Order#:

Taco Booster Pump Sets

Installation, Operation, and Maintenance Manual

SUPERSEDES: New

EFFECTIVE: July 1, 2019

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1. Safety Requirements

CAUTION: These instructions should be read completely prior to installation of the equipment. A copy of these instructions should be retained on file for future reference.

WARNING: Electrical shock hazard. Disconnect **ALL** power sources when installing or servicing this equipment to prevent electrical shock or equipment damage.

This pump set is intended for boosting pressure of water or other suitable HVAC media (Single Point Discharge pressure, ΔP or ΔT control). It is not intended for hazardous, corrosive, or flammable liquids and is not certified as a fire protection device. The Booster must not be operated until all piping and/or electrical connections are in place and piping connections have been checked for leaks and proper strain relief has been installed for all field wiring connections.

Proper care and suitable equipment should be used to move and install this heavy equipment at the job site. Care should be taken when installing piping systems to avoid placing an excessive load on the pump or piping connections. Any external piping used to connect to the pump set may not rely on the provided headers and/or valves to provide support to field installed piping.

Refer to motor installation instructions to determine proper terminal connections in order to obtain correct pump rotation. A copy of the motor wiring is printed on the motor nameplate(s). Motor rotation is checked at the factory but must be verified during installation.

When the system piping is used as an earth bonding path for the building electrical services (check local codes), the booster should not be relied upon as part of the circuit. A properly installed bridging connection should be provided.

If electrical connection is to be made by using any means other than rigid conduit, proper strain relief must be provided (min 100N tension).

The pump set should be installed according to all applicable local electrical and safety codes using appropriate size wire and suitable over current protection. Circuit breakers are not included as part of the package and must be provided by the installing contractor, and installed external to the booster (i.e. remote circuit breaker panel). Careful attention must be paid when sizing remote circuit breakers, as it is possible that all motors included in the package may run simultaneously even though the package was selected with a standby pump.

WARNING: The product nameplate indicates the maximum pressure the components have been selected for. It is the responsibility of the installing contractor to install an appropriately sized pressure relief valve to ensure that the nameplate ratings are not exceeded. Failure to follow these instructions could result in injury, death or property damage.

2. General Installation Requirements

2.1 Receiving Pump Set

Inspect for shipping damage immediately upon receipt. If a shortage or damage occurs, ensure that the issue is properly recorded on the bill of lading (BOL) and notify you Taco representative immediately. **In cases of extreme and significant visible damage to the crate, do not accept the shipment.**

2.2 Installation Location & Orientation

Install the pump set on the floor or suitable vibration isolation pad/base. Bolt Holes are factory pre-drilled onto the skid mounting flange at the bottom of the base for anchoring to the building structure or field-provided vibration isolation pad/base. The pump set should be located such that there is adequate space for inspection, maintenance or repair of the package. The pump set should be oriented such that access to the controller(s) and Variable Frequency Drives (VFD) is unobstructed. Additional head space is recommended to be provided for the use of a hoist or tackle for motor maintenance as required.

- **The pump set must not be suspended with piping, and no external loads shall be applied to the pump set (i.e. external piping loads).**
- **DO NOT use the motor eye-bolts to lift the package!**
- **DO NOT cover the motor or pump with insulation!**

2.3 Piping

The pump set is provided with all connection tightened and is pressure tested at the factory. Prior to installing the pump set, check all connections for tightness to ensure nothing has come loose during transportation.

Supply and Return connections to the package are to be connected to the header subassembly which is provided with a standard Victaulic grooved connection. Provisions for flexible couplings and vibration isolation of the header connections to the building system are the responsibility of the installing contractor, follow the project specifications to determine if this is an installation requirement.

It is recommended that isolation valves (provided by the installing

contractor) are installed on the header inlet and outlet in order to properly isolate the package from the building system in the event of maintenance or repair.

A suitable check valve should be installed on the discharge piping downstream from the pump set as an additional backflow prevention measure.

For domestic potable water pump sets, a double check valve assembly should also be present in the system as part of the incoming city water supply (installed upstream of the booster suction header).

For packages with 6” diameter headers, the headers are supported to the fabricated base using piping clamps to secure the package during transportation. For packages with header diameters less than 6”, a formed base is used to mount the pumps and the headers will overhang, and it is the responsibility for the installing contractor to supply and install adequate pipe supports in the field during installation.

If the system includes a thermal relief valve, piping from the outlet of the valve to drain is the responsibility of the installing contractor. Use rigid piping suitable to withstand the total pressure of the pump set (max. suction pressure + maximum pump deadhead pressure at 60 Hz/Max motor RPM). Ensure that the piping is rigidly secured to the building structure.

WARNING!

Failure to properly secure piping to the building structure could result in injury or equipment damage should the pump set discharge high pressure water through improperly sized, selected or secured pipe.

2.4 Wiring

This section details the various installation requirements for electrical wiring. Features that are offered but not standard are indicated as such. Refer to the pump set submittal to determine if the pump set was ordered with any additional options and follow the instructions accordingly.

2.4.1 Power Wiring (Standard)

Standard pump sets are provided with a power distribution block for a single point power input. The individual VFD’s are provided with fused disconnect switches, however a suitably sized circuit breaker is to be provided by the installing contractor and

installed external to the booster in order to isolate the wiring between the power distribution block and the VFD input connection, in the event maintenance is required. The wiring diagram is included with the package in a pouch on the interior of the control panel. The wire sizing to the terminal block should be sized in accordance with all local codes and the National Electrical Code (NEC) or Canadian Electrical Code (CEC), as applicable. Field provided conductors must be copper rated at 90°C sized for the load of all motors included on the package, as all motors may run simultaneously, regardless of operating sequence.

2.4.1.1 Emergency Power Wiring (Optional)

If the pump set was provided with emergency power, this will be indicated on the wiring diagram included with the pump set and will be listed in the pump set submittal. The emergency power option for a triplex includes a 120V control transformer complete with fusing, contactor(s) as required, and an external relay (C1) to switch between normal operation and emergency operation. By default, the pump set is provided with 120 VAC or a 24VAC relay; select the appropriate relay coil to be used based off the Automatic Transfer Switch (ATS) output signal.

The relay for the control circuit is wired normally closed by default. When no signal to the control relay C1 is present, all VFD’s/Pumps on the package will receive power. When a 24 VAC or 120VAC signal is applied to relay C1, the contactor(s) will open and disconnect power to all VFD’s/Pumps except for the first pump.

If opposite action is required, change the wiring connections on the terminals of the socket mount for the relay in order to change the configuration of the relay to normally open.

The emergency power option for a duplex pump package includes a contactor (120VAC or 24VAC) as well as 2 terminal blocks for easy customer connection. When the contactor coil receives power all VFD’s/Pumps will be energized. Once the signal is lost the unit will go into emergency power mode which means only the first pump will operate.

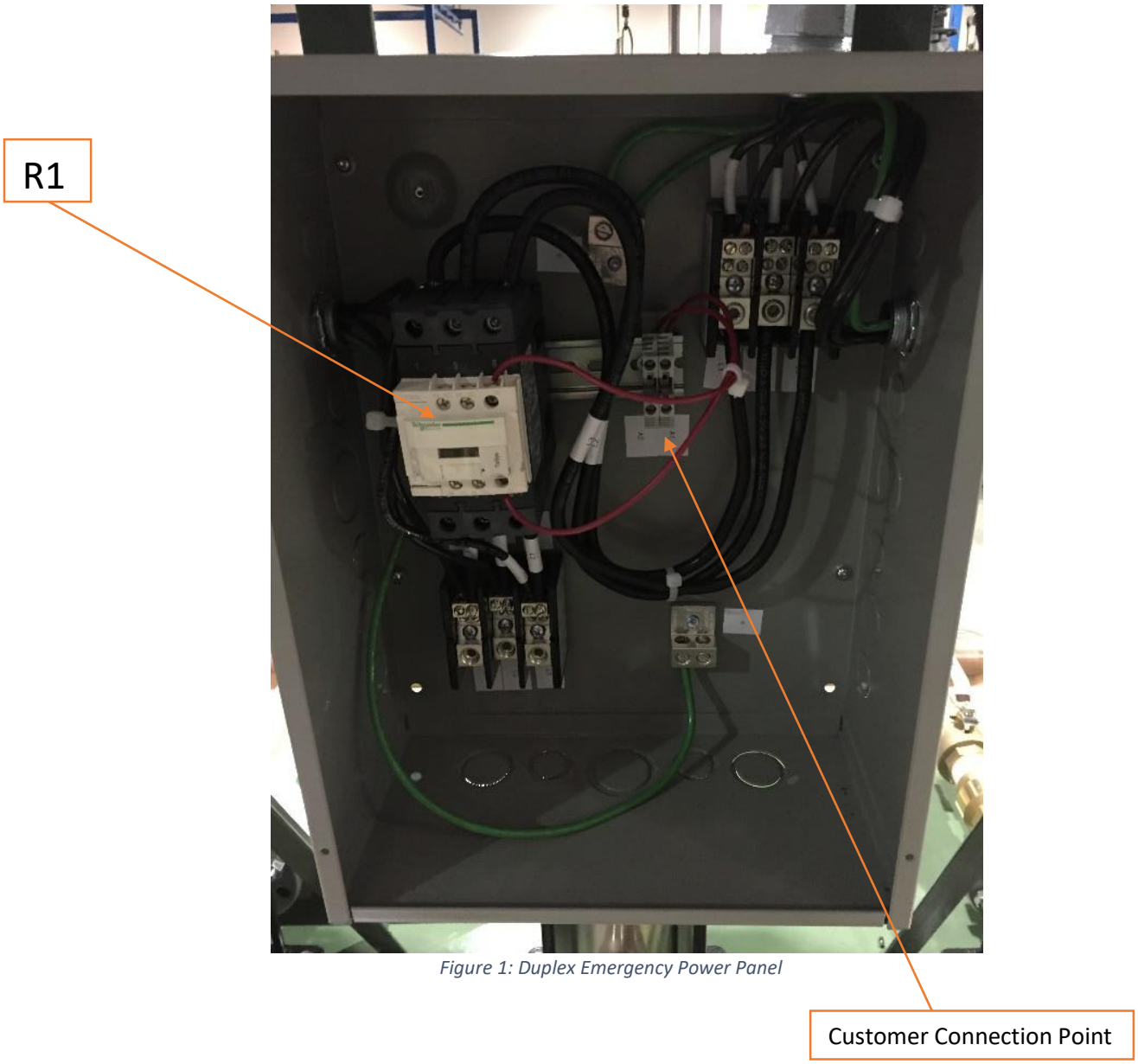


Figure 1: Duplex Emergency Power Panel

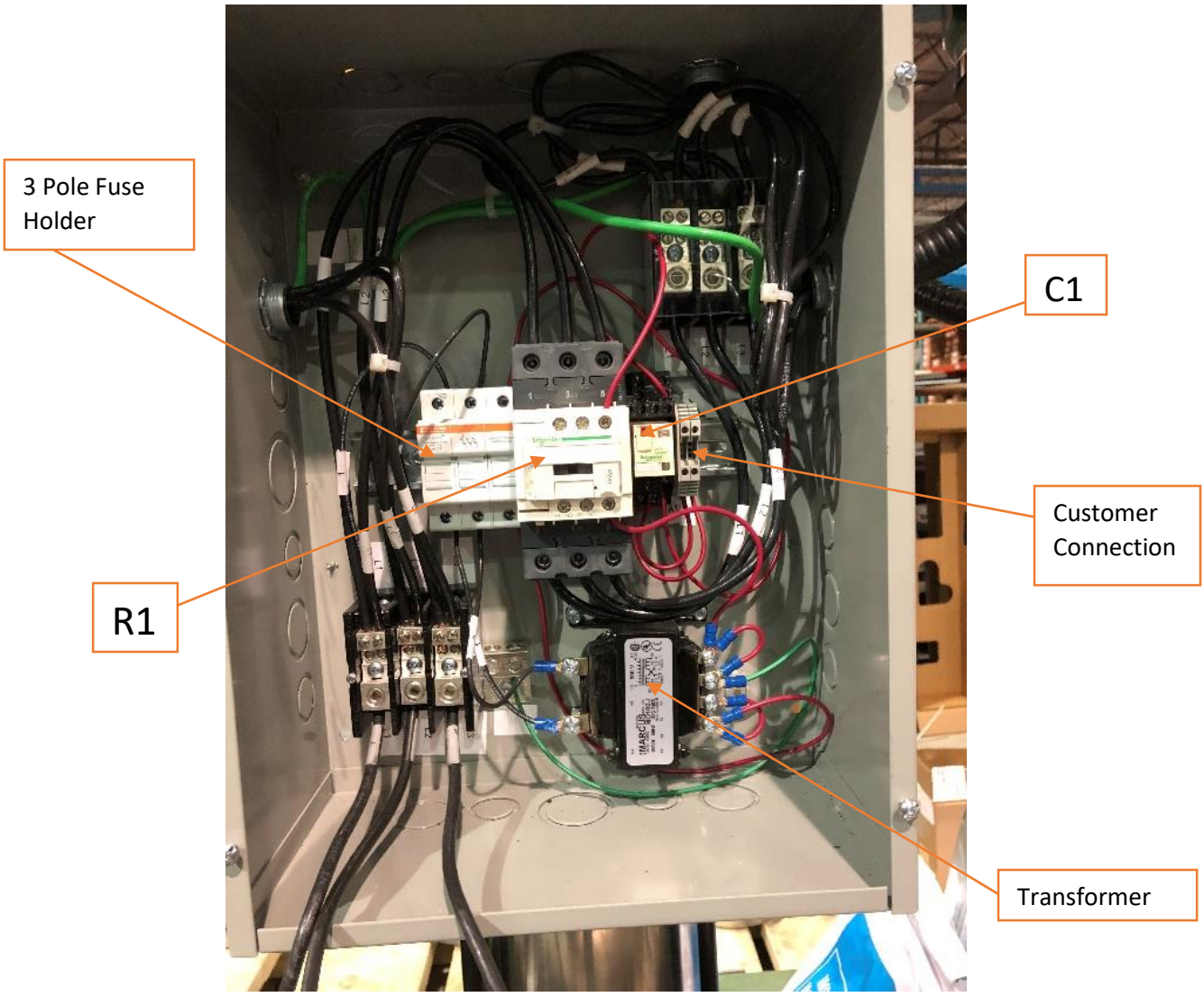


Figure 2: Triplex Emergency Power Panel

2.4.2 Controls Wiring

Control wiring is factory installed and tested. Optional features that may require additional installation steps are listed below.

2.4.2.1 External Interlock

The terminals for external interlock are daisy chained between all drives so only one connection to the lead drive is required. If a low suction or high discharge pressure switch is included, the contacts from the switch(es) will be wired to terminals 19 and power

(terminals 12 or 13) on the lead drive for a duplex. Triplex interlock is very similar however connected to terminal x58/1 and x46/1 on the extended relay attached to the third drive. The wiring to the switch contacts is wired such that in a high pressure or low pressure instance, terminal 19 (Duplex) or terminal x46/1 (Triplex) will get a signal for external interlock and the drives will be locked out, showing an “external interlock” fault.

