skip range, and it is given a speed command that is within the skip range, the drive will accelerate to the start of the skip range (20 Hz in the example) and run at that speed until the speed command is greater than or equal to the "top" of the skip range. The drive will then accelerate through the skip range to the new speed. Likewise, if the drive is running at a speed above the skip range, and it is given a speed command that is within the skip range, the drive will decelerate to the "top" of the skip range (26 Hz in the example) and run at that speed until the speed command is less than or equal to the "bottom" of the skip range. The drive will then decelerate through the skip range to the new speed.

NOTE: PRESET SPEEDS #6 and #7 can still be used as preset speeds even if they are also being used as skip frequencies.

P39 SPEED SCALING

This scales the display to indicate speed or user units other than frequency. This parameter should be set to the desired display value when the drive output is 60 Hz. The highest setting is 6500, and the highest value that can be displayed is 6553.6.

Example: A machine produces 175 parts per hour when the motor is running at 60 Hz. Setting the SPEED SCALING to 175 will calibrate the drive's display to read 175 when the motor is running at 60 Hz. This is a linear function, so at 30 Hz the display would read 87.5, and at 120 Hz, the display would read 350.

NOTE: If SPEED SCALING is set such that the maximum displayable value (6553.6) is exceeded, the display will flash "9999" to indicate that the value is out of range. For example, if SPEED SCALING is set to 6000, the drive will display 6000 when it is running at 60 Hz. If the speed is increased past 65.5 Hz (at 65.5 Hz, the scaled value would be 6550), the display will flash "9999" because a scaled value above 6553.6 cannot be displayed.

P40 FREQUENCY SCALING

This scales the analog output signal at TB-30 when it is configured for a frequency output. This setting is the output frequency that is indicated when the output signal measures 10 VDC.

Example: A 0-5 VDC signal is required to indicate 0-60 Hz. Setting this parameter to 120 Hz would yield 10 VDC at 120 Hz, and 5 VDC at 60 Hz. If the drive only operates up to 60 Hz, the output signal at TB-30 is limited to the desired 0-5 VDC.

P41 LOAD SCALING

This scales the analog output signal at TB-30 and/or TB-31 when they are configured for a load output. This setting is the load (in %) that is indicated when the output signal measures 10 VDC.

Example: A 0-10 VDC signal is required to indicate 0-150% load. Setting this parameter to 150% will yield 10 VDC at 150% load.

P42 ACCEL / DECEL #2

This parameter sets the second acceleration and deceleration rate of the drive. To activate this acceleration and deceleration rate, use terminal TB-13A, TB-13B or T-13C. TB-13A and TB-13B can be set to AUXILIARY STOP which will cause the drive to decelerate to a stop according to the time programmed in this parameter. TB-13C can be set to ACCEL/DECEL #2, which causes the drive to accelerate and decelerate according to the time programmed in this parameter.

P43 SERIAL ADDRESS

If a serial link is being used to communicate with multiple drives, each drive must be given a different address (from 1 to 247) so that an individual drive in the network can be accessed.

P44 PASSWORD

This allows the PASSWORD to be changed to any number between 000 and 999. Setting PASSWORD to 000 disables the password function.

NOTE: The factory default password is 225.

P47 CLEAR FAULT HISTORY

01 MAINTAIN: Maintains the FAULT HISTORY (Parameter 50) entries for troubleshooting.

02 CLEAR: Erases the FAULT HISTORY (Parameter 50) entries.

P48 PROGRAM SELECTION

This is used to select whether the drive will operate according to the user settings or the optional OEM default settings, and to reset the parameters to default settings. Refer to Section 13.2.

01 OPERATE WITH USER SETTINGS: The drive will operate according to the user settings. Operation in USER mode allows the parameter values to be changed to suit any application.

02 OPERATE WITH OEM DEFAULTS: The drive will operate according to the optional OEM default settings, which configure the drive for a specific application. When operating in OEM mode, the parameter values can be viewed, but not changed. If an attempt is made to change a parameter setting, the display will flash "GE". If the drive is not programmed with OEM default settings, the display will flash "GF" if this option is selected.

03 RESET OEM: Resets the user parameters to the OEM default settings. If the drive is not programmed with OEM default settings, the display will flash "GF" if this option is selected.

04 RESET 60: Resets the user parameters to the factory defaults for a 60 Hz base frequency.

05 RESET 50: Resets the user parameters to the factory defaults for a 50 Hz base frequency. Parameters 24, 27, and 40 will reset to 50.0 Hz.

06 TRANSLATE: If an EPM from a drive with a previous parameter version is installed in a new drive, the new drive will function like the previous version drive, but none of the parameter settings can be changed ("cE" will be displayed if this is attempted). The TRANSLATE function converts the EPM to the new parameter version so that the parameters can be changed, but it also retains the old parameter settings so the new drive will operate like the old drive without having to re-program all of the parameters.

NOTE 1: If the user parameters are reset to the OEM defaults (using the RESET OEM option), and then OPERATE WITH USER SETTINGS is selected, the USER settings will be the same as the OEM default settings. This allows the drive to operate as if it was in OEM mode, but the parameter values can be changed. This is useful if some of the OEM default settings need to be fine-tuned for proper operation. The new parameter values are not actually stored as new OEM default settings however; they are simply stored as new USER settings. Therefore, if the parameters are reset to the OEM defaults again, the parameters that were changed will be reset to their "old" value. The optional EPM Programmer is required to change OEM default settings. Refer to Section 13.2.

NOTE 2: Only the TRANSLATE (06) function can be performed while the drive is running. The display will flash "Er" if an attempt is made to select any other function while the drive is running.

P50 FAULT HISTORY

The FAULT HISTORY stores the last eight faults that tripped the drive. Refer to Section 16.0 - TROUBLESHOOTING for a list of the faults and possible causes.

Use the ▲ and ▼ buttons to scroll through the fault entries. The far left digit of the display will be the fault number and the remaining two digits will be the fault code. The faults are stored from newest to oldest, with the first fault shown being the most recent.

The display will read "_ _" if the FAULT HISTORY does not contain any fault messages.

P51 SOFTWARE VERSION

This displays the software version number for the control board software. This information is useful when contacting the factory for programming or troubleshooting assistance.

The software version is displayed in two parts which alternate. The first part is the software version, and the second part is the revision number. For example, if the display shows "64-" and "-02", this indicates that the drive contains the second revision of version 64 software.

P52 DC BUS VOLTAGE

This displays the DC bus voltage in percent of nominal. Nominal DC bus voltage is determined by multiplying the drive's nameplate input voltage rating by 1.4.

P53 MOTOR VOLTAGE

This displays the output voltage in percent of the drive's nameplate output voltage rating.

P54 MOTOR LOAD

This displays the motor load in percent of the drive's output current rating.

P55 0-10 VDC ANALOG INPUT

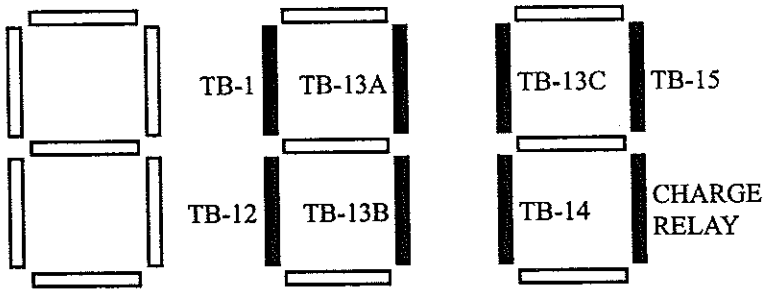
This displays the level of the 0-10 VDC analog input signal at TB-5. A reading of 100% indicates a 10 VDC input at TB-5.

P56 4-20 mA ANALOG INPUT

This displays the level of the 4-20 mA analog input signal at TB-25. A reading of 20% indicates a 4 mA input at TB-25, and a reading of 100% indicates a 20 mA input at TB-25.

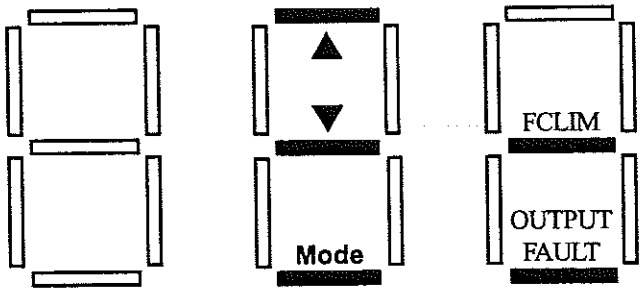
P57 TERMINAL STRIP STATUS

This indicates the status of several terminals using the vertical segments of the LED display. An illuminated segment indicates that the particular terminal is closed with respect to TB-2. The CHARGE RELAY is not a terminal, and should always be illuminated. See the diagram below:



P58 KEYPAD AND PROTECTION STATUS

This indicates the status of the buttons on the keypad, and the status of the protective circuitry in the drive, using the horizontal segments of the LED. An illuminated segment indicates that the corresponding button is pressed, or the protective circuit is active. See the diagram below:



NOTE: FCLIM is an abbreviation for Fast Current Limit.

P59-P60 TB-30 and TB-31 ANALOG OUTPUT

This displays the level of the analog output signals at TB-30 (Parameter 59) and TB-31 (Parameter 60). A reading of 100% indicates that the output is 10 VDC.

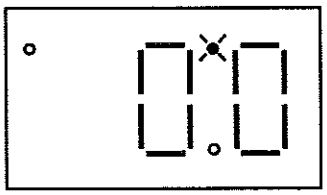
16.0 TROUBLESHOOTING

To aid in troubleshooting, Parameters 50 through 60 can be accessed without entering the PASSWORD. Simply press the **Mode** button twice to "skip" over the PASSWORD prompt, and "P50" will be displayed to indicate that the parameter menu has been entered and Parameter 50 (FAULT HISTORY) can be viewed. The ▲ and ▼ buttons can then be used to scroll from Parameter 50 to Parameter 60. Once the desired parameter is found, press the **Mode** button to view its "contents". When finished, press **Mode** to exit the parameter menu. An example is shown below:

Press **Mode** once

Display reads "00"

Upper right decimal point blinks

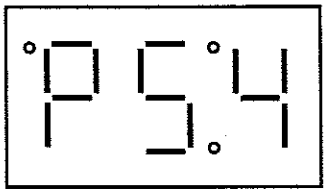


Press **Mode** again

Display reads "P50" (FAULT HISTORY)

Use ▲ and ▼ to scroll to the desired parameter number

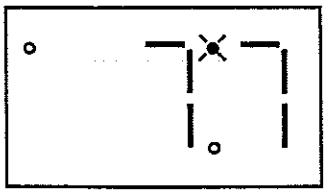
(In this example Parameter 54 has been selected, which is MOTOR LOAD)



Press **Mode** to view parameter contents (77 = 77% LOAD)

Upper right decimal point blinks

Press **Mode** again to exit



In the example above, Parameter 54 - MOTOR LOAD is being viewed. The "77" in the example indicates that the load on the motor is 77% of the output current rating of the drive.

The table below lists the fault conditions that will cause the drive to shut down, as well as some possible causes. Please contact the factory for more information on troubleshooting faults.

FAULT MESSAGES	
FAULT	**DESCRIPTION & POSSIBLE CAUSES**
AF	High Temperature Fault: Ambient temperature is too high; Cooling fan has failed (if equipped).
CF	Control Fault: A blank EPM, or an EPM with corrupted data has been installed. Perform a factory reset using Parameter 48 - PROGRAM SELECTION.
cF	Incompatibility Fault: An EPM with an incompatible parameter version has been installed. Either remove the EPM or perform a factory reset (Parameter 48) to change the parameter version of the EPM to match the parameter version of the drive.
dF	Dynamic Braking Fault: The drive has sensed that the dynamic braking resistors are overheating and shuts down to protect the resistors.
EF	External Fault: TB-13A and/or TB-13C is set as an External Fault input and TB-13A and/or TB-13C is open with respect to TB-2. Refer to Parameter 10 and/or 12.
GF	Data Fault: User data and OEM defaults in the EPM are corrupted.
HF	High DC Bus Voltage Fault: Line voltage is too high; Deceleration rate is too fast; Overhauling load. For fast deceleration or overhauling loads, dynamic braking may be required.
JF	Serial Fault: The watchdog timer has timed out, indicating that the serial link has been lost.
LF	Low DC Bus Voltage Fault: Line voltage is too low.
OF	Output Transistor Fault: Phase to phase or phase to ground short circuit on the output; Failed output transistor; Boost settings are too high; Acceleration rate is too fast.
PF	Current Overload Fault: VFD is undersized for the application; Mechanical problem with the driven equipment.
SF	Single-phase Fault: Single-phase input power has been applied to a three-phase drive.
UF	Start Fault: Start command was present when the drive was powered up. Must wait 2 seconds after power-up to apply Start command if START METHOD is set to NORMAL.
F1	EPM Fault: The EPM is missing or damaged.
F2 - F9, Fo	Internal Faults: The control board has sensed a problem - consult factory.

To clear a fault, issue a STOP command, either on the terminal strip, or using the STOP button on the optional remote keypad. The fault will only clear if the condition that caused the fault has passed. For example, if the drive trips on a LOW DC BUS VOLTAGE FAULT (LF) due to low input voltage, the fault cannot be cleared until the input voltage returns to a normal level.

If the drive is programmed to automatically restart after a fault (see Parameter 03), the drive will attempt to restart three times after a fault (the drive will not restart after CF, cF, GF, F1, F2-F9, or Fo faults). If all three restart attempts are unsuccessful, the drive will trip into FAULT LOCKOUT (LC), which requires a manual reset as described above.

17.0 SCF DISPLAY MESSAGES

The following describes the various displays and messages that can appear on the SCF drive.

17.1 SPEED DISPLAY

If the drive is in a STOP state (indicated by "- - -" on the display), and the commanded speed is changed, the display will show the commanded speed, and the upper left decimal point will turn on solid. About five seconds after a change is made, the display will begin to alternate between the commanded speed value and the "- - -" display. If the **Mode** button is pressed, the display will stop alternating and show the "- - -" display only.

When the drive is given a START command, the displayed speed will start increasing as the drive accelerates up to the commanded speed. If the commanded speed is changed while the drive is running, the display will show the commanded speed rather than the actual speed, until the actual speed reaches the commanded speed.

If the commanded speed is changed faster than the drive can accelerate or decelerate, the upper left decimal point will blink to indicate that the the drive is accelerating or decelerating to the new speed. Once the actual speed reaches the commanded speed, the upper left decimal point will turn on solid for 5 seconds and then turn off to indicate that the commanded speed has been reached, and that the display is now showing the actual speed.

17.2 CHANGING THE SPEED REFERENCE SOURCE

When the speed source is changed while the drive is running, the display will flash the message for the new speed source to indicate that the new speed source is active. Also, if the drive is being controlled from a speed source other than the ▲ and ▼ buttons (0-10 VDC, 4-20 mA, etc), and one of the ▲ or ▼ buttons is pressed, the display will flash the present speed source message to indicate that the ▲ and ▼ buttons are invalid.

Example 1: The drive is running and the present speed source is the keypad. TB-13A is programmed to select a 4-20 mA signal as the speed source. When TB-13A is closed to TB-2, the display will flash "EI" to indicate that the speed source has changed to the 4-20 mA signal. If the contact between TB-13A and TB-2 is opened, the display will flash "CP" to indicate that the speed source has changed back to the ▲ and ▼ buttons.

Example 2: The speed source is a 0-10 VDC signal. If the ▲ or ▼ button is pushed, the display will flash "EU" to indicate that the present speed source is the 0-10 VDC signal and that the ▲ and ▼ buttons are invalid.

Refer to the table below for the possible speed reference source displays:

SPEED SOURCE DISPLAYS	
DISPLAY	**DESCRIPTION**
CP	CONTROL PAD: Speed is set using the ▲ and ▼ buttons on the front of the drive.
EI	EXTERNAL CURRENT: Speed is controlled by a 4-20 mA signal wired to TB-25 and TB-2
EU	EXTERNAL VOLTAGE: Speed is controlled by a 0-10 VDC signal wired to TB-5 and TB-2.
JG	JOG: The drive is in Jog mode, and the speed is set by Preset Speed #2 (Parameter 32).
OP	MOP (Motor Operated Pot): Contacts wired to TB-13B and TB-13C are used to increase and decrease the drive speed.
Pr1 - Pr7	PRESET SPEEDS #1-7: Speed is set by the indicated Preset Speed (Parameters 31-37).

NOTE: The speed source displays will flash when the speed reference source is changed while the drive is running to indicate that the new speed reference source is active.

17.3 STATUS AND WARNING MESSAGES

STATUS AND WARNING MESSAGES	
DISPLAY	**DESCRIPTION**
br	DC BRAKING: The DC braking circuit is activated.
CL	CURRENT LIMIT: The output current has exceeded the CURRENT LIMIT setting (Parameter 25) and the drive is reducing the output frequency to reduce the output current. If the drive remains in CURRENT LIMIT for too long, it can trip into a CURRENT OVERLOAD fault (PF).
Er	ERROR: Invalid data has been entered or an invalid command was attempted.
GE	"GE" will be displayed if an attempt is made to change the OEM default settings when the drive is operating in the OEM mode (see Parameter 48).
GF	If "GF" is displayed when a RESET OEM is attempted, it indicates that the OEM defaults in the EPM are corrupted. If "GF" is displayed upon power-up, it indicates that the OEM defaults and the user settings in the EPM are corrupted. Refer to Section 13.2.
LC	FAULT LOCKOUT: The drive has failed three restart attempts and requires a manual reset.
SE	SERIAL: The optional remote keypad is active as the user interface instead of the buttons on the front of the drive. See Parameter 14 - CONTROL.
SP	START PENDING: "SP" blinks during the interval between restart attempts.
✕ ✕	DECEL OVERRIDE (both upper decimal points blinking): The drive has stopped decelerating to avoid tripping into an HF fault due to regenerative energy from the motor.

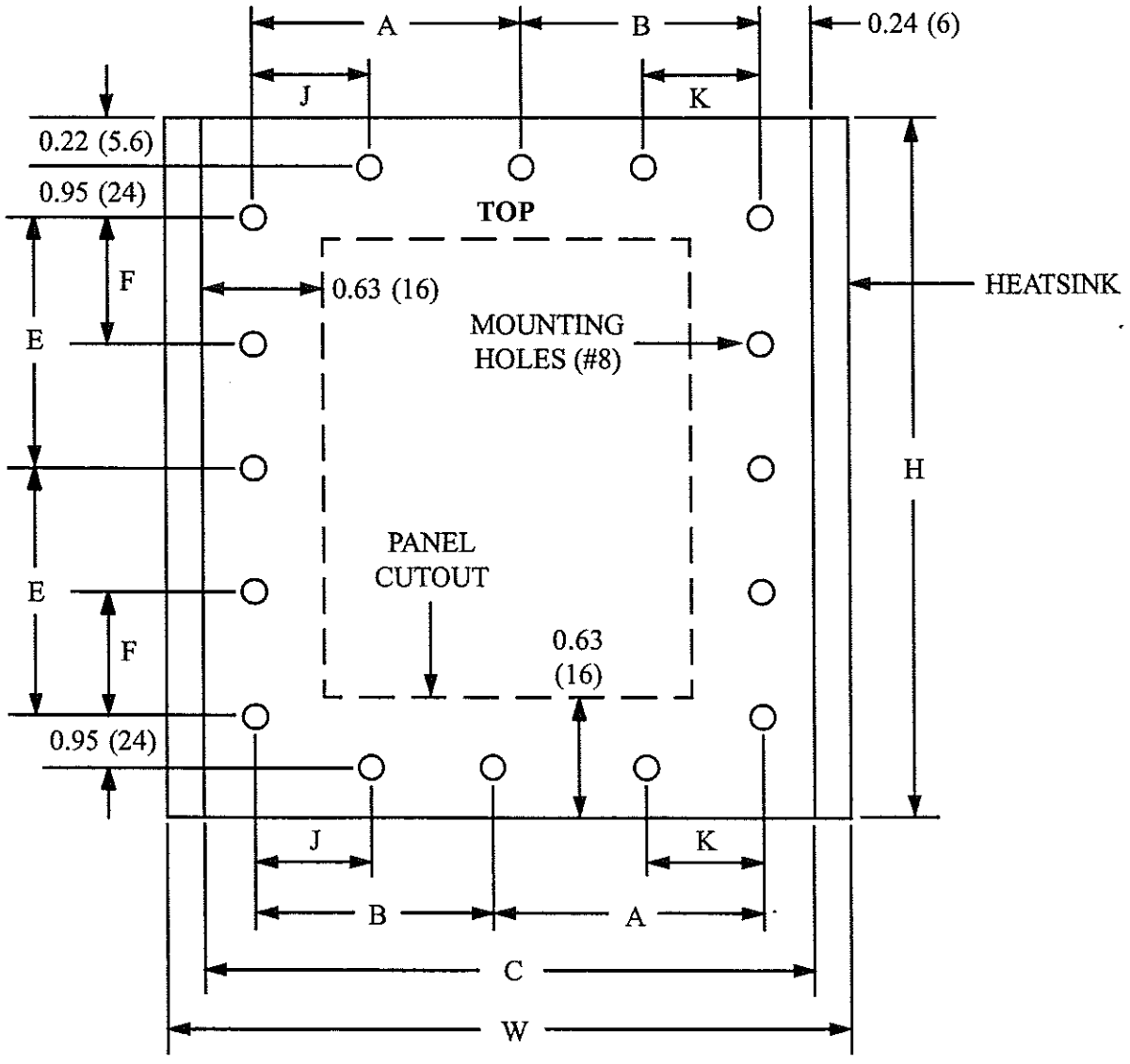
APPENDIX A - THROUGH-HOLE MOUNT OPTION

The Through-Hole Mount option for the SCF drive allows the drive to be mounted with the heatsink outside of the enclosure for better heat dissipation. This is done by using a special heatsink that mounts to the outside of the enclosure. The drive (which has a flat plate instead of a heatsink) is mounted to the heatsink from the inside of the enclosure. This requires cutting a hole in the enclosure that is slightly smaller than the heatsink. Up to NEMA 4X can be achieved with this option. Panel cutout and mounting hole dimensions are provided below for the different drive sizes.

NOTE 1: The temperature inside the enclosure must be maintained at 50°C or less, and the ambient temperature outside of the enclosure must be 40°C or less. Refer to Section 5.0 - SCF RATINGS for heat loss information.

NOTE 2: Cutout view is shown from the drive side (inside) of the panel.

THROUGH-HOLE DRAWING FOR MODELS UP TO 10 HP (7.5 kW)



THROUGH-HOLE MOUNT DIMENSIONS FOR MODELS UP TO 10 HP (7.5 kW)

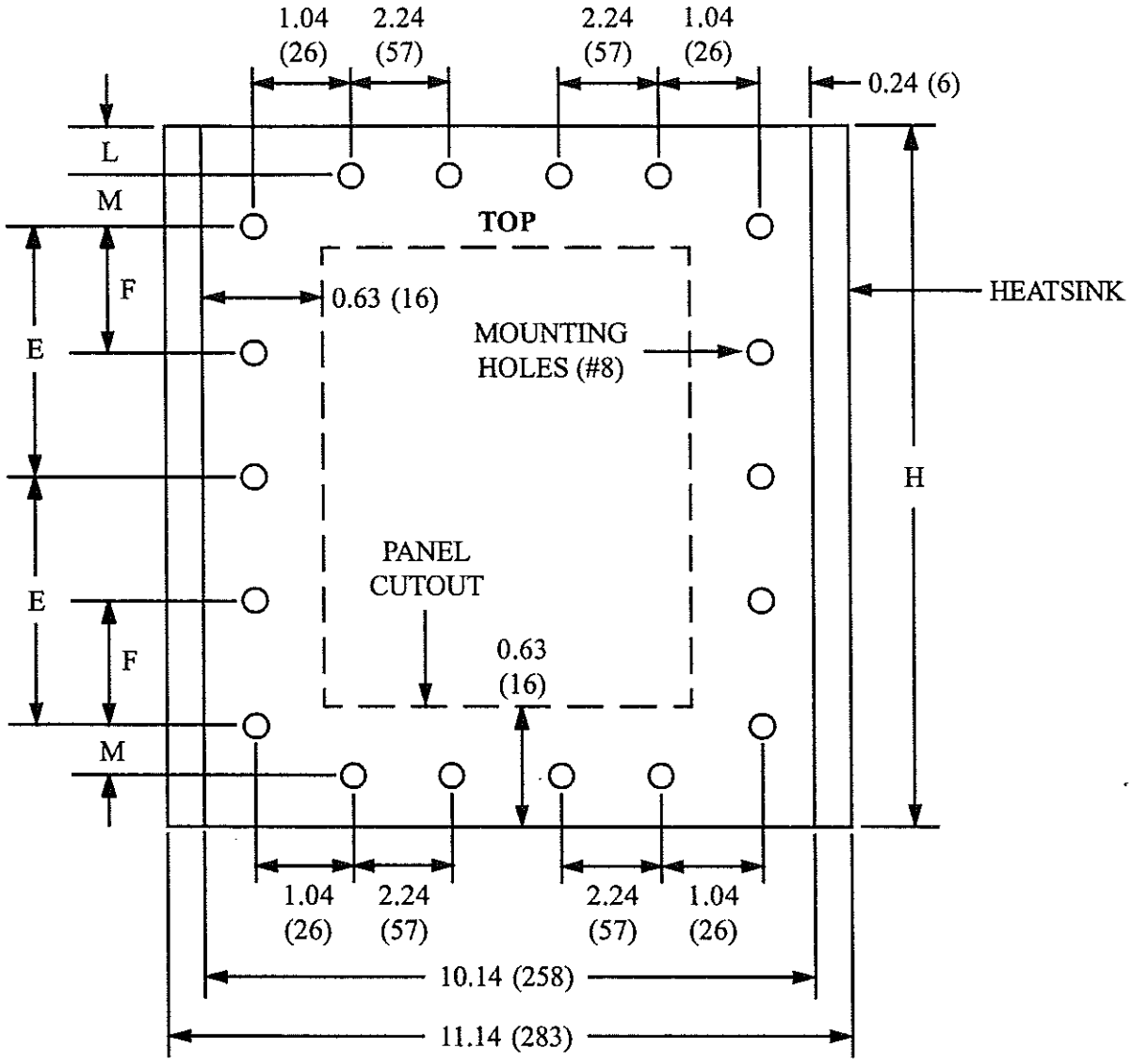
HP (kW)	MODEL	H	W	A	B	C	E	F	J	K
1 (0.75)	SF210YF	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF210F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF410F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF510F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
1.5 (1.1)	SF215YF	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF215F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF415F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
2 (1.5)	SF220YF	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF220F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF420F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
	SF520F	7.72	6.80	2.76	2.76	6.00	2.69	N/A	N/A	N/A
3 (2.2)	SF230YF	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
	SF230F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
	SF430F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
	SF530F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
5 (3.7)	SF250YF	9.59	11.14	5.06	4.60	10.14	3.63	N/A	2.32	2.32
	SF250F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
	SF450F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
	SF550F	7.72	8.54	3.80	3.46	7.74	2.69	N/A	1.72	1.75
7.5 (5.5)	SF275F	11.59	11.14	5.06	4.60	10.14	4.63	2.31	2.32	2.32
	SF475F	9.59	11.14	5.06	4.60	10.14	3.63	N/A	2.32	2.32
	SF575F	9.59	11.14	5.06	4.60	10.14	3.63	N/A	2.32	2.32
10 (7.5)	SF2100F	15.59	11.14	5.06	4.60	10.14	6.63	3.31	1.94	2.32
	SF4100F	11.59	11.14	5.06	4.60	10.14	4.63	2.31	2.32	2.32
	SF5100F	11.59	11.14	5.06	4.60	10.14	4.63	2.31	2.32	2.32

NOTE 1: The N/A indication for dimensions F, J, and K indicate that the heatsinks for these models have fewer mounting holes than shown in the drawing.

NOTE 2: For mm, multiply inches listed above by 25.4.

THROUGH-HOLE DRAWING FOR 15 HP (11 kW) AND 20 HP (15 kW) MODELS

This drawing applies to the following models only: SF2150F, SF4150F, SF5150F, SF4200F, and SF5200F.

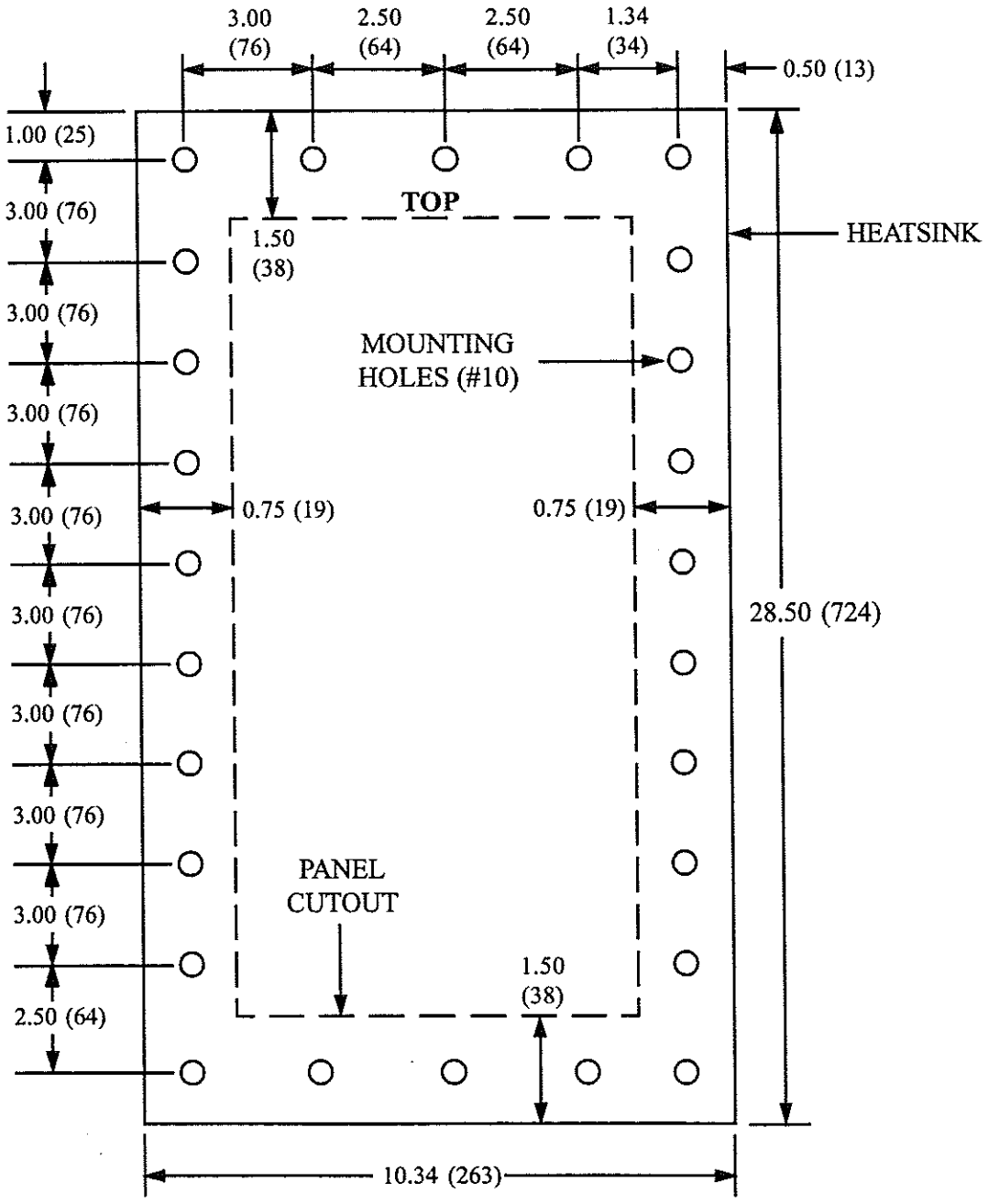


THROUGH-HOLE CUTOUT DIMENSIONS FOR 15 HP (11 kW) & 20 HP (15 kW) MODELS

HP (kW)	MODEL	H	E	F	L	M
15	SF2150F	18.09 (459)	6.03 (153)	3.02 (77)	0.50 (13)	2.52 (64)
(11)	SF4150F	15.59 (396)	6.03 (153)	3.31 (84)	0.22 (5.6)	0.95 (24)
	SF5150F	15.59 (396)	6.03 (153)	3.31 (84)	0.22 (5.6)	0.95 (24)
20	SF4200F	18.09 (459)	6.03 (153)	3.02 (77)	0.50 (13)	2.52 (64)
(15)	SF5200F	18.09 (459)	6.03 (153)	3.02 (77)	0.50 (13)	2.52 (64)

THROUGH-HOLE MOUNT DRAWING FOR 25 HP (18.5 kW) MODELS

This drawing applies to SF4250F and SF5250F models only.

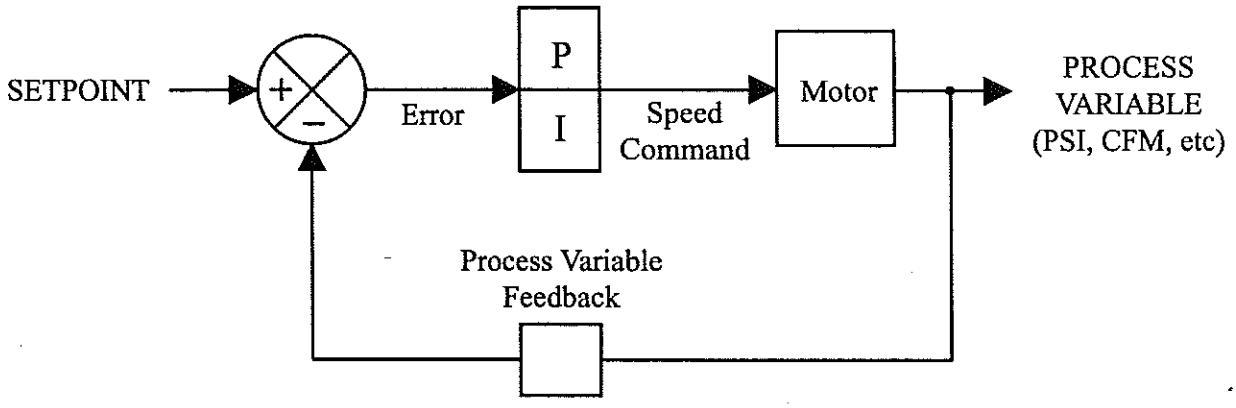


APPENDIX B - PI SETPOINT CONTROL OPTION

The following describes the PI Setpoint Control software option for the SCF drive. This software option has additional parameters compared to the standard SCF drive. Also, some of the parameters found in the standard drive have changed in the PI version.

