CALIFORNIA

Proposition 65 Warning

WARNING: Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer and birth defects or other reproductive harm.

WARNING: Battery posts, terminals, and related accessories contain lead and lead compounds, and chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

NOTICE

ANY PICTURES CONTAINED WITHIN THIS OPERATOR'S MANUAL THAT DEPICT SITUATIONS WITH SHIELDS, GUARDS, RAILS, OR LIDS REMOVED ARE FOR DEMONSTRATION ONLY. HAGIE MANUFACTURING STRONGLY URGES THE OPERATOR TO KEEP ALL SHIELDS AND SAFETY DEVICES IN PLACE AT ALL TIMES.

Battery Acid Accident Prevention

Avoid serious injury by avoiding battery acid contact with your body. Battery electrolyte contains sulfuric acid that is strong enough to eat holes in clothing and cause blindness if splashed into eyes.

Make sure to:

- Fill batteries in a well ventilated area.
- Wear Personal Protective Equipment when servicing a battery.
- Avoid breathing in the fumes when recharging with electrolyte.
- Avoid spilling or dripping electrolyte.
- When charging a battery, connect positive cable to positive terminal and negative cable to negative terminal. Failure to do so may result in an explosion and cause injury.

If you spill on yourself:

- Immediately begin flushing affected area with cold water while removing any contaminated clothing and shoes. Continue to flush the area for a minimum of 15 minutes.
- Call a physician.
- While transporting or waiting for medical attention, apply compresses of iced water or immerse affected area in iced water. Do not allow tissue to freeze.
- Do not apply creams or ointments until you have been seen by a physician.

If acid is swallowed:

- Do not induce vomiting.
- Drink large amounts of water.
- Get medical attention immediately!
- Do not neutralize the acid.

If fumes are inhaled:

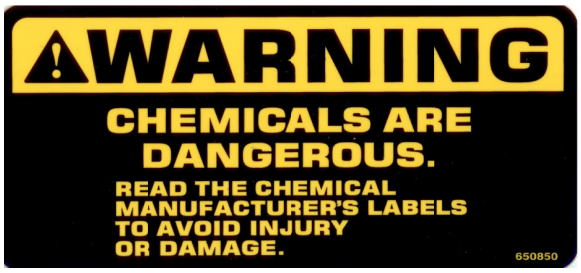
- Move the person into fresh air.
- Do not give artificial respiration to a person that is able to breathe on their own.
- Give CPR only if there is no breathing AND no pulse.
- Seek medical attention IMMEDIATELY!

DECALS

650850

Front fill– on solution tank near fill lid (1).

Side fill– on educator tank lid (2).



650851

Left side rear mainframe, near ladder.

SPECIFICATIONS

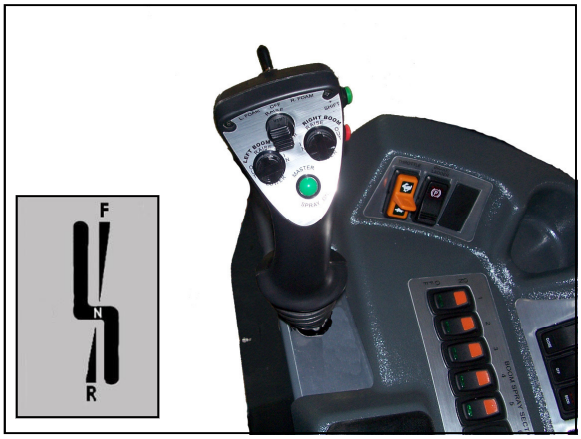
ITEM	SPECIFICATION
CAB AND INSTRUMENTS	
Cab	
General Cab	Tilt steering, windshield wiper/ washer, dual side mirrors, dome light, tinted glass, training seat
Temperature Control	Full range
A/C Charge Type	R-134a
Fresh Air Filtration	Paper and charcoal filter
Seat	Air ride
Instruments	
MD3	Hour meter, fuel, water temperature, battery voltage, engine oil pressure, ground speed, engine RPM, tread adjust assist
Stereo	AM/FM/WB with CD
CAPACITIES	
Solution Tank	1000 gallons (3785 L)
Fuel Cell	150 gallons (530 L)
Cooling System (including block, lines, and radiator)	18 gallons (68 L)
Hydraulic Oil (including tank, filter, and cooler)	55 gallons (208 L)
Rinse System Tank	100 gallons (379 L)
Foam Marker	36 gallons (136 L)
Engine Oil (including crankcase, lines, filter, and cooler)	17 quarts (16 L)
Wheel Hubs (front and rear)	40 ounces (1.18 L)

Forward, Neutral, Reverse

The hydrostatic lever is used to determine the direction of motion of the machine. To move the machine forward, pull the lever slightly to the right and push forward. The farther you push, the faster the speed of the machine.

To stop the machine, or put the machine in neutral, slowly pull the lever back to the center position and move it slightly to the left. The neutral position must be met before changing direction of the machine. The machine must also be in neutral before several functions can be performed.

To move the machine in reverse, move the lever to the far right and slowly pull back. The farther back the lever is pulled, the faster the machine's speed.

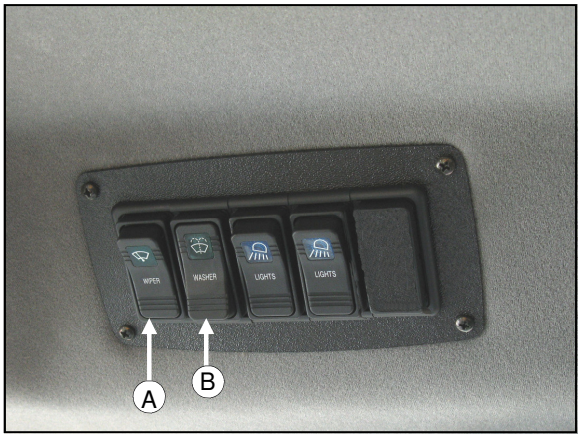


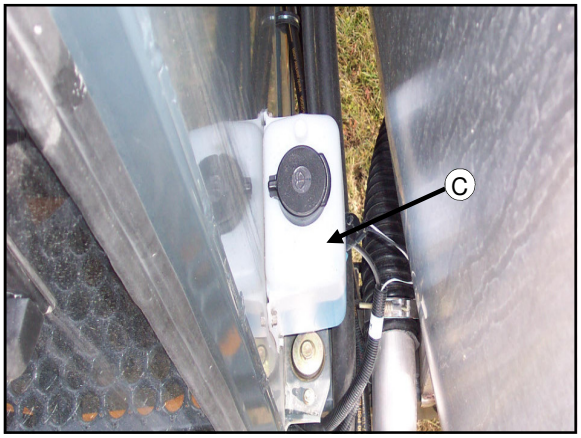
Windshield Wiper and Washer Fluid Switches

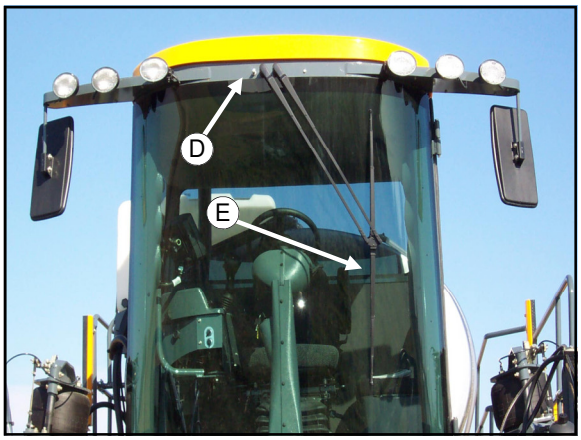
The windshield wiper switch (A) located on the right side of the cab headliner operates the windshield wiper (E). The wiper will continue to operate until the switch is returned to the OFF position. Replace the 39 inch wiper blade as necessary.

To activate the washer fluid pump, press the washer fluid switch (B) and hold until the desired amount of fluid is dispensed and then release the switch. You must turn the wiper OFF when the fluid has been completely wiped away. The washer fluid reservoir is located behind the cab (C).

The fluid spray nozzle (D) is adjustable. The fluid spray pattern should be checked at the beginning of each season and adjusted as necessary.







MD3 OPERATING INSTRUCTIONS

Toggling Between Menu Screens

To navigate from the Home Page to the Main Menu (A), press the Menu button (B) in the lower right hand corner of the display face.

Use the Cancel/Home button (C) to go back one page at a time while in the Adjust, Measure, Preferences, and Info menus.

Use the “F” buttons (D) to select the group or menu from the Main Menu page. Also use them while in the menu for prompted requests.

Use the Cancel/Home button to go back to the Home Page from the Main Menu.

Adjusting the Display Lighting

To adjust the lighting of the display:

1. Press the Menu button (B). The Main Menu will appear.
2. Press the F3 button (C) under “Preferences”
3. Press the F1 button under “Display”
4. Press the F2 button under “Backlight” to change the lighting or press the F3 button under ”Screen Saver” to adjust the time that the screen is lit to its full intensity.
5. Toggle with the Up and Down arrow buttons (D) to desired level and then press the OK button (E) to accept the change.

Machine Hours

The second page of the MD3 is titled “Machine Hours” and can be found by using the Down Arrow (A) key to toggle to the next page from the Home Page.

This page is a service tool for operators to use to set and track service intervals. There are several things that need to be serviced at specific intervals and you will see these intervals on this page (50 hrs, 100 hrs, 500 hrs, etc.). Please refer to the service section of this manual for details regarding on what parts of the machine need serviced and the procedure to perform the service at each interval.

Some of the service intervals can be adjusted to suit your schedule if you do not want to wait as long as possible to perform some of the services, such as oil and filter servicing. The default on the Machine Hours page is the recommended practices of the engine manufacturer, however, these practices are also discussed as being fairly loosely interpreted based on how the machine is used and they can be done on shorter intervals than what is recommended. The default will not be able to be extended past the recommendation.

When a service interval is reached, a “manual” icon (B) will appear at the top of the Home Page and a message telling you that a service interval has been reached (C). The message will disappear by pressing F2, but the icon will remain at the top of the page until the hours of the interval have been reset.

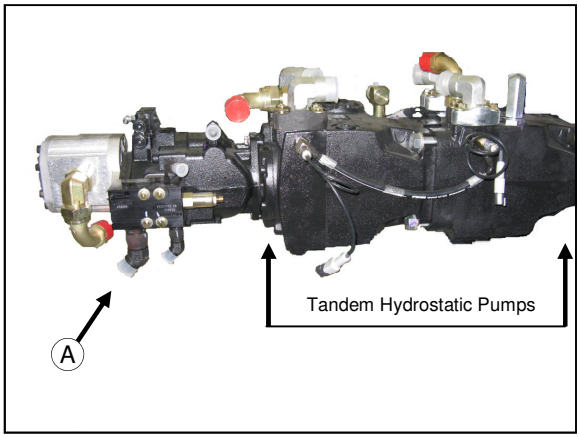
HYDRAULIC SYSTEM

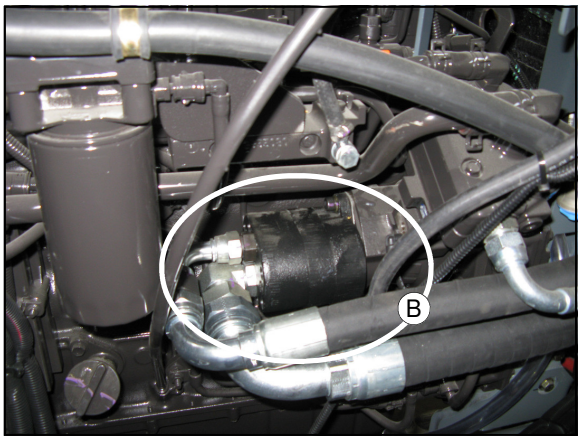
Hydraulic System Components

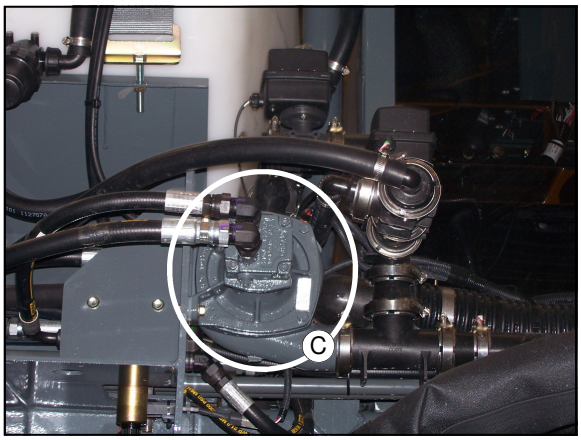
A. Hydraulic pump

B. Gear pump

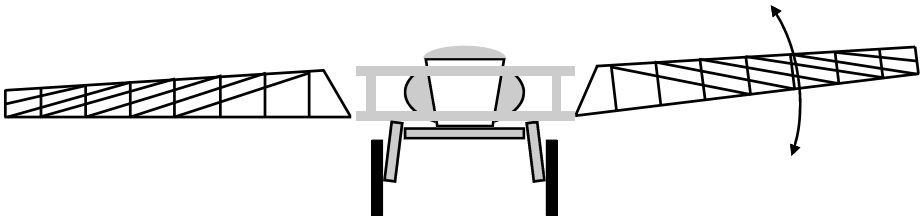
C. Solution pump







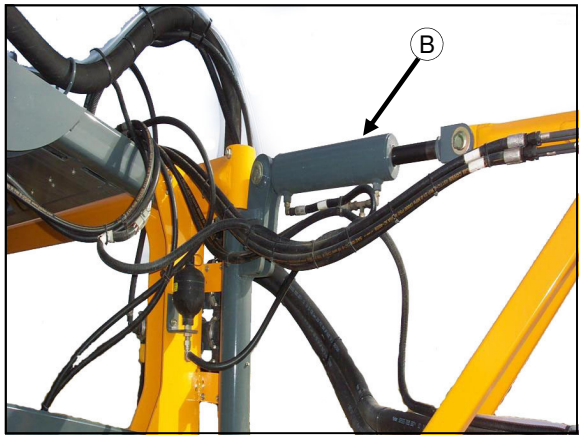
continued on next page



Level

To increase or decrease the angle of the individual boom levels, depress the right or left "round rocker" UP or DOWN on the hydrostatic lever (A). While depressed, these buttons activate the level cylinders connecting either boom to the transom (B).

This adjustment also aids in placing the booms correctly n the cradles for transporting and storage.



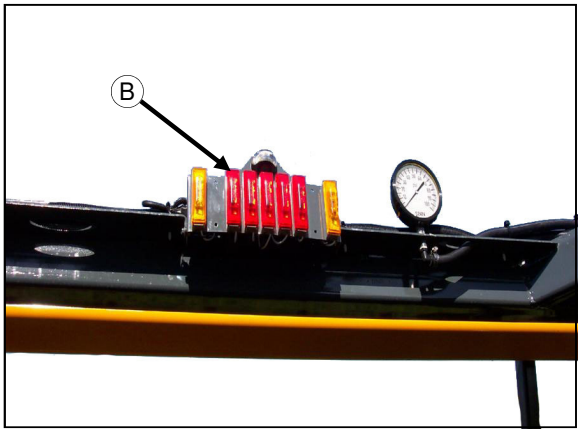
Individual Boom Solution Valve Switches

The spray booms are divided into sections that are independently supplied with solution and can therefore be shut off or turned on independently. The hydro-electric boom solution valves are controlled by a row of switches mounted on the right hand console (A).

Sixty foot boom configurations are divided into three sections and the valves are mounted on the transom. Eighty and ninety foot booms are divided into five sections with three of the valves mounted on the transom and one on each boom.

Boom Solution Valve L.E.D. Indicators

Boom solution valve status is displayed on the transom by a series of L.E.D. indicators (B). Each indicator will illuminate if that particular boom solution valve is turned **OFF.**



FOAM MARKER SYSTEM

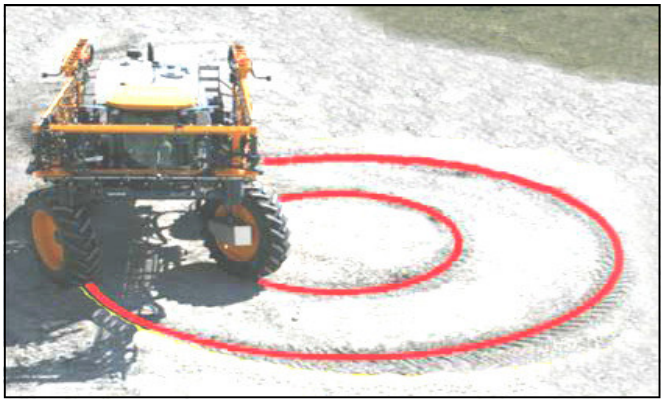
Filling the Foam Marker Tank

1. Relive the pressure from the foam marker tank by opening the ¼" ball valve on the side of the foam marker tank (B).
2. Close the ball valve after the pressure is relieved.
3. Open the top 2" ball valve (A).
4. Add water to the tank, leaving enough room for the foam concentrate.
5. Next add the foam concentrate according to the label on the container.
6. After filling is complete, close the 2" ball valve on the top of the tank.
7. Start the sprayer 's engine and adjust the air pressure accordingly (see previous page).

Caution: Before performing any service on or refilling of the foam marker, shut the engine off and relieve system pressure from the tank.

Warning: DO NOT stand directly over or in front of the valves when opening.

ALL WHEEL STEER ⚠



Introduction

It is very important that you study this section if AWS (All Wheel Steer) is installed on the machine.

The AWS system is set up to keep the machine safe, however, each driver's experience behind the wheel of a Hagie Machine may be different. Hagie Manufacturing Company strongly suggests driving a machine in Conventional Steer initially to get a feel of the machine. Get a feel for how different the machine turns at different speeds and at different steering angles in both forward and reverse. It would probably be in your best interest o make sure you are very comfortable in driving the machine on the road and in the field, with the booms in the transport position and in the spray position, and by doing a lot of different turning scenarios before attempting to drive the machine with the AWS.

After all of the test driving is done and you feel comfortable with the machine, you can begin to understand how to put the machine into an AWS state. Hagie Manufacturing uses the term "Coordinated Steering" to describe the AWS feature. Coordinated Steering refers to the situation created when the front wheels turn one direction and the rear wheels turn in the opposite direction to create tighter turn angle and allow the rear wheels to follow the front wheel tracks. Coordinated Steering should make turning more efficient and less damaging to your crops.

Coordinated Steering mode (AWS) needed to be limited in relation to speed, and you will notice that the new "LOW" gear allows for this limitation. If the machine is above the first gear (speed range), the AWS system will not engage (even if speed is less in a higher gear at times). You will want to see how this works in a wide open and flat area first so you can understand what to expect.

⚠ Operators with machines equipped with All Wheel Steer pay special attention!

RAVEN SPRAY CONTROL CONSOLE

NOTICE

THIS IS JUST A GUIDE TO GET STARTED! REFER TO THE RAVEN INSTALLATION MANUAL FOR MORE INFORMATION AND TROUBLE SHOOTING.

Momentarily depressing the **CE** key is similar to using an arrow key to scroll through menu selections.

Initial Contrast Adjustment

Use the ▲ 1 key to lighten or the ▼ 2 key to darken the contrast.

Press the **Enter** key when done.

Acre-US, Hectare-SI or Turf– SQ Feet

Depress **CE** until the unit of measure desired is displayed. Momentarily depress **Enter** to select.

Continued on next page

RAVEN SPRAY CONTROL CONSOLE

NOTICE

THIS IS JUST A GUIDE TO GET STARTED! REFER TO THE RAVEN INSTALLATION MANUAL FOR MORE INFORMATION AND TROUBLE SHOOTING.

Product Low Offset

Depress ▼ 2 the until the **LOW OFFSET** is highlighted.

Press **Enter** to select.

Change the number to **60**. This indicates the slowest rate in which the solution valve will function.

Tank Volume

Depress the **VOLUME TANK 9** to set the tank volume.

Depress **Enter** to select.

Enter the amount of solution in the tank.*

Depress **Enter** to select.

*This measure must be accurate. Re-enter every time you fill the tank.

The initial programming is now complete. You may have to refine some of the numbers to better suit your unique situation. This is just a guide to get you started, these numbers may not be specific to your machine. We can not account for every individual situation.

SERVICE INTERVALS

Inspection Point	Action (if necessary)
Check	
Engine oil level	Add oil
Radiator coolant level	Add antifreeze solution
Engine drive belt	Replace belt
Filter Minder®	Replace air filter element/reset gauge
Hydraulic reservoir oil level	Add hydraulic oil
Solution line strainer	Remove and clean
Batteries	Clean and/or tighten
Radiator grille screen	Clean
Look for loose or missing items such as shields	Tighten or replace
Look for any fluid leaks on machine or ground	Determine cause and correct
Drain	
Fuel/water separator	See page 85-4
Wet tank/air tank	See page 115-2

SERVICE: FILTERS

Other Strainers

Poly Rinse Tank Strainer– If you have the pressure washer option on your sprayer you will have a 100 mesh strainer in the line from the rinse tank to the pressure washer (refer to Hagie Parts Manual for location). Check the strainer for blockage if you are unable to get pressure.

Rinse Strainer– The poly tanks have a 150 PSI (32 mesh) strainer in the line from the rinse valve to the solution tank rinse. If you are experiencing issues with pressure through your rinse cycle, you may check this strainer.

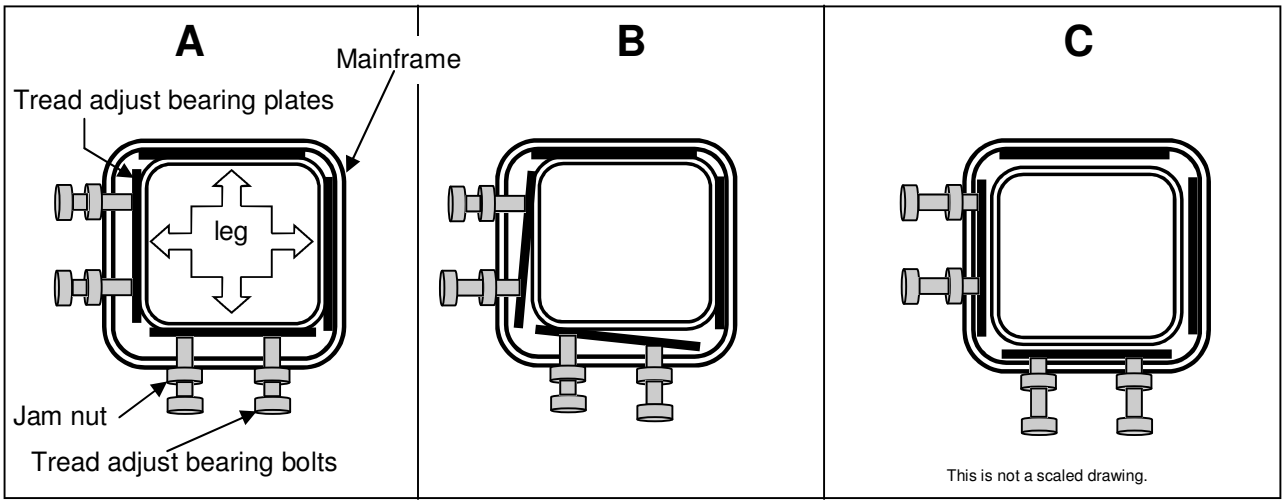
Solution Line "Y" Strainer– To help maintain consistent application rates, check the solution line strainer (A) daily for blockage. Clean the strainer screen as required. Be sure to wear appropriate clothing while removing and cleaning the line strainer screen. Confirm the gasket is in place before re-installing the screen.

Check all strainers occasionally for blockage and replace them if they show signs of deterioration. Refer to the Hagie Parts Manual for replacement part numbers and specific locations.

SERVICE: BOLT TORQUE

Hydraulic Tread Adjust Units

Even pressure of the tread adjust bearing plates is required for proper operation! Figure A shows the correct position of the tread adjust bearing plates and bolts as well as the outer leg. Figure B shows the plates when there is not even torque on each of the tread adjust bearing bolts. Figure C shows a situation in which there is not enough torque on the tread adjust bearing bolts. Both figure B and C will cause the tread adjust to operate incorrectly or not at all.