If a field provided device is required to be wired to the package to interlock the drives, it may be connected to terminals 19 and 12 or 13 (Duplex) or x58/1 and x46/1 (Triplex), provided that the device does not consume power and consists only of a dry contact. If this must be installed where one or more pressure switch has been provided from the factory, the external device should be connected to the pressure switch(es) by wiring them in series together. It should be noted that because all switches/interlocks are wired to a single terminal, the drives cannot differentiate between which source is causing the interlock. If more specific operation is require contact your local Taco representative for a solution.

2.4.2.2 Transducer Connection

If a transducer was provided at the factory, it will be wired to the lead drive (VFD #1), to terminals 54 (Feedback Signal) and 55 (Feedback Common Signal), and power (Terminal 12 or 13) as required. These terminals are daisy chained between all drives on the pump set so that all VFD’s receive the same signal.

By standard, the drives are configured for a 0-10Vdc signal and the sensors used are 0-10V. However, 4-20mA is available as an option upon request.

2.4.2.3 Communication Wiring

Terminals for communication via Danfoss supported communication protocols are 68 and 69. These are not daisy chained at the factory due to variances in building automation systems. Based off project requirements, Building Automation Systems (BAS) may be connected to the lead drive (VFD #1) and these terminals daisy chained together between all drives on the package, or

each VFD may be connected to the BAS individually.

2.5 Pump Startup

The pumps provided on the pump set are sized for application based off the specification provided at the time of order. If the pump impeller (KV/KS or CI/FI Series) has a specific trim to it, it will be noted on the product nameplate.

Once mechanical piping and power has been connected to the package, with the power turned off, the system may be filled with water. As the system is filling, ensure that no leaks are present in the piping.

If the package is equipped with Franklin Electric VR pumps or if the pump has a bleed valves be sure to purge the air out of the system. VR pumps have air valves as shown below. Loosen this on all 2(Duplex) or 3(Triplex) pumps and wait for water to exit the valve and re-tighten it. Do this before pressure is added to the system, this must be done every time pressure is released from the system.

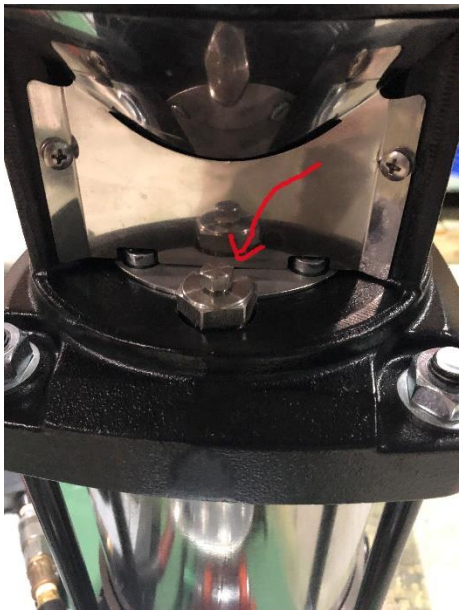


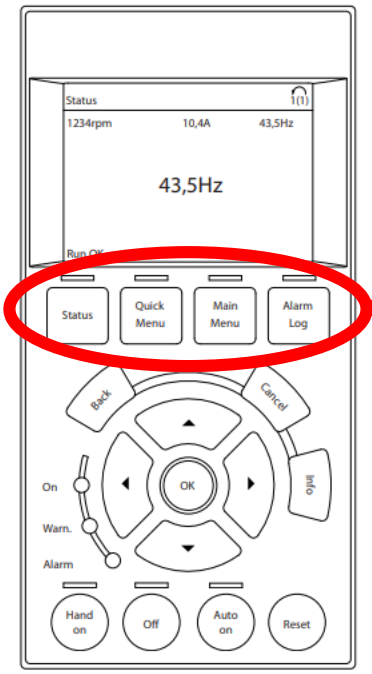
Figure 3: Bleed Valve of a VR Pump

Once the package has been filled and purged of air, power may be turned on.

Motor rotation is checked at the factory but should always be checked by bump testing the motors to verify the direction of rotation. Refer to the labels on the pump for the correct rotation direction. If the motors are running in the incorrect direction, correct this by changing any two leads on the terminal connector that connects the motors to the VFD motor output. Repeat this process until it has been verified that all motors are rotating in the desired direction.

2.6 VFD Programming

2.6.1 Drive Controller Navigation



The control panel drives are equipped with individual LCD screen and keypad assembly for navigation. The following is the button layout:

GENERAL MENU ACCESS:

The four menu access keys can be used to access parameters and various display states.

STATUS:

The menu access keys can be used to access parameters and various display states. The status key is used to scroll through the status screen which displays operating information.

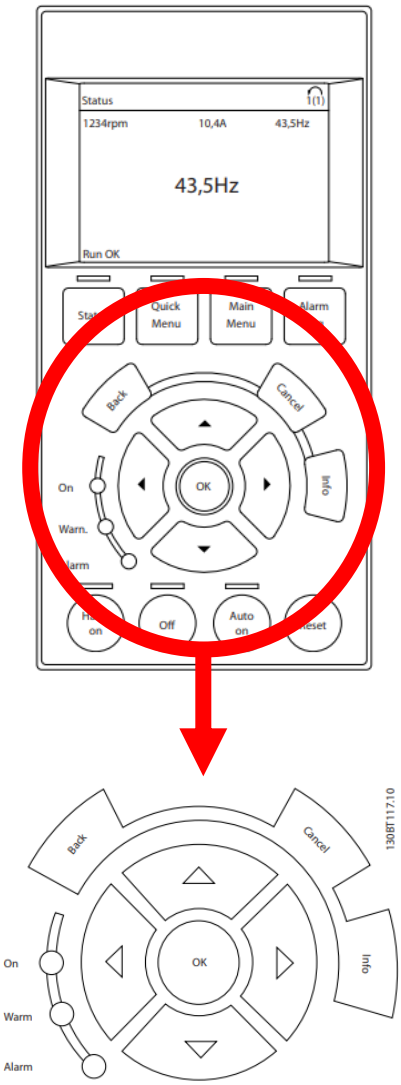
QUICK MENU:

This menu allows access to "***My Personal Menu***" Which includes a factory pre-defined list of parameters that are to be used for package optimization. No additional parameters in the VFD programing should require changing (for most installations).

MAIN MENU:

The "***Main Menu***" button provides access to all parameters available in the current setup. This button can also be used for the following functions accordingly to navigate the parameter index:

• Press twice: access top-level index



• Press once to return to the last location accessed

• Press and hold: direct access to parameter number

ALARM LOG:

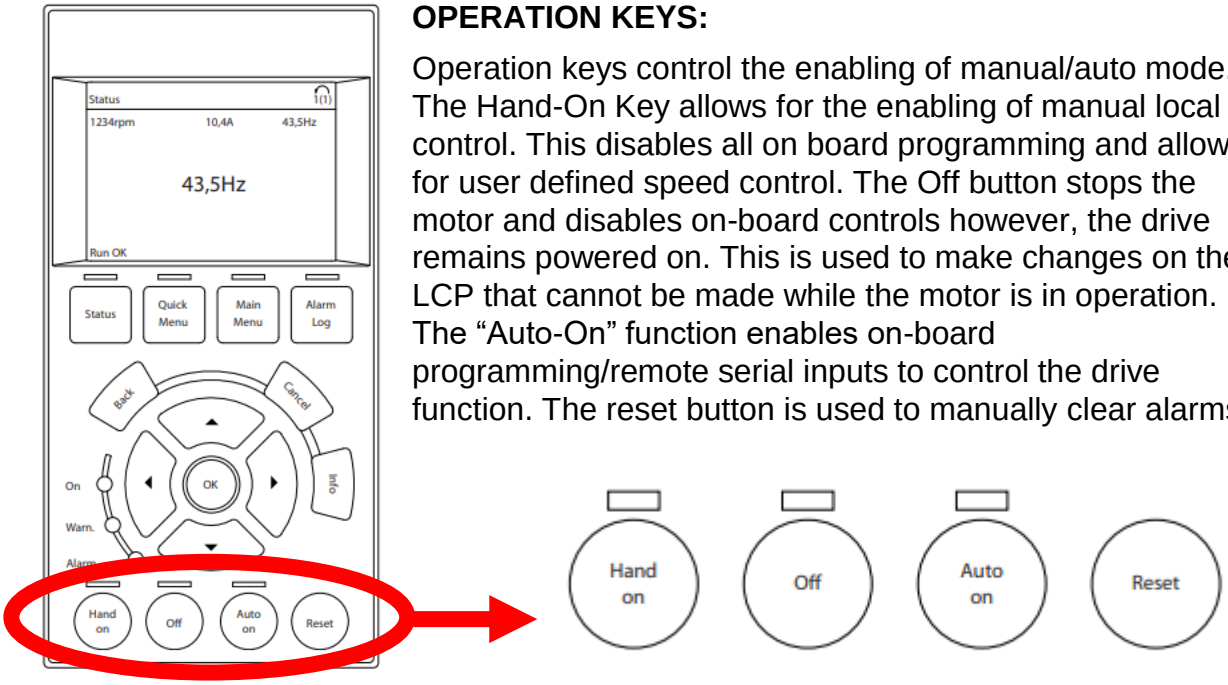
The “Alarm Log” shows a list of the last 10 alarms and current warnings.

NAVIGATION KEYS:

The navigation keys allow for entering and exiting parameter indexes and entering values/choices as required. The cancel button will cancel the last change made on the current display screen. Please note: if a parameter is changed and the screen is exited, the cancel function will not work. Press the “***info***” button at any time when hovering over a value to display a definition of the parameter/menu option.

The following table shows the function of each light:

Light	Indicator	Function
Green	ON	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply.
Yellow	WARN	When warning conditions are met, the yellow WARN light comes on and text appears in the display area identifying the problem.
Red	ALARM	A fault condition causes the red alarm light to flash and an alarm text is displayed.



OPERATION KEYS:

Operation keys control the enabling of manual/auto mode. The Hand-On Key allows for the enabling of manual local control. This disables all on board programming and allows for user defined speed control. The Off button stops the motor and disables on-board controls however, the drive remains powered on. This is used to make changes on the LCP that cannot be made while the motor is in operation. The “Auto-On” function enables on-board programming/remote serial inputs to control the drive function. The reset button is used to manually clear alarms.

2.6.2 Sequence of Operations

Upon startup, all pumps turn on and modulate to achieve the designated set-point. Once the set-point is achieved, pumps will stage off starting with pump 3 (Lag 2) [If Applicable], followed by pump 2 (Lag 1) and pump 1 (Lead). This is controlled by the “Sleep Mode” feature. Each pump will enter “Sleep Mode” upon operating at its specified minimum speed for the specified amount of time. These conditions are field optimizable. The pumps will stage on one by one as demand increases.

In addition to the pump staging, the “Lead” pump will switch to the next one in line every 24 hours. This ensures that each pump records the same operating time to increase the lifecycle of the package.

In the case of an alarm/trip/failure of a pump on the package, the next pump in line will take over as “Lead” to continue package operation.

2.6.3 General Settings

This section lists the different parameters that are factory set for both the Duplex and Triplex Boosters.

2.6.3.1 Duplex

Below is a chart for the factory settings on a duplex booster unit. These parameters are changed by Taco. Highlighted in the chart are job specific and change depending on customer needs.

ID	Name	Setup 1	Setup 2	Factory Setup	Units
1	Language	English	English	English	
3	Regional Settings	North America	North America	International	
510	Terminal 18 Digital Input	Start	Start	Start	
511	Terminal 19 Digital Input	No operation	No operation	No operation	
20	Display Line 1.1 Small	Reference [Unit]	Reference [Unit]	Reference [%]	
21	Display Line 1.2 Small	Feedback[Unit]	Feedback[Unit]	Motor current	
22	Display Line 1.3 Small	None	None	Power [kW]	
23	Display Line 2 Large	Frequency	Frequency	Frequency	
24	Display Line 3 Large	Display Text 1	Display Text 2	kWh Counter	
37	Display Text 1	Taco Lead	Taco Lead		
38	Display Text 2	Taco Lag	Taco Lag		
10	Active Set-up	Multi Set-up	Multi Set-up	Set-up 1	
12	This Set-up Linked to	Not linked	Set-up 1	Not linked	
501	Terminal 27 Mode	Output	Output	Input	
515	Terminal 33 Digital Input	Set-up select bit 0	Set-up select bit 0	No operation	
530	Terminal 27 Digital Output	No alarm	No alarm	No operation	
540	Function Relay	No alarm	No operation	Alarm	
540.1	Function Relay	Control Ready	Control Ready	Running	
1300	SL Controller Mode	On	On	Off	
1301	Start Event	Digital input DI32	Digital input DI32	Start command	
1302	Stop Event	Logic rule 0	Logic rule 0	Drive stopped	
1320	SL Controller Timer	24:00:00	24:00:00	00:00.0	
1320	SL Controller Timer	0:00:02	0:00:02	00:00.0	
2000	Feedback 1 Source	Analog Input 54	Analog Input 54	Analog Input 54	
2003	Feedback 2 Source	No function	No function	No function	
2006	Feedback 3 Source	No function	No function	No function	
2012	Reference/Feedback Unit	psi	psi	%	
2013	Minimum Reference/Feedb.	20	20	0	%
2014	Maximum Reference/Feedb.	200	200	100	%

ID	Name	Setup 1	Setup 2	Factory Setup	Units
600	Live Zero Timeout Time	5	8	10	s
601	Live Zero Timeout Function	Stop and trip	Stop and trip	Off	
620	Terminal 54 Low Voltage	1	1	0.07	V
621	Terminal 54 High Voltage	10	10	10	V
622	Terminal 54 Low Current	4	4	4	mA
623	Terminal 54 High Current	20	20	20	mA
624	Terminal 54 Low Ref./Feedb. Value	20	20	0	
625	Terminal 54 High Ref./Feedb. Value	200	200	100	
626	Terminal 54 Filter Time Constant	0.001	0.001	0.001	s
627	Terminal 54 Live Zero	Enabled	Enabled	Enabled	
2021	Setpoint 1	90	0	0	%
2081	PID Normal/ Inverse Control	Normal	Normal	Normal	
2083	PID Start Speed [Hz]	0	0	0	Hz
2093	PID Proportional Gain	4.79	4.79	0.5	
2094	PID Integral Time	2.06	2.06	20	s
315	Reference 1 Source	No function	Pulse input 29	Analog Input 53	
316	Reference 2 Source	No function	No function	Digital pot.meter	
317	Reference 3 Source	No function	No function	No function	
502	Terminal 29 Mode	Output	Input	Input	
513	Terminal 29 Digital Input	No operation	Pulse input	Jog	
531	Terminal 29 Digital Output	Pulse output	No operation	No operation	
550	Term. 29 Low Frequency	100	0	100	Hz
551	Term. 29 High Frequency	100	5000	100	Hz
552	Term. 29 Low Ref./Feedb. Value	0	0	0	
553	Term. 29 High Ref./Feedb. Value	100	100	100	
563	Terminal 29 Pulse Output Variable	Output freq. 0-100	No operation	No operation	
565	Pulse Output Max Freq #29	5000	5000	5000	Hz
412	Motor Speed Low Limit [Hz]	20	45	0	Hz
414	Motor Speed High Limit [Hz]	60	60	50	Hz
2222	Low Speed Detection	Enabled	Enabled	Disabled	
2223	No-Flow Function	Sleep Mode	Sleep Mode	Off	
2224	No-Flow Delay	5	10	10	s
2240	Minimum Run Time	10	10	10	s
2241	Minimum Sleep Time	10	10	10	s
2243	Wake-up Speed [Hz]	20	55	0	Hz
2244	Wake-up Ref./FB Difference	10	0	10	%
2245	Setpoint Boost	5	0	0	%
2246	Maximum Boost Time	60	60	60	s
1340	Logic Rule Boolean 1	Digital input DI32	Digital input DI32	FALSE	
1341	Logic Rule Operator 1	NOT AND	NOT AND	DISABLED	

ID	Name	Setup 1	Setup 2	Factory Setup	Units
1342	Logic Rule Boolean 2	TRUE	TRUE	FALSE	
1340	Logic Rule Boolean 1	OK Key	OK Key	FALSE	
1341	Logic Rule Operator 1	AND	AND	DISABLED	
1342	Logic Rule Boolean 2	Right Key	Right Key	FALSE	
1343	Logic Rule Operator 2	OR	OR	DISABLED	
1344	Logic Rule Boolean 3	SL Time-out 0	SL Time-out 0	FALSE	
1351	SL Controller Event	TRUE	TRUE	FALSE	
1352	SL Controller Action	Start timer 1	Start timer 1	Disabled	
1351	SL Controller Event	SL Time-out 1	SL Time-out 1	FALSE	
1352	SL Controller Action	Start timer 0	Start timer 0	Disabled	
1351	SL Controller Event	Logic rule 1	Logic rule 1	FALSE	
1352	SL Controller Action	Select set-up 2	Select set-up 2	Disabled	
1351	SL Controller Event	TRUE	TRUE	FALSE	
1352	SL Controller Action	Start timer 1	Start timer 1	Disabled	
1351	SL Controller Event	SL Time-out 1	SL Time-out 1	FALSE	
1352	SL Controller Action	Start timer 0	Start timer 0	Disabled	
1352	SL Controller Event	Logic rule 1	Logic rule 1	FALSE	
1353	SL Controller Action	Select set-up 1	Select set-up 1	Disabled	

2.6.3.2 Triplex

Below is a chart for the factory settings on a triplex booster unit. These parameters are changed by Taco. Highlighted in the chart are job specific and change depending on customer needs.