PI Setpoint Control allows the SCF drive to maintain a process setpoint, such as PSI or CFM, without using an external controller. When PI is activated the SCF will operate in a closed-loop fashion, automatically adjusting the motor speed to maintain the process setpoint.

PI setpoint control requires feedback from the process in order to compare the actual process value to the setpoint. The difference between this value and the setpoint is called the error. The SCF drive will increase or decrease the motor speed in an attempt to minimize the error. By constantly adjusting the motor speed, the PI control will drive the process toward the setpoint. Refer to the PI block diagram below:



B.1 DIRECT ACTING vs. REVERSE ACTING SYSTEMS

The PI function must be set to match the type of system that it will control. A direct (or normal) acting system requires an increase in motor speed if the process variable decreases. A reverse acting system requires a decrease in motor speed if the process variable decreases. Parameter 61 - PI MODE must be programmed to the setting that matches the system (normal or reverse acting) and also the type of feedback signal that is used (0-10 VDC or 4-20 mA).

B.2 FEEDBACK DEVICES

A transducer or transmitter is required to monitor the process variable and provide feedback to the PI unit in order to compare the process value with the desired setpoint. A transducer outputs a signal corresponding to a fixed range of the process variable. A transmitter provides offset and gain adjustments to allow the output signal to be adjusted to correspond to different ranges of the process variable. Typical output signals for transducers and transmitters are 0-10 VDC or 4-20 mA.

NOTE: If a 4-20 mA signal is used for feedback, and the signal is lost, the drive will display "FL" to indicate the lost signal. The signal is considered lost if it drops below 2 mA.

B.3 SETPOINT REFERENCES

The following references can be used to adjust the process setpoint:

1. Keypad (▲ and ▼ buttons)
2. 0-10 VDC signal (from speed pot or other source)
3. 4-20 mA signal
4. Preset Setpoints (using Preset Speeds #4 and #5)

NOTE: The setpoint reference and the PI feedback cannot be the same signal. If the drive is mistakenly programmed so that the setpoint reference is the same as the feedback reference, the setpoint reference will default to the ▲ and ▼ buttons.

B.4 ADDITIONS TO THE STANDARD PARAMETER MENU

NO.	PARAMETER NAME	RANGE OF ADJUSTMENT	FACTORY DEFAULT
06 13	TB-14 OUTPUT TB-15 OUTPUT	MIN ALARM (11), MAX ALARM (12), MIN/MAX ALARM (13), INV MIN ALARM (14), INV MAX ALARM (15), INV MIN/MAX ALARM (16)	NONE (01)
10	TB-13A FUNCTION	KEYPAD SETPOINT (12)	NONE (01)
11	TB-13B FUNCTION	KEYPAD SETPOINT (09)	NONE (01)
12	TB-13C FUNCTION	KEYPAD SETPOINT (10)	NONE (01)
45	SPD AT MIN SIGNAL	MINIMUM FREQ - 999.0 Hz	0.0 Hz
46	SPD AT MAX SIGNAL	MINIMUM FREQ - 999.0 Hz	60.0 Hz
61	PI MODE	OFF (01), NORMAL 4-20 mA (02), NORMAL 0-10 VDC (03), REVERSE 4-20 mA (04), REVERSE 0-10 VDC (05)	OFF (01)
62	MIN FEEDBACK	0.0 - 999.0	0.0
63	MAX FEEDBACK	0.0 - 999.0	100.0
64	PROPORTIONAL GAIN	0.0 - 99.9 %	5.0 %
65	INTEGRAL GAIN	0.0 - 99.9 SEC	0.0 SEC
66	PI ACCEL/DECEL	0.0 - 999.0 SEC	20.0 SEC
67	MIN ALARM	0.0 - 999.0	0.0
68	MAX ALARM	0.0 - 999.0	0.0
69	0-10 VDC FEEDBACK	(VIEW-ONLY)	(N/A)
70	4-20 mA FEEDBACK	(VIEW-ONLY)	(N/A)
71	ACTUAL FREQUENCY	(VIEW-ONLY)	(N/A)
74	ANALOG INPUT FILTER	1 - 1000	2
75	SLEEP THRESHOLD	0.0 - 360 Hz	0.0 Hz
76	SLEEP DELAY	0.0 - 300 SEC	30.0 SEC
77	SLEEP BANDWIDTH	MIN FEEDBACK - MAX FEEDBACK	0.0

B.5 DESCRIPTION OF PI PARAMETERS

P10 TB-13A FUNCTION SELECT

12 KEYPAD SETPOINT: This option has been added so that the ▲ and ▼ buttons on the front of the drive can be used as the PI setpoint reference source. Closing TB-13A to TB-2 will enable the PI mode and the ▲ and ▼ buttons can be used to select the desired process setpoint.

P11 TB-13B FUNCTION SELECT

09 KEYPAD SETPOINT: This option has been added so that the ▲ and ▼ buttons on the front of the drive can be used as the PI setpoint reference source. Closing TB-13A to TB-2 will enable the PI mode and the ▲ and ▼ buttons can be used to select the desired process setpoint.

P12 TB-13C FUNCTION SELECT

10 KEYPAD SETPOINT: This option has been added so that the ▲ and ▼ buttons on the front of the drive can be used as the PI setpoint reference source. Closing TB-13A to TB-2 will enable the PI mode and the ▲ and ▼ buttons can be used to select the desired process setpoint.

P61 PI MODE

This parameter must be set to match the type of system and the type of feedback signal used. A direct acting system is one that requires the motor speed to increase as the feedback signal decreases, while a reverse acting system requires the motor speed to decrease as the feedback signal decreases.

01	DISABLED	Disables the PI function to allow standard drive operation.
02	NORMAL 4-20 mA	Enables the PI function for a direct-acting system with a 4-20 mA feedback signal.
03	NORMAL 0-10 VDC	Enables the PI function for a direct-acting system with a 0-10 VDC feedback signal.
04	REVERSE 4-20 mA	Enables the PI function for a reverse-acting system with a 4-20 mA feedback signal.
05	REVERSE 0-10 VDC	Enables the PI function for a reverse-acting system with a 0-10 VDC feedback signal.

When PI is disabled, the drive will operate in an OPEN LOOP mode, responding directly to a speed reference source selected using STANDARD SPEED SOURCE (Parameter 05) or terminals TB-13A, 13B, and/or 13C).

P62 MIN FEEDBACK

This parameter should be set to the value of the process variable that corresponds to the minimum transducer feedback signal (0 VDC or 4 mA). See the example below.

P63 MAX FEEDBACK

This parameter should be set to the value of the process variable that corresponds to the maximum transducer feedback signal (10 VDC or 20 mA). See the example below.

Example: A 0-100 psi transducer outputs 4 mA at 0 psi and 20 mA at 100 psi. Set MIN FEEDBACK to 0, and set MAX FEEDBACK to 100. The setpoint will then be adjustable between 0 and 100.

NOTE: If a reverse-acting feedback device is being used, MIN FEEDBACK should be set to the maximum process value, and MAX FEEDBACK should be set to the minimum process value.

P64 PROPORTIONAL GAIN

The Proportional Gain setting represents the speed command output (in % of maximum speed) that results from each 1% of error.

P65 INTEGRAL GAIN

The Integral Gain setting represents the ramp rate of the speed command output (in % of maximum speed per second) that results from each 1% of error.

P66 PI ACCEL/DECEL

When the PI unit attempts to respond to a sudden step change in setpoint, the result can be unstable operation. This parameter acts like a "filter" and ramps the setpoint from the old value to the new value over a programmable period of time to smooth the PI unit's response. If PI ACCEL/DECEL is set to 0.0 seconds, it is effectively disabled.

P67 MIN ALARM

This parameter represents the process value that the feedback signal must fall below to activate the MIN ALARM output (see Parameters 6 and 13).

P68 MAX ALARM

This parameter represents the process value that the feedback signal must exceed to activate the MAX ALARM output (see Parameters 6 and 13).

NOTE: The MIN ALARM function can be used to start and stop the drive based on the level of the PI feedback signal. This is done by wiring a 2-wire start/stop circuit through the drive's open-collector output, and setting the open-collector output for MIN ALARM (see Parameters 6 and 13). When the signal drops below the MIN ALARM setting, the open-collector output will de-energize, which will stop the drive. When the signal is equal to or greater than the MIN ALARM setting, the open-collector output will energize and start the drive.

P69 0-10 VDC FEEDBACK

This can be used to monitor the PI feedback when using a 0-10 VDC feedback signal. The displayed value will be scaled according to the MIN and MAX FEEDBACK parameters (62 and 63).

P70 4-20 mA FEEDBACK

This can be used to monitor the PI feedback when using a 4-20 mA feedback signal. The displayed value will be scaled according to the MIN and MAX FEEDBACK parameters (62 and 63).

P71 ACTUAL FREQUENCY

This can be used to monitor the actual output frequency of the drive when operating in PI mode, as the normal display is scaled to PI units according to the MIN and MAX FEEDBACK parameters.

P74 ANALOG INPUT FILTER

This adjusts the filter on the analog input terminals (TB-5 and TB-25) to reduce the effect of any electrical noise that may be present on the analog input signals. This filter works both in PI mode and standard speed control mode. It should be set to the lowest value that yields acceptable performance, as setting it too high may cause the drive to react too slowly to signal changes. The range of adjustment is 1 to 1000, which actually corresponds to 0.01 to 10.0 seconds.

P75 SLEEP THRESHOLD

The PI option has a Sleep Mode function that allows the drive to cease operation when system demand falls below a preset level. This is to prevent the the motor from operating at low speeds for long periods of time.

When the commanded speed falls below the SLEEP THRESHOLD setting for the defined SLEEP DELAY time (see P76 below), the drive will "go to sleep" and the motor will stop. The drive will remain "sleeping" until the it is commanded to operate at a speed that is 2 Hz above the SLEEP THRESHOLD, at which point it will "wake up" and ramp the motor up to the commanded speed.

NOTE 1: While the drive is in Sleep Mode, the display will read "SLP".

NOTE 2: If the drive's commanded speed goes below the SLEEP THRESHOLD, the SLEEP DELAY timer will start to count down. If the commanded speed equals or exceeds the SLEEP THRESHOLD before the SLEEP DELAY times out, the SLEEP DELAY timer will be reset.

NOTE 3: If the drive is in a Stop state, and the commanded speed is below the SLEEP THRESHOLD, the drive will immediately go to sleep upon a Start command, bypassing the SLEEP DELAY.

P76 SLEEP DELAY

This sets the amount of time the drive must operate below the SLEEP THRESHOLD (see P75 above) before the drive "goes to sleep" and brings the motor to zero speed.

Example: SLEEP THRESHOLD is set to 15 Hz and SLEEP DELAY is set to 60 seconds. If the drive operates below 15 Hz for 60 seconds, the drive will go to sleep and the motor will stop. The drive will display "SLP", and the drive will remain sleeping until the drive is commanded to a speed equal to or greater than 17 Hz. At this point, the drive will wake up and and ramp the motor up to the commanded speed. This example assumes that SLEEP BANDWIDTH (P77) is set to 0.

P77 SLEEP BANDWIDTH

This allows the PI feedback signal to determine when the drive should "wake up" when operating in Sleep Mode. In process systems that utilize Integral Gain (see P65), the drive may cycle in and out of Sleep Mode more often than desired, due to the Integral function of the PID algorithm.

When SLEEP BANDWIDTH is used, the feedback signal must change by the programmed amount before the drive will wake up.

Example: In a normal-acting system, the PI setpoint is 50 PSI, SLEEP THRESHOLD is set to 20 Hz, and SLEEP BANDWIDTH is set to 5 PSI. The drive will enter Sleep Mode when the commanded speed drops below 20 Hz for the time defined in SLEEP DELAY. The drive will wake up when the feedback signal drops below 45 PSI (50 PSI setpoint minus 5 PSI bandwidth = 45 PSI), even if the commanded speed is still below 20 Hz.

B.6 DESCRIPTION OF OTHER PARAMETERS

In addition to the PI feature, two parameters have been added, and additional options have been added to the open-collector status outputs:

P06/P13 TB-14 / TB-15 OUTPUT

Three more options have been added to the open-collector outputs:

11 MIN ALARM: Opens when the feedback signal falls below the MIN ALARM setting.

12 MAX ALARM: Opens when the feedback signal exceeds the MAX ALARM setting.

13 MIN/MAX ALARM: Opens when the feedback signal falls below the MIN ALARM setting or exceeds the MAX ALARM setting.

14 INV MIN ALARM: Opens when the feedback signal exceeds the MIN ALARM setting.

15 INV MAX ALARM: Opens when the feedback signal falls below the MAX ALARM setting.

16 INV MIN/MAX ALARM: Opens when the feedback signal is within the range defined by the MIN ALARM and MAX ALARM.

P45 SPEED AT MIN SIGNAL

This sets the speed at which the drive will run when it receives the minimum speed reference signal (0 VDC or 4 mA). This is used in conjunction with SPEED AT MAX SIGNAL (Parameter 46) to define the speed range of the drive when following an analog speed reference signal.

P46 SPEED AT MAX SIGNAL

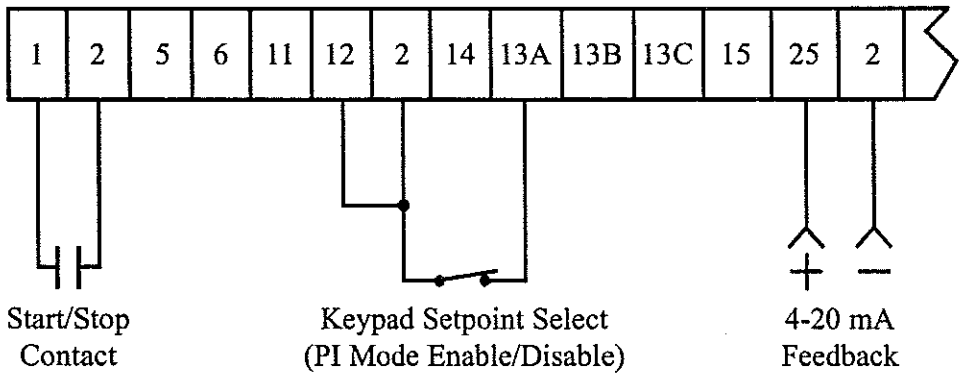
This sets the speed at which the drive will run when it receives the maximum speed reference signal (10 VDC or 20 mA). This is used in conjunction with SPEED AT MIN SIGNAL (Parameter 45) to define the speed range of the drive when following an analog speed reference signal.

NOTE: If SPEED AT MIN SIGNAL is set higher than the SPEED AT MAX SIGNAL, the drive will react inversely to the speed reference signal. Therefore, as the speed reference signal increases, the drive speed will decrease, and vice-versa.

B.7 SCF SERIES PI CONTROL WIRING EXAMPLES

The following diagrams illustrate the most common PI control configurations. The wiring and corresponding parameter settings are given. In these examples, TB-13A is used to select the setpoint reference (TB-13B or TB-13C could also be used for this function). The examples show a 2-wire start/ stop circuit.

Example 1: Keypad Setpoint and 4-20 mA Feedback



- Set PI MODE (Parameter 61) to NORMAL 4-20 mA (02) or REVERSE 4-20 mA (04) depending on the system. Refer to section B.1 to determine whether the system is normal or reverse acting.

- Set TB-13A FUNCTION SELECT (Parameter 10) to KEYPAD SETPOINT (12).

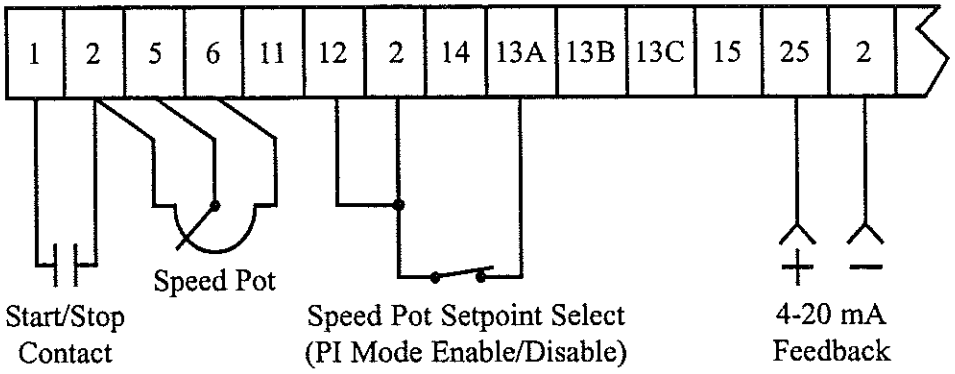
- Close TB-13A to TB-2 to put the drive into PI mode. The ▲ and ▼ buttons can then be used to adjust the PI setpoint.

- Open TB-13A to TB-2 to disable PI mode and control speed directly by the method selected in STANDARD SPEED SOURCE (Parameter 05). For example, if Parameter 5 is set to 0-10 VDC, a speed pot could be used for manual speed control when the PI mode is disabled.

NOTE 1: When TB-13A is closed to TB-2, the drive's display will flash "PIC" to indicate the drive is in PI Control mode. When TB-13A is opened, the display will flash "SPd" to indicate the drive is in Speed Control mode.

NOTE 2: The setpoint reference and the PI feedback cannot be the same signal. If the drive is mistakenly programmed so that the setpoint reference is the same as the feedback reference, the setpoint reference will default to the ▲ and ▼ buttons.

Example 2: Speed Pot Setpoint and 4-20 mA Feedback



- Set PI MODE (Parameter 61) to NORMAL 4-20 mA (02) or REVERSE 4-20 mA (04) depending on the system. Refer to section B.1 to determine whether the system is normal or reverse acting.

- Set TB-13A FUNCTION SELECT (Parameter 10) to 0-10 VDC (02).

- Close TB-13A to TB-2 to put the drive into PI mode. The Speed Pot can then be used to adjust the PI setpoint.

- Open TB-13A to TB-2 to disable PI mode and control speed directly by the method selected in STANDARD SPEED SOURCE (Parameter 05). For example, if Parameter 5 is set to 0-10 VDC, a speed pot could be used for manual speed control when the PI mode is disabled. In this case, one speed pot would serve two purposes: adjusting the setpoint when PI mode is enabled, and adjusting the motor speed directly when PI mode is disabled.

NOTE 1: When TB-13A is closed to TB-2, the drive's display will flash "PIC" to indicate the drive is in PI Control mode. When TB-13A is opened, the display will flash "SPd" to indicate the drive is in Speed Control mode.

NOTE 2: The setpoint reference and the PI feedback cannot be the same signal. If the drive is mistakenly programmed so that the setpoint reference is the same as the feedback reference, the setpoint reference will default to the ▲ and ▼ buttons.

B.8 TUNING THE PI CONTROL

Once the PI control is configured properly, it needs to be tuned in order to maintain the process setpoint. First, set the Integral Gain (Parameter 65) to zero, and increase the Proportional Gain (Parameter 64) until the system becomes unstable, then lower the gain until the system stabilizes again. Set the Proportional Gain about 15% less than that value that stabilizes the system. If only Proportional Gain is used, and the system is operating in a steady-state condition (setpoint is fixed and process variable has settled to a fixed value), there will always be a certain amount of error in the system. This is called the steady-state error.

Integral Gain (Parameter 65) is used to force the steady-state error to zero by increasing the output speed command with respect to time. Over time, the error will be forced to zero because the Integral term will continue to change the speed command, even after the Proportional term reaches steady state and no longer affects the speed command. The Integral Gain affects the rate of rise of the output speed command from the Integral term. Small amounts of Integral Gain can cause large changes in PI performance, so care must be taken when adjusting Integral Gain. Too much Integral Gain will result in overshoots, especially if large step changes in error occur.

The other parameter setting that affects the response of the PI control is Parameter 66 - PI ACCEL/ DECEL. This sets the acceleration and deceleration rate of the setpoint reference into the PI unit. When the setpoint changes, this function will "filter" the input to the PI unit by ramping the setpoint reference from the previous value to the new value. This will help prevent overshoots that can occur when the PI control attempts to respond to step changes in setpoint, resulting in smoother operation. If PI ACCEL/DECEL is set to 0.0 seconds, it is effectively disabled.

B.9 ADDITIONAL STATUS DISPLAYS

The PI option contains additional messages that may appear on the display:

PI OPTION DISPLAYS	
DISPLAY	**DESCRIPTION**
ACP	AUTO CONTROL PAD: The ▲ and ▼ buttons are used to adjust the setpoint in PI mode.
nCP	MANUAL CONTROL PAD: The ▲ and ▼ buttons are used for manual speed control when PI mode is enabled but the drive is operating in open-loop mode.
FL	FOLLOWER LOST: If a 4-20 mA signal is used as a speed reference, PI setpoint reference, or PI feedback, and the signal drops below 2 mA, the drive will trip and display "FL" to indicate that the signal is lost.
SLP	SLEEP MODE: The drive is in Sleep Mode. The motor is at zero speed. The drive will wake up when system demand requires a motor speed above SLEEP THRESHOLD (P75).

AC Tech
a member of the Lenze Group
Drive for Global Excellence

EC DECLARATION OF CONFORMITY

In accordance with EN45014:1998

Applied Council Directive(s): EMC Directive 89/336/EEC, as amended: 92/31/EEC and Low Voltage Directive 73/23/EEC, as amended: 93/68/EEC

We, **Manufacturer:**
AC Technology Corporation
660 Douglas Street
Uxbridge, MA 01569 U.S.A.

Authorized Representative:
AC Technology Europe
4 Shackleton Way
Bowbrook
Shrewsbury, Shropshire SY3 8SW U.K.

declare under our sole responsibility that the products to which this Declaration relates, are in conformity with the relevant provisions of the following standards, provided that installations are carried out in accordance with manufacturer's instructions.

PRODUCTS RELATED TO DECLARATION

SCF Series AC Variable Frequency Motor Drives Models:

SF203Y	SF250Y	SF275	SF415	SF4150	SF530	SF5250
SF205Y	SF210	SF2100	SF420	SF4200	SF550	
SF210Y	SF215	SF2150	SF430	SF4250	SF575	
SF215Y	SF220	SF2200	SF450	SF4300	SF5100	
SF220Y	SF230	SF405	SF475	SF510	SF5150	
SF230Y	SF250	SF410	SF4100	SF520	SF5200	

NOTE: Model numbers may be followed by: "F" (through-hole mount), "F1" (through-hole mount without heatsink), "P" (PI setpoint), and/or "V" (high frequency output)

RELEVANT EUROPEAN STANDARDS

EN 50081-2* Electromagnetic compatibility
– Generic emission standard – Part 2: Industrial environment
EN 50082-2* Electromagnetic compatibility
– Generic immunity standard – Part 2: Industrial environment
EN 50178:1998 Electronic equipment for use in power installations
* with suitable line filters that are properly installed.

YEAR OF CE Marking (Low Voltage Directive): 1999

Signature: Jim Reinwald

Jim Reinwald, Compliance Manager

Date: 5 April 1999

Gerling CA+20 ACTech VFD Setup		
VFD:	AC Tech Model SF215F	
Speed Signal:	Moeller 820-DC-RC	
VFD Wiring:	Maintained Run Contact via Moeller	TB1 to TB2
	Forward Rotation Jumper	TB12 to TB2
	Speed Signal from Moeller 0-10 VDC	TB5 (+)
	Output Analog Signal to Moeller 0-10 VDC	TB30 (+)
	Common for 0-10 VDC In/Out	TB2 (-)
Operation:	On / Off and Speed Control by Moeller 820-DC-RC	
	Analog Output to Moeller for Monitoring	
Parameter	**Description**	**Setting**
P01	Line Voltage	Low (02)
P03	Start Method	Auto Restart (04)
P04	Stop Method	Brake (04)
P05	Standard Speed Source	0-10 VDC (03)
P08	Analog Output	Freq 0-10 VDC (02)
P19	Acceleration Time	5.0 sec
P20	Deceleration Time	10.0 sec
P21	DC Brake Time	0.5 sec
P22	DC Brake Voltage	10%
P26	Motor Overload (4.6 FLA/6.9)	67%

SUPERIOR
REFRIGERATION PRODUCTS

Pressure Relief Valves
"A" Series

Superior offers the most complete range of refrigeration relief valves in the industry. All valves have been designed, constructed and rated in accordance with ANSI/ASHRAE 15 Standard Safety Code for Mechanical Refrigeration and the Canadian Standards Association.

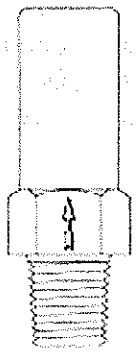
Each valve is stamped U.V./N.B. to indicate National Board certifications as to capacities. Certified National Board ratings are printed below. Minimum setting for all relief valves listed is 150 psi. These "A" series pressure relief valves are all Teflon seated, permitting their use in applications of either high or low temperatures where many times the conventional rubber seated valves are completely unsatisfactory.

Catalog numbers indicate style and size of relief valve only - customer must specify pressure setting when ordering. Standard settings are 235, 300, 350, 400, 425 and 450 psig; settings from 150 up to 450 psig with certified discharge capacities are available at a slight additional cost.

Note: Prior to installation or during pressure vessel testing, Superior pressure relief valves should not be discharged. Any dirt in the system may embed in the seat and prevent the pressure relief valve from resealing properly.

Important: A pressure relief valve is installed in a refrigeration system primarily to protect the receiver. Since it is not intended to be an overload or high pressure cutout, we recommend that the pressure relief valve be set at the working pressure marked on the receiver, regardless of the type of refrigerant used. The method for determining "set pressure" is outlined in ANSI/ASHRAE 15 Standard Safety Code for Mechanical Refrigeration, or write for Technical Bulletin 77-28:90.

Atmospheric - Type 3000A



Catalog Number	Port Diameter	Size (Inches)		Weight (Pounds)
		Inlet	Outlet	
NPT X				
3002	3/16	3/8	*	0.25

* Atmospheric - No External Connection

SUPERIOR
REFRIGERATION PRODUCTS

INTEGRA-SEAL® Ball Valves

WA Series (Welded)

WAS Series (Welded with Access Fitting)

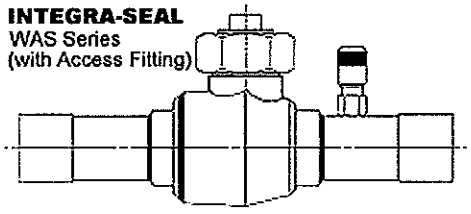
Robotically Welded Body Joint! Full Size Ports for Unrestricted Flow!

The new line of **INTEGRA-SEAL®** ball valves employ the latest robotic welding technology. Every continuous welded body joint is 100% factory tested to ensure positively leak-free performance. Dual Teflon ball seals surround a polished brass or chrome plated steel ball at each end on all valves. A secondary seal becomes effective if foreign material scores the primary seal . . . even in extremely unfavorable conditions such as compressor burnout - a Superior exclusive!

INTEGRA-SEAL® ball valves are constructed using all forged brass body with copper tube extensions on all sizes. Mechanical internal forged stops ensure positive open or closed positions - another Superior exclusive! Full open to full close with 1/4 turn.

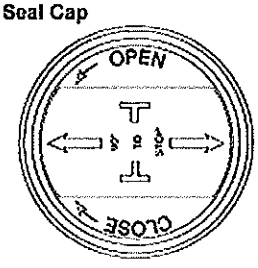
All sizes incorporate a dual stem seal design utilizing Teflon packing compressed by an internal packing nut forming the primary seal. The unique seal cap design permits valve operation without removal of the seal cap and uses Teflon gaskets to provide a secondary seal - a third Superior exclusive! There are no synthetic "O" rings. Ball internal relief port design ensures shut-off in either direction of flow . . . even during evacuation of the system. Full flow ports in all sizes 3/8" through 3-1/8".

All **INTEGRA-SEAL®** ball valves are non-directional flow, may be installed in any position and are UL and C-UL listed.



Size (Inches)							
Catalog Number	IBCA Number	With Access Fitting	IBCA Number	Connection (ODS)	Ball Port Diameter	Weight (Pounds) WA	WAS
587WA-14ST	58584	587WAS-14ST	59729	7/8	0.75	1.0	1.10

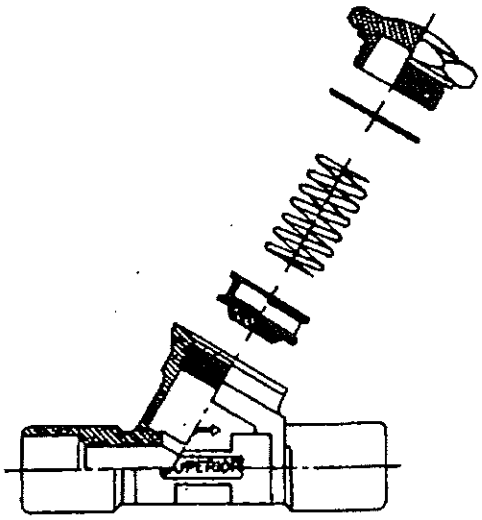
Seal Cap



Seal Cap
Exclusive Seal Cap design permits operation of valve without removal. Markings on cap designates at-a-glance open or closed ball position.

INSTRUCTIONS

For Installation of SUPERIOR Check Valves
With Solder Connections
TYPE 804A



A - Valves With Brass ODS Connections (No Tube Extensions)

For your convenience, these valves are shipped from the factory loosely assembled because it is necessary to remove the internal parts before soldering. Unless the internal parts are removed, the special plastic seat might be damaged by heat penetration.

AFTER SOLDERING - Assemble parts as shown above with the copper gasket between the body and cap. Lightly lubricate the gasket with refrigerant oil. Use 65 ft. lbs. of torque on cap.

B - Valves With Copper Tube Extensions

These valves are shipped from the factory tightly assembled. Do Not Disassemble before soldering. Wrap valve in wet cloth during soldering operation.

SUPERIOR REFRIGERATION PRODUCTS
TAYLOR-WHARTON GAS EQUIPMENT DIVISION harsco corporation
ISO/QS 9001
Sherwood 2200 North Main Street, Washington, PA 15301-6181

SUPERIOR
REFRIGERATION PRODUCTS

"A" Series Pressure Relief Valve
Operation / Installation Sheet

Installation of Pressure Relief Valve

Care should be taken to ensure that pressure relief valves are properly installed in the refrigeration system. A relief valve should be oriented to not directly discharge on persons or system components. The valve should also be oriented to prevent the possible accumulation of liquid or debris in the relief valve body.

NOTE: Because these valves are pre-set, they should not be operated prior to installation or during system testing.

Operation of Pressure Relief Valve

Pressure relief valves are factory pre-set and sealed in accordance with ASME Pressure Vessel Code, Section VIII, Division 1. The "start-to-discharge" (initial leak) is +/- 3% of the set pressure marked on the valve. The operational temperature range is from –40°F (-40°C) to 325°F (162°C). These valves are intended for use with approved refrigerants in refrigeration systems.

IMPORTANT: A pressure relief valve is installed in a refrigeration system primarily to protect the receiver. A pressure relief valve is not intended to function as an overload or high-pressure cutout and should not be used for that purpose. The pressure relief valve should be rated for the working pressure of the receiver.

Markings on Pressure Relief Valve

Pressure relief valves are marked with the series, catalog number (type description followed by a dash), set pressure (in psig), flow capacity, and appropriate regulatory identification.

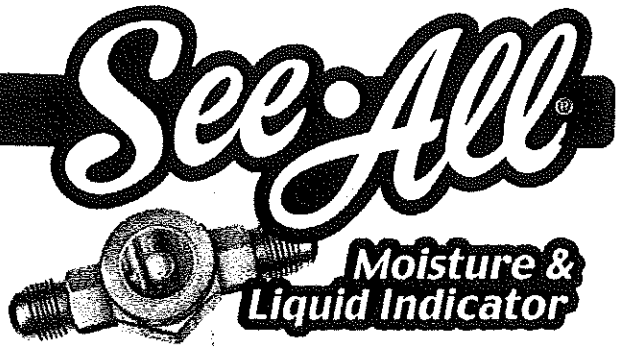
Repair and Testing

Never attempt to repair or change the setting of pressure relief valves. Any change in setting or repair in the field will void the ASME certification and the manufacturer's warranty. It may also create a safety hazard because the valve may not function as intended.

Inspection and Replacement

WARNING: As with any durable product, the operation of pressure relief valves can be affected by factors such as corrosion and aging. The environment and sue conditions will determine the safe service life. All pressure relief valves should be visually inspected regularly. Pressure relief valves should be replaced immediately if there is any evidence of contamination, corrosion, leakage, tampering, or improper operation.

Installation Instructions



GENERAL – The See·All® Moisture & Liquid Indicator may be installed anywhere in the liquid line. When located between the Catch-All® Filter-Drier and the expansion device, bubbles indicate a shortage of refrigerant **or** a restriction in the liquid line such as a plugged drier. **Change the drier when the color is in the caution or wet range.** When received, the indicator may not indicate dry. This in no way affects operation or calibration of the indicator. **The action of the indicator element is completely reversible and will change color whenever the moisture content of the system changes.**

The indicating element may change color rapidly on some installations, while others may take a much longer period of time. New systems or systems where the drier has been replaced will cause the indicator to start changing color almost immediately. However, it is recommended that the equipment **operate for 12 hours** to allow the system to reach equilibrium before deciding if the drier should be changed.

The drying of the system should be continued until the indicating element stays **Dark Green.**

The moisture change level of the refrigerant in Parts Per Million (PPM) for the various See·All Moisture Indicator colors is shown below.

BRAZING INSTRUCTIONS – See·All Moisture & Liquid Indicators with 1/4" through 1-1/8" ODF connections are ready for brazing as received. Avoid overheating the body since extreme heat could damage the glass joint. If a wet rag is used it should be wrapped around the fittings and bottom of the body, but not around the top of the See·All body. In this way, any moisture inside the See·All will not condense on the cool glass surface and wash away the color indicator material.

The **indicator cartridge** must be removed from the SA-211, SA-213 and SA-217 (1-3/8", 1-5/8" and 2-1/8" line sizes) See·All indicators before brazing into the liquid line. It is shipped hand tight.