TROUBLESHOOTING

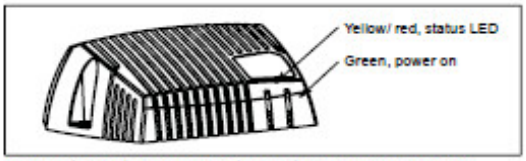
PROBLEM	POSSIBLE CAUSE	SUGGESTED REMEDY
Solution pump will not prime	• Low water level in pump	• Make sure the solution tank is not empty, solution pump is self -priming
	• Air leak in suction line	• Inspect and tighten all fittings on suction line
	• Solution tank valve closed	• Open solution tank valve, allow air to leave the system
Erratic reading on pressure gauge	• Orifice in back of gauge clogged	• Remove gauge; clean orifice; reinstall
	• Faulty gauge	• Replace gauge
	• Air leak in suction line	• Inspect and tighten all fittings in suction line
	• Glycerin leaking from gauge	• Replace gauge
Malfunction of electric solution valve	• Faulty ground	• Clean and tighten ground
	• Dirty contact terminals	• Clean contact terminals
	• Separation in wire	• Check continuity and replace wire
	• Faulty switch	• Replace switch
	• Short in solenoid coil	• Replace valve
	• Bad valve	• Replace valve

INDEX

Appendix B

Error codes, messages and actions

If one of the following error is detected, a message will be presented on the display together with an error code on the module. In some cases, the module will turn off or at least shut down the outputs, to increase safety.

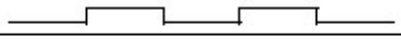


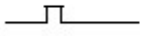
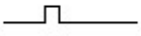
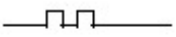
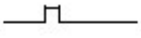
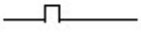
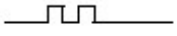
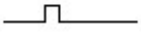
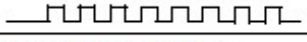
The location of the LED indicators on the IQAN-XA2 module.

OBSERVE
Don't use the machine if an error message or error code is activated.

The following sections will present what measures to take for different error situations put into appropriate context.

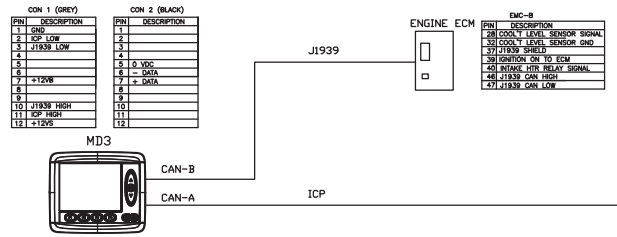
LED indicator showing different XA2 modes

Status	Flash
Normal operation (yel.)	

Error code	Error	Primary Flash (red) Error category	Secondary Flash (yellow) Error description
1:n	See note [a]		
2:n	See note [a]		
3:1	CAN error		
3:2	Address error		
4:1	Memory error[b]		
FE	Fatal error		

a. Error groups 1:n and 2:n are controlled by the master.
b. FRAM memory error.

CAN ARCHITECTURE 2010 STS10 & 12



CON 1 (GREY)

PIN	DESCRIPTION
1	GND
2	ICP LOW
3	J1939 LOW
4	
5	
6	
7	+12VB
8	
9	
10	J1939 HIGH
11	ICP HIGH
12	+12VS

CON 2 (BLACK)

PIN	DESCRIPTION
1	
2	
3	
4	
5	0 VDC
6	- DATA
7	+ DATA
8	
9	
10	
11	
12	

ENGINE ECM

EMC-B

PIN	DESCRIPTION
28	COOL'T LEVEL SENSOR SIGNAL
32	COOL'T LEVEL SENSOR GND
37	J1939 SHIELD
39	IGNITION ON TO ECM
40	INTAKE HTR RELAY SIGNAL
46	J1939 CAN HIGH
47	J1939 CAN LOW

CAB MOD 1 (XS2-A0)

PIN	DESCRIPTION	PIN	DESCRIPTION
1		22	
2		23	
3		24	VIN, 90° FOLD IN SIGNAL
4		25	VIN, 90 FOLD OUT SIGNAL
5		26	CAN HIGH IN
6		27	CAN HIGH OUT
7		28	12 VDC
8	NORAC CANCEL	29	-VREF
9		30	DIN, LR TREAD IN SIGNAL
10	VIN, LF TREAD IN SIGNAL	31	DIN, RF TREAD OUT SIGNAL
11	VIN, LF TREAD OUT SIGNAL	32	VIN, RF TREAD IN SIGNAL
12	VIN, LR TREAD OUT SIGNAL	33	NORAC LOCK VLV INPUT
13	VIN, CRUISE CON SIGNAL	34	NORAC LIFT UP INPUT
14		35	NORAC LIFT DOWN INPUT
15	GROUND	36	
16	DIN, NUTRAL SW	37	
17	DIN, PARK BRAKE SW	38	VIN, 120°FOLD IN SIGNAL
18	DIN, THROTTLE INCREASE	39	VIN, 120°FOLD OUT SIGNAL
19	DIN, THROTTLE DECREASE	40	CAN LOW IN
20	DIN, RR TREAD OUT SIGNAL	41	CAN LOW OUT
21	DIN, RR TREAD IN SIGNAL	42	+VREF

CAB MOD 2 (XS2-A1)

PIN	DESCRIPTION	PIN	DESCRIPTION
1		22	DOUT, AGITATION VLV CLOSE
2	DOUT, SPRAY ON	23	DOUT, TANK RINSE VLV
3		24	SPRAY SEC'N 10
4		25	AUTO STEER IN SIGNAL
5		26	CAN HIGH IN
6		27	CAN HIGH OUT
7	ALL-WHL STR OUT SIGNAL	28	12 VDC
8		29	
9	DOUT, AGITATION VLV OPEN	30	SPRAY SEC'N 7
10	VIN, LEFT FENCE ROW	31	SPRAY SEC'N 8
11	VIN, RIGHT FENCE ROW	32	SPRAY SEC'N 9
12	VIN, AGITATION OPEN	33	DIN, BOOM RINSE SW
13	VIN, AGITATION CLOSE	34	DIN, TANK RINSE SW
14		35	DIN, SOLUTION TANK VLV
15	GROUND	36	DOUT, BOOM RINSE VLV
16	SPRAY SEC'N 1	37	DOUT, SOL'N TANK VLV
17	SPRAY SEC'N 2	38	
18	SPRAY SEC'N 3	39	
19	SPRAY SEC'N 4	40	CAN LOW IN
20	SPRAY SEC'N 5	41	CAN LOW OUT
21	SPRAY SEC'N 6	42	+VREF, FENCE ROW SW

CHASSIS MOD 1 (XT2-A0)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	VIN, PT5
2	DOUT, BACK UP ALARM	23	VIN, OIL TEMP SENSOR
3	E-BRAKE	24	VIN, FUEL SENSOR
4	DOUT, DETASSLER VLV	25	VIN, OIL LEVEL SW
5	MAIN FOAMER VLV	26	
6	LEFT FOAMER VLV	27	CAN HIGH OUT
7	RIGHT FOAMER VLV	28	12 VDC
8		29	
9		30	CAN LOW IN
10		31	COUT, DP1/2 REV
11		32	COUT, DP1/2 REV -RET
12	+VREF	33	
13	-VREF	34	
14	ID TAG	35	
15	GROUND	36	
16	CAN HIGH IN	37	FIN, RR SPEED SENSOR
17	COUT, DP1/2 FWD	38	FIN, LR SPEED SENSOR
18	COUT, DP1/2 FWD +RET	39	
19		40	
20		41	CAN LOW OUT
21	VIN, PT4	42	

CHASSIS MOD 2 (XA2-A0)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	DOUT,LR TREAD ADJ-IN
2	DOUT, RR SHIFT VLV	23	RR TREAD-OUT
3	COUT, LR STRG-TOP/BOT	24	LR POSITION SENSOR
4	COUT, RR STRG-TOP/BOT	25	VIN, RR POS SENSOR
5		26	CAN HIGH IN
6		27	CAN HIGH OUT
7		28	12 VDC
8	DOUT,BRAKE VLV SIGNAL	29	
9	DOUT,LR TREAD ADJ OUT	30	
10	VIN, PT6	31	COUT, LR STRG TOP -RET
11	VIN, PT7	32	COUT, RR STRG TOP -RET
12	VIN, LR POS SENSOR	33	
13	VIN, RR PROX SENSOR	34	
14	ID TAG	35	
15	GROUND	36	DOUT, RR TREAD ADJ IN
16		37	DOUT, LR SHIFT VLV
17	COUT, LR STRG BOT+RET	38	
18	COUT, RR STRG BOT+RET	39	
19		40	CAN LOW IN
20		41	CAN LOW OUT
21		42	

CHASSIS 3 (XS2-A2)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	DOUT, RF TREAD ADJ OUT
2		23	DOUT, RF TREAD ADJ IN
3		24	
4	NTB SPRAY #3	25	
5	DOUT, HID AUX LIGHT	26	CAN HIGH IN
6	DOUT, LF SHIFT VLV	27	CAN HIGH OUT
7	DOUT, RF SHIFT VLV	28	12 VDC
8	DOUT, LF TREAD ADJ OUT	29	
9	DOUT, LF TREAD ADJ IN	30	
10	VIN, LF POS SENSOR	31	
11	VIN, RF POS SENSOR	32	
12	VIN, PT1	33	
13	VIN, PT2	34	
14	ID TAG	35	
15	GROUND	36	DIN, BRAKE LTS
16		37	NTB SPRAY #2
17		38	
18	DIN, IMPLT ID BIT 1	39	
19	DIN, IMPLT ID BIT 2	40	CAN LOW IN
20	DIN, IMPLT ID BIT 3	41	CAN LOW OUT
21	DIN, IMPLT ID BIT 4	42	

BOOM MOD 1(XA2-A3)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	DOUT, MAIN SPRAY LT
2	COUT, TRANSOM UP/DOWN	23	
3	COUT, LEFT FOLD IN/OUT	24	
4	COUT, LEFT FOLD UP/DWN	25	
5	COUT, 90° FOLD IN/OUT	26	CAN HIGH IN
6	COUT, RIGHT FOLD IN/OUT	27	CAN HIGH OUT
7	COUT, RIGHT FOLD UP/DN	28	12 VDC
8	DOUT, CHARGING VLV	29	
9	DOUT, LOCK VLV	30	COUT, TRANSOM DWN -RET
10		31	COUT, FOLD OUT-RET
11		32	COUT, FOLD UP +RET
12		33	COUT, 90° FOLD OUT -RET
13		34	COUT, RIGHT FOLD OUT-RET
14	ID TAG	35	COUT, RIGHT FOLD UP+RET
15	GROUND	36	
16	COUT, TRANSOM UP +RET	37	
17	COUT, FOLD IN +RET	38	
18	COUT, FOLD UP -RET	39	
19	COUT, 90° FOLD IN +RET	40	CAN LOW IN
20	COUT, RIGHT FOLD IN+RET	41	CAN LOW OUT
21	COUT, RIGHT FOLD DN-RET	42	

BOOM MOD 2 (XS2-A4)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	DOUT, SPRAY IND LT 3
2	DOUT, SPRAY SECN VLV1-LEFT	23	DOUT, SPRAY IND LT 4
3	DOUT, SPRAY SECN VLV2-LEFT	24	
4	DOUT, SPRAY SECN VLV3-CTR	25	
5		26	CAN HIGH IN
6	DOUT, SPRAY SECN VLV1-CTR	27	CAN HIGH OUT
7	DOUT, SPRAY SECN VLV1-RIGHT	28	12 VDC
8		29	
9		30	
10		31	
11		32	
12		33	
13		34	
14	ID TAG	35	
15	GROUND	36	DOUT, SPRAY IND LT 5
16		37	DOUT, SPRAY IND LT 6
17		38	
18		39	
19		40	CAN LOW IN
20		41	CAN LOW OUT
21		42	

BOOM MOD 3 (XS2-A5)

PIN	DESCRIPTION	PIN	DESCRIPTION
1	ID TAG	22	
2	DOUT, SPRAY SECN VLV1-RIGHT	23	
3	DOUT, SPRAY SECN VLV3-CTR	24	
4	DOUT, SPRAY SECN VLV1-RIGHT	25	
5	DOUT, SPRAY SECN VLV2-CTR	26	CAN HIGH IN
6	DOUT, LH FENCE ROW VLV	27	
7	DOUT, FENCE ROW VLV-RIGHT	28	12 VDC
8	DOUT, SPRAY IND LT 7	29	
9		30	
10		31	
11		32	
12		33	
13		34	
14	ID TAG	35	
15	GROUND	36	DOUT, LH FENCE ROW VLV
16		37	DOUT, FENCE ROW IND LT-RIGHT
17		38	
18		39	
19		40	CAN LOW IN
20		41	
21		42	

2010 STS10/12	PREP'D BY: DINDO IDIO	CONTENTS: IQAN MODULE ICP NETWORK LAYOUT			
	CHK'D BY: ALEX CASTILLO	APRV'D BY: BRYAN HRNICEK	DWG NO.	PG 9 OF 9	REV. 0

Product Information Bulletin

PIB: HY2009-004 A

Date: 01 September 2009, Update

PRODUCTS AFFECTED:	**SUBJECT:**
S90 Pumps	**Design and supplier change for shipping plugs**

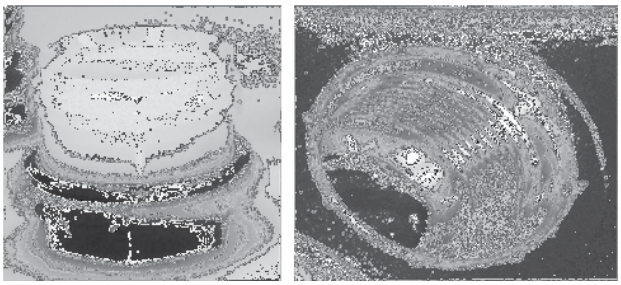
MODELS AFFECTED: All S90 Pumps manufactured in Ames, IA – 55, 75, 100 cc

Component	Plastic shipping plugs
Modified	Improved plug design
Date of introduction	12 October 2009
Customer Action	Note the change in hex sizes and ensure proper tooling is present on assembly line.

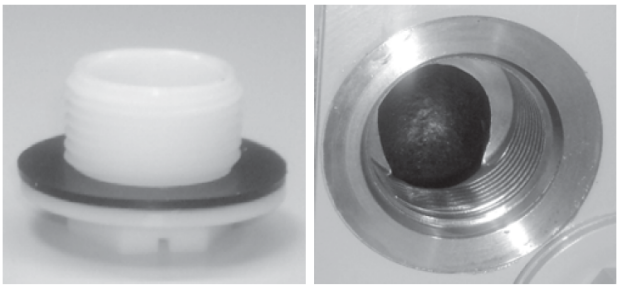
As a product quality improvement, Sauer-Danfoss is changing the design of the shipping plugs used on all S90 pumps manufactured in Ames, IA. The current plug design uses a nubbed flange with an o-ring seal on the port chamfer. The new plug design utilizes a wide smooth edged flange that seals with a flat rubber gasket along the spot face of the port. The smooth edge provides a clean paint break and greatly minimizes the potential for paint tear during plug removal.

The new plugs are presently used with PVG valves made at the Easley facility and the H1 team recently made the change to the new plug design.

Old – Was



New – will be



	Current Plug	**New Plug**
Port Size	**Hex Size**	**Hex Size**
7/8”	3/4”	1-1/16”
1 5/16”	1-1/16”	1-1/16”
1 5/8”	1-1/8”	1-3/16”

APPLICATION

Advantages of the KVE are;

- Reduction in deceleration rollout characteristics
- Optional input currents (part number specific)
- Uses no loctite, which eases repair and internal parts replacement

The KVE is intended as a direct replacement for the MCV111. But when 2 or more EDC are used in a vehicle propel application they should all be of one type or the other, don't mix them for reasons as described in this application section.

The KVE and MCV use a torque-motor based electrical actuator scheme that is designed to work with a current (dc mA) signal, i.e., 75 mA will produce the same pump flow every time. However, the KVE and MCV have different electrical coil arrangements, resulting in the following precautions:

- Both are dual coil, but have different coil values (KVE 16 Ω and 20 Ω/MCV 25 Ω and 25 Ω). This may cause problems in applications where there is a mix of KVE and MCV, they are controlled simultaneous and electrically tied together in a parallel arrangement. In those parallel circuits the KVE pump will be stroked ahead of the MCV by approximately 25%. Therefore to ensure that KVE and MCV pumps stroke at the same rate use a series electrical connection, which will ensure that all EDCs receive the same electrical current.

- The MCV coils are arranged on a T-bar-style armature. This allows the coils to be physically separated by a small air gap. The KVE coils are arranged on a stand-up style armature (which is the same used on all other dual coil EDCs and servovalves) and they are stacked one atop the other. In some rare instances, this may induce current changes resulting from the magnetic effects of one coil on another (see Precautions When Driving Dual Coil PCPs With A PWM Drive). Contact Sauer-Danfoss for applications concerns.

KVEBXXXXX REPLACES KVEAXXXXX

The new control will be identified by a new letter in the control part number. The control will be designated KVEB, whereas the previous control p/n was designated as KVEA.

When servicing the new EDC, a different pilot valve part number will be required (as compared to the existing EDC) when replacement is necessary.

As a product improvement, design changes to the Series 90 Electric Displacement Control have been made:

1. Improvements in the area of the control spool and feedback mechanism.
2. Revisions in the nozzle area/clearance with related parts of the pilot valve.

These changes will not affect form or fit. In nearly all cases, function is not affected. There is one exception: When one side of the pilot valve is tapped to utilize the absolute pressure to pilot external devices such as a one line motor control (see details below).

1. Abnormal case drain pressures.
2. Oil cleanliness.

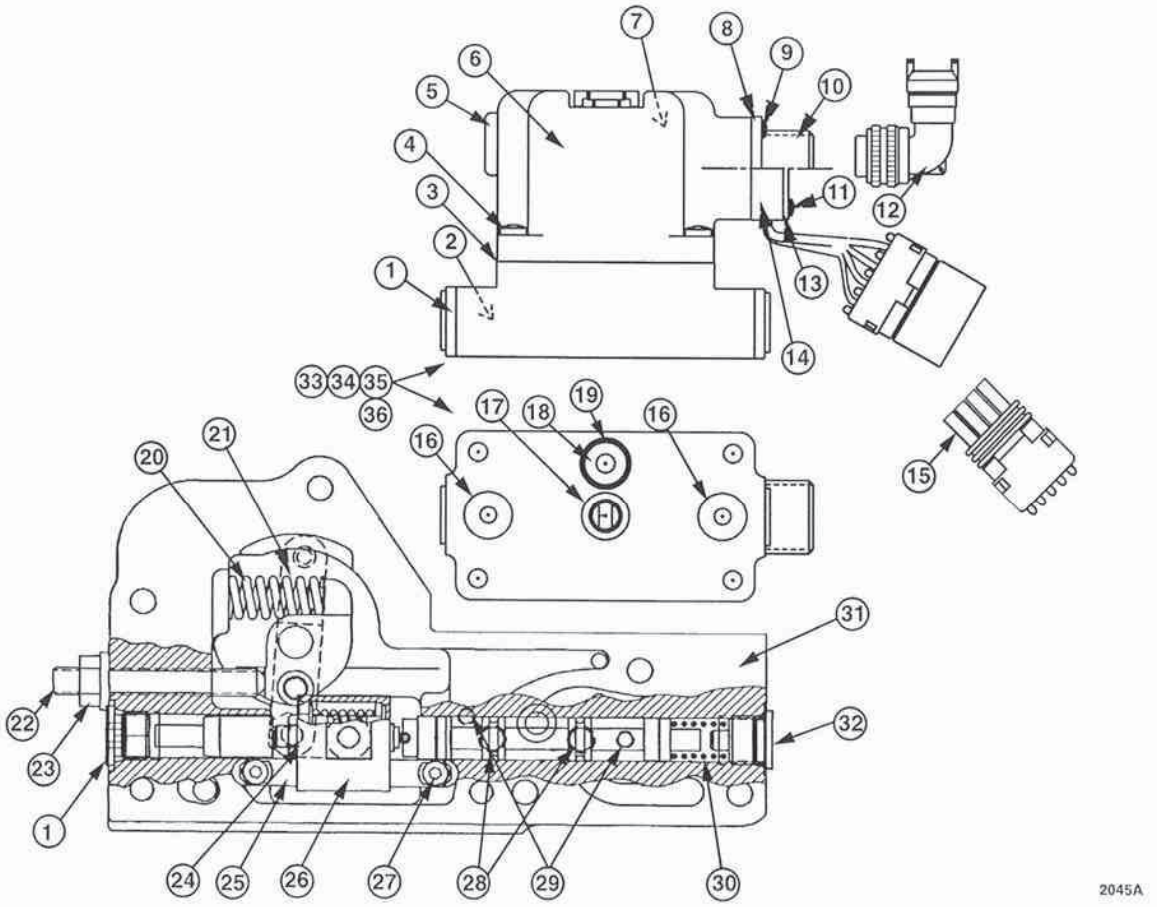
This change went into effect January 1, 1999. Various pump frame sizes may incorporate this change at different times dependent upon the manufacturing location and initial control availability.

One line motor controls: It is always best to use a two line motor control when phasing a variable motor hydraulically with a Series 90 pumps (via the X1 and X2 ports). Applications using only a one line hydraulic control rely on controlling the variable motor with pressure from only one of the EDC ports, either X1 or X2, but not both. The pump phasing in these applications will be adversely affected by this EDC change. Although the delta pressure (X1 - X2) versus coil current is not affected by this change, the individual gage pressures at X1 and X2 are significantly reduced. Depending on fluid temperature and viscosity, and the pump charge pressure setting, this reduction in gage pressures will be in the range of 60 - 80 psig (current range of 120 - 160 psig).

If no change is made to the motor control threshold, and/or ramp in a one-line controlled motor, the motor shift will not occur until coil current reaches much higher levels. In fact, it may not even be possible to fully shift the motor with any coil current level. Therefore, any applications phasing a one-line hydraulically controlled motor with a Series 90 pump with one of the above controls, the motor threshold and/or ramp levels must be changed, and coordinated with the timing of the Series 90 pump EDC change. In the case of Series 51 motors with one line controls, the threshold setting, and likely the threshold spring and ramp spring will have to be changed. Please contact Sauer-Danfoss Applications Engineering for assistance in determining the new motor specifications required.

Since the delta pressure versus coil current relationship is not affected by this nozzle change, the phasing of motors with two line controls (controls which change motor displacement based on the difference between X1 and X2) are not affected.

SERVICE PARTS *(continued)*



REFERENCE ITEMS IN SERVICE PARTS TABLE (SEE PAGE 15)

(1) **Item 35** has an internal scale factor (psid/mA) that is factory calibrated to a special second stage which yields 4-20 mA control.

(2) **Item 4.**

WARNING

DO NOT Remove Cover Screws, unless replacing cover.

(3) **Item 28.** All units are factory shipped without orifices installed, and are not recommended.

(4) **Items 4, 6, 8, 9, 10, 11, 13, 14.** The following steps are recommended when servicing those piece parts listed in Service Parts-Table A. (page 11).

Preferred service tools are:

- Screw driver TX 15 and TX 10
- Solder SN62
- Needle nose pliers, small tip
- Solder iron, electronic type
- Volt/ohm meter (VOM)
- Cleaning solvent, Chemtronics 2000 ES 1601
- Torque wrench, 0-50 in•lb (0-66 N•m)

REPLACING COVER AND/OR ELECTRICAL CONNECTOR

1. Wipe down external surface to ensure that loose contaminants will not fall inside the housing.
2. Place the valve in a firm position at 45° with the electrical connector tilted upwards (PCPs built after 1988 are filled with a silicon oil). Locate and remove the four connector screws in Item 7 if MS connector, or Item 9 if Packard connector.
3. Hold the electrical connector and untwist wires by rotating the connector CCW two turns while gently pulling away from the housing.
4. Clean the solder connections inside connection of the electrical connector with degreaser. Unsolder the wires noting which pin goes to which wire color (i.e., Pin A to black, Pin B to red, Pin C to brown, etc.). With the connector held firmly, place the solder iron against the base solder cup if MS, and pin if Packard, until the wires can be gently pulled away.
5. The cover can now be removed and replaced if required. Be sure the cover O-ring (Item 1) is firmly seated into the cover base and is in good condition before cover is installed. Torque cover screws to 8-10 in•lb (11-13 N•m).