ID	Name	Setup 1	Setup 2	Setup 3	Factory Setup	Unit
1	Language	English US	English US	English US	English	
3	Regional Settings	North America	North America	North America	International	
510	Terminal 18 Digital Input	Start	Start	Start	Start	
511	Terminal 19 Digital Input	No operation	No operation	No operation	No operation	
37	Display Text 1	Taco Lead	Taco Lead	Taco Lead		
38	Display Text 2	Taco Lag	Taco Lag	Taco Lag		
20	Display Line 1.1 Small	Reference [Unit]	Reference [Unit]	Reference [Unit]	Reference [%]	
21	Display Line 1.2 Small	Feedback[Unit]	Feedback[Unit]	Feedback[Unit]	Motor current	

ID	Name	Setup 1	Setup 2	Setup 3	Factory Setup	Unit
22	Display Line 1.3 Small	Display Text 1	Display Text 2	Display Text 2	Power [kW]	
23	Display Line 2 Large	Frequency	Frequency	Frequency	Frequency	
24	Display Line 3 Large	kWh Counter	kWh Counter	kWh Counter	kWh Counter	
10	Active Set-up	Multi Set-up	Multi Set-up	Multi Set-up	Set-up 1	
12	This Set-up Linked to	Not linked	Set-up 1	Set-up 1	Not linked	
501	Terminal 27 Mode	Output	Output	Output	Input	
515	Terminal 33 Digital Input	No Operation	Pulse input	Pulse input	No operation	
530	Terminal 27 Digital Output	Alarm	Alarm	Alarm	No operation	
540	Function Relay	No alarm	No alarm	No alarm	Alarm	
540.1	Function Relay	Running	Running	Running	Running	
540.2	Function Relay	No alarm	No alarm	No alarm	No operation	
540.3	Function Relay	No alarm	No operation	No operation	No operation	
540.4	Function Relay	No operation	No alarm	No operation	No operation	
540.5	Function Relay	No alarm	No alarm	No alarm	No operation	
540.6	Function Relay	No operation	No operation	No operation	No operation	
540.7	Function Relay	No operation	No operation	No operation	No operation	
540.8	Function Relay	No operation	No operation	No operation	No operation	
1300	SL Controller Mode	On	On	On	Off	
1301	Start Event	Logic rule 1	Logic rule 1	Logic rule 1	Start command	
1302	Stop Event	Logic rule 2	Logic rule 2	Logic rule 2	Drive stopped	
1320	SL Controller Timer	24:00:00	24:00:00	24:00:00	00:00.0	
1320	SL Controller Timer	0:00:02	0:00:02	0:00:02	00:00.0	
1300	SL Controller Mode	On	On	On	Off	
1301	Start Event	Logic rule 1	Logic rule 1	Logic rule 1	Start command	
1302	Stop Event	Logic rule 2	Logic rule 2	Logic rule 2	Drive stopped	
1320	SL Controller Timer	24:00:00	24:00:00	24:00:00	00:00.0	
1320	SL Controller Timer	0:00:02	0:00:02	0:00:02	00:00.0	
600	Live Zero Timeout Time	10	10	10	10	s
601	Live Zero Timeout Function	Stop and trip	Stop and trip	Stop and trip	Off	
620	Terminal 54 Low Voltage	1	1	1	0.07	V
621	Terminal 54 High Voltage	10	10	10	10	V
622	Terminal 54 Low Current	4	4	4	4	mA
623	Terminal 54 High Current	20	20	20	20	mA
624	Terminal 54 Low Ref./Feedb. Value	20	20	20	0	
625	Terminal 54 High Ref./Feedb. Value	200	200	200	100	

ID	Name	Setup 1	Setup 2	Setup 3	Factory Setup	Unit
626	Terminal 54 Filter Time Constant	2	2	2	0.001	s
627	Terminal 54 Live Zero	Enabled	Enabled	Enabled	Enabled	
2021	Setpoint 1	25	0	0	0	%
2081	PID Normal/ Inverse Control	Normal	Normal	Normal	Normal	
2083	PID Start Speed [Hz]	18	0	0	0	Hz
2093	PID Proportional Gain	4.78	4.78	4.78	0.5	
2094	PID Integral Time	2.06	2.06	2.06	20	s
315	Reference 1 Source	No function	Pulse input 33	Pulse input 33	Analog Input 53	
316	Reference 2 Source	No function	No function	No function	Digital pot.meter	
317	Reference 3 Source	No function	No function	No function	No function	
502	Terminal 29 Mode	Output	Output	Output	Input	
513	Terminal 29 Digital Input	No operation	No operation	No operation	Jog	
531	Terminal 29 Digital Output	Pulse output	Pulse output	No operation	No operation	
550	Term. 29 Low Frequency	100	100	100	100	Hz
551	Term. 29 High Frequency	100	100	100	100	Hz
552	Term. 29 Low Ref./Feedb. Value	0	0	0	0	
553	Term. 29 High Ref./Feedb. Value	100	100	100	100	
563	Terminal 29 Pulse Output Variable	Output freq. 0-100	Output freq. 0-100	No operation	No operation	
565	Pulse Output Max Freq #29	5000	5000	5000	5000	Hz
412	Motor Speed Low Limit [Hz]	20	35	45	0	Hz
414	Motor Speed High Limit [Hz]	60	60	60	50	Hz
2222	Low Speed Detection	Enabled	Enabled	Enabled	Disabled	
2223	No-Flow Function	Sleep Mode	Sleep Mode	Sleep Mode	Off	
2224	No-Flow Delay	20	15	10	10	s
2240	Minimum Run Time	1	1	1	10	s
2243	Wake-up Speed [Hz]	20	40	50	0	Hz
2244	Wake-up Ref./FB Difference	10	10	10	10	%
2245	Setpoint Boost	5	0	0	0	%
2246	Maximum Boost Time	60	60	60	60	s
1340	Logic Rule Boolean 1	FALSE	FALSE	FALSE	FALSE	
1341	Logic Rule Operator 1	DISABLED	DISABLED	DISABLED	DISABLED	
1342	Logic Rule Boolean 2	FALSE	FALSE	FALSE	FALSE	
1340	Logic Rule Boolean 1	Start command	Start command	Start command	FALSE	
1341	Logic Rule Operator 1	AND	AND	AND	DISABLED	

ID	Name	Setup 1	Setup 2	Setup 3	Factory Setup	Unit
1342	Logic Rule Boolean 2	Digital input DI19	Digital input DI19	Digital input DI19	FALSE	
1343	Logic Rule Operator 2	DISABLED	DISABLED	DISABLED	DISABLED	
1344	Logic Rule Boolean 3	FALSE	FALSE	FALSE	FALSE	
1340	Logic Rule Boolean 1	OK Key	OK Key	OK Key	FALSE	
1341	Logic Rule Operator 1	AND	AND	AND	DISABLED	
1342	Logic Rule Boolean 2	Reset Key	Reset Key	Reset Key	FALSE	
1343	Logic Rule Operator 2	OR NOT	OR NOT	OR NOT	DISABLED	
1344	Logic Rule Boolean 3	Digital input DI19	Digital input DI19	Digital input DI19	FALSE	
1340	Logic Rule Boolean 1	OK Key	OK Key	OK Key	FALSE	
1341	Logic Rule Operator 1	AND	AND	AND	DISABLED	
1342	Logic Rule Boolean 2	Right Key	Right Key	Right Key	FALSE	
1343	Logic Rule Operator 2	OR	OR	OR	DISABLED	
1344	Logic Rule Boolean 3	SL Time-out 0	SL Time-out 0	SL Time-out 0	FALSE	
1351	SL Controller Event	TRUE	TRUE	TRUE	FALSE	
1352	SL Controller Action	Start timer 1	Start timer 1	Start timer 1	Disabled	
1351	SL Controller Event	SL Time-out 1	SL Time-out 1	SL Time-out 1	FALSE	
1352	SL Controller Action	Start timer 0	Start timer 0	Start timer 0	Disabled	
1351	SL Controller Event	Logic rule 3	FALSE			
1352	SL Controller Action	Select set-up 3	Disabled			
1351	SL Controller Event	TRUE	TRUE	TRUE	FALSE	
1352	SL Controller Action	Start timer 1	Start timer 1	Start timer 1	Disabled	
1351	SL Controller Event	SL Time-out 1	SL Time-out 1	SL Time-out 1	FALSE	
1352	SL Controller Action	Start timer 0	Start timer 0	Start timer 0	Disabled	
1352	SL Controller Event	Logic rule 3	FALSE			
1353	SL Controller Action	Select set-up 2	Disabled			
1352	SL Controller Event	TRUE	FALSE			
1353	SL Controller Action	Start timer 1	Disabled			
1352	SL Controller Event	SL Time-out 1	SL Time-out 1	SL Time-out 1	FALSE	
1353	SL Controller Action	Start timer 0	Start timer 0	Start timer 0	Disabled	
1352	SL Controller Event	Logic rule 3	Logic rule 3	Logic rule 3	FALSE	
1353	SL Controller Action	Select set-up 1	Select set-up 1	Select set-up 1	Disabled	

2.6.4 Adjustable Field Settings

Parameters for various features available can be changed through the "***My Personal Menu***" as well as the "***Main Menu***". To access "***My Personal Menu***", click "***Quick Menu***" and select the "***My Personal Menu***" from the list. ***"My Personal Menu***" is a simplified and customizable parameter list

for easy access to adjust key operating features. Additional parameters can be added to this list through the “Main Menu” under parameter section 0-2*.

By Default, “My Personal Menu” contains the following important parameters:

- 20-21[*]

This parameter defines the set-point (discharge pressure) the package is to achieve.

- 4-12[**]

This parameter defines the minimum speed of the pump at which the “Sleep Mode” timer will start.

- 22-24[**]

This parameter defines the time the pump is required to stay at its minimum speed before entering “Sleep Mode”

- 22-41[**]

This parameter defines the minimum time the pumps stay in sleep mode before checking for changes in demand

- 22-43[**]

This parameter defines the speed reference of the Lead pump at which the lag pump will exit sleep mode

- 22-40[**]

Minimum time pump shall run before sleep mode timer starts.

- 22-45[**]

This parameter defines the percentage over the set point that the booster will aim at achieving.

- 13-20.0[**]

This parameter defines the time period after which auto alternation occurs and the next pump in line becomes the Lead pump.

- 0-10

This parameter defines the current setup of the VFD. This is used to cycle through Lead/Lag in order to make changes as required

- [*]- Changes should be made in lead setup (setup 1) of each pump
- [**]- Changes should be made in all setups of each pump

Motor Information: Confirm that all values in the following parameters on the drive match the nameplate of the respective motor.

- 1-21: Motor Horsepower (HP)
- 1-22: Motor Voltage (V)
- 1-23: Motor Frequency (Hz)
- 1-24: Motor Current (FLA)
- 1-25: Motor Nominal Speed (RPM)

- Sleep Mode:
  - Once the set-point is met by the package, pumps will modulate- by turning off and on, as demand increases/decreases. "***User defined set-point boosts***" and feedback differentials [Parameter 22-44] define max limits and minimum limits at which the booster will enter/exit sleep mode and to prevent short cycling. Variables can be adjusted in "My Personal Menu"

2.6.5 Communication

For Modbus and Full BACnet communication setup, please refer to Danfoss Instruction in APPENDIX

Important BACnet Points for Boosters

AI:1	analog_input: 1 (Analog Input 54)	Read
AV:4	analog_value: 4 (PID Feedback)	Read
AV:30	analog_value: 30 (Setpoint 1)	W/R
BV:1	binary_value: 1 (Run/Stop Command)	W/R
BV:3	binary_value: 3 (Fault Reset Command)	Write
BV:4	binary_value: 4 (Run/Stop Monitor)	Read
BV:5	binary_value: 5 (OK/Fault Monitor)	Read
BV:6	binary_value: 6 (Hand/Auto Reference)	Read
BV:33	binary_value: 33 (Running)	Read
MSO:1	Multi_state_value: 1 (Active Setup)	R/W

2.7 Commissioning Procedure

2.7.1 Motor Rotation

With power to the pump set on, ensure all VFD's on the pump set are turned off. Manually bump test each motor, individually,

by using the manual mode on the VFD's. Verify each pump is rotating in the correct direction. If a pump is rotation backwards, with power to the drive turned off, switch any two leads from the motor connector (U, V, W) inside the drive. Repeat the procedure to confirm the motor is rotating in the correct direction if re-wiring was necessary.

If the motors do not run upon rotation check, it is possible that that moving parts have seized during transportation and storage. The starting torque may not be strong enough to loosen the seized parts. If this occurs, if TEFC motors are provided, the seized parts can be loosened by removing the fan cover on the motor and using a wrench on the shaft to apply enough torque to loosen seized components.

2.7.2 Dry Run and No-Flow Protection

This feature protects pump against dry run or no-flow conditions. This is done by comparing the speed of the motor to the power consumption. At high speeds, in the case of no-flow or dry pump, the power consumed by the motor would be significantly less compared to the power consumed to pump moving water. This comparison would be used to determine if the protection feature is to be initiated. It is recommended that this feature be done manually, based off motor information and drive readings, then be programmed for warning or trip as desired.