All See·All indicators with sweat fittings are suitable for use with any of the **commonly used** brazing alloys including silver solder, Sil-Fos, Phos-copper or Sta-Brite.

BRAZING TECHNIQUE –

1. Fittings are clean and ready to braze as received. **Avoid excessive polishing with steel wool** since this may rub off the copper plating on models with plated steel fittings, making brazing more difficult.
2. During brazing, bleed an inert gas (dry nitrogen or CO_2) through the tubing and See·All.
3. Use a torch that is large enough to rapidly heat the line size being used.

MOISTURE CONTENT PPM

See·All Shows	Refrigerant											
	11 & 12		123 & 22		134a		113, 114 & 502		404A & 507		407C	410A
	Liquid Line Temperature (°F)											
	75°	100°	75°	100°	75°	100°	75°	100°	75°	100°	75°	75°
Green DRY	Below 5	Below 10	Below 30	Below 45	Below 50	Below 80	Below 10	Below 20	Below 15	Below 30	Below 120	Below 75
Chartreuse CAUTION	5-15	10-30	30-90	45-130	50-200	80-225	10-45	20-65	15-90	30-140	120-180	75-150
Yellow WET	Above 15	Above 30	Above 90	Above 130	Above 200	Above 225	Above 45	Above 65	Above 90	Above 140	Above 280	Above 150

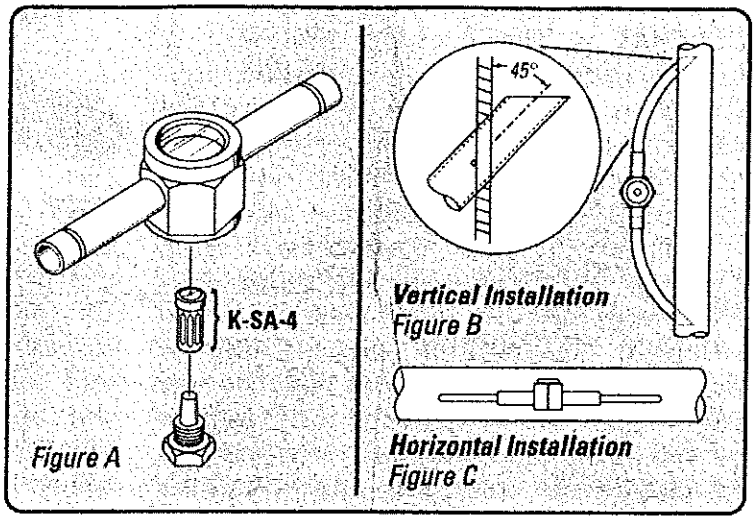
For use on Refrigeration and/or Air Conditioning Systems ONLY

4. Direct the flame away from the See•All body.
5. Perform the brazing as rapidly as possible.

consists of a new slotted cylinder and indicator assembly. These parts can be replaced by removing the plug opposite to the glass. See Figure A.

FLARING TECHNIQUE –

1. Deburn tubing before flaring.
2. Use a drop of oil on the cone of the flaring tool.
3. Place drops of refrigerant oil on the front and back surface of the flare before drawing the nut tight. This allows flare and fitting to mate smoothly.
4. **It is especially important to use oil on joints where both the male and female fittings are plated steel. The oil will prevent galling.**



APPLICATION SUGGESTIONS – The Sporlan See•All Moisture & Liquid Indicator should not be used on systems containing **methyl alcohol** or similar liquid dehydrating agents unless and oversize Catch-All Filter-Drier has been installed previously to remove these additives. Certain colored liquid leak detectors in a system may permanently discolor the moisture indicating element.

On systems containing an **excessive amount of water**, as a result of a broken condenser or water chiller, do not install the See•All indicator until the Catch-All Filter Drier or the replaceable cores have been changed several times to reduce the initial high moisture content. Liquid water will dissolve and wash away the color indicator material resulting in a light yellow or white color. This type of damage is permanent – the See•All will no longer change color. If the indicator paper is damaged, it is preferable to change the See•All.

When the See•All is soldered in a **difficult location**, it may be desirable to change only the indicator. This can be done with the fused glass models manufactured since 1984. Sporlan kit K-SA-4

The recommended clean-up procedure **after a hermetic motor burnout** is described completely in Bulletin 40-10. A See•All should be installed after the clean-up procedure is nearly complete (when the Catch-All Filter-Drier is being replaced.)

Do not use See•All indicators at temperatures below –50°F.

BYPASS INSTALLATION – The See•All Moisture & Liquid Indicator may be installed in a bypass to the main liquid line when desired – and must be installed in this manner on lines larger than 2-1/8" OD.

BYPASS INSTALLATION KITS – Are available from your Sporlan Wholesaler. While satisfactory liquid and moisture indication will generally be obtained in any position, preferred methods of installation are shown in Figures B and C.

All Sporlan See•All indicators are suitable for use with the halocarbon refrigerants, including 11, 12, 22, 113, 114, 134a, 404A, 407C, 410A, 502 and 507. Listed by Underwriter's Laboratories, Inc. for a working pressure of 650 psig or 4482 kPa.

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SOLENOID VALVES

Installation and Servicing Instructions

NOT FOR USE ON HAZARDOUS OR CORROSIVE FLUIDS

- **The molded MKC-1 coil fits the A3, E3, W3, S4, E5, B6, E6, S6, W6, S7, R183, R184 and R246 series normally closed solenoid valves.**
- **The OMKC-1 coil fits the XWG, XUP and XXF series rapid cycle solenoid valves.**
- **The MKC-2 coil fits the B9, E9, B10, E10, B14, E14, W14, B19, E19, W19, B25, E25, W25, B33, E33, E34, E42 series normally closed solenoid valves and the 180 solenoid pilot control... and all solenoid valves in the field that are equipped with the old style KC-2 coil.**
- **When changing from the old KC model coils to the current MKC molded model coils, discard the coil housing, coil housing bottom plate, two coil sleeves (not used with KC-1 coil) AND THE SPACER.**
- **The OMKC-2 coil fits the OB9, OE9, OB10, OE10, OB14, OE14, OB19, OE19, OB25, OE25, OB33, OE33, OE34, OE42 series normally open solenoid valves and the XRN, XRM, XPO series rapid cycle solenoid valves.**
- **Other Sporlan Valve products using a molded coil are as follows:**
  MKC-1 — OM-1, SORIT, 8D, 12D, 10G, SORIT-PI, 5D, SHGB(E)-8.
  MKC-2 — 16D, DDR-20, SHGB(E)-15, OLDR-15 and OLDR-20.
  OMKC-2 — LDR-15, LDR-20, XTM and XTO.

To insure peak performance, solenoid valves must be selected and applied correctly; however, proper installation procedures are equally important. The following instructions list the essential points for correct installation.

An exploded view of a typical solenoid valve is illustrated in Figures 5, 5A and 6, page 4.

Position — All standard solenoid valves may be mounted horizontal, on its side or in a vertical line with the exception of the following: A3 dated 6-86 or before, MA32, B33, OB33, MA42, MA50, MA5A, MA17A, XWG, XUP, XRN, XRM and XPO series. These valves **MUST** be installed in horizontal lines with the coil housing no more than 45° from vertical, see table on page 2. The direction of flow is indicated by an **arrow** or the word **IN** on the inlet of the valve body. For heat pump applications, valve types C(M)E and C(M)B are typically installed with the directional arrow pointing toward the outdoor coil. Or, the **IN** connection toward the indoor coil.

NOTE: Solenoid valves having a type number starting with the letter "X" are Special Solenoid Valves (non-standard). Contact Sporlan Valve Company, Washington, MO if valve mounting is in question.

SOLDER CONNECTIONS

Because of possible damage to valve components due to the high temperatures of soldering and brazing, "B" Series Solenoid Valves with brass connections are shipped handtight to facilitate disassembly, with the exception of the (M)B33S2 & OB33S2. It is necessary to completely disassemble these valves before any heat is applied to the valve body. The following steps outline recommended procedures when installing these valves.

Soldering Precautions — Solder connections on Sporlan Solenoid Valves are either copper or brass. Any of the commonly used types of solder are satisfactory with these materials. Regardless of the type of solder used, it is important to avoid overheating the valve.

The tip of the soldering torch should be large enough to avoid prolonged heating of the connection during the soldering operation. Overheating can also be minimized by directing the flame away from the valve body.

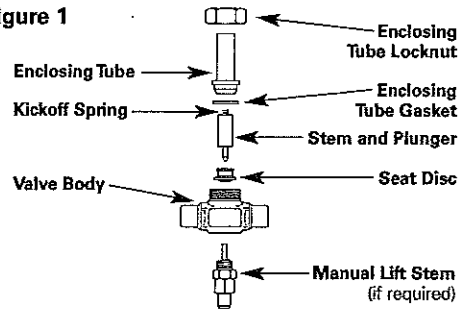
Type A3S1, S4S1, S6S1, S7S1

1. Remove the coil assembly.
2. Locate the word **IN** or the directional **arrow** on the valve body.
3. Place the valve in the line, in the proper direction of flow, and solder.
4. Replace the coil assembly and tighten coil hex screw.

Types B6, B9, B10, B14, B19, B25 Series (Brass Connections)

1. Remove the coil assembly, enclosing tube and nut, all internal parts, and manual lift stem assembly.
2. Locate the word **IN** or the directional **arrow** on the valve body.
3. Place the valve in the line in the proper direction of flow and solder.

■ **Figure 1**



4. Re-assemble as follows, see Figures 1, 5, and 5A:
   a. Place the seat disc into the valve body with the smaller diameter end facing up.
   b. Place the enclosing tube gasket onto the valve body above the threads.
   c. Hold the plunger with one hand so that the pointed end is resting in the pilot port of the disk. Make sure the small spring is in place on the top of the plunger. **(NOTE: Does not apply to normally open and rapid cycle series.)**
   d. With the other hand, place the enclosing tube over the plunger, making sure the enclosing tube gasket is in position.
   e. Replace the enclosing tube locknut and tighten. (See recommended torque in the table on page 2.) **Do not over tighten.**
   f. Replace manual lift stem. Tighten lift stem assembly and seal cap.
   g. Replace the coil assembly. **(NOTE: For normally open and rapid cycle valves replace spacer and spacer cup with coil assembly.)**

NOTE: Excessive tightening of the enclosing tube locknut can damage the valve body bore. Please observe the torques listed on page 2.

Types: All E Series (Extended Copper Connections)

Brazed into the line without disassembly because the valve contains extended connections. Use caution by placing a wet cloth or chill block on the extensions at the body to prevent excessive overheating. Follow Type A3S1 installation instructions.

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BULLETIN 30-11, AUGUST 2003 SUPERSEDES BULLETIN 30-11, NOVEMBER 2000 AND ALL PRIOR PUBLICATIONS.

RECOMMENDED TORQUE (ft.–lbs.)

VALVE SERIES①	ENCLOSING TUBE LOCKNUT⑤	ENCLOSING TUBE SCREWS	PILOT VALVE ASSEMBLY LOCKNUT	LOWER BODY LOCKNUT	COIL SCREW	COIL LOCKNUT	FLANGE PLATE BOLTS/ SCREWS	FLANGE CONNECTION BOLTS	MANUAL LIFT STEM ASSEMBLY	SEAL CAP	VALVE MOUNTING POSITION		
											VERTICAL LINE③	HORIZONTAL LINE	ON SIDE③
A3, S4, S6, S7	—	—	—	—	2.3	—	—	—	—	—	YES dated 7-86 or later	YES	
E3, E5	—	—	—	—	2.3	—	—	—	—	—	YES	YES	
W3		1.5 – 1.67									NO	YES②	
XWG		—											
B6, E6, W6	10 – 15	—	—	—	2.3	4.0	—	—	11 – 12	4 – 6	YES	YES	
XUP											NO	YES②	
B9, E9, OB9, OE9	25 – 30	—	—	—	2.3	4.0	—	—	11 – 12	4 – 6	YES	YES	
XRN											NO	YES②	
B10, E10, OB10, OE10	20 – 40	—	—	—	2.3	4.0	—	—	11 – 12	4 – 6	YES	YES	
B14, E14, W14, OB14, OE14													
XRM											NO	YES②	
B19, E19, W19, OB19, OE19	35 – 45	—	—	—	2.3	4.0	—	—	11 – 12	4 – 6	YES	YES	
XPO											NO	YES②	
B25, E25, W25	60 – 65	—	—	—	2.3	4.0	—	—	11 – 12	4 – 6	YES	YES	
OB25, OE25													
B33	25 – 30	—	—	—	2.3	4.0	8 – 12	37	11 – 12	4 – 6	NO	YES②	
E34								—			YES	YES	
OB33								37			NO	YES②	
OE34								—			YES	YES	
E42, OE42	25 – 30	—	—	—	2.3	4.0	13 – 20	—	11 – 12	10 – 15	YES	YES	
MA5A3	25 – 50	—	—	—	—	4.0	—	24	11 – 12	10 – 15	NO	YES	NO
MA17A3								37					
MA32	—	—	—	—	—	4.0	8 – 12	74	11 – 12	10 – 15	NO	YES	NO
MA42							12 – 20						
MA50							25 – 35						
R183, R184, R246	—	6	—	—	2.3	—	—	—	—	—	YES	YES	
8D	10 – 15	—	60 – 65	60 – 65	2.3	—	—	—	—	—	YES	YES	
12D				—			15 – 18						
16D	30 – 35	—	④	—			20 – 24						
10G	10 – 15	—	60 – 65	60 – 65			—						

①Valves with mounting holes use a #8-32 screw torqued not more than 15 in.-lb. **Note:** Standard torque charts do not apply. ②Coil housing to be no more than 45° from the vertical. ③Coil housing must not be below horizontal. ④The 16D pilot assembly is connected to the body with a pipe connection. Apply a light coat of #242 (Blue) Loctite to the male pipe thread and torque to 30-60 ft.-lb. ⑤Do not over tighten the enclosing tube locknut. Damage to the enclosing tube assembly could result from over tightening.

PIPE CONNECTIONS

Types A3, W3, B6, W6, B9, B10, B14, W14, B19, W19, B25, W25, (K)(B)R183, (K)(B)R184, (K)(B)R246 Series

These valves can be installed without disassembly. Avoid excessive amounts of pipe sealing compounds. It will interfere with the valve operation if it comes in contact with the valve's internal parts.

NOTE: When pipe type solenoid valves are installed with pipe to ODF adaptors, the valve must be disassembled prior to brazing the ODF adaptors.

FLANGED CONNECTIONS— PIPE or SOLDER

Solenoid valves with flanged connections may be installed without disassembly. In most cases the flanges are packed disassembled from the valve body. Therefore, they may be installed in the line before the valve is installed. Be certain that the correct flange is installed on the inlet line in order to properly match the flow direction of the valve. If the valve is installed backwards, it will not function properly.

Types MA5A3, MA17A3, MA32P3, MA42P3, MA50P3

Avoid the use of excessive amounts of pipe sealing compounds. It will interfere with the valve operation if it comes in contact with the valve's internal parts.

Types B33S2, MB33S2, OB33S2, MA42S3, MA50S3

These valves are supplied with a two piece flange assembly, a semi-steel flange ring and a brass solder bushing. The flange should be placed on the pipe before the bushing is soldered or brazed. The soldering discussion given under "Solder Connections" applies for these valves except where the discussion deals with non-flanged valves only.

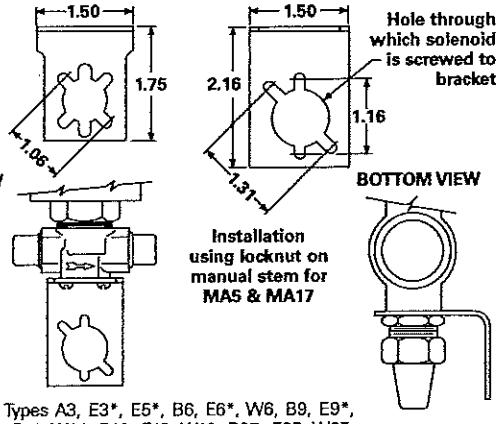
With Types MA42S3 and MA50S3, use the correct flange and bushing that corresponds with its mating flange on the valve to insure correct flow direction.

These valves have male flange connections on the inlet of the valve; therefore, the flange and bushing for the inlet must be the female pair.

INSTALLATION—ALL VALVES

Mounting — A Type 1216-1 universal mounting bracket, Figure 2, is available, when ordered. It fits all standard Sporlan Solenoid Valves except the Types W3, MA32, B33, E33, E34, E42, MA42, MA50, (K)(B)R183, (K)(B)R184, (K)(B)R246 series and the Type 180 Solenoid Pilot Control. The slots in the bracket match the tapped holes in the standard solenoid valves so that they may be secured by two screws supplied with the bracket. A locknut is also furnished for use with Types MA5A3 and MA17A3. Both types of installations are shown in Figure 2. The manual lift stem seal cap is replaced after the locknut is tightened against the bracket.

■ Figure 2

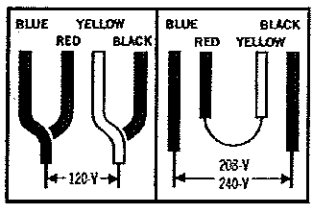


Installation for Types A3, E3*, E5*, B6, E6*, W6, B9, E9*, B10, E10, B14, E14, W14, B19, E19, W19, B25, E25, W25, Series & Types MA5A, MA17A Solenoid Valves.
*Are not supplied standard with mounting holes.

Wiring — Check the electrical specifications of the coil to be sure they correspond to the available electrical service.

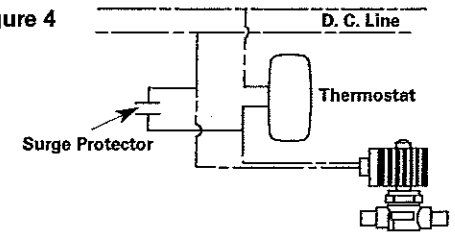
The 1/2" BX conduit connection or junction box on the coil may be rotated to any position by loosening the coil hexscrew. Solenoid valves with four-wire dual voltage coils have a wiring diagram decal, Figure 3, on the coil housing or bracket. This illustrates which wires to connect for either 120, 208 or 240 volt operation. Wiring and fusing (when used) must comply with prevailing local and national wiring codes and ordinances.

■ Figure 3



Direct Current Valves — A surge protector is supplied with each solenoid valve with a 115 volt DC coil. The surge protector is necessary to absorb the high counter-voltage generated when the circuit is broken, thereby protecting the electrical contacts of the thermostat. It should be wired as shown in Figure 4.

■ Figure 4



TRANSFORMER SELECTION

COIL KIT	24v/50-60c		120v/50-60c		240v/50-60c		Transformer Rating Volt-Amperes
	Current Amperes		Current Amperes		Current Amperes		For 100% of rated MOPD of Valve
	In-rush	Hold-ing	In-rush	Hold-ing	In-rush	Hold-ing	
MKC-1	1.9	.63	.39	.14	.19	.09	60
OMKC-1	1.9	.94	.42	.21	.20	.10	60
MKC-2 OMKC-2	3.1	1.4	.60	.26	.31	.13	100
KC-3	7.9	1.9	1.7	.41	.83	.21	250

SERVICING INSTRUCTIONS

CAUTION — Dangerous hydraulic pressures may develop if a hand valve is installed in the liquid line ahead of the solenoid valve and the hand valve is closed while the solenoid valve is closed. This may cause extrusion of the teflon seat in the disc. Extrusion may cause the valve to fail to open, fail to close and/or have excessive seat leakage. Also the line between these two valves should be pumped down completely before disassembling the solenoid valve for service.

NOTE: The optional manual lift stem is designed to prevent damage to the disc. If the stem is turned in too far, the threads become disengaged. These threads can be re-engaged by applying slight outward force while turning counterclockwise. A thread stop is provided to prevent the stem from backing all the way out of the assembly. Back the stem to the stop and replace the seal cap when service is complete.

TYPICAL MALFUNCTIONS

There are only three possible malfunctions: **1. Coil burnout. 2. Failure to open. 3. Failure to close.** Each is discussed.

1. COIL BURNOUT

Coil burnouts are extremely rare unless caused by one of the following:

1. Improper electrical characteristics.
2. Continuous over-voltage, more than 10%.
3. Under-voltage of more than 15%. This applies only if the operating conditions are such that the reduced MOPD causes stalling of the plunger, which results in excessive current draw.
4. 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 KC model coil and coil yoke, coil backplate or plunger on the MKC molded model coils.
5. Mechanical interference with plunger movement which may be caused by a deformed enclosing tube.
6. Voltage spike.
7. Valve ambient exceeds 120°F.
8. Fluid or gas temperatures greater than 240°F, while the valve ambient is 120°F.

2. FAILURE TO OPEN (Normally Closed Types)

1. Coil burned out or an open circuit to coil connections.
2. Improper electrical characteristics.
3. 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.
4. High differential pressure that exceeds the MOPD rating of the valve.
5. Diameter reduction of synthetic seating material in pilot port because of high temperatures and/or pressures, or severe pulsations. Contact Sporlan Valve Co., Washington, MO.

The problem of dirt can be avoided by installing a Sporlan Catch-All® Filter-Drier upstream from the solenoid valve. The Catch-All® Filter-Drier will retain much smaller particles than a conventional strainer.

Use a Sporlan strainer for water applications upstream of every industrial solenoid valve.

3. FAILURE TO CLOSE

1. Valve is oversized. Pilot operated valves may fail to close due to low pressure drop.
2. In pilot operated valves, dirt, scale or sludge may prevent the piston, disc or diaphragm from closing. This could also be caused by a deformed body.
3. Held open by the manual lift stem.
4. In pilot operated valves only, a damaged pilot port may prevent closing.
5. A floating disc due to severe discharge pulses, contact Sporlan Valve Co., Washington, MO.
6. Have voltage feedback to the coil after the coil de-energizes.

MISCELLANEOUS

1. **Liquid Hammer** — Industrial solenoid valves, or other liquid line valves, may cause liquid hammer when installed on liquid lines with high liquid velocities. If this occurs, it can be minimized by the use of larger pipes, (i.e. lower velocities), or a standpipe installed in the piping near the solenoid valve inlet. Commercially available shock absorbers may also be used to reduce this noise. Recommended maximum velocity is approximately 300 fpm.

2. **AC Hum** — This problem may be caused by a loose coil housing on a KC model coil. On rare occasions this may be caused by loose coil sleeves, in which case deforming them slightly will eliminate the hum. A loose coil hex screw or coil locknut may cause this problem on the MKC molded model coils.

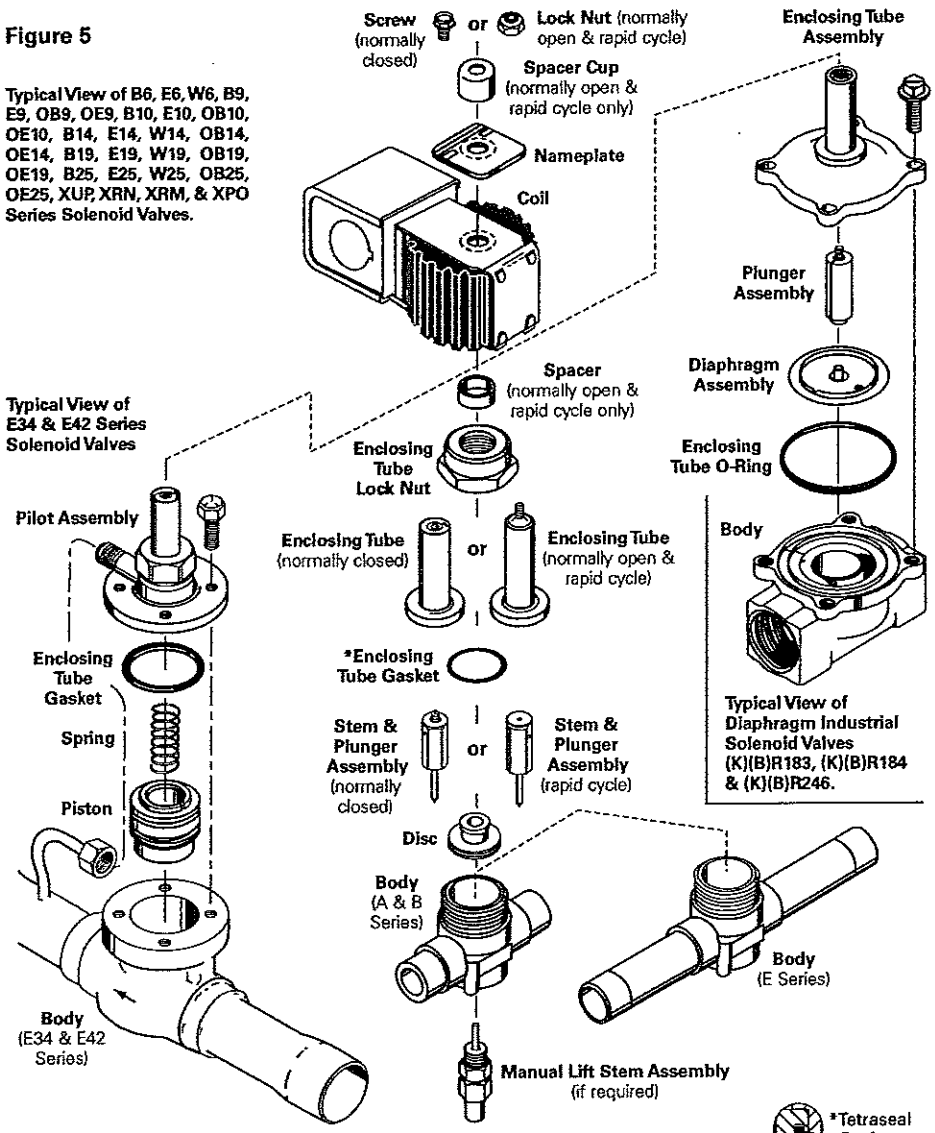
   Foreign material between the magnetic top plug and the plunger in the Types A3, E3, W3, E5, B6, E6, W6, B9, E9, B10, E10, B14, E14, W14, B19, E19, W19, B25, E25, W25, B33, E33, E34 and E42 Series Solenoid valves may cause AC hum also.

   On water applications, deposits may accumulate in the valve which could cause AC hum. This may be eliminated by cleaning or flushing the valve.

3. **Leak Testing** — Special care should be taken when leak testing valves with synthetic gaskets. Gasket materials are slightly permeable. Leak rates of 0.5 oz. per year should be acceptable. Note the sensitivity of electronic leak detectors. Most have the capability of finding a leak smaller than 0.05 oz. per year. Double check small seal leaks with soap bubbles or a halide torch if possible. **Do not over tighten the enclosing tube locknut.** If a leak occurs, change the gasket and verify the metal surfaces have a clean smooth finish.

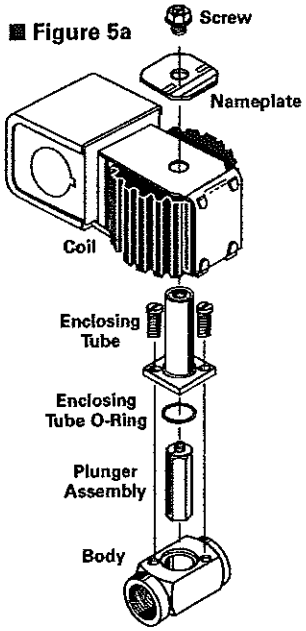
Figure 5

Typical View of B6, E6, W6, B9, E9, OB9, OE9, B10, E10, OB10, OE10, B14, E14, W14, OB14, OE14, B19, E19, W19, OB19, OE19, B25, E25, W25, OB25, OE25, XUP, XRN, XRM, & XPO Series Solenoid Valves.



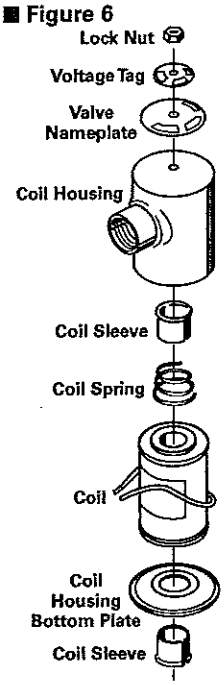
*B and E Series Solenoid Valves have been redesigned. The new design can be easily identified as a thin, synthetic coated metal gasket, known as a Wolverine gasket. The old gasket is a thicker type of O-ring with a square cross section, known as a tetraseal. See the partial cross sections of the valve body at right. The gaskets and the enclosing tubes of the two designs are not interchangeable. The new enclosing tube assembly is included in the replacement parts kits.

Figure 5a



Typical View of W3, XOF & XJH Solenoid Valve

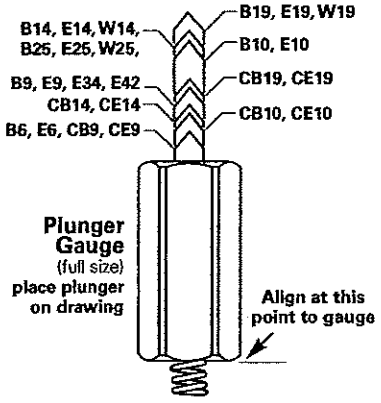
Figure 6



Typical View of KC-3 Coil used on valve types: MA5A, MA17A, MA32, MA42 & MA50.

For installation and service instructions on Three-Way Heat Reclaim Valves Type 8D, 12D & 16D, request Form SD-114.

Figure 7



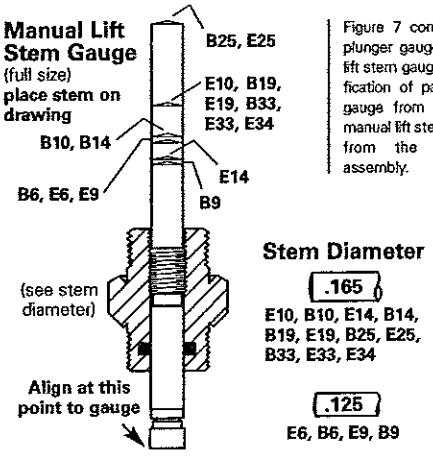


Figure 7 contains a full size plunger gauge, and a manual lift stem gauge for easy identification of parts. Be sure to gauge from the end of the manual lift stem. Do not gauge from the packing gland assembly.

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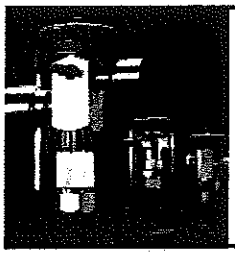

Thermostatic Expansion Valves

Installation, Field Service, and Assembly

SPORLAN

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Installation

For peak performance, it is important to select a Sporlan Thermostatic Expansion Valve (TEV) with correct capacity, selective charge, external or internal equalizer, etc. See Bulletins 10-9 and 10-10 for complete application information. Equally important is the proper installation, which can determine the success or failure of the entire system.

Valve Location

TEVs may be mounted in any position, but they should be installed as close to the evaporator as possible. If a refrigerant distributor is used with the expansion valve, best performance is obtained if the distributor is mounted directly to the valve outlet. If the distributor cannot be mounted directly to the valve outlet, the distance between the valve outlet and distributor should not exceed 24 inches or refrigerant distribution problems may occur. Also, the tube connecting the valve outlet and distributor can be sized smaller to maintain refrigerant velocity and better distribution. Elbows located between the expansion valve and distributor will hinder proper distribution and therefore, are not recommended.

Best distribution is usually obtained if the expansion valve feeds vertically up or down into the distributor. System manufacturers, however, have successfully applied distributors in other orientations. See Bulletin 20-10 for application and selection information on refrigerant distributors.

While not always convenient or possible, valve Types BI, F, FB, and O are easier to service if mounted in a vertical and upright position. If mounted in a horizontal position, the internal parts must be carefully reassembled to prevent damage to them. Also, some consideration should be taken in mounting larger sized expansion valves. They must be adequately supported since system vibration and the weight of the valve may cause valve connections to fracture.

If a hand valve is located on the outlet side of the TEV it should have a full sized port. No restrictions should appear between the TEV and the evaporator, except a refrigerant distributor if one is used.

Sporlan TEVs having Selective Charges C, Z, L, or X may be installed and operated in most locations. The amount of thermostatic charge and the bulb size are such that the bulb retains control despite a colder valve body or diaphragm case. The exception is when the element is subjected to sub-zero temperatures for extended periods of time during an off-cycle. In this case, start-up may be prolonged until the bulb and element are warmed sufficiently to open the valve.

To minimize the possibility of charge migration, the Sporlan MOP type charges (CP series, ZP series, and VGA) should be installed so the diaphragm case is warmer than the bulb. Special non-condensable charges without MOP and double diaphragm hydraulic elements with MOP are available for system manufacturers to overcome this potential problem.

Occasionally, TEVs are located in corrosive atmospheric conditions that can damage the valve and/or the element assembly. Due to this possibility, the valve must be protected with appropriate materials to prevent premature failure. Consult specialists in protective coatings.

Precautions:

When the evaporator and TEV are located above the receiver, there is a static pressure loss in the liquid line. This is due to the weight of the column of liquid refrigerant, and this weight may be interpreted in terms of pressure loss in pounds per square inch as shown in Table 3, Bulletin 10-9. If the vertical lift is great enough, vapor or ***flash gas*** will form in the liquid line causing a serious reduction in the capacity of the TEV.

When an appreciable vertical lift is unavoidable, precautions should be taken to prevent the accompanying pressure loss from producing liquid line vapor. This can be accomplished by providing enough subcooling to the liquid refrigerant, either in the condenser or after the liquid leaves the receiver. Subcooling is determined by subtracting the actual liquid temperature from the condensing temperature (corresponding to the condensing pressure). A subcooling calculation example is provided in the "subcooling" section of Bulletin 10-9.

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Bulletin 10-11, October 2003 Supersedes Bulletin 10-11, September 1996 and all prior publications.

Liquid subcooling is provided by the following methods:

1. **In the condenser**
2. **Suction – liquid heat exchanger**
3. **Special devices**

Method 1 – will provide sufficient subcooling for the simple short-coupled system that has only moderate liquid line pressure drop.

Method 2 – will usually not provide more than 20°F subcooling on air conditioning systems operating at normal head pressures. The amount of subcooling will depend on the design and size of the heat exchanger and on the operating suction and discharge pressures.

Method 3 – may be used to provide considerable subcooling required for systems with excessive vertical lift. The following special devices are the most commonly used methods:

- Water coils in heat exchange relationship with the liquid line.
- Separate refrigeration system.
- Special heat exchanger which uses a portion of the refrigerant to cool the main body of liquid. See Figure 1.