SYMBOLS USED IN SAUER-DANFOSS LITERATURE

- WARNING may result in injury
- CAUTION may result in damage to product or property
- Reusable part
- Non-reusable part, use a new part
- Non-removable item
- Option – either part may exist
- Superseded – parts are not interchangeable
- Measurement required
- Flatness specification
- Parallelism specification
- External hex head
- Internal hex head
- Torx head
- O-ring boss port
- Tip, helpful suggestion
- Lubricate with clean hydraulic fluid
- Apply grease/petroleum jelly
- Apply locking compound
- Inspect for wear or damage
- Clean area or part
- Be careful not to scratch or damage
- Note correct orientation
- Mark orientation for reinstallation
- Torque specification
- Press in – press fit
- Pull out with tool – press fit
- Cover splines with installation sleeve
- Pressure measurement/gauge location or specification

The symbols above appear in the illustrations and text of this manual. They are intended to communicate helpful information at the point where it is most useful to the reader. In most instances, the appearance of the symbol itself denotes its meaning. The legend above defines each symbol and explains its purpose.

TEMPERATURE AND VISCOSITY

Temperature

The high temperature limits apply at the hottest point in the transmission loop, which is normally the motor case drain. Maintain system temperature below the quoted **rated temperature**.

Never exceed the **maximum intermittent temperature**.

Cold oil will generally not affect the durability of the transmission components, but it may affect the ability of oil to flow and transmit power; therefore temperatures should remain 16 °C [30 °F] above the pour point of the hydraulic fluid.
The **minimum temperature** relates to the physical properties of component materials. Size heat exchangers to keep the fluid within these limits. Test heat exchangers to verify that these temperature limits are not exceeded.

Viscosity

For maximum efficiency and bearing life, ensure the fluid viscosity remains in the **recommended range**.

Minimum viscosity should be encountered only during brief occasions of maximum ambient temperature and severe duty cycle operation.

Maximum viscosity should be encountered only at cold start.

LOW MOTOR OUTPUT TORQUE

Item	Description	Action
System pressure at motor	Low system pressure at the motor will reduce torque	Measure system pressure at motor. If pressure limiter setting is low, increase setting.
Variable motor stuck at minimum displacement	Minimum motor displacement yields low output torque.	Check control supply pressure or repair displacement control. Check motor control orifices.
Internal leakage	Internal leakage will reduce system pressure.	Check for leaking O-rings, gaskets and other fittings. Repair unit as required, or replace leaking unit.

IMPROPER MOTOR OUTPUT SPEED

Item	Description	Action
Oil level in reservoir	Insufficient hydraulic fluid will reduce motor speed.	Fill oil to proper level.
Pump output flow	Incorrect outflow will affect output speed. Incorrect output flow indicates the swashplate is out of position.	Measure pump output and check for proper pump speed. Ensure the pump is in full stroke.
Variable motor displacement control	If variable motor displacement control is not functioning correctly, variable motor swashplate may be in wrong position.	See if variable motor displacement control is responding. If not, repair or replace control.
Internal leakage	Internal leakage will reduce system pressure.	Check for leaking O-rings, gaskets, and other fittings. Repair unit as required, or replace leaky unit.

SYSTEM NOISE OR VIBRATION

Item	Description	Action
Oil in reservoir	Insufficient hydraulic fluid will lead to cavitation.	Fill reservoir to proper level.
Air in system	Air bubbles will lead to cavitation.	Look for foam in reservoir. Check for leaks on inlet side system loop and repair. Afterwards, let reservoir settle until foam dissipates. Run system at low speed to move system fluid to reservoir. Repeat.
Pump inlet vacuum	High inlet vacuum causes noise. A dirty filter will increase the inlet vacuum.	Inspect and replace filter as necessary. Check for proper suction line size.
Shaft couplings	A loose shaft coupling will cause excessive noise.	Replace loose shaft coupling or replace pump or motor.
Shaft alignment	Misaligned shafts cause noise.	Align shafts.

NON-LINEAR MANUAL DISPLACEMENT CONTROL (MDC)

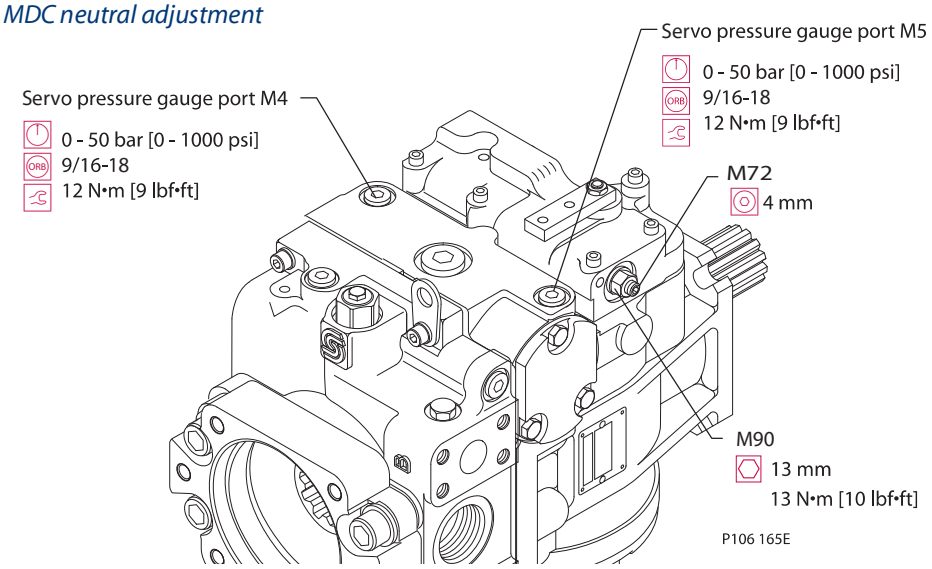
A centering spring, located on the control input shaft, locates the control shaft in its neutral position. A bias spring on the control spool maintains a force on the spool and the control linkage to eliminate free-play in the linkage.

Neutral adjustment is the only adjustment that can be made on the nonlinear manual displacement control. All other functions are preset at the factory. Perform neutral adjustment on a test stand or on the vehicle/machine with the prime mover operating.

⚠ Warning

Unintended movement of the machine or mechanism may cause injury to the technician or bystanders. To protect against unintended movement, secure the machine or disable/disconnect the mechanism while servicing.

MDC neutral adjustment



1. Install a 50 bar [1000 psi] gauge in each of the two servo cylinder gauge ports (M4 and M5). Disconnect the external control linkage from the control handle and make certain the control shaft is in its neutral position. Start the prime mover and operate at normal speed.

2. Loosen the lock nut (M90) on the neutral adjusting screw (M72) with a 13 mm hex wrench.

3. Using a 4 mm internal hex wrench, rotate the neutral adjusting screw clockwise until the pressure increases on one of the pressure gauges. Note the angular position of the wrench. Then rotate the adjusting screw counterclockwise until the pressure increases by an equal amount on the other gauge. Note the angular position of the wrench.

4. Rotate the adjusting screw clockwise half the distance between the locations noted above. The gauges should read the same pressure, indicating that the control is in its neutral position.

SHAFT SEAL AND SHAFT REPLACEMENT

You can replace the shaft and seal without major disassembly of the unit. Clean pump and surrounding area thoroughly. Disconnect and remove the pump from the unit, and clean it thoroughly before starting repairs. Mark all connections for later reassembly.

Shaft removal

1. Position the pump with the shaft facing up.

If the unit is positioned horizontally, or moved or jarred while the shaft is out, the cylinder block could move out of place, making shaft installation difficult.

2. Remove the three or four screws (L70) holding the retainer plate (L60) and seal carrier (L30) to the housing, using a 10 mm hex wrench (042 unit), a 5 mm internal hex wrench (055 through 100 units), or a 6 mm internal hex wrench (130 through 250 units). Remove the retainer plate.

Certain earlier production units use a one piece retainer plate and seal carrier.

3. After removing the screws, the spring force on the shaft may move the seal carrier out of its bore by approximately 5 mm [1/4 inch]. If the seal carrier does not move from its bore, pry it from its bore and/or lightly tap the end of the shaft with a soft mallet.

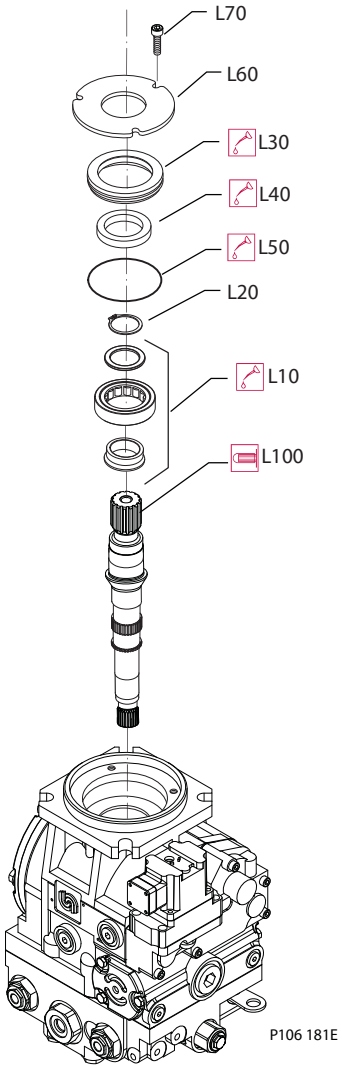
4. Remove the O-ring (L50) from the seal carrier and discard.

5. Place seal carrier and seal in an arbor press and press out the seal (L40).

6. Remove shaft (L100) and roller bearing assembly (L10) from pump. You can transfer the bearing assembly to the new shaft.

7. Using snap-ring pliers, remove the retaining ring (L20) that secures the roller bearing assembly. Remove the roller bearing assembly.

Shaft assembly



CHARGE PUMP (continued)

Intermediate production 75 cm³ and 100 cm³ pumps use the same charge pump coupling. Two keyways are provided in the coupling for the charge pumps used in these units. The rear keyway (with identifier groove) is used in 75 cm³ pumps. The front keyway (closest to the internally splined end of the shaft) is used in 100 cm³ pumps.

8. Install the charge pump coupling. The internally splined end of the coupling must engage the main pump shaft.

The outside diameter of the internally splined end of some early production charge pump couplings were chamfered. Early production end caps may not be machined to accept a non-chamfered coupling. Always use a chamfered charge pump coupling in pumps with the early endcap.

9. For pumps with an auxiliary mounting pad, install the auxiliary drive coupling.

10. For pumps with no auxiliary pad, install a new O-ring (J50) onto charge pump cover. (If an auxiliary pad is installed, an O-ring is not used on the cover.)

11. Carefully remove the alignment pin from the charge pump parts. Install the pin in its hole in the charge pump cover (J15) (see previous page for correct orientation) and retain with petroleum jelly. Install the cover (with alignment pin) into the end cap and aligned charge pump parts. (Take care not to damage the cover O-ring, if used.)

Caution

In order to avoid loss of charge pressure in pumps with an auxiliary mounting pad, always install the charge pump cover with the pad drain hole located on the same side of the end cap as the charge inlet port. Refer to the section *"Auxiliary Pad Installation"* for details.

12. Install the charge pump cover retainer (H70) and the six internal hex screws (H80). Torque the screws per the table at the right..

Retainer screw torque

Frame size	Torque
030 – 100	16 N•m [11.85 lbf•ft]
130 – 250	32.5 N•m [24 lbf•ft]

13. For pumps with auxiliary mounting pads, install the O-ring and auxiliary mounting pad adaptor onto the end cap. Refer to the corresponding section for instructions on auxiliary pad installation.

ADDING AN AUXILIARY PAD TO A PUMP PREVIOUSLY WITHOUT ONE

1. If installing an auxiliary pad kit on a pump that was previously without one, carefully remove the alignment pin from the charge pump parts.

2. Install the pin in its hole in the new charge pump cover (with hole for the auxiliary coupling) and retain with petroleum jelly.

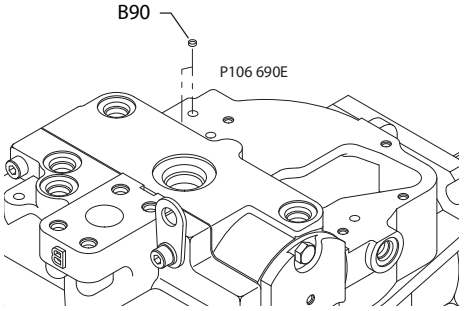
3. Install the new charge pump cover with alignment pin into the end cap and the aligned charge pump parts.

4. Lubricate and install O-ring. Install auxiliary pad. Refer to previous sections, *Auxiliary pad*, page 55, and *Charge pump*, page 56, for instructions.

DISPLACEMENT CONTROL FILTER SCREENS

If the pump is equipped with control filter screens in the pump housing (late production), press them into position (with the rounded edge of the filter screens facing the control) until they are flush to 2.0 mm [0.08 inch] below the surface of the housing.

Filter screen installation



SPEED SENSOR

Removal

1. Loosen the lock nut using a 11/16 in hex wrench.

2. Unscrew the speed sensor (B83) from the pump housing. Remove and discard the O-ring (B83A).

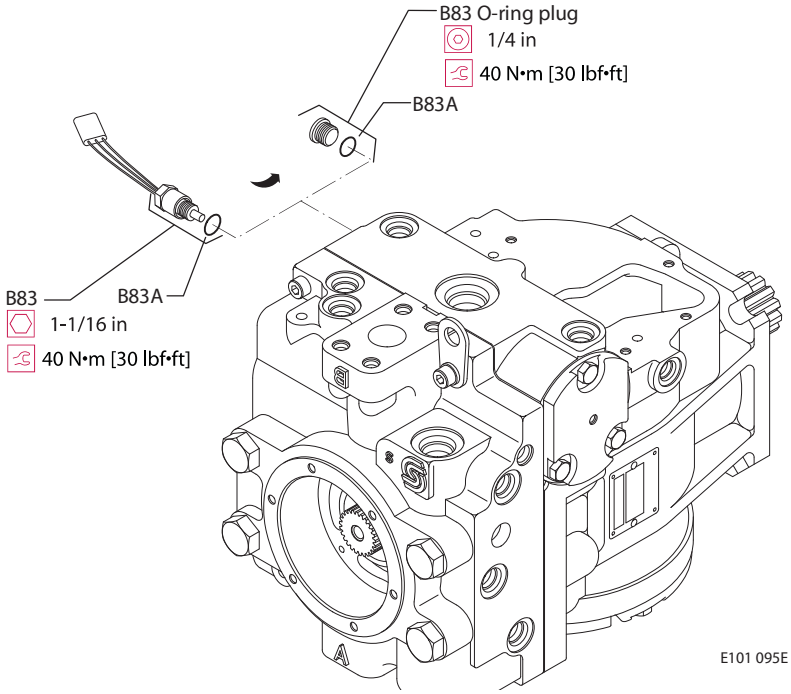
Reassembly

3. Install a new O-ring before reinstalling the sensor.

4. Reinstall the speed sensor (with lock nut and O-ring) into the housing. Adjust the gap between the sensor and the magnetic speed ring as instructed in *Speed sensor adjustment* (page 46) and torque the sensor lock nut to 13 N•m [10 lbf•ft].

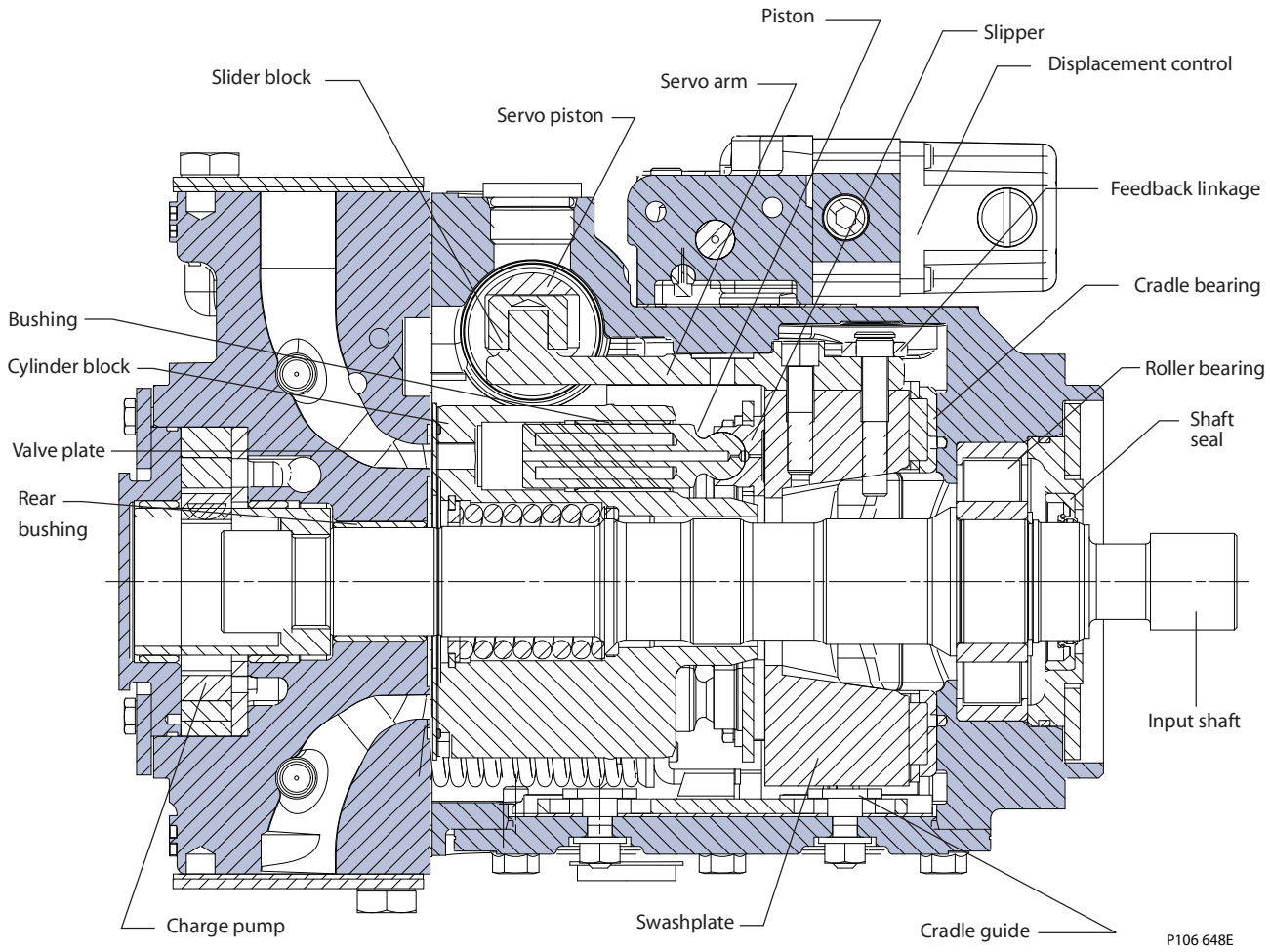
5. If a speed sensor is not installed, use a 1/4 in internal hex wrench to torque the housing plug (B83) to 40 N•m [30 lbf•ft].

Typical location of speed sensor

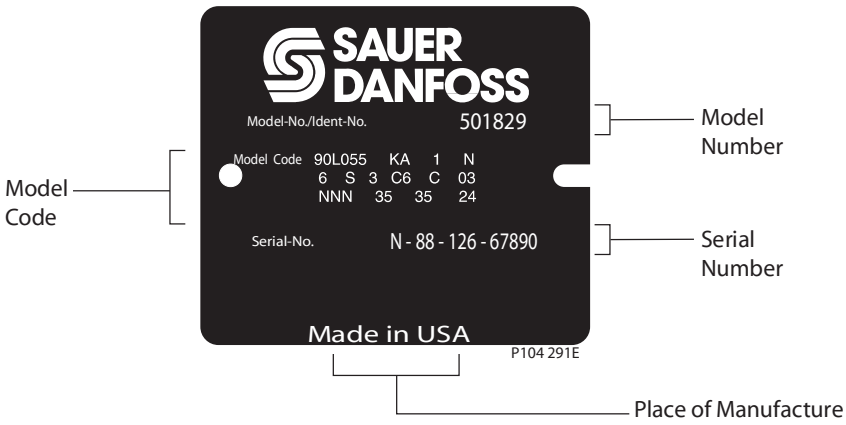


DESIGN

Series 90 pump cross-section



Name plate



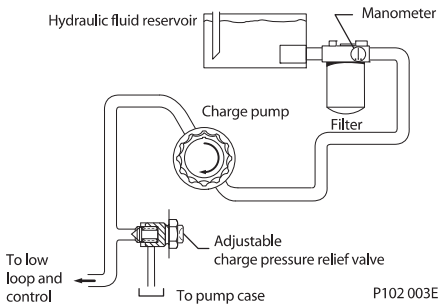
FILTRATION OPTIONS

Suction filtration – option S

The suction filter is placed in the circuit between the reservoir and the inlet to the charge pump, as shown below.

The use of a filter contamination monitor is recommended.

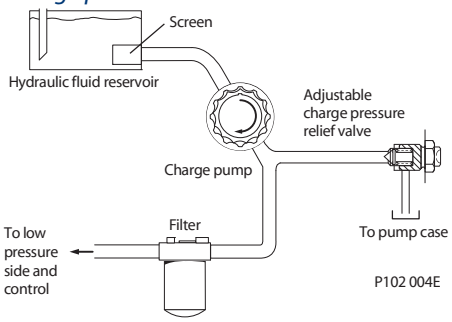
Suction filtration



Charge pressure filtration – option R, T, P, and L

The pressure filter can be mounted directly on the pump or mounted remotely for ease of servicing. A 100-125 µm mesh screen, located in the reservoir or the charge inlet line, is recommended when using charge pressure filtration. This system requires a filter capable of withstanding charge pressure.

Charge pressure filtration

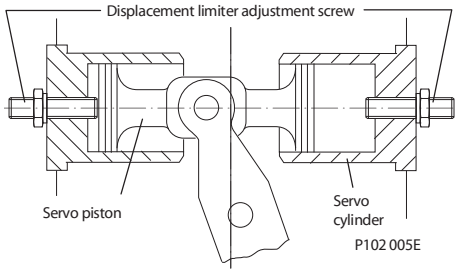


DISPLACEMENT LIMITER

All Series 90 pumps are designed with optional mechanical displacement (stroke) limiters.

The maximum displacement of the pump can be set independently for forward and reverse using the two adjustment screws.

Displacement limiter



Displacement limiter location

Pump rotation	Displacement limiter mounted on servo side	Displacement limitation at high pressure side
Right	1	A
	2	B
Left	1	B
	2	A

HYDRAULIC DISPLACEMENT CONTROL (HDC)

Operation

The hydraulic displacement control uses a hydraulic input signal to operate a 4-way servo valve, which ports hydraulic pressure to either side of a double acting servo piston. The servo piston tilts the cradle swashplate, thus varying the pump's displacement from full displacement in one direction to full displacement in the opposite direction.

The control has a mechanical feedback mechanism which moves the servo valve in relation to the input signal and the angular rotation of the swashplate. The hydraulic displacement control is designed so the angular position of the swashplate (pump displacement) is proportional to the hydraulic input signal pressure. Due to normal operating force changes, the swashplate tends to drift from the position preset by the machine operator. Drift, sensed by feedback linkage system connecting the swashplate to the control valve, activates the valve to supply pressure to the servo piston, maintaining the swashplate in its preset position.