For programming the dry pump feature:

1. Under parameter 1-00- Configuration Mode, set the drive to "Open Loop"
2. Run the pump in "Hand-On" Mode to the low speed limit
3. Record the power reading under parameter 16-27
4. Press the "Status" Button
5. Now increase the speed to the high speed limit
6. Record the power reading under parameter 16-27
7. Press "OFF"
8. Under the 22-3* Parameter Series populate the following parameters according to your observations:

ID	Name	Unit
2233	Low Speed [Hz]	Hz
2235	Low Speed Power [HP]	hp
2237	High Speed [Hz]	Hz

2239	High Speed Power [HP]	hp

9. Press Main Menu, Select 1-**, 1-0* and under 1-00 Configuration Mode, return the drive to closed loop.
10. Under the parameter series 22-**, enter into 22-2* and adjust 22-21 Low Power Detection to “Enable”

2.7.3 End of Curve Protection

This is a safety feature in the case of leaks on the discharge side. A leak in the system or a failed check valve may cause the pressure to decrease and the pumps to run at full speed. This feature compares the feedback from the sensor and speed of pumps to the set point. If the drives reach maximum speed and the feedback signal is 97.5% of the setpoint, the drives react to via the End of Curve Protection and warn/trip in order to protect the pumps.

The end of curve parameters can be found in the 22-5 “End of Curve” series of parameters.

- 22-50: End of Curve Function- can be set to warning/trip as required
- 22-51: End of Curve Delay- time before function occurs. This should be set such that false alarms are not generated if the time delay is too short and pump damage/excessive leakage does not occur if timer is too long.
- 22-52: Tolerance [%]- field adjustable

If feedback drops to the percentage from set point defined as the tolerance, the end of curve timer will start after which the function specified will occur (warning/trip)

2.7.4 Low Suction Pressure Switch (Optional)

The Low Suction Pressure Switch has an adjustable set point from 3-150 psig, with an adjustable differential from 4-22 psig. The pressure switch is wired Normally Open. When the pressure decreases below the trip point, the contacts close and send a signal to the VFD's to signal an external interlock. The contacts of the switch will open once the pressure in the suction header reaches the trip pressure **plus** the differential. The factory settings are shown below.

Factory Settings:
Cut-out: 30 psig
Cut-in: 45 psig

To set the switch to a different set point, with power to the drives on but without running the pumps, pressurize the package using the city pressure. Once the package is pressurized to the city supply pressure, close the isolation valve on the suction header upstream of the pressure gage connection to the header. Ensure the pressure on the gage is above the desired trip point. Use the air bleed valve that is located next to the connection for the pressure switch and slowly bleed pressure until the pressure reading on the suction pressure gage reaches the desired trip point.

Once the gage is pressurized to the desired pressure, close the air bleed valve. On the switch, adjust the set point adjustment dial "A" using a flathead screwdriver. Turning the dial to the left raises the set point, while turning to the right lowers the set point. Adjust the dial to the desired set point until the switch clicks. Once the switch clicks the trip pressure has been set. With the VFD's powered on, the operation of the switch can be verified by confirming that the VFD's show an external interlock fault. Bleed out the remaining pressure in the switch. Once the pressure reads zero psig, slowly open the isolation valve that was closed and observe the pressure of the gage increasing, and make note of cut in pressure. Once the switch clicks and cuts in, the external interlock fault will clear once the reset button is pressed. If desired, the differential can also be adjusted using adjustment dial "B". Repeat the procedure above

until the desired cut-in pressure is achieved. For further information on the pressure switch. Refer to the manufacturer's instructions located in the appendix of this manual.

If desired, the operation of the pressure switch can be verified with the package in full operation by closing the isolation valve to the suction header while the package is in operation.

2.7.5 High Discharge Pressure Switch (Optional)

The Standard High Discharge Pressure Switch that is provided has an adjustable set point from 5-250 psig, with an adjustable differential from 7-56 psig. The pressure switch is wired Normally Closed and an increase of pressure will cause the switch to send an external interlock signal to the VFD's. The contacts will open again once the pressure in the discharge header reaches the trip pressure **minus** the differential. By default, the pressure switch is factory set 10 psig higher than the boost pressure plus the suction pressure, as follows:

Factory Settings:
Cut-out: Suction Pressure + Design Boost Pressure + 10 psig.
Cut-in: Cut-out Pressure - Differential

To set the switch to a different set point, pressurize the package using the pumps in manual mode. Slowly increase the pump speed until the discharge pressure gage reading is higher than the typical suction pressure plus the design boost pressure which is printed on the nameplate. Once the desired trip pressure is reached, close the isolation valve on the discharge header upstream of the pressure gage connection to the header. Use the air bleed valve that is located next to the connection for the pressure switch and slowly bleed pressure until the pressure reading on the discharge pressure gage reaches the desired trip point. Once the gage is pressurized to the desired pressure, close the air bleed valve. On the switch, adjust the set point adjustment dial "A" using a flathead screwdriver. Turning the dial to the left raises the set point, while turning to the right lowers the set point. Adjust the dial to the desired set point until the switch clicks. Once the switch clicks the trip pressure has been set. With the VFD's powered on, the operation of the switch can be verified by confirming that the VFD's show an external interlock fault. Slowly bleed out the

remaining pressure in the switch, listening for a clicking sound. When the switch clicks, the cut-in pressure has been reached. Adjust the differential adjustment dial “B” until the desired cut-in pressure is achieved, by repeating the procedure. Once the switch clicks and cuts in, the external interlock fault will clear once the reset button has been pressed. Refer to the manufacturer’s instructions located in the appendix of this manual for further information on the pressure switch.

If desired, the operation of the pressure switch can be verified with the package in full operation by running the pumps manually and increasing the motor frequency until the trip pressure is reached, at which time the pressure switch should trip and send an external interlock signal to the VFD’s.

Note: For End Suction and Vertical inline pumps where the impeller has a specific trim, the package will not be able to pressurize above the typical suction pressure plus the boost pressure unless the suction pressure increases. To set the pump in this case, use the procedure above but the cut-in pressure should be set to the typical suction pressure plus the design boost pressure (refer to nameplate). The pressure switch has a scale marked on the side, ensure that the cut out point, dial “A” is set no more than approximately 10 psig above the desired cut-in setting. This will ensure that if there are any pressure fluctuations on the suction of the pump set, the switch will cut out when the discharge pressure exceeds the total design pressure output by 10 psig for package and system protection.

2.7.6 Thermal Relief Valve

WARNING!

Prior to commissioning the Thermal Relief Valve, ensure that the outlet of the valve has been installed with piping to the proper specification and is safely secured to the building structure

The Thermal relief assembly consists of two components, the thermal relief valve and the temperature sensing element. The thermal relief valve is connected to the discharge header and will discharge water from the package in the event there is no water usage but the pumps continue to run. The temperature sensor is installed on the suction line and will monitor temperature in the suction header. When the temperature in the suction header reaches the set point of the thermal relief valve, the valve will open and discharge water from the discharge header until the temperature drops below the set point on the valve.

To set the trip temperature, adjust the grey adjustment dial on the valve to the numbered position corresponding to the temperature scale in the Danfoss Instructions located in the appendix of this manual. If desired, the function of the valve can be tested by running the pumps in manual mode with the discharge header isolation valve closed. If the valve operation will not be checked it is recommended to adjust the temperature set point to the lowest temperature to prevent the pumps from deadheading for a prolonged period of time.

2.7.7 Emergency Power

The Emergency power sequence of operation is described in section 2.4.1.1. To test operation of the emergency power on a Duplex, with the pump set running in auto mode, remove the signal to the emergency power relay and observe all pumps other than the first pump shut down. Observe that the drives that do not operate in emergency power mode lose power and shut down. For a Triplex run the unit in auto mode, send a signal either 120V or 24V to the customer connection terminals. Verify that all pumps other than the first pump shut down. Observe that the drives that do not operate in emergency power mode lose power and shut down

2.7.8 Check Valve/Sleep Mode Verification

With all drives turned off, record the suction pressure on the suction header. Manually run each pump individually, one at a time, while observing the suction pressure to ensure that the

suction pressure remains constant. This ensures that there are no leaks in the other check valves that could possibly allow the discharge water to recirculate backwards through the check valve and back into the suction header.

Once each individual check valve has been checked, run the pump set in auto mode, with the pump set discharge header isolated from the building system, observe the pump set reach the discharge pressure. Once the set point has been reached, the lag pumps (if applicable) should slow down and shut off sequentially until the lead pump finally shuts down and goes into sleep mode. Once the pump set has shut down and entered sleep mode, monitor the booster discharge and suction pressure gages to ensure there are no fluctuations and suction pressure gage.

2.7.9 Lead/Lag Changeover and Auto Alternation Verification

WARNING!

Please refer to pump datasheet prior to performing this test. Performing this test without package optimization for required set point may result in injury or system damage due to high discharge pressure.

For package optimization, please refer to the “Package Features” document. The package optimization must be performed to limit maximum speed of all pumps to required operating speed to achieve duty point (can be found on pump datasheet). Further to this, according to hydronic system, the minimum speed/sleep speed, minimum run times, PID settings and alternation timers may be adjusted as required.

With all pumps in “OFF” via the VFD, verify the left-most pump is in setup 1(1) (check top right corner of display) followed by 2(2) and 3(3) for the second and third pump, respectively. Start the verification by pressing “Auto ON” on the LCP of the pump in setup 3(3). Allow the pump to reach the set minimum speed and ensure the pump enters “sleep mode” within the designated sleep time **parameter 22-41**. Similarly, allow pump in setup 2(2) to enter “sleep mode”. With pumps 2(2) and 3(3) in sleep mode, press “Hands On” on the LCP of the pump in setup 1(1). Slowly increase the Hz of the pump above the wake up speed of pumps 2(2) and 3(3), ensuring the lag pumps stage correctly with 2(2) exiting sleep mode at its respective wake up speed defined in **parameter 22-43** followed by 3(3). Pump 1(1) can now be switched to “Auto ON” via the LCP. The pumps should now modulate to meet set point and enter/exit sleep mode as required.

Please note the lead/lag verification should be tested for the lead setup of every pump. To scroll through the setups of the pumps- press “***OK***” **+** “***Righ***t” key of the Master Drive (**1st drive on the panel from the left).** This will change the setup of all pumps simultaneously. Repeat the lead/lag verification for each pump being the “LEAD” pump.

The auto alternation feature automatically scrolls the pump setups after the time period defined in **parameter 13-20** This switchover also occurs in the event of a fault/alarm on any of the drives, the next drive in sequence will take over. To test this, the timer in **parameter 13-20** can be shortened to allow for a quicker alternation. The parameter value should be set back to the required timer. In addition to this, a “fault/alarm” event can be induced by turning the lead drive “OFF” at the disconnect. This should result in the next pump in the sequence taking over as the lead pump. This can be performed in various combinations to verify the next drive in line properly changed to the setup of the drive at fault.

2.8 Troubleshooting

Lead/Lag Change Over Issues: Check the wiring to the relays (Duplex) or extended relay (Triplex) and compare it to the drawing attached to the inside of the enclosure. If the

issue continues navigate to 0-1* and find 0-10. Ensure that all set-ups are set to Multi Set-up. Now navigate down to 0-12, make sure set up 1 is set to Not linked and the remaining Set-ups are set to Set-up 1.

Booster Not Going into Sleep Mode: Check the unit's pressure sensor and compare the readout given to the gauge attached to the discharge, ensure both are the same. If the read out is wrong which causes the measurement to be substantially lower than the actual system pressure, navigate to the main menu and check the following parameters. 6-20 make sure this is set to 1.00. 6-24 ensure the parameter is 10% of the sensor rating shown on the sensor. 6-25 ensure that the parameter is the same number as the rating on the pressure sensor. Navigate to 20-13 and change this parameter to the same value as 6-24, 20-14 to the same value as 6-25. You may also need to adjust the Low frequencies on the drive to be higher as well with parameter 4-12.

Pressure Drops Too Fast when the unit is in sleep mode: Navigate to the main menu and locate 22-4*. Locate 22-41 this parameter is minimum sleep time before the booster reads the set point. Lower this so the booster reacts quicker to change once the unit goes into sleep mode. You can also lower 22-44 which is the wake up reference from sleep mode, this will kick the booster on closer to the set point if you lower the percentage value.

The Booster Overshoots Pressure Too Much: Navigate to 22-45 in the main menu. This parameter defines the percentage over the set point the booster will achieve. Lower this value to lower the amount of overshoot achieved by the booster.

The Booster is Cycling Too Much: Check parameter 4-12 which is your motor speed low limit. This may be too high for the system, causing the booster to not have enough band width to operate. Other parameters to check are 22-40 Minimum run time, 22-41 Minimum sleep time, 22-43 Wake up speed, 22-45 Set point boost and 22-46 Max Boost Time. These all may cause the unit to short cycle adjust these parameters to get best results.

Appendix

Modbus Manual

For Further Information, please see DATA COMMUNICATION MODBUS RS 485 RTU on the Danfoss website.

PKE = E19E Hex - Write single word in *4-14 Motor Speed High Limit [Hz]*
IND = 0000 Hex
PWEHIGH = 0000 Hex
PWELOW = 03E8 Hex - Data value 1000, corresponding to 100 Hz, see *chapter 8.4.12 Conversion*.

The telegram looks like this:

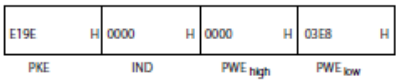


Illustration 8.12 Write Data in EEPROM

NOTICE

***4-14 Motor Speed High Limit [Hz]* is a single word, and the parameter command for write in EEPROM is "E". Parameter number 4-14 is 19E in hexadecimal.**

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The response from the follower to the master is:

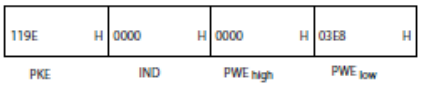

Illustration 8.13 Response from Follower

8.5.2 Reading a Parameter Value

Read the value in *3-41 Ramp 1 Ramp Up Time*

PKE = 1155 Hex - Read parameter value in *3-41 Ramp 1 Ramp Up Time*
IND = 0000 Hex
PWEHIGH = 0000 Hex
PWELOW = 0000 Hex

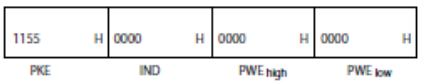

Illustration 8.14 Parameter Value

If the value in *3-41 Ramp 1 Ramp Up Time* is 10 s, the response from the follower to the master is

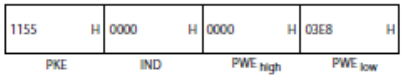

Illustration 8.15 Response from Follower

3E8 Hex corresponds to 1000 decimal. The conversion index for *3-41 Ramp 1 Ramp Up Time* is -2, i.e. 0.01.
3-41 Ramp 1 Ramp Up Time is of the type *Unsigned 32*.

8.6 Modbus RTU Overview

8.6.1 Assumptions

Danfoss assumes that the installed controller supports the interfaces in this document, and strictly observes all requirements and limitations stipulated in the controller and frequency converter.

8.6.2 What the User Should Already Know

The Modbus RTU (Remote Terminal Unit) is designed to communicate with any controller that supports the interfaces defined in this document. It is assumed that the user has full knowledge of the capabilities and limitations of the controller.