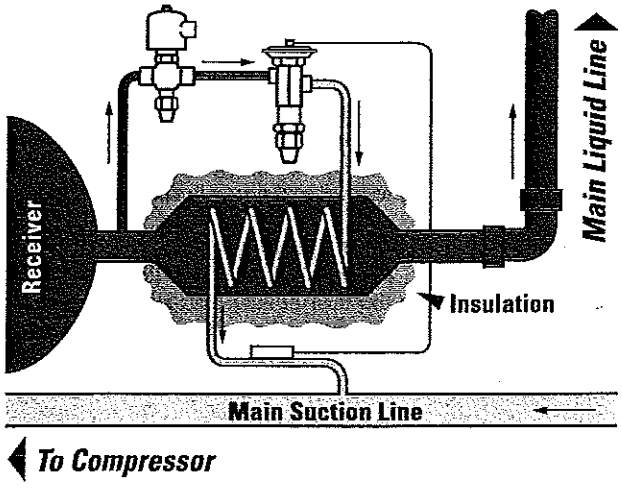


Figure 1

Ordinarily the conventional suction-liquid heat exchanger is installed near the evaporator, where the suction vapor is the coldest, to re-condense any vapor in the liquid line. When the primary purpose of the heat exchanger is to prevent the formation of flash gas – particularly on systems that have a long liquid line or excessive vertical lift – install the heat exchanger near the receiver ***before the vertical lift occurs.*** (This also applies to the special devices described in Method 3). Because vapor in the liquid line considerably increases friction losses, the total pressure drop available across the expansion device on these types of systems is reduced. Also, the suction line and liquid line should be carefully insulated to minimize heat gain if subcooled below ambient temperature.

Important

Preventing the formation of vapor in liquid lines having high pressure losses does not eliminate the requirement that an adequate pressure drop must be available across the TEV. The capacity tables show valve capacities at pressure drops lower than normal. For TEV application data and capacities at pressure drops below those listed, ***consult Sporlan Valve Company.***

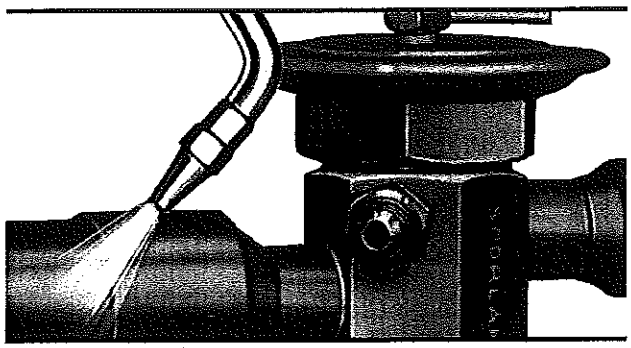


Figure 2

Solder Techniques

It is not necessary to disassemble solder type valves when soldering to the connecting lines. Any of the commonly used types of solders, e.g., 95-5, Sil-Fos, Easy-Flo, Phos-Copper, Stay Brite 8 or equivalents may be used for copper to copper connections. When soldering a brass refrigerant distributor to the valve, appropriate solders for these connections, such as 95-5, Easy-Flo, Stay Brite 8 or equivalents must be used. It is important however, regardless of the solder used, to direct the flame away from the valve body and avoid excessive heat on the diaphragm, Figure 2. As an extra precaution, a wet cloth may be wrapped around the body and element during the soldering operation.

This precaution will prevent overheating the valve body which could damage the superheat spring and result in flood back problems. In addition, the Type O, EBF/SBF, and EBS valve contain synthetic parts which can be damaged due to overheating, resulting in poor valve performance.

Bulb Location and Installation

The location and installation of the bulb is extremely important to the proper performance of the system and care should be taken with its final location.

Accepted principles of good suction line piping should be followed to provide a bulb location that will give the best possible valve control. When system manufacturers have piping recommendations that differ from the general industry recommendations and Sporlan's suggestions shown in this section, those recommendations should be used. When specific recommendations are not available, the suggestions below should be used.

The bulb should be attached to a horizontal suction line at the evaporator outlet (See Figures 3, 4, and 5) If the bulb cannot be located in that manner, it may be located on a ***descending*** vertical line only (as shown in Figure 5 for "pumpdown control"). The bulb should never be located in a trap or downstream of a trap in the suction line. Liquid refrigerant or mixture of liquid refrigerant and oil boiling out of the trap will falsely influence the temperature of the bulb and result in poor valve control.

On suction lines 7/8" OD and larger, the surface temperature may vary slightly around the circumference of the line. On these lines, it is generally recommended that the bulb be installed at 4 or 8 o'clock on the side of the horizontal line, and parallel with respect to the direction of flow. On smaller lines the bulb may be mounted at any point around the circumference, however locating the bulb on the bottom of the line is not recommended as an oil-refrigerant mixture is generally present at that point. Certain conditions peculiar to a particular system may require a different bulb location than normally

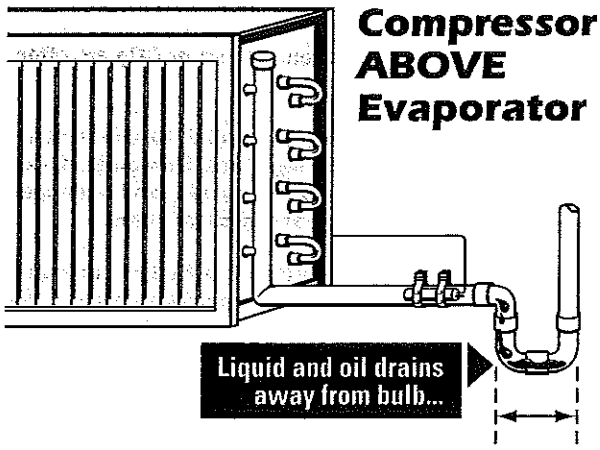


Figure 3

recommended. In these cases the proper bulb location may be determined by trial.

For satisfactory expansion valve control, ***good thermal contact*** between the bulb and suction line is essential. The bulb should be securely fastened with two bulb straps, supplied with each expansion valve, to a clean straight section of the suction line.

Recommended suction line piping usually includes a horizontal line leaving the evaporator to which the TEV bulb is attached. This line is pitched slightly downward, and when a vertical riser follows, a short trap is placed immediately ahead of the vertical line, see Figure 3. The trap will collect any liquid refrigerant or oil passing through the suction line and prevent it from influencing the bulb temperature.

On multiple evaporator installations the piping should be arranged so that the flow from any valve cannot affect the bulb of another. Approved piping practices including the proper use of traps insures individual control for each valve without the influence of refrigerant and oil flow from other evaporators.

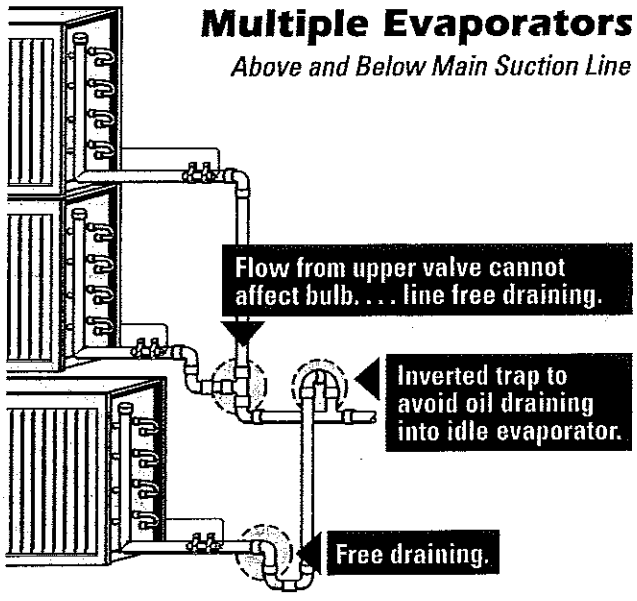


Figure 4

For recommended suction line piping when the compressor is located below the evaporator see Figure 5. The vertical riser extending to the height of the evaporator prevents refrigerant from draining by gravity into the compressor during the off-cycle. When a pumpdown control is used the suction line may turn immediately down without a trap.

On commercial and low temperature applications requiring Sporlan Selective Charges C, Z, or X the bulb should be clamped on the suction line at a point where the bulb temperature will be the same as the evaporator temperature during the off-cycle. This will insure tight closing of the valve when the compressor stops. If bulb insulation is used on lines operating below 32°F, use non-water absorbing insulation to prevent water from freezing around the bulb.

On brine tanks and water coolers, the bulb should be below the liquid surface where it will be at the same temperature as the evaporator during the off-cycle. When locating the bulb in a brine tank, paint it and the capillary tubing with pitch or other corrosion resistant paint.

If, for practical reasons, the bulb must be located where its temperature will be higher than the evaporator during the off-cycle, a solenoid valve must be used ahead of the TEV.

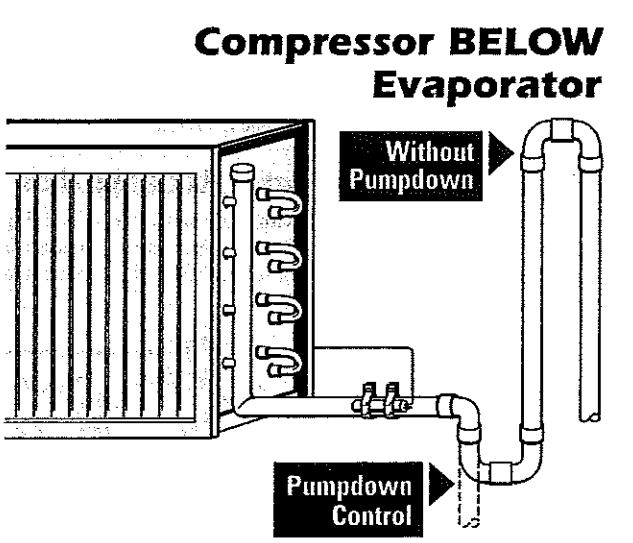


Figure 5

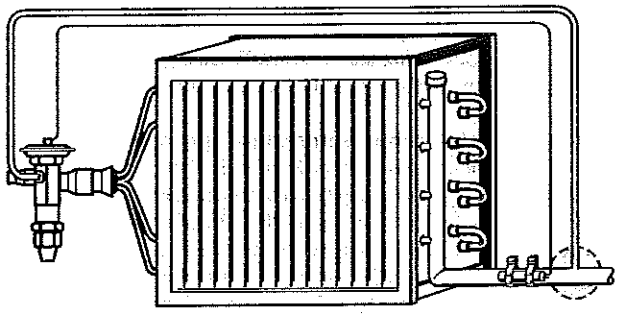
On air conditioning applications having TEVs equipped with VCP100 or VGA elements, the bulb may be located inside or outside the cooled space or duct. The valve body should not be located in the air stream leaving the evaporator. Avoid locating the bulb in the return air stream unless it is well insulated.

External Equalizer Connection

For a complete explanation of when an externally equalized valve should be used, refer to "equalization method," Bulletin 10-9. Valves supplied with an external equalizer ***will not operate*** unless this connection is made.

The equalizer connection should be made at a point that will most accurately reflect the pressure existing in the suction line at the bulb location. See Figure 6. Generally, the connection is immediately downstream of the bulb. However, equipment manufacturers sometimes locate them in return bends or suction headers that are

External Equalizer Connection



It must be connected - NEVER CAPPED!
Must be free of crimps, solder, etc.

Figure 6

compatible with their specific design requirements. The difference between the pressure at the equalizer connection and the suction pressure at the bulb location should not exceed reasonable pressure drop values. The values shown in Table 1 of Bulletin 10-9 can be used as a guide in determining the value.

If any evaporator pressure or temperature control valves are located in the suction line at or near the evaporator outlet, the equalizer must be connected on the evaporator side of these valves.

Driers, Strainers, and Accessories

Most Sporlan TEVs are equipped with built-in screens of varying mesh sizes depending on the valve size and type. These strainers are effective only in removing particles of scale, solder, etc. which could obstruct the closure of the pin and seat.

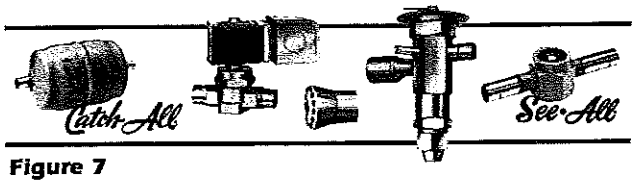


Figure 7

Moisture and smaller particles of foreign materials are equally harmful to the system and must be removed for peak system performance. Field experience has proven that, without a doubt, most expansion valve failures are due to the presence of dirt, sludge, and moisture in the system. Furthermore, the performance and life of other system components are also seriously affected by these foreign materials. The Sporlan **Catch-All Filter-Drier®** removes dirt, moisture, acids, and sludge, and insures the circulation of clean, dry refrigerant through the system at all times.

For all refrigeration and air conditioning applications we recommend that a Sporlan Catch-All Filter-Drier be installed in the liquid line ahead of the TEV. See Bulletin 40-10 for complete Catch-All Filter-Drier specifications.

Further system protection is easily and inexpensively provided with the installation of a Sporlan **See-All®**. The See-All is a combination liquid and moisture indicator that visually indicates if there is a shortage of refrigerant in the liquid line, or if the moisture content of the refrigerant is at a dangerous level. See Bulletin 70-10 for complete See-All specifications.

Test Pressures and Dehydration Temperatures

Inert dry gases such as nitrogen, helium or CO_2 are often used for leak detection.

CAUTION: Inert gases must be added to the system carefully through a pressure regulator. Unregulated gas pressure can seriously damage the system and endanger human life. Never use oxygen or explosive gases.

Excessive test pressures can shorten the life of the TEV diaphragm. Table 1 lists the maximum pressure that can safely be applied with the expansion valve connected to the evaporator. These maximum pressures are well above the minimum field leak test pressures for low sides, listed by the ANSI/ASHRAE Standard 15-2001 or latest revision.

The external equalizer line should be disconnected if there is any possibility of exceeding the recommended maximum pressures listed below.

If elevated temperatures are used to assist in dehydrating the system, the TEV should not be exposed to temperatures exceeding those shown in Table 2.

Table 2 refers to the maximum dehydration temperatures when the bulb and valve body are subjected to the same temperature. On L, C, Z, and X charges, 250°F maximum valve body temperature is permissible ***if the bulb temperature*** does not exceed those shown in the table.

Table 1
Maximum Low Side Test Pressures

Valve Type	psig
(B)I, X, NI, F, FB, (E)BF/SBF, RI, G, EG, C, S, EBS, Small 0	450
D, P, H, Large 0	425
A, M, V, W	400

Table 2
Maximum Dehydration Temperatures – Degrees F

Refrigerant	Thermostatic Charge					
	L	C	Z	X	VGA	P Type, ZP Series
12, 134a	190	190	250	210	---	250
22	160	160	185		250	
404A, 502, 507	150	150	170		---	
717 (Ammonia)	150	190	235	---	---	---

Expansion Valve Adjustment

Each Sporlan TEV is thoroughly tested and set at the factory before shipment. This factory superheat setting will be correct and no further adjustment is required for the majority of applications. However, there are many factors which can affect the performance of a TEV. These factors are independently variable and all of them cannot be compensated for in the design of a valve. When the application or operating conditions require a different valve setting due to one or more of the factors listed below, the valve may be adjusted to obtain the required operating superheat. Therefore, an adjusting stem is provided on all standard valves. The valve should be set with the system as near as possible to design conditions.

Factors which affect valve performance and may make it necessary to adjust the valve are:

1. Low temperature difference (TDs) between the refrigerant and the air
2. TEV bulb location
3. Balance between compressor and evaporator
4. Ratio of load to TEV capacity
5. Condenser capacity
6. Operation of several fixtures on multiple installation
7. Seasonal variation in head pressure caused by extreme changes in ambient air temperature.

Note: Valve Types F, (E)BF/SBF, Q, A, M, V, K, and W have non-rising adjusting stems and a change in adjustment does not change the stem position.

When setting valves on multi-evaporator refrigeration systems with pressure or temperature sensitive evaporator control valves, the following procedure is recommended:

1. Evaporator Pressure Regulating Valve (ORI Type): the ORI valve is set first at the minimum load condition. Then, if necessary, the expansion valve is adjusted to the desired superheat setting while under the normal operating load condition.
2. Temperature Sensitive Evaporator Regulating Valves (CDS Type): The CDS valve is forced into a fully open position first. Then the expansion valve is adjusted to the desired superheat setting at full load condition. Finally, the controller for the CDS is set to the desired temperature. Contact Sporlan Valve Company, or the case manufacturer, for additional details on setting the CDS controller.

When the adjustment is completed on the TEV, always tighten the adjusting stem packing nut and replace the seal cap tightly.

Many expansion valves are made ***non-adjustable*** for use on Original Equipment Manufacturer's units, particularly those valves used on residential air conditioning and heat pump systems. These valves are set at a superheat predetermined by the manufacturer's laboratory tests and cannot be adjusted in the field.

Some ***non-adjustable*** models are modifications of standard adjustable type valves. This is done by using a solid bottom cap instead of one equipped with an adjusting stem and seal cap. These valves can be identified by an **N** preceding the standard valve designation. Adjustable bottom cap assemblies are available for converting most non-adjustable valves to the adjustable type. However, this is rarely required. If symptoms indicate that a valve adjustment is needed, carefully check the other possible causes of incorrect superheat, pages 6 through 10, before attempting an adjustment.

How to Determine Superheat Correctly

1. Measure the temperature of the suction line at the bulb location.
2. Obtain the suction pressure that exists in the suction line at the bulb location by **either** of the following methods:
   - **a.** If the valve is externally equalized, a gauge in the external equalizer line will indicate the desired pressure directly and accurately.
   - **b.** Read the gauge pressure at the suction valve of the compressor. To the pressure add the estimated pressure drop through the suction line between bulb location and compressor suction valve. The sum of the gauge reading and the estimated pressure drop will equal the approximate suction line pressure at the bulb.
3. Convert the pressure obtained in **2a** or **2b** above to saturated evaporator temperature by using a temperature-pressure chart.
4. Subtract the two temperatures obtained in **1** and **3** – the difference is superheat.

Figure 8 illustrates a typical example of superheat measurement on an air conditioning system using Refrigerant 22. The temperature of the suction line at the bulb location is read at 52°F. The suction pressure at the compressor is 66 psig and the estimated suction line pressure drop is 2 psi ...66 psig + 2 psig = 68 psig at the bulb, which is equivalent to a 40°F saturation temperature. (Use dew point temperature for refrigerant blends.) 40°F subtracted from 52°F = 12°F superheat.

Note: Refrigerated case manufacturers frequently use a "temperature difference" method to approximate superheat. This procedure consists of measuring the temperature of a location on the evaporator which is representative of saturated vapor temperature; and, then subtracting that temperature from the outlet evaporator temperature which is measured at the bulb location.

While this method of reading "superheat" is acceptable on those manufacturer's cases where the pressure drop through the evaporator is low, Sporlan does not recommend the "temperature difference" method for other types of systems.

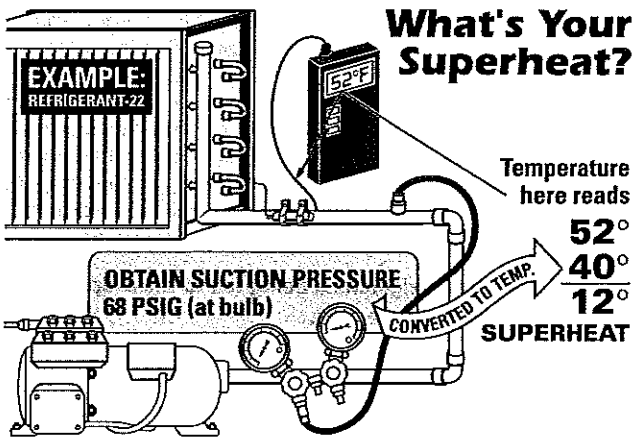


Figure 8

How to Change the Superheat Setting

Note: There are some valve bodies (G, EG, C, S, EBS and EMC) that have a packing nut around the adjustment stem. It may be necessary to loosen the packing nut slightly to turn the adjusting stem. Do not forget to retighten the nut after the superheat is set.

To reduce the superheat, turn the adjusting stem **counterclockwise**. To increase the superheat, turn the adjusting stem **clockwise**. When adjusting the valve, make no more than one turn of the stem at a time and observe the change in superheat closely to prevent ***over-shooting*** the desired setting. As much as 30 minutes may be required for the new balance to take place after an adjustment is made.

If in doubt about the correct superheat setting for a particular system, consult the equipment manufacturer. As a general rule, the proper superheat setting will depend on the amount of temperature difference **(TD)** between refrigerant temperature and the temperature of the air or other substance being cooled. Where high **TD's** exist, such as on air conditioning applications, the superheat setting can be made as high as 15°F without noticeable loss in evaporator capacity. Where low **TD's** exist, such as in low temperature blower coil applications, a superheat setting of 10°F or below is usually recommended for maximum evaporator capacity. It is these applications that the TEV will more than likely need to be adjusted.

For the correct valve setting on factory built equipment, manufacturers' recommendations should be followed. Some manufacturers specify the superheat directly; others may recommend valve adjustment to a given suction pressure at certain operating conditions, or until a certain frost line is observed. Such recommendations, however they are stated, represent the results of extensive laboratory testing to determine the best possible operation.

■ Field Servicing

The TEV is erroneously considered by some to be a mysterious and complex device. As a result, many valves are needlessly replaced when the cause of the system malfunction is not immediately recognized.

Actually the TEV performs only one very simple function – **it keeps the evaporator supplied with enough refrigerant to satisfy all load conditions.** It is not a temperature control, suction pressure control, a control to vary the compressor's running time, or a humidity control.

How effective the valve performs is easily determined by measuring the superheat as outlined in Figure 8. Observing the frost on the suction line, or considering only the suction pressure may be misleading. **Checking the superheat is the first step in a simple and systematic analysis of TEV performance.**

- **If not enough refrigerant is being fed to the evaporator — the superheat will be high.**
- **If too much refrigerant is being fed to the evaporator — the superheat will be low.**

Although these symptoms may be attributed to improper TEV control, more frequently the origin of the trouble lies elsewhere.

Note: TEVs with permanent bleed ports **(BP)** or Rapid Pressure Balancer **(RPB)** construction are applied on many air conditioning and refrigeration systems by original equipment manufacturers. Each application is tested and approved by the manufacturer. The primary function of these devices is to equalize high-to-low side pressures during the off cycle on systems equipped with low starting torque compressors.

However, some BP type valves are applied to allow small amounts of liquid refrigerant to pass for compressor motor cooling. The specific function of the feature on a given unit must be determined from the system manufacturer. Once that is determined, it is easier to troubleshoot the system.

The primary cause of difficulty with either the BP or RPB feature is dirt and other foreign materials that restrict or plug them. And if the system purpose intended for either feature is not being satisfied, the valve probably needs cleaning or replacing.

As stated in Bulletin 10-9, the RPB type valve is not to be applied on systems using high starting torque compressors or "hard-start" electrical components, on outdoor coils of heat pumps, or on any refrigeration system, and it should ***not*** be used to replace BP type valves that are applied on those types of systems. On systems other than those described above, the RPB type valve can replace the BP type valve when necessary. Usually it is advisable to replace a valve with one of the same specification unless advised differently. Consult with the system manufacturer for assistance.

Complaint "A"

"Valve does not feed enough refrigerant."

SYMPTOMS:

- **Load temperature (air or water leaving evaporator) too high.**
- **Superheat too high.**
- **Suction pressure lower than normal with compressor unloaders locked out or hot gas bypass shut off.***

THE CAUSE MAY BE:

1. **Moisture** — Water or a mixture of water and oil frozen in the valve port or working parts of the valve will prevent proper operation. This is a common source of trouble on expansion valves. Since the valve is the first cold spot in the system, moisture will freeze and block the valve open, closed, or any position in between. If the valve is frozen in the intermediate position so that flow is restricted, the superheat will be high.

   Remedy — Install a Sporlan Catch-All Filter-Drier in the liquid line for removal of moisture from the refrigerant and oil. See Bulletin 40-10.

   To determine a safe level of moisture in the system, install a Sporlan See•All Moisture and Liquid Indicator. See Bulletin 70-10.

   Excessive moisture has a damaging effect on all system components regardless of the evaporating temperature. Moisture must be removed for trouble-free performance.

2. **Dirt or foreign material** — Contaminants such as copper oxide scale, metal chips, oil breakdown sludge, etc. will restrict the flow of refrigerant when it collects in strainers or other liquid line accessories. This produces a shortage of refrigerant at the TEV port. Conventional strainers frequently allow the material to pass through the screen and obstruct the flow at the valve port. If a See•All is installed downstream of the restriction, bubbles will be visible. This should not be confused, however, with a refrigerant shortage or excessive liquid line pressure loss which are also indicated by bubbles in the See•All.

   Remedy — Locate and remove the foreign material creating the restriction. Install a Sporlan Catch-All Filter-Drier to provide effective filtration of the refrigerant. See Bulletin 40-10.

* When system has some form of capacity reduction — cylinder unloaders or hot gas bypass, a low suction pressure will not exist. Therefore, when checking TEV performance, a better analysis is possible when these devices are locked out or shut off so the suction pressure will respond to variations in load or valve feed.

3. **Wax** — Certain systems are contaminated with small amounts of wax which will precipitate at low temperatures in systems with Refrigerants 22 or 502. Since the TEV represents the first cold point in the refrigeration cycle, wax is most likely to form at the valve port.

   It is sometimes difficult to observe the wax in a valve because it may exist in solid form only at very low temperatures. By the time the valve has been taken apart, the temperature has increased enough to cause the wax to melt and thus become difficult to detect. When wax is suspected, it can usually be detected on the pin and seat by packing the valve in dry ice while disassembling.

   Remedy — Clean the valve with solvent before reassembling the valve. The Sporlan HH style Catch-All Filter-Driers have a special activated charcoal desiccant that is designed to remove wax in the liquid line before it causes trouble. Therefore, to prevent wax problems, use these HH style driers (e.g., C-415-S-HH) on all low temperature systems using Refrigerants 22 or 502.

4. **Refrigerant shortage** — See-All or sight glass in the liquid line will show bubbles when the system is short of refrigerant charge. Before adding more refrigerant however, be sure the bubbles are not produced by other causes (See Paragraphs **A-2** and **A-5**).

   A lack of refrigerant charge may also be detected by a hissing sound at the TEV. Some systems not equipped with a liquid line sight glass will have test cocks or other devices for checking the refrigerant level in the receiver.

   Remedy — Add enough refrigerant to obtain desired result.

5. **Gas in the liquid line** — As explained in Paragraphs **A-2** and **A-4**, liquid line vapor can be produced by a partially plugged strainer or drier and by a shortage of refrigerant charge. In addition, gas in the liquid line can be caused by air or other non-condensable gases in the system or by excessive pressure losses in the liquid line as a result of:

   - Long or undersized line.
   - Liquid line vertical lift.

   Remedy — Verify the correct liquid line size for the equivalent length and system tonnage. Consult liquid line sizing data published in many manufacturers' catalogs and in textbooks. If undersized, repipe with the correct size.

   Determine amount of vertical lift, and obtain the resulting pressure loss from Table 3, Bulletin 10-9. Using the subcooling calculation example provided in the "subcooling" section of Bulletin 10-9, find required subcooling necessary to prevent gasification with the existing pressure losses. Provide the necessary subcooling by using one of the methods described on Page 1.

6. **Misapplication of internally equalized valve or incorrect location of external equalizer** — If the pressure drop through the evaporator exceeds the predetermined values shown in Table 1, Bulletin 10-9, an externally equalized valve must be used. When an externally equalized valve is used, the equalizer connection should be made at a point in the suction line that will reflect the pressure existing in the line at the bulb location.

   Remedy — Replace internally equalized valve with one having an external equalizer.

   If external equalizer is installed incorrectly, change to correct location. See Page 3.

7. **Insufficient pressure drop across valve** — One of the factors that influence expansion valve capacity is the pressure drop that exists between the inlet and outlet. Anything contributing to a reduction in this pressure drop will reduce valve capacity. Abnormally low condensing pressures, excessive liquid line pressure losses (even with adequate subcooling), undersized distributor nozzle or distributor tubes may also be responsible for a very low net pressure drop across the valve port.

   Remedy — Remove source of pressure loss, or install valve with adequate capacity at the reduced pressure drop. If inlet pressure to valve is low due to low condensing pressure, raise pressure.

   If the refrigerant distributor nozzle is undersized replace with correct size. See Bulletin 20-10.

8. **Dead thermostatic element or wrong thermostatic charge** — If the element has partially or completely lost its thermostatic charge, the valve will be unable to feed sufficient refrigerant or will remain closed. A wrong charge may cause insufficient feed also.

   Remedy — Replace the element if it is dead. If charge is incorrect, replace with proper selective charge. See Bulletin 10-9.

9. **Charge migration (CP series, ZP series, and VGA charges only)** — In order for valves with these charges to maintain control at the bulb, the bulb must be kept at a lower temperature than the element (diaphragm case). If the thermostatic charge does migrate to the element because of a lower element temperature, the valve will throttle.

   Detection — Warm the element with a cloth saturated with hot water. If this produces more refrigerant feed and reduces the superheat to normal, charge migration is responsible for the starved evaporator.

   Causes —
   - Insufficient pressure drop between the valve outlet and bulb location, possibly due to an oversized distributor nozzle or no nozzle at all.
   - Excessive pushrod leakage, which allows the leaking refrigerant to cool the diaphragm case before passing into the equalizer line. This is a rare occurrence and should be carefully checked before arriving at this conclusion.
   - Cold location of TEV, or condensate drippage on the diaphragm case.

   Remedies —
   - Install distributor nozzle correctly sized in accordance with nozzle sizing procedure given in Sporlan Bulletin 20-10.
   - On valves with packed pushrod construction, remove element and tighten the pushrod packing nuts.
   - Relocate the TEV away from cold outlet air, or condensate drippage.

10. **Undersized valve**

    Remedy — Install valve sized in accordance with procedure given in Bulletin 10-9, or Bulletin 10-10.

11. **High Superheat adjustment**

    Remedy — Turn the adjusting stem counter clockwise until the correct superheat is indicated.

12. **Feed-back from another valve** — Review instructions for Bulb Location and Installation, Page 2.

    Remedy — Check the bulb temperature and calculate the superheat. If superheat is normal but too little refrigerant is

flowing through the evaporator, check the piping for possible refrigerant flow from another evaporator affecting the bulb. Re-pipe if necessary. See Figure 4.

13. High pressure drop through evaporator

Remedy — Check the pressure at the evaporator inlet and outlet with gauges. If pressure difference is greater than the values shown in Table 1, Bulletin 10-9, use an externally equalized valve.

14. Restricted, plugged, or capped external equalizer — If the pressure under the diaphragm builds up due to pushrod leakage and cannot escape through the external equalizer line, the valve will remain closed.

Remedy — Check the external equalizer line to be sure it is open or not capped.

Complaint "B"

"Valve feeds too much refrigerant."

SYMPTOMS:

- ***Liquid returns to compressor.***
- ***Superheat is low.***
- ***Suction pressure is normal or higher than normal.***

THE CAUSE MAY BE:

1. Moisture — Water or a mixture of water and oil frozen in the valve port or working parts of the valve will prevent proper operation. This is the most common source of trouble on TEVs. Since the valve is the first cold spot in the system, moisture will freeze and block the valve open, closed, or any position in between. If the valve is held in the open position by ice, liquid flood-back will occur.

Remedy — Install a Sporlan Catch-All Filter-Drier in the liquid line for removal of moisture from the refrigerant and oil. See Bulletin 40-10.

For additional protection, install a Sporlan See•All Moisture and Liquid Indicator for a positive indication of when a safe moisture level is reached. See Bulletin 70-10.

2. Dirt or foreign material — Contaminants such as copper oxide scale, metal chips, oil breakdown sludge, etc. may pass through ordinary strainers and lodge at the TEV port and prevent the valve from closing.

Remedy — Disassemble the valve and remove all foreign material from the internal parts. Install a Sporlan Catch-All Filter-Drier in the liquid line. The Catch-All filters out the smallest particles of foreign material that might interfere with the operation of any system component.

3. Expansion valve seat leak — When the valve port does not seat tightly, refrigerant will pass through during the off-cycle and fill the evaporator with refrigerant. If the seat leak is severe, the valve will feed too much refrigerant during the operating cycle as well. (Not applicable to valves with permanent bleed ports or RPB feature.)

Remedy — If the valve seat is leaking, a gurgling or hissing sound can usually be heard during the off-cycle. Also, a sight glass or See•All in the liquid line may indicate continued refrigerant flow for a long period after the compressor has stopped. Make certain however, that the bubbles are not the result of ***back-flow*** through a vertical liquid line.

Disassemble the valve to be certain that dirt or foreign material is not responsible (see **B-2**). If the pin and seat are worn or damaged and an internal parts kit is available, replace the parts. When parts are not available, the valve must be replaced.

4. Oversized valve — Check valve ratings considering all the factors which affect its capacity. See Page 16, Bulletin 10-9, or Page 3, Bulletin 10-10.

Remedy — Install correctly sized valve.

5. Incorrect bulb installation — The bulb should be securely fastened to a straight, clean, section of the suction line using two bulb straps for good thermal contact. Also, the temperature of the bulb should not be influenced by ambient temperature — an external heat source such as a steam pipe or heating coil.

Remedy — Install bulb correctly. See Bulb Location and Installation, Page 2.

6. Low superheat adjustment

Remedy — Turn the adjusting stem clockwise until the correct superheat is indicated. See Page 4.

7. Incorrect thermostatic charge

Remedy — Select and install the correct selective charge. See Bulletin 10-9.

8. Incorrectly located external equalizer

Remedy — Relocate external equalizer or the connection between evaporator and any other temperature or pressure sensitive evaporator control valve near bulb location. See Page 3 for recommendations.

9. Inefficient compressor — If the compressor is inefficient or for some other reason lacks capacity, the suction pressure will operate higher than normal. This may or may not be accompanied by low superheats.

Remedy — Consult with compressor manufacturer.

Complaint "C"

"Valve feeds too much refrigerant at start-up only."

SYMPTOMS:

- ***Liquid returns to compressor.***
- ***No superheat.***
- ***Suction pressure higher than normal.***

THE CAUSE MAY BE:

1. Refrigerant drainage — Drainage of refrigerant from the evaporator (during the off-cycle) when installed at a higher level than the compressor.