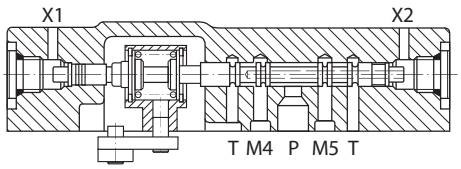
Features and benefits of the hydraulic displacement control:

- The hydraulic displacement control is a high gain control: With only small change of the input signal, the servo valve moves to a full open position porting maximum flow to the servo cylinder.
- Internal mechanical stops on the servo valve allow rapid changes in input signal pressure without damaging the control mechanism.
- Precision parts provide repeatable, accurate displacement settings with a given input signal.
- The swashplate is coupled to a feedback mechanism. The control valve drains the ends of the servo piston when an input signal is not present.
- Benefits:
  - Simple - low cost design.
  - Pump returns to neutral after prime mover shuts down.
  - Pump returns to neutral if there is a loss of input signal pressure or if there is a loss of charge pressure.

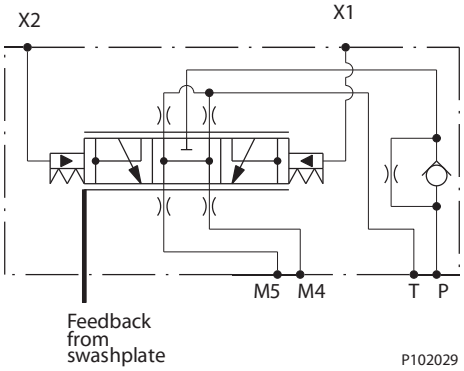
*Hydraulic signal pressure range**

a	3 ± 0.5 bar	[43 ± 6 psi]
b	11 ± 0.5 bar	[160 ± 6 psi]

Cross-section



Hydraulic displacement control schematic

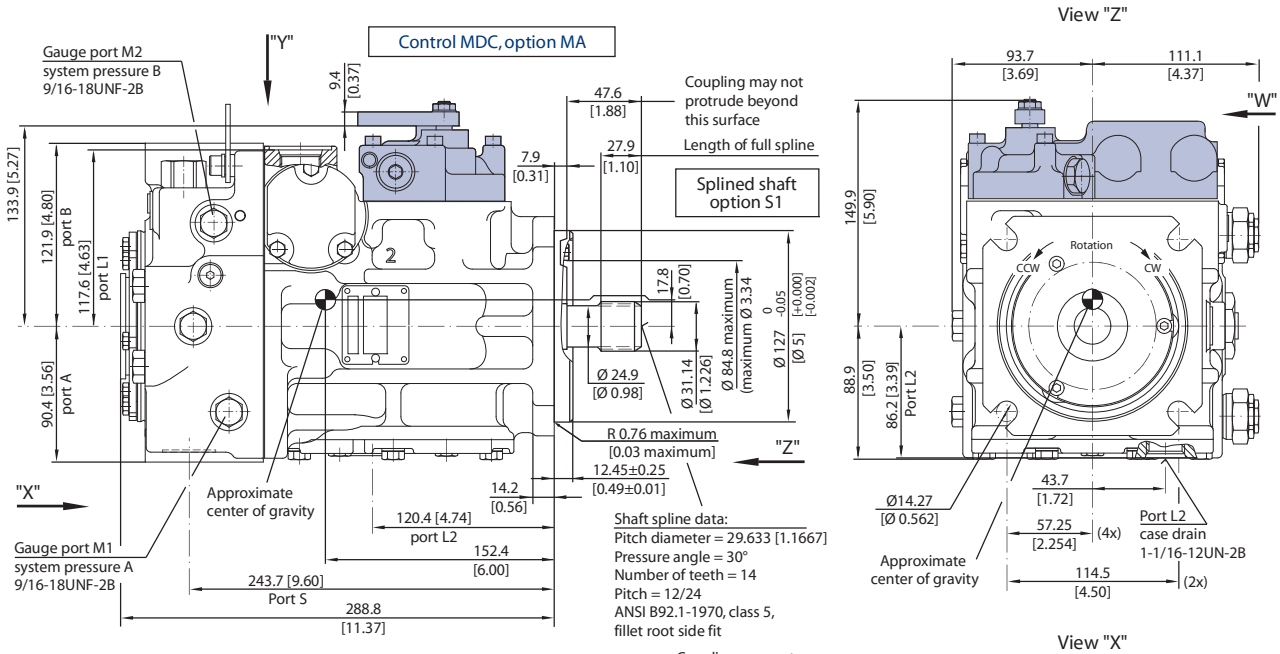


*see diagram page 27

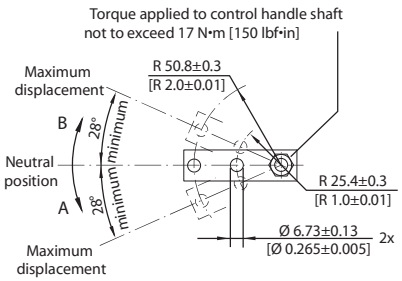
mm [in]

FRAME SIZE 055

Manual displacement control (MDC), endcap side ports, option 60



Manual Displacement Control Handle Dimensions



P102 042

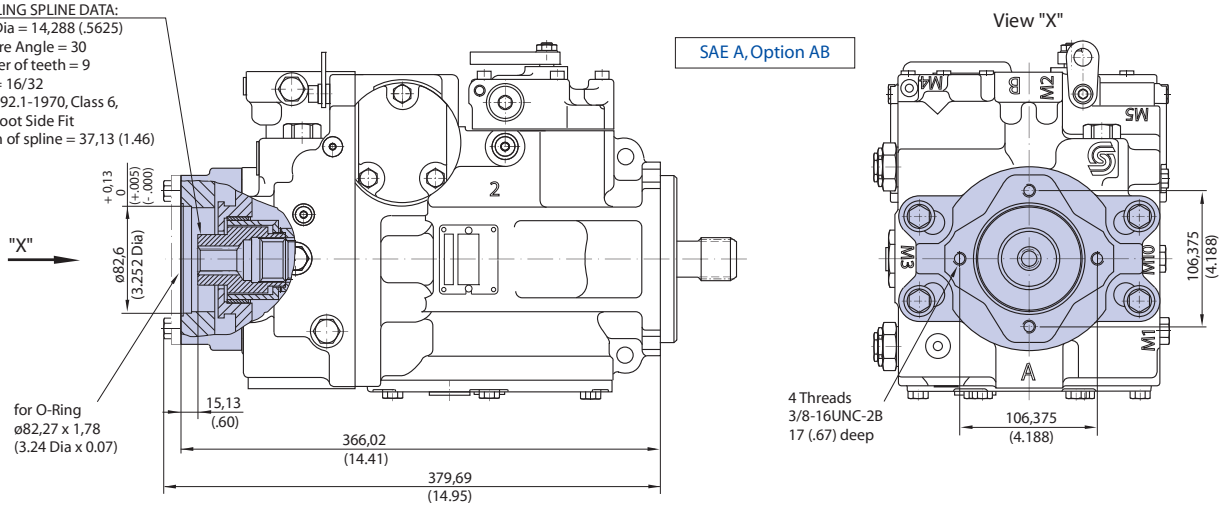
mm [in]

FRAME SIZE 100 (continued)

Auxiliary mounting pads, SAE AB, SAE BC, SAE CD

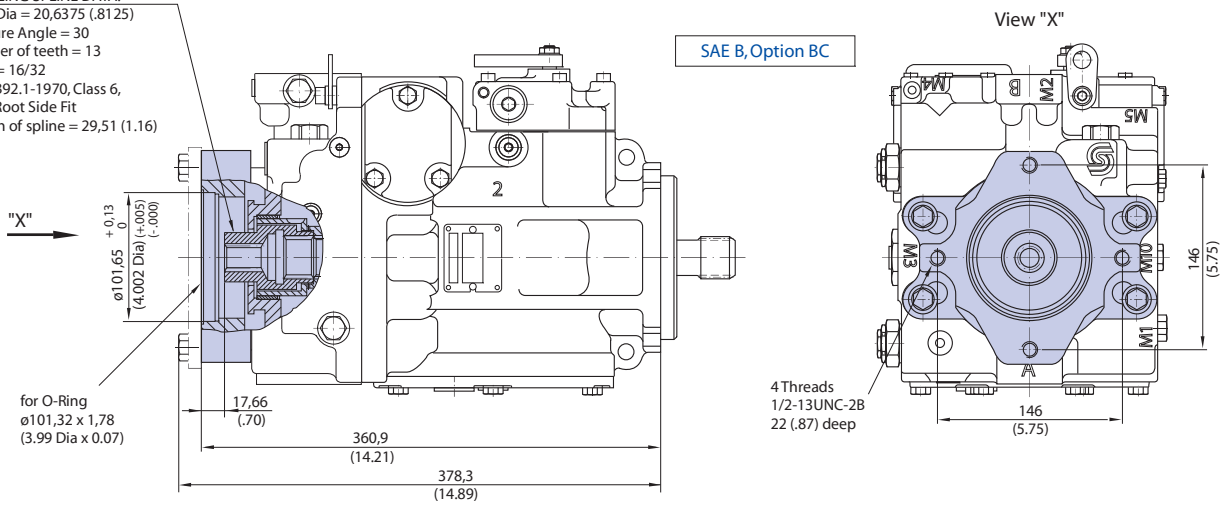
COUPLING SPLINE DATA:
Pitch Dia = 14,288 (.5625)
Pressure Angle = 30
Number of teeth = 9
Pitch = 16/32
ANSI B92.1-1970, Class 6,
Fillet Root Side Fit
Length of spline = 37,13 (1.46)

SAE A, Option AB



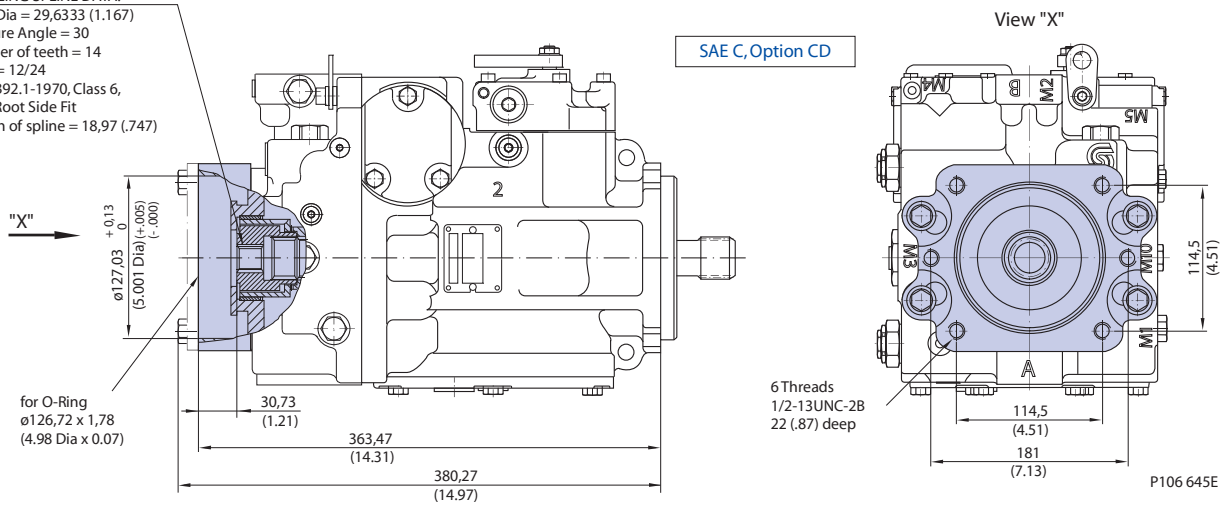
COUPLING SPLINE DATA:
Pitch Dia = 20,6375 (.8125)
Pressure Angle = 30
Number of teeth = 13
Pitch = 16/32
ANSI B92.1-1970, Class 6,
Fillet Root Side Fit
Length of spline = 29,51 (1.16)

SAE B, Option BC



COUPLING SPLINE DATA:
Pitch Dia = 29,6333 (1.167)
Pressure Angle = 30
Number of teeth = 14
Pitch = 12/24
ANSI B92.1-1970, Class 6,
Fillet Root Side Fit
Length of spline = 18,97 (.747)

SAE C, Option CD

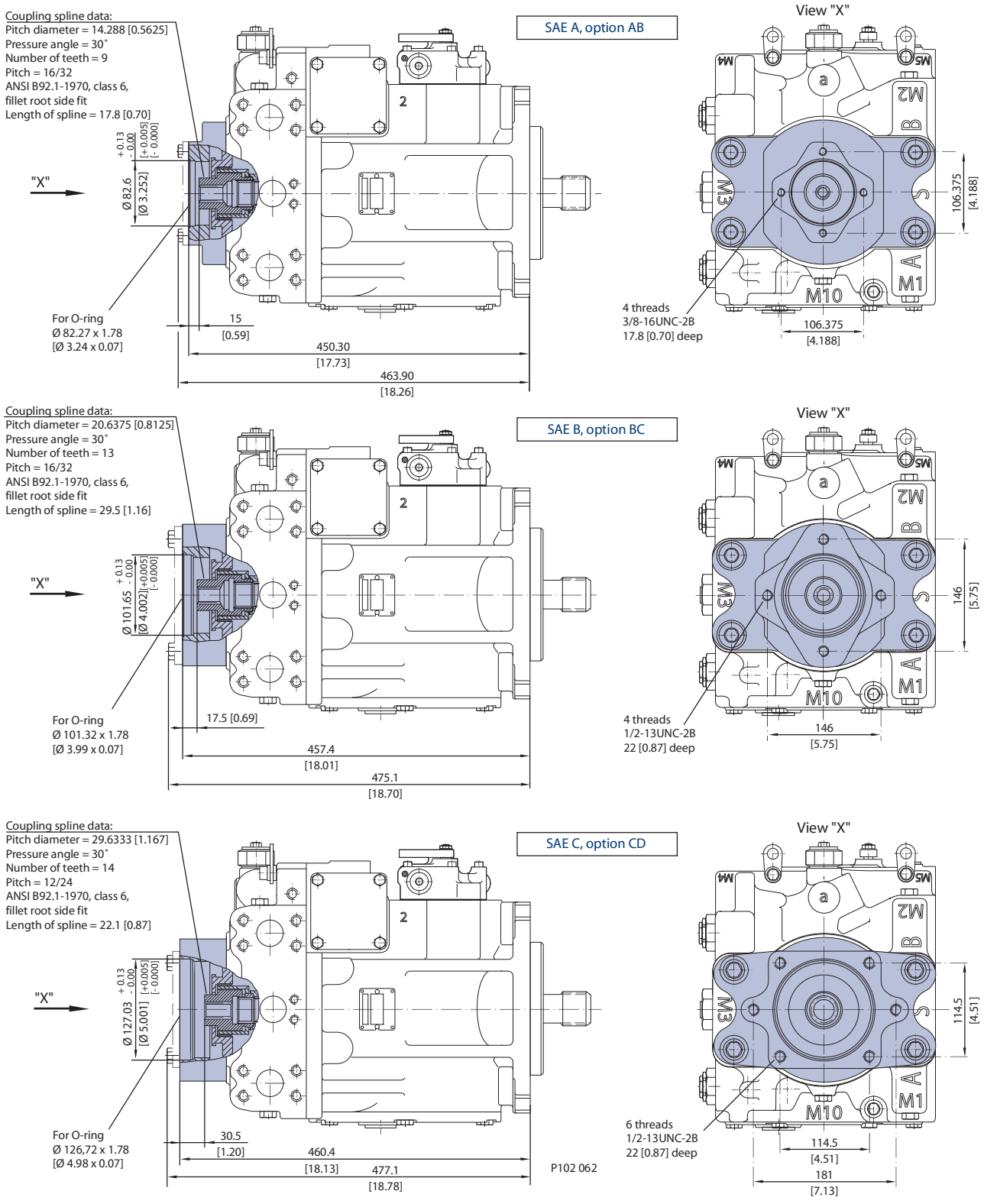


P106 645E

mm [in]

FRAME SIZE 250 (continued)

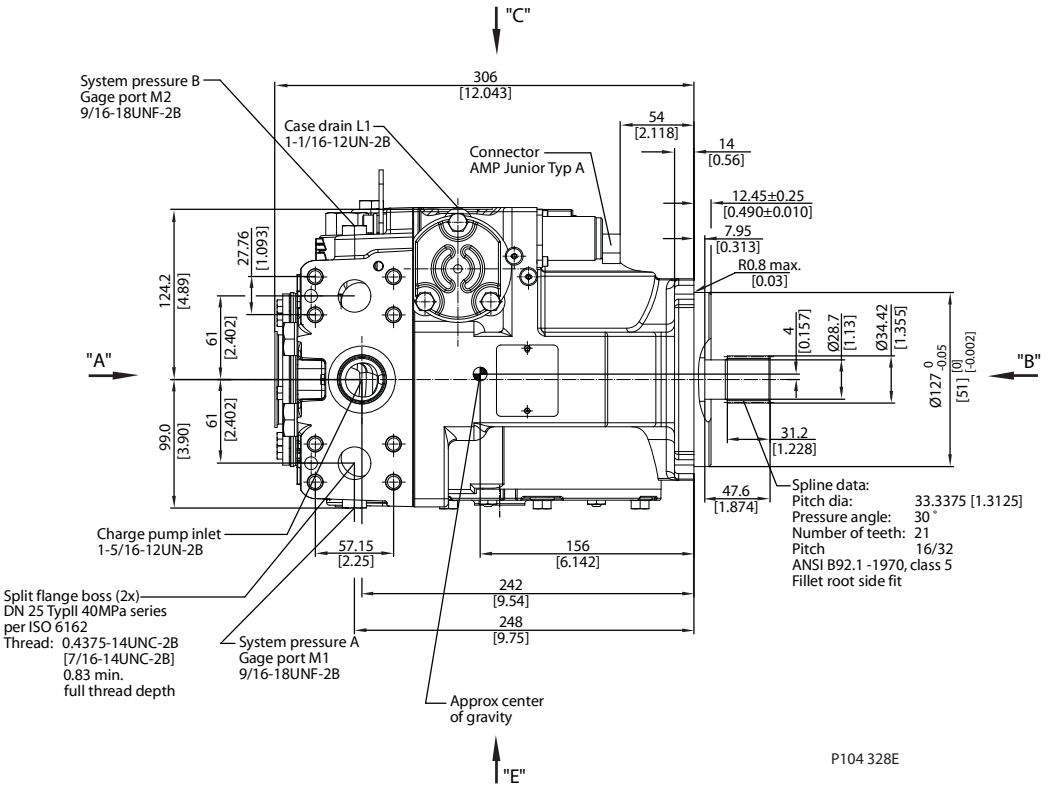
Auxiliary mounting pad - options AB, BC, CD, DE, EF, EG, BB



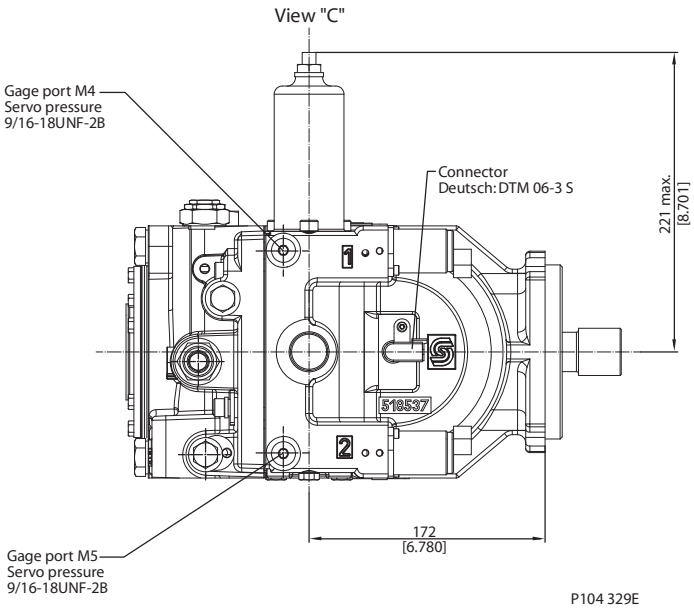
mm [in]

FRAME SIZE 075 NFPE (continued)

Integrated NFPE control, endcap twin ports



P104 328E



P104 329E

Procedure 6: Adjusting Maximum Drive Pump Current

GOAL 1: Determine maximum current value necessary to ensure drive pumps are getting to full stroke and achieving correct maximum speed for the drive system configuration and tire size.

Goal 2: Make sure max current setting is not "overdriving" the pumps

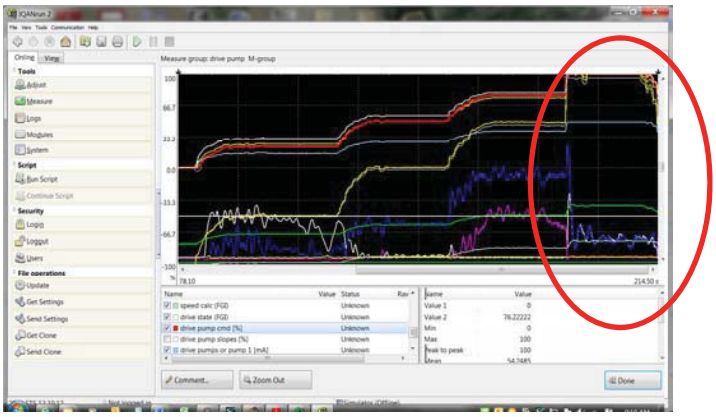
- The following conditions are necessary before proceeding with this check:
  - Machine should be running and hydraulic oil temperature should be a minimum of 60 deg F. (See Appendix E for info on monitoring oil temp)
  - Jump hose between drive pumps must be disconnected.
  - Must be on level, straight road of minimum 1000'.

Scenarios 1 and 2 detailed below use the baseline graph generated in Step 1.

Goal 1

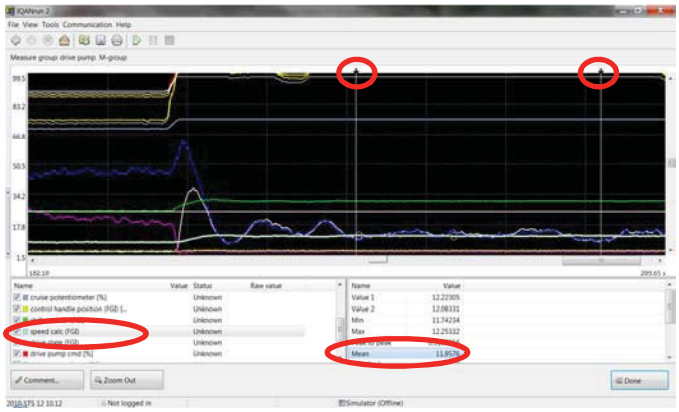
Scenario 1: PT4 and PT6 pressure traces match at 100% ***drive pump cmd***

1. Example of baseline graph



2. Zoom in on area of graph at 100% ***drive pump cmd.*** (See Appendix B). It is clear in this example that the pressure traces come together and stay matched. This is a very good indication that both pumps are getting to full stroke.

3. Check to make sure speed is correct for the tire size and drive configuration. Highlight ***speed calc*** channel in channel list, move graph cursors such that a good average reading can be obtained and then note ***Mean*** value in statistics area. Compare the speed to the tabulated value in the Machine Speeds spreadsheet (Appendix D). If speed does not match within +/- 0.5 mph check the following and perform test again.
   - Make sure control handle signal is reaching 100%
   - Make sure cruise control potentiometer signal is reaching at least 95%
   - Make sure correct tire size is selected.



Appendix C: How to Adjust Drive Pump Channels Using MD3

1. Press the "Menu" button in the lower right corner of the MD3.

2. The "Main" menu screen appears. Select the "Adjust" menu by pressing F1.

3. Scroll to highlight **"HAGIE Personel Only"** group by using the up/down arrows and select by pushing the OK button.

4. Unlock group by entering the PIN CODE using up/down arrows and pushing OK button to select each character. Contact Hagie Customer Service Technical Support for pin code.

9. Scroll down to **"manufacturing/service open bit"** using the up/down arrows and select by pushing the OK button.

10. Change the value to 1 using the up arrow and press OK. (This unlocks additional adjust groups where the drive pump settings are located.) **NOTE:** Default value for this channel is 0. If value = 1, change value to 0 and then back to 1.

