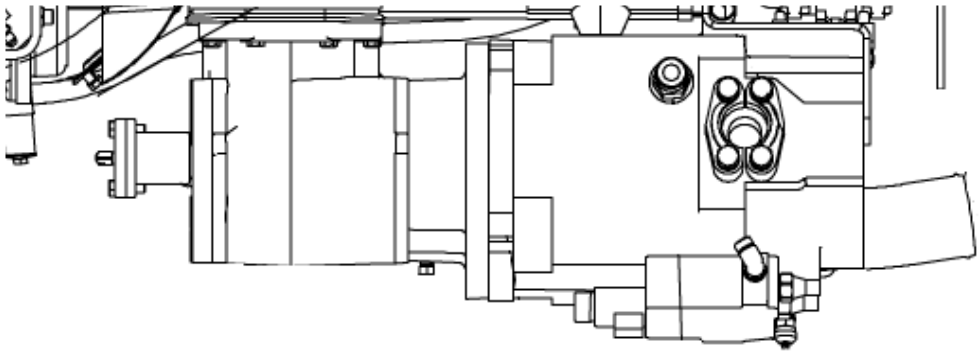
GRADALL System Operation

Highway speed models
XL3100-III
XL4100-III
XL5100-III

Gradall Industries, Inc.

ALAMO GROUP

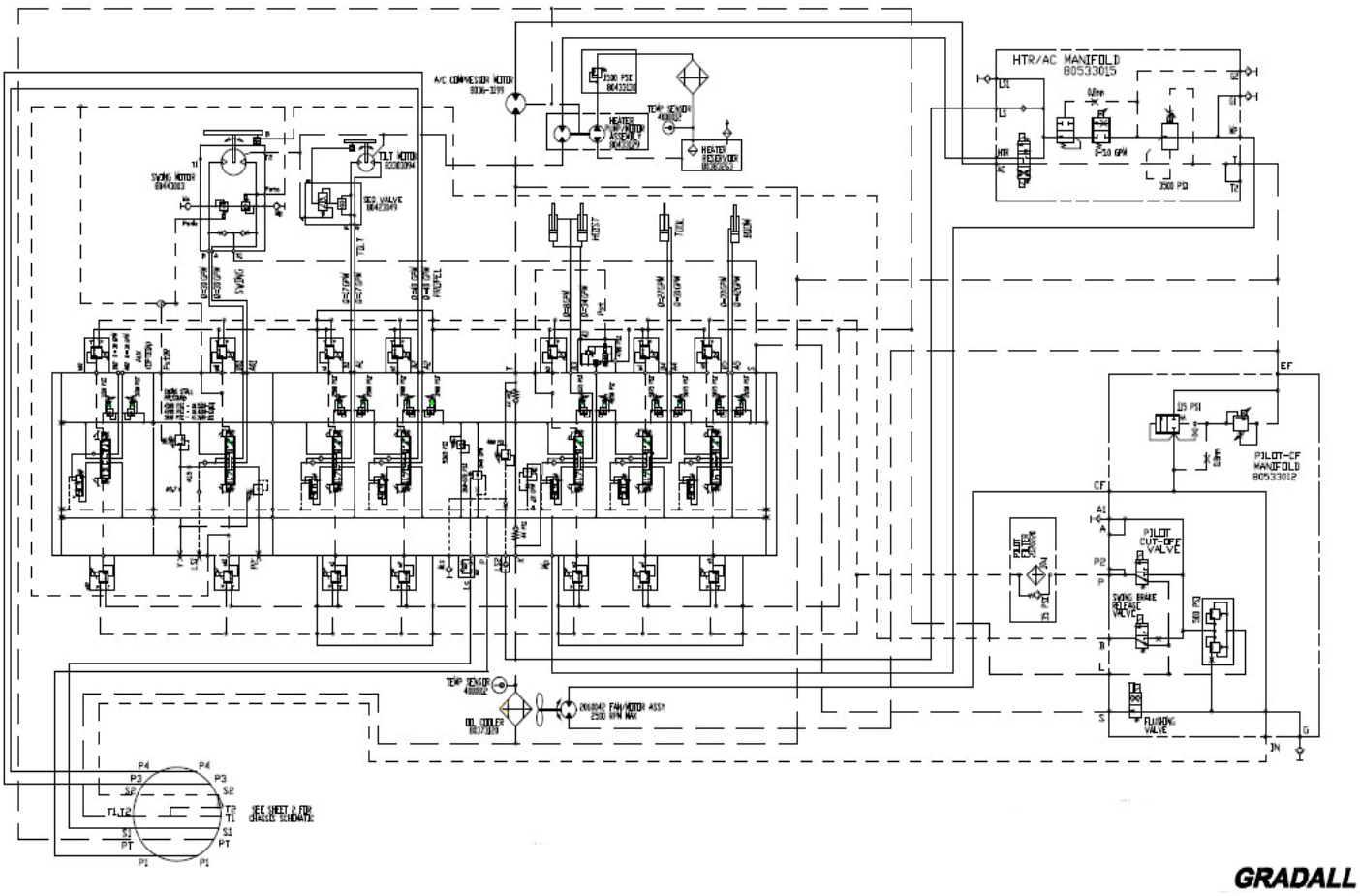
Hydraulic System Introduction



GRADALL XL series Highway Speed Excavators machines use hydraulics to power all major machine functions. Hydraulics provide power, speed, control, and flexibility to perform machine operation. The system is a variable flow, load sensing system made up of *components* that work together within the system.

This training will provide insight into the component operation within the system. Understanding the components makes understanding the system simpler.

Hydraulic System Overview



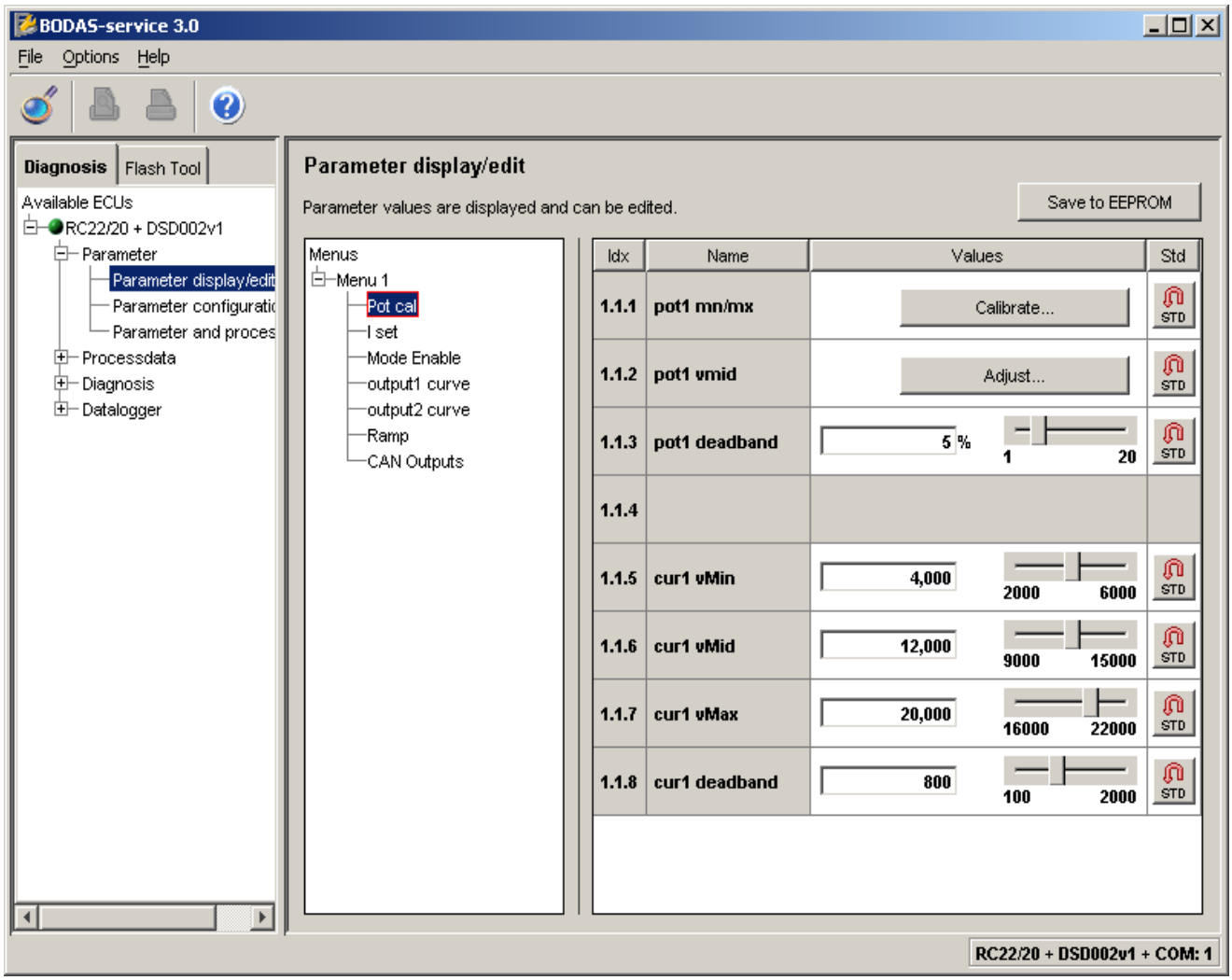
The hydraulic system, when viewed as a schematic, appears very complex. Yet the system is merely many simple components and circuits working together. The schematic shows the entire system, today's program will break the complex system into components and circuits within the system.

Hydraulic Pressure Gauge Kits

Gradall has hydraulic pressure gauge kits available for troubleshooting use. Gauge kit 80404127 is a digital gauge kit that supplies a gauge, hoses, and extra test adapters.

Digital gauges provide much better accuracy for use on high pressure hydraulic systems.

Bodas Software

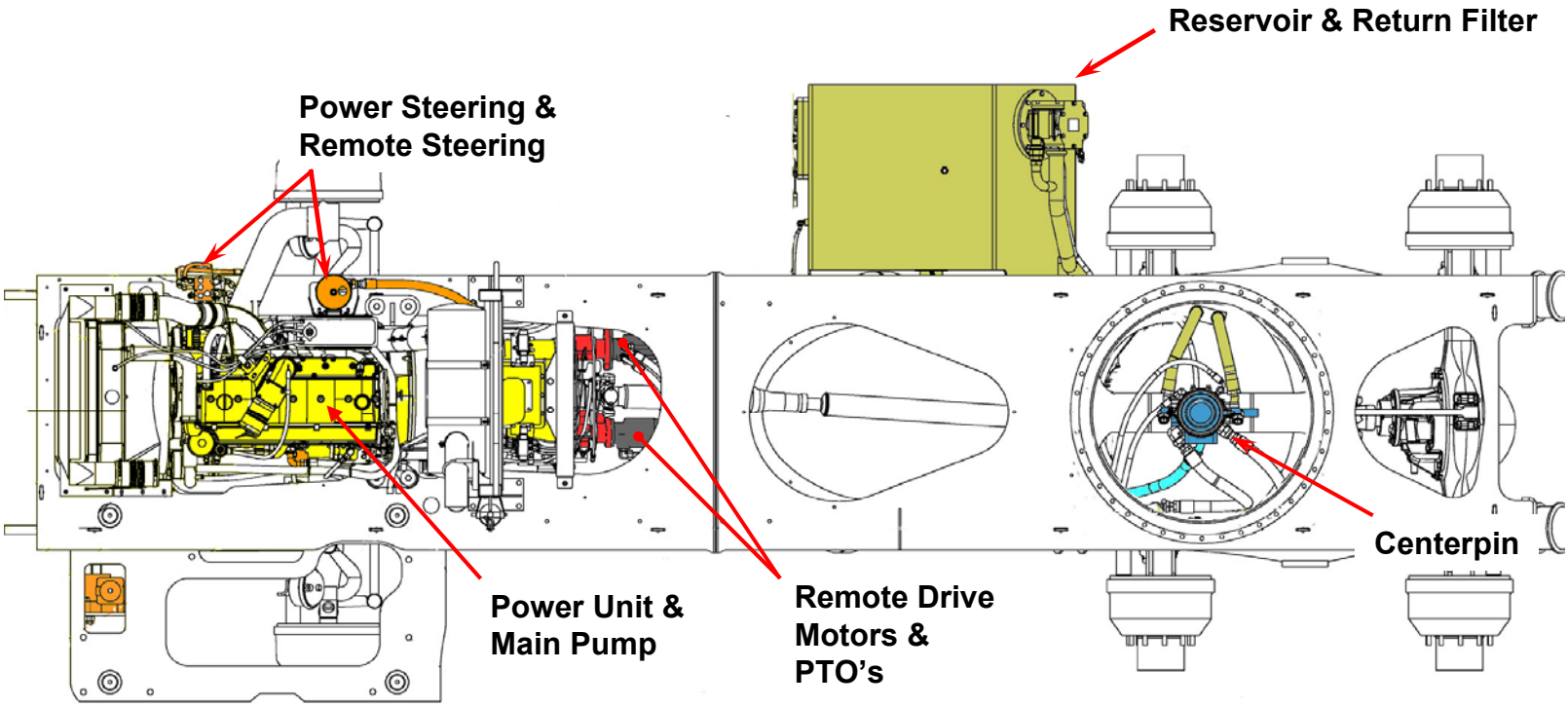


Bodas software is used to communicate with the machine processors & a PC based laptop. Bodas software is available from Gradall as P/N 80414109 and cable kit 80364206.

Bodas allows for troubleshooting the electronic control system and check/adjust parameters as needed.

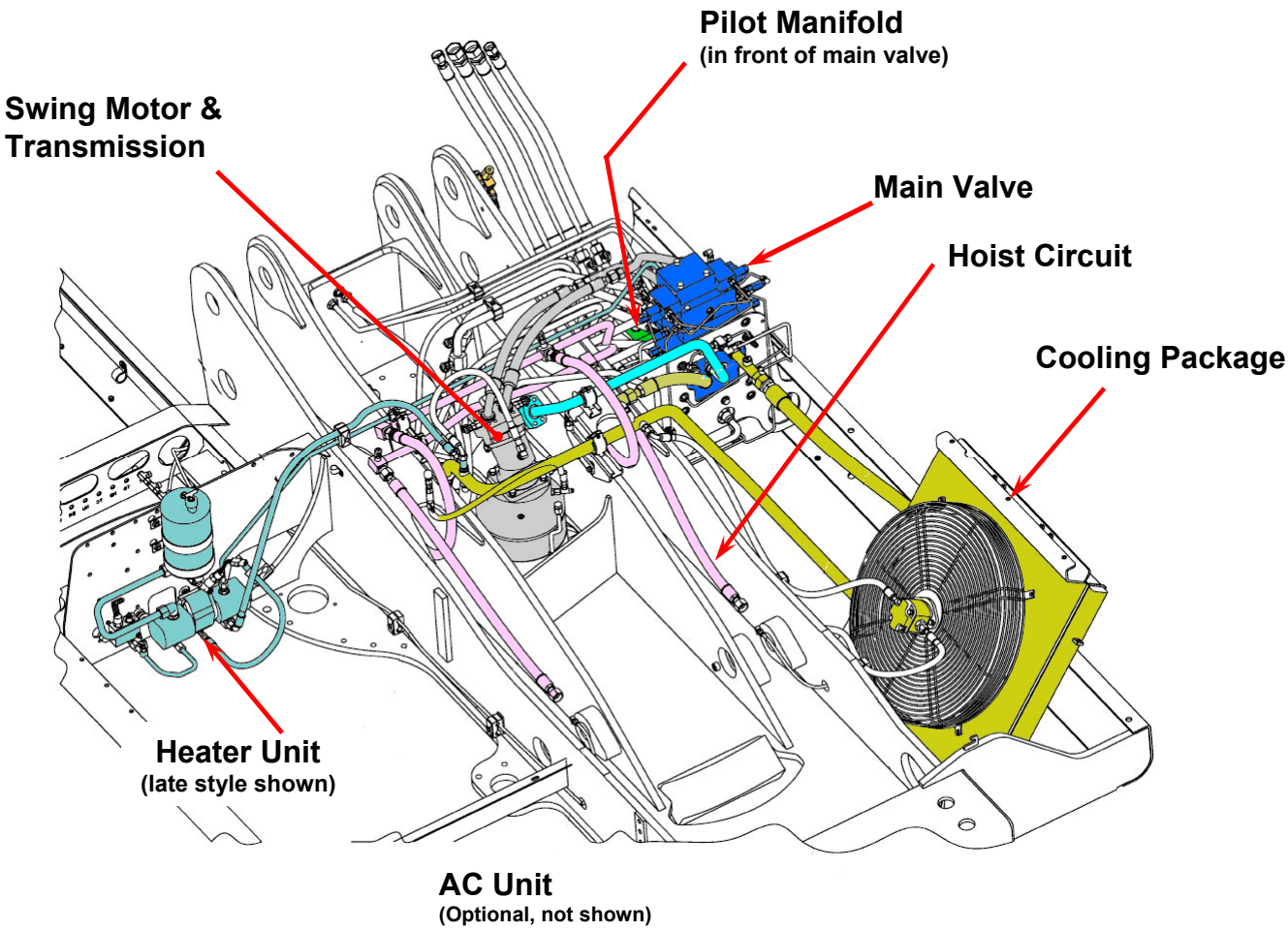
Bodem software and the BB3 handheld are no longer available, but existing versions work with Series III machines.