8.6.3 Modbus RTU Overview

Regardless of the type of physical communication networks, the Modbus RTU Overview describes the process a controller uses to request access to another device. This process includes how the Modbus RTU responds to requests from another device, and how errors are detected and reported. It also establishes a common format for the layout and contents of message fields.
During communications over a Modbus RTU network, the protocol determines:

- How each controller learns its device address
- Recognises a message addressed to it
- Determines which actions to take
- Extracts any data or other information contained in the message

If a reply is required, the controller constructs the reply message and sends it.
Controllers communicate using a master-follower technique in which only the master can initiate transactions (called queries). Followers respond by supplying the requested data to the master, or by taking the action requested in the query.
The master can address individual followers, or initiate a broadcast message to all followers. Followers return a response to queries that are addressed to them individually. No responses are returned to broadcast queries from the master. The Modbus RTU protocol establishes the format for the master's query by providing the device (or broadcast) address, a function code defining the requested action, any data to be sent, and an error-checking field. The follower's response message is also constructed using Modbus protocol. It contains fields confirming the action taken, any data to be returned, and

an error-checking field. If an error occurs in receipt of the message, or if the follower is unable to perform the requested action, the follower constructs an error message, and send it in response, or a time-out occurs.

8.6.4 Frequency Converter with Modbus RTU

The frequency converter communicates in Modbus RTU format over the built-in RS-485 interface. Modbus RTU provides access to the control word and bus reference of the frequency converter.

The control word allows the modbus master to control several important functions of the frequency converter:

- Start
- Stop of the frequency converter in various ways:
  - Coast stop
  - Quick stop
  - DC Brake stop
  - Normal (ramp) stop
- Reset after a fault trip
- Run at a variety of preset speeds
- Run in reverse
- Change the active set-up
- Control the frequency converter's built-in relay

The bus reference is commonly used for speed control. It is also possible to access the parameters, read their values, and where possible, write values to them. This permits a range of control options, including controlling the setpoint of the frequency converter when its internal PI controller is used.

8.7 Network Configuration

To enable Modbus RTU on the frequency converter, set the following parameters

Parameter	Setting
8-30 Protocol	Modbus RTU
8-31 Address	1-247
8-32 Baud Rate	2400-115200
8-33 Parity / Stop Bits	Even parity, 1 stop bit (default)

Table 8.11 Modbus RTU Parameters

8.8 Modbus RTU Message Framing Structure

8.8.1 Frequency Converter with Modbus RTU

The controllers are set up to communicate on the Modbus network using RTU (Remote Terminal Unit) mode, with each byte in a message containing 2 4-bit hexadecimal characters. The format for each byte is shown in *Table 8.12*.

Start bit	Data byte								Stop/ parity	Stop

Table 8.12 Format for Each Byte

Coding System	8-bit binary, hexadecimal 0-9, A-F. 2 hexadecimal characters contained in each 8-bit field of the message
Bits Per Byte	1 start bit 8 data bits, least significant bit sent first 1 bit for even/odd parity; no bit for no parity 1 stop bit if parity is used; 2 bits if no parity
Error Check Field	Cyclical Redundancy Check (CRC)

8.8.2 Modbus RTU Message Structure

The transmitting device places a Modbus RTU message into a frame with a known beginning and ending point. This allows receiving devices to begin at the start of the message, read the address portion, determine which device is addressed (or all devices, if the message is broadcast), and to recognise when the message is completed. Partial messages are detected and errors set as a result. Characters for transmission must be in hexadecimal 00 to FF format in each field. The frequency converter continuously monitors the network bus, also during 'silent' intervals. When the first field (the address field) is received, each frequency converter or device decodes it to determine which device is being addressed. Modbus RTU messages addressed to zero are broadcast messages. No response is permitted for broadcast messages. A typical message frame is shown in *Table 8.13*.

Start	Address	Function	Data	CRC check	End
T1-T2-T3-T4	8 bits	8 bits	N x 8 bits	16 bits	T1-T2-T3-T4

Table 8.13 Typical Modbus RTU Message Structure

8.8.3 Start/Stop Field

Messages start with a silent period of at least 3.5 character intervals. This is implemented as a multiple of character intervals at the selected network baud rate (shown as Start T1-T2-T3-T4). The first field to be transmitted is the device address. Following the last transmitted character, a similar period of at least 3.5 character intervals marks the end of the message. A new message can begin after this period. The entire message frame must be transmitted as a continuous stream. If a silent period of more than 1.5 character intervals occurs before completion of the frame, the receiving device flushes the incomplete message and assumes that the next byte is the address field of a new message. Similarly, if a new message begins before 3.5 character intervals after a previous message, the receiving device considers it a continuation of the previous message. This causes a time-out (no response from the follower), since the value in the final CRC field is not valid for the combined messages.

8.8.4 Address Field

The address field of a message frame contains 8 bits. Valid follower device addresses are in the range of 0-247 decimal. The individual follower devices are assigned addresses in the range of 1-247. (0 is reserved for broadcast mode, which all followers recognise.) A master addresses a follower by placing the follower address in the address field of the message. When the follower sends its response, it places its own address in this address field to let the master know which follower is responding.

8.8.5 Function Field

The function field of a message frame contains 8 bits. Valid codes are in the range of 1-FF. Function fields are used to send messages between master and follower. When a message is sent from a master to a follower device, the function code field tells the follower what kind of action to perform. When the follower responds to the master, it uses the function code field to indicate either a normal (error-free) response, or that some kind of error occurred (called an exception response). For a normal response, the follower simply echoes the original function code. For an exception response, the follower returns a code that is equivalent to the original function code with its most significant bit set to logic 1. In addition, the follower places a unique code into the data field of the response message. This tells the master what kind of error occurred, or the reason for the exception. Also refer to
chapter 8.8.10 Function Codes Supported by Modbus RTU and
chapter 8.8.11 Modbus Exception Codes

8.8.6 Data Field

The data field is constructed using sets of 2 hexadecimal digits, in the range of 00 to FF hexadecimal. These are made up of one RTU character. The data field of messages sent from a master to follower device contains additional information which the follower must use to take the action defined by the function code. This can include items such as coil or register addresses, the quantity of items to be handled, and the count of actual data bytes in the field.

8.8.7 CRC Check Field

Messages include an error-checking field, operating based on a Cyclical Redundancy Check (CRC) method. The CRC field checks the contents of the entire message. It is applied regardless of any parity check method used for the individual characters of the message. The CRC value is calculated by the transmitting device, which appends the CRC as the last field in the message. The receiving device recalculates a CRC during receipt of the message and compares the calculated value to the actual value received in the CRC field. If the 2 values are unequal, a bus time-out results. The error-checking field contains a 16-bit binary value implemented as 2 8-bit bytes. When this is done, the low-order byte of the field is appended first, followed by the high-order byte. The CRC high-order byte is the last byte sent in the message.

8.8.8 Coil Register Addressing

In Modbus, all data are organised in coils and holding registers. Coils hold a single bit, whereas holding registers hold a 2-byte word (i.e. 16 bits). All data addresses in Modbus messages are referenced to zero. The first occurrence of a data item is addressed as item number zero. For example: The coil known as 'coil 1' in a programmable controller is addressed as coil 0000 in the data address field of a Modbus message. Coil 127 decimal is addressed as coil 007EHEX (126 decimal).
Holding register 40001 is addressed as register 0000 in the data address field of the message. The function code field already specifies a 'holding register' operation. Therefore, the '4XXXX' reference is implicit. Holding register 40108 is addressed as register 006BHEX (107 decimal).

8.8.9 How to Control the Frequency Converter

This section describes codes which can be used in the function and data fields of a Modbus RTU message.

8.8.10 Function Codes Supported by Modbus RTU

Modbus RTU supports use of the following function codes in the function field of a message.

Function	Function code
Read coils	1 Hex
Read holding registers	3 Hex
Write single coil	5 Hex
Write single register	6 Hex
Write multiple coils	F Hex
Write multiple registers	10 Hex
Get comm. event counter	B Hex
Report follower ID	11 Hex

Table 8.18 Function Codes

Function	Function Code	Sub-function code	Sub-function
Diagnostics	8	1	Restart communication
		2	Return diagnostic register
		10	Clear counters and diagnostic register
		11	Return bus message count
		12	Return bus communi-cation error count
		13	Return bus exception error count
		14	Return follower message count

Table 8.19 Function Codes

8.8.11 Modbus Exception Codes

For a full explanation of the structure of an exception code response, refer to *chapter 8.8.5 Function Field*.

Code	Name	Meaning
1	Illegal function	The function code received in the query is not an allowable action for the server (or follower). This may be because the function code is only applicable to newer devices, and was not implemented in the unit selected. It could also indicate that the server (or follower) is in the wrong state to process a request of this type, for example because it is not configured and is being asked to return register values.
2	Illegal data address	The data address received in the query is not an allowable address for the server (or follower). More specifically, the combination of reference number and transfer length is invalid. For a controller with 100 registers, a request with offset 96 and length 4 would succeed, a request with offset 96 and length 5 generates exception 02.
3	Illegal data value	A value contained in the query data field is not an allowable value for server (or follower). This indicates a fault in the structure of the remainder of a complex request, such as that the implied length is incorrect. It specifically does NOT mean that a data item submitted for storage in a register has a value outside the expectation of the application program, since the Modbus protocol is unaware of the significance of any particular value of any particular register.
4	Follower device failure	An unrecoverable error occurred while the server (or follower) was attempting to perform the requested action.

Table 8.20 Modbus Exception Codes

8.9 How to Access Parameters

8.9.1 Parameter Handling

The PNU (Parameter Number) is translated from the register address contained in the Modbus read or write message. The parameter number is translated to Modbus as (10 x parameter number) DECIMAL. Example: Reading *3-12 Catch up/slow Down Value* (16bit): The holding register 3120 holds the parameters value. A value of 1352 (Decimal), means that the parameter is set to 12.52%

Reading *3-14 Preset Relative Reference* (32bit): The holding registers 3410 & 3411 holds the parameters value. A value of 11300 (Decimal), means that the parameter is set to 1113.00 S.

For information on the parameters, size and converting index, consult the product relevant programming guide.

BACnet Communication

For further details, see BACnet Operating Instructions on the Danfoss website.

FC-102 Embedded BacNET		
Object ID	**Object Name**	**Read / Write**
AI:0	analog_input: 0 (Analog Input 53)	Read
AI:1	analog_input: 1 (Analog Input 54)	Read
AI:2	analog_input: 2 (Analog Input X30/11)	Read
AI:3	analog_input: 3 (Analog Input X30/12)	Read
AI:4	analog_input: 4 (Analog Input X42/1)	Read
AI:5	analog_input: 5 (Analog Input X42/3)	Read
AI:6	analog_input: 6 (Analog Input X42/5)	Read
AO:0	analog_output: 0 (Terminal 42 Output Bus Control)	W/R
AO:1	analog_output: 1 (Pulse out #27 Bus Control)	W/R
AO:2	analog_output: 2 (Pulse out #29 Bus Control)	W/R
AO:3	analog_output: 3 (Analogue Out X30/8 [mA])	W/R
AO:4	analog_output: 4 (Analogue Out X42/7 [V])	W/R
AO:5	analog_output: 5 (Analogue Out X42/9 [V])	W/R
AO:6	analog_output: 6 (Analogue Out X42/11 [V])	W/R
AV:0	Reserved	Read
AV:1	analog_value: 1 (Input Reference 1)	W/R
AV:2	analog_value: 2 (Input Reference 2)	W/R
AV:3	analog_value: 3 (Output Speed)	Read
AV:4	analog_value: 4 (PID Feedback)	Read
AV:5	analog_value: 5 (Motor Current)	Read
AV:6	analog_value: 6 (Power)	Read
AV:7	Reserved	Read
AV:8	Reserved	Read
AV:9	Reserved	Read
AV:10	Reserved	Read
AV:11	Reserved	Read
AV:12	Reserved	Read
AV:13	Reserved	Read
AV:14	Reserved	Read
AV:15	analog_value: 15 (Motor Thermal)	Read
AV:16	Reserved	Read
AV:17	Reserved	Read
AV:18	Reserved	Read
AV:19	Reserved	Read
AV:20	Reserved	Read
AV:21	analog_value: 21 (Operating Hours)	Read
AV:22	analog_value: 22 (Running Hours)	Read
AV:23	analog_value: 23 (kWh Counter)	Read
AV:24	analog_value: 24 (Motor Voltage)	Read
AV:25	analog_value: 25 (Frequency)	Read
AV:26	analog_value: 26 (Torque)	Read
AV:27	analog_value: 27 (DC Link Voltage)	Read
AV:28	analog_value: 28 (Heatsink Temp.)	Read
AV:29	analog_value: 29 (Inverter Thermal)	Read
AV:30	analog_value: 30 (Setpoint 1)	W/R

AV:31	analog_value: 31 (Bus Feedback 1)	W/R
AV:32	Reserved	Read
AV:33	Reserved	Read
AV:34	Reserved	Read
AV:35	analog_value: 35 (Setpoint 2)	W/R
AV:36	analog_value: 36 (Bus Feedback 2)	W/R
AV:37	Reserved	Read
AV:38	Reserved	Read
AV:39	Reserved	Read
AV:40	analog_value: 40 (Setpoint 3)	W/R
AV:41	analog_value: 41 (Bus Feedback 3)	W/R
AV:42	Reserved	Read
AV:43	Reserved	Read
AV:44	Reserved	Read
AV:45	analog_value: 45 (Running Bypass)	Read
AV:46	Reserved	Read
AV:47	Reserved	Read
AV:48	Reserved	Read
AV:49	Reserved	Read
AV:50	analog_value: 50 (Last Alarm)	Read
AV:51	analog_value: 51 (Fault Code)	Read
AV:52	analog_value: 52 (PID Start Speed)	W/R
AV:53	analog_value: 53 (On Reference Bandwidth)	W/R
AV:54	analog_value: 54 (PID Proportional Gain)	W/R
AV:55	analog_value: 55 (PID Integral Time)	W/R
AV:56	analog_value: 56 (PID Differentiation Time)	W/R
AV:57	analog_value: 57 (PID Diff. Gain Limit)	W/R
AV:58	analog_value: 58 (Sensorless Readout)	Read
BI:0	binary_input: 0 (Digital input Term 33)	Read
BI:1	binary_input: 1 (Digital input Term 32)	Read
BI:2	binary_input: 2 (Digital input Term 29)	Read
BI:3	binary_input: 3 (Digital input Term 27)	Read
BI:4	binary_input: 4 (Digital input Term 19)	Read
BI:5	binary_input: 5 (Digital input Term 18)	Read
BI:6	binary_input: 6 (Digital input Term 37)	Read
BI:7	binary_input: 7 (Digital Input X30/2)	Read
BI:8	binary_input: 8 (Digital Input X30/3)	Read
BI:9	binary_input: 9 (Digital Input X30/4)	Read
BI:10	binary_input: 10 (Digital input P1660/10)	Read
BI:11	binary_input: 11 (Digital input P1660/11)	Read
BI:12	binary_input: 12 (Digital input P1660/12)	Read
BI:13	binary_input: 13 (Digital input P1660/13)	Read
BI:14	binary_input: 14 (Digital input P1660/14)	Read
BI:15	binary_input: 15 (Digital input P1660/15)	Read
BO:0	binary_output: 0 (Digital Output Term 27)	W/R
BO:1	binary_output: 1 (Digital Output Term 29)	W/R
BO:2	binary_output: 2 (GPIO Output Term X30/6)	W/R