Remedy — Install a trap-riser to top of evaporator or use pump-down control. See Figure 5.

2. Compressor or suction line in cold location — During the period when the system is not in operation, liquid refrigerant will condense at the coldest point in the system. Liquid will condense in the compressor or suction line, if they are located in an ambient temperature below that of the evaporator during the off-cycle. Upon re-starting, this liquid will slug the compressor.

Remedy — Keep compressor or suction line warm during the off-cycle. Some compressors are equipped with crankcase heaters

for this purpose. Another corrective measure is to install a suction line solenoid valve that is de-energized during the off-cycle.

3. ***Restricted or plugged external equalizer*** — A momentary flood can occur when the load increases suddenly, such as at start-up because the higher suction pressure cannot reach the underside of the diaphragm and help close the valve. If the pressure under the diaphragm increases due to any pressure leakage around the pushrods, the valve will eventually throttle.

   Remedy — Remove the restriction or plugged portion of the external equalizer.

4. ***Liquid line solenoid valve seat leak or interrupted pumpdown*** — Liquid refrigerant can continue to feed the TEV and/or remain in evaporator upon shut-down causing flood-back to the compressor upon start-up.

   Remedy — Disassemble and clean solenoid valve and/or replace damaged internal parts if seat leakage is the problem. If the pumpdown cycle isn't completed before the compressor cycles off, or the thermostat calls for cooling and reopens the liquid line solenoid before the evaporator has been properly evacuated, check the low pressure cut-off setting or the electrical controls for possible causes.

Complaint "D"

"Valve doesn't feed properly."

SYMPTOMS:

- ***Poor system performance.***
- ***Superheat normal or lower than normal.***
- ***Suction pressure lower than normal with compressor unloaders locked out or hot gas bypass shut off.****

THE CAUSE MAY BE:

1. ***Unequal circuit loading (Multi-circuit evaporators and parallel evaporators connected to a single refrigerant distributor)*** — When each circuit is not subjected to the same heat load, the lightly loaded circuits will allow unevaporated refrigerant or low temperature vapor to enter the suction line and throttle the valve. This will cause normally loaded circuits to be deprived of their share of refrigerant. The net result is a loss of refrigerated evaporator surface.

   Remedy — Make necessary modifications which will allow each evaporator circuit to receive the same percentage of the total load. See Bulletin 20-10 for application information on multi-circuit evaporators using a refrigerant distributor.

2. ***Poor refrigerant distribution (Multi-circuit evaporators and parallel evaporators connected to a single refrigerant distributor)*** — If the refrigerant distribution is faulty, the circuits receiving the largest portion of refrigerant will have the controlling influence on the TEV. The result is the same as in paragraph 1 above.

   Remedy — Correct refrigerant distribution. See Bulletin 20-10 for complete information on Refrigerant Distributors.

3. **Low load**— Low evaporator load may be caused by insufficient air over the coil as a result of an undersized blower, dirty air filters, or an obstruction in the air stream. In addition, frost formation on the coil or low entering air temperatures will reduce the evaporator load.

   Remedy — Correct the condition responsible.

4. ***Flow from one coil affecting TEV bulb of another (Multiple evaporator systems only)*** — The temperature of the bulb may be falsely influenced by flow from another evaporator usually because of incorrect piping.

   Remedy — Correct the piping. See Figure 4, Page 3.

5. ***Improper compressor-evaporator balance*** — If the compressor is too large for the load and evaporator capacity, the low suction pressure which results will cause poor system performance.

   Remedy — Consult with the manufacturer or consulting engineer, or the ASHRAE Handbook on component balancing. If necessary, change or correct the improperly sized component. Hot gas bypass may be used to balance properly.

6. ***Evaporator oil-logged*** — Poor heat transfer occurs and unpredictable performance takes place. If erratic performance is observed over a period of time, and other causes are omitted from consideration, review the amount of oil in the system. Turbulent compressor oil level with little or no return to the compressor sump indicates oil problems.

   Remedy — Remove excessive oil from evaporator and connecting piping. Many times the evaporator temperature will be too low for the oil to be removed. Therefore, the system must be allowed to warm sufficiently to get cold oil to drain. Analyze system components for possible causes of oil problem before restarting the system. Consult with the compressor manufacturer for specific details on their compressor.

Complaint "E"

"System hunts or cycles."

SYMPTOMS:

- ***Suction pressure fluctuates****
- ***Superheat fluctuates.***
- ***Valve does not feed enough, and then too much refrigerant.***

THE CAUSE MAY BE:

1. ***System characteristics*** — Certain design characteristics of the system may have an effect on the system's tendency to hunt or cycle. As an example, after the valve admits refrigerant to the evaporator inlet, there is a time delay before the bulb senses the effect at the evaporator outlet. This time delay is dependent on evaporator length, tube size, and load. Generally, there is more likelihood for hunting to occur when this time interval is long. Other influencing factors are circuit arrangement, load per circuit, and temperature difference.

   Remedy — When hunting is moderate particularly with no floodback, the effect on the system is insignificant and correc-

* When system has some form of capacity reduction — cylinder unloaders or hot gas bypass, a low suction pressure will not exist. Therefore, when checking TEV performance, a better analysis is possible when these devices are locked out or shut off so the suction pressure will respond to variations in load or valve feed.

tions are not necessary. If hunting is severe with floodback to the compressor, check the possible remedies shown in paragraphs below.

2. **Valve size** — An over-sized valve usually aggravates hunting. Carefully check the valve rating considering all the factors affecting its capacity. See Bulletin 10-9, or Bulletin 10-10.

   Remedy — Replace valve with one correctly sized. On multiple circuit evaporators using a refrigerant distributor, the capacity of the valve can be reduced, within certain limits, by installing a smaller distributor nozzle. See Bulletin 20-10.

3. **Bulb location** — If the bulb is located in a suction line trap, its temperature will be affected by liquid oil and refrigerant alternately collecting and evaporating at this point. This condition frequently results in severe hunting.

   Remedy — As a temporary measure relocate the bulb away from the trap, and any turbulent areas created by elbows, tees, etc. Also remove the bulb from the air stream or insulate. Re-pipe if necessary. Sometimes another position around the circumference of the suction line will minimize hunting. Follow the Bulb Location and Installation instructions given on Page 2 for the best TEV control.

4. **Refrigerant and load distribution** — In addition to the effects of poor distribution explained in paragraphs **D-1** and **D-2**, hunting also frequently results. This is caused by liquid refrigerant from the overfed circuits occasionally reaching the bulb of the valve.

   Remedy — Correct the faulty distribution.

5. **Superheat adjustment** — All Sporlan TEVs are preset at the factory to give the best performance on the average system. A valve should not be adjusted unnecessarily, but occasionally another setting may prove to be better.

   Remedy — Turn the adjusting stem clockwise a turn at a time. If the hunting stops or is reduced, turn the adjusting stem counter clockwise a turn at a time to obtain the lowest superheat with stable operation.

6. **Moisture** — As ice forms in a TEV from excessive moisture, a very erratic hunt may result.

   Remedy — Remove the moisture with the installation of a Sporlan Catch-All Filter-Drier. A safe moisture level can be determined by installing a Sporlan See•All.

Complaint "F"

"System won't perform properly."

SYMPTOM:

- ***Cannot get valve to react or regulate at all.***

THE CAUSE MAY BE:

1. **No refrigerant being fed to evaporator.** See Section **A** on Pages 6 & 7.
2. **Too much refrigerant being fed to evaporator.** See Section **B** on Page 8.
3. **Too much refrigerant being fed to evaporator at start-up only.** See Section **C** on Page 8.
4. **Refrigerant control is erratic.** See Section **D** on Page 9.
5. **System is hunting or cycling.** See Section **E** on Page 9.
6. **The TEV has been physically abused in an effort to make the valve work properly.** This is usually the result of a mistaken analysis. It is frequently assumed that if a valve does not feed properly, it is stuck (either opened or closed). Beating the valve body with a hammer will only distort the body and make it impossible for the valve to work once the real cause is determined.

   If a valve "sticks," it is usually due to moisture freezing in the port, dirt and other foreign material restricting or plugging the internal parts, wax forming on the internal parts at low temperatures, or the valve has been physically abused so it **cannot** function.

   Remedy — Inspect the valve and its internal parts, including the inlet strainer. If plugged or restricted in any way, clean the parts thoroughly, oil the parts with a good grade of refrigerant oil, and reassemble the parts. Complete details on this subject are found on Pages 10 through 12.

   If the valve is beyond normal cleaning processes, or if it is physically damaged in any way, replace the valve with its proper replacement model.

Field Assembly Instructions

Sporlan valves my be opened easily for inspection.

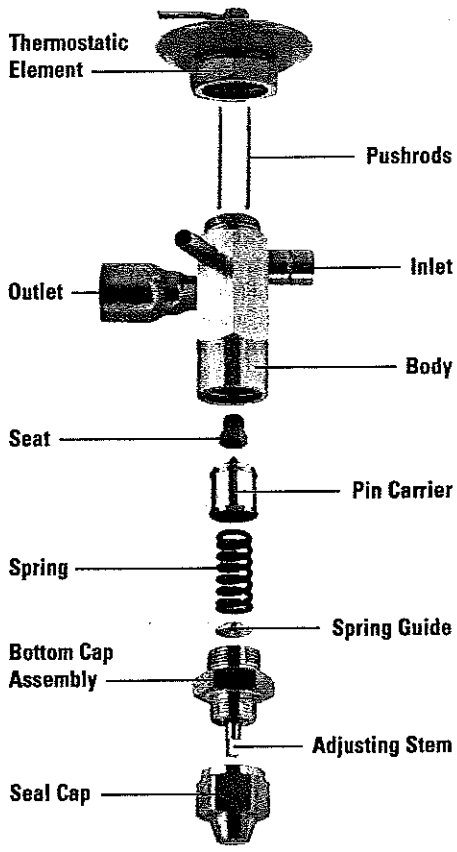


Figure 9

Note: These Field Assembly Instructions apply in part to all Sporlan TEVs. See Figure 9 for an "exploded" view of those models that can be completely disassembled. When a TEV is to be disassembled for inspection and cleaning, or for replacement of the thermostatic element or the internal parts, the following information should be reviewed for assistance.

Types F dated approximately C84 or earlier and Types I, BI, NI, RI, FB manufactured prior to 1994 do not have replaceable elements nor internal parts kits, but can be disassembled for inspection and cleaning. Type F dated D84 or later, Type S valves dated B69 or later, Type C valves dated C70 or later, and **ALL** Type G, X, (E)BF/SBF and EBS valves employ packless pushrod construction and internal parts are NOT available for use with them. However, their elements can be replaced and they can be disassembled for inspection and cleaning. Due to the single pushrod construction of the Type (E)BF/SBF and EBS valves, only the bottom cap assembly, pin guide, and superheat spring may be removed for inspection and cleaning.

Early production of the Type F valve with the replaceable element requires a 15/16" **thin jaw**, open end type element wrench such as a Bonney 1230. Subsequent production of the Type F valve and all Types (E)BF/SBF, I, BI, NI, RI, and FB valves require a 1" **thin jaw**, open end type element wrench such as the one available from Sporlan wholesalers. An open end wrench is necessary because of limited space between the body and element of these valves. Precautions must be taken in removing the KT-43 element (F) so the element, body, or connections are not damaged by the wrenches.

While standard open end or adjustable wrenches fit the other element sizes, the **thin jaw** type wrenches are also available for the other element sizes: Bonney 1236 (1-1/8") for KT-53 elements, Bonney 1240 (1-1/4") for KT-83 elements, Bonney 1248 for KT-33 elements, and Bonney 1252 for KT-63 and 7 elements.

Replaceable elements and internal parts kits are available for current valves with ***packed*** pushrod construction:
Types P, H, M, D, and A.

Replaceable elements for Types O, V, W, and U are also available. However, special field assembly instructions are included with their internal parts kits.

Assembling Instructions

The following steps are necessary in properly disassembling, inspecting, cleaning, and reassembling a TEV whether the valve is in or out of the refrigerant piping.

1. Before disassembling the valve, be sure the refrigerant pressure in the system has been reduced to a safe level **(0 psig)**.

2. Remove the seal cap and turn the adjustment stem counter-clockwise to relieve the spring force. Count and record the number of turns so adjustment can be returned to its original position.

3. Using appropriate wrenches or a vise to properly support the valve body, remove the element (if a replaceable type), the bottom cap assembly, and the internal parts. (Only remove the bottom cap, pin guide, and superheat spring on Type (E)BF/SBF and EBS valves. **DO NOT** remove the single pushrod from these valves.)

   Caution: Regardless of whether the valve is in the system or in a vise, care must be taken to prevent distorting the body by exerting too much pressure in tightening the element or in clamping the body in the vise. Also, do not use a wrench on the outer welded edge of the element.

4. Inspect parts, element, and body for any foreign materials or physical damage.

5. On valves with replaceable elements and/or internal parts, replace any items that appear damaged.

6. Clean all parts with solvent, preferably by applying and then blowing off with clean dry compressed air.

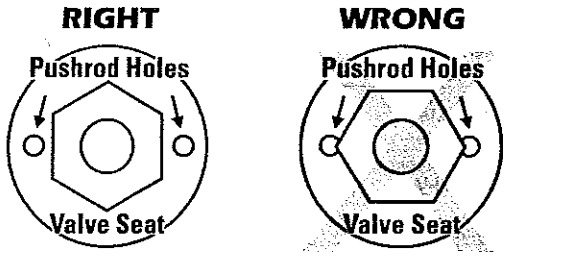


Figure 10

7. To reassemble valves with replaceable seats, screw seat into body with a fairly light pressure since it does not require a heavy pressure to make this small knife-edge joint.

   Caution: Be sure hexagon corners of seat do not protrude into pushrod holes (see Figure 10).

   For valves that do not have replaceable elements or for Type O valves, place the pushrod(s) into the body now.

8. Next, slip the pin and carrier (which have been pressed together at the factory) into the body and tap the pin into the seat to form a true seating surface. It is generally advisable, before tapping these parts together, to check the concentricity of both the pin and seat by engaging the parts by pressing them lightly together with one finger and noting that there is no tendency to stick together. This should be repeated several times after rotating the pin carrier a quarter of a turn. In assembling valves with port sizes of 1/4" and larger which use the flat disc instead of the tapered pin, **DO NOT TAP THE DISC AGAINST THE SEAT.**

9. Now place the spring guide stamping (when used), and spring, in the pin carrier, place the lower spring guide on the opposite end of the spring and screw the bottom cap in place. (Replace the pin guide, spring, and bottom cap assembly together on Type (E)BF/SBF and EBS valves.) After screwing bottom cap assembly in place, carefully tighten, preferable with two 10" wrenches, to seal the metal-to-metal knife edge joint. The sealing surfaces should be free of any foreign material or nicks that might prevent a leak-tight joint.

10. On valves with replaceable elements (except Types O, (E)BF/SBF and EBS), place the pushrods into the body and open the valve several times by pressing down on the pins with a flat metal surface. This will help seat the pin properly.

11. Check the height of the pushrod(s) above the element sealing surface with the pushrod gauge (see Figure 11). The gauge is supplied with internal parts kits or can be obtained at no charge

Table 3

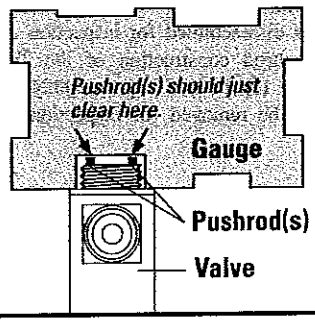
Valve Type①		Gauge Number
Current	Obsolete	
AA(E), LMC-AA(E)	---	1
DA(E), LMC-DA(E)	---	2
PFE or HFE-1½, 3, 4, 5, 8, 12	PFE or HFE-6, 7½, 10, 11	3
PVE or HVE-2½, 5½, 7, 11, 16, 20	PVE or HVE-2, 5, 8, 10, 12, 15, 17, 18	
PDE or HDE-5, 8, 14	PDE or HDE-6, 7½, 9, 12, 13	
PRE or HRE-1½, 4, 6½, 9, 12	PRE or HRE-6, 7½, 11, 13	
---	UFE-12, 17	
	UVE-22, 30	
	UDE-15, 21	
	URE-16, 22	
OFE-23, 32, 40	UFE-23	3A
OVE-40, 55, 70	UVE-40	
ODE-28, 40, 50	UDE-28	
ORE-30, 35, 45	URE-30	
All F Models② except FF(E)-¼, FV(E)-¼, FD(E)-¼, FR(E)-⅛	---	4
All G Models except GF(E)-¼, GV(E)-¼, GR(E)-⅛	All small K models	5
All X Models	---	
MFE-5, 7½, 11, 13, 15, 20	MFE-12, 17	6
MVE-8, 12, 18, 21, 26, 34	MVE-30	
MDE-6, 9, 13, 15, 18, 25	MDE-14, 20	
MRE-9, 15, 20, 25	---	
KFE or VFE-45, KVE or VVE-70		
KDE or VDE-55, KRE or VRE-50		
MFE-25	MFE-22	6A
MVE-42	MVE-40	
MDE-30	MDE-26	
MRE-30	---	
KFE or VFE-35, 55	VFE-50	
KVE or VVE-52, 100	VVE-90	
KDE or VDE-40, 65	VDE-42, 60	
KRE or VRE-38, 70	---	
WFE-80, 110	WFE-75, 100	7
WVE-135, 180	---	
WDE-95, 130	WDE-90, 120	
WRE-100, 130	---	
CF(E) or SF(E)-¼, ½, 1, 1½, 2, 2½, 3	R and T Models with 83 elements	8
CV(E) or SV(E)-½, 1, 1½, 2, 3, 4, 5		
CD(E) or SD(E)-¼, ½, 1, 1½, 2, 2½, 3, 3½		
CR(E) or SR(E)-¼, ½, 1, 1½, 2, 3, 4		
CFE-5, SFE-5, 6	---	8A
CVE-8, SVE-8, 10		
CDE-6, SDE-6, 7		
CRE-6, SRE-6, 7		
OFE-6, 9, 12		
OVE-10, 15, 20		
ODE-7, 11, 14		
ORE-6, 9, 12		
OFE-16, OVE-30 ODE-20, ORE-21③	---	8B

upon request. (Since the internal parts of the Type (E)BF/SBF and EBS valves cannot be replaced, it is not necessary to check the pushrod height of these valves.)

The appropriate gauge numbers for the various TEV's are given in Table 3.

Caution: If the element-to-body joint utilizes a gasket, the gasket must be removed before checking pushrod height.

If the pushrod(s) are too long, they must be carefully ground off to the proper length. Clean the pushrod(s) of all dirt and grindings and place them into the body.



Check Height of Pushrod(s) with Gauge

Figure 11

12. Element Replacement — If the element is damaged or has lost its thermostatic charge, replace it with the same type.

To properly replace the element without damaging the element or the valve body on valves which utilize a gasketed joint, be sure only one gasket is used before assembling the element. In assembling gasketed elements held in place by two cap screws, be sure to pull up the cap screws evenly.

On valves which utilize the threaded type of element with metal-to-metal knife edge joints, always use an appropriate wrench (10") on the wrench flats. **DO NOT** use a wrench on the outer welded edge of the element. The sealing surfaces should be free of any foreign materials or nicks that might prevent a leak-tight joint. A few drops of refrigerant oil on the element threads will facilitate easy assembling and removal.

13. Return the superheat spring adjustment to its original position. Replace the seal cap tightly.

① Type F (internally and externally equalized) valves dated D84 or later, Type S valves dated B69 or later, Type C valves dated C70 or later, and all Type G (externally equalized only) and X valves have packless pushrod construction and internal parts kits are not available for use with them.
② Applies only to Type F valves with a replaceable element.
③ Formerly used the KT-33-8 element and gauge number 33-8 (redesignated 8B). The KT-33-8 element has been replaced by the KT-83.

SPORLAN VALVE COMPANY
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INSTALLATION & SERVICE INSTRUCTIONS

Head Pressure Control Valves

OROA-5, ORI-6-65/225H, ORI-10-65/225-H, ORD-4

INSTALLATION INSTRUCTIONS

To ensure proper performance, head pressure control valves must be selected and applied correctly. This is covered thoroughly in Bulletin 90-30. However, proper installation procedures are equally important.

VALVE LOCATION/PIPING SUGGESTIONS — The OROA, ORI and ORD valves can be installed in horizontal or vertical lines – whichever best suits the application, and permits easy accessibility of all valves. Consideration should be given to locating these valves so they do not act as an oil trap and so solder cannot run into the internal parts during brazing. Precautions should also be taken to install the valves with the flow in the proper direction.

The ORI valve CANNOT be installed in the discharge line for any reason.

Figures 1 and 2 are piping schematics only to illustrate the general location of the OROA, ORI, and ORD valves in the system. Sporlan recommends that recognized piping references be consulted for assistance in piping procedures. Sporlan is not responsible for system design, or for misapplication of its products. If these valves are applied in any manner other than described in this bulletin, the Sporlan warranty is void.

In most cases, the valves are located at the condensing unit. When the condenser is remote from the compressor, the usual location is near the compressor. In all cases, it is important that some precautions be taken in mounting the valves. It is suggested that they be adequately supported to prevent excessive stress on the connections. Discharge lines are a possible source of vibrations and gas pulsations, which may result in fatigue in tubing, fittings, and connections. The severity of discharge gas pulses differs with each system. On some applications it may be necessary to dampen the pulses to protect the ORD-4 internal parts. **Pulsations are best handled by a good muffler placed as close to the compressor as possible.**

Vibrations from moving parts of the compressor are best isolated by flexible loops or coils (discharge lines 1/2" or smaller), or flexible metal hoses for larger lines.

For best results, the hoses should be installed as close to the compressor shut-off valves as possible, and mounted horizontal and parallel to the crankshaft **or** vertically upward. The hoses should **never** be mounted horizontal **and** 90° from the crankshaft. A rigid brace should be placed on the outlet end of the hose to prevent vibrations beyond the hose.

The inlet connections on the OROA-5, ORI-6 and ORI-10 valves should be sized the same as the outlet of the condenser where possible. The ORD-4 is available with 5/8" ODF and 7/8" ODF solder connections. On systems with discharge lines smaller than 5/8" OD, the bypass line can be the same size as the discharge line and the ORD-4 connections can be bushed down. If the system capacity is greater than any of the head pressure control valves ratings, these valves can be applied in parallel.

CAUTION: When the head pressure control valves are factory installed and capped for future hook-up in the field, any holding charge in the condensing unit and valve assembly should be bled off from **all** sides of the valves before removing the caps. This will prevent the caps from blowing off due to any trapped refrigerant.

VALVE STRAINERS – *Catch-All® filter-driers – See-All® moisture and liquid indicator* — Just as with any refrigerant flow control device, the need for an inlet strainer is a function of system cleanliness and proper installation procedures. When the strainer is used with the ORI, the tubing is inserted in the valve connection until the tubing and strainer flange ring are up against the tubing stop, thus locking the strainer in place. See Figure 3. In order for the strainer to seat properly against the tubing stop of the OROA condenser connection, the strainer is inserted into the tubing. The tubing is then inserted into the valve connection, thus locking the strainer in place. See Figure 4.

Figure 1

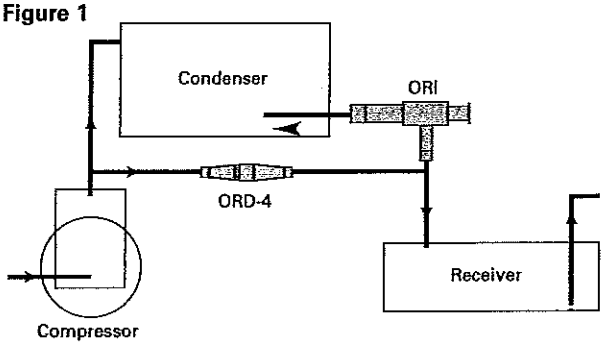


Figure 2

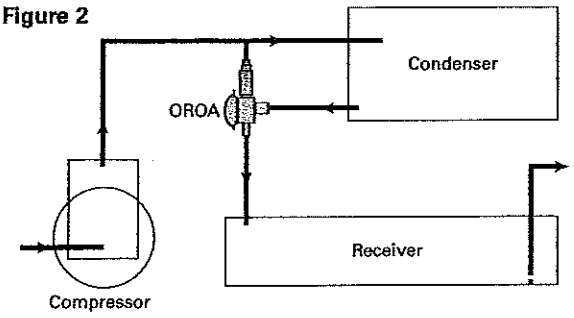


Figure 3

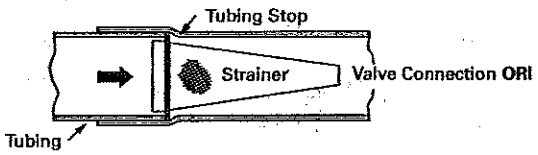
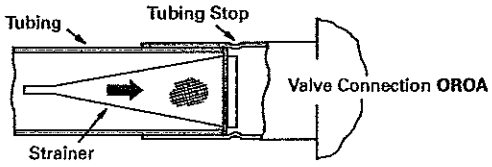


Figure 4



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Bulletin 90-31, November 2002, supersedes Bulletin 90-31, January 1990, and all prior publications.
FOR USE ON REFRIGERATION and/or AIR CONDITIONING SYSTEMS ONLY

Moisture and particles too small for the inlet strainer are harmful to the system and must also be removed. Therefore, for complete system protection, it is recommended that a **Catch-All Filter-Drier** be installed in the liquid line according to the application recommendations given in Bulletin 40-10.

Moisture detection is easily and inexpensively provided with the installation of a **See-All moisture and liquid indicator.** Complete information is given in Bulletin 70-10. Furthermore, a **See-All moisture and liquid indicator** at the receiver is necessary to charge the system properly.

BRAZING PROCEDURES — Any of the commonly used brazing alloys for high side usage are satisfactory. However, when soldering or brazing, it is very important that the internal parts be protected by wrapping the valve with a WET cloth to keep the body temperature below 250°F for the OROA and ORI; and, 300°F for the ORD-4. Also, when using high temperature solders, the torch tip should be large enough to avoid prolonged heating of the copper connections. And, always direct the flame away from the valve body.

TEST and OPERATING PRESSURES — Excessive leak testing or operating pressures may damage these valves and reduce the life of the operating members. For leak detection an inert dry gas, such as nitrogen or CO_2, may be added to an idle system to supplement the refrigerant pressure.

CAUTION: ***Inert gases must be added to the system carefully through a pressure regulator. Unregulated gas pressure can seriously damage the system and endanger human life. Never use oxygen or explosive gases.***

The table below lists the maximum values each valve can withstand without damage. Precautions must be taken to keep test or operating pressures below these values.

Valve Type	Safe Working Pressure - psig
OROA	420
ORI-6-65/225-H	400
ORI-10-65/225-H	400
ORD-4	450

VALVE SETTINGS and ADJUSTMENT — A complete discussion on pressure settings is given in the Application Section of Bulletin 90-30. To determine the proper setting for a specific system, that section should be reviewed.

Table 1 lists the setting data for the OROA, ORI and ORD valves. Other ORI settings can be obtained by adjusting the valves a proportionate amount between those values shown.

Table 1

Valve Type	Standard Factory Setting for Refrigerant 12		Setting for Refrigerants 22 and 502		
	Pressure Setting psig	Depth of adjusting nut from top of Spring Housing	Pressure Setting psig	Depth of adjusting nut from top of Spring Housing	Turns IN from Refrigerant 12 Setting
OROA	100	—	180	—	—
ORI-6	120	1/4"	200	1/2"	3
ORI-10	120	3/8"	200	3/4"	5
ORD-4-20	20	—	20	—	—

The ORD-4-20 setting means that the ORD-4 will start to open when the pressure difference between the discharge line and the receiver is 20 psig. This setting is suitable for all systems where the combined pressure drop through the condenser, the ORI and connecting piping is **less than 14 psi.** Therefore, if the ORI is selected for 2 psi ΔP, then the maximum allowable pressure drop through the condenser is 12 psi. Normally, condenser pressure drop on refrigeration systems is less than 10 psi. However, many condensers on air-conditioning systems may have pressure drops up to 25 psi. Therefore, when in doubt, consult with the equipment manufacturer or, if possible, measure it by reading the discharge pressure at the compressor and the receiver pressure **during full load operation.** That is, this reading should be taken with a normal condensing temperature at full load. For systems where the condenser pressure drop is higher than normal, OROA and ORD valves with higher settings are available upon **special** request. See Table 4, page 4.

To adjust the ORI valve, remove the cap and turn the adjustment screw with the proper size hex wrench (1/4" for ORI-6 and 5/16" for ORI-10). A clockwise rotation increases the valve setting while a counter-clockwise rotation decreases the setting. To obtain the desired setting, a pressure gauge should be utilized at the compressor discharge service valve so the effects of any adjustment can be observed. Small adjustments are recommended to allow the system adequate time to settle out after each adjustment.

NOTE: Even though the ORI valve is selected on the basis of the full load conditions or summer operation, it should be adjusted to maintain the desired condensing pressure whenever the ambient is below 70°F.

REFRIGERANT CHARGE AND CHARGING PROCEDURES — When this method of head pressure control is utilized on a system, there must be enough refrigerant to flood the condenser at the lowest expected ambient and still have enough charge in the system for proper operation. A shortage of refrigerant will cause hot gas to enter the liquid line and the expansion valve, and refrigeration will cease.

Secondly, the receiver must have sufficient capacity to hold at least **all** of the excess liquid refrigerant in the system, since it will be returned to the receiver when high ambient conditions prevail. If the receiver is too small, liquid refrigerant will be held back in the condenser during the high ambient conditions and excessively high discharge pressures will be experienced.

CAUTION: All receivers must utilize a pressure relief device according to the applicable standards or codes (e.g. ARI Standard 495).

The charging instructions described on page 3 use average values. The exact charge required will vary with unit design and piping. These instructions are intended to provide assistance to the service technician where specific charging instructions for the condensing units involved are not available.

Charging Procedure:

1. Before starting the system, charge approximately 2-1/2 lbs. per ton of liquid refrigerant into the receiver **or** enough refrigerant to provide a liquid seal in the receiver.

2. Put refrigerant vapor into the suction side to break the vacuum.

3. Start the system and charge to a **clear See-All moisture and liquid indicator.**

   CAUTION: Bubbles in the See-All don't necessarily indicate a shortage of charge, especially when it is located downstream of other liquid line components and/or remotely from the receiver. When satisfied with a clear See-All (or that any bubbles are caused by reasons other than a shortage of charge), the system is correctly charged for the charging ambient.

4. The extra **winter** charge (as calculated below) is now weighed into the receiver.

To determine the extra charge required, calculate the total length of tubing in the condenser including the equivalent length for return bends. See Table 2. Then multiply the total length in feet by the number of pounds per foot for the proper refrigerant and condenser tube size from Table 2.

Table 2

Tubing Size and Thickness Inches		Equivalent Length for Each Return Bend-Feet	Refrigerant per Foot of Tubing Pounds @ -20°F		
			Refrigerant		
			12	22	502
3/8	.016	.20	.060	.055	.057
1/2	.017	.25	.110	.102	.106
5/8	.018	.30	.175	.163	.169

Example: R-12 system with 1170 equivalent feet of 1/2 inch tubing in the condenser.

1170 x .110 = 130 pounds

The amount of refrigerant calculated using Table 2 must be corrected since the condenser might be already partially flooded especially if charging is being done at low ambients. Table 3 provides information on percentage of condenser to be flooded at various ambients for high, medium and low suction condensing units. To determine the **extra charge,** determine the difference in percentage between the charging ambient and the minimum winter ambient and multiply the figure by the pounds of refrigerant calculated before.

Example: High Suction Condensing Unit, 40°F evaporating temperature

-20°F Minimum Winter Ambient	**.79**
50°F Charging Ambient	**-.40**
	.39

130 x .39 = 51 lbs. of *extra charge*

These calculations do not take into account cylinder unloading. Additional charge will be required. For more complete charging recommendations, see Sporlan Bulletin 90-30-1.

Table 3

Condenser Ambient Temperature °F	Percentage of Condenser to be Flooded											
	Low Suction Condensing Units				Medium Suction Condensing Units				High Suction Condensing Units			
	Evaporating Temperature – °F											
	-35	-25	-15	-5	0	10	20	30	35	40	45	50
80	27	15	0	0	0	0	0	0	0	0	0	0
70	62	49	35	15	40	24	0	0	0	0	0	0
60	76	65	56	45	60	47	33	17	26	20	10	4
50	83	75	68	60	70	60	50	38	45	40	33	28
40	86	80	74	68	76	68	60	50	56	52	46	42
30	88	84	79	74	80	73	66	59	64	60	55	51
20	90	86	82	78	83	77	72	65	69	66	62	59
0	92	89	86	82	87	83	78	73	76	73	70	68
-20	94	91	88	86	91	87	82	77	80	79	76	73
-40	97	94	92	90	94	89	84	79	83	81	79	77

SERVICE INSTRUCTIONS

There are several possible causes for system malfunction with "refrigerant side" head pressure control and these may be difficult to isolate from each other. As with any form of system trouble-shooting, it is necessary to know the existing operating temperatures and pressures before system problems can be determined. Once the actual malfunction is established, it is easier to pinpoint the cause and then take suitable corrective action. The following chart lists the most common malfunctions, the possible causes, and the remedies. Since the OROA, ORI and ORD are hermetic valves and cannot be disassembled for inspection and/or replacement of parts, they must be replaced if they become inoperative.

Malfunction – Low Head Pressure	
Possible Cause	**Remedy**
1. Insufficient refrigerant charge to adequately flood condenser.	Add charge.
2. Low pressure setting on ORI.	Increase setting.
3. ORI fails to close due to foreign material in valve.	Turn adjustment out so material passes through valve. If unsuccessful, replace ORI.
4. ORI fails to adjust properly.	See 3 above.

Malfunction – Low Head Pressure (Continued)	
Possible Cause	**Remedy**
5. Wrong setting on OROA (e.g. 100 psig on Refrigerant 22 or 404A system).	Replace OROA with valve at correct setting.
6. OROA fails to close due to: a. Foreign material in valve. b. Loss of air charge in element.	See below: a. Cause OROA to open by raising condensing/receiver pressure above valve setting by cycling condenser fan. If foreign material does not pass through valve, replace OROA. b. Replace OROA.
7. ORD fails to open due to: a. Less than 20 psi pressure drop across ORD. b. Internal parts damaged by overheating when installed.	See below: a. Check ORI causes/remedies on page 3: 2, 3, or 4. b. Replace ORD.
8. Refrigerant leak at adjustment housing of ORI.	Replace ORI.