Chassis Hydraulic Component Locations



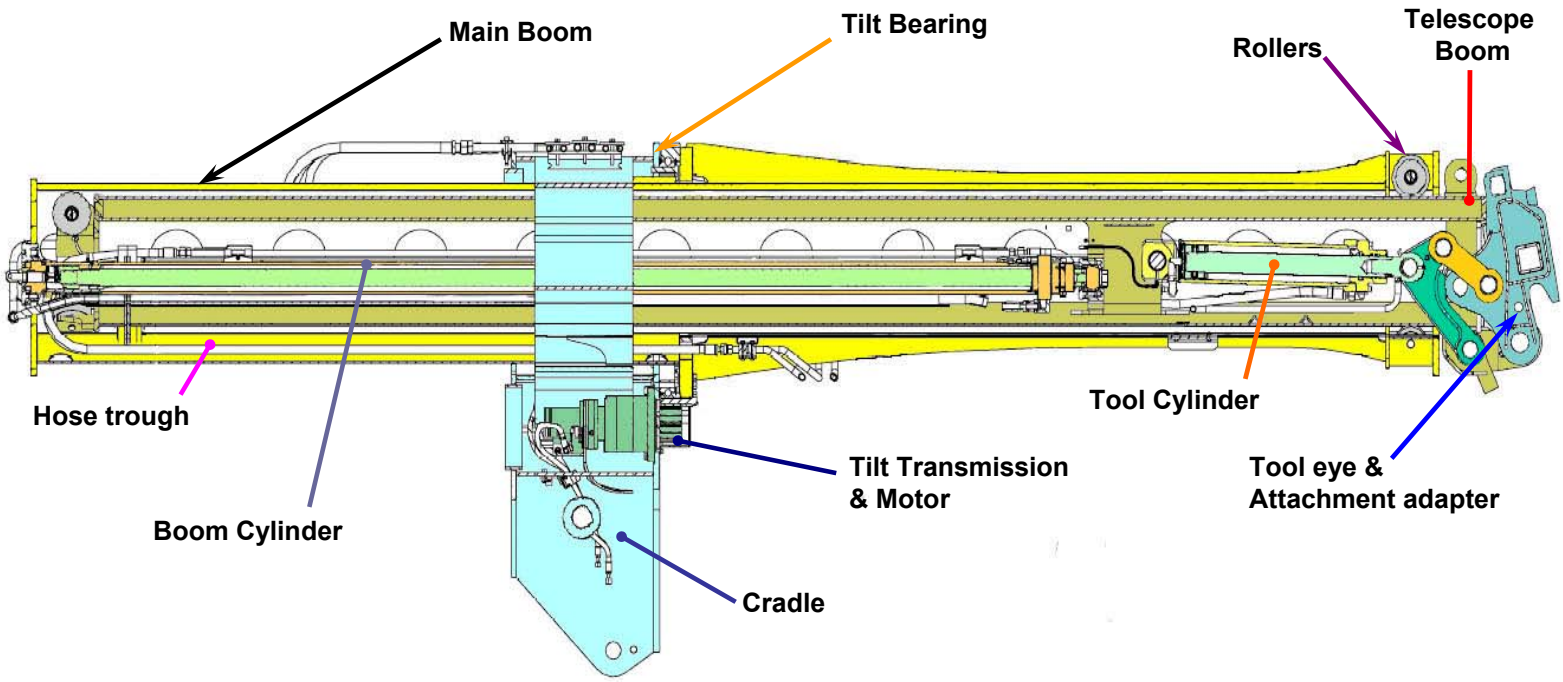
Highway speed machines also have major hydraulic components located on the chassis. As a single engine machine, the chassis power unit not only drives the highway speed carrier but also provides power for the hydraulic pump. Reservoir and filter are mounted on the chassis also. Some other chassis mounted hydraulic components are center pin, remote drive motors, remote steering, and power steering.

Frame Hydraulic Component Locations



Upper frame provides mounting platform for cab, boom, and other major components. Hydraulic components mounted on the frame include hoist cylinders for boom, main valve, hydraulic heater, air conditioner, cooling package, pilot manifold and controls, and other components.

Boom Hydraulic Component Locations

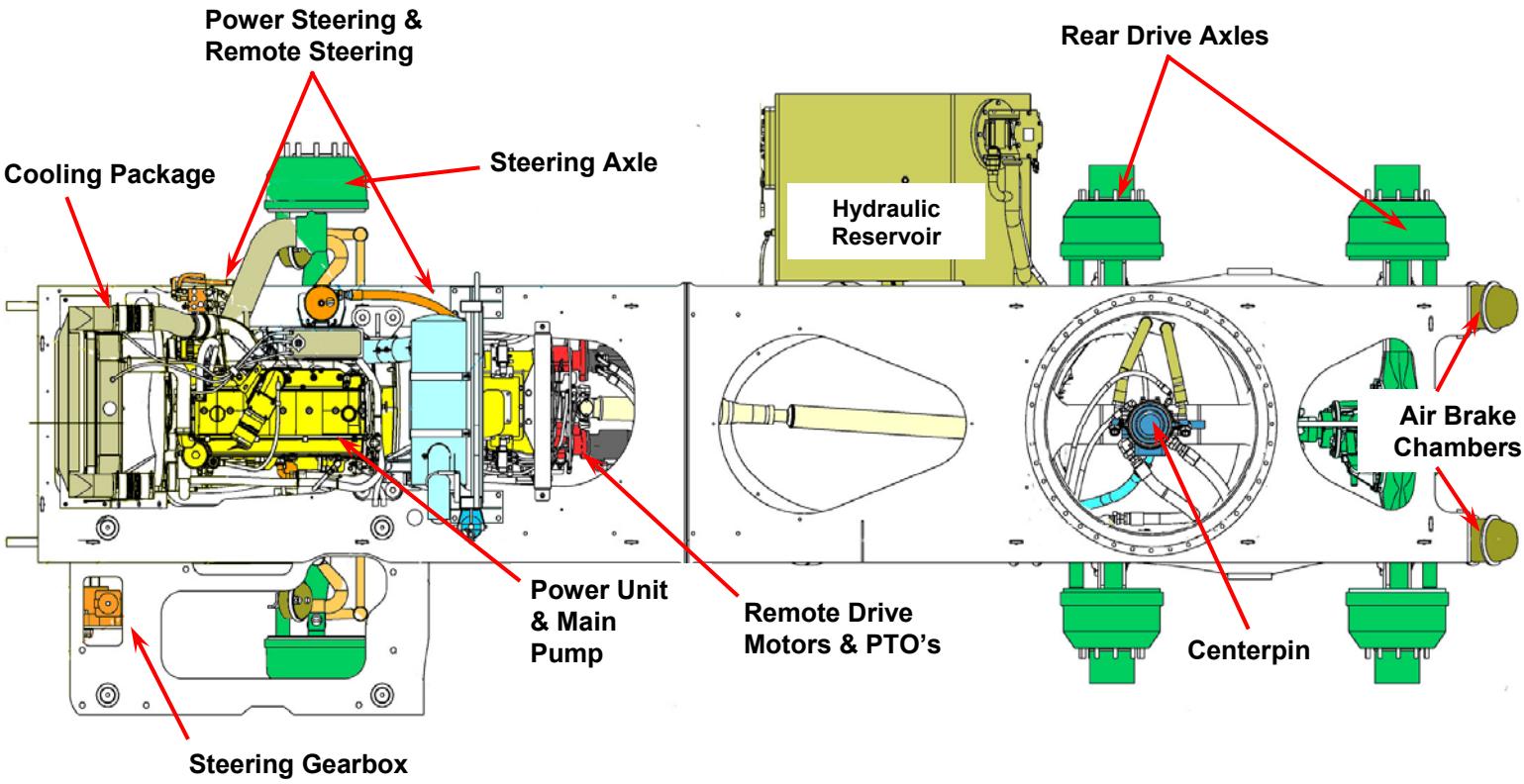


Boom and cradle consist of 3 major weldments: Cradle which pivots on machine frame, Main boom attached to cradle by tilt bearing, Telescope boom which rides inside of main boom using rollers. A “tool eye” at end of telescope is used to for attachment installation and operation.

The boom cylinder moves the telescope boom in/out, The tool Cylinder moves the attachment. A tilt transmission and motor works with the tilt bearing to tilt the boom assembly.

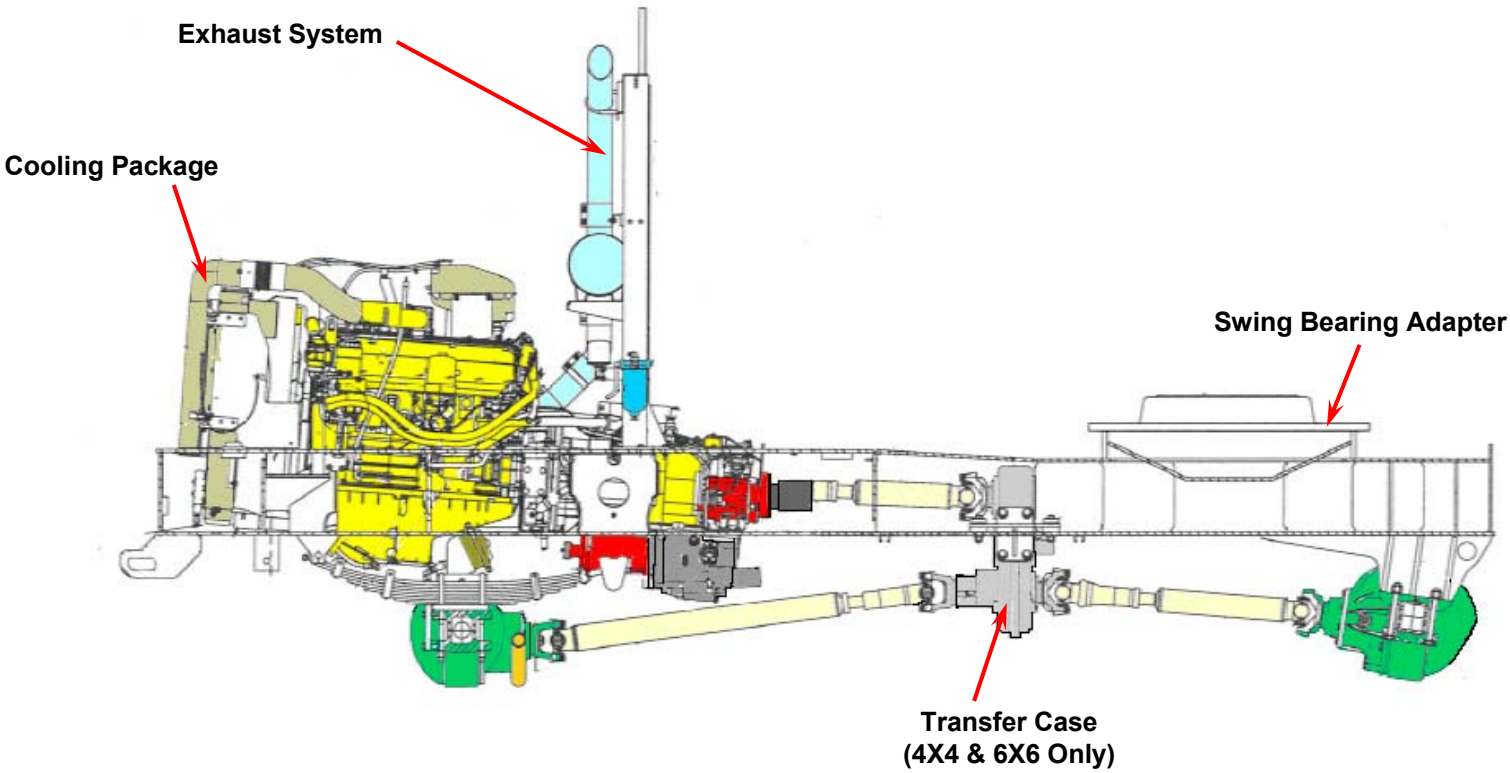
A hose trough provides area for the tool hoses to move with the telescope boom.

Highway Speed Chassis



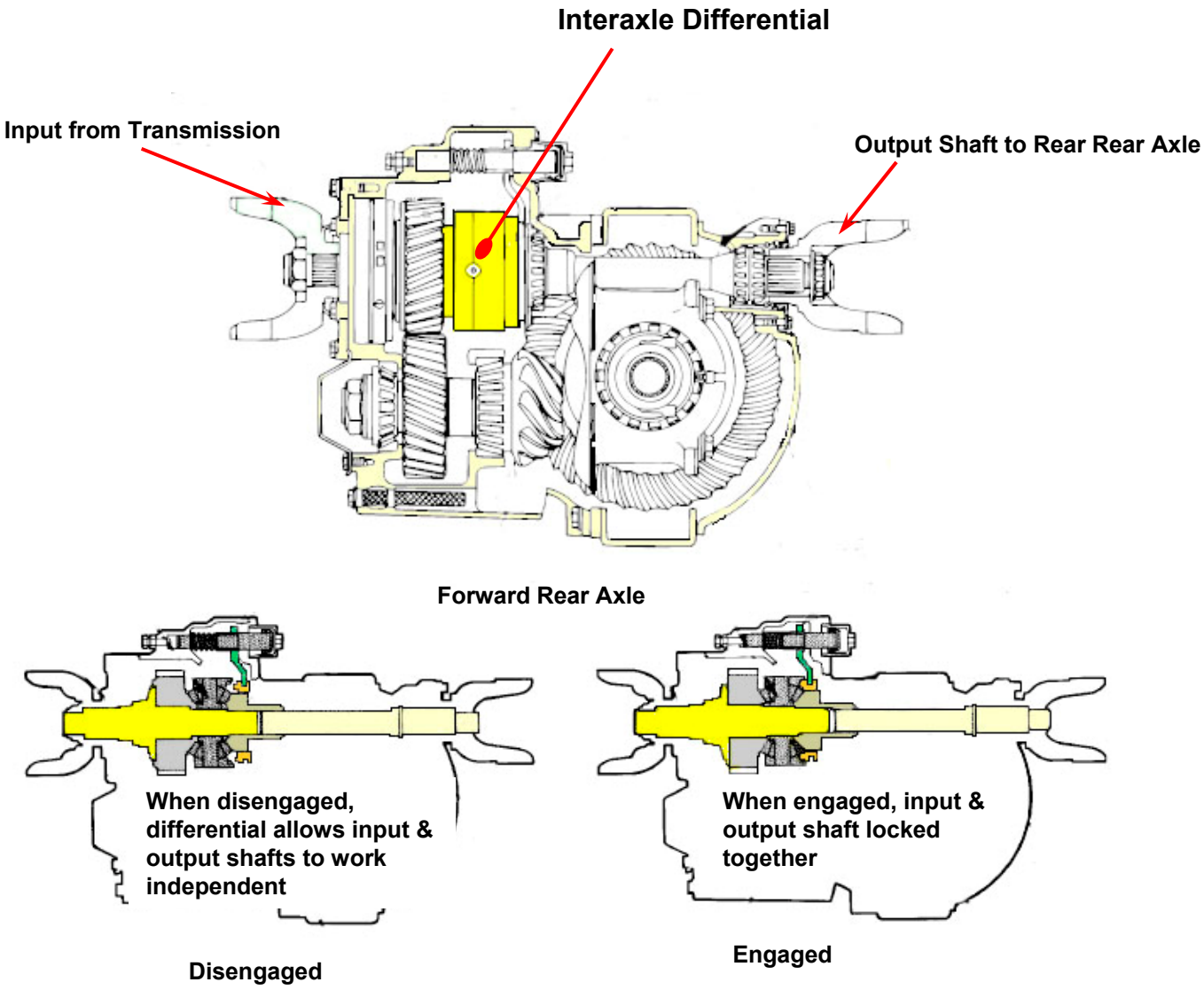
Highway speed excavators have a highly specialized chassis. It provides mounting for upper structure, highway operation, and remote drive operation from the excavator. The engine of the highway speed machines also provide power for the excavator operation. The chassis is equipped with axles, transmission, brakes, steering gear, and other components required to provide dual operation of the undercarriage.

Highway Speed Drive Train



Side view of highway speed chassis showing additional components and location. Some optional equipment is shown for reference.

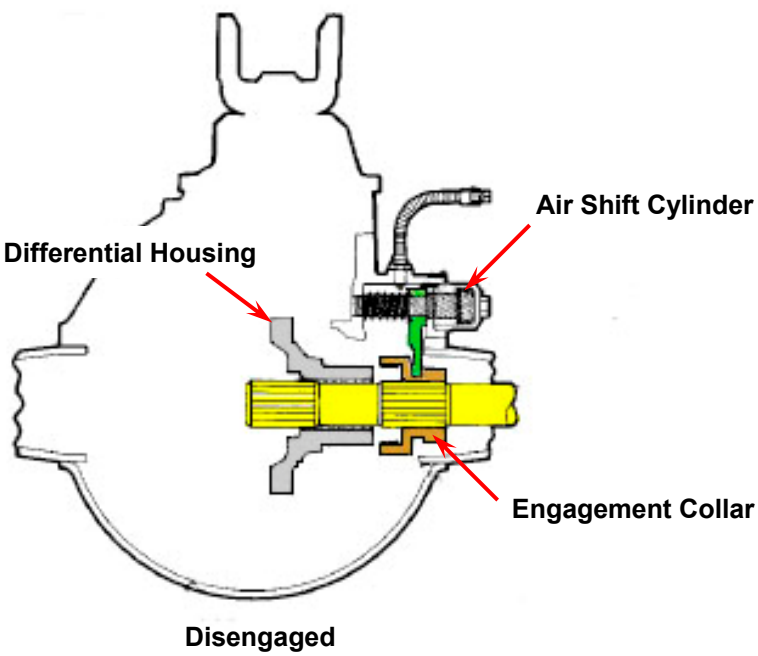
Differential Operation
XL4100-III & XL5100-III



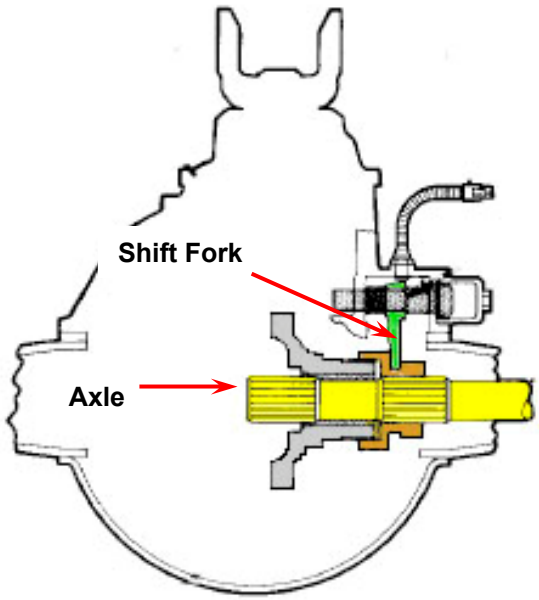
XL4100-III & XL5100-III machines have an interaxle differential as part of the forward rear differential. The interaxle differential is driver controlled for lock/unlock. Locking the differential allows power to be transmitted to both rear axles in poor traction conditions. The interaxle differential should never be engaged with wheels spinning.