11. Use the back arrow button to return to the adjust group list.

SAUER DANFOSS

Genuine Parts

Series 51-1 Controls
B1, B2, B7, E1, E2, E7, F1, F2, N1, T1, T2, T7, TA, TH, P7, P8

Service Manual

250 - 210

FUNCTIONAL DESCRIPTION

The **N1** control consists of a ported housing that is mounted on the endcap over the piston end of the servo piston.

The housing contains two external ports, designated **M3** and **M5**. These ports serve as the control inputs. There are three interface ports[1] that connect to the rod and piston ends of the servo, and to the servo supply port in the endcap. The servo supply connects to the output of the loop flushing spool so it dispenses low loop pressure to the control regardless of motor direction.

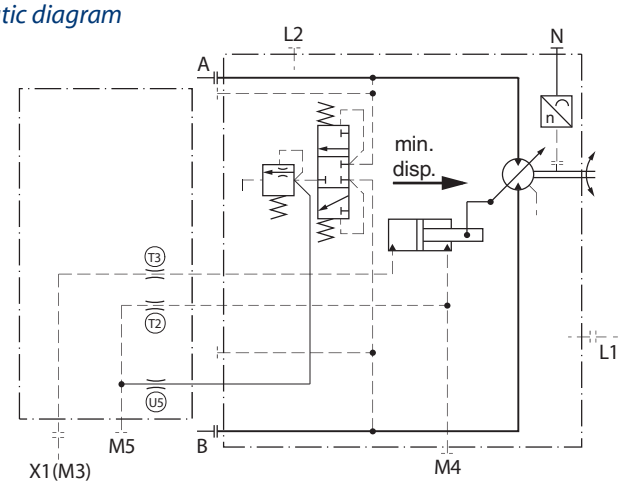
The control routes servo supply pressure through orifices **U5** and **T2** to the rod end of the servo piston. This holds the motor at maximum displacement until pressure from an external source is applied at port **M3**. This signal pressure then routes through orifice **T3** to the piston end of the servo, shifting the motor to minimum displacement. Typically 20 to 25 bar [290 to 360 psi] is necessary to shift the motor.

You may also install a plug in place of orifice **U5**, blocking the connection to servo supply. You can then apply pressure from an external source at port **M5** to shift the motor to maximum displacement.

Orifices **T2** and **T3** set the control response by limiting the flow to either end of the servo piston.

Schematic diagram

N1 control schematic diagram



ADJUSTMENTS

This control requires no adjustments.

[1] Interface ports are those between the control and the endcap.

FUNCTIONAL DESCRIPTION

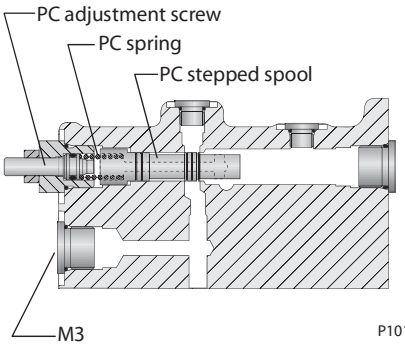
Overview

Pressure Compensator (PC) controls operate by routing system (high) pressure to both ends of the servo piston. Because the piston end of the servo piston has greater area, this causes the motor to shift to minimum displacement by default. When system pressure reaches the PC setpoint, the control drains the piston end of the servo piston allowing the motor to shift toward maximum displacement. The control modulates the displacement position of the motor, keeping system pressure at or below the PC set point. When the motor reaches maximum displacement, system pressure may rise above the PC set point until the pump pressure limiter or system relief valve begins to operate

Option TA

TA option PC controls operate strictly as described above, with the option of several brake pressure defeat configurations that we explain later.

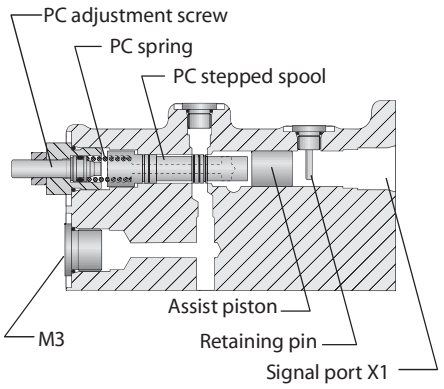
TA control cross section



Option TH

TH option PC controls operate as described above except a piston is installed to operate the PC control spool and shift the motor to maximum displacement when a hydraulic-pressure signal is applied. 10 to 35 bar [145 to 507 psi] applied at port X1 overrides the PC function and shifts the motor to maximum displacement. There is a second option of several brake pressure defeat configurations. We explain this option later.

TH control cross section



MINOR REPAIR (continued)

Always ensure you have the correct replacement parts (O-rings/seals) before discarding the used ones.

Servo/PC supply option CA (with hydraulic signal)

Disassembly

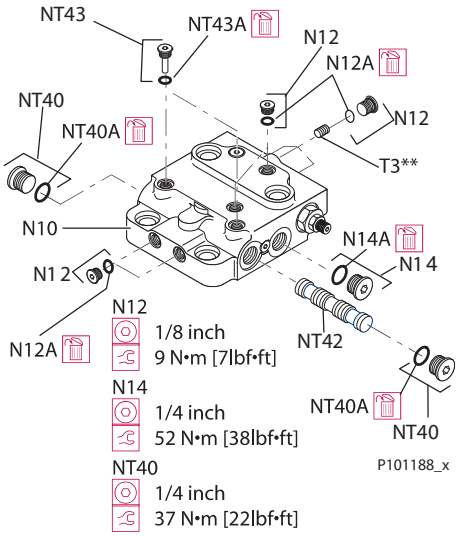
1. Thoroughly clean all external surfaces before disassembly.

2. Using a 1/8 inch internal hex wrench, remove seven plugs (N12) from the control housing (N10). Remove and discard the O-rings (N12A).

3. Using a 1/4 inch internal hex wrench remove the plug (N14) from the control housing. Remove and discard the O-ring (N14A).

4. Using a 3mm internal hex wrench, remove the orifice (T3). Note the location for reassembly.

CA servo supply option components



5. Using a 1/4 inch internal hex wrench or 11/16 inch hex wrench, remove the plugs/fittings (NT40) from ports XA and XB in the control housing. Remove and discard the O-rings (NT40A).

6. Using a 1/8 inch internal hex wrench, remove the two pin-plugs (NT43) from the control housing. Remove and discard the O-rings (NT43A).

7. Slide the BPD spool (NT42) from the housing bore.

Inspection

Thoroughly clean and inspect all components for damage or foreign material. Replace damaged parts as necessary.

Assembly

1. Using clean hydraulic oil, lubricate the BPD shuttle spool (NT42) and slide into the housing bore.

2. Lubricate and install new O-rings (NT43A) on to pin-plugs (NT43). Using a 1/8-inch internal hex wrench, install the pin-plugs into the housing. Torque to 9 N•m [7 lbf• ft].

3. Using a 3mm internal hex wrench, install the T3 orifice. Torque to 6 N•m [4 lbf•ft].

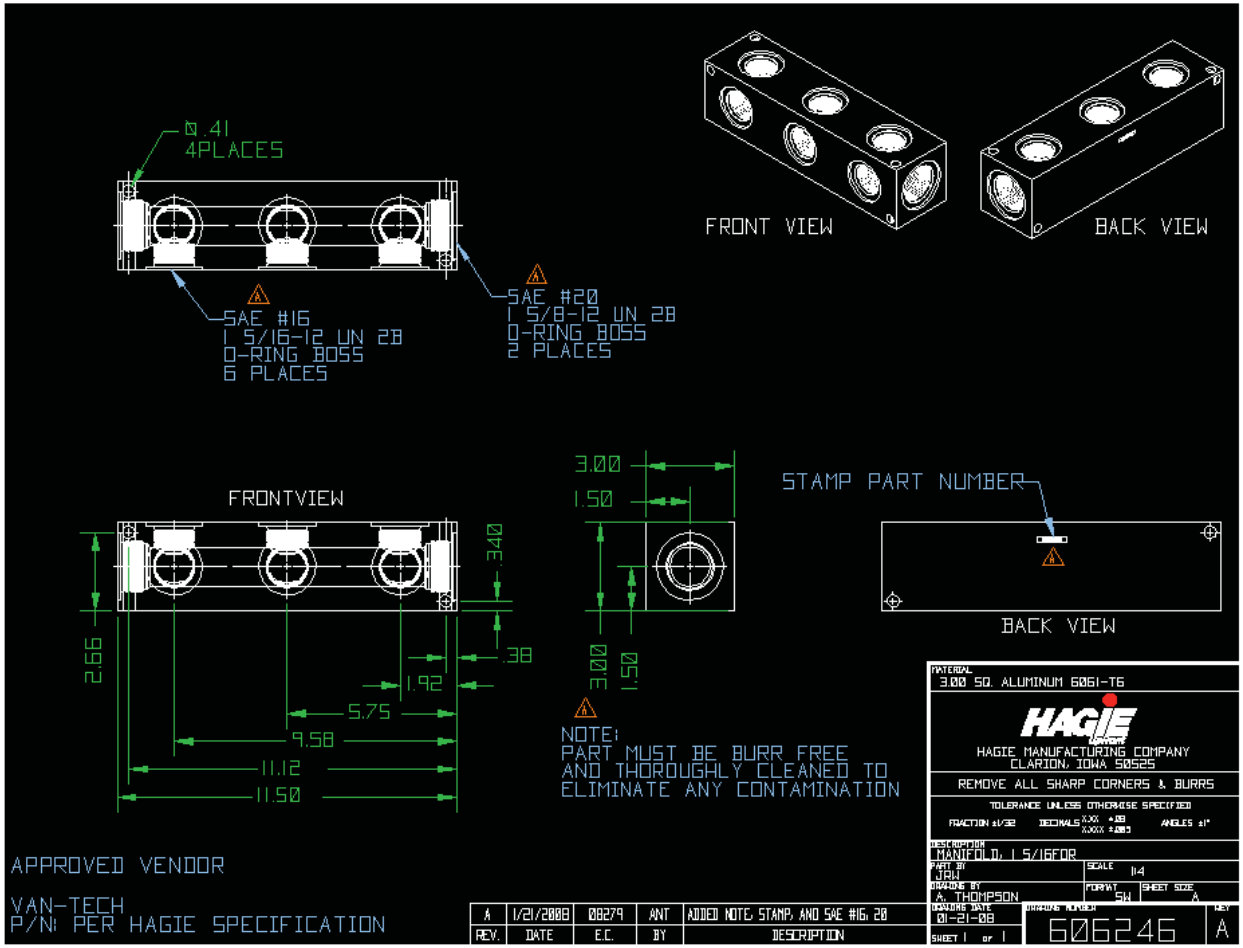
4. Lubricate and install new O-rings to plugs/fittings (NT40). Install plugs/fittings to ports XA and XB. Using a 1/4 inch internal hex wrench or 11/16 inch hex wrench, torque the plugs/fittings 37 N•m [28 lbf•ft].

5 Lubricate and install new O-rings to seven plugs (N12). Using a 1/8 inch internal hex wrench, install and torque the plugs to 9 N•m [7 lbf•ft].

6. Lubricate and install new O-ring to plug (N14). Using a 1/4 inch internal hex wrench, install and torque the plugs to 52 N•m [38 lbf•ft].

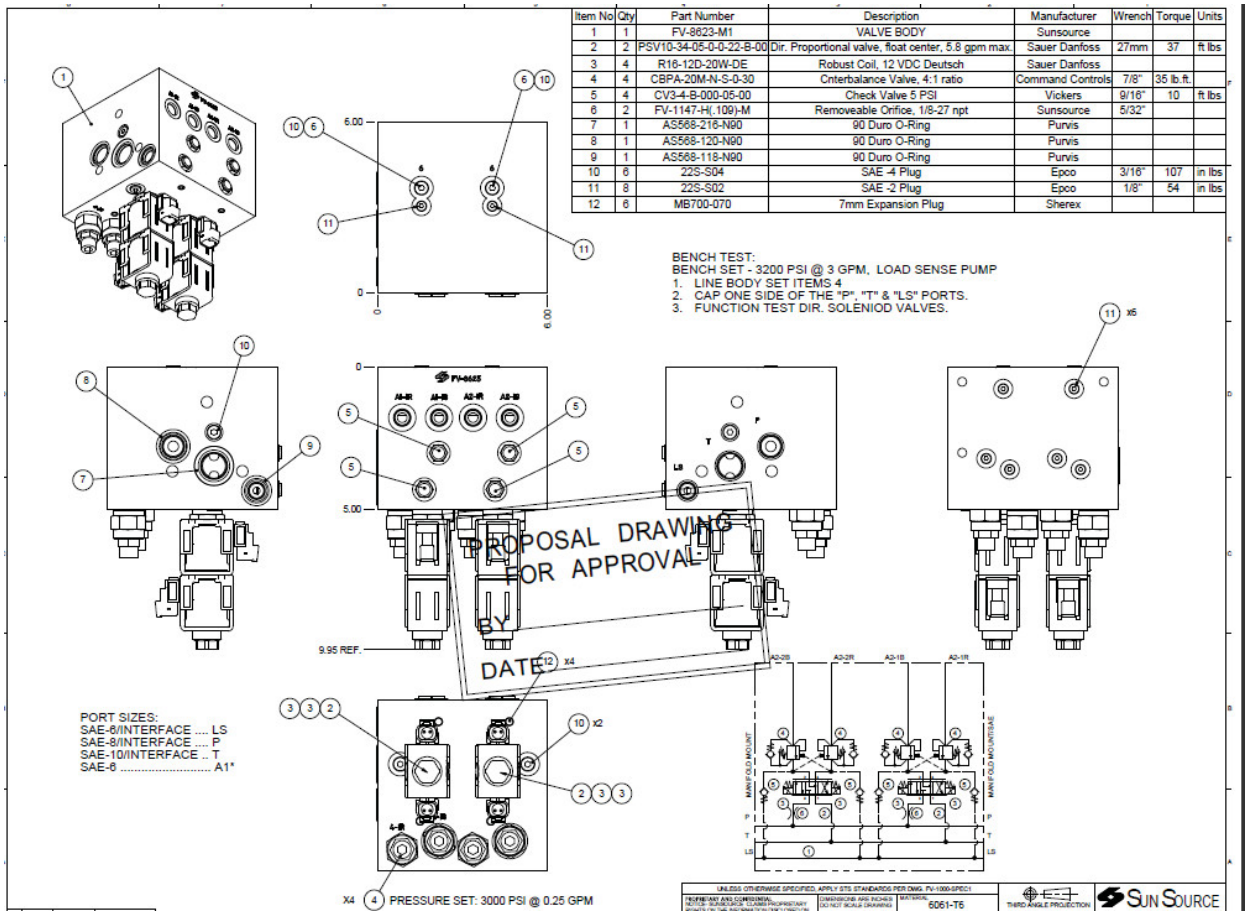
Hagie Manufacturing Company

606246 Junction Manifold



Hagie Manufacturing Company

606370 AWS Manifold



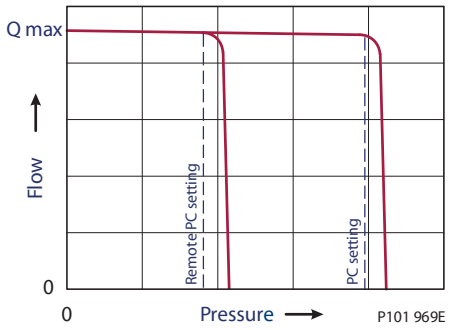
Item No	Qty	Part Number	Description	Manufacturer	Wrench	Torque	Units
1	1	FV-8623-M1	VALVE BODY	Sunsource			
2	2	PSV10-34-05-0-0-22-B-00	Dir. Proportional valve, float center, 5.8 gpm max	Sauer Danfoss	27mm	37	ft lbs
3	4	R16-12D-20W-DE	Robust Coil, 12 VDC Deutsch	Sauer Danfoss			
4	4	CBPA-20M-N-S-0-30	Cnterbalance Valve, 4:1 ratio	Command Controls	7/8"	35 lb.ft.	
5	4	CV3-4-B-000-05-00	Check Valve 5 PSI	Vickers	9/16"	10	ft lbs
6	2	FV-1147-H(.109)-M	Removeable Orifice, 1/8-27 npt	Sunsource	5/32"		
7	1	AS568-216-N90	90 Duro O-Ring	Purvis			
8	1	AS568-120-N90	90 Duro O-Ring	Purvis			
9	1	AS568-118-N90	90 Duro O-Ring	Purvis			
10	6	22S-S04	SAE -4 Plug	Epco	3/16"	107	in lbs
11	8	22S-S02	SAE -2 Plug	Epco	1/8"	54	in lbs
12	6	MB700-070	7mm Expansion Plug	Sherex			


Measure
wheel motor M-group
brake control M-group
hour counters
fault counters
Aux hydraulic diagnostics
AWS M-group
cab inputs
cab module outputs
chassis inputs
Main
OK
F1
F2
F3
F4

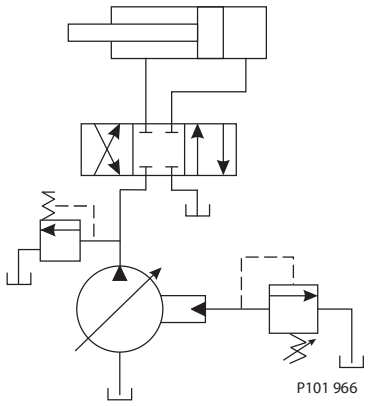
REMOTE PRESSURE COMPENSATED CONTROLS

The remote PC control is a two-stage control that allows multiple PC settings. Remote PC controls are commonly used in applications requiring low and high pressure PC operation.

Typical operating curve



Closed center circuit with remote PC



The remote PC control uses a pilot line connected to an external hydraulic valve. The external valve changes pressure in the pilot line, causing the PC control to operate at a lower pressure. When the pilot line is vented to reservoir, the pump maintains a low standby pressure of 15 to 20 bar [215 to 300 psi]. When pilot flow is blocked, the pump maintains pressure at the PC setting. An on-off solenoid valve can be used in the pilot line to create a low-pressure standby mode. A proportional solenoid valve, coupled with a microprocessor control, can produce an infinite range of operating pressures.

Each section includes control schematic diagrams, setting ranges, and response / recovery times for each control available. **Response** is the time (in milliseconds) for the pump to reach zero displacement when commanded by the control. **Recovery** is the time (in milliseconds) for the pump to reach full displacement when commanded by the control. Actual times can vary depending on application conditions.

Size the external valve and plumbing for a pilot flow of 3.8 l/min [1 US gal/min]. For additional system protection, install a relief valve in the pump outlet line.

Remote pressure compensated system characteristics

- Constant pressure and variable flow
- High or low pressure standby mode when flow is not needed
- System flow adjusts to meet system requirements
- Single pump can provide flow to multiple work functions
- Quick response to system flow and pressure requirements

Typical applications for remote pressure compensated systems

- Modulating fan drives
- Anti-stall control with engine speed feedback
- Front wheel assist

SIZING EQUATIONS

Use these equations to help choose the right pump size and displacement for your application:

	Based on SI units	Based on US units
Flow	Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{1000}$ (l/min)	Output flow $Q = \frac{V_g \cdot n \cdot \eta_v}{231}$ (US gal/min)
Torque	Input torque $M = \frac{V_g \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ (N•m)	Input torque $M = \frac{V_g \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ (lbf•in)
Power	Input power $P = \frac{M \cdot n \cdot \pi}{30\,000} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ (kW)	Input power $P = \frac{M \cdot n \cdot \pi}{198\,000} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$ (hp)

Variables SI units [US units]

V_g	=	Displacement per revolution	cm^3/rev [in^3/rev]
p_O	=	Outlet pressure	bar [psi]
p_i	=	Inlet pressure	bar [psi]
Δp	=	$p_O - p_i$ (system pressure)	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Volumetric efficiency	
η_m	=	Mechanical efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_m$)	

CONTROLS (continued)

Load sensing control (LS)

Specifications

PC setting range

Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

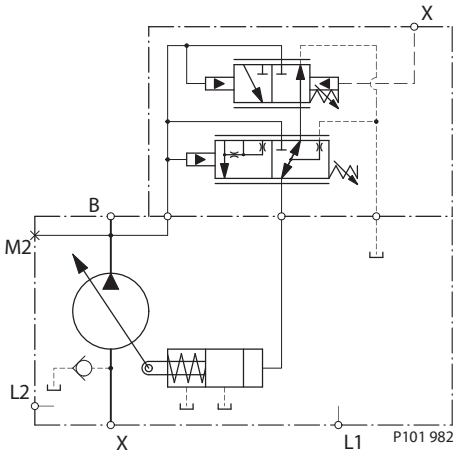
*Response/recovery times**

(ms)	Response	Recovery
L25C	30	70
L30D	30	70
K38C	30	80
K45D	30	80

* For definitions, *see page 11*.

Schematic diagram

LS Schematic



LS setting range

Model	bar	psi
All	12–40	174–580

Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
X = LS signal port

Load sensing control with internal bleed orifice (LB)

Specifications

PC setting range

Model	bar	psi
L25C	100–260	1450–3770
L30D	100–210	1450–3045
K38C	100–260	1450–3770
K45D	100–210	1450–3045

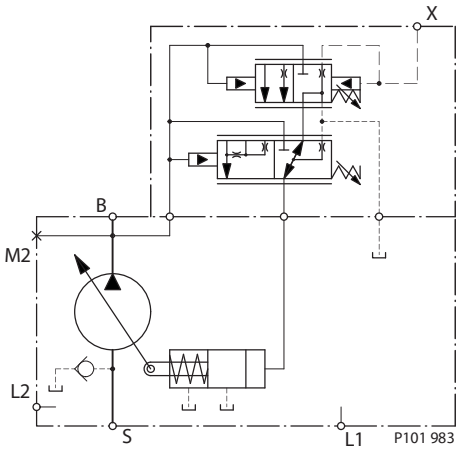
*Response/recovery times**

(ms)	Response	Recovery
L25C	30	70
L30D	30	70
K38C	30	80
K45D	30	80

* For definitions, *see page 11*.