Malfunction – High Head Pressure	
Possible Cause	**Remedy**
1. Dirty condenser coil.	Clean coil.
2. Air on condenser blocked off.	Clear area around unit.
3. Too much refrigerant charge.	Remove charge until proper head pressure is maintained.
4. Undersized receiver.	Check receiver capacity against refrigerant required to maintain desired head pressure.
5. Non-condensibles (air) in system.	Purge from system.
6. High pressure setting on ORI.	Decrease setting.
7. ORI or OROA restricted due to inlet strainer being plugged.	Open inlet connection to clean strainer.
8. ORI fails to adjust properly or to open due to foreign material in valve.	Turn adjustment out so material passes through valve. If unsuccessful, replace ORI.
9. Wrong setting on OROA (e.g., 180 psig on Refrigerant 12 system).	Replace OROA with valve at correct setting.
10. Bypassing hot gas when not required due to: a. If ORI, ORD are used and internal parts of ORD are damaged by overheating when installed. b. If OROA is used and internal parts are damaged by overheating when installed. c. If ORI used and pressure drop across condenser, associated piping and ORI exceeds 14 psi under full load conditions. d. If OROA used and pressure drop across condenser, associated piping and OROA exceeds 14 psi under full load conditions.	See below: a. Replace ORD. b. Replace OROA. c. Reduce pressure drop in piping by using larger ORI or ORI valves in parallel or use ORD with higher setting. d. Reduce pressure drop by using 2 – OROA in parallel or substitute OROA with higher ORD setting. See table below.

INSTALLATION PRECAUTIONS

1. See page 2 for safe working pressures.
2. Do not overcharge — see charge and charging procedures on pages 2 and 3.
3. Be sure that the piping does not allow liquid refrigerant to be trapped in sections where hydrostatic pressure can develop.
4. Be sure that the receiver is large enough to hold the entire charge during "warm" operation.
5. Do not overheat — see brazing procedures on page 2.
6. "Caution:" on page 1, right column.
7. "Caution:" on page 2, left and right column.
8. "Caution:" on page 3, left column.

Table 4

Maximum Pressure Drop Between Compressor and Receiver – psi	Head Pressure Component Selection
Below 14	**OROA**-5-100 or –180 ORD-4-**20** & ORI
15 – 19	*OROA**B**-5-100 or –180 *ORD-4-**25** & ORI
20 – 24	*OROA**C**-5-100 or –180 *ORD-4-**30** & ORI
25 – 29	*OROA**D**-5-100 or –180 *ORD-4-**35** & ORI

Bold type indicates pressure range.
*Available on special order ONLY.

WARNING: Serious injury could result from an explosion caused by the rapid expansion of trapped liquid refrigerant subjected to high temperature. ALWAYS OPEN OR VENT THE SYSTEM BEFORE APPLYING HEAT TO REMOVE SYSTEM COMPONENTS. Break the element charging cap tube on valve dome by hand or with a clean cut tool. DO NOT use side cutters, which may seal the opening.

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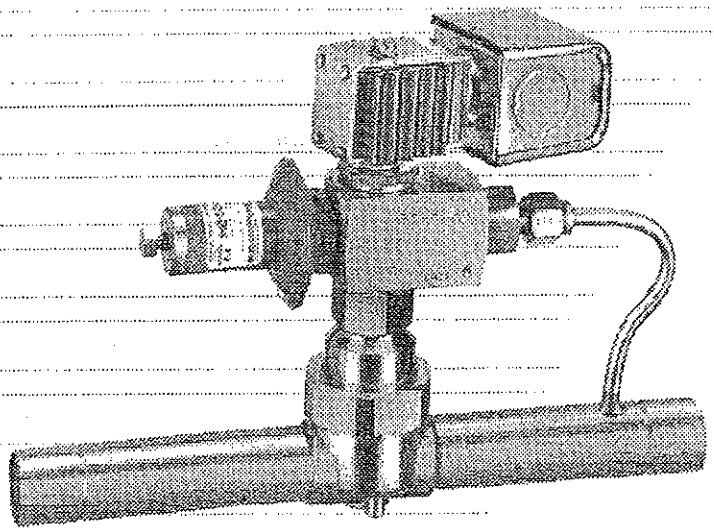
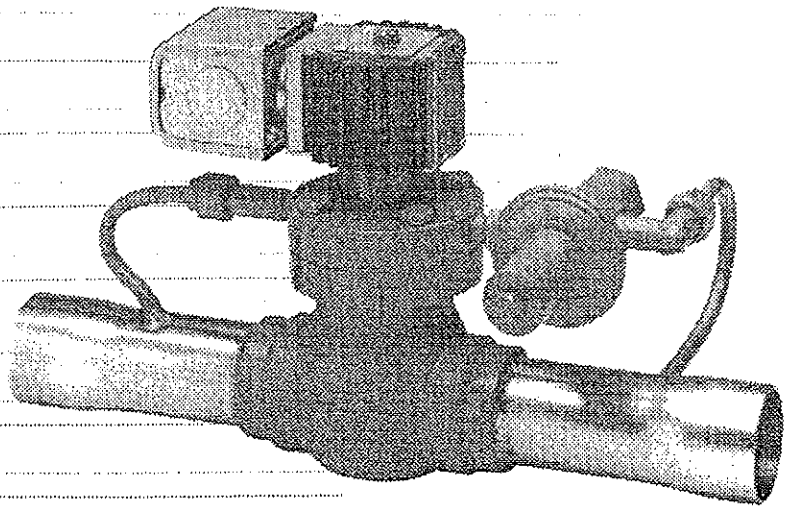
DISCHARGE BYPASS VALVES

Installation & Service Instructions

SHGBE(J)-8



SHGBE(J)-15



SPORLAN

To insure proper performance, discharge bypass valves must be selected and applied correctly. However, proper installation procedures are equally as important. Complete selection and application information on the SHGB(E)-8 is covered in Bulletin 90-40-2 and the SHGB(E)-15 is covered in Bulletin 90-40-1. For information on other models, see Bulletins 90-40 and 90-41, or contact your Sporlan Representative.

VALVE LOCATION

SHGB(E) valves can be installed in horizontal or vertical lines, whichever best suits the application and permits easy accessibility of the valves. However, consideration should be given to locating these valves so they do not act as oil traps and so solder cannot run into the internal parts during brazing.

The discharge bypass valve should always be installed at the condensing unit rather than at the evaporator section. Not only will this insure the rated bypass capacity of the valve but it will eliminate the possibility of hot gas condensing in the bypass line (especially on remote systems). In all cases it is important that some precautions be taken in mounting the valves. It is suggested that they be adequately supported to prevent excessive stress on the connections. See the **PIPING** section for additional piping suggestions.

When externally equalized valves are used, the equalizer connection must be connected to the suction line where it will sense the desired operating pressure.

PIPING

Sporlan recommends that recognized piping references, such as equipment manufacturers' literature and the ASHRAE Handbooks, be consulted for assistance with proper piping procedures. Sporlan is not responsible for system design, any damage arising from faulty system design, or for misapplication of its products. If these valves are applied in any manner other than as described in this bulletin, Bulletins 90-40-1, 90-40-2, and other Sporlan product literature, the Sporlan warranty is void.

Actual system piping must be done so as to protect the compressor at all times. This includes protection against over-heating, slugging with liquid refrigerant, and trapping of oil in various system locations. A few piping guidelines plus some other installation details are given below for the various components involved.

Since the SHGB(E) is applied in a bypass line between the discharge line and the low side of a system, the valve may be subjected to compressor vibrations which result from discharge gas pulses and inertia forces associated with the moving parts. Pulsations are best handled by a good muffler placed as close to the compressor as possible. Vibrations from the moving parts of the compressor are best isolated by using flexible metal hoses for larger lines. For best results, the hoses should be installed as close to the compressor as possible, and mounted horizontal and parallel to the crankshaft **or** vertically upwards. The hoses should **never** be mounted horizontal **and** 90° from the crankshaft. A rigid brace should be placed on the outlet end of the hose to prevent vibrations beyond the hose.

DISCHARGE BYPASS VALVE with OTHER PRESSURE REGULATING VALVES

A discharge bypass valve can be applied on any system that experiences undesirable compressor cycling during low load. However, when other pressure regulating valves are also used, some consideration should be given to prevent undesirable operation. For example, when the bypass valve is required on a system with an evaporator pressure regulating valve (ORIT or other type), less hunting will probably occur if the hot gas is bypassed directly to the suction line along with a desuperheating TEV. However, this may leave oil trapped in the evaporator due to the low velocity flow when the ORIT is throttled. Therefore, depending on the specific system involved, the hot gas may be bypassed either to the evaporator inlet or directly to the suction line.

If the discharge bypass valve is required on a system with a crankcase pressure regulating valve (CRO or other type), the pressure setting of the discharge bypass valve must be lower than the CRO valve setting for each valve to function properly.

Very often, low load conditions will occur during periods when the outdoor ambient drops below 70°F. Head pressure on systems with air cooled condensers becomes too low for satisfactory discharge bypass valve performance at these lower ambient temperatures. Therefore, all air cooled systems that utilize discharge bypass for capacity control should have some type of head pressure control to maintain satisfactory performance.

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BRAZING PROCEDURES

Any of the commonly used brazing alloys for high side usage are satisfactory. However, when soldering or brazing, it is very important that the internal parts be protected by wrapping the valve with a **WET** cloth to keep the body temperature below 300°F. SHGB(E) valves use synthetic material in the piston ring and seating surface that must be protected from overheating. The pilot valve diaphragm and springs are also susceptible to damage from overheating and must be protected. The extended fittings will adequately protect the synthetic material under normal conditions. However, when using high temperature solders, the torch tip should be large enough to avoid prolonged heating of the copper connections. Always direct the flame away from the valve body and pilot valve.

TEST and OPERATING PRESSURES

Excessive leak testing or operating pressures may damage these valves and reduce the life of the operating members. The maximum allowable test pressure for the SHGB(E) valve is 450 psig. If greater high side test pressures are to be used, some method must be used to isolate the valve from these high pressures.

For leak detection, an inert **dry** gas such as nitrogen or CO_2 may be added to an idle system to supplement the refrigerant pressure.

CAUTION: Inert gases must be added to the system carefully through a pressure regulator. Unregulated gas pressure can seriously damage the system and endanger human life. Never use oxygen or explosive gases.

VALVE SETTING and ADJUSTMENT

The model SHGB(E)-8 is adjustable from 0 to 100 psig. The SHGB(E)-15 is adjustable from 0 to 75 psig. See the table below for standard factory settings and average psi change in setting per turn of adjustment. Adjustment is made by turning the adjusting screw on the pilot valve. Turning this screw clockwise will increase the valve setting. Turning this screw counter-clockwise will decrease the valve setting.

Adjusting these valves can be complicated because the load must be varied during the setting procedure. The load on the system must be decreased to lower the suction pressure so that the valve can control. The valve should then be adjusted to maintain the desired pressure. The load on the system should then be increased to raise the suction pressure above the valve setting to close the valve. Once this is accomplished, the valve setting can be checked by slowly decreasing the load until the discharge bypass valve begins to open (a hissing sound and/or an accompanying pressure rise at the outlet connection will indicate the bypass valve has opened).

Hot gas may be required for other system functions besides hot gas bypass capacity control., e.g., hot gas defrost and head pressure control. Normally, these functions will not interfere with each other. However, compressor cycling on low suction pressure may be experienced on system startup when the discharge bypass valve is operating and other functions require the hot gas also. For example, the head pressure control valve (e.g., Sporlan ORD-4 type) requires hot gas to adequately pressurize the receiver and liquid line to keep the thermostatic expansion valve operating properly. In this case the discharge bypass valve should be prevented from functioning by keeping the solenoid coil de-energized until adequate liquid line or suction pressure is obtained.

There are several possible causes for system malfunction when hot gas bypass for capacity control is used. As with any form of trouble-shooting, it is essential to know the existing operating temperatures and pressures before the malfunction can be determined. Once the actual malfunction is pinpointed, it is easier to isolate the cause and then take appropriate corrective action.

The following charts list the two basic malfunctions of a discharge bypass valve – failure to open and failure to close – along with possible causes and remedies.

STANDARD PRESSURE SETTINGS and AVERAGE PSI CHANGE PER TURN

MODEL	ADJUSTMENT RANGE	STANDARD SETTING (PSIG)	AVERAGE PSI CHANGE PER TURN
SHGB(E)-8	0/100	69	16
SHGB(E)-15	0/75	69	13.5

SERVICE TIPS - SHGB(E)-8

MALFUNCTION - FAILURE TO OPEN	
POSSIBLE CAUSE	**REMEDY**
1. Pilot solenoid coil de-energized.	1. Energize solenoid coil.
2. Pilot solenoid coil failure.	2. Replace solenoid coil.
3. External equalizer line pinched shut, plugged or not connected.	3. Connect or replace external equalizer line.
4. Main piston sticking due to foreign material.	4. Disassemble valve and clean. Replace piston if necessary.
5. Pilot solenoid port blocked with foreign material.	5. Remove enclosing tube and clean pilot solenoid port.
6. Pilot valve port blocked with foreign material.	6. Disassemble pilot valve and clean.
MALFUNCTION - FAILURE TO CLOSE	
1. Main piston sticking due to foreign material.	1. Disassemble valve and clean. Replace piston if necessary.
2. Pilot valve port not closing due to foreign material.	2. Disassemble pilot valve and clean.
If solenoid coil is de-energized	
3. Solenoid plunger not closing solenoid pilot due to foreign material or damaged enclosing tube.	3. Remove enclosing tube and clean or replace if necessary.
4. Solenoid pilot port worn or damaged due to foreign material.	4. Inspect and replace pilot assembly if necessary.

SERVICE INSTRUCTIONS - SHGB(E)-8

The SHGB(E) valves can be easily disassembled for inspection and cleaning or for replacement of parts. **CAUTION!** The valve should be isolated from inlet, outlet and equalizer pressure before disassembly. Replacement parts are available as described in the Replacement Parts Section.

PILOT REPLACEMENT INSTRUCTIONS

1. Disconnect the equalizer connection.

2. With the locknut still intact, place a wrench on the bottom fitting of the pilot valve. Turn counterclock-wise and remove the pilot assembly from adaptor.

3. Install the new pilot assembly. Again place a wrench on the bottom connection of the pilot valve. Turn clockwise until the pilot assembly is firmly in place.

4. Remove the locknut and replace the gasket under the adaptor.

5. Reassemble the valve. Before completely tightening the locknut, rotate the pilot valve to properly align the equalizer connection. Join the equalizer connection and tighten the locknut. The pilot replacement is now complete.

INTERNAL PARTS REPLACEMENT

1. Remove the pilot assembly from the adaptor as described in steps 1 and 2 of the pilot replacement instructions.

2. Remove the locknut and replace the adaptor, gasket, spring and the piston assembly. Reassemble the valve and tighten the locknut to 30 ft. lbs.

3. Reinstall the pilot assembly. Place a wrench on the bottom connection of the pilot valve. turn clock-wise until the pilot assembly is firmly in place.

4. Loosen the locknut and rotate the pilot valve to properly align the equalizer connection. Join the equalizer connection and tighten the locknut. The internal parts replacement is now complete.

SHGB(E)-8-0/100 REPLACEMENT PARTS and PARTS KITS

REPLACEMENT PARTS SOLD SEPARATELY

PART NUMBER	DESCRIPTION	QUANTITY REQUIRED
A-4-0/100	Adjustable Element	1
1390-000	Coil Screw	1
MKC-1 Coil (Specify voltage and frequency)	MKC-1 Coil	1
5014-000	Valve Nameplate for SHGB-8	1
5014-001	Valve Nameplate for SHGBE-8	1

REPLACEMENT PARTS KITS

PILOT ASSEMBLY KIT		
K-SHGB(E)-8	Includes: Pilot Valve Assembly, Gasket, Adaptor, Coil Screw, and Valve Nameplate	1
INTERNAL PARTS KIT		
KS-SHGB(E)-8	Includes: Adaptor, Tetraseal, Spring, and Piston	1

① Replacement part **not** available.

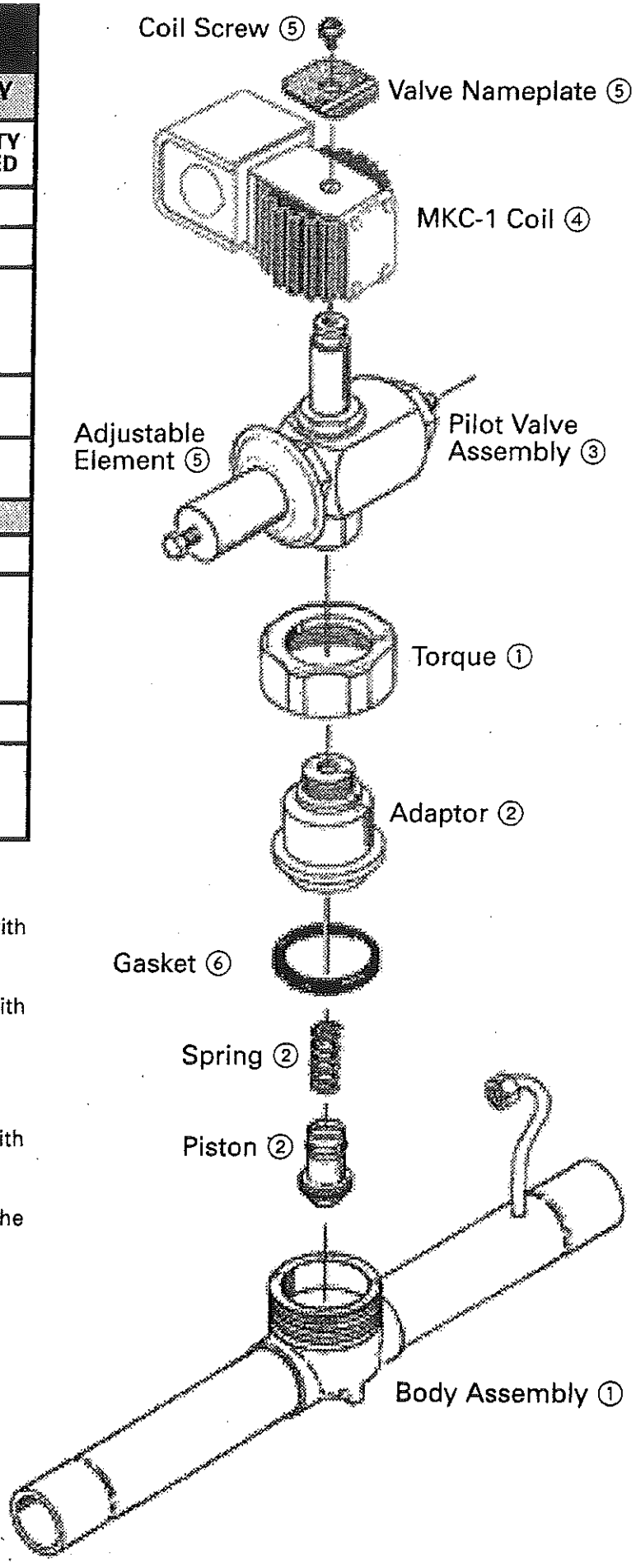
② Part **is not** available separately but, **is** included with the Internal Parts Kit.

③ Part **is not** available separately but, **is** included with the Pilot Assembly Kit.

④ Part **is** available separately.

⑤ Part **is** available separately, and **is also** included with the Pilot Assembly Kit.

⑥ Part is not available separately but, is included in the Pilot Assembly Kit and Internal Parts Kit.



SERVICE TIPS - SHGB(E)-15

MALFUNCTION - FAILURE TO OPEN	
POSSIBLE CAUSE	**REMEDY**
1. Pilot solenoid coil de-energized.	1. Energize solenoid coil.
2. Pilot solenoid coil failure.	2. Replace solenoid coil.
3. Pilot solenoid port blocked with foreign material.	3. Remove enclosing tube and clean pilot solenoid port.
4. Pilot valve port blocked with foreign material.	4. Disassemble valve and clean.
5. External equalizer line pinched shut, plugged or not connected.	5. Connect or replace external equalizer line.
6. Main piston sticking due to foreign material between piston and sleeve.	6. Disassemble valve and clean. Replace piston and sleeve if necessary.
MALFUNCTION - FAILURE TO CLOSE	
1. Inlet strainer to pilot flange plugged with foreign material.	1. Clean or replace strainer.
2. Pilot valve port not closing due to foreign material.	2. Disassemble pilot valve and clean.
3. Main piston sticking due to foreign material between piston and sleeve.	3. Disassemble valve and clean. Replace piston and sleeve if necessary.
4. Scoring of piston or sleeve causing excessive piston ring leakage.	4. Inspect piston and sleeve and replace if necessary.
If solenoid coil is de-energized	
5. Solenoid plunger not closing solenoid pilot due to foreign material or damaged enclosing tube.	5. Remove enclosing tube and clean or replace if necessary.
6. Solenoid pilot port worn or damaged due to foreign material.	6. Inspect and replace pilot flange assembly if necessary.

SERVICE INSTRUCTIONS - SHGB(E)-15

The SHGB(E) valves can be easily disassembled for inspection and cleaning or for replacement of parts. **CAUTION!** The valve should be isolated from inlet, outlet and equalizer pressure before disassembly. Replacement parts are available as described in the Replacement Parts Section.

PILOT REPLACEMENT INSTRUCTIONS

1. Disconnect the two connections of the pilot valve and remove the four cap screws. The complete pilot and body flange assembly can now be lifted off the main valve body and replaced.

2. Install the new gasket and reassemble the valve. A torque value for the cap screws is not recommended but uniformity of compression from the four cap screws is important. Screw the flange down evenly and firmly.

INTERNAL PARTS REPLACEMENT

1. Disconnect the two connections of the pilot valve and remove the four cap screws. The complete pilot and body flange assembly can now be lifted off the main valve body and replaced.

2. Replace the piston assembly, body sleeve and spring.

3. Install the new gasket and reassemble the valve. A torque value for the cap screws is not recommended but uniformity of compression from the four cap screws is important. Screw the flange down evenly and firmly.

SHGB(E)-15-0/75 REPLACEMENT PARTS and PARTS KITS

REPLACEMENT PARTS SOLD SEPARATELY

PART NUMBER	DESCRIPTION	QUANTITY REQUIRED
A-4-0/75	Adjustable Element	1
2625-002	Cap Screw	4
1390-000	Coil Screw	1
MKC-2 Coil (Specify voltage and frequency)	MKC-2 Coil	1
641-3	Enclosing Tube Gasket (Not shown)	1
2645-000	Gasket	1
621-028	O-Ring	1
2445-000	Strainer	1
14115 (Specify valve type, voltage and frequency)	Valve Nameplate	1

REPLACEMENT PARTS KITS

PILOT ASSEMBLY KIT		
K-Y917	Includes: Pilot Valve Assembly, Inlet Strainer Screen and Tetraseal, (4) Cap Screws	1
INTERNAL PARTS KIT		
KS-SHGB(E)-15	Includes: Piston, Body Sleeve, O-Ring, Spring and Gasket	1

① Replacement part **not** available.

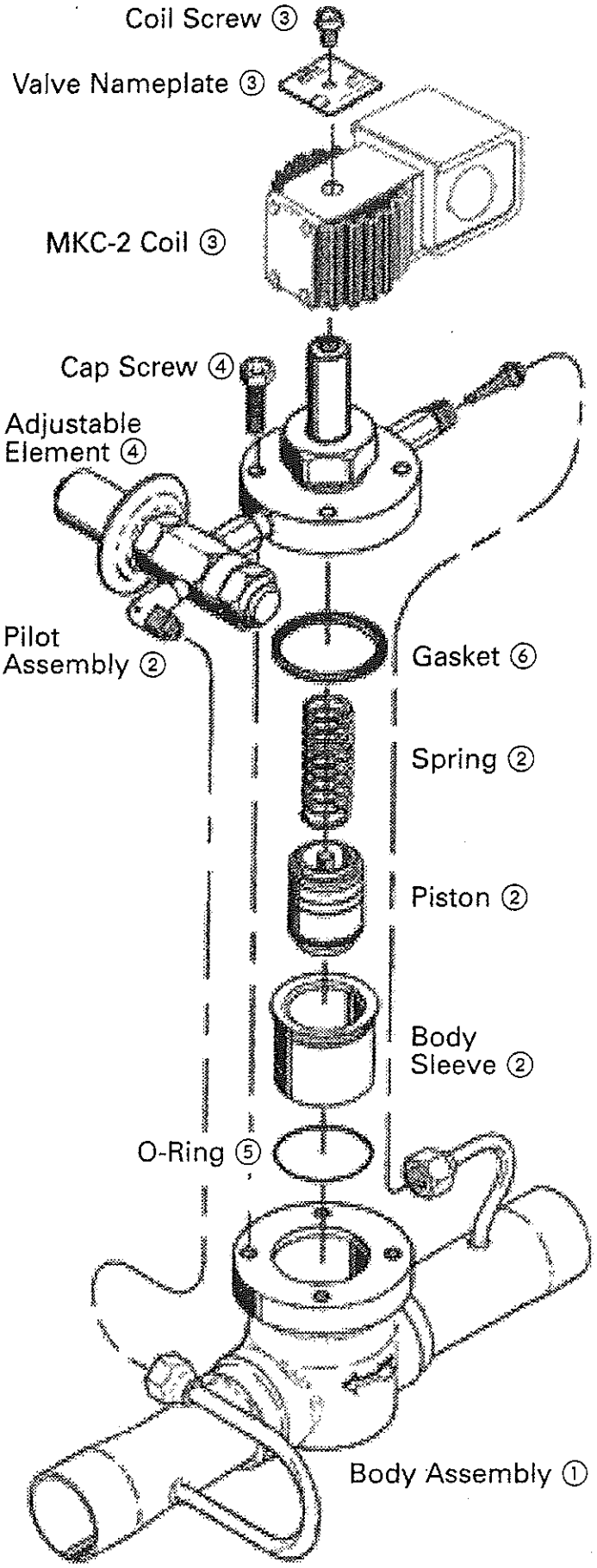
② Part **is not** available separately but, **is** included with the Parts Kits.

③ Part **is** available separately.

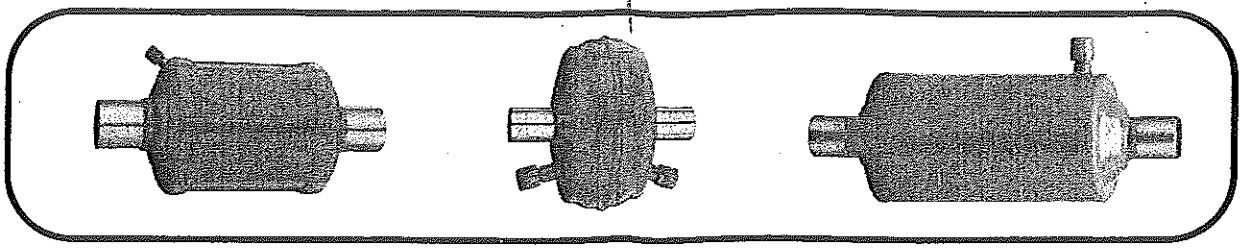
④ Part **is** available separately, and **is also** included with the Pilot Assembly Kit.

⑤ Part **is** available separately, and **is also** included with the Internal Parts Kit.

⑥ Part **is** available separately, and **is also** included with the Pilot Assembly Kit and the Internal Parts Kit.



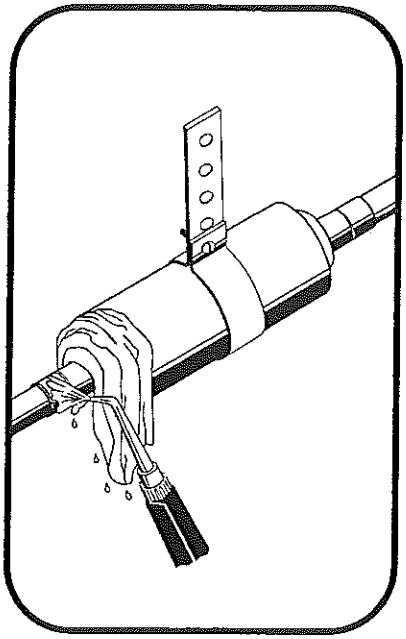
INSTALLATION INSTRUCTIONS



SUCTION LINE FILTER-DRIERS & SUCTION FILTERS

GENERAL SUGGESTIONS

Suction Line Filter-Driers and Suction Filters should be installed as close to the compressor as possible. If a suction vibration eliminator is used, the drier or filter should be installed upstream of it. Suction Line Filter-Driers and Suction Filters may be installed either in a **horizontal** or **vertical position.** If the vertical position is used, the flow should be downward to prevent oil trapping. Always install the unit with the **flow direction** as specified on the product label.



A **support bracket** should be used with the Suction Line Filter so its weight does not add undue strain to the refrigerant line. The A-685 bracket can be used with types SF-6417-T, SF-6421-T, and the C-430-S-T-HH Series Filter-Driers.

All sealed model suction line filters and filter-driers have copper fittings. It is not necessary to clean the fittings prior to brazing.

Any **brazing alloy** may be used, including Sil-Fos, Phos-Copper, silver solder, or soft solder. It is suggested that a **wet cloth** be wrapped around the end of the shell, and that the flame be directed away from shell to protect the paint from deterioration by the heat of brazing. Avoid touching the paint while it is soft from the heat of brazing. These precautions will maintain the corrosion protective finish and prevent rust in service.

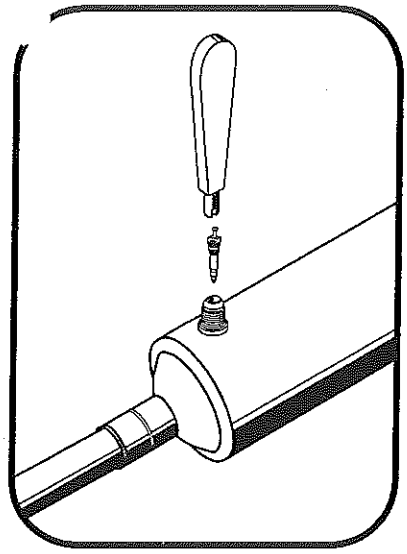
The Suction Line Filter-Driers and Suction Filters are dehydrated and sealed. Do not remove the seals until ready for installation to prevent moisture pickup from the atmosphere.

When a need exists, a Suction Line Filter-Drier can be used in a liquid line application. The construction of both types is similar, except the Suction Line Filter-Drier has larger connections and an access valve. The performance characteristics of the two drier types are similar.

SPECIAL SUGGESTIONS FOR PARTICULAR TYPES

"-T", "-TT" MODELS WITH ACCESS VALVES - These types have an access valve on the inlet end or both the inlet and outlet to permit **pressure drop readings** during

clean-up. The access valve can also be used for charging purposes. The valve cores are shipped in a separate envelope in the box. **No additional charge** is needed when filter-drier is installed in the suction line of a system.



The **valve core** should be installed after the unit has been brazed in the line, and after it has cooled to room temperature. Insert the core and tighten with a tire valve wrench. The proper torque is 1-1/2 to 3 inch-lbs. When properly installed the tip of the access valve actuator will be no more than 1/32" below the end of the flare fitting. Use the seal cap supplied as a further precaution against leaks.

During brazing, the access valve will serve as a vent to relieve internal pressure or as a port for entry or venting of dry nitrogen. Passing dry nitrogen through the joint during brazing is recommended to prevent the formation of copper oxide scale on the inside of the line.

COMPACT MODELS - C-140 Series - The C-140-S-TT-HH is specifically designed for cramped piping situations such as heat pumps. However, it is **not** a reversible filter-drier, therefore it must be installed in the common suction line of heat pump units.

SUCTION FILTERS - Types SF-285-T through SF-4813-T - The design of these Suction Filters permit their installation **with** or **without** the optional relief (bypass) feature. When installed with the flow in the same direction as the flow arrow marked on the product "with bypass relief", this feature will be active.

If the bypass relief feature is not desired, install the Suction Filter "without bypass relief" as indicated on the product. When used on **heat pumps** and systems with hot gas defrost, the Suction Filter should be installed in this direction of flow, without bypass relief.

To effectively use the access valve for pressure drop measurement on these Suction Filters, the filter must be installed without bypass relief.

SUCTION FILTERS - Types SF-114, SF-115, SF-6417-T and SF-6421-T - These types do not have the bypass relief feature and are always installed in the same flow direction.

If a Suction Line Filter-Drier is dropped, be sure to shake it to see if the core has been broken. Do not install a drier with a broken core since particles might escape and damage the system. Sporlan Suction Filters and Filter-Driers should not be subjected to temperatures below -50°F. All Suction Filters and Filter-Driers are suitable to use with Refrigerants 11, 12, 22, 113, 114, 115, 134a, 404A, 407C, 500, 502 and 507. Suction line filter-driers can be used with R-410A since the shells are qualified to handle the higher working pressure. Listed by Underwriters' Laboratories Inc. - Guide Card SMGT - File No. SA1756. For more detailed information on **Suction Line Filter-Driers** for clean-up after a hermetic motor burnout see Bulletin 40-10. Additional information on **Suction Filters** is available in Bulletin 80-10.

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P70, P72, and P170 Controls for Dual Pressure Applications

The P70, P72, and P170 controls for dual pressure applications are designed primarily for use as combination high and low pressure controls on commercial refrigeration and air conditioning applications.

These controls are available in several pressure ranges and are compatible with most common refrigerants. Ammonia compatible models are also available.

These controls respond directly to system pressure changes on both high and low sides, and can provide single-device control of the compressor.

Controls are available in several different electrical ratings and switch configurations, including independent high and low pressure switches (on P70S and P170S models). The P72 models provide direct control of 208-240 volt, single-phase motors up to 3 horsepower, and 208-220 volt, 3-phase motors up to 5 horsepower.