It is recommended the interaxle differential be engaged during excavator operation to provide maximum traction while moving the excavator in remote control

Differential Lock Operation



Disengaged

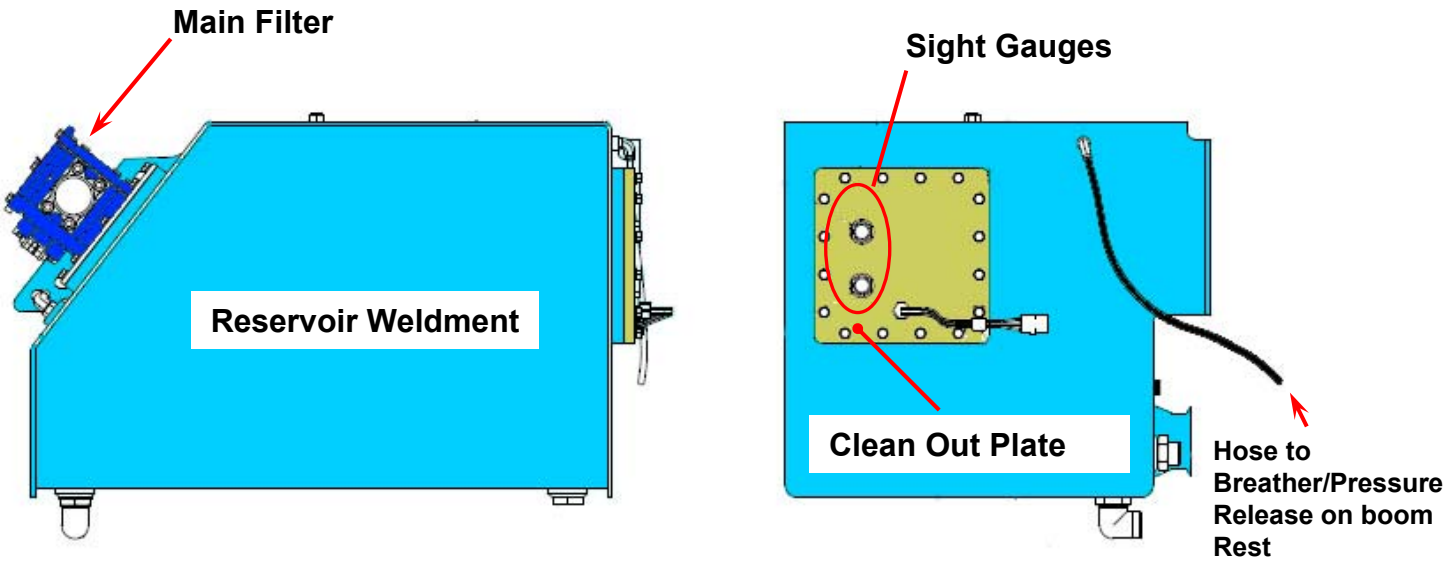


Engaged

Forward rear axle on machines with 2 axles and rear axle on XL3100-III have a differential lock. Differential lock is driver controlled. A differential lock engages the differential to allow drive to both axles for traction. It should never be engaged with the wheels spinning.

It is recommended the differential lock be engaged during excavator operation for maximum traction when moving the excavator in remote control.

Reservoir & Filtration

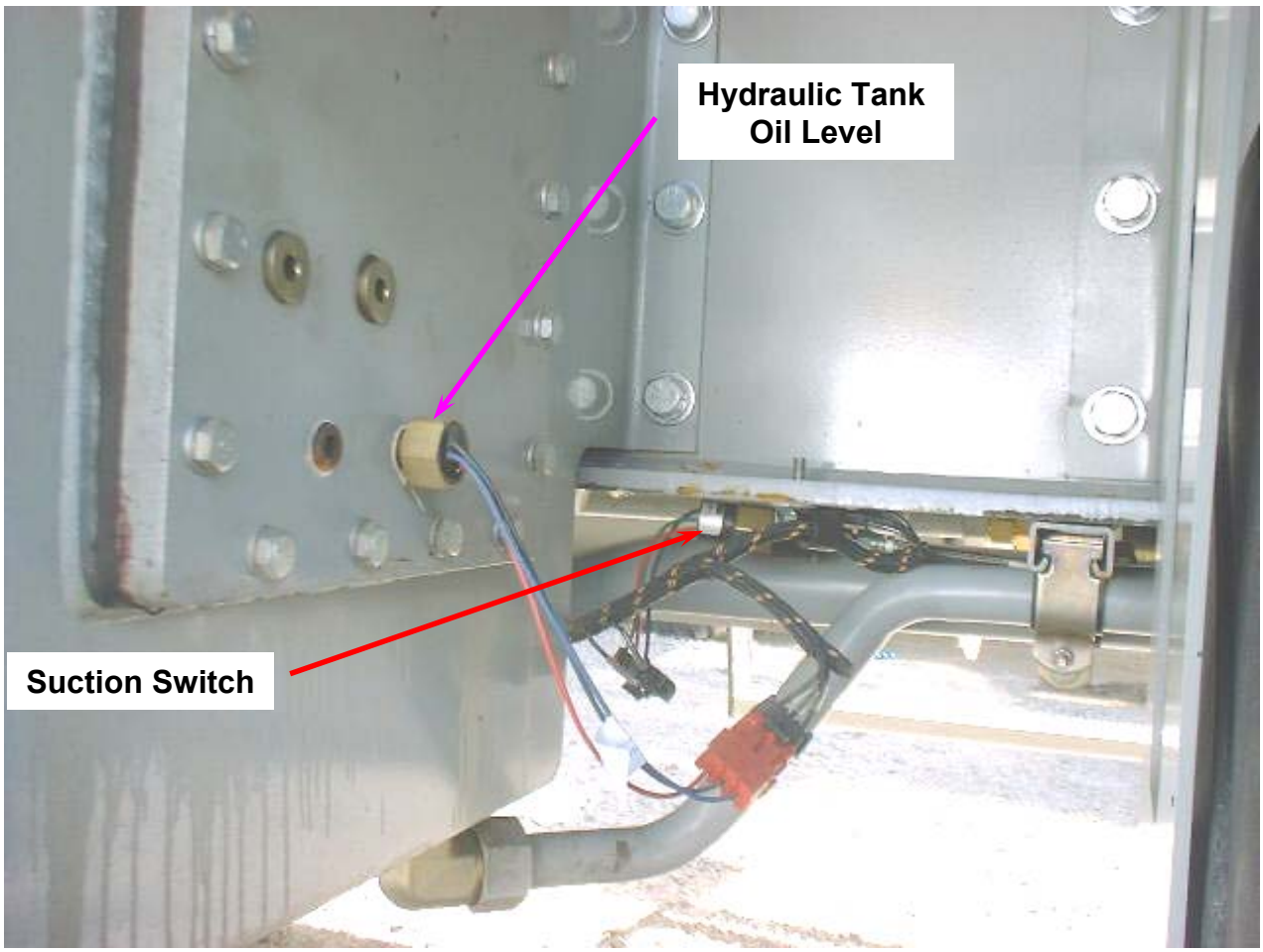


Reservoir and main filter are mounted on RH side of the undercarriage. The reservoir weldment is bolted to the frame and provides mounting for the main filter.

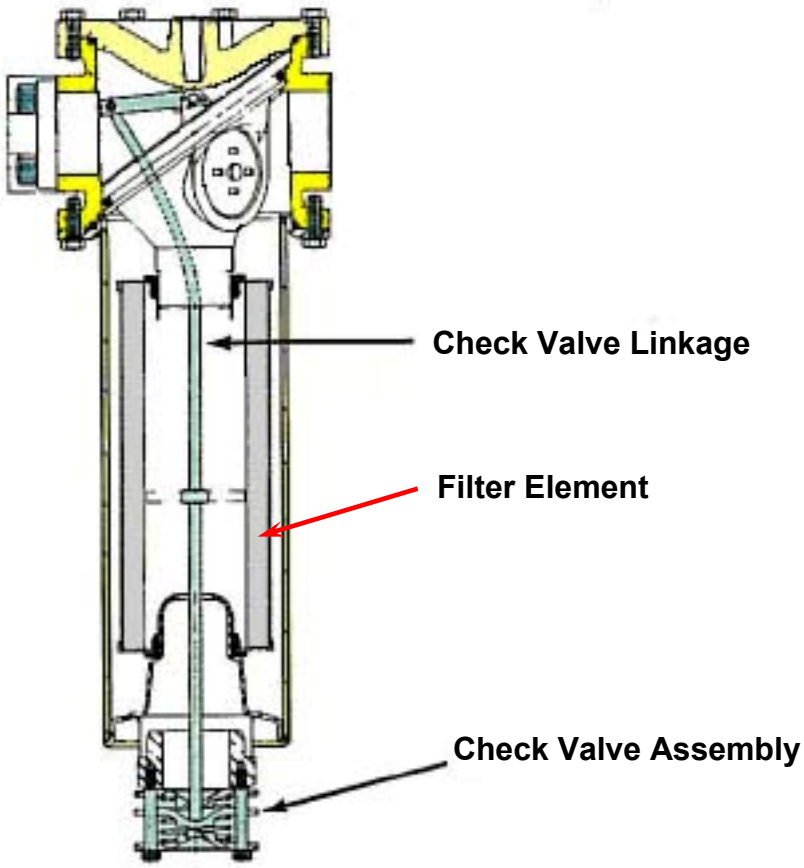
Reservoir has a capacity of 50 gallons (189 L) with a system capacity of 70 gallons (265 L) on XL4100-III/XL5100-III. XL3100-III machines have a system capacity of 65 gallons (246 L). Standard hydraulic oil is a mineral oil (Mobil 424).

Reservoir has internal baffles, clean out plate, port for breather, sight gauges, pump supply ports, and level switches. The baffle is provided to allow oil to aerate and settle during use. Sight gauges are provided to easily check oil level in reservoir.

Hydraulic Switch Locations



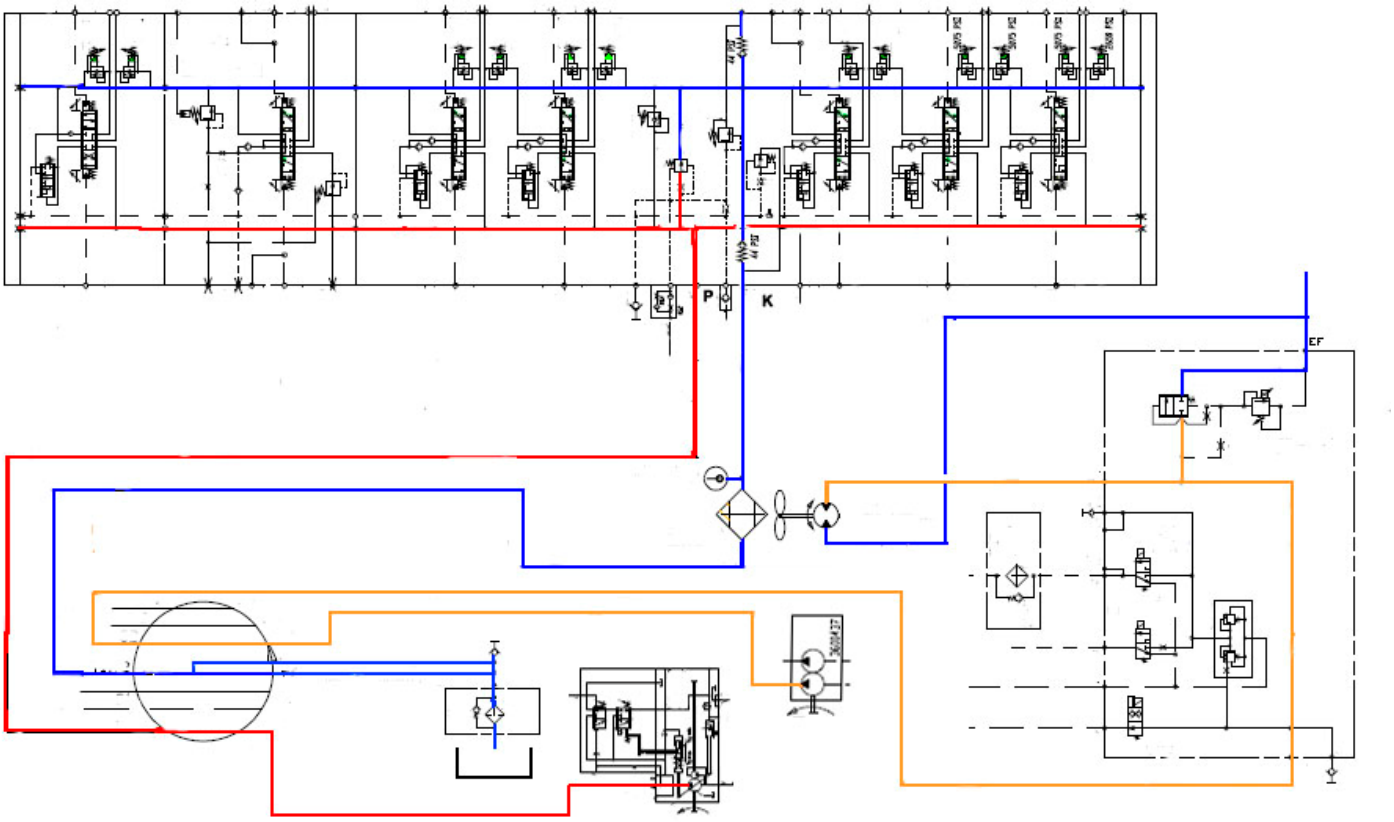
Hydraulic Return Filter



Filter assembly is installed in the reservoir. Return oil is routed through the filter element. If the element is becoming clogged, a bypass valve opens and allows oil into tank without filtration. A pressure switch on the filter head warns of high filter pressure. Switch turns on at 35 psi.

Filter is a high density 10 micron rated filter.

Heat Exchanger Circuit

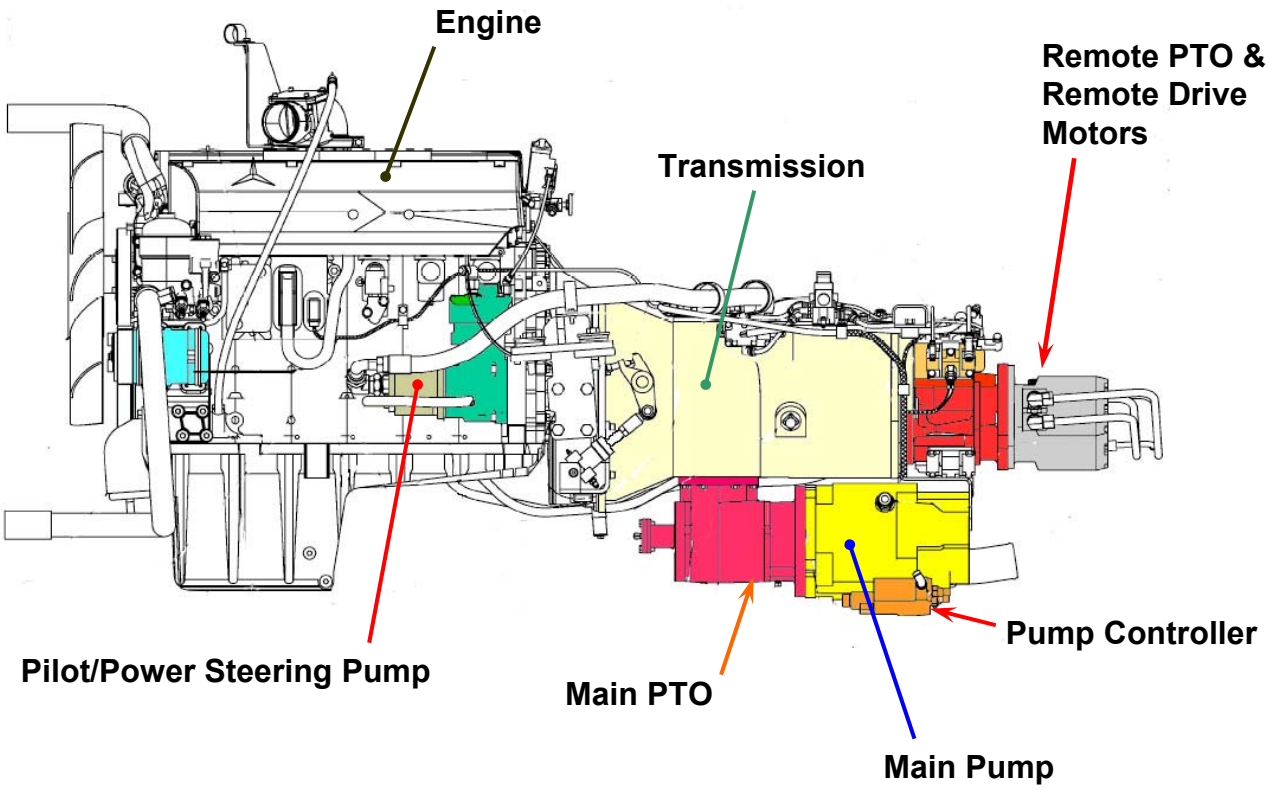


Heat exchanger circuit and fan circuit shown schematically. Processor receives temperature signal from sensor in return line to heat exchanger. As oil warms, processor directs flow to fan motor to provide adequate fan speed to cool hydraulic oil.

Hydraulic Cooling Fan Motor Location

Cooler Fan Motor has a controlled flow setting that is controlled by the oil temperature switch and the processor.