BO:3	binary_output: 3 (GPIO Output Term X30/7)	W/R
BO:4	binary_output: 4 (Relay 1)	W/R
BO:5	binary_output: 5 (Relay 2)	W/R
BO:6	binary_output: 6 (Option B Relay 1 Output)	W/R
BO:7	binary_output: 7 (Option B Relay 2 Output)	W/R
BO:8	binary_output: 8 (Option B Relay 3 Output)	W/R
BO:9	binary_output: 9 (Reserved output P590/09)	W/R
BO:10	binary_output: 10 (Reserved output P590/10)	W/R
BO:11	binary_output: 11 (Reserved output P590/11)	W/R
BO:12	binary_output: 12 (Reserved output P590/12)	W/R
BO:13	binary_output: 13 (Reserved output P590/13)	W/R
BO:14	binary_output: 14 (Reserved output P590/14)	W/R
BO:15	binary_output: 15 (Reserved output P590/15)	W/R
BO:16	binary_output: 16 (Option C Relay 1 Output)	W/R
BO:17	binary_output: 17 (Option C Relay 2 Output)	W/R
BO:18	binary_output: 18 (Option C Relay 3 Output)	W/R
BO:19	binary_output: 19 (Option C Relay 4 Output)	W/R
BO:20	binary_output: 20 (Option C Relay 5 Output)	W/R
BO:21	binary_output: 21 (Option C Relay 6 Output)	W/R
BO:22	binary_output: 22 (Option C Relay 7 Output)	W/R
BO:23	binary_output: 23 (Option C Relay 8 Output)	W/R
BO:24	binary_output: 24 (Reserved output P590/24)	W/R
BO:25	binary_output: 25 (Reserved output P590/25)	W/R
BO:26	binary_output: 26 (Reserved output P590/26)	W/R
BO:27	binary_output: 27 (Reserved output P590/27)	W/R
BO:28	binary_output: 28 (Reserved output P590/28)	W/R
BO:29	binary_output: 29 (Reserved output P590/29)	W/R
BO:30	binary_output: 30 (Reserved output P590/30)	W/R
BV:0	Reserved	Read
BV:1	binary_value: 1 (RUN/STOP Command)	W/R
BV:2	binary_value: 2 (REF 1/REF 2 Select)	W/R
BV:3	binary_value: 3 (Fault Reset Command)	Write
BV:4	binary_value: 4 (RUN/STOP Monitor)	Read
BV:5	binary_value: 5 (OK/FAULT Monitor)	Read
BV:6	binary_value: 6 (HAND / AUTO Reference)	Read
BV:7	Reserved	Read
BV:10	Reserved	Read
BV:12	Reserved	Read
BV:13	Reserved	Read
BV:14	Reserved	Read
BV:15	Reserved	Read
BV:16	Reserved	Read
BV:17	Reserved	Read
BV:18	Reserved	Read
BV:19	Reserved	Read
BV:20	Reserved	Read
BV:21	binary_value: 21 (Warning)	Read
BV:22	binary_value: 22 (Trip)	Read

BV:23	binary_value: 23 (Triplock)	Read
BV:24	binary_value: 24 (Coasting)	W/R
BV:25	binary_value: 25 (CW/CCW)	W/R
BV:26	binary_value: 26 (Jog)	W/R
BV:27	binary_value: 27 (Reset)	W/R
BV:28	binary_value: 28 (Reset KWh Counter)	Write
BV:29	binary_value: 29 (Reset Running Hours Counter)	Write
BV:30	binary_value: 30 (Reverse)	Read
BV:31	binary_value: 31 (Speed = reference)	Read
BV:32	binary_value: 32 (Bus Control)	Read
BV:33	binary_value: 33 (Running)	Read
BV:34	binary_value: 34 (Ramp 1/Ramp 2)	Read
BV:35	binary_value: 35 (ECB Test Mode)	Read
BV:36	binary_value: 36 (ECB Drivemode)	Read
BV:37	binary_value: 37 (ECB Aut. Bypass Enable)	Read
BV:38	binary_value: 38 (ECB Bypass Mode)	Read
BV:39	Reserved	Read
BV:40	binary_value: 40 (ECB State)	Read
BV:41	binary_value: 41 (ECB Overload Trip)	Read
BV:42	binary_value: 42 (M2 Fault)	Read
BV:43	binary_value: 43 (M3 Fault)	Read
BV:44	binary_value: 44 (ECB External Interlock)	Read
BV:45	binary_value: 45 (ECB Manual Override)	Read
BV:46	NA	NA
BV:47	NA	NA
BV:48	NA	NA
BV:49	NA	NA
BV:50	NA	NA
BV:51	NA	NA
BV:52	NA	NA
BV:53	NA	NA
BV:54	NA	NA
BV:55	NA	NA
BV:56	NA	NA
BV:57	NA	NA
BV:58	NA	NA
BV:59	NA	NA
BV:60	NA	NA
BV:61	NA	NA
BV:62	NA	NA
BV:63	NA	NA
BV:64	NA	NA
BV:65	NA	NA
BV:66	NA	NA
BV:67	NA	NA
BV:68	NA	NA
BV:69	NA	NA
BV:70	NA	NA
BV:71	NA	NA

MSO:0	multi_state_value: 0 (Smart Logic Controller State)	Read
MSO:1	multi_state_value: 1 (Active Setup)	R/W

High & Low Pressure Switch Manual

Instruction Bulletin | Boletín de instrucciones | Directives d'utilisation

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Industrial Pressure Switches
Interruptores de presión industriales
Manostats industriels

Retain for future use. / Conservar para uso futuro. / À conserver pour usage ultérieur.

Class / Clase / Classe	Type / Tipo / Type: Adjustable Differential / Diferencial ajustable / Différentiel réglable	Type / Tipo / Type: Non-adjustable Differential / Diferencial fijo / Différentiel non réglable	Series / Serie / Série
9012	GNO, GNG, GPO, GPG, GQO, GQG	GRO, GRG, GSO, GSG, GTO, GTG	B

USE LIMITATIONS

Pressure Ratings

LIMITACIONES DE USO

Valores nominales de presión

LIMITATIONS D'UTILISATION

Valeurs nominales de pression

⚠ CAUTION / PRECAUCIÓN / ATTENTION

EXCESSIVE PRESSURE

Ensure that pressures applied to the switch, including surges, are within the stated range of the switch.

Failure to follow this instruction can result in injury or equipment damage.

PRESIÓN EXCESIVA

Asegúrese de que las presiones aplicadas al interruptor, incluyendo sobretensiones, se encuentren dentro de la gama especificada para el interruptor.

El incumplimiento de esta instrucción puede causar lesiones o daño al equipo.

PRESSION EXCESSIVE

Assurez-vous que les pressions appliquées sur le manostat, y compris les surpressions, se trouvent dans la gamme indiquée pour le manostat.

Si cette directive n'est pas respectée, cela peut entraîner des blessures ou des dommages matériels.

The maximum allowable pressure printed on the device nameplate is the maximum pressure, including surges, to which the pressure switch actuator may be exposed for brief or extended periods of time without altering the performance characteristics of the switch.

Do not expose the pressure actuators to system or surge pressures greater than the maximum pressure rating, to avoid leakage from the actuator or a change in operating setpoints.

NOTE: For Types GN• and GR•, periodically retorque the actuator mounting screws to 8–10 lb-in.

Ensure that the maximum system pressure applied on a continual basis, including surges, does not exceed the maximum stated range. The mechanical life of any diaphragm-actuated switch decreases if the pressure exceeds the maximum stated range. The more frequent the application and the greater the value of excessive pressure, the more diaphragm life decreases.

La presión máxima permitida especificada en la placa de datos del dispositivo es la presión máxima, incluyendo presiones excesivas, en la cual el accionador del interruptor de presión puede ser expuesto durante períodos de tiempo breves o prolongados sin alterar las características de funcionamiento del interruptor.

No exponga los accionadores de presión al sistema ni a presiones excesivas mayores que el valor nominal máximo de la presión, para evitar fugas del accionador o un cambio en los puntos de referencia de funcionamiento.

NOTA: En los tipos GN• y GR•, periódicamente vuelva a apretar los tornillos de montaje del accionador de 0,9 a 1,13 N•m (8 a 10 lbs-pulg).

Asegúrese de que la presión máxima del sistema aplicada de forma continua, incluyendo presiones excesivas, no exceda la gama máxima especificada. La vida mecánica de cualquier interruptor accionado por diafragma disminuye si la presión excede la gama máxima especificada. Entre más se usa la aplicación y mayor es el valor de la presión excesiva, más corta es la vida mecánica del diafragma.

La pression maximale autorisée imprimée sur la plaque signalétique du dispositif est la pression maximale, y compris les surpressions, à laquelle l'actionneur du manostat peut être exposé pendant des périodes brèves ou prolongées sans altérer les caractéristiques de performance du manostat.

N'exposez pas les actionneurs de pression au système ou à des surpressions supérieures à la pression nominale maximale, afin d'éviter une fuite de l'actionneur ou une modification des points de consigne de fonctionnement.

REMARQUE : Pour les types GN• et GR•, resserrer périodiquement les vis de montage de l'actionneur au couple de 0,9 a 1,13 N•m (8 à 10 lb-po).

S'assurer que la pression maximale du système appliquée continuellement, y compris les surpressions, ne dépasse pas la gamme maximale indiquée. La durée de vie mécanique de tout manostat actionné par membrane diminue si la pression dépasse la gamme maximale indiquée. Plus l'application est fréquente et plus la valeur de pression excessive est grande, plus la durée de vie de la membrane diminue.

Taco Comfort Solutions®
A Taco Family Company

Temperature Ratings

Refer to Table 1. The switch may not operate properly if the media fluid freezes or if frost or ice forms inside the switch.

Valores nominales de temperatura

Consulte la tabla 1. Es posible que el interruptor no funcione adecuadamente si se congela el líquido o si se forma hielo o escarcha dentro del interruptor.

Valeurs nominales de température

Consulter le tableau 1. Le manostat peut ne pas fonctionner correctement si le fluide sous pression gèle ou si du givre ou de la glace se forme à l'intérieur du manostat.

Table / Tabla / Tableau 1 : Continuous-Use Temperature Ratings / Valores nominales en temperaturas de uso continuo Valeurs nominales de température en régime d'utilisation continu

Ambient Temperature –10 to +185 °F (–25 to +85 °C)	**Temperatura ambiente** –25 a +85 °C (–10 a +185 °F)	**Température ambiante** –25 à +85 °C (–10 à +185 °F)
Pressure Media Temperature –10 to +250 °F (–25 to +120 °C)	**Temperatura de los medios de presión** –25 a +120 °C (–10 a +250 °F)	**Température des milieux sous pression** –25 à +120 °C (–10 à +250 °F)

Use on Steam

Do not use the switch directly on steam that exceeds 15 psig (1 bar). For indirect use, attach a minimum of 10 ft (3.05 m) of capillary tubing with an outer diameter (OD) of 1/8 in. (3.2 mm) between the steam source and the actuator. Ensure that the tubing is rated for use on steam up to 250 psig (17 bars). (Tubing is not available from Schneider Electric.) Do not exceed the maximum pressure and temperature ratings of the switch. Coil the tubing in the pressure line in several loops of 4–8 in. (100–200 mm) diameter, to serve as a heat exchanger and to form a static water head as a buffer to steam temperature. See Figure 1.

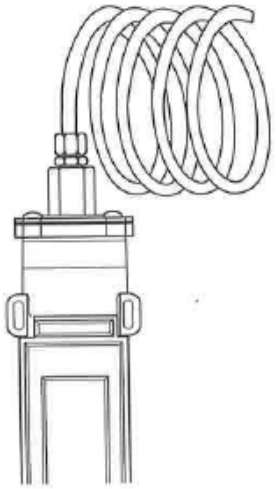
Uso en vapor

No utilice el interruptor directamente en vapor que exceda 15 psig (1 bar) de presión. Para un uso indirecto, conecte un tubo capilar de 3 m (10 pies) de largo como mínimo y un diámetro exterior de 3,2 mm (1/8 pulgada) entre la fuente de vapor y el accionador. Asegúrese que el tubo sea adecuado para usarse en vapor de hasta 250 psig (17 bars) de presión, (el tubo capilar no se encuentra disponible de Schneider Electric). No exceda los valores nominales máximos de la presión ni de la temperatura especificados para el interruptor. Enrolle el tubo en la línea de presión en varios bucles de 100 a 200 mm (4 a 8 pulgadas) de diámetro; para que sirva como termointercambiador y que forme un tope de altura de elevación para la temperatura del vapor. Vea la figura 1.

Utilisation sur de la vapeur

Ne pas utiliser le manostat directement sur les lignes de vapeur qui dépasse 15 lb/po^2 (1 bar) de pression. Pour une utilisation indirecte, attacher un tube capillaire d'une longueur minimale de 3 m (10 pi) et d'un diamètre extérieur de 3,2 mm (1/8 po) entre la source de vapeur et l'actionneur. S'assurer que le tube est d'une valeur nominale pour être utilisé sur de la vapeur allant jusqu'à 250 lb/po^2 (17 bars) de pression. (Le tube n'est pas disponible chez Schneider Electric). Ne pas dépasser la pression maximale et les températures nominales du manostat. Bobiner le tube de la ligne de pression dans plusieurs boucles de 100 à 200 mm (4 à 8 po) de diamètre, pour servir d'échangeur thermique et former une tête de pression statique d'eau servant de tampon à la température de la vapeur. Voir la figure 1.

Figure / Figura / Figure 1 : Capillary Tubing / Tubo capilar / Tube capillaire



⚠ DANGER / PELIGRO / DANGER

HAZARDOUS VOLTAGE	TENSIÓN PELIGROSA	TENSION DANGEREUSE
Turn off all power supplying this pressure switch before working on or inside the switch.	Desenergice el interruptor de presión antes de efectuar cualquier tabajo dentro o fuera de él.	Coupez l'alimentation du manostat avant d'y travailler.
Failure to follow this instruction will result in death or serious injury.	**El incumplimiento de esta instrucción podrá causar la muerte o lesiones serias.**	**Si cette directive n'est pas respectée, cela entraînera la mort ou des blessures graves.**

MOUNTING

Do not mount the switch by its pressure connection only. Use the mounting holes (**N**) and slots (**M**) shown in Figure 2 for surface-mounting the switch.

*NOTE: Open devices (Type G•O) have mounting slots (**M**) but not mounting holes (**N**).*

When connecting the switch to the pressure system piping, turn the switch onto the pipe using a wrench on the hexagonal body of the actuator. Do not apply leverage through the switch housing.

The standard pressure connection is 1/4–18 NPTF. The dryseal thread should seal against a new external 1/4 NPT thread without sealing tape or compounds.

For alternate pressure connections, refer to Table 2.

MONTAJE

No monte el interruptor empleando sólo sus conexiones de presión. Para montar el interruptor sobre una superficie, emplee los agujeros de montaje (**N**) y ranuras (**M**) que se muestran en la figura 2.