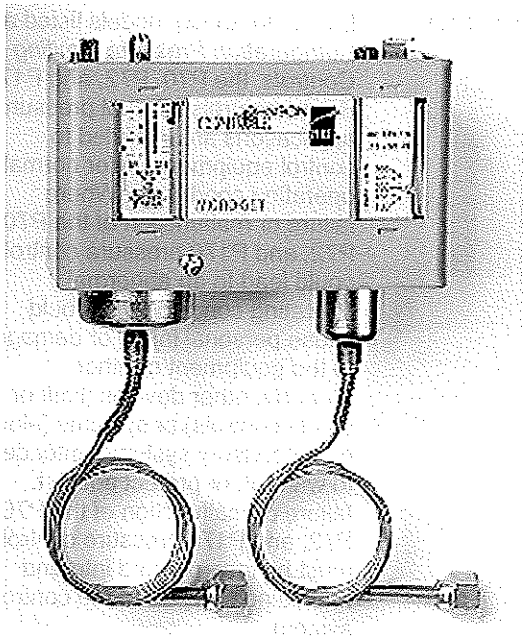

Figure 1: P70SA-1 Dual Pressure Control

Features and Benefits	
❑ **All Steel Case and Cover**	Provides long lasting, rugged protection for internal components
❑ **"Sight-Set" Calibrated Pressure Adjustments**	Provides visible pressure scales, fully adjustable through all ranges without removing the cover
❑ **MICRO-SET™ Differential Adjustment Option**	Allows for precise pressure control of low pressure applications
❑ **Independent High and Low Pressure Switches (P70S and P170S Models)**	Satisfies a variety of dual pressure application wiring requirements with a single versatile control
❑ **Convertible, High Pressure Reset–Auto Reset or Manual Reset Lockout (P70S and P170S Models)**	Reduces inventory—one control can be adapted to several dual pressure applications in the field

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Application

The P70, P72, and P170 controls for dual pressure applications are designed to provide combined high and low pressure control of compressors on commercial refrigeration and air conditioning applications.

IMPORTANT: Except for those models listed as *Refrigeration Pressure Limiting Controls*, the P70, P72, and P170 Series controls for dual pressure applications are intended to control equipment under normal operating conditions. Where failure or malfunction of the P70, P72, and P170 pressure controls could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices (limit or safety controls) or systems (alarm or supervisory systems) intended to warn of, or protect against, failure or malfunction of the P70, P72, and P170 pressure controls must be incorporated into and maintained as part of the control system.

- **P70S and P170S models** have independently operated high and low pressure Single-Pole Double-Throw (SPDT) switches that can be wired to satisfy a variety of control requirements. These adaptable controls also come with a high pressure manual reset lockout mechanism that may be converted to automatic reset.
- **P70L, M, N, and P170L, M, N models** have a Single-Pole Single-Throw (SPST) switch. Models are available with automatic or manual reset lockout options. Models with manual reset are available with either high-side-only manual reset, or low-side **and** high-side manual reset. (See Table 1.) Ammonia compatible models are also available (P70L and P70M only).
- **P72 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, and 208-220 VAC, 3-phase motors up to 5 hp. (See Table 6.)

These dual pressure controls are available in several pressure ranges and are compatible with most common refrigerants. Ammonia compatible models are also available (P70L and P70M only).

CAUTION: **Equipment Damage Hazard.** Ammonia is very corrosive to copper and brass components. On ammonia applications, **only** ammonia compatible control models and pressure connections must be used. The pressure control must be mounted separately from the electrical cabinet and all electrical piping sealed to prevent ammonia from migrating to electrical components.

The **MICRO-SET** option provides fine adjustment of the differential setting for precision pressure control of low pressure applications.

Some models are available with **Limited Knob Adjustment,** which restricts adjustment of the pressure settings and deters over-adjustment or tampering. See *Low Pressure Limited Knob Adjustment.*

A **Manual Reset Lockout** option does not allow the pressure control to reset automatically after CUT OUT is reached, and provides shutdown capability for unmonitored equipment. See *Manual Reset Operation.*

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

Table 1 lists the standard models and features of P70, P72, and P170 controls for dual pressure applications, which are available through most authorized Johnson Controls/PENN distributors.

Operation

The high pressure and low pressure actuated bellows are connected to the controlled equipment by capillaries or field-installed flexible hoses (except on ammonia compatible models).

On most dual pressure control models, the two bellows are mechanically interconnected to operate a single switch. The switch is typically wired to provide control of the refrigeration or air conditioning compressor. On some models, the switch may also be wired to control alarms or other auxiliary devices.

On the P70S and P170S models, the high and low pressure bellows are not mechanically interconnected, and each bellows operates one of two SPDT switches independently.

Dimensions

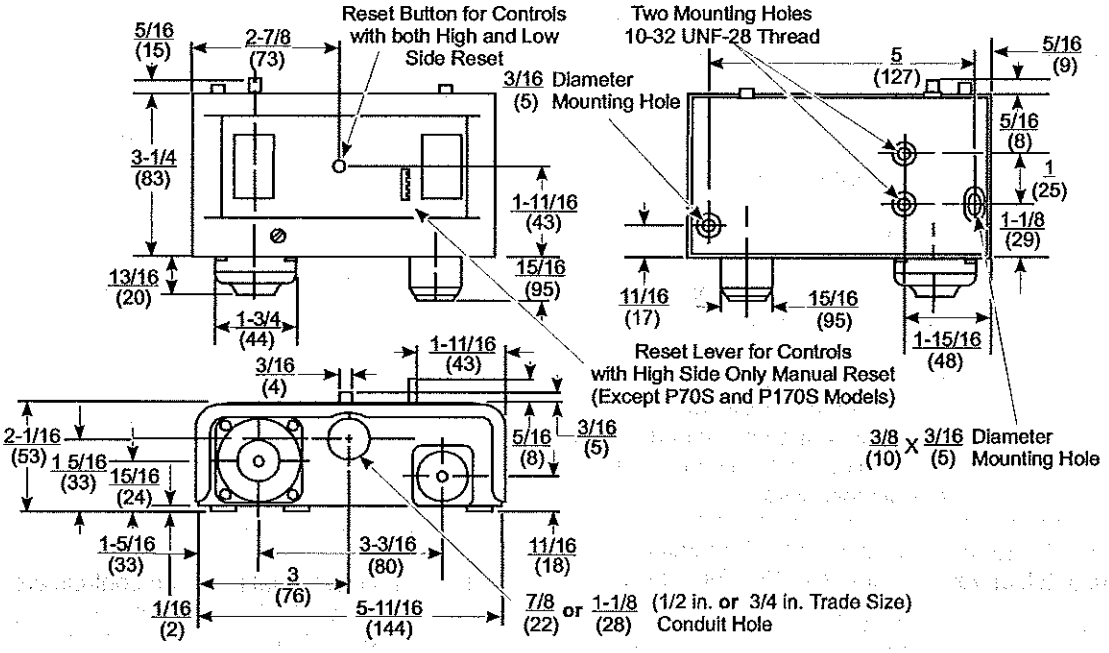


Figure 2: Dimensions for P70, P72, and P170 Dual Pressure Controls with NEMA 1 Enclosure, in. (mm)

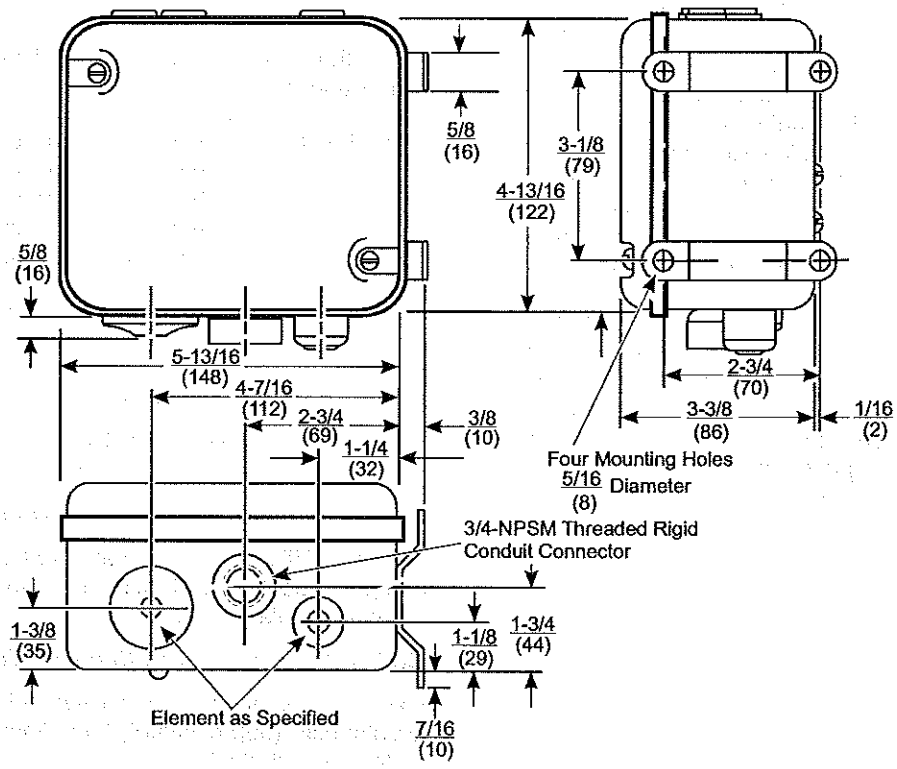


Figure 3: Dimensions for P70, P72, and P170 Dual Pressure Control with NEMA 3R Enclosure, in. (mm)

Note: These dimensions are nominal and are subject to accepted manufacturing tolerances and application variables.

Mounting

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

> **CAUTION: Equipment Damage Hazard.** Mount the pressure control upright and level. Position the pressure connection lines to allow drainage away from control bellows. Pressure tap points must be located on the top side of the refrigerant lines. This reduces the possibility of oil, liquids, or sediment accumulating in the bellows, which could cause control malfunction.

Controls with NEMA 1 enclosures may be mounted on flat, horizontal, or vertical surfaces. (See Figure 4.)

Use two screws or bolts through the two outer holes on the back of the control case when mounting 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.

> IMPORTANT: Use **only** the mounting screws provided with the Universal Mounting Bracket to avoid damaging internal components. Do not warp control case when mounting control to uneven surface.

Controls with NEMA 3R enclosures are designed to be mounted in a level, upright position with the bellows and conduit connection facing down. All gaskets must be 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.

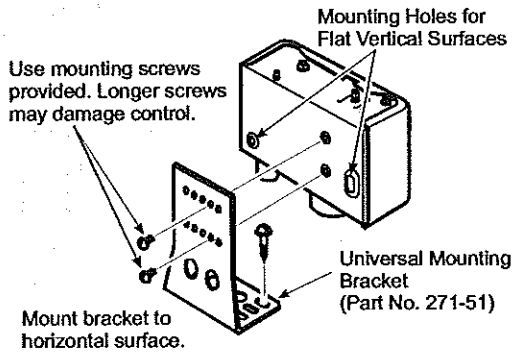


Figure 4: Mounting Dual Pressure Controls with NEMA 1 Enclosures

Pressure Connections

P70, P72, and P170 dual pressure controls are connected to the controlled equipment by a capillary or flexible hose (except ammonia compatible models). These controls are available with a variety of pressure connection styles. See Figure 13 for pressure connection styles.

Follow these guidelines when installing pressure connection lines.

> IMPORTANT: If these controls are installed on equipment that contain hazardous or regulated materials, such as refrigerants or lubricants, the installer and user should observe all regulations governing the handling and containment 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 Tube

Carefully loop any excess capillary tube into smooth, circular coils (approximately 3 in. diameter). Securely fasten the coiled tubing.

Avoid Contact Between the Capillary Tube 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 High Side Pressure Connections

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

IMPORTANT:	After installing control, evacuate control and pressure connection lines in accordance with applicable EPA and other regulations, to remove air, moisture, and other contaminants.

Wiring

P70, P72, and P170 controls for dual 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 action and models.) 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 power supply before making electrical connections to avoid possible electrical shock or equipment damage. On multiple circuit units, more than one disconnect may be required to completely de-energize equipment.

IMPORTANT:	Use terminal screws furnished in the switch block. Using other terminal screws will void the warranty and may damage the switch.

IMPORTANT:	Make all wiring connections in accordance with the National Electrical Code and all local regulations. Use copper conductors only. Do not exceed the control's electrical rating.

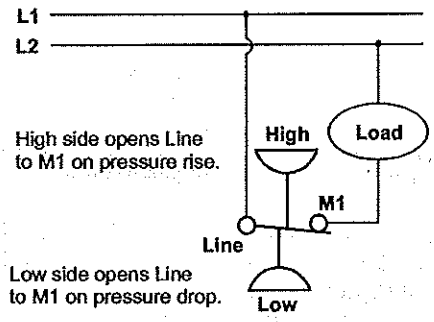


Figure 5: Typical Wiring for SPST Switch (P70L, M, and N, and P170L, M, and N Models)

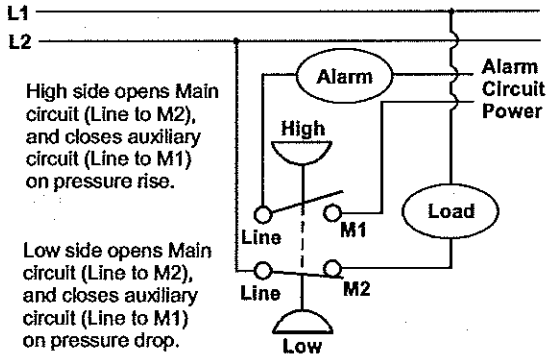
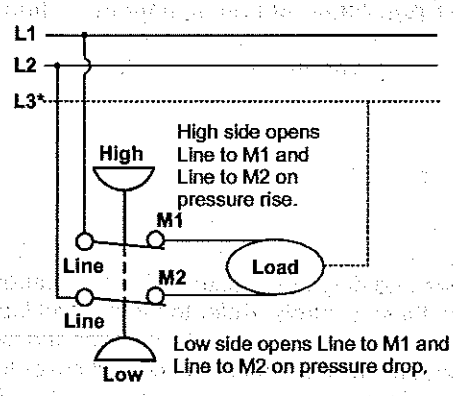


Figure 6: Typical Wiring for 4-wire, 2-circuit Switch (P70P, Q and R Models)



*(L3 is third supply line in 3-phase applications.)

Figure 7: Typical Wiring for DPST Switch (P72L, M, and N Models)

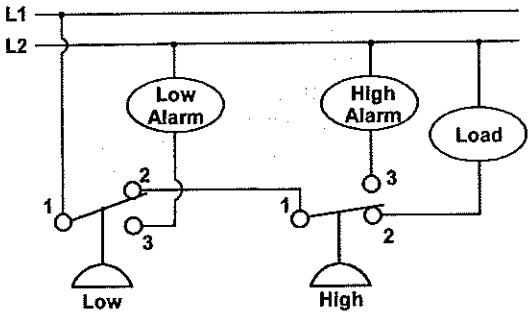


Figure 8: Two SPDT Switches Wired as a Dual Pressure Control (Switching a Single Load with Optional High Side Alarm and Low Side Alarm) (P70S and P170S Models)

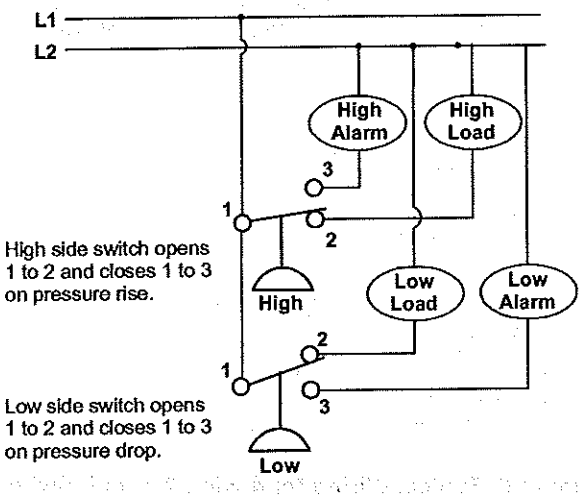


Figure 9: Two SPDT Switches Wired to Control Two Different Loads, (Optional High Side Alarm and Low Side Alarm) (P70S and P170S Models)

Adjustments

Adjustment of the P70, P72, and P170 dual pressure controls varies, 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, and check the front of the control cover to determine if the control is All-Range or MICRO-SET.

All-Range Controls (Low Side Only)

The low side of All-Range pressure controls has a scaleplate that displays the CUT IN and CUT OUT setpoints. (See visible scale on left side of control.) Turning the range screw adjusts the CUT IN and CUT OUT setpoints up or down simultaneously, while maintaining a constant pressure differential. Turning the differential screw adjusts the CUT OUT setpoint only on the left side of the scale, and changes the pressure differential.

MICRO-SET Controls (Low Side Only)

The low side of MICRO-SET pressure controls has a scaleplate that displays the CUT IN setpoint and DIFFERENTIAL setting. (See visible scale on left side of control.) Turning the range screw adjusts the CUT IN setpoint on the right side of the scale. Turning the differential screw adjusts the DIFFERENTIAL setting on the left side, which changes the resulting CUT OUT pressure.

High Side—Dual Pressure Controls

The high side of the P70, P72, and P170 dual pressure controls has a scaleplate that displays only the CUT OUT setpoint. (See the visible scale on right side of control.) Turning the range screw adjusts the CUT OUT setpoint. The differential is fixed at approximately 65 psi.

For controls with the high side (or combination low side and high side) Manual Reset Lockout option, see *Manual Reset Operation.*

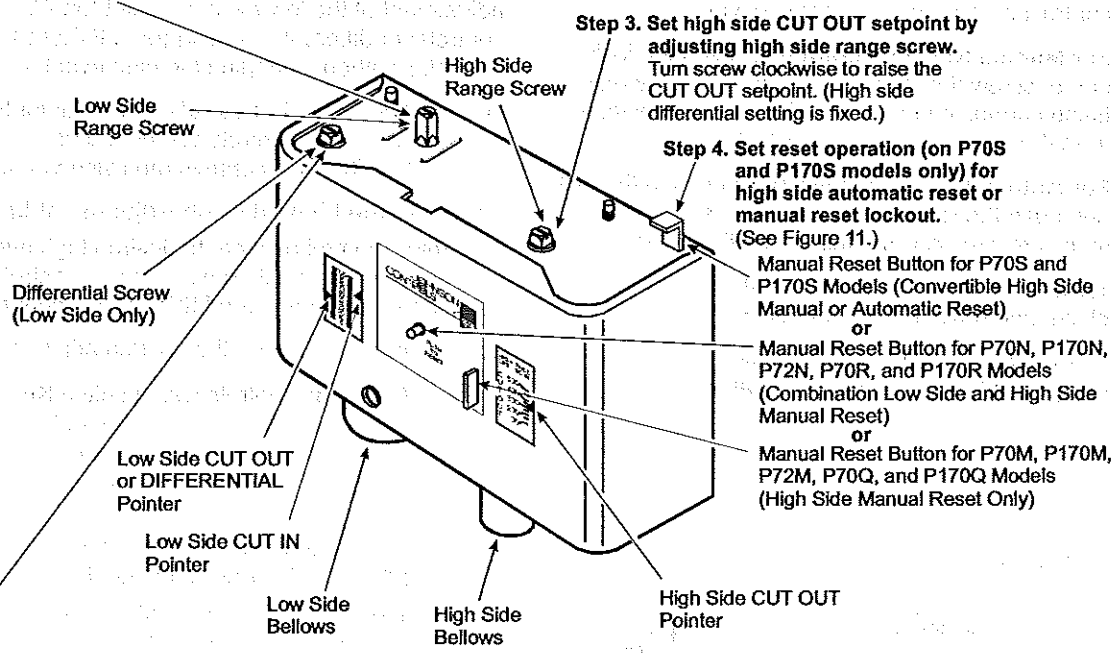
For P70S and P170S controls, see *Convertible High Pressure Reset Mechanism on P70S and P170S Controls.*

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 and cause inaccurate control operation.

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.

IMPORTANT:	After installing and adjusting pressure control, and before leaving installation, cycle the controlled equipment several times (at least three) at normal operating conditions. Use reliable pressure gauges to verify proper control settings and equipment operation.

Step 1. Set low side CUT IN by adjusting low side range screw.
All-Range Controls: Turn screw clockwise to raise the CUT IN setpoint.
MICRO-SET Controls: Turn screw clockwise to lower the CUT IN setpoint.



Step 2. Adjust the differential screw.
All-Range Controls: Turning the differential screw changes the CUT OUT setpoint. Turn screw clockwise to raise CUT OUT setpoint.
MICRO-SET Controls: Turning the differential screw changes the differential setting. Turn screw clockwise to increase differential setting.

Figure 10: Adjusting the Dual Pressure Controls

Manual Reset Operation

Pressure controls with the Manual Reset option lock out when they reach the CUT OUT pressure setpoint 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 before proceeding.

When lockout is caused by the control's low side CUT OUT, allow the sensed pressure to raise to the CUT IN setpoint.

When lockout is caused by the control's high side CUT OUT, allow the sensed pressure to drop at least 70 psig below the CUT OUT setpoint.

After the sensed pressure has reached the desired pressure (as described above), press and release the Reset button on the front of the control to restore operation of the controlled equipment.

Convertible High Pressure Reset Mechanism on P70S and P170S Controls

The P70S and P170S type dual pressure controls are equipped with a convertible high side pressure reset. The control may be configured to automatically reset after CUT OUT (when the pressure drops to CUT OUT minus differential), or to manually reset after CUT OUT (by pressing down the reset lever).

To change the Convertible High Pressure Reset operation:

1. Disconnect all power sources to the pressure control and remove the control cover.
2. **For Manual Reset Operation:** Loosen the lock nut, unscrew the stop screw (counterclockwise) being careful to not remove the screw completely from the bracket. (See Figure 11.)

   For Automatic Reset Operation: Loosen the lock nut, push the reset lever down, and screw in the stop screw (clockwise) fully. (See Figure 11.)
3. Tighten the lock nut to hold the stop screw in place, and replace the control cover.
4. Restore all power sources and cycle the equipment to check control operation.

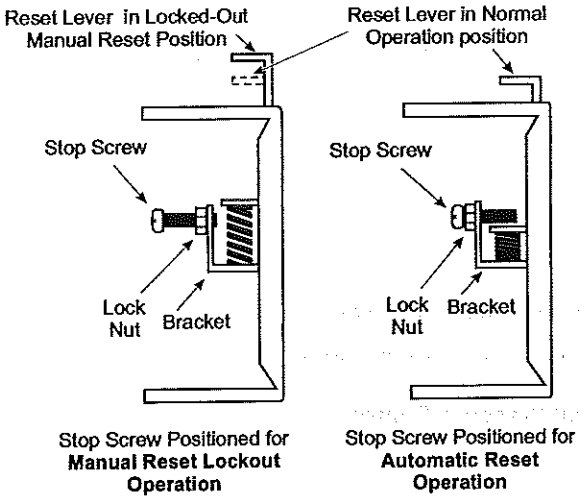


Figure 11: Setting the Convertible High Pressure Reset Mechanism (P70S or P170S Controls)

Low Pressure Limited Knob Adjustment

Some dual pressure controls are supplied with a Limited Knob Adjustment kit for the low pressure side of the control, which restricts the adjustment of the low side range and differential screws, and helps deter overadjustment or tampering. A stop on the bottom of the knob limits adjustment to less than one turn.

The Limited Knob Adjustment may be installed at the factory or included as a separate kit, depending on the model ordered. To install the Limited Knob Adjustment kit refer to the following guidelines and steps.

To lock the differential screw and allow limited adjustment of the range screw, install the knob on the range screw. This configuration allows limited adjustment of the low event and high event setpoints, without changing the differential.

To lock the range screw and allow limited adjustment of the differential screw, install the knob on the differential screw. This configuration allows limited adjustment of the low event setpoint (on All-Range controls) or differential setting (on MICRO-SET controls), without changing the high event setpoint.

Note: The Limited Knob Adjustment kit for the All-Range controls can not be used with the MICRO-SET controls (and vice-versa).

To install the Limited Knob Adjustment kit:

1. Adjust control pointers to desired high event and low event setpoints (on All-Range controls), or differential setting (on MICRO-SET controls).
2. Place the spacer on the desired adjustment screw.
   - All-Range controls (with Limited Knob Adjustment kits) have round and knurled adjustment screws—the spacer must always be placed on the range screw.
   - MICRO-SET controls have square adjustment screws, always place the spacer on the same adjustment screw as the knob.
3. Align the large end of the indicator plate over the adjustment screw with spacer, and align the small end of the indicator plate over the adjustment screw to be locked, and attach the indicator plate.
4. Align the knob over the large end of the indicator plate, attach the knob to the adjustment screw, and tighten the setscrew.

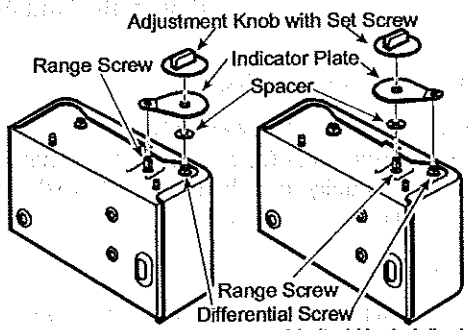


Figure 12: Limited Knob Adjustment Installation

Ordering Information

P70, P72, and P170 controls for dual pressure applications are available in a variety of standard and non-standard models. Table 1 is a model selection chart that lists the features on standard dual pressure control models available through most Johnson Controls/PENN Authorized Distributors.

Table 2 is a type identification matrix that itemizes all the potential P70, P72, and P170 dual pressure control types. Not all combinations in Table 2 are manufactured and available. Figure 13 illustrates the pressure connection styles available on P70, P72, and P170 control models.

Contact your Johnson Controls/PENN Authorized Representative for availability and price.

Table 1: Standard Model Selection Chart for P70, P72, and P170 Dual Pressure Controls

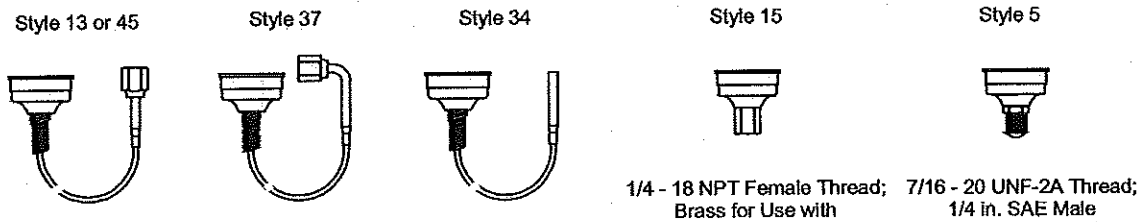
Model Code Number	Switch Action	Low Pressure Side psig (kPa)		High Pressure Side psig (kPa)		Pressure Connector	Limited Knob Adjustment
		Range	Differential	Range	Differential (Non-Adjustable)		
MICRO-SET Controls for Non-Corrosive Refrigerants							
P70LB-6*	SPST	12 in. to 80 (-41 to 552)	Min 5 (34) Max 35 (241)	100 to 500 (690 to 3447)	Fixed Approx. 65 (448)	36 in. Capillary with 1/4 in. Flare Nut	Low CUT OUT
P70MA-18*					Lockout Requires Manual Reset		None
P70SA-1*	Two Independent SPDT				Fixed at 65 (448) **or** Lockout Requires Manual Reset		
P170LB-6*	SPST				Fixed Approx. 65 (448)	1/4 in. Male Flare Connector	Low CUT OUT
P170MA-18*					Lockout Requires Manual Reset		None
P170SA-1*	Two Independent SPDT				Fixed at 65 (448) **or** Lockout Requires Manual Reset		
All Range Controls for Non-Corrosive Refrigerants							
P70LB-1*	SPST	20 in. to 100 (-68 to 690)	Min 6 (41) Max 50 (345)	100 to 500 (690 to 3447)	Fixed Approx. 65 (448)	36 in. Capillary with 1/4 in. Flare Nut	Low CUT OUT
P70MA-1*					Lockout Requires Manual Reset		None
P70NA-1			Fixed (Manual Reset)				
P72LA-1*	DPST		Min 7 (48) Max 50 (345)		Fixed Approx. 65 (448)		Low CUT OUT
P72LB-1*							
P72MA-1*					Lockout Requires Manual Reset		None
P72NA-1*			Fixed (Manual Reset)				
P170LB-1*	SPST		Min 7 (48) Max 50 (345)		Fixed Approx. 65 (448)	1/4 in. Male Flare Connector	Low CUT OUT
P170MA-1*					Lockout Requires Manual Reset		None
P170NA-1			Fixed (Manual Reset)				
All Range Ammonia Compatible Controls							
P70LA-2*	SPST	20 in. to 100 (-68 to 690)	Min 7 (48) Max 50 (345)	100 to 500 (690 to 3447)	Fixed Approx. 65 (448)	1/4 in. Female NPT Connector	None
P70MA-2*					Lockout Requires Manual Reset		

*Control models with high pressure side (only) that are UL Listed as Refrigeration Pressure Limiting Controls.

Table 2: Identification Matrix for P70, P72, and P170 Controls Dual Pressure Applications

P70			Various pressure connection styles available on many models (See Figure 13.)
P170			1/4 in. male flare pressure connection only (Style 5, see Figure 13.)
P72			DPST switch only, 3/4 in. conduit opening on most models, (P,Q, R, S, types not available)
	L		SPST switch (except P72), automatic reset
	M		SPST switch (except P72), high side manual reset lockout switch
	N		SPST switch (except P72), high and low side manual reset lockout switch
	P		4-wire, 2-circuit switch, automatic reset
	Q		4-wire, 2-circuit switch, high side manual reset lockout switch
	R		4-wire, 2-circuit switch, high and low side manual reset lockout switch
	S		Two SPDT switches, convertible high side reset–auto/manual lockout
		A	NEMA 1 enclosure, no adjustment knob
		B	NEMA 1 enclosure, with adjustment knob
		C	No enclosure, no adjustment knob
		D	No enclosure, with adjustment knob
		E	NEMA 3R enclosure, no adjustment knob
		G	NEMA 3R enclosure, no adjustment knob, 1/2 in. conduit
		H	NEMA 1 enclosure, no adjustment knob, 1/4 in. quick connects
		J	NEMA 1 enclosure with adjustment knob, 1/4 in. quick connects
		N	NEMA 1 enclosure no adjustment knob, transportation application
		P	NEMA 1 enclosure with adjustment knob, transportation application
		S	NEMA 3R enclosure, no adjustment knob, transportation application

Note: Not all combinations shown on this chart are available. To verify product availability and for quantity orders of non-standard items, please contact Refrigeration Application Engineering at (414) 524-5535.



*Note: Style 5, 1/4 in. SAE Male Flare Connector may require a copper flare saver gasket, which must be purchased separately.

Figure 13: Pressure Connection Styles Available on P70, P72, and P170 Controls

Electrical Ratings

Table 3: SPST Electrical Ratings (P70L, M, and N, and P170L, M, and N Types)

	Standard Single-Phase Ratings			Hermetic Compressor Single-Phase Ratings
	120 VAC	208 VAC	240 VAC	208/240 VAC
Motor Horsepower	1.5	3	3	–
Motor Full Load Amperes	20	18.7	17	20
Motor Locked Rotor Amperes	120	112.2	102	120
Non-Inductive Amperes	22	22	22	–
Pilot Duty	125 VA at 120 to 600VAC; 57.5 VA at 120 to 300 VDC			

Table 4: 4-wire 2-circuit Electrical Ratings (P70P, Q, and R Types)

	Standard Single-Phase Ratings							
	Line-M2 (Main Contacts)				Line-M1 (Auxiliary Contacts)			
	120 VAC	208 VAC	240 VAC	277 VAC	120 VAC	208 VAC	240 VAC	277 VAC
Motor Full Load Amperes	16.0	9.2	8.0	–	6.0	3.3	3.0	–
Motor Locked Rotor Amperes	96.0	55.2	48.0	–	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							

Table 5: SPDT Electrical Ratings (P70S and P170S Types)

	Standard Single-Phase Ratings			
	120 VAC	208 VAC	240 VAC	277 VAC
Motor Full Load Ampere	16.0	9.2	8.0	7.0
Motor Locked Rotor Ampere	96.0	55.2	48.0	42.0
Non-Inductive Ampere	16.0	9.2	8.0	7.0
Pilot Duty	125 VA at 24 VAC, 720 VA at 120 to 277 VAC			

Table 6: DPST Electrical Ratings (P72L, M, and N Types)

	Standard Ratings					Hermetic Compressor Ratings	
	120 VAC 1Ø	208 VAC 1Ø	240 VAC 1Ø	208 VAC 3Ø	220 VAC 3Ø	208 VAC 1Ø	240 VAC 1Ø
Motor Horsepower	2	3	3	5	5	–	–
Motor Full Load Amperes	24	18.7	17	15.9	15	24	24
Motor Locked Rotor Amperes	144	112.2	102	95.4	90	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 600VAC; 57.5 VA at 120 to 300 VDC						

Specifications

Product	P70, P72, and P170 Dual Pressure Controls		
Switch Action	**P70, P170:** SPST or 4-wire, 2-circuit	**P70S, P170S:** Two SPDT PENN switches	**P72:** DPST
Pressure Connection Call Application Engineering at (414) **524**-5535 for pressure connection styles available	**P70, P72 Standard Models** various connections available (Styles 5, 13, 15, 34, 37) See Figure 13.	**P170 Standard Models** 1/4 in. male flare hose connection (Style 5) See Figure 13.	**P70LA-2, P70MA-2 Ammonia Compatible Models** 1/4 in. female NPT connection (Style 15) See Figure 13.
Maximum Overpressure	Low Side All-Range: 325 psig (2241 kPa) Low Side MICRO-SET: 525 psig (3620 kPa) High Side (All-Range and MICRO-SET): 525 psig (3620 kPa)		
Maximum Working Pressure	Low Side All-Range: 100 psig (552 kPa) Low Side MICRO-SET: 80 psig (690 kPa) High Side (All-Range and MICRO-SET): 500 psig (3447 kPa)		
Ambient Conditions	-40 to 104°F (-40 to 40°C)		
Case and Cover	NEMA 1 Enclosures: Galvanized steel case, plated and painted steel cover NEMA 3R Enclosures: Plated and painted steel case and cover		
Dimensions (H x W x D)	NEMA 1 Enclosure: 3-1/4 x 5-11/16 x 2-1/16 in. (83 x 144 x 53 mm) NEMA 3R Enclosure: 4-13/16 x 5-13/16 x 3-3/8 in. (122 x 148 x 86 mm)		
Approximate Shipping Weight	NEMA 1 Individual: 3.5 lb (1.6 kg); Bulk pack (multiples of 25 controls): 75.5 lb (34.2 kg) NEMA 3R Individual: 4.7 lb (2.1 kg); Bulk pack (multiples of 25 controls): 116.5 lb (52.9 kg)		
Agency Listings	For information on specific items, contact the Refrigeration Application Engineering Group at (414) 524-5535.		
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 Refrigeration Application Engineering at (414) 524-5535. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.