Power Unit Assembly

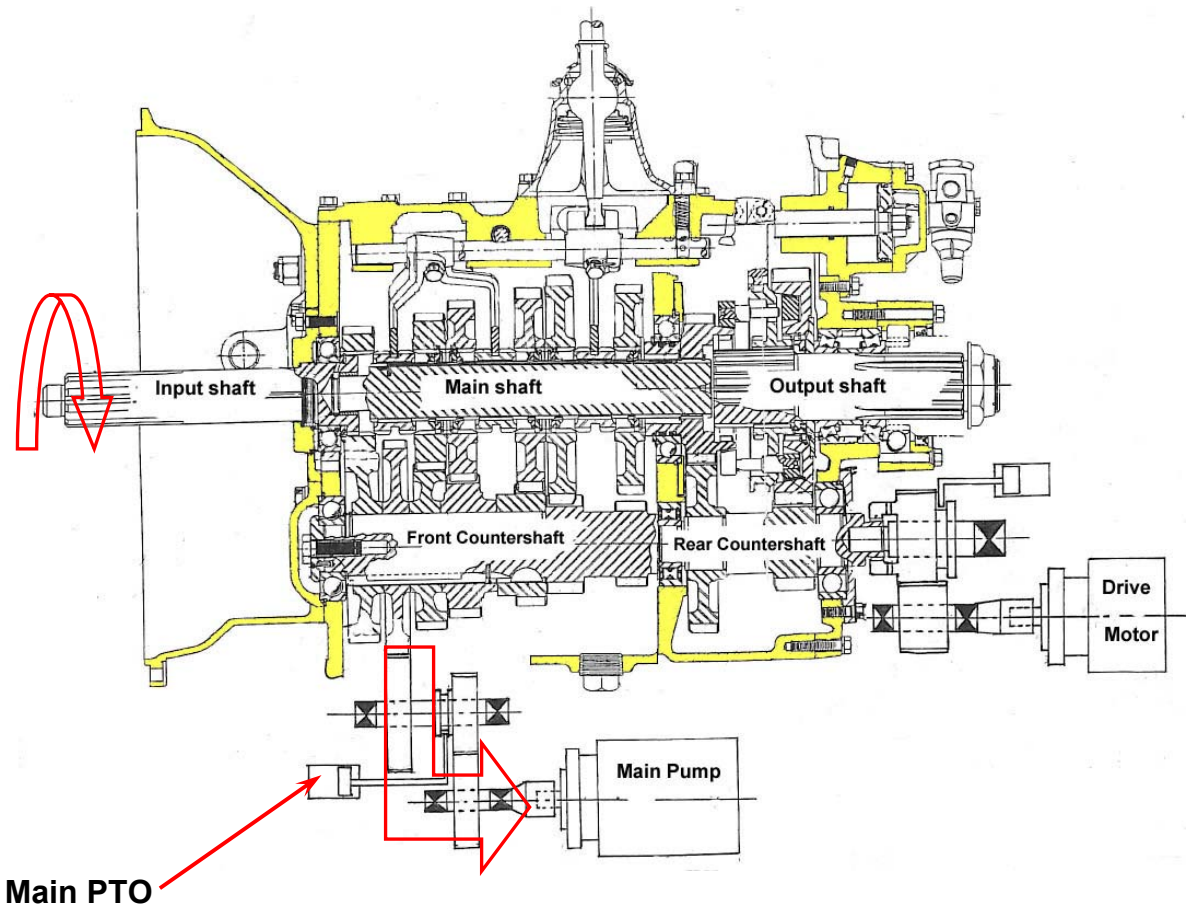


Chassis power unit supplies power for both hiqhway speed and remote (excavator) operation. Diesel engine drives through the transmission to provide power for highway speed drive.

Transmission is also used along with 3 PTO's to provide pump drive for excavator operation (Main PTO) and remote drive via the transmission auxiliary box to provide remote drive (remote PTO).

PTO's are air shifted for remote and highway speed positions. Engine speed is controlled from both cabs.

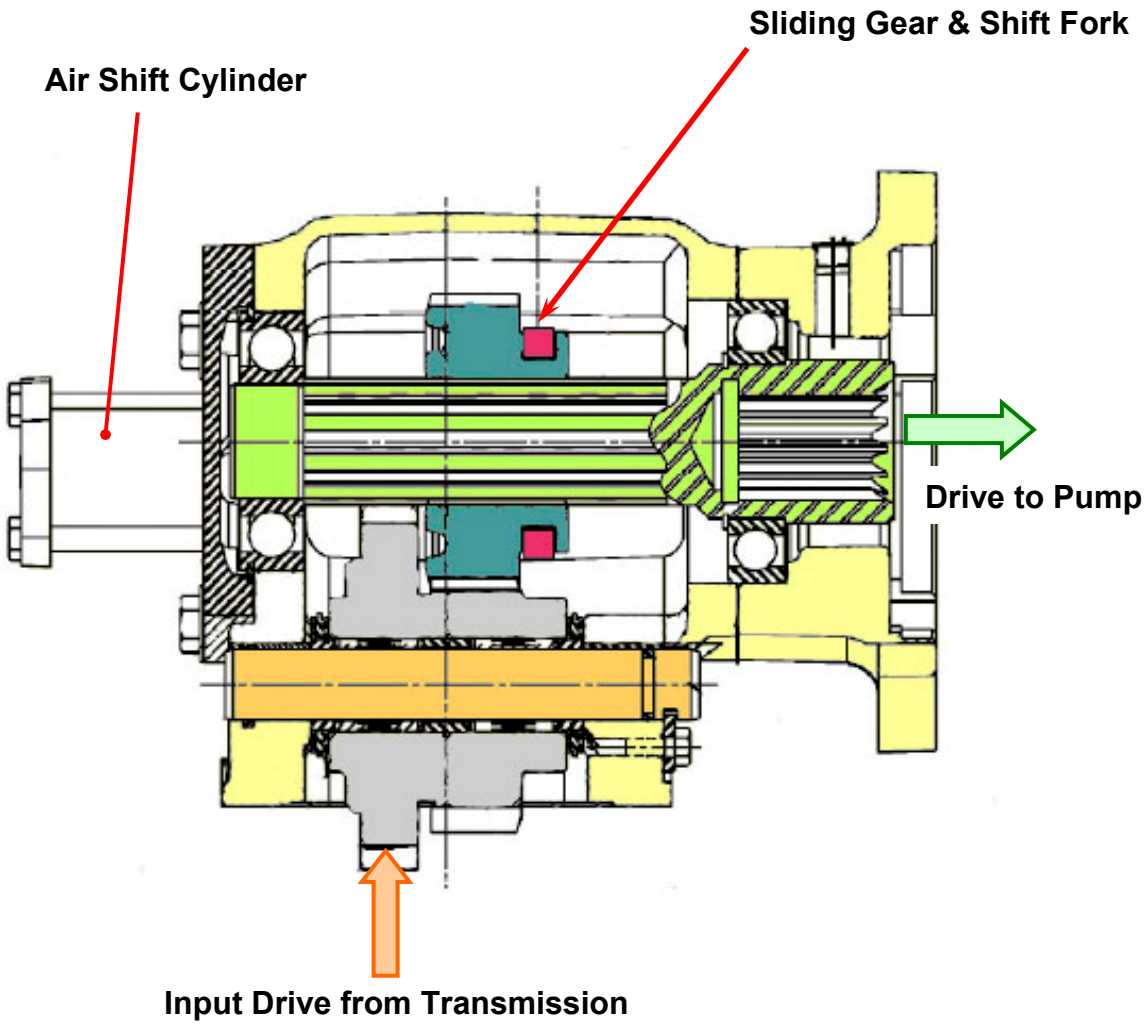
Main Transmission and Pump Drive PTO



Engine drives main pump for excavator operation off main transmission. A PTO (Main PTO) is used to support and drive the pump.

The Main PTO is air engaged for excavator operation. Engine drives input shaft of main transmission through the clutch. Power is transmitted through the main transmission to the Main PTO. Pump is driven by the main PTO. During highway operation, the Main PTO is disengaged from the main transmission.

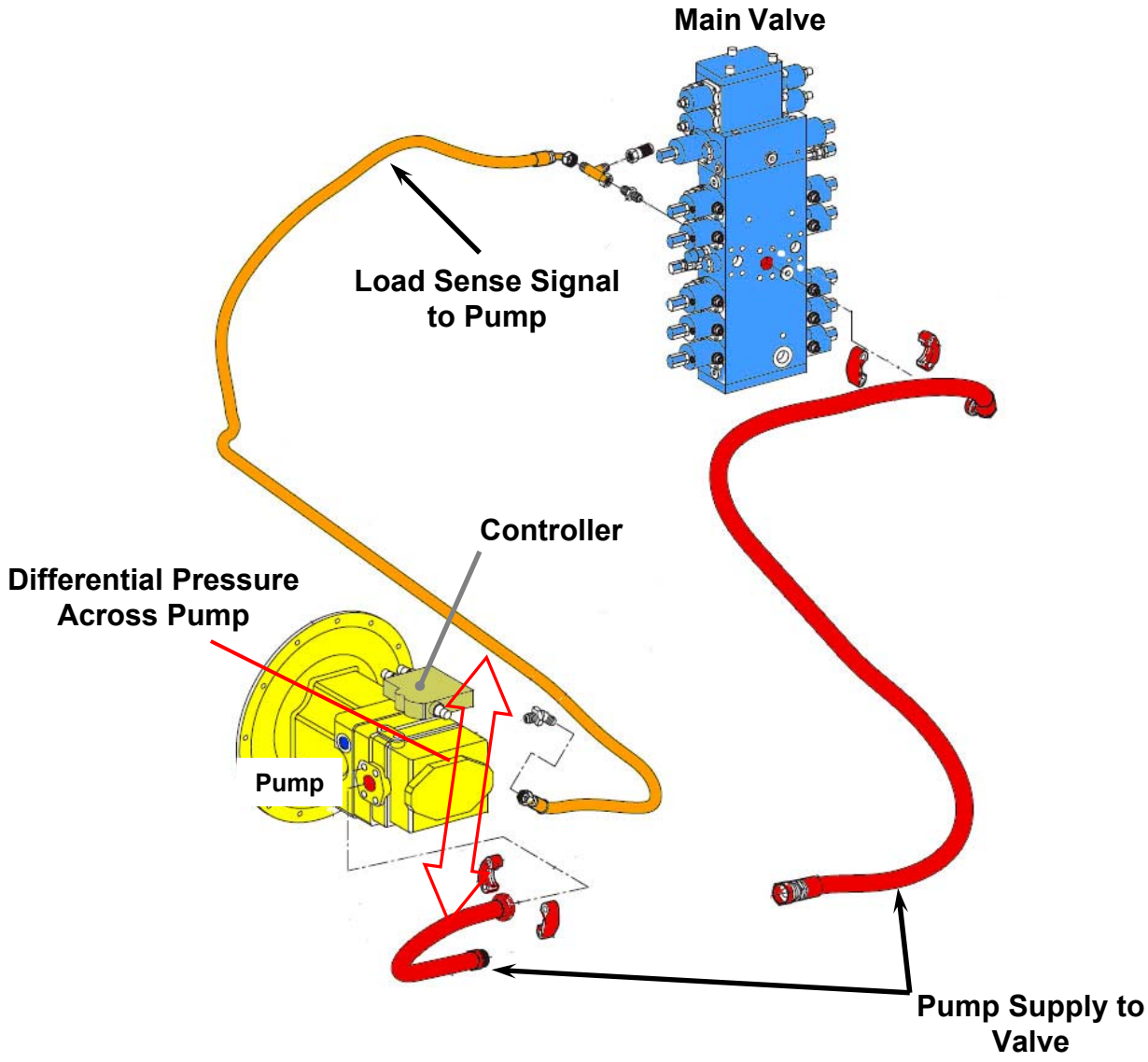
Main Pump PTO



Main PTO attaches to bottom of transmission. Pump is attached to and driven by PTO. Pump is only engaged during remote operation.

Electrical switch on PTO shift rail signals engagement and disengagement. Full engagement/disengagement is required to allow engine start.

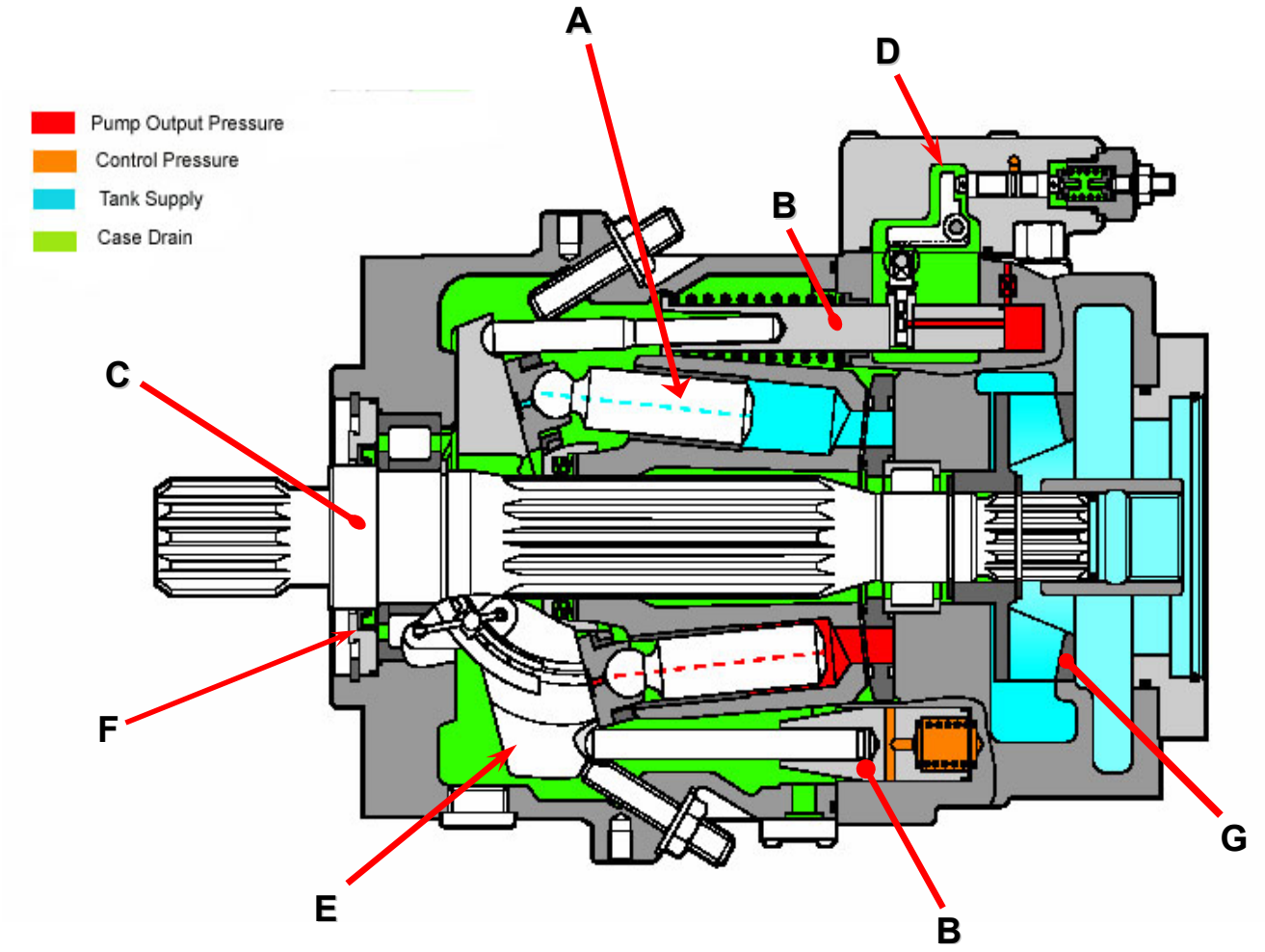
Pump Circuit



Pump circuit consists of pump output to the main valve and load sense signal back to pump from main valve. Pump requires a load sense signal to provide proper output.

Load sense signal pressure is less than pump output pressure. The main valve is sensed as a variable orifice in the circuit. As flow and pressure requirements change during machine operation, the load sense signal works with the controller and pump to provide sufficient flow from the pump to maintain "differential pressure" between pump output and load sense input.