Schematic diagram

LB Schematic



LS setting range

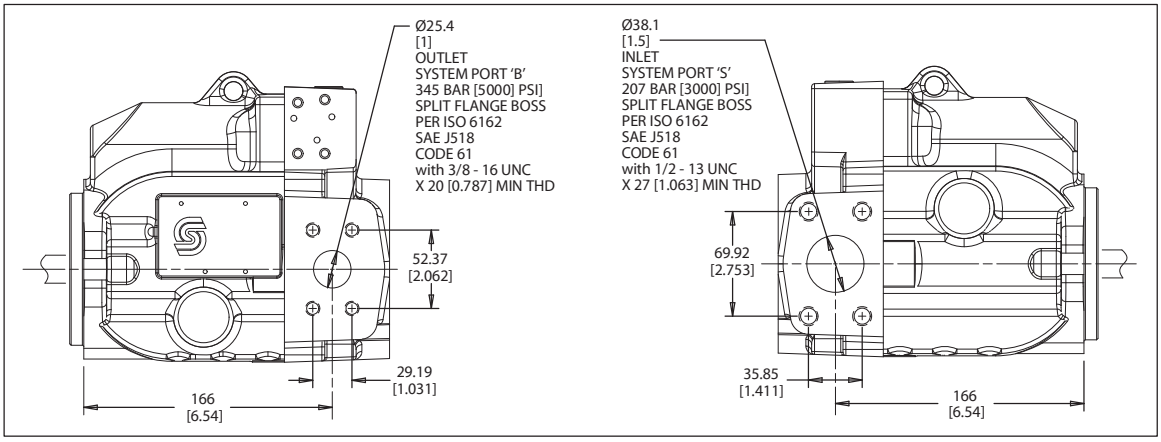
Model	bar	psi
All	12–40	174–580

Legend

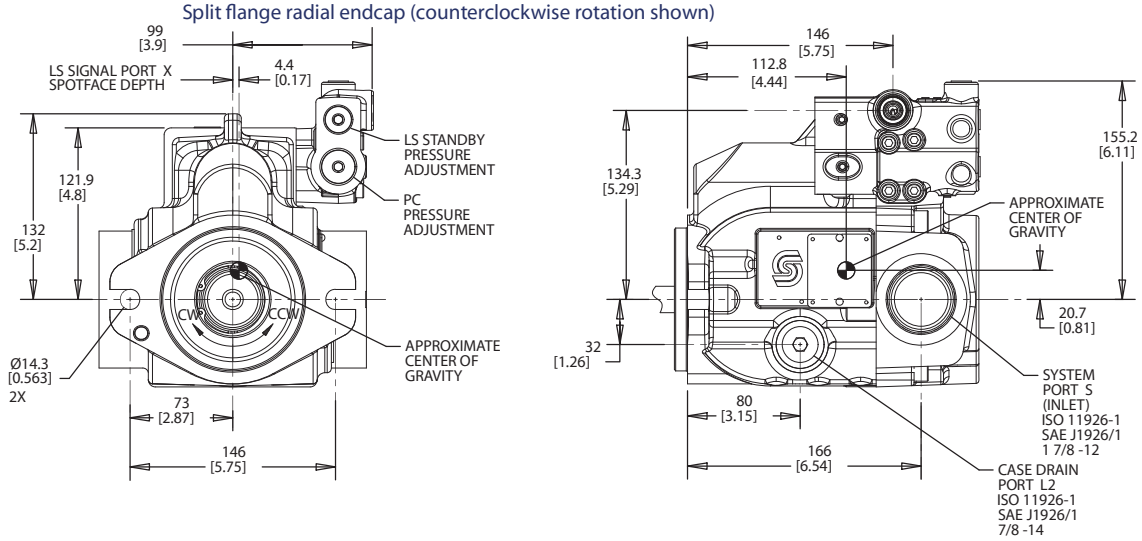
B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
X = LS signal port

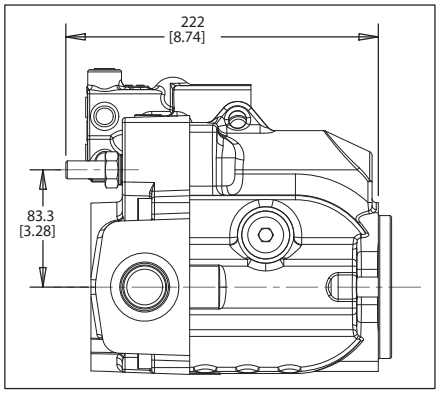
INSTALLATION DRAWINGS (continued)

Radial ported endcap (continued)



Split flange radial endcap (counterclockwise rotation shown)





P104 065E

Adjustable displacement limiter

Third-angle projection mm [in]

ORDER CODE (continued)

J1 *Input shaft*

C2	13 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
C3	15 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
S1	14 tooth, 12/24 pitch (ANSI A92.1 1970 - Class 5)
K4	Ø 31.75 mm [1.25 in] straight key
TO	Ø 31.75 mm [1.25 in], 1:8 taper

J2 *Auxiliary mounting flange type and coupling*

N	None (Use with axial ported endcap options 3 and 4 below)
A	SAE-A, 9-tooth output spline
B	SAE-B, 13-tooth output spline
C	SAE-C, 14-tooth output spline
T	SAE-A, 11-tooth output spline
V	SAE-BB, 15-tooth output spline
R	Running cover (Radial ported endcap machined for aux. pad. Pad and coupling sold separately.)

J3 *Endcap option (system port size and location)*

Code	Port location	Port type	Inlet size	Outlet size
2	Radial	4-bolt split flange	50.8 mm [2.0 in]	25.4 mm [1.0 in]
3	Axial	O-ring boss	1 7/8 in.	1 5/16 in.
4	Axial	4-bolt split flange	50.8 mm [2.0 in]	25.4 mm [1.0 in]

K1 *Shaft seal*

A	Single lip seal, viton

K2 *Mounting flange and housing port style*

2	SAE-C 4-bolt, SAE O-ring boss housing ports
8	SAE-B 2-bolt, SAE O-ring boss housing ports

K3 *Not used*

N	Not applicable

L *Displacement limiter*

NNN	Consult Sauer-Danfoss representative.

M *Special hardware*

NNN	None

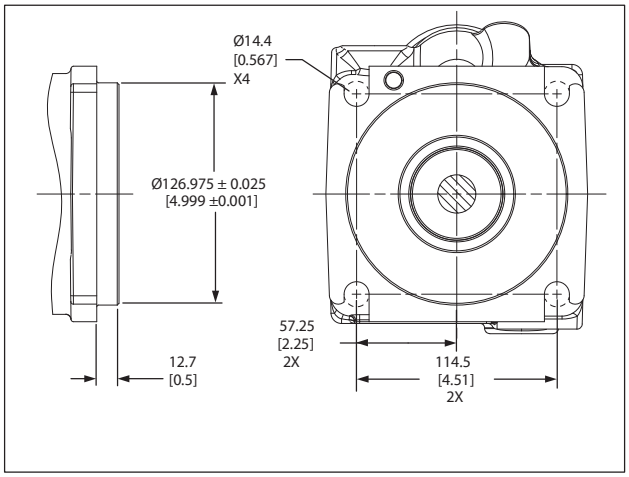
N *Special features*

NNN	None

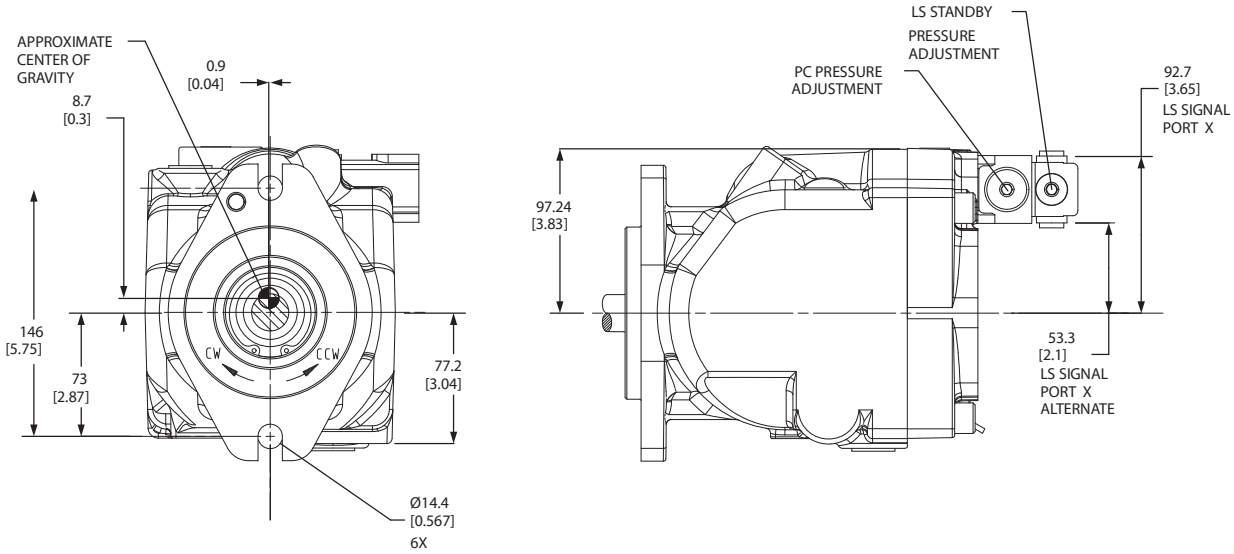
INSTALLATION DRAWINGS (continued)

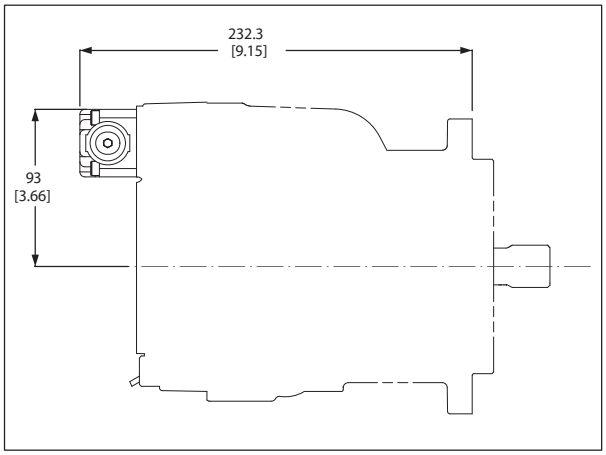
Axial ported endcap (continued)

The drawings on these pages show a pump with two-bolt SAE-B mounting flange. This pump is also available with a four-bolt SAE-C mounting flange. The differences are detailed in the drawing to the right. All other dimensions are common.



SAE-C four-bolt housing





PC only control

P104 234E

Third-angle projection mm [in]

ORDER CODE (continued)

G *Pilot orifice*

N	Standard

H *Gain orifice*

3	Standard

J1 *Input shaft*

S1	14 tooth, 12/24 pitch (ANSI B92.1 1970 - Class 5)
S2	17 tooth, 12/24 pitch (ANSI B92.1 1970 - Class 5)
K4	Ø 31.75 mm [1.25 in], straight keyed

J2 *Auxiliary mounting flange*

N	None
A	SAE-A, 9-tooth coupling
T	SAE-A, 11-tooth coupling
B	SAE-B, 13-tooth coupling
V	SAE-BB, 15-tooth coupling
C	SAE-C, 14-tooth coupling

J3 *System port size and location*

Code	Location	Port type	Inlet size	Outlet size
2	Radial	4-bolt split-flange	2 in.	1 in.
4	Axial	4-bolt split-flange	2 in.	1 in.

K1 *Shaft seal*

A	Single lip seal, viton

K2 *Mounting flange and housing port style*

1	SAE-C 4-bolt, SAE O-ring boss housing ports

K3 *Not used*

N	Not applicable

L *Displacement limiter*

NNN	None
AAA	Adjustable, factory set at max angle (074B)
CAA	Adjustable, factory set at max angle (090C)

M *Special hardware*

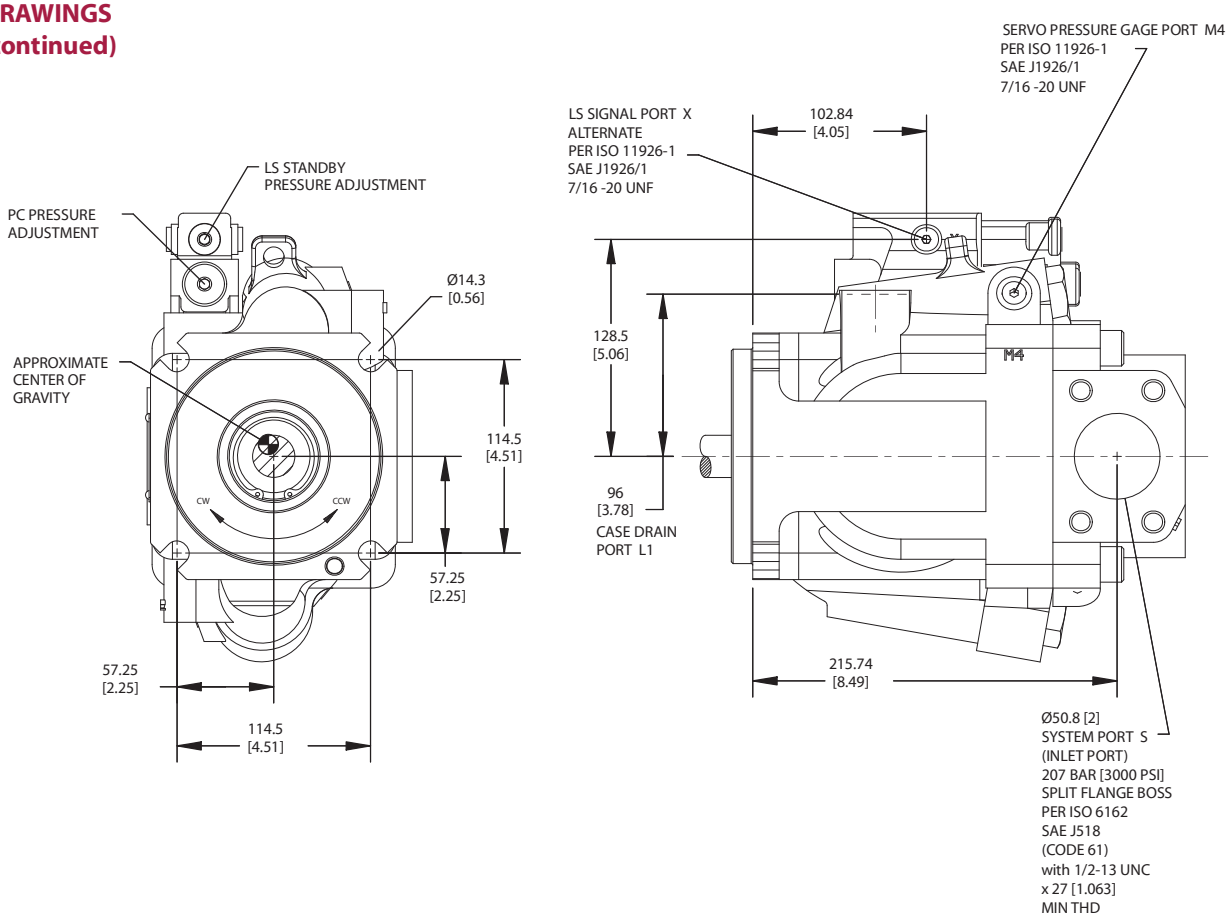
NNN	None

N *Special features*

NNN	None

INSTALLATION DRAWINGS (continued)

Radial ported endcap (continued)

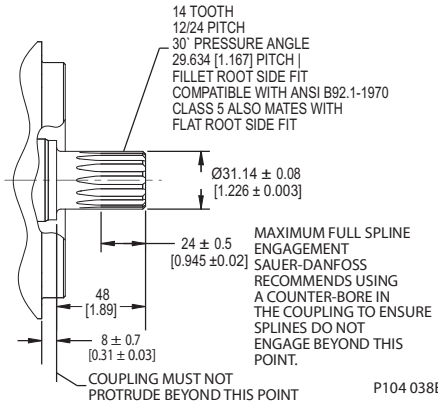
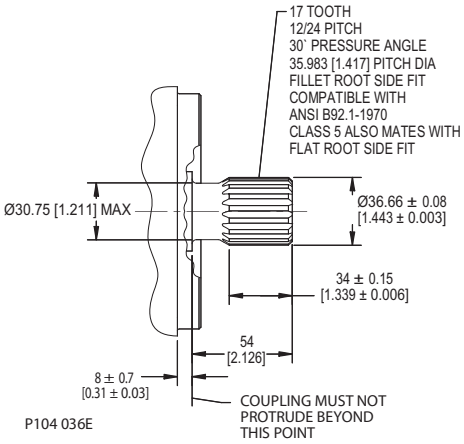
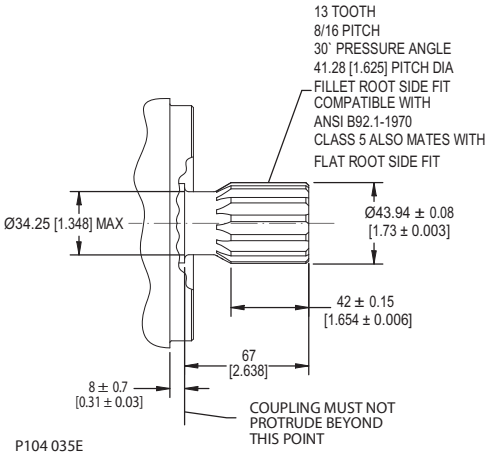


P104 075E

Third-angle projection
mm [in]

INPUT SHAFTS

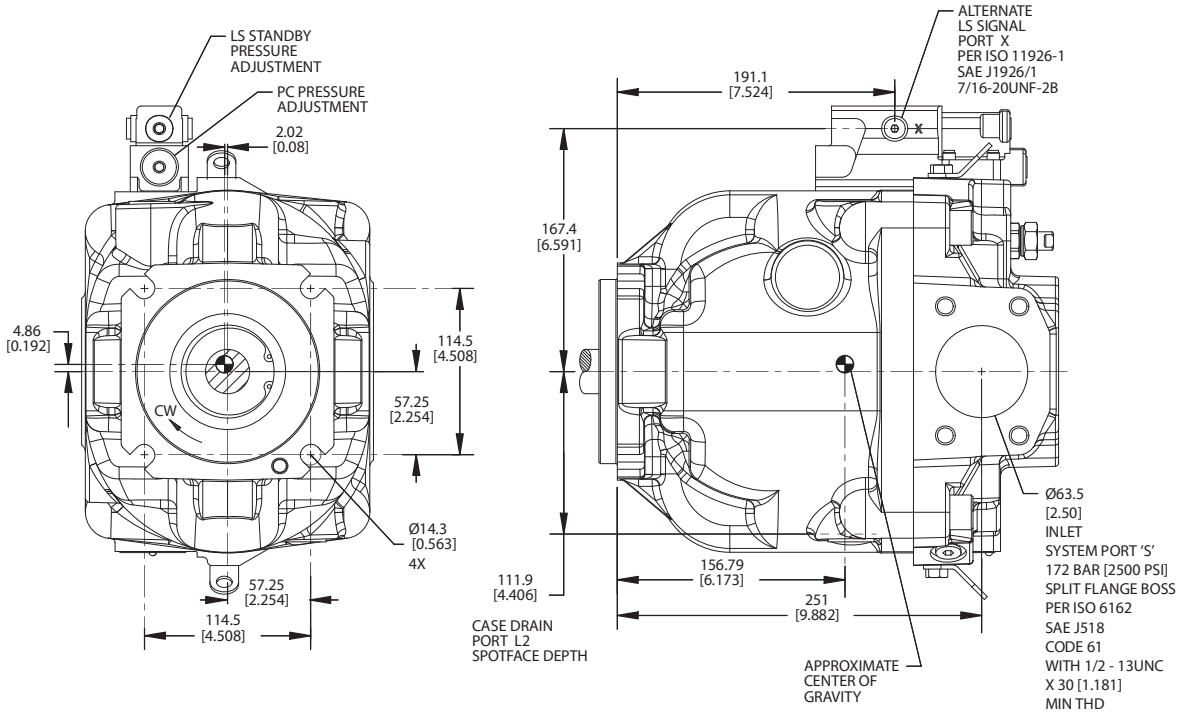
Shaft data

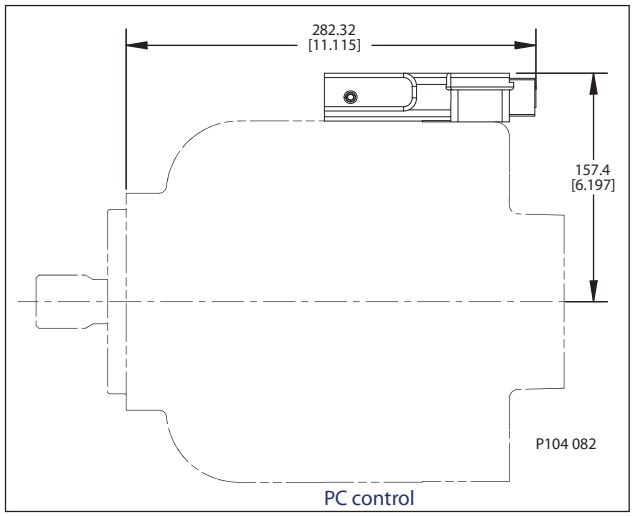
Code	Description	Maximum torque rating[1] N•m [lbf•in]	Drawing
S1	14-tooth spline 12/24 pitch (ANSI B92.1 1970 - Class 5)	1093 [9675]	
S2	17-tooth spline 12/24 pitch (ANSI B92.1 1970 - Class 5)	1044 [9240]	
S4	13-tooth spline 8/16 pitch (ANSI B92.1 1970 - Class 5)	1551 [13 730]	

1. See *Input shaft torque ratings*, page 18 for an explanation of maximum torque.

INSTALLATION DRAWINGS (continued)

Radial ported endcap, clockwise rotation (continued)





Third-angle projection mm [in]

SYMBOLS USED IN SAUER-DANFOSS LITERATURE

These symbols are in the illustrations and text of this manual. They communicate helpful information at the point where it is most useful to the reader.

In most instances, the appearance of the symbol itself denotes its meaning. The legend below defines the symbol and explains its purpose.

- WARNING may result in injury
- CAUTION may result in damage to product or property
- Reusable part
- Non-reusable part, use a new part
- Non-removable item
- Option – either part may exist
- Superseded – parts are not interchangeable
- Measurement required
- Flatness specification
- Parallelism specification
- External hex head
- Internal hex head
- Torx head
- O-ring boss port
- Tip, helpful suggestion
- Lubricate with hydraulic fluid
- Apply grease/petroleum jelly
- Apply locking compound
- Inspect for wear or damage
- Clean area or part
- Be careful not to scratch or damage
- Note correct orientation
- Mark orientation for reinstallation
- Torque specification
- Press in – press fit
- Pull out with tool – press fit
- Cover splines with installation sleeve
- Pressure measurement/gauge location or specification

Fluid and filter maintenance

RECOMMENDATIONS

To ensure optimum life of Series 45 products, perform regular maintenance of the fluid and filter. Contaminated fluid is the main cause of unit failure. Take care to maintain fluid cleanliness when servicing.

Check the reservoir daily for proper fluid level, the presence of water, and rancid fluid odor. Water in the fluid may be noted by a cloudy or milky appearance or free water in the bottom of the reservoir. Rancid odor indicates the fluid has been exposed to excessive heat. Change the fluid immediately if these conditions occur. Correct the problem immediately.

Change the fluid and filter per the vehicle/machine manufacturer's recommendations or at these intervals:

Fluid and filter change interval

Reservoir type	Maximum change interval
Sealed	2000 hours
Breather	500 hours

Change the fluid more frequently if it becomes contaminated with foreign matter (dirt, water, grease, etc.) or if the fluid is subjected to temperature levels greater that the recommended maximum.

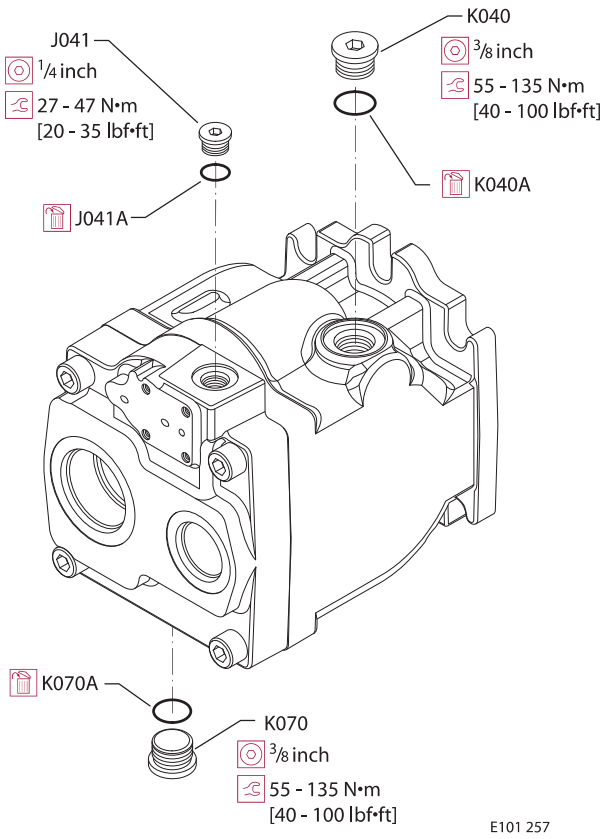
Dispose of used hydraulic fluid properly. Never reuse hydraulic fluid.

Change filters whenever the fluid is changed or when the filter indicator shows that it is necessary to change the filter. Replace all fluid lost during filter change.