*NOTA: Los dispositivos abiertos (tipo G•O) tienen las ranuras de montaje (**M**) y no los agujeros de montaje (**N**).*

Al conectar el interruptor a los tubos del sistema de presión, gire el interruptor sobre el tubo empleando una llave para tuercas en el cuerpo hexagonal del accionador. No aplique fuerza sobre la caja del interruptor para hacer palanca.

La conexión de presión estándar es de 1/4–18 NPTF. La rosca de sellado en seco deberá sellar herméticamente contra una nueva rosca de 1/4 NPT sin necesidad de usar compuestos o cinta de cierre hermético.

Para obtener conexiones alternativas de presión, consulte la tabla 2.

MONTAGE

Ne pas monter le manostat uniquement par le raccordement de pression. Utiliser les trous de montage (**N**) et les fentes (**M**) indiqués à la figure 2 pour le montage du manostat en surface.

*REMARQUE : Les dispositifs ouverts (type G•O) possèdent des fentes de montage (**M**) mais pas de trous de montage (**N**).*

Lors du raccordement du manostat à la tuyauterie du système de pression, faire pivoter le manostat sur le tuyau en utilisant une clé sur le corps hexagonal de l'actionneur. Ne pas appliquer d'effet de levier sur l'enveloppe du manostat.

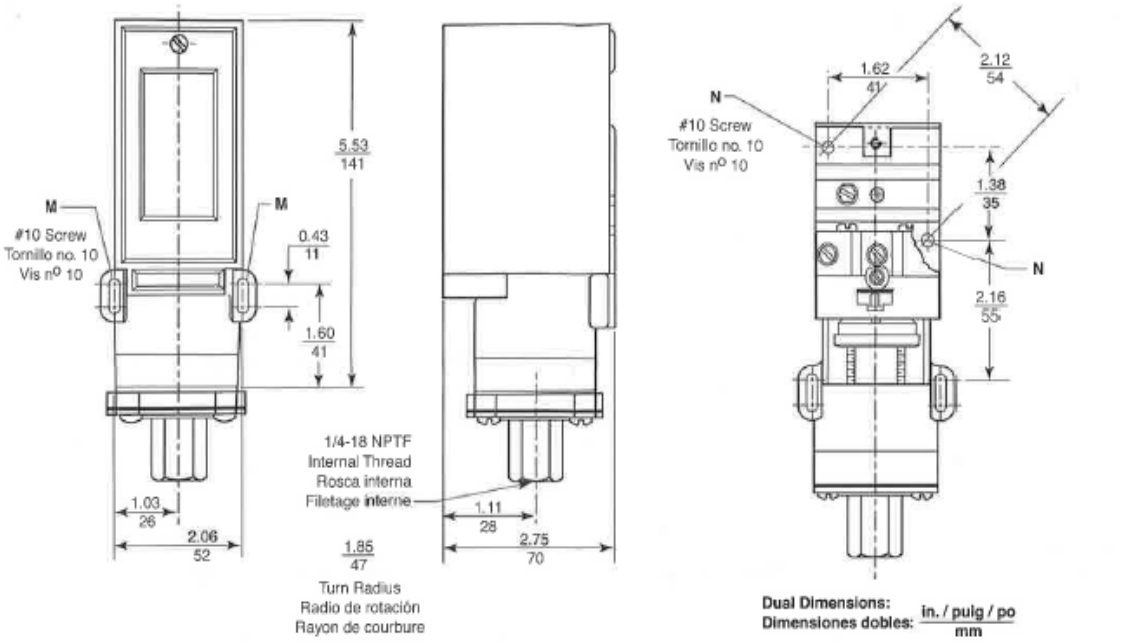
Le raccordement normal de pression est de 1/4–18 NPTF. Le filetage à joint sec doit être étanche avec le nouveau filetage externe de 1/4 NPT sans bande ou pâte d'étanchéité.

Pour d'autres raccordements de pression, voir le tableau 2.

Table / Tabla / Tableau 2 : Alternate Pressure Connections / Conexiones alternativas de presión / Autres raccordements de pression

Form Forma Forme	Type Tipo Type	Connection	Conexión	Raccordement
Z	GNO, GNG, GRO, GRG	1/4-18 NPT external thread	Rosca externa de 1/4 -18 NPT	Filetage externe de 1/4–18 NPT
Z16	GNO, GNG, GRO, GRG	1/2-14 NPT external and 1/4-18 NPTF internal thread	Rosca externa de 1/2-14 NPT e interna de 1/4-18 NPTF	Filetage externe de 1/2-14 NPT et filetage interne de 1/4-18 NPTF
Z18	G•O, G•G	7/16-20 UNF-2B	7/16-20 UNF-2B	7/16-20 UNF-2B

Figure / Figura / Figure 2 : Standard Dimensions / Dimensiones estándar / Dimensions normales



NOTE: Do not plug the 1/4 in. diameter holes on Types GP• and GS•.

WIRING

These pressure switches are suitable for #12–16 AWG (1.0–2.5 mm^2), solid or stranded copper wire. Do not use aluminum wire. Tighten the terminal screws to 6–9 lb-in (0.7–1 N•m). For enclosed Types G•G, the grounding (earthing) provision, marked ⏚, is located above the snap switch on the enclosure backplate.

The single-pole, double-throw snap switch contains single-break contacts offering one normally open circuit and one normally closed circuit. These circuits are electrically separate, but they must be used on circuits of the same polarity. For proper wiring, refer to the wiring diagram on the snap switch, not the terminal identification on the snap switch.

NOTA: No cubra los agujeros de 6,35 mm (1/4 pulg) de diámetro en los dispositivos tipos GP• y GS•.

ALAMBRADO

Es posible utilizar un conductor de cobre calibre 1,0 –2,5 mm^2(12 –16 AWG), sencillo o trenzado, con estos interruptores de presión. No utilice conductores de aluminio. Apriete los tornillos de las terminales en 0,7–1 N•m (6–9 lbs-pulg). En los dispositivos en gabinete tipo G•G, la provisión de conexión a tierra, marcada ⏚, se encuentra arriba del interruptor de resorte en la placa posterior del gabinete.

El interruptor de resorte de un polo, doble tiro contiene contactos de ruptura única con un circuito normalmente abierto y el otro normalmente cerrado. Estos circuitos están eléctricamente separados; sin embargo, estos deben ser usados en circuitos de la misma polaridad. Para realizar las conexiones correctas de los cables, consulte el diagrama de alambrado en el interruptor de resorte, asegurándose de no utilizar la identificación de las terminales en el interruptor de resorte.

REMARQUE : Ne pas boucher les trous d'un diamètre de 6,3 mm (1/4 po) sur les types GP• et GS•.

CÂBLAGE

Ces manostats conviennent à un fil de cuivre, rigide ou toronné, de calibre 12 à 16 AWG (1,0 à 2,5 mm^2). Ne pas utiliser des fils en aluminium. Serrer les vis de bornes au couple de 0,7 à 1 N•m (6 à 9 lb-po). Pour les types G•G sous coffret, l'option de mise à la terre, marquée ⏚, est située au-dessus de l'interrupteur à ressort sur la plaque arrière du coffret.

L'interrupteur à ressort unipolaire bidirectionnel contient des contacts à simple rupture offrant un circuit normalement ouvert et un circuit normalement fermé. Ces circuits sont séparés électriquement, mais ils doivent être utilisés sur des circuits de la même polarité. Pour obtenir un câblage approprié, se reporter au schéma de câblage sur l'interrupteur à ressort, non à l'identification des bornes sur l'interrupteur à ressort.

SETPOINT ADJUSTMENT

The pressure switch is factory set to the operating points marked on the outside of the mechanism housing. Cycle the switch to determine the actual operating points before readjusting.

Nonadjustable Differential—Types GR, GS, and GT

1. While facing the switch mounted as shown in Figure 3, place a flat-blade screwdriver in the slots of the range adjustment nut (**A**).
2. Rotate the nut toward the left to simultaneously raise both setpoints, or toward the right to lower both setpoints.

Adjustable Differential—Types GN, GP, and GQ

1. Adjust the setpoint on decreasing pressure: Follow the procedure for nonadjustable differential types.
2. Adjust the setpoint on increasing pressure: Turn the adjusting screw (**B**) clockwise to raise the setpoint, or counterclockwise to lower the setpoint. (This does not affect the decreasing-pressure setpoint.)

AJUSTE DEL PUNTO DE REFERENCIA

El interruptor de presión viene ajustado de fábrica en los puntos de funcionamiento marcados en el exterior de la caja del mecanismo. Apague y vuelva a encender el interruptor para determinar los puntos de funcionamiento actuales antes de volver a realizar cualquier ajuste.

Diferencial fijo—Tipos GR, GS y GT

1. Cuando el interruptor se monta orientado de la manera mostrada en la figura 3, coloque un desatornillador de punta plana en la ranura de la tuerca de ajuste (**A**).
2. Gire la tuerca hacia la izquierda para aumentar simultáneamente ambos puntos de referencia, o hacia la derecha para disminuirlos.

Diferencial ajustable—Tipos GN, GP y GQ

1. Ajuste el punto de referencia en la presión descendente: siga este procedimiento para los tipo de diferencial fijo.
2. Ajuste el punto de referencia en la presión ascendente: Gire el tornillo de ajuste (**B**) en sentido de las manecillas del reloj para aumentar el punto de referencia o en sentido contrario de las manecillas del reloj para disminuir el punto de referencia (esto no afecta el punto de referencia de la presión descendente).

RÉGLAGE DES POINTS DE CONSIGNE

Le manostat est réglé à l'usine aux points de consigne de fonctionnement indiqués à l'extérieur de l'enveloppe du mécanisme. Mettre le manostat hors puis sous tension pour déterminer les points de fonctionnement réels avant de refaire le réglage.

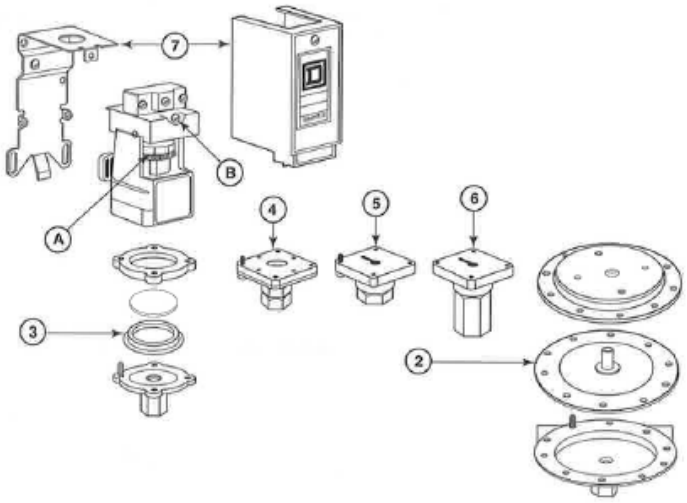
Différentiel non réglable—Types GR, GS et GT

1. Tout en faisant face au manostat monté comme indiqué à la figure 3, placer un tournevis à lame plate dans la fente de l'écrou de réglage (**A**).
2. Faire tourner l'écrou vers la gauche pour augmenter simultanément les deux points de consigne, ou vers la droite pour les diminuer.

Différentiel réglable—Types GN, GP et GQ

1. Régler le point de consigne sur la pression descendante : suivre la procédure pour des types de différentiels non réglables.
2. Régler le point de consigne sur la pression ascendante : tourner la vis de réglage (**B**) dans le sens horaire pour augmenter le point de consigne ou anti-horaire pour le diminuer. (Cela n'affecte pas le point de consigne de la pression descendante.)

Figure / Figura / Figure 3 : Pressure Switch Assembly / Ensamble del interruptor de presión / Assemblage du manostat



REPLACEMENT PARTS

When ordering replacement parts, specify the Class, Type, and Form of the switch. For item numbers, refer to Figure 3.

PIEZAS DE REPUESTO

Al solicitar las piezas de repuesto, especifique la clase, el tipo y la forma del interruptor. Consulte la figura 3 para obtener el número de identificación de las piezas.

PIÈCES DE RECHANGE

Pour commander une pièce de rechange, il faut toujours spécifier la classe, le type et la forme de l'interrupteur. Pour les numéros des articles, consulter la figure 3.

Table / Tabla / Tableau 3 : Replacement Parts / Piezas de repuesto / Pièces de rechange

Item / Pieza / Art.	Description / Descripción / Description	Class / Clase / Classe	Type / Tipo / Type	Switch Type / Tipo de interruptor / Type de manostat
2	Diaphragm assembly / Ensamble del diafragma / Assemblage de membrane	9998	PC265	GNO-, GNG-, GRO-, GRG1
3	Diaphragm assembly / Ensamble del diafragma / Assemblage de membrane	9998	PC266 PC267	GNO-, GNG-, GRO-, GRG3 GNO-, GNG-, GRO-, GRG4
4	Diaphragm assembly / Ensamble del diafragma / Assemblage de membrane	9998	PC268 PC269	GNO-, GNG-, GRO-, GRG5 GNO-, GNG-, GRO-, GRG6
5	Diaphragm actuator assembly / Ensamble del accionador del diafragma / Assemblage d'actionneur de membrane	9998	PC177 PC178	GPO-, GPG-, GSO-, GSG1 GPO-, GPG-, GSO-, GSG2
6	Piston actuator assembly / Ensamble del accionador del pistón / Assemblage de l'actionneur du piston	9998	PC270 PC271 PC272 PC273	GQO-, GQG-, GTO-, GTG1 GQO-, GQG-, GTO-, GTG2 GQO-, GQG-, GTO-, GTG3 GQO-, GQG-, GTO-, GTG4
7	Enclosure assembly / Ensamble del gabinete / Assemblage de coffret	9049	UE1	Converts Type G•O to G•G / Convierte los dispositivos tipo G•O en G•G / Convertit le type G•O en G•G

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Thermal Relief Valve

INSTRUCTIONS

AVTB-RA Cooling

INSTAVTBRA

Product

AVTB-RA thermostatic water valve (reverse-acting) open on rise in temperature.

Application

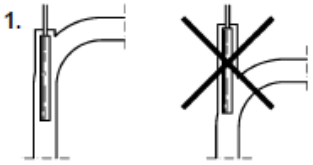
For use in regulating water flow of cooling applications.

Maximum working pressure.....: 232psig(16bar)
Maximum differential pressure.: 102psi (7bar)
Maximum test pressure.....: 362psig (25bar)
Maximum water temperature.: 266°F (130°C)

Installation

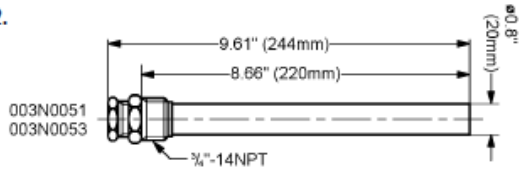
Install the valve with flow in the direction indicated by the arrow on the valve body. The valve can be mounted in any position. It is recommended that a strainer be fitted ahead of the valve. The spring housing can be removed and replaced on the valve body to make reading the scale easier. Turn the hand knob clockwise until the valve is set at 1. Remove the 4 screws holding the spring housing to the body. Turn the spring housing to the desired position and secure it in the new position.

1.