Main Pump – Side View



Cross section of pump showing:

A. **Rotary group**

B. **Stroking pistons**

C. **Driveshaft**

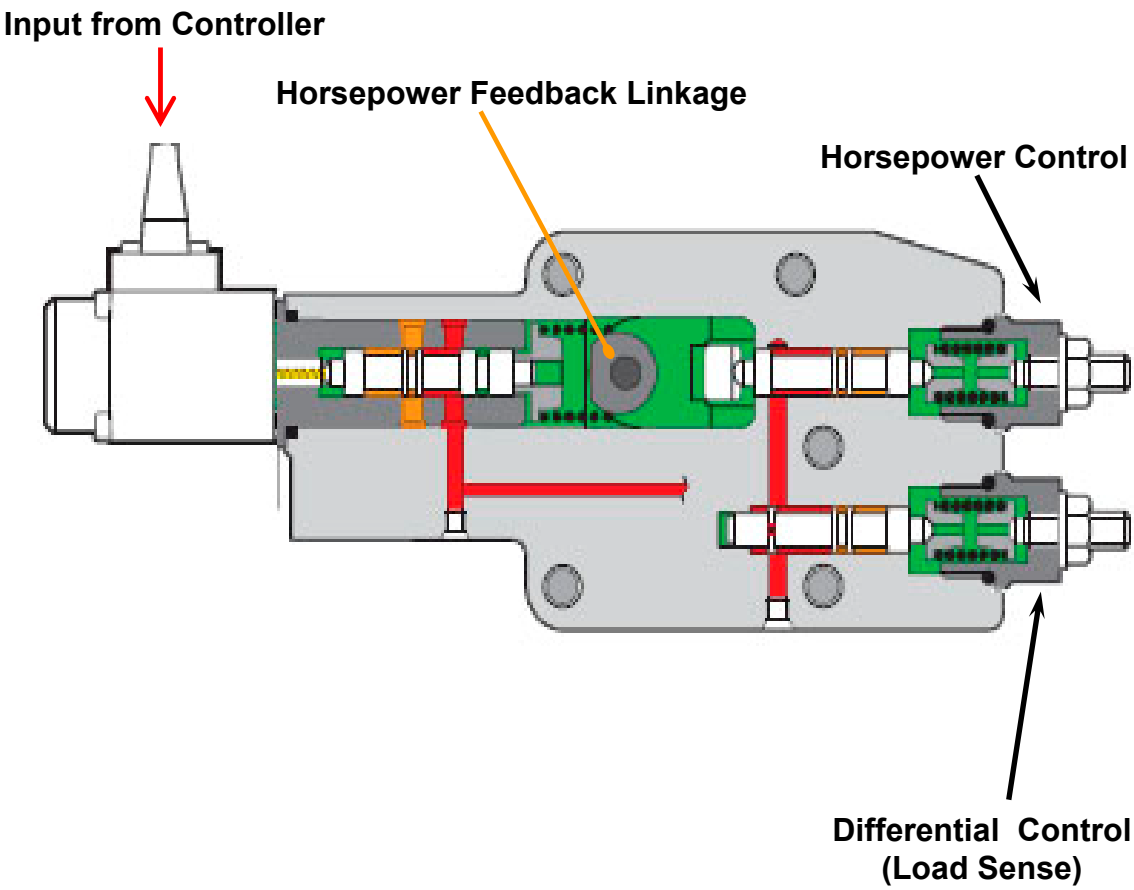
D. **Feedback control for horsepower sensing**

E. **Swash plate**

F. **Shaft Seal**

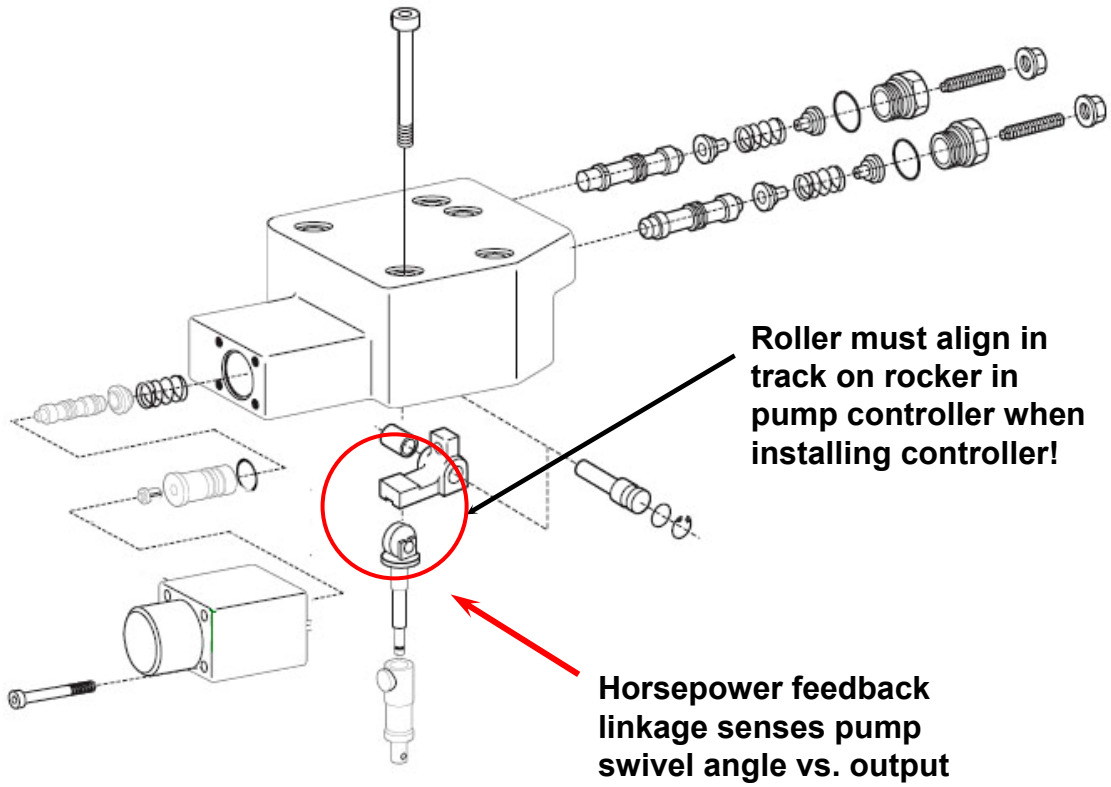
G. **Charge Pump Impeller**

Pump Controller



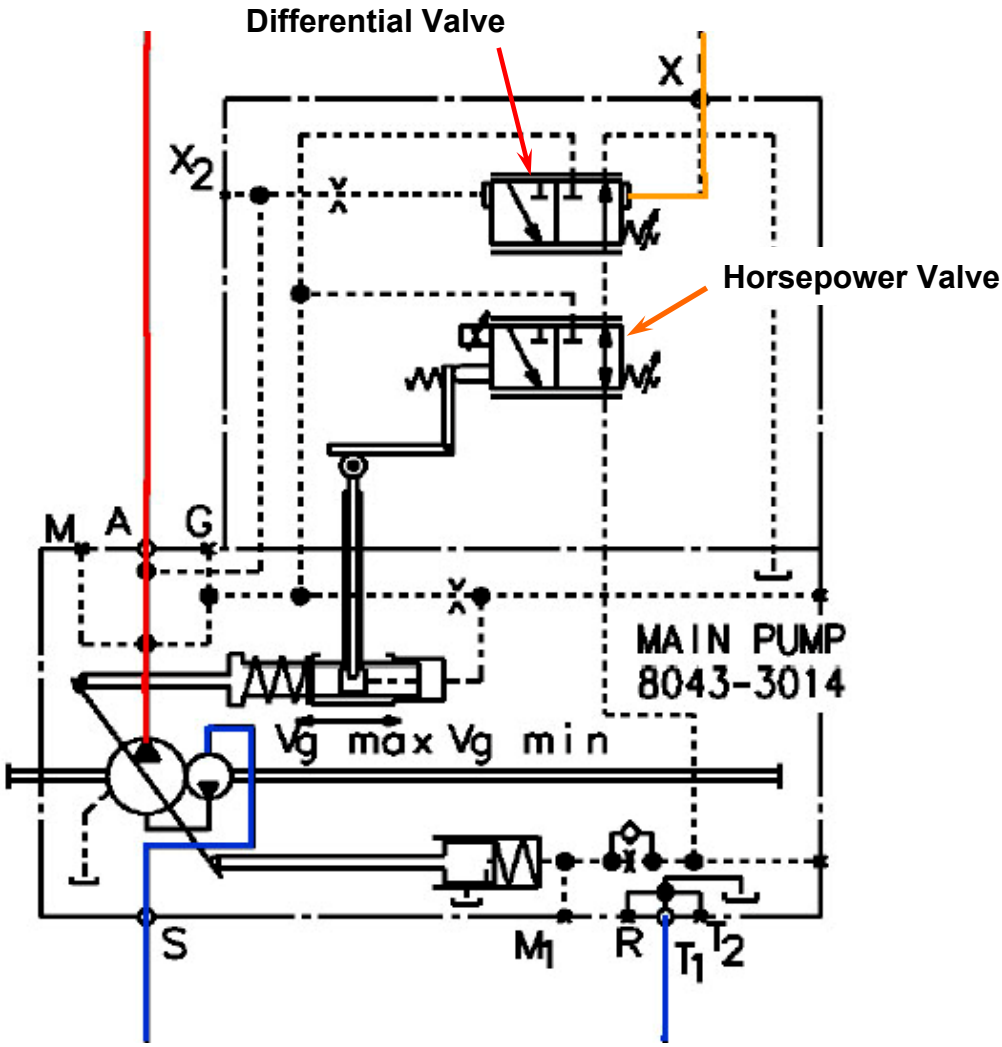
Pump controller is attached to top of pump. Controller uses load sense pressure to determine displacement required for the load/flow conditions from the valve. The pump output pressure is measured at the controller. A “differential” is always maintained between output pressure and load sense pressure. The controller is also mechanically linked to swash plate position to be used by the horsepower control. When hydraulic horsepower reaches a preset level, the pump horsepower is limited to prevent excess lugging of the engine. A solenoid valve linked to the controller also affects pump horsepower setting when RPM is less than high idle.

Pump Controller – Horsepower Linkage



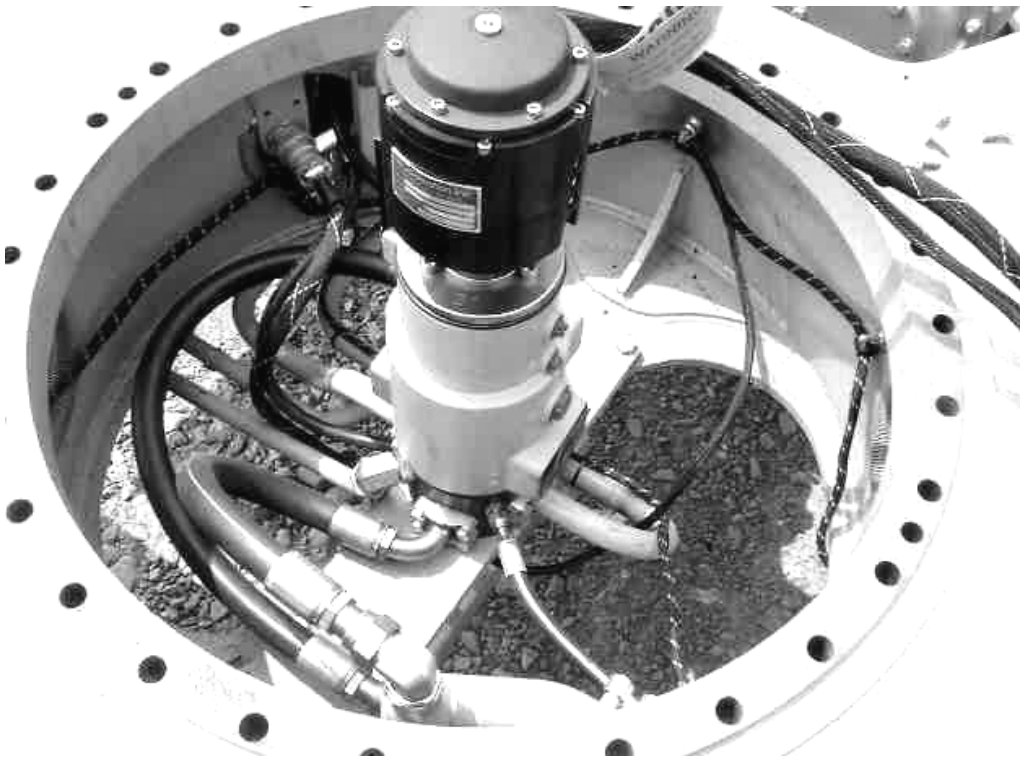
View of pump controller parts breakdown. Most parts are not serviceable in this controller as they are matched at assembly.

Pump Schematic



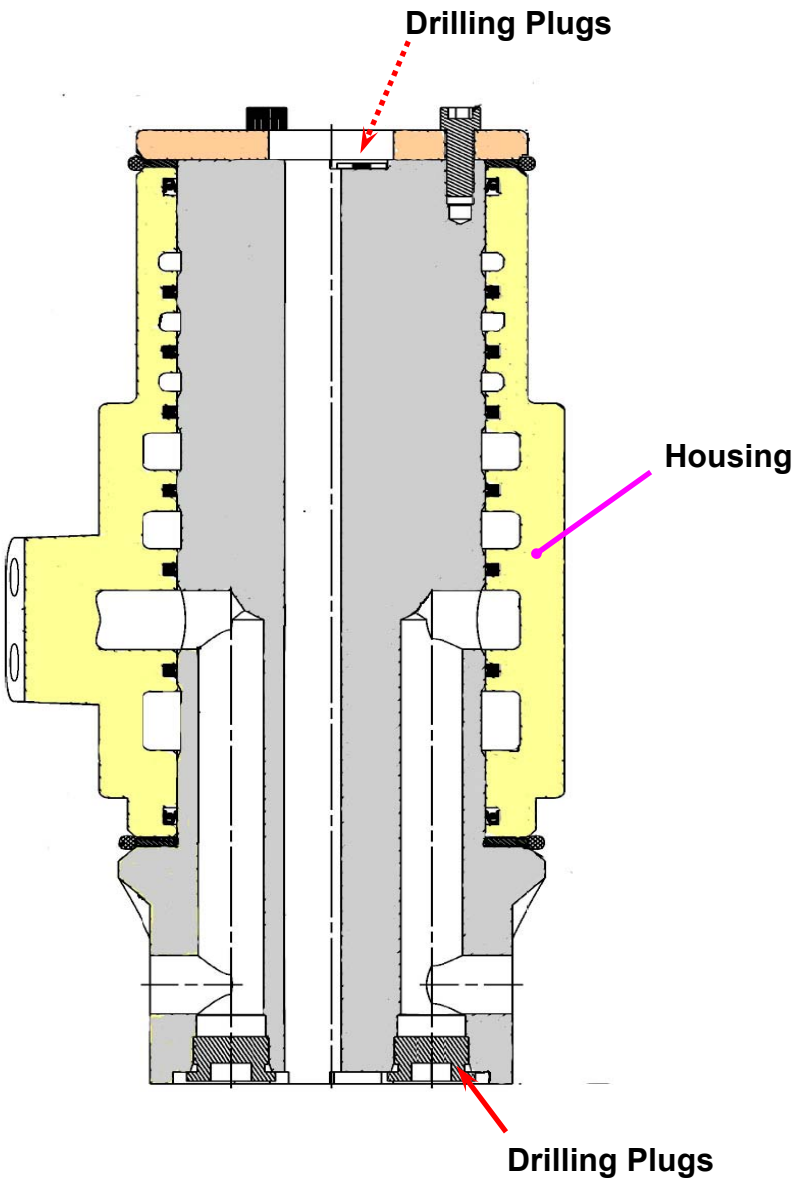
Schematic view of pump

Pump to Centerpin



The center pin has a one piece housing and pin. An electrical center pin is attached to the top of the hydraulic center pin

Center Pin Cross Section

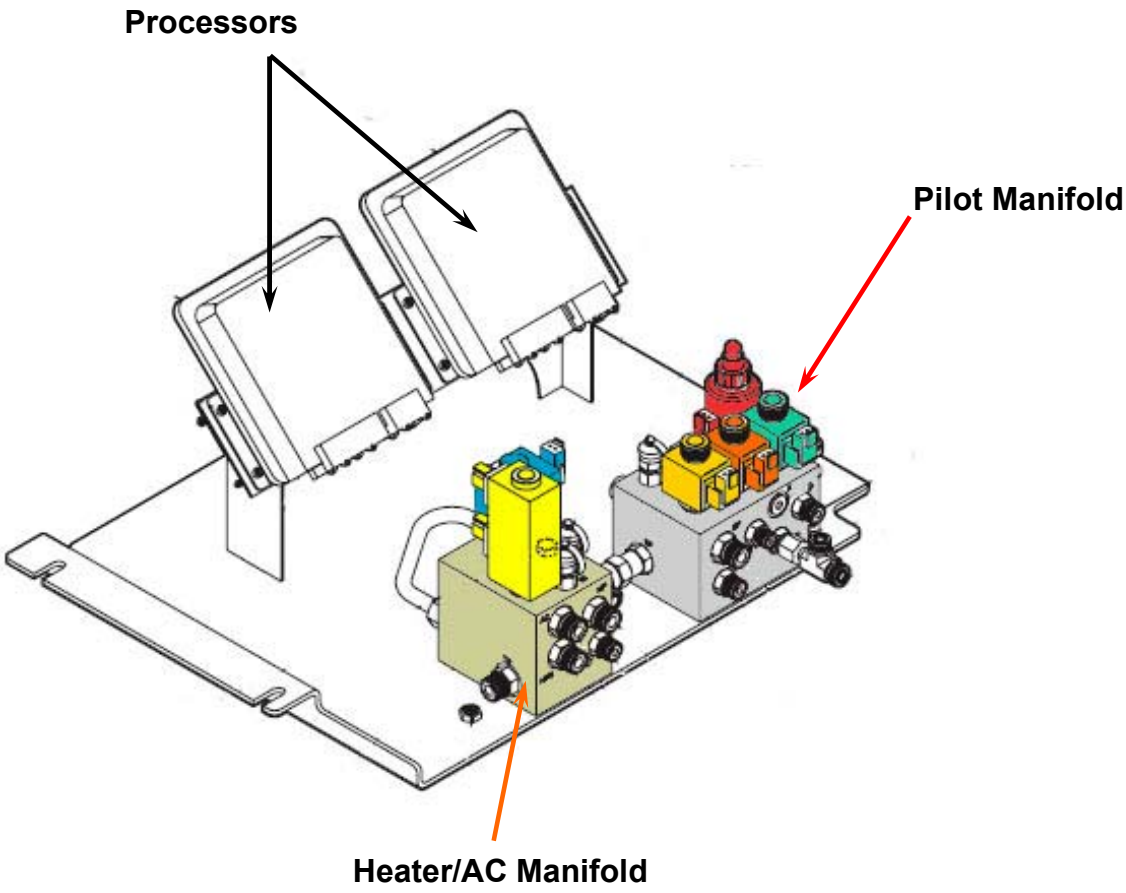


Hydraulic center pin for highway speed excavators consists of a hydraulic and electrical center pin. The hydraulic is shown in this slide.

Hydraulic center pin consists of a housing and pin. The pin is bolted to the chassis, the housing is rotated by the excavator upperstucture.

Ports and drillings in the housing and pin route the oil from the chassis to the upper and back as required.

Pilot Manifold Tray



Pilot Manifold tray has mounting for Pilot Manifold, Heater/AC Manifold, and Processors.