PLUG AND FITTING SIZES AND TORQUES

If any plugs or fittings are removed from the unit during service, install and torque as indicated here. This drawing is a composite. Your configuration may differ but here is the appropriate wrench size and torque:

Plug locations, sizes, and torques



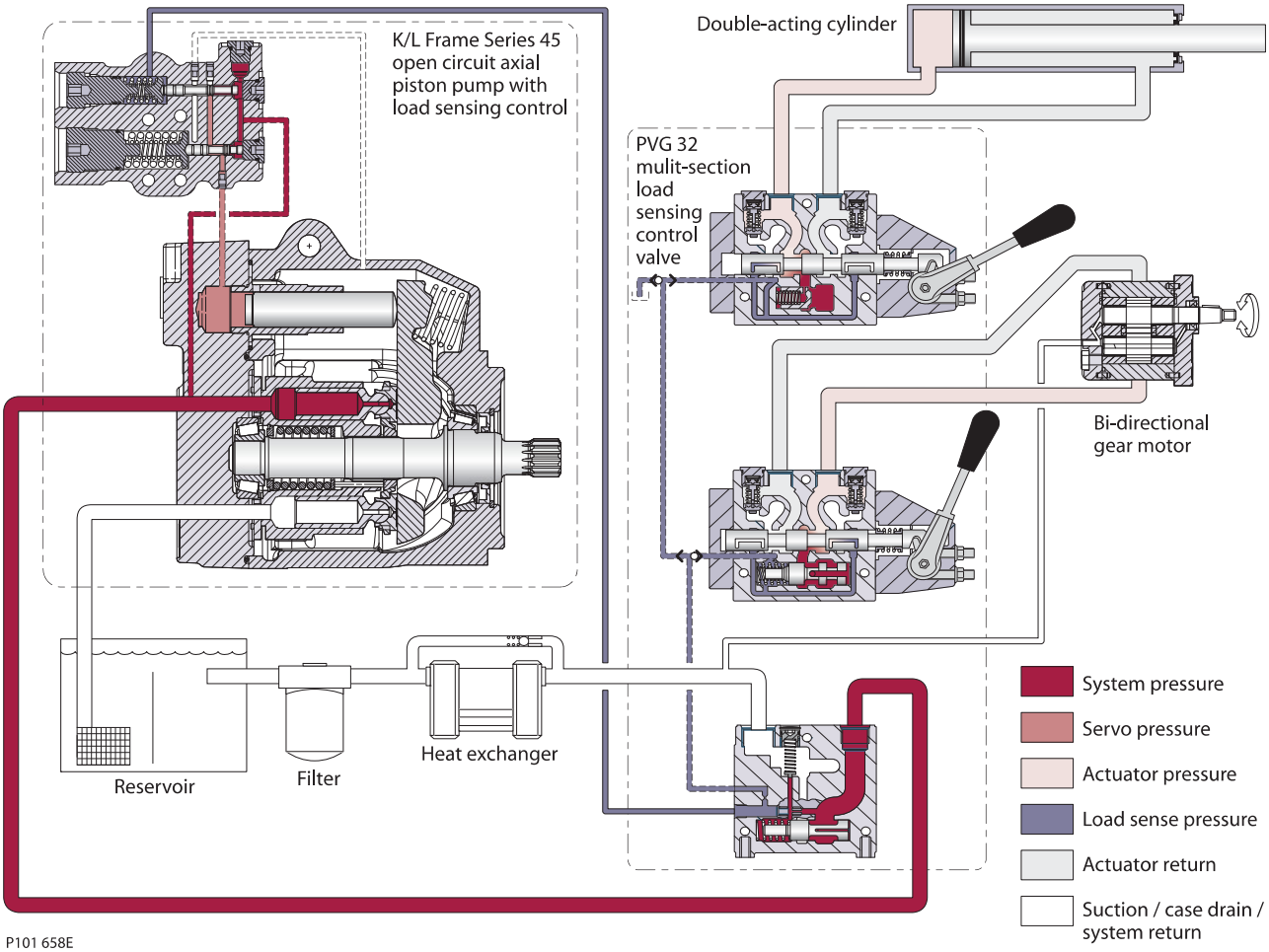
LOAD SENSING OPEN CIRCUIT SYSTEM

The pump receives fluid directly from the reservoir through the inlet line. A screen in the inlet line protects the pump from large contaminants. The pump outlet feeds a PVG-32 multi-section, load sensing, directional control valve. The PVG valve directs pump flow to the cylinder and gear motor. A heat exchanger cools the fluid returning from the valve. A filter cleans the fluid before it returns to the reservoir.

Flow in the circuit determines the speed of the actuators. The position of the PVG valve determines the flow demand. A hydraulic pressure signal (LS signal) communicates demand to the pump control. The pump control monitors the pressure differential between pump outlet and the LS signal, and regulates servo pressure to control the swashplate angle. Swashplate angle determines pump flow.

Actuator load determines system pressure. The pump control monitors system pressure and will decrease the swashplate angle to reduce flow if system pressure reaches the PC setting. A system relief valve in the PVG valve acts as a back-up to control system pressure.

Pictorial circuit diagram



P101 658E

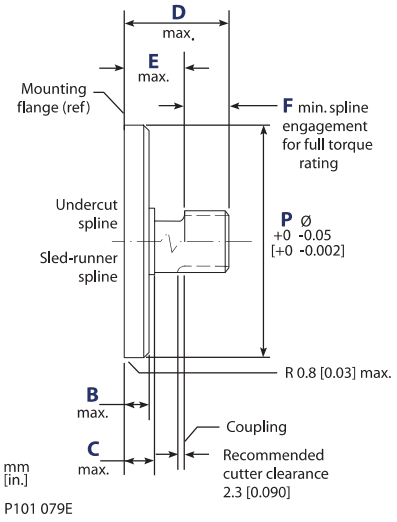
DESIGN PARAMETERS (continued)

Auxiliary mounting pads

Auxiliary mounting pads are available for all radial ported Series 45 pumps. Since the auxiliary pad operates under case pressure, use an O-ring to seal the auxiliary pump mounting flange to the pad. Oil from the main pump case lubricates the drive coupling.

- All mounting pads meet SAE J744 Specifications.
- The combination of auxiliary shaft torque and main pump torque must not exceed the maximum pump input shaft rating. Tables in each section give input shaft torque ratings for each frame size.
- Applications subject to severe vibratory or shock loading may require additional support to prevent mounting flange damage. Tables in each section give allowable continuous and shock load moments for each frame size.
- The drawing and table below give mating pump dimensions for each size mount. Refer to installation drawings in each section for auxiliary mounting pad dimensions.

Mating pump specifications



Dimensions

	SAE A	SAE B	SAE C
P	82.55 [3.250]	101.60 [4.000]	127.00 [5.000]
B	6.35 [0.250]	9.65 [0.380]	12.70 [0.500]
C	12.70 [0.500]	15.20 [0.600]	23.37 [0.920]
D	58.20 [2.290]	53.10 [2.090]	55.60 [2.190]
E	15.00 [0.590]	17.50 [0.690]	30.50 [1.200]
F	13.50 [0.530]	14.20 [0.560]	18.30 [0.720]

Input shaft torque ratings

Input shaft tables in each section give maximum torque ratings for available input shafts. Ensure that your application respects these limits.

Maximum torque ratings are based on shaft strength. Do not exceed them.

Coupling arrangements that are not oil-flooded provide a reduced torque rating. Contact your Sauer-Danfoss representative for proper torque ratings if your application involves non oil-flooded couplings.

Sauer-Danfoss recommends mating splines adhere to ANSI B92.1-Class 5. Sauer-Danfoss external splines are modified class 5 fillet root side fit. The external major diameter and circular tooth thickness dimensions are reduced to ensure a good clearance fit with the mating spline. Tables in each section give full spline dimensions and data.

ORDER CODE (continued)

J1 *Input shaft*

C2	13 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
C3	15 tooth, 16/32 pitch (ANSI A92.1 1970 - Class 5)
T1	Ø 25.4 mm [1 in], 1:8 taper
T2	Ø 22.23 mm [0.875 in], 1:8 taper
K1	Ø 22.23 mm [0.875 in] (short)
K2	Ø 22.23 mm [0.875 in] (long)

J2 *Auxiliary mounting flange*

N	None
A	SAE-A, 9-tooth output spline
T	SAE-A, 11-tooth output spline
B	SAE-B, 13-tooth output spline
V	SAE-BB, 15-tooth output spline

J3 *System port size and location*

Code	Location	Port type	Inlet size	Outlet size
2	Radial	4 bolt split flange	31.8 mm [1.25 in]	25.4 mm [1 in]
4	Axial	4 bolt split flange	31.8 mm [1.25 in]	25.4 mm [1 in]
F	Axial	O-ring boss	1 7/8 in.	1 5/16 in.
G	Radial	O-ring boss	1 7/8 in.	1 5/16 in.

K1 *Shaft seal*

A	Single lip seal, viton

K2 *Mounting flange and housing port style*

6	SAE-B 2-bolt, SAE O-ring boss housing ports

K3 *Not used*

N	Not applicable

L *Displacement limiter*

KNB	None
PLB	Endcap machined and plugged
AAA	Adjustable, factory set at max angle

M *Special hardware*

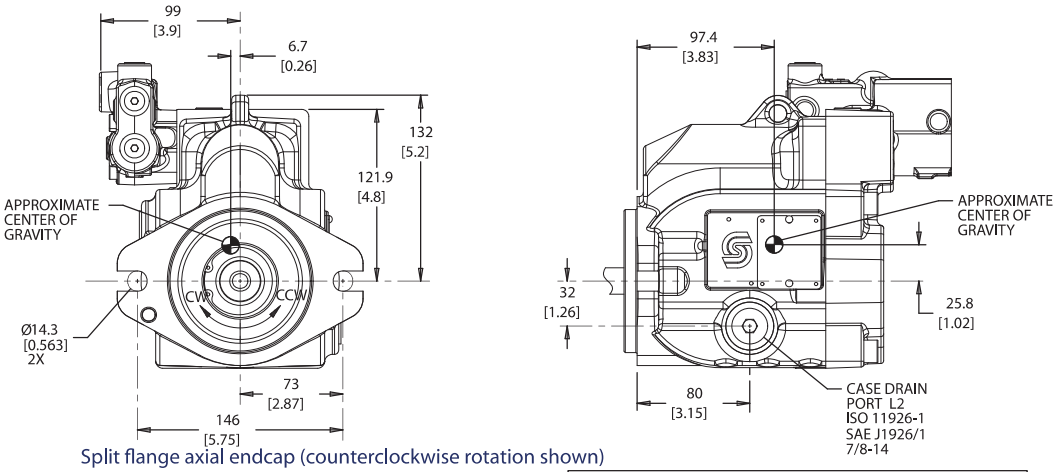
NNN	None

N *Special features*

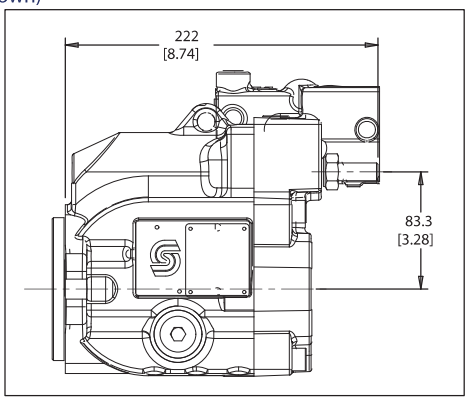
NNN	None

INSTALLATION DRAWINGS (continued)

Axial ported endcap (continued)



Split flange axial endcap (counterclockwise rotation shown)



Adjustable displacement limiter

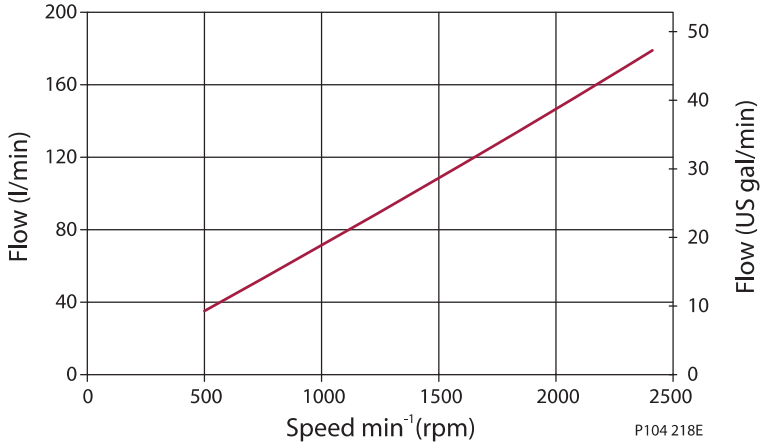
P104064E

Third-angle projection mm [in]

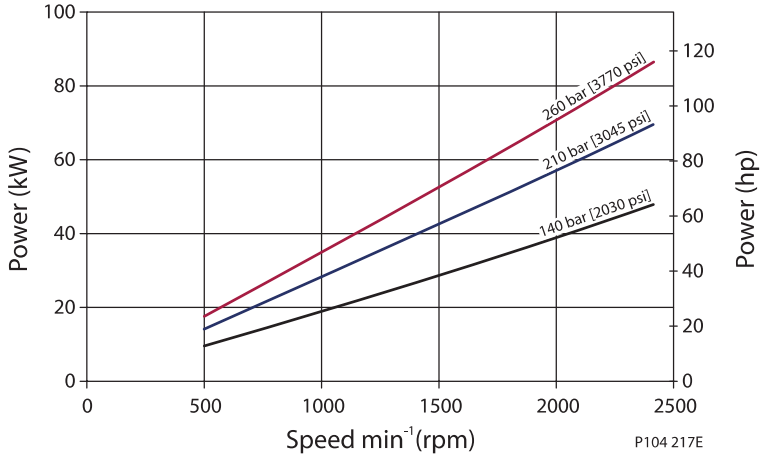
PERFORMANCE J75C

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

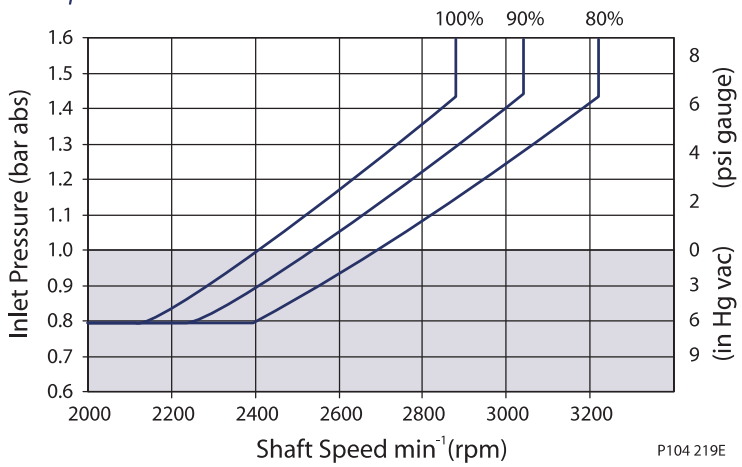


Input power vs. speed



The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Inlet pressure vs. speed

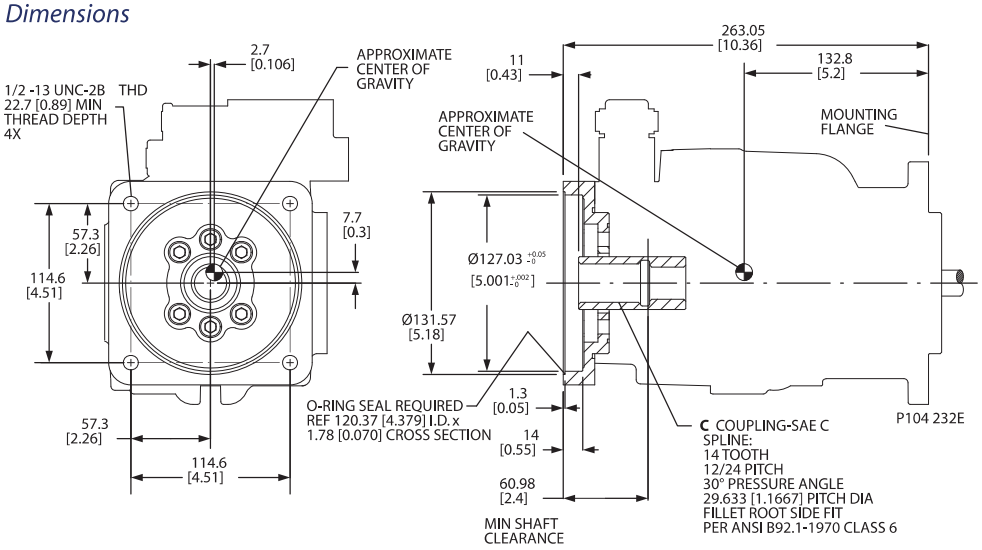


AUXILIARY MOUNTING PADS (continued)

See page 18 for mating pump pilot and spline dimensions.

SAE-C auxiliary mounting pad

Dimensions

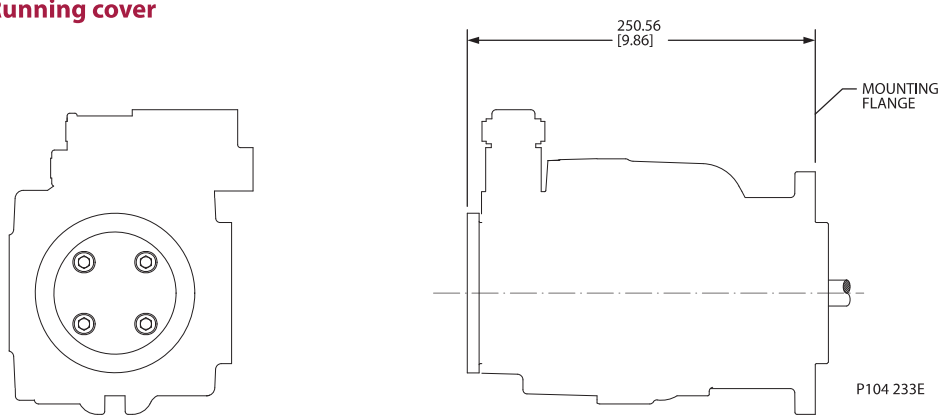


Specifications

Coupling	14-tooth
Spline minimum engagement	18.3 mm [0.72 in]
Maximum torque	339 N•m [3000 lbf•in]

Running cover

Endcap and shaft machined to accommodate auxiliary mounting pads; pad and coupling not included. Conversion kits are available for installation in the field.



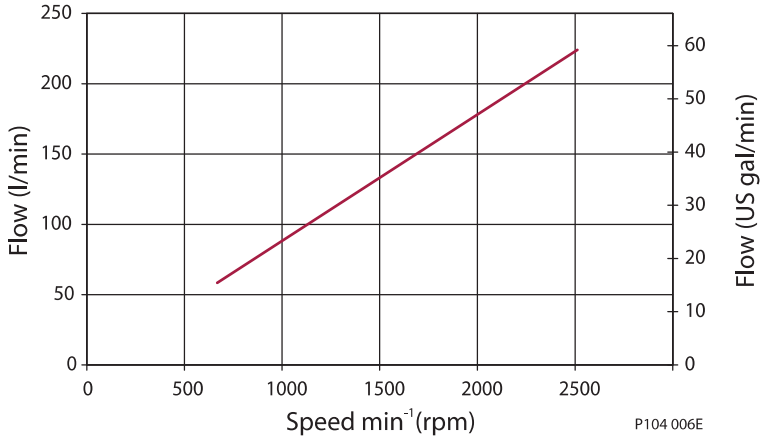
DISPLACEMENT LIMITER

For information on the J Frame displacement limiter, contact your Sauer-Danfoss representative.

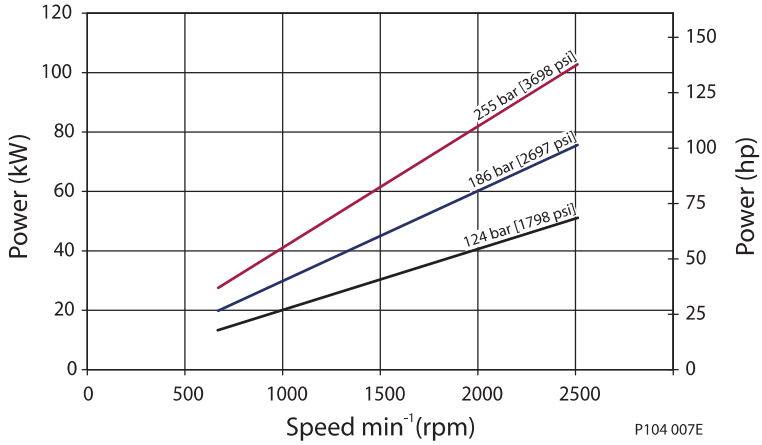
PERFORMANCE G90C

Flow and power data valid at 49°C [120°F] and viscosity of 17.8 mm²/sec [88 SUS].

Flow vs. speed

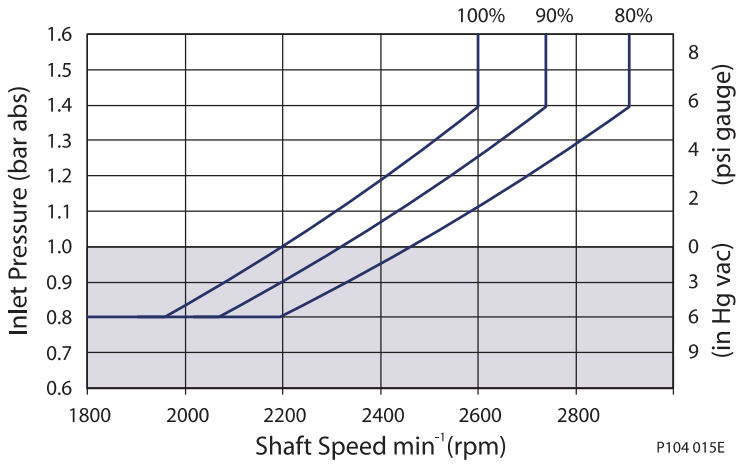


Input power vs. speed



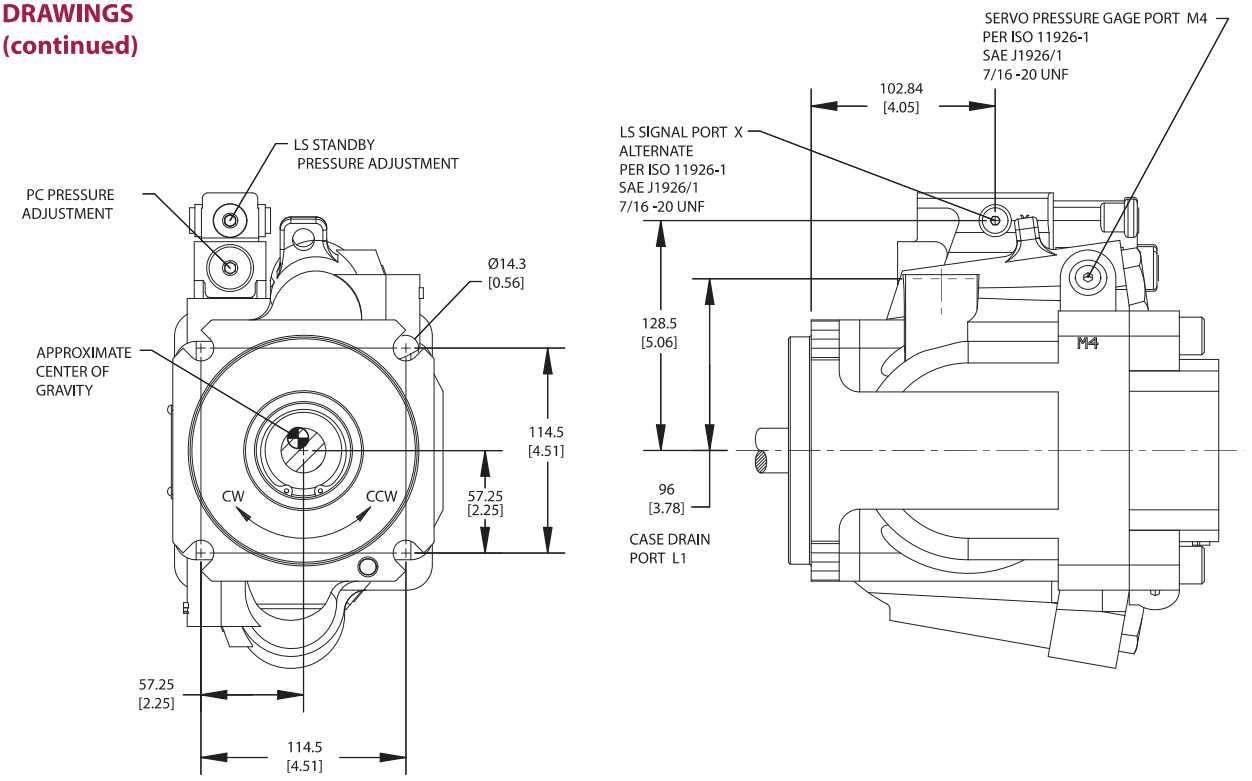
The chart on the right shows allowable inlet pressure and speed at various displacements. Greater speeds and lower inlet pressures are possible at reduced displacement. Operating outside of acceptable limits reduces pump life.