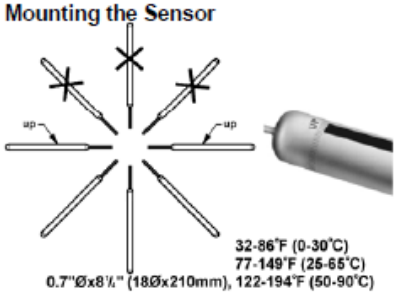
The entire sensor must be in contact with the fluid being controlled in order to obtain a proper reading of the temperature. Avoid sharp bends in the capillary tube.

2.



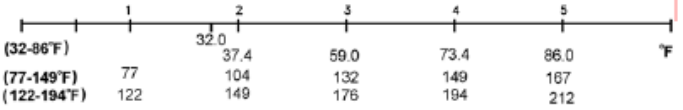
If the sensor will be installed in a pocket, the free space in the sensor pocket should be with heat conducting compound to ensure proper heat transfer from the fluid to the sensor.

Mounting the Sensor



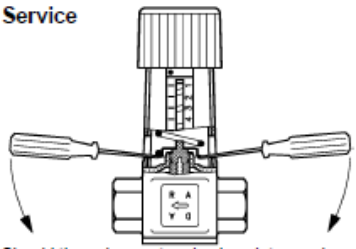
The standard large sensor must be installed so that the tip is never higher than the capillary tube end. Unless fitted vertical the RED line on the bulb and the label "UP" must face upwards.
Ensure a flow past the sensor exists at all times. A bypass may be necessary for start-up.

Temperature Setting



Adjust the setting by turning the hand knob to the required reference number on the valve scale. A thermometer placed near the sensor will provide a more accurate setting.
To **increase** the temperature setting, turn the hand knob *counter-clockwise*.
To **decrease** the temperature setting, turn the hand knob *clockwise*.

Service

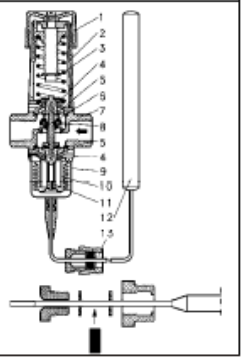


Should the valve seat and valve plate require cleaning after start-up, insert two screwdrivers through the two access holes and under the spring retainer. Push down on the screwdrivers to open the valve.

To replace the thermostatic element set the valve to "1" on the valve scale.
Remove the four screws holding the thermostatic element to the valve. Replace element and tighten screws.
The element can be replaced with water in the system.

Spare Parts:
All spare parts are common between the AVTB heating valve and the AVTB-RA cooling valve.

Thermostatic element 32-85°F (0-30°C)		003N0075
Thermostatic element 77-149°F (25-65°C)		003N0078
Thermostatic element 125-190°F (50-90°C)		003N0062
Spring Housing		003N0001
Repair kit AVTB/RA15	(items 4,5,8 & screws)	003N4006
Repair kit AVTB/RA20	(items 4,5,8 & screws)	003N4007
Repair kit AVTB/RA25	(items 4,5,8 & screws)	003N4008
Heat conducting paste		041E0110



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Data sheet

AVTB-RA, Reverse Acting Thermostatic Water Valve

Applications:

AVTB-RA is a reverse acting thermostatic temperature controller used to regulate the water temperature where cooling is required. As the water temperature rises the thermostatic controller opens.
Typical applications could involve:

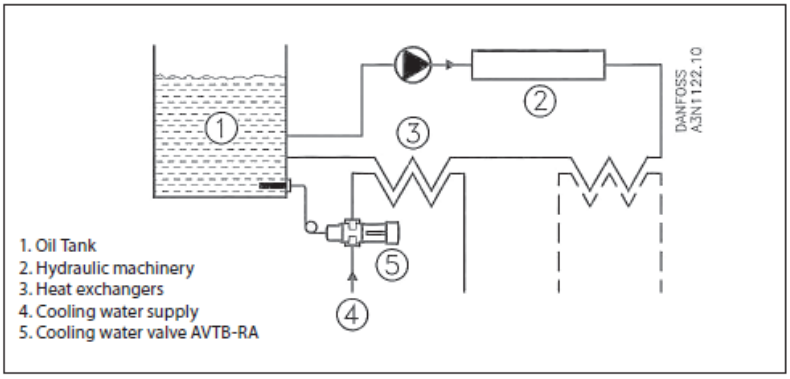
- Injection molding machines
- Compressors
- Vacuum pumps
- Dry cleaning machines

The thermostatic controller is a three part assembly consisting of the valve body, the thermostatic element and an adjustment assembly.

Features:

- For water
- Self-acting
- Opens on rising temperature
- Can be fitted in the supply or return
- Pressure range PN 16 (232 psi/16 bar)

Typical Application:



1. Oil Tank
2. Hydraulic machinery
3. Heat exchangers
4. Cooling water supply
5. Cooling water valve AVTB-RA

Ordering Information:

Code No.	Model	Connection (FNPT)	Capillary Tube Length	Max. Sensor Temperature °F (°C)	C_v	Temperature Range °F (°C)
003N6032RA	AVTB-RA 15	1/2"	6'6" (2.0 m)	130 (55)	2.2	32-85 (0-30)
003N6252RA				190 (90)		77-150 (20-60)
003N6272RA				255 (125)		125-190 (50-90)
003N7032RA	AVTB-RA 20	3/4"		130 (55)	4.0	32-86 (0-30)
003N7252RA				190 (90)		70-150 (20-60)
003N7272RA				255 (125)		125-190 (50-90)
003N8032RA	AVTB-RA 25	1"		130 (55)	6.4	32-86 (0-30)
003N8252RA				190 (90)		70-150 (20-60)
003N8272RA				255 (125)		125-190 (50-90)

Data sheet

AVTB-RA, Reverse Acting Thermostatic Water Valve

Ordering Information (Cont.):

Accessories

Code No.	Components
003N0056	Capillary tube gland, 3/4" NPT
003N0418	Gasket for capillary tube gland
AVTBWELL	Sensor pocket, 3/4" NPT, brass
003N0053	Sensor pocket, 3/4" NPT, stainless steel

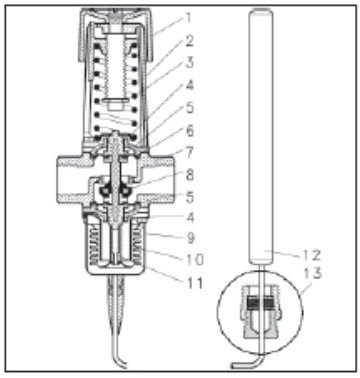
[1] Include gasket for capillary tube gland

Spare Parts

Code No.	Components	Cap. tube length ft (m)
003N0075	Thermostatic element 32-85°F (0-30°C)	6'6 (2)
003N0078	Thermostatic element 77-150°F (20-60°C)	
003N0062	Thermostatic element 125-190°F (50-90°C)	
003N4006	For 1/2"	*Repair set:* Two diaphragms, two O-rings, one rubber cone, one tube of grease and eight valve cover crews
003N4007	For 3/4"	
003N4008	For 1"	
003N6100	1/2"	Brass AVT body and adjustment knob, less element
003N7100	3/4"	
003N8100	1"	
003N0520	AVT spare handle	

Design:

1. Handle for temperature setting
2. Spring housing
3. Setting spring
4. O-ring
5. Diaphragm
6. Spindle
7. Valve body
8. Valve cone
9. Bellows
10. Bellows stop
11. Pressure stem
12. Temperature sensor
13. Capillary tube gland



Materials, parts in contact with water:

Valve body:	Ms 58, hot-pressed
Other metal parts:	Ms 58
Diaphragms:	EPDM rubber (alt. NBR rubber for mineral oils)
Capillary tube gland:	NBR rubber
Valve cone:	NBR rubber
Valve seat:	CR Ni steel
Sensor:	Cu
Sensor pocket:	Ms 63

Specifications:

Supply temperature range:	-13°F to 266°F (-25°C to 130°C)
Maximum working pressure:	232 psi (16 bar)
Maximum differential pressure:	100 psi (7 bar)
Maximum test pressure:	365 psi (25 bar)

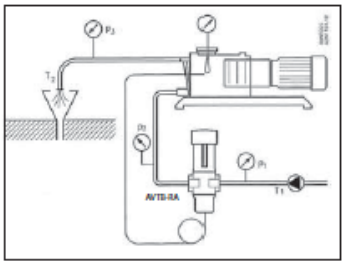
Sizing:

Example

Cooling water valve for temperature regulation of a vacuum pump. Regulation of the oil temperature is required. The sensor to be placed horizontally.

Given

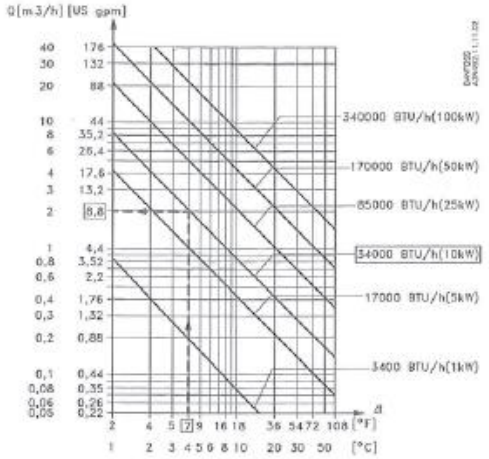
- Necessary cooling effect at full load, 34,000 BTU/h
- Required oil temperature: 113°F (45°C)
- Cooling water pressure P_1= 28.5 psi (2 bar)
- Outlet pressure P_3= 0 psi (0 bar)
- Cooling water temperature T_1= 77°F (25°C)
- Oulet temperature T_2= 84°F (29°C), (ΔT= 7°F (4°C))



Data sheet **AVTB-RA, Reverse Acting Thermostatic Water Valve**

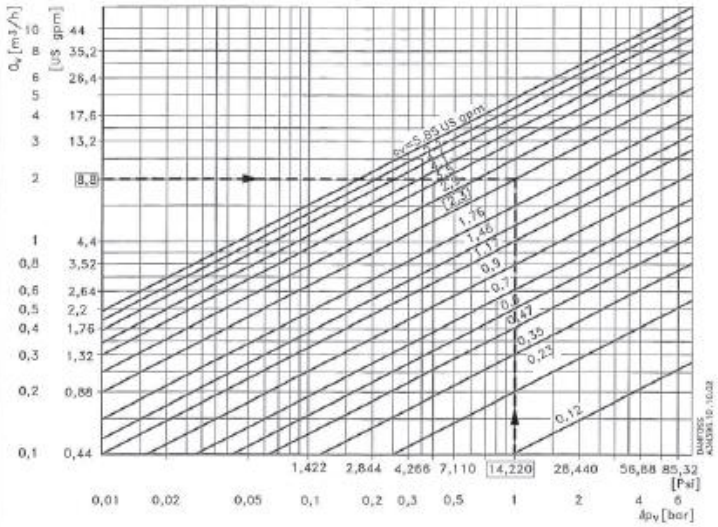
Sizing:

Heating or cooling with water



1. By means of the curves for heating or cooling with water the necessary amount of cooling water is detected to be 8.8 gpm at ΔT= 7°F (84-77 = 7°F)

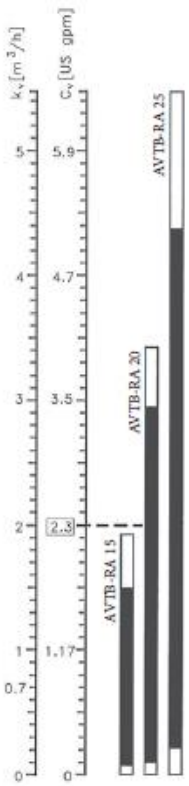
Relationship between water flow and pressure drop across the valve



C_v values = water flow in US gpm at a pressure drop Δp = 1 psi

2. In order to obtain an effective regulation, the pressure drop across the valve should be half the entire pressure drop: 28psi (2bar) / 2= 14.22psi (1 bar). By means of the curves for the water amount and pressure drop the necessary Cv value is detected to be 2.3 US gpm.

Nomogram showing the C_v-values



3. By means of the bar chart the AVTB-RA 20 is the appropriate valve size for the application.

Temperature range: 77 to 150°F. Code no. 003N7252RA will meet the requirements

Due to the mounting conditions a sensor pocket is required. The ¾" brass sensor pocket, code no. AVTBWELL is selected.

Data sheet

AVTB-RA, Reverse Acting Thermostatic Water Valve

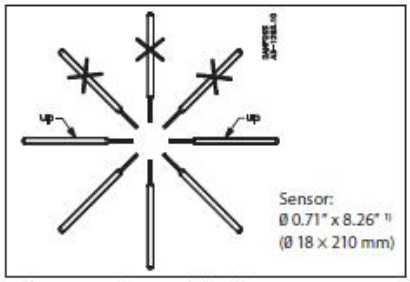
Setting:

Relation between scale numbers 1-5 and the closing temperature. The values given are approximate.

Scale setting	1	2	3	4	5	
Closing temperature						
(0 … 30 °C)	0	3	15	23	30	°C
(20 … 60 °C)	20	35	50	60	70	
(30 … 100 °C)	30	35	55	75	95	120
(32...85°F)	32	39	60	73	85	°F
(77...150°F)	77	95	122	140	158	
(125...190°F)	125	150	176	194	210	

Installation:

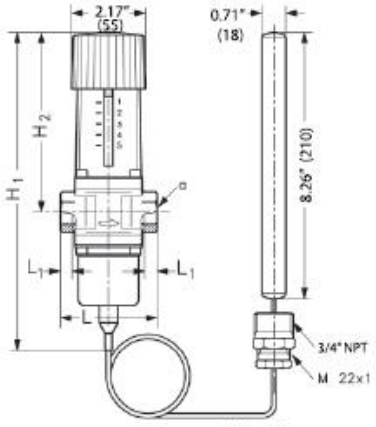
The valve can normally be fitted in the supply or return, in any position, provided the flow is always in the direction indicated by the arrow. Elements with a small sensor Ø 0.4" (9.5 mm) ("sensor warmer") must always have the valve housing fitted in the return.



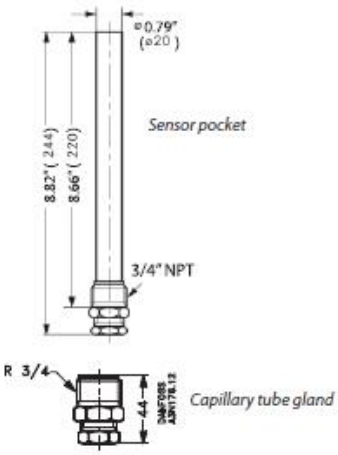
1) *The sensor can be mounted where the system temperature is either warmer or colder than the temperature in the valve body*

Dimensions:

Type	H_1 in (mm)	H_2 in (mm)	L in (mm)	L_1 in (mm)	L2 in (mm)	L3 in (mm)	L4 in (mm)	a (int. thread)
AVTB-RA 15	8.54 (217)	5.24 (133)	2.84 (72)	0.56 (14)	5.6 (141)	5.87 (149)	2.95 (75)	½" NPT
AVTB-RA 20	8.54 (217)	5.24 (133)	3.55 (90)	0.63 (16)	6.06 (154)	6.45 (164)	3.15 (80)	¾" NPT
AVTB-RA 25	8.54 (227)	5.43 (138)	3.74 (95)	0.75 (19)	6.61 (168)	6.57 (167)	3.27 (83)	1" NPT



AVTB-RA with internal thread



Capillary tube gland

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