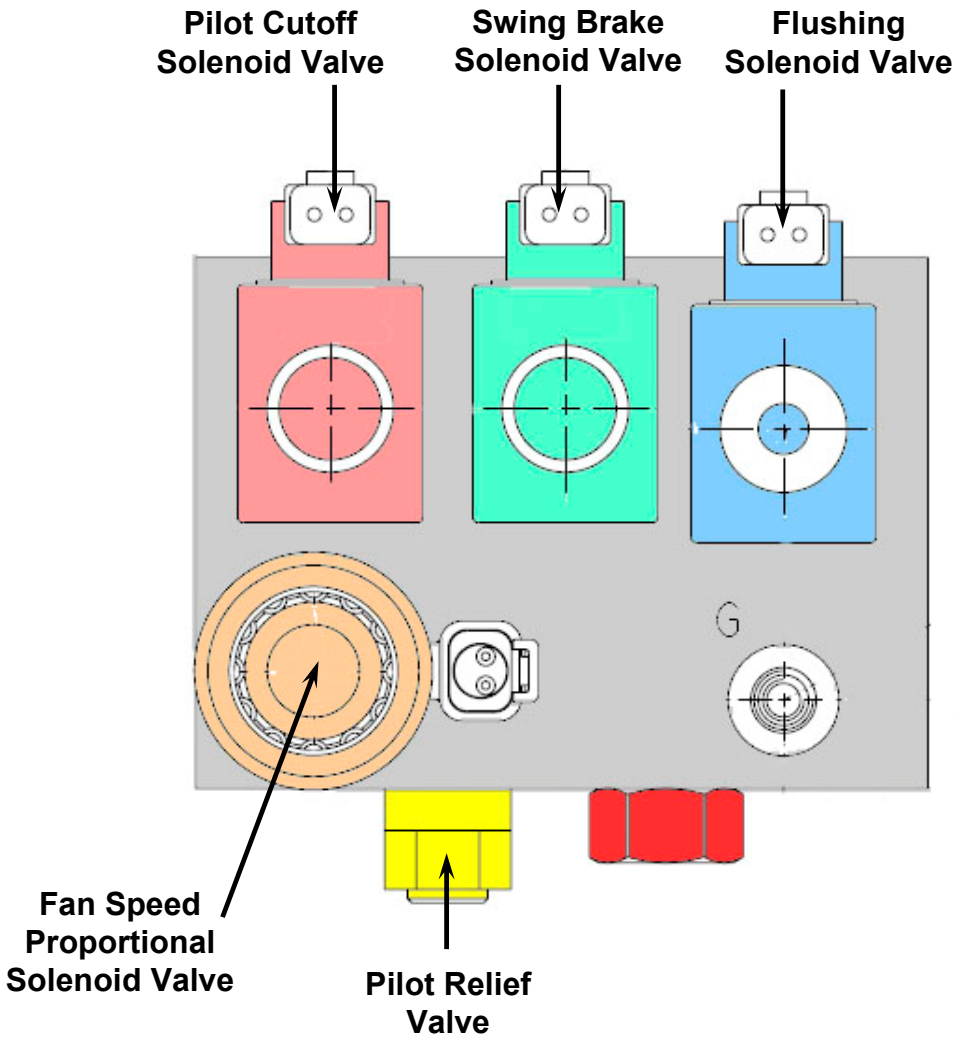
Pilot Manifold tray is located in the valve compartment in front of the Main Valve.

Processors work with machine controls and provide signals for hydraulic system operation.

Pilot Manifold directs oil to valves, swing brake, cooling fan, and provides flushing flow during highway speed operation. Oil for the pilot manifold comes from the pilot pump on the chassis.

Heater/AC manifold powers the heater system and AC system. Oil is provided from the main valve.

Pilot Manifold



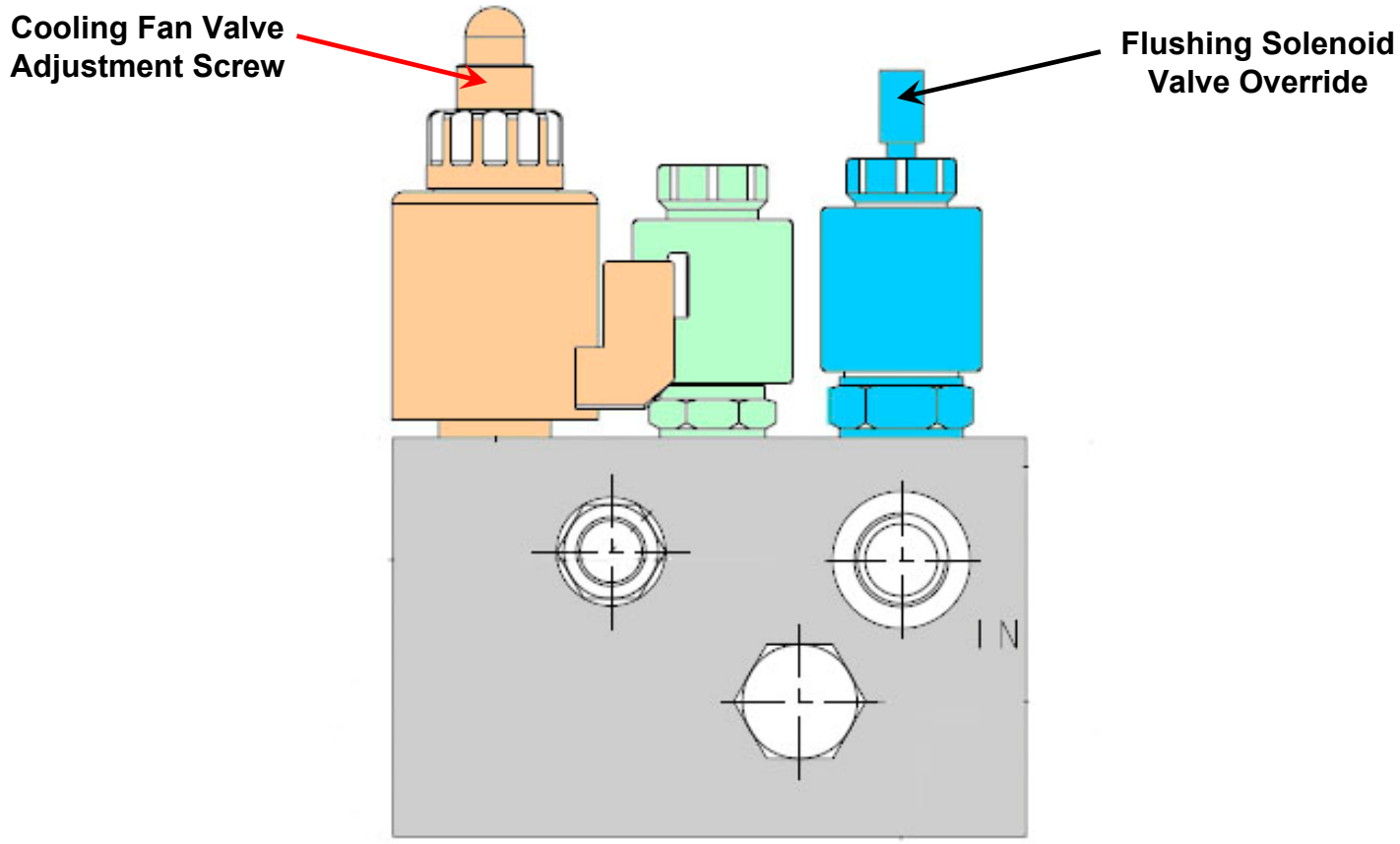
Pilot manifold is located in valve compartment of excavator. The pilot manifold is supplied by chassis pilot pump.

Pilot manifold has solenoid valves for Pilot Cutoff, Swing Brake, Flushing, and Fan Speed control. It also has a relief valve to set pilot pressure.

Flushing solenoid is powered during excavator operation. During chassis operation, flushing solenoid allows flushing oil into the main valve.

Fan Speed Proportional Solenoid controls cooling fan speed. A signal from the processor sets the fan speed.

Pilot Manifold



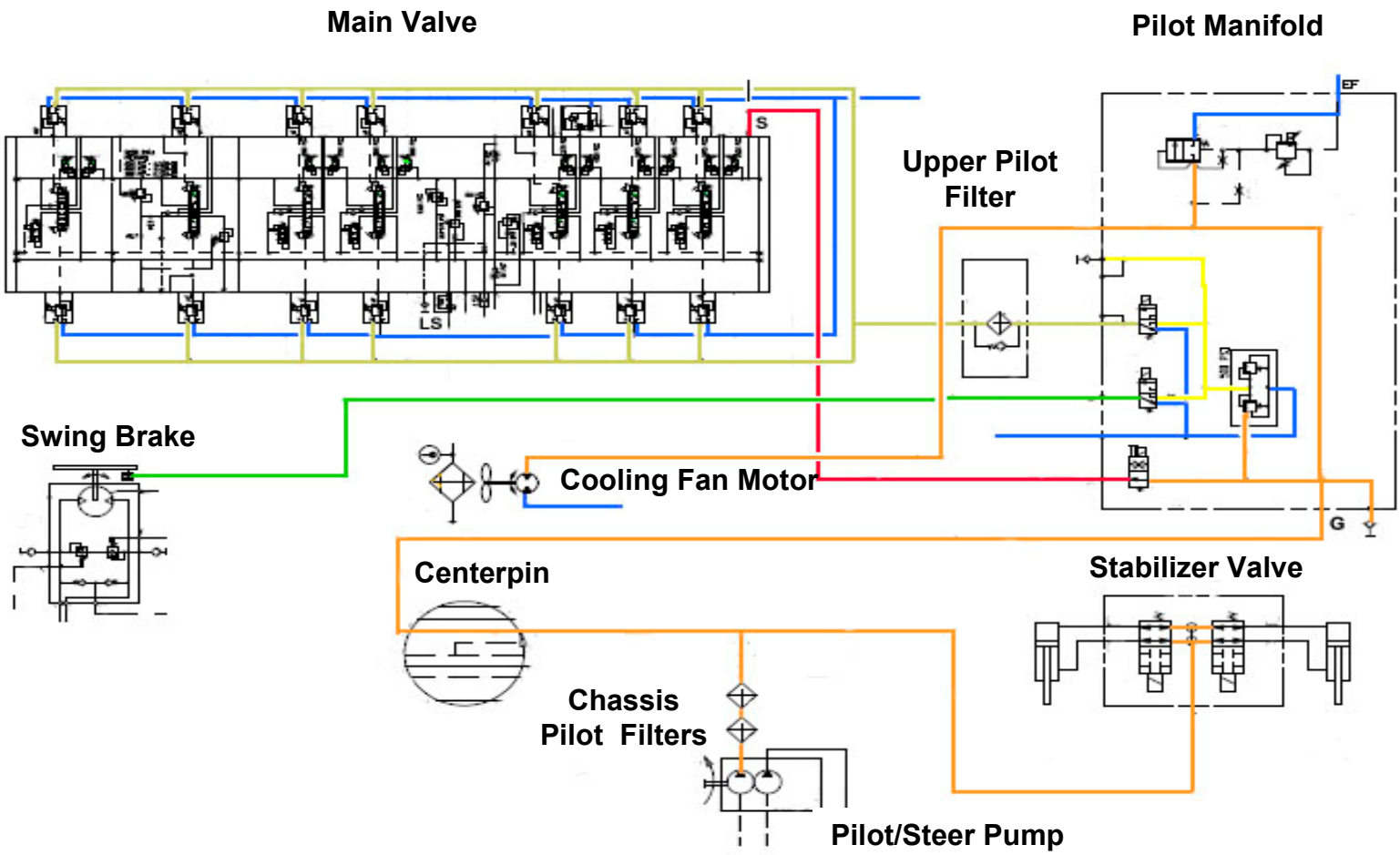
Cooling fan valve has a cap over an adjustment screw. The adjustment screw is used during initial valve set up on a test stand. **Do not loosen locknut or alter settings. The fan valve will be damaged and cannot be repaired.**

The flushing solenoid valve is active in remote only. When active, it closes off the flushing circuit to allow cooling fan and pilot oil flow. If the solenoid valve or circuit would fail, the flushing solenoid valve has a manual override button on the top to override the solenoid and allow pilot and cooling fan oil to flow.

If the Flushing valve solenoid override button is used, it MUST be switched back to the off position before switching to travel. **Failure to switch the solenoid override back to off position will cause significant damage to the pilot circuit!**

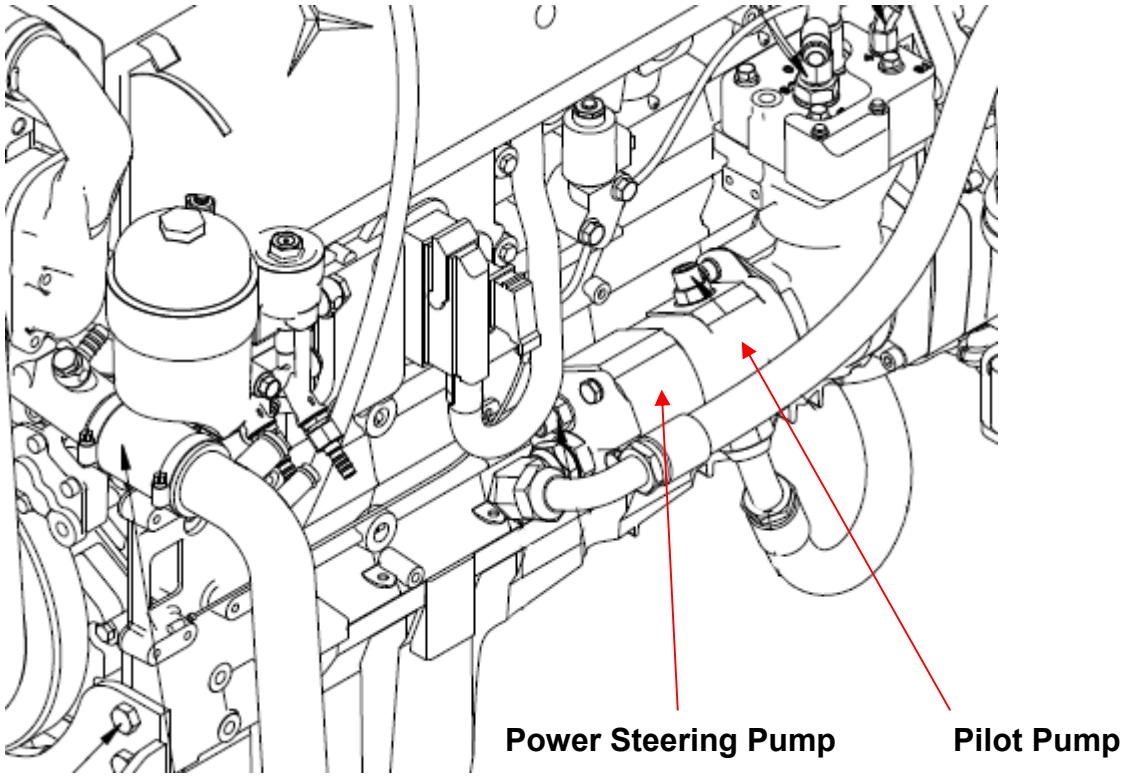
A red tie wrap is installed on the flushing valve solenoid to prevent accidental engagement. The tie wrap must be removed to use the solenoid override and must be replaced if the override has been activated.

Pilot Schematic – HS Machines



Pilot system on highway speed machines provides multiple machine functions. Valve shift, cooling fan motor, and stabilizer cylinders for front axle are all fed by the pilot pump.

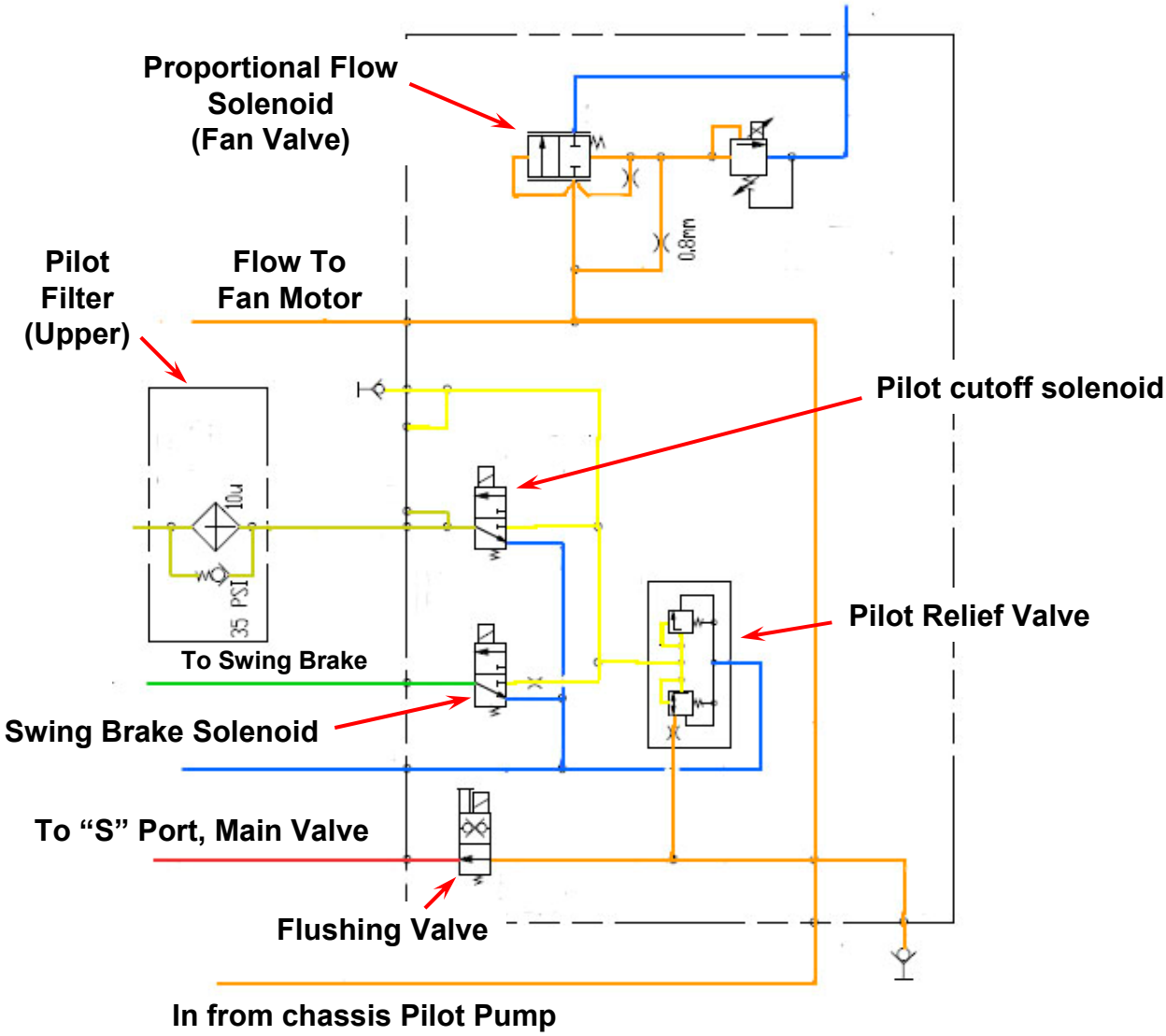
Pilot Pump Location



Pilot pump is in tandem with power steering pump. The pump assembly is driven by the accessory drive located at the chassis engine air compressor. The pilot pump is the first section (drive end) of the pump assembly. The power steering pump is the second section of the pump.

Both pumps are fixed displacement gear pumps.

Pilot Manifold Schematic

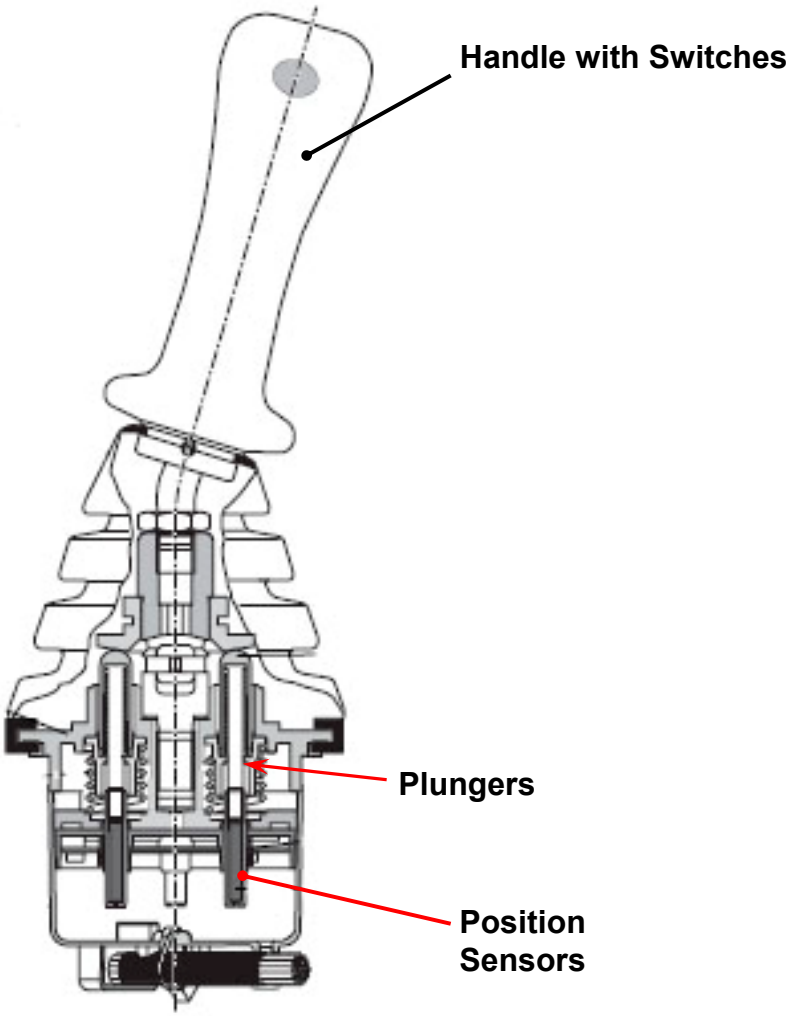


This is the schematic view of the pilot manifold. Pilot manifold on highway speed machines not only provide oil for pilot functions at the main valve, but also provide flushing flow to main valve during chassis operation.

During excavator operation, the pilot manifold provides cooling fan speed control and swing brake operation.

The flushing valve is switched when machine is being driven from the chassis. Flushing flow is directed into the main valve. A tie wrap is on the flushing valve to prevent it from being manually shifted unless required. If the flushing valve solenoid would fail, you need to manually shift the flushing valve to allow pilot operation from the excavator. **It must be shifted back to flushing mode for road operation!**

Joystick

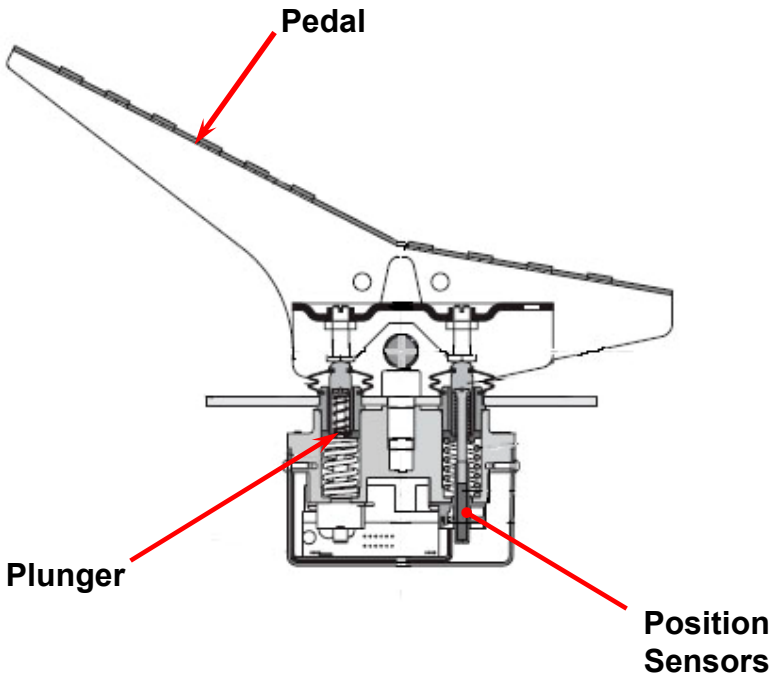


Joystick control is provided in operator's cab. There are left & right joystick controls. Joystick is electronic control on Series III machines. Position sensors sense handle position and use the machine CAN system to signal the processors.

The processors use the signals from the joystick and other sensors and switches to provide a signal to the main valve end cap and pump.

The handle is angled and shaped for operator comfort. Switches are part of the handle to allow additional control functions to be run from the joystick. Each switch is an electrical function. Typical functions that are controlled from the joystick switches are: Horn, boom tilt, bucket shake, tilt override, & auxiliary (optional).

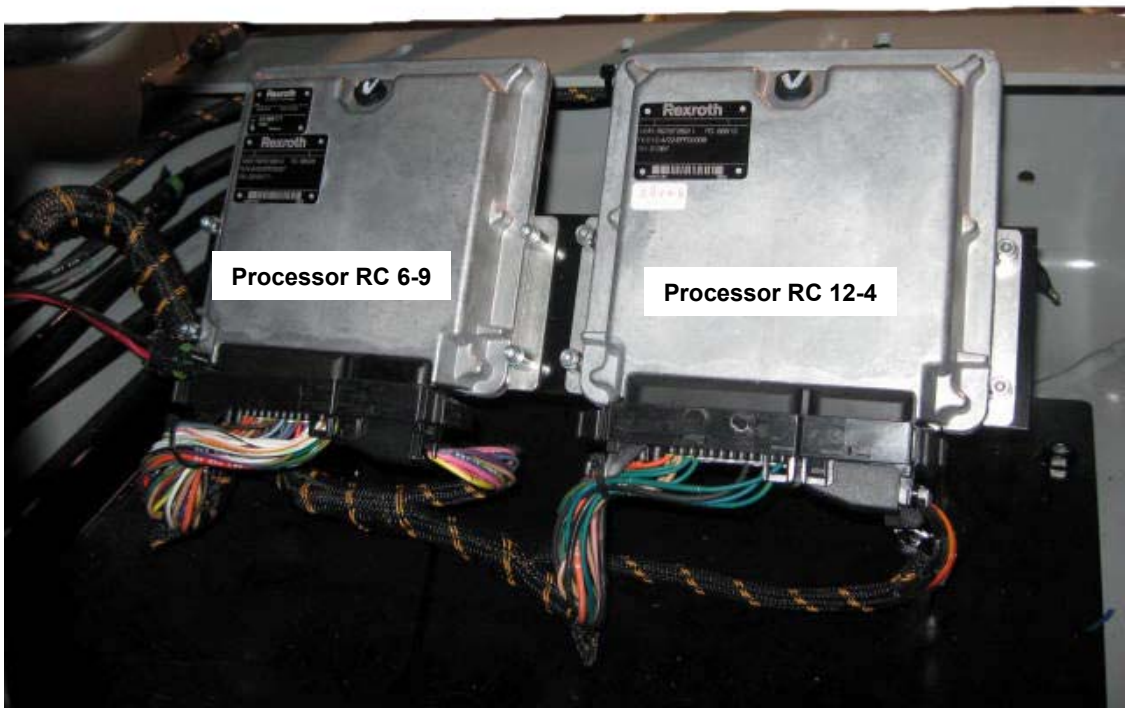
Travel Pedal



A foot pedal control is provided in operator's cab for travel. Foot pedal is an electronic control on Series III machines. Position sensors sense pedal position and use the machine CAN system to signal the processors.

The processors use the signals from the pedal and other sensors and switches to provide a signal to the main valve end cap and pump.

Processor Installation



Processors are mounted at the front of the valve compartment. Each processor has specific functions assigned. A CAN Bus circuit is used for primary communication between processors, engine, controls, and control valves.

Highway speed machines also have a processor mounted on the front of the chassis cab. It is known as Processor RC 4-4.

Software is preloaded onto the processors. Parameters are loaded at assembly to set defaults on the machine.

A communication port is provided in the cab. Processor status and operation can be read using a BB3 hand held unit, Bodem software, or Bodas software.

Other inputs and outputs are used at the processor to provide assorted machine functions.

Processor 6-9 Inputs

The Input/Output Charts for each processor show the specific functions controlled by the processors. If the function is not listed on these charts, the function is not processor controlled.

The Inputs and Outputs can be viewed using a laptop and software (Bodas) This provides the fastest and most accurate means of checking the system. If Bodas is not available, a VOM can be used and each circuit check individually. Measurable values for each processor function are listed.

INPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Analog 2	STEER RIGHT INPUT	SWITCH INPUT	12V+	OV
Analog 3	ENGINE SPEED POT	POTENTIOMETER INPUT - Throttle Potentiometer		
Analog 4	STEER LEFT INPUT	SWITCH INPUT	12V+	OV
Analog 6	HEATER POT	POTENTIOMETER INPUT - Heater Potentiometer		
Analog 7	TRAVEL PEDAL SIGNAL	POTENTIOMETER INPUT - Travel Pedal Signal for travel speed		
Analog 8	UPPER KEY START REQ	SWITCH INPUT	12V+	OV
Current 1	GRADALL CONTROL PATTERN	SWITCH INPUT - @ Monitor	12V+	0V
Current 2	JOHN DEERE CONTROL PATTERN	SWITCH INPUT - @ Monitor	12V+	0V
Current 3	GRADE MODE SWITCH	SWITCH INPUT - @ Monitor	12V+	0V
Current 4	AC POWER ON	SWITCH INPUT - @ Console	12V+	0V
Pulse 1	BUCKET SHAKE INPUT	SWITCH INPUT - @ Left Joystick	12V+	0V
Pulse 2	HEATER ON	SWITCH INPUT - From Heater Switch	12V+	0V
Switch 1	PILOT LEVER	SWITCH INPUT- Switch in LH Console	12V+	0V
Switch 2	AUTO IDLE ENABLE	SWITCH INPUT - Switch at RH Console	12V+	0V
Switch 3	UPPER SHIFT	SWITCH INPUT - Switch at RH Console	12V+	0V
Switch 5	AUX	SWITCH INPUT - Switch at Joystick	12V+	0V
Switch 6	HOIST UP PROXIMITY SWITCH	SWITCH INPUT - Switch on Frame @ Boom	12V+	0V
Switch 7	TRAVEL FORWARD SWITCH	SWITCH INPUT - Limit Switch in Travel Pedal	5V+	0V
Switch 8	TRAVEL REVERSE SWITCH	SWITCH INPUT - Limit Switch in Travel Pedal	5V+	0V

Outputs from Processor 6-9

OUTPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Prop 1	BOOM IN	PROPORTIONAL OUTPUT - Boom In Solenoid		
Prop 2	BOOM OUT	PROPORTIONAL OUTPUT - Boom Out Solenoid		
Prop 3	TOOL OPEN	PROPORTIONAL OUTPUT - Tool Open Solenoid		
Prop 4	TOOL CLOSE	PROPORTIONAL OUTPUT - Tool Closed Solenoid		
Prop 5	HOIST UP	PROPORTIONAL OUTPUT - Hoist Up Solenoid		
Prop 6	HOIST DOWN	PROPORTIONAL OUTPUT - Hoist Down Solenoid		
Switched 1	PILOT ENABLE	SWITCHED OUTPUT - Signal to Pilot Cutoff Solenoid (Pilot Manifold)	12V+	0V
Switched 2	WAIT START LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light	12V+	0V
Switched 3	CHECK ENGINE LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light	12V+	0V
Switched 4	ENGINE STOP LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light	12V+	0V
Switched 5	LOW AIR LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light - From Low Air Signal @ Chassis	12V+	0V
Switched 7	HF LEVEL LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light - From HF Level switch on chassis	12V+	0V
Switched 8	HF TEMP LIGHT	SWITCHED OUTPUT - Signal to travel alarm when travel pedal active	12V+	0V
CAN L (1939)	CAN BUS	Communicates with processor RC4-4 (chassis), engine processors, joysticks		
CAN H (1939)	CAN BUS	Communicates with processor RC4-4 (chassis), engine processors, joysticks		
1939L-RC	CAN BUS	CAN - To processor 12-4		
1939H-RC	CAN BUS	CAN - To processor 12-4		

Processor 12-4 Inputs

INPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Resistor 1	HYDRAULIC OIL TEMP	Temperature Sender Input (900 - 1800 Ω)		
Resistor 2	HEATER TEMP	Temperature Sender Input (900 - 1800 Ω)		
	TEMP SENDER POWER	Regulated 5V power to Oil Temp Sender & Heater Temp Sender	+5V	

Processor 12-4 Outputs

OUTPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Prop 1	SWING RIGHT	PROPORTIONAL OUTPUT- Swing Right Solenoid		
Prop 2	SWING LEFT	PROPORTIONAL OUTPUT - Swing Left Solenoid		
Prop 3	TRAVEL FORWARD	PROPORTIONAL OUTPUT - Travel Forward Solenoid		
Prop 4	TRAVEL REVERSE	PROPORTIONAL OUTPUT - Travel Reverse Solenoid		
Prop 5	HEATER/AC FLOW	PROPORTIONAL OUTPUT - Flow Control Valve @ Heater/AC Manifold		
Prop 7	OIL COOLER FAN	PROPORTIONAL OUTPUT - Flow Control Valve for fan on Pilot Manifold		
Prop 9	SWING LIGHT - A	SWITCHED OUTPUT - Powers 12V Light, Active with Swing Brake Release signal	12V+	0V
Prop 10	SWING LIGHT - B	SWITCHED OUTPUT - Powers 12V Light, Active with Swing Brake Release signal	12V+	0V
Prop 11	SWING BRAKE RELEASE	SWITCHED OUTPUT - Active anytime swing is activated. Has time delay for brake set	12V+	0V
Switched 1	WARNING ALARM	SWITCHED OUTPUT - Active with low air, travel Lockout, or engine stop	12V+	0V
Switched 2	PARK BRAKE ON	SWITCHED OUTPUT - Powers 12V Indicator Light if park brake is on	12V+	0V
Switched 3	TRAVEL LOCKOUT LIGHT	SWITCHED OUTPUT - Powers 12V Indicator Light if either travel motor is disengaged	12V+	0V
Switched 4	FLUSHING VALVE	SWITCHED OUTPUT - Powers 12V Solenoid when upper key is on with time delay	12V+	0V
1939L-RC	CAN BUS	CAN to Processor RC 6-9		
1939H-RC	CAN BUS	CAN to Processor RC 6-9		
1939L-RC	CAN BUS	CAN to Internal resistor.		

Chassis Processor 4-4 Inputs

Chassis processor is under cab front cover. Chassis processor receives upper information via the CAN Bus, chassis information is from specific switches and senders located on the chassis. A data port connection for the chassis processor is located on the dash of the cab.

INPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Analog 1	Hi/LOW RANGE SWITCH	MECHANICAL LIMIT SWITCH - Active with Hi/Low Engaged	12V+	0V
Analog 2	NEUTRAL SWITCH	MECHANICAL LIMIT SWITCH - Active with Trans in Neutral	12V+	0V
Analog 3	TRAVEL MODE REQUEST	SWITCH INPUT - Active with cab switch set for travel mode	12V+	0V
Analog 4	PUMP ENGAGED SWITCH	MECHANICAL LIMIT SWITCH - Active with pump engaged	12V+	0V
Analog 5	PARK BRAKE ON SWITCH	AIR PRESSURE SWITCH - Active with park brake set	12V+	0V
Pulse 1	LEFT MOTOR ENGAGED	MECHANICAL LIMIT SWITCH - Active when left PTO is engaged	12V+	0V
Pulse 2	RIGHT MOTOR ENGAGED	MECHANICAL LIMIT SWITCH - Active when right PTO is engaged	12V+	0V
Pulse 3	REMOTE MODE REQUEST	SWITCH INPUT - Active with cab switch set for remote mode	12V+	0V
Switch 1	LOW AIR SWITCH	AIR PRESSURE SWITCH - GND air pressure < 60 psi. > 60 PSI - 0V	GND	0V
Switch 2	HF LEVEL SWITCH	FLUID LEVEL SWITCH - GND = Low, Float (0V) = Fluid level ok	GND	0V
Switch 3	RETURN FILTER SWITCH	HYD PRESSURE SWITCH - GND - Filters Plugged, Float (0V) - OK	GND	0V
Switch 4	SUCTION SWITCH	HYD PRESS SWITCH - GND=Hi Suction Pressure, Float (0V) - Suction pressure OK	GND	0V
Switch 5	FUEL LEVEL	FLUID LEVEL SWITCH - GND = Low, Float (0V) = Fluid level ok	GND	0V

Chassis Processor 4-4 Outputs

OUTPUTS	DESCRIPTION	FUNCTION	ACTIVE STATE	INACTIVE STATE
Prop 1	UPPER SHIFT	SWITCHED OUTPUT - Powers 12V on/off solenoid (based upon upper shift from CAN)	12V+	0V
Prop 2	TRAVEL MODE ENGAGE	SWITCHED OUTPUT - 12V output to switch air valve to travel mode	12V+	0V
Switched 1	STEER RIGHT OUTPUT	SWITCHED OUTPUT - Powers 12V solenoid for right steer (Based on CAN signal)	12V+	0V
Switched 2	STEER LEFT OUTPUT	SWITCHED OUTPUT - Powers 12V solenoid for left steer (Based on CAN signal)	12V+	0V
Switched 3	STARTER RELAY	SWITCHED OUTPUT - 12V output to starter relay (See Logic Chart)	12V+	0V
Switched 4	DIG BRAKE SIGNAL	SWITCHED OUTPUT - Powers 12V on/off solenoid (See Logic Chart)	12V+	0V
RS232-TXD	DATA CONNECTOR POS C			
RS232-RXD	DATA CONNECTOR POS D			
LOGIC GND	DATA CONNCETOR POS B			
PULL-UP	DATA CONNECTOR POS H			
CAN H1	DATA CONNECTOR POS G			
CAN L1	DATA CONNECTOR POS F			
CAN L (1939)	CAN BUS	Communicates with Processor 6-9, engine processors, joysticks		
CAN H (1939)	CAN BUS	Communicates with Processor 6-9, engine processors, joysticks		

Chassis Processor Logic

Chassis Start Circuit

Logic Charts give the interaction of various circuits affecting specific circuit function at the processor. If certain conditions are not met, then the processor will prevent a specific function from operating.

Function	Pin	Logic Required	Output	Notes
Chassis Start - Travel	5	A. Travel mode selected - Pin #8 @ 12+V B. Transmission in Neutral - Pin 46 @ 12+V C. Park Brake Set - Pin #19 @ 12+V D. Pump PTO disengaged - Pin #20 @ 0V E. Chassis Key Start Active - Pin #34 @ 12+V	Starter Relay Output becomes active - Pin #5 @ 12+V	

Chassis Processor Logic

Upper Start Circuit – Pump Disengaged

Function	Pin	Logic Required	Output	Notes
Chassis Start – Remote **Pump Disengaged**	5	A. Remote mode selected - Pin #18 @ 12+V B. Pilot lever in upper off (inactive) - Pin #37 @ 0V - Upper processor "A" C. Transmission in neutral Pin #46 @ 12+V D. Park Brake Set - Pin #19 @ 12+V E. Pump PTO disengaged - Pin #20 @ 0V F. Upper key start active - Pin 9 @ 12+V Upper Processor "A"	Starter Relay Output becomes active - Pin #5 @ 12+V	Pin #5 will be active for 2 seconds to allow pump to engage. If pump does not engage, upper key start, Pin # 9 @ upper processor "A" must become inactive (0V) to reset When Pump PTO engages - Pin #20 @12+V, applies.

Chassis Processor Logic

Upper Start Circuit – Pump Engaged

Function	Pin	Logic Required	Output	Notes
Chassis Start- Remote **Pump Engaged**	5	A. Remote mode selected - Pin #18 @ 12+V B. Pilot lever in upper off (inactive) - Pin #37 @ 0V - Upper processor "A" C. Transmission in neutral Pin #46 @ 12+V D. Park Brake Set - Pin #19 @ 12+V E. Pump PTO engaged - Pin #20 @ 12+V F. Upper key start active - Pin 9 @ 12+V Upper Processor "A"	Starter Relay Output becomes active - Pin #5 @ 12+V	

Chassis Processor Logic

Travel & Remote Engage Circuits

Function	Pin	Logic Required	Output	Notes
Travel Mode Engage	30	A. Travel mode selected - Pin #8 @ 12+V B. Park Brake Set - Pin #19 @ 12+V	Travel mode engage becomes active - Pin #30 @ 12+V	This function will "**latch**" even with power off..

Function	Pin	Logic Required	Output	Notes
Remote Mode Engage	4	A. Remote mode selected - Pin #18 @ 12+V B. Park Brake Set - Pin #19 @ 12+V	Remote Mode engage becomes active - Pin #4 @ 12+V	This function will "**latch**" even with power off.

Chassis Processor Logic

Dig Brake Signal Circuit

Function	Pin	Logic Required	Output	Notes
Dig Brake Signal	6	A. Remote mode active - Pin #4 @ 12+V B. Pump PTO engaged - Pin #20 @ 12+V C. Left PTO engaged - Pin #33 @ 12+V D. Right PTO engaged - Pin #44 @ 12+V F. High/Low Range engaged - Pin #35 @ 12+V G. Upper park brake released - Pin #10 @ 12+V Upper Processor "A" H. Travel pedal forward is active – Pin #61 @ 5V upper processor "A" **OR** H. Travel pedal reverse is active – Pin #60 @ 5V upper processor "A"	Dig brake signal becomes active – Pin # 6 @ 12+V	

Chassis Processor Logic

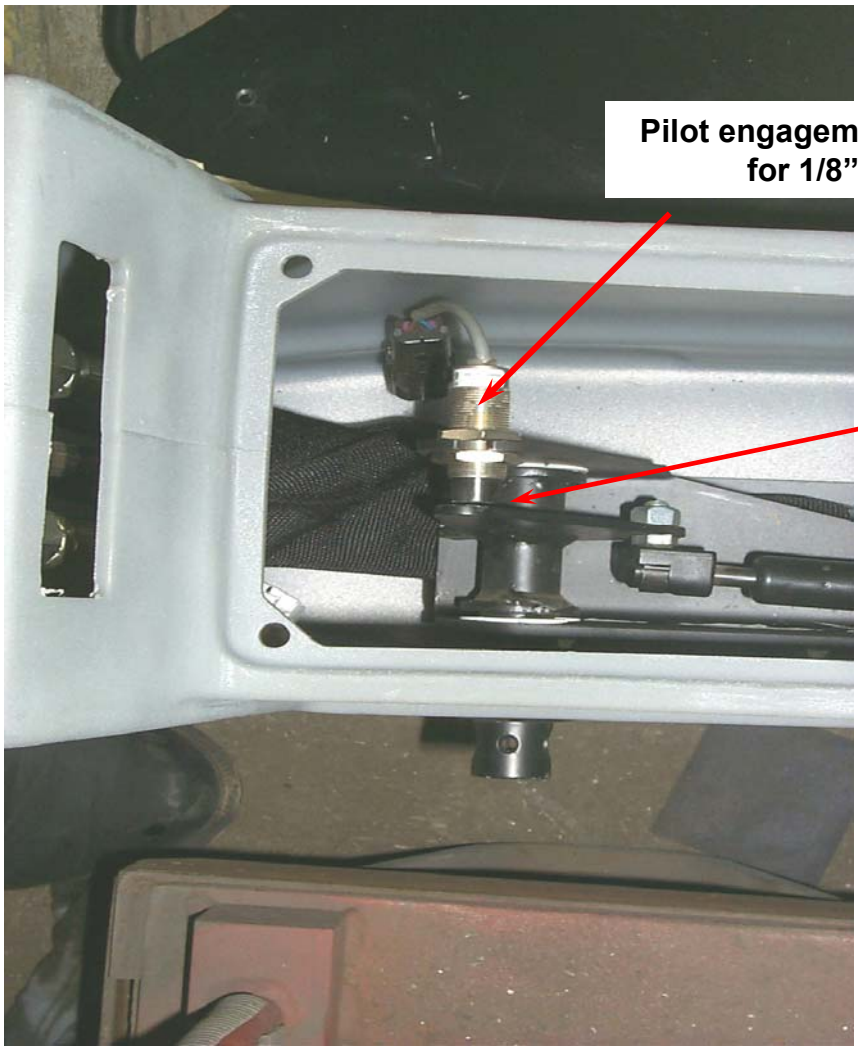
Upper Shift & Steering Circuits

Function	Pin	Logic Required	Output	Notes
Upper Shift	31	A. Remote mode active - Pin #4 @ 12+V B. Dig brake set - Pin #6 @ 0V C. Travel pedal forward is inactive - Pin #61 @ 0V upper processor "A" D. Travel pedal reverse is inactive - Pin #60 @ 0V upper processor "A"	Upper shift becomes active - Pin # 31 @ 12+V	

Function	Pin	Logic Required	Output	Notes
Steer Right	29	A. Steer right active - Pin #46 @ 12+V Upper processor "A"	Steer right becomes active - Pin #29 @ 12+V	Processor "C" in chassis receives signal via CAN

Function	Pin	Logic Required	Output	Notes
Steer Left	15	A. Steer left active - Pin #20 @ 12+V Upper processor "A"	Steer left becomes active - Pin #15 @ 12+V	Processor "C" in chassis receives signal via CAN

Pilot Cutoff Lever Switch

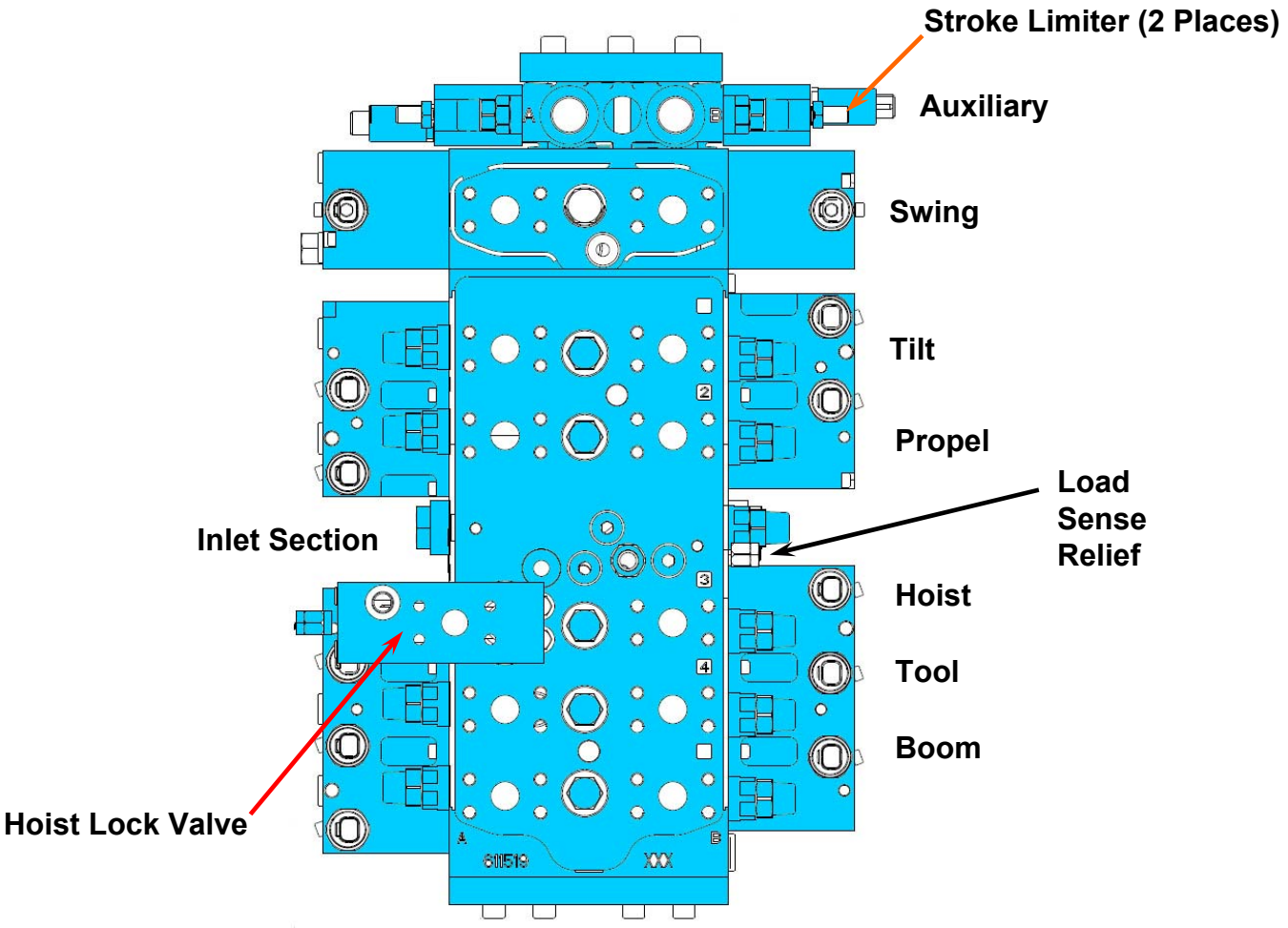


Cab is equipped with pilot cutoff lever. When raised, it turns off pilot feed to joysticks. When lowered, it turns on pilot to joysticks.

Pilot cutoff lever uses a “Hall Effect” switch to turn pilot cutoff solenoid on/off. It also is used for starter lockout. Pilot cutoff lever must be up to start engine.

Switch does require a gap for proper operation. Gap is set by adjusting nuts on switch body.

Main Control Valve – On Highway

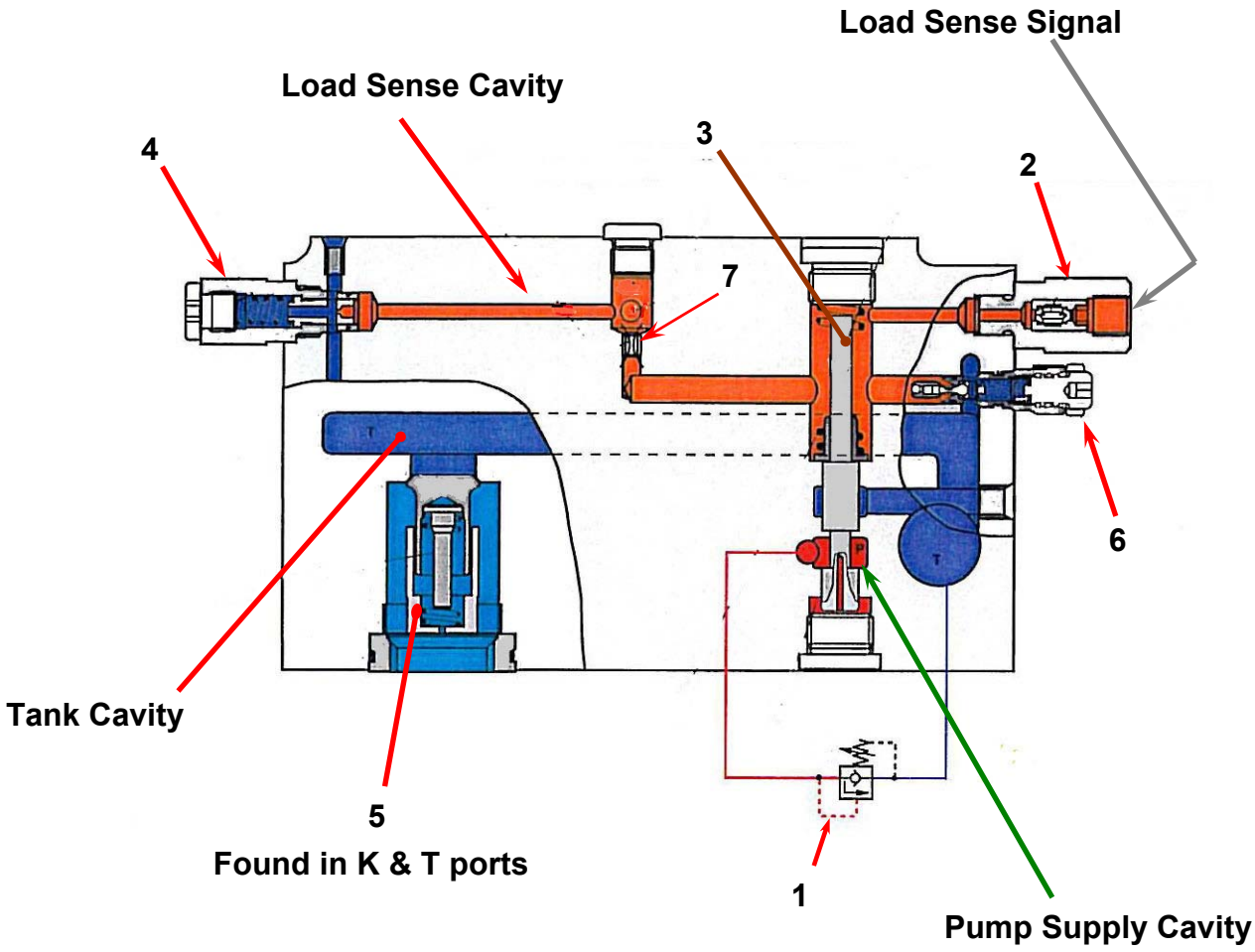


Main Control valve receives oil from the center pin on the LH side of the upper structure.

Main control valve is a monoblock type valve, with a bolt on auxiliary hydraulic option section.

Major functions are pilot operated from the end caps which are signaled from the processor. Bolt on sections for auxiliary use solenoids that are switch controlled.