Inlet pressure vs. speed



INSTALLATION DRAWINGS (continued)

Axial ported endcap (continued)



P104 074E

Third-angle projection mm [in]

CONTROLS

Pressure compensated control (PC)

Specifications

PC control setting range

Model	bar	psi
E100B	100–310	1450–4495
E130B	100–310	1450–4495
E147C	100–260	1450–3770

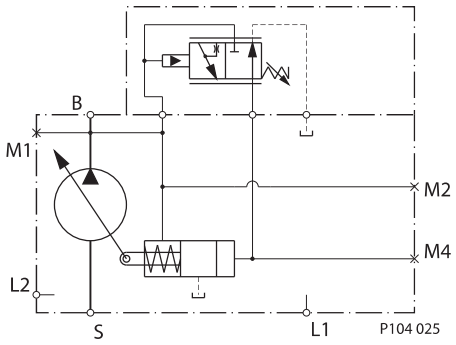
*Response/recovery times**

(ms)	Response	Recovery
E100B	45	175
E130B	55	175
E147C	60	190

* For definitions, *see page 9*.

Schematic diagram

PC schematic



Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
M4 = Servo pressure gauge port

Remote PC control (RP)

Specifications

PC control setting range

Model	bar	psi
E100B	100–310	1450–4495
E130B	100–310	1450–4495
E147C	100–260	1450–3770

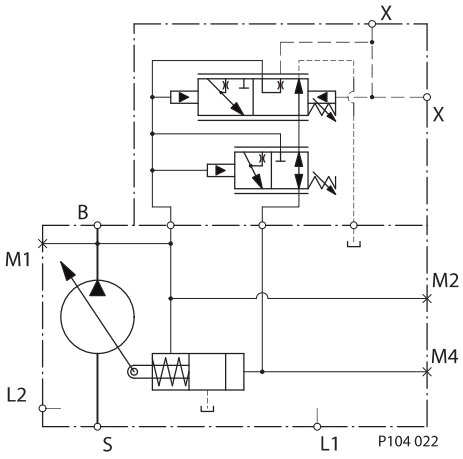
*Response/recovery times**

(ms)	Response	Recovery
E100B	45	175
E130B	55	175
E147C	60	190

* For definitions, *see page 10*.

Schematic diagram

Remote PC schematic

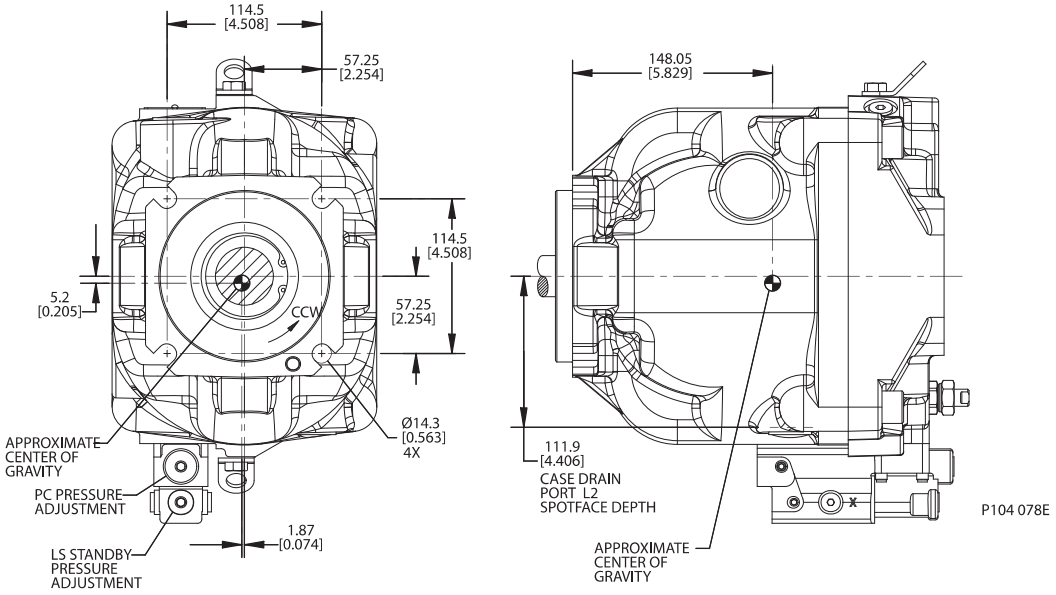


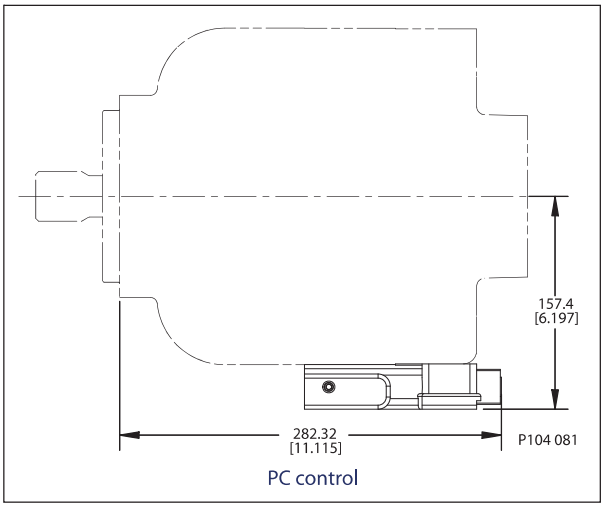
Legend

B = Outlet
S = Inlet
L1, L2 = Case drain
M2 = System pressure gauge port
M4 = Servo pressure gauge port
X = Remote PC port

INSTALLATION DRAWINGS (continued)

Axial ported endcap, counterclockwise rotation (continued)





Third-angle projection
mm [in]

RAVEN INDUSTRIES

LIMITED WARRANTY

WHAT IS COVERED?

This warranty covers all defects in workmanship or materials in your Raven Flow Control Product under normal use, maintenance, and service.

HOW LONG IS THE COVERAGE PERIOD?

This warranty coverage runs for 12 months from the purchase date of your Raven Flow Control Product. This warranty coverage applies only to the original owner and is not transferrable.

HOW CAN YOU GET SERVICE?

Bring the defective part, and proof of date of purchase, to your local dealer. If your dealer agrees with the warranty claim, he will send the part, and proof of purchase to his distributor or to Raven for final approval.

WHAT WILL RAVEN INDUSTRIES DO?

When our inspection proves the warranty claim, we will, at our option, repair or replace the defective part and pay for return freight.

WHAT DOES THIS WARRANTY NOT COVER?

Raven Industries will not assume any expense or liability for repairs made outside our plant without written consent. We are not responsible for damage to any associated equipment or product and will not be liable for loss of profit or other special damages. The obligation of this warranty is in lieu of all other warranties, expressed or implied, and no person is authorized to assume for us any liability. Damages caused by normal wear and tear, mis-use, abuse, neglect, accident, or improper installation and maintenance are not covered by this warranty.

3. MOUNTING THE CONTROL VALVE (LIQUID APPLICATIONS)

1) Mount the motorized Control Valve in the main hose line between the Flow Meter and the booms, with motor in the upright position. (For flow less than 3 GPM [11 lit/min], the motorized Control Valve is mounted in a by-pass line. Refer to Appendix 3 for alternate plumbing diagram).

2) Connect the Product Cable connectors to boom valves, Flow Meter, and motorized Control Valve. (Reference Figure 5 or Figure 6) NOTE: Black wire to boom valve #1, Brown wire to boom valve #2, Blue wire to boom valve #3, Black/White wire to boom valve #4, Brown/White wire to boom valve #5, Blue/Wht wire to boom valve #6, White/Black wire to boom valve #7, White/Brown wire to boom valve #8, White/Blue wire to boom valve #9 and Pink wire to boom valve #10.

6) Selecting STD VALVE, FAST VALVE, FST CLS VALVE, PWM VALVE or PWM CLS VALVE.

a) To select STD VALVE, FAST VALVE, FST CLS VALVE, PWM VALVE or PWM CLS VALVE, step [CE] until desired code is displayed.

b) Momentarily depress [ENTER], the display will now display METER CAL (liquid mode) or SPREADER CONSTANT (granular mode).

7) For Liquid applications, enter METER CAL calibration number. For Granular applications, enter SPREADER CONSTANT and PRODUCT DENSITY or METER CAL. Use [METER CAL 5] to toggle between Spreader Constant and Product Density/Meter Cal.

8) Enter appropriate VALVE CAL calibration number (2123, 743, or 43).

9) Enter the target RATE CAL (GPA) [lit/ha] {GPK}.

10) Repeat steps 3-9 for multiple products. Active product will be highlighted.

11) Display WHEEL-SP1 or RADAR-SP2.

a) Depressing momentarily [CE] steps the display from WHEEL-SP1 to RADAR-SP2.

b) Depressing momentarily [CE] steps the display from RADAR-SP2 to WHEEL-SP1.

12) Selecting WHEEL-SP1 or RADAR-SP2.

a) To select WHEEL-SP1 or RADAR-SP2, step [CE] until desired code is displayed.

b) Momentarily depress [ENTER], the display will now display SPEED CAL.

13) Enter SPEED CAL calibation number.

14) Enter BOOM CAL calibration numbers.
Definition of Boom Calibration Keys.

[BOOM CAL 3] Depressing this key displays selected boom number in display.
EXAMPLE: Boom 1 will be displayed as BOOM 1 CAL.

[▲ 1] Depressing this key after selecting BOOM CAL changes the boom number.
EXAMPLE: BOOM 1 CAL 0 to BOOM 2 CAL 0.

[▼ 2] Depressing this key after selecting BOOM CAL changes the boom number.
EXAMPLE: BOOM 2 CAL 0 to BOOM 1 CAL 0.

Enter Boom Data:
a) Select Boom 1 CAL.
b) Use boom width as calculated under "CALCULATING BOOM CAL".
c) If a boom is not needed, enter a "0" for the length.

7. Data logging is now ready to begin. Press ▽ 2 until DATA LOGGER OFF appears. Press CE to turn DATA LOGGER ON. The percentage of the CF card used will appear in the lower section of the LCD. If no card is inserted, the display will read "DISK NONE". If the card is full, the display will read "DISK FULL". A flashcard graphic appears above the disk percentage to indicate that data is being saved to the card. A GPS icon appears above the disk percentage to indicate the GPS signal is being received. (See Figure 9)

8. Proceed with application normally. When finished with operation, press the DATA MENU key to bring up DATA LOGGER ON. Press CE key to turn DATA LOGGER OFF. When finished with operation, switch power OFF and then remove CF card.

9. Data logging settings will be saved for future use. When starting a new operation, press the DATA MENU key to turn DATA LOGGER ON.

CAUTION:	DO NOT REMOVE OR INSERT COMPACT FLASH CARD WITH CONSOLE POWER TURNED ON. DATA MAY BECOME CORRUPTED. USE ONLY SANDISK BRAND COMPACT FLASH CARDS.

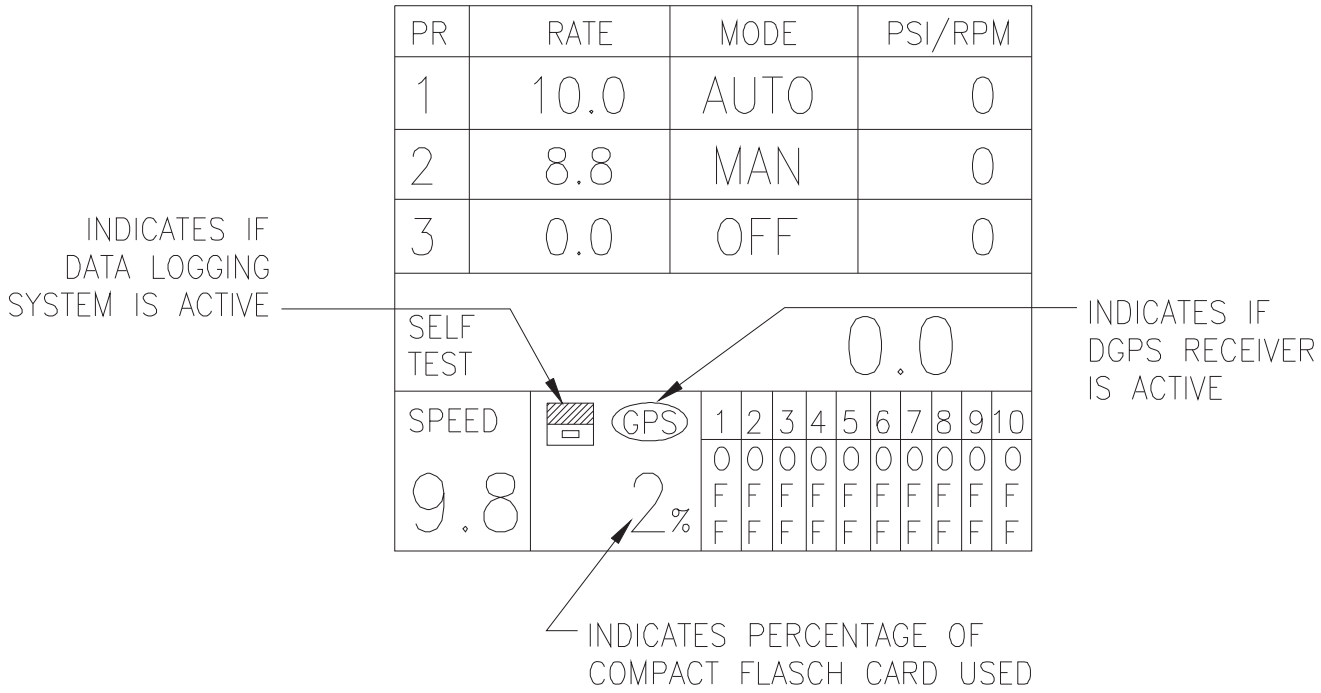


FIGURE 9
SCS 4400/4600 DISPLAY

CONSOLE CALIBRATION

1. CALCULATING "BOOM CAL"

Enter the total width of the spread pattern in inches [cm] as boom length.

2. CALCULATING "SPREADER CONSTANT"

1) Find the cubic feet [Cubic cm] of discharge per 1 revolution of the sensor.

L = Length in inches [cm], of belt travel per 1 revolution of sensor
GH = Gate Height in inches [cm]
GW = Gate Width in inches [cm]

Cubic Feet [cubic cm] of Discharge per 1 revolution of sensor:

$$\text{cu ft/rev. of sensor} = \frac{L \times GH \times GW}{1728}$$

cu cm/rev. of sensor **=** L x GH x GW

EXAMPLE: 1) L = 13 inches [33 cm]
2) GH = 7 inches [18 cm]
3) GW = 15 inches [38 cm]

$$\text{cu ft/rev. of sensor} = \frac{13" \times 7" \times 15"}{1728} = .789$$

cu cm/rev. of sensor **=** 33 x 18 x 38 = 22,572

2) For RATE displayed in 1 lb increments:

$$\text{Spreader Constant (1 lb)} = \frac{\text{counts per rev of sensor}}{\text{cu ft/rev. of sensor}}$$

EXAMPLE: 180 counts per rev $= \frac{180}{.789} = 228$

3) For RATE displayed in 1 Kg increments

$$\text{Spreader Constant (1 Kg)} = \frac{\text{counts per 1 rev of sensor x 100,000}}{\text{cu cm / rev of sensor}}$$

EXAMPLE: 180 counts per rev $= \frac{18{,}000{,}000}{22{,}572} = 797$

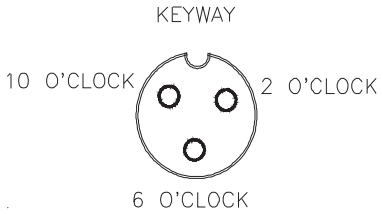
Counts per 1 rev of sensor may be determined by entering a METER CAL number of 10, SPREADER CONSTANT of 0, and TOTAL VOLUME of 0 and turning sensor exactly 1 revolution. The number in TOTAL VOLUME will be the counts per 1 rev of sensor.

For systems where calculating volume of discharge is difficult (metering wheels, augers, etc.), Spreader Constant can be determined by perfoming a catch test.

21)	COMPACT FLASH CARD NOT RECOGNIZED.	1) Reboot console. 2) Replace compact flash card. 3) Return console to dealer for service.
22)	DISPLAY READS "LOOKING FOR DATA TO FLASH IC WITH"	1) Console was put into program update mode. Unhook cable from console, wait 30 seconds, and reboot console. Wait for program to be restored.
23)	LCD CONTRAST IS TOO DARK OR TOO LIGHT	1) To lighten LCD contrast, hold key [1]. After one second, contrast will begin to lighten until key [1] is released. 2) To darken LCD contrast, hold key [2]. After one second, contrast will begin to darken until key [2] is released. 3) LCD contrast can also be adjusted from the Console Menu within the Data Menu.
24)	CONSOLE DISPLAYS "CHECK CAN NODES OR CAN COMMUNICATION"	1) If no CAN nodes are attached to the CAN bus, press [DATA MENU] key. CAN menu will appear and CAN node options will automatically be shut off. Operation can then be resumed as normal. 2) Verify that CAN nodes and console are connected to the CAN bus and that the cabling between them is connected and in tact. 3) Verify that terminators are placed at both ends of the CAN bus. 4) Verify that CAN nodes have logic power and ground are properly connected and energized and no fuses are blown on power leads. 5) Verify that CAN power adapter "T" cable is plugged in at the front of the CAN bus and 12V switched power is applied to the bus. 6) Reboot the console. 7) Contact service technician for CAN system repair.
25)	CONSOLE DISPLAYS "CHECK CONTROL NODE x" (where x refers to 1, 2, or 3)	1) If Product Control Node x is not connected to the CAN bus, press [DATA MENU] key. CAN menu will appear and CAN node options can be toggled ON and OFF using the [CE] key. Operation can then be resumed as normal. 2) Verify that Product Control Node x is connected to the CAN bus. 3) Verify that Product Control Node x has logic power and ground properly connected and energized and no fuses are blown on power leads. 4) Verify that CAN bus cabling from the console to the node is connected and in tact.

APPENDIX 5
PROCEDURE TO TEST FLOW METER CABLES

Disconnect cable from Flow Meter. Hold Flow Meter cable so that the keyway is pointing in the 12 o'clock position:



PIN DESIGNATIONS
2 o'clock socket location is ground.
10 o'clock socket location is power.
6 o'clock socket location is signal.

VOLTAGE READINGS
1) 2 o'clock socket to 6 o'clock socket = +5 VDC.
2) 2 o'clock socket to 10 o'clock socket = +5 VDC.

If a +5 VDC voltage reading is not present, disconnect the Speed Sensor cable. If the voltage reading is restored, test the Speed Sensor cable per Appendix 4, "PROCEDURE TO TEST SPEED SENSOR EXTENSION CABLES".

PROCEDURE TO CHECK CABLE:

1) Enter a METER CAL number of one (1) in key labelled METER CAL 5 .

2) Depress key labelled TOTAL VOLUME .

3) Place BOOM switches and MASTER switch to ON.

4) With small jumper wire (or paper clip), short between the 2 o'clock and 6 o'clock sockets with a "short-no short" motion. Each time a contact is made, the TOTAL VOLUME should increase by increments of 1 or more counts.

5) If TOTAL VOLUME does not increase, remove the section of cable and repeat test at connector next closest to Console. Replace defective cable as required.

6) Perform above voltage checks.

7) If all cables test good, replace Flow Meter.

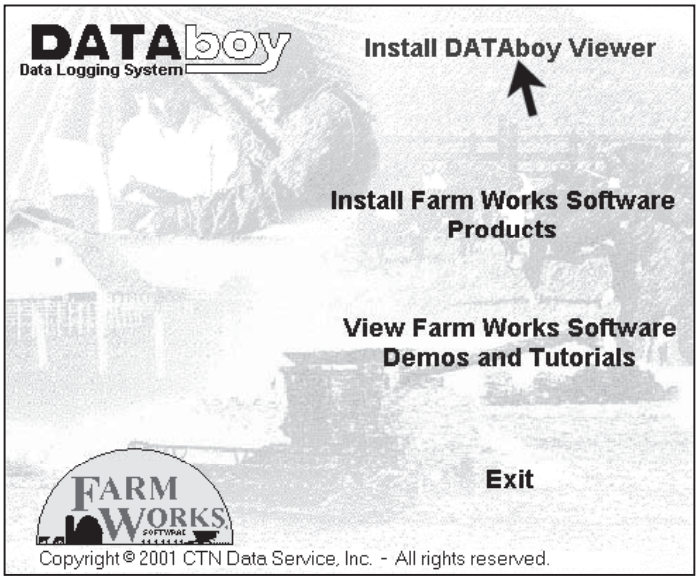
NOTE: After testing is complete, re-enter correct METER CAL numbers before application.

APPENDIX 15
DATAboy Viewer Installation

The DATAboy Viewer software is an optional software program (p/n 077-0171-138) that the user can install on a desktop or laptop computer to view the maps created with DATAboy.

SOFTWARE INSTALLATION

1. Insert the Farm Works CD into the appropriate CD ROM drive. Windows will automatically start the installation process for you. (If it does not start automatically, choose RUN from the START menu if you are using Windows 95 or higher. Type D:\SETUP in the box (where "D" is your CD ROM drive) and choose OK.)
2. Select Install DATAboy Viewer from the installation screen.
3. Follow the instructions on the screen to complete the installation process.



REGISTRATION

1. The registration screen will appear on the initial startup of DATAboy Viewer program.
2. There are three ways to register your software:
   * Call 800-225-2848 and provide the Install ID number shown on the screen.
   * Go to the website online listed *http://www.farmworks.com/databoy/register.cgi* and fill out the registration screen.
   * Send e-mail to *databoy@ctndata.com* with your name, address, phone number, and Install ID.
3. When you receive the registration number, enter in the Registration Number box and choose OK.

FOAMHEAD TUBING

Route one 3/8" and one ¼" poly tube from each foamhead assembly to the power unit. The 3/8" line routes the air to the foamhead and the ¼" line routes the liquid to the foamhead. Beginning at the end of your boom, attach the tubing using nylon cable ties, provided, to secure the tubing at 3 to 6 foot intervals. These ties assure a positive clamping without damaging the tubing. Be sure to leave enough slack at the hinge to fold and extend the spray boom. Repeat this procedure for the other ½ of your boom.

DROP HOSE

After the foamhead and boom end assemblies are in place, the 1 ½" drop hoses are secured onto the boom end elbow assembly with the #28 hose clamps provided. The drop hoses should be trimmed so the discharge end is left approximately 1 foot above the ground or to desired length. If Collector Deflectors are to be used, it may be desirable to trim drop hoses higher. This will prevent loss of the collectors from impact with the ground.

FOAM STREAMERS™

Neon Orange Foam Streamers are standard equipment with all VERSATRAC foam markers. When placed on the drop hose, these attachments produce a stream of foam. This will be particularly effective in "over the top" post emergent crop conditions.

COLLECTOR DEFLECTORS

Collector Deflectors are standard equipment on VERSA TRAC foam markers. Collector Deflectors, when attached to the drop hose, will produce a larger, denser foam ball. The resulting foam ball will be more visible due to its size, and will last longer on the ground. However, the heavier foam from Collector Deflectors normally will not stay on top of vegetation when post-emergent spraying. You may choose to remove the Collector Deflectors and install foam streamers, under these conditions.

SWITCH BOX

Mount the switch box in a location convenient to the operator. VERSA TRAC foam markers are equipped with an electrical plug assembly. This plug assembly allows for easy separation of the switch plate from the power unit. After the switch plate and power unit are installed, connect the plug assembly.