JOHNSON CONTROLS

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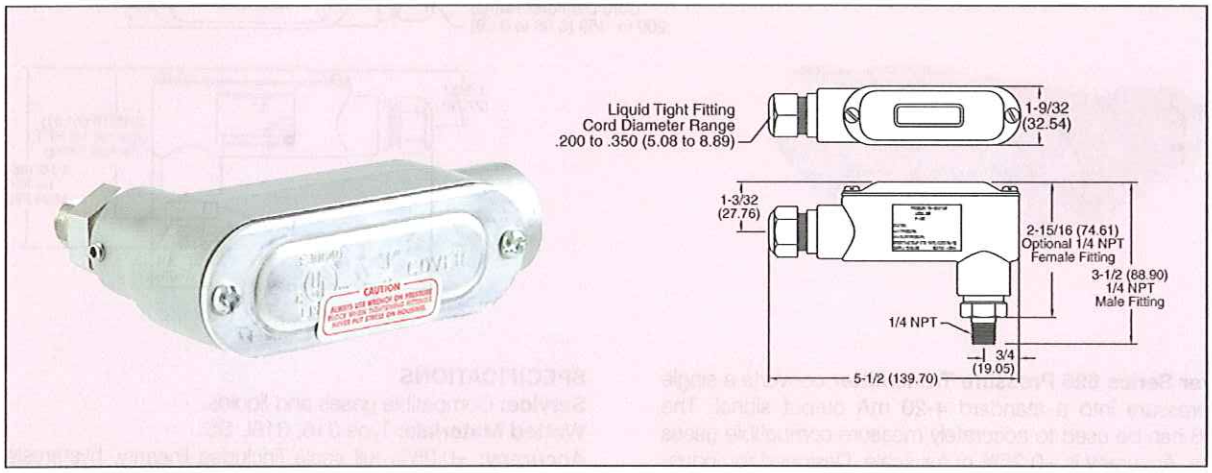
507 E. Michigan Street
P.O. Box 423
Milwaukee, WI 53201

www.johnsoncontrols.com
FAN 125
Master Catalog
Printed in U.S.A.

Series 626

Industrial Pressure Transmitter

0.25% Accuracy, NEMA 4X Enclosure



The Dwyer Series 626 Pressure Transmitter converts a single positive pressure into a standard 4-20 mA output signal. The Series 626 can be used to accurately measure compatible gases and liquids. Accuracy is ±0.25% of full scale. Designed for industrial environments, with its NEMA 4X (IP66) housing and 1/2" female NPT conduit connection, this transmitter resists most effects of shock and vibration. Independently adjustable zero and span controls are provided, located inside the enclosure.

APPLICATIONS

- Compressors
- Pumping Systems
- Irrigation Equipment
- Hydraulic
- Industrial Process Monitoring

STOCKED MODELS

Model Number	Pressure Ranges		
	Pressure Range	Maximum Pressure	Over Pressure
626-07-CH-P1-E5-S1	0-15 psi	30 psi	150 psi
626-08-CH-P1-E5-S1	0-30 psi	60 psi	300 psi
626-09-CH-P1-E5-S1	0-50 psi	100 psi	300 psi
626-10-CH-P1-E5-S1	0-100 psi	200 psi	500 psi
626-12-CH-P1-E5-S1	0-200 psi	400 psi	1000 psi
626-13-CH-P1-E5-S1	0-300 psi	600 psi	1500 psi
626-14-CH-P1-E5-S1	0-500 psi	1000 psi	2500 psi

SPECIFICATIONS

Service: Compatible gases and liquids.

Wetted Materials: Type 316, 316L SS.

Accuracy: ±0.25% full scale (includes linearity, hysteresis, and repeatability).

Temperature Limit: 0 to 200°F (-18 to 93°C).

Compensated Temperature Range: 0 to 175°F (-18 to 79°C).

Thermal Effect: ±0.02% FS/°F (includes zero and span).

Pressure Limits: See Table.

Power Requirements: 13 to 35 VDC (2-wire).

Output Signal: 4 to 20 mA.

Zero and Span Adjustments: Accessible potentiometers.

Response Time: 50 msec.

Loop Resistance: 0 - 1300 ohms maximum.

Current Consumption: 38 mA (max.).

Electrical Connections: Terminal block; 1/2" female NPT conduit.

Process Connection: 1/4" male NPT (optional 1/4" female NPT).

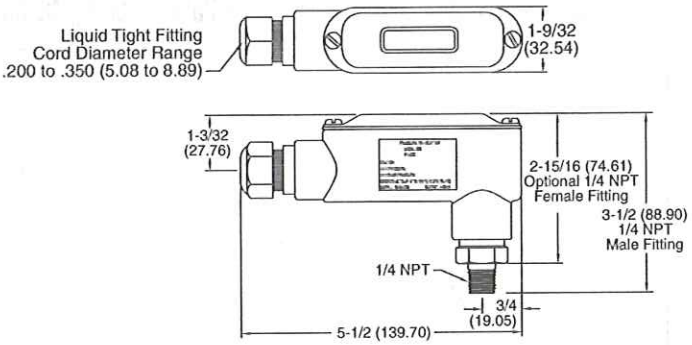
Enclosure Rating: NEMA 4X (IP66).

Mounting Orientation: Mount in any position.

Weight: 10 oz (283 g).

Series 626 Pressure Transmitter

Specifications - Installation and Operating Instructions



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INSTALLATION

1. Location: Select a location where the temperature of the transmitter will be between 0 and 175°F (-18 to 79°C). Distance from the receiver is limited only by total loop resistance. The tubing or piping supplying pressure to the unit can be practically any length required but long lengths will increase response time slightly.

2. Position: The transmitter is not position sensitive. However all standard models are originally calibrated with the unit in a position with the pressure connection downward. Although they can be used at other angles, for best accuracy it is recommended that final zeroing and spanning be done while unit is in its final position.

3. Pressure Connection: Use a small amount of Teflon® thread tape or other suitable sealants to prevent leaks. Be sure the pressure passage inside the port is not blocked.

CAUTION: Do not exceed specified supply voltage ratings. Permanent damage not covered by warranty will result. This device is not designed for 120 or 240 volt AC operation. Use only on 13 to 35 VDC.

4. Electrical Connections: Electrical connections to the Series 626 pressure transmitter are made to the terminal block located inside the housing. Remove the screws and lift off the cover. Wire as shown below in Fig. B.

SPECIFICATIONS

Service: Compatible gases and liquids.
Wetted Materials: Type 316, 316L SS.
Accuracy: ±0.25% full scale (includes linearity, hysteresis, and repeatability).
Temperature Limit: 0 to 200°F (-18 to 93°C).
Compensated Temperature Range: 0 to 175°F (-18 to 79°C).
Thermal Effect: ±0.02% FS/°F (includes zero and span).
Pressure Limits: See Table.
Power Requirements: 13 to 35 VDC (2-wire).
Output Signal: 4 to 20 mA.
Zero and Span Adjustments: Accessible potentiometers.
Response Time: 50 msec.
Loop Resistance: 0 - 1300 ohms maximum.
Current Consumption: 38 mA (max.).
Electrical Connections: Terminal Block.
Process Connection: 1/4" male NPT (optional 1/4" female NPT).
Enclosure Rating: NEMA 4X (IP66).
Mounting Orientation: Mount in any position.
Weight: 10 oz (283 g).

Pressure Ranges		
Pressure Range	**Maximum Pressure**	**Over Pressure**
0-15 psi	30 psi	150 psi
0-30 psi	60 psi	300 psi
0-50 psi	100 psi	300 psi
0-100 psi	200 psi	500 psi
0-200 psi	400 psi	1000 psi
0-300 psi	600 psi	1500 psi
0-500 psi	1000 psi	2500 psi

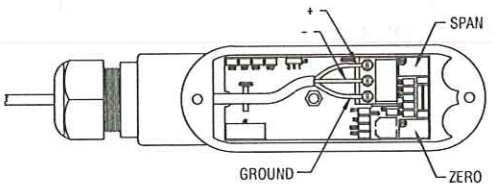


Fig. B

Wire Length - The maximum length of wire connecting the transmitter and receiver is a function of wire size and receiver resistance. Wiring should not contribute more than 10% of the receiver resistance to total loop resistance. For extremely long runs (over 1000 feet), choose receivers with higher resistance to minimize the size and cost of connecting leads. Where wiring length is under 100 feet, wire as small as 22 AWG can be used.

2-Wire Operation - An external power supply delivering 13-35 VDC with minimum current capability of 40 mA DC (per transmitter) is required to power the control loop. See Fig. C for connection of the power supply, transmitter and receiver. The range of appropriate receiver load resistance (R_L) for the DC power supply voltage available is expressed by the formula:

$$R_L \text{ Max} = \frac{Vps - 13}{20 \text{ mA DC}}$$

Shielded two wire cable is recommended for control loop wiring. If grounding is required, use negative side of the control loop after the receiver. Otherwise, it is not necessary to observe polarity of control loop connections.

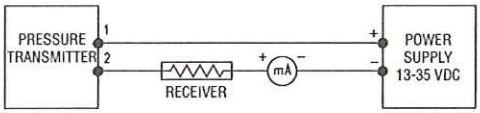


Fig. C

Recalibration Procedure - If the transmitter needs to be recalibrated use the following procedure.

1. Zero and span adjustments are located under the cover on top of transmitter body. Loosen the two screws and gently pull and rotate the assembly until it comes loose.
2. With the transmitter connected to the companion receiver, insert an accurate milliammeter in series with the current loop. Full scale range should be approximately 30 mA.
3. Connect a controllable pressure source to one leg of a tee with the second leg connected to the pressure port of the transmitter and the third leg to an accurate test gage or manometer. Calibration should be done with the unit in the same position in which it will be mounted.
4. Apply electrical power to the unit and allow it to stabilize for 10 minutes.
5. With no pressure applied to the transmitter, adjust the Zero (Z) control so that loop current is 4.00 mA. See Fig. B.
6. Apply full range pressure and adjust loop current to 20 mA using the Span (S) control. See Fig. B.
7. Relieve pressure and allow unit to stabilize for 2 minutes.
8. Zero and span controls are slightly interactive, so repeat steps 4 through 7 until zero and full span pressure consistently produce loop currents of 4 and 20 mA respectively.
9. Remove the milliammeter from the current loop, reinstall the cap assembly and proceed with final installation.

MAINTENANCE

After final installation of the Series 626 Pressure Transmitter and its companion receiver, no routine maintenance is required. A periodic check of system calibration is suggested following the procedure above. The Series 626 Transmitter is not field repairable and should be returned, freight prepaid, to the factory if repair is needed. Be sure to include a brief description of the problem plus any relevant application notes. Contact Customer Service to receive a Return Goods Authorization Number before shipping.

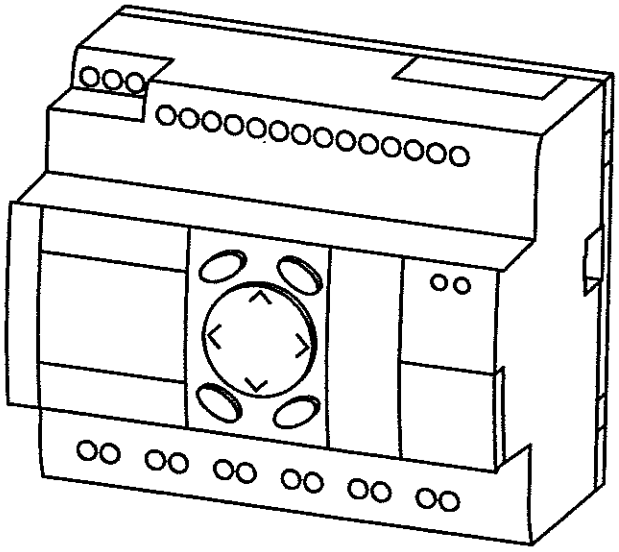
MOELLER

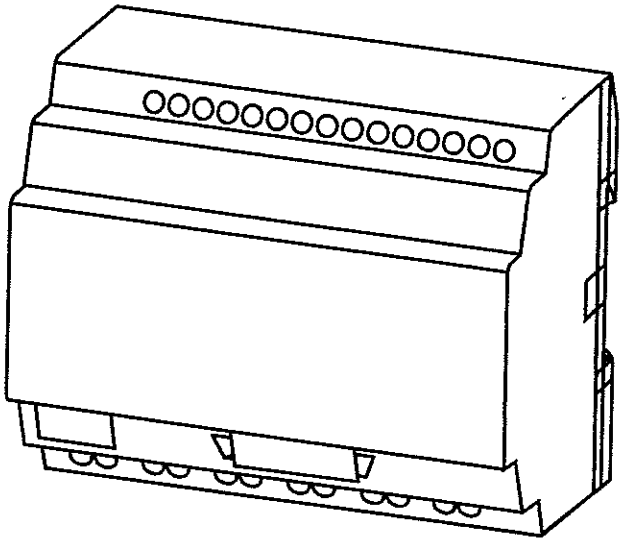
Installation Instructions

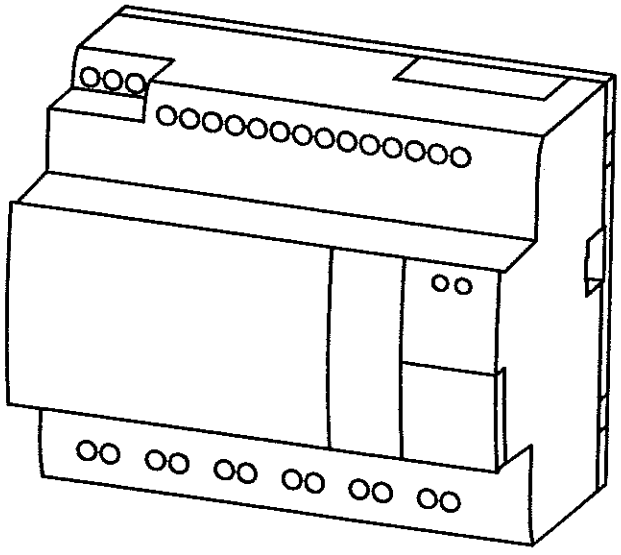
ALPHA LOVAG

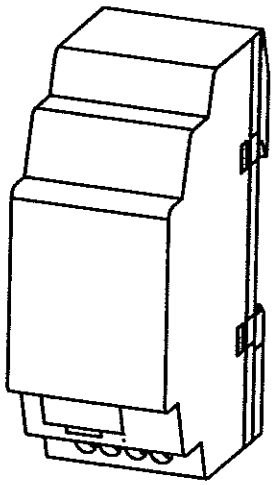
EASY820DC-RC.4

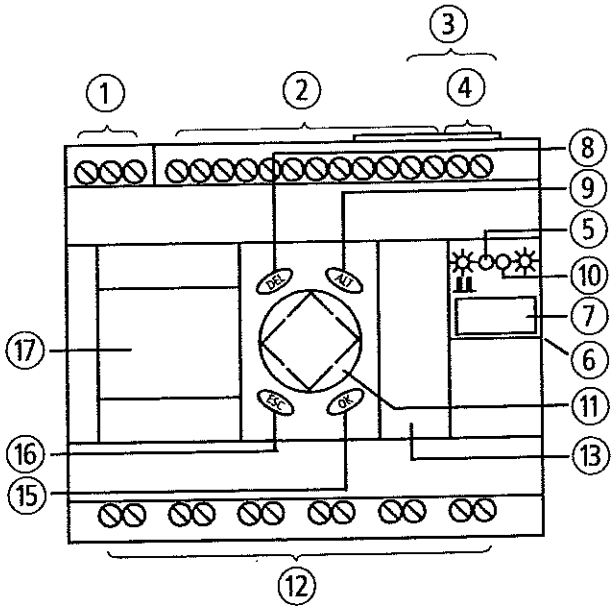
Electric current! Danger to life!
Only skilled or instructed persons may carry out the following operations. The power supply units are mounting devices. The national regulations/ specifications must be observed for the installation of the devices.

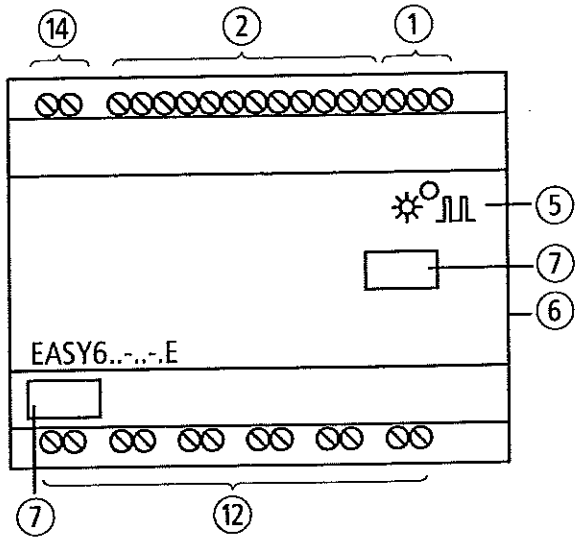


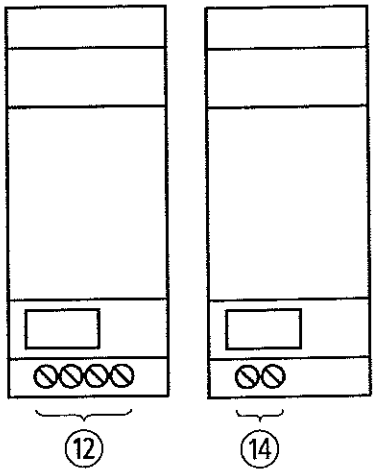












① Voltage supply
EASY8..-.DC-... 24 V DC
EASY8..-AC-... 85 to 264 V AC 50/60 Hz

② Inputs
EASY8..-DC-... 12 inputs 24 V DC (4 can also be used as 0 to 10 V DC/10 Bit analog inputs)
EASY8..-AC-... 12 inputs 0 to 264 V AC

③ Network connection NET

④ EASY820-DC-.., EASY822-DC-..
analog output 0 to 10 V DC/10 bits

⑤ Power/RUN LED

⑥ Central connection (Link)

⑦ Space for component label

⑧ DEL button
Delete contacts/relays/connections/
empty current path/value

⑨ ALT button
Draw connection
Toggle between make or break contact
Insert current path
Special functions

⑩ Network NET LED

⑪ Cursor buttons: right, left, up, down
Select contacts, relays, value, numbers
P button on: Input P1 -> Cursor left
Input P2 -> Cursor up
Input P3 -> Cursor right
Input P4 -> Cursor down

⑫ Outputs
EASY8..-..-RC. 6 x relay/EASY6..RE
EASY8..-DC-TC. 8 x transistor/EASY6..TE

⑬ Interface (with cover)
Slot for memory card, battery, PC interface, modem interface

⑭ Remote connection

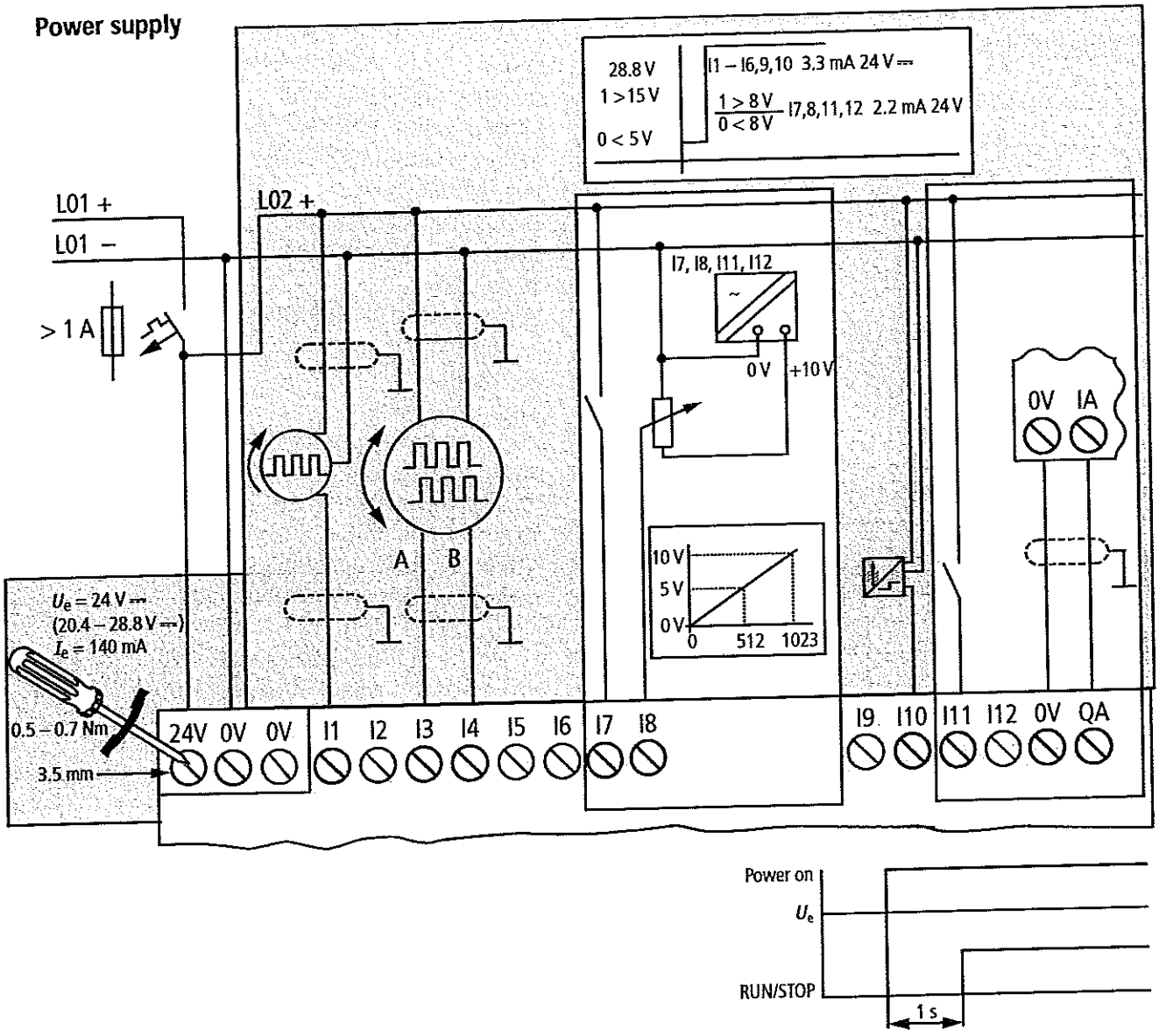
⑮ OK button
Enter menu, action, accept value

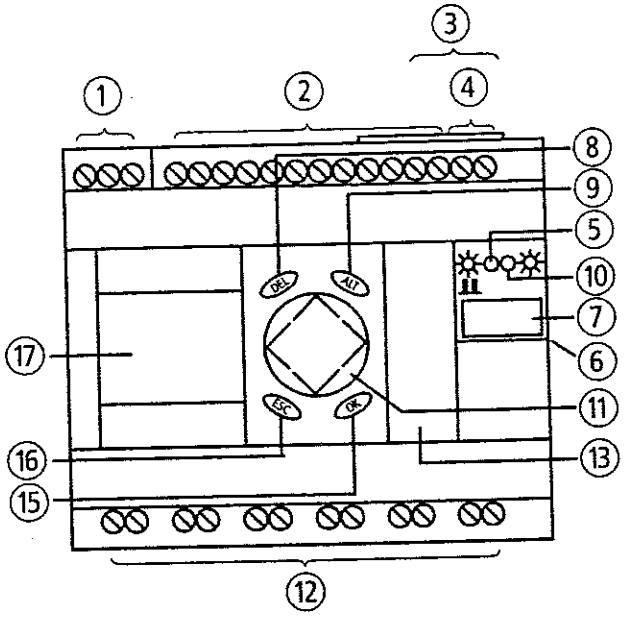
⑯ ESC button
One menu back
Quit menu, selection, end

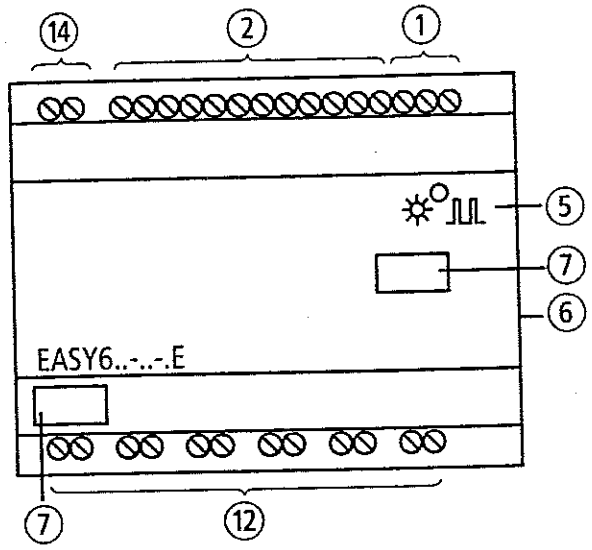
⑰ LCD display (where present)

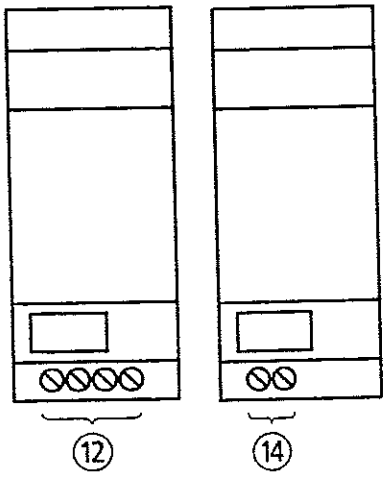
Standard connection

Digital inputs, analog inputs, analog output









① Voltage supply
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② Inputs
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③ Network connection NET

④ EASY820-DC-.., EASY822-DC-..
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Insert current path
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⑩ Network NET LED

⑪ Cursor buttons: right, left, up, down
Select contacts, relays, value, numbers
P button on: Input P1 -> Cursor left
Input P2 -> Cursor up
Input P3 -> Cursor right
Input P4 -> Cursor down

⑫ Outputs
EASY8..-..-RC. 6 x relay/EASY6..RE
EASY8..-DC-TC. 8 x transistor/EASY6..TE

⑬ Interface (with cover)
Slot for memory card, battery, PC interface, modem interface

⑭ Remote connection

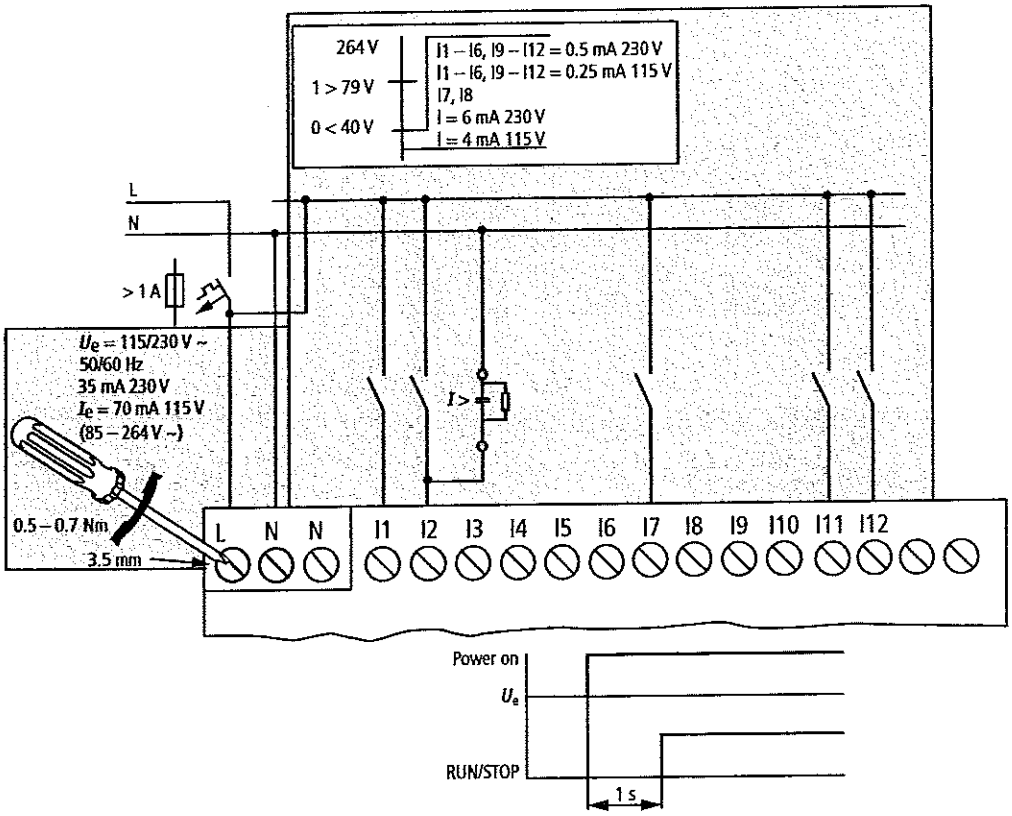
⑮ OK button
Enter menu, action, accept value

⑯ ESC button
One menu back
Quit menu, selection, end

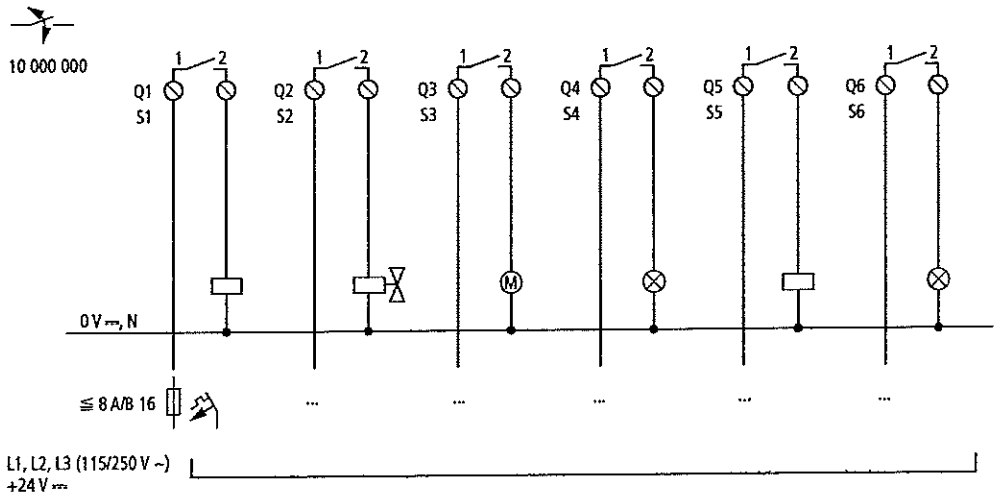
⑰ LCD display (where present)

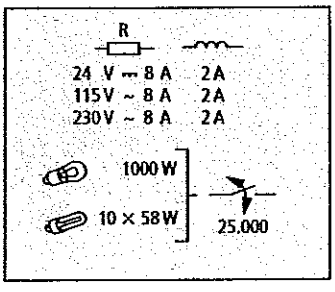
Digital inputs

EASY8..-AC-...

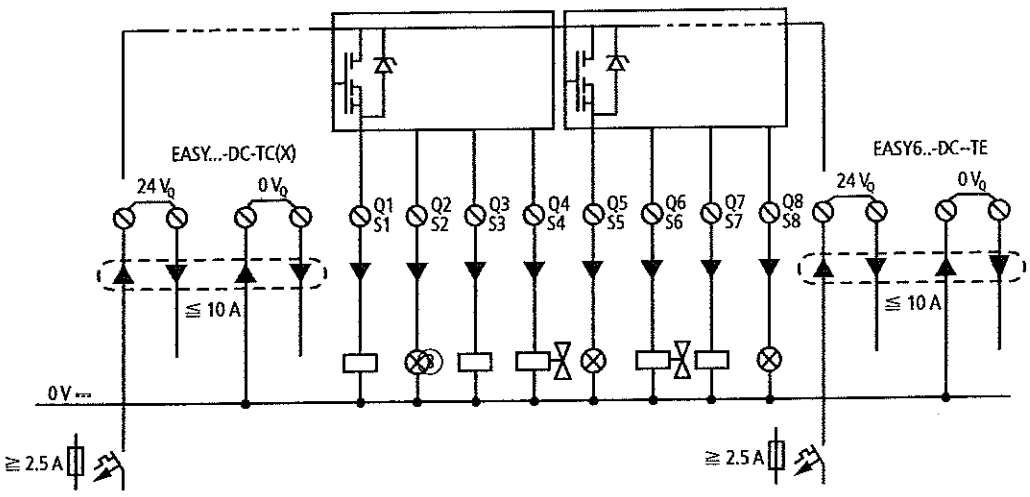


Relay outputs



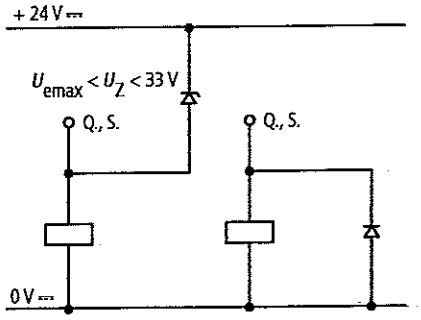


Transistor outputs



	R	
24 V ⎓	0.5 A	0.5 A
Q1 – Q4	3 W	24 V
Q5 – Q8	5 W	

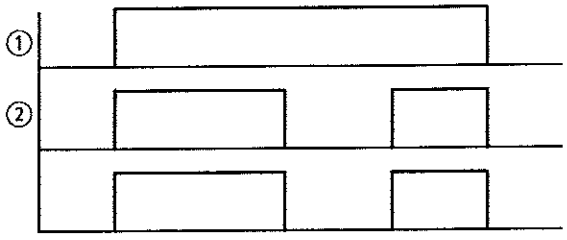
Protective circuit



Temperature range: –25...+55°C

- LCD display legible in range 0 to 55 °C
- On no account allow condensation to form on the device!

Short-circuit detection



① Power supply of the outputs

② Short-circuit, overload, overtemperature

③ Fault detection

I16 = Q1–Q4
I15 = Q5–Q8
R16 = S1–S4
R15 = S5–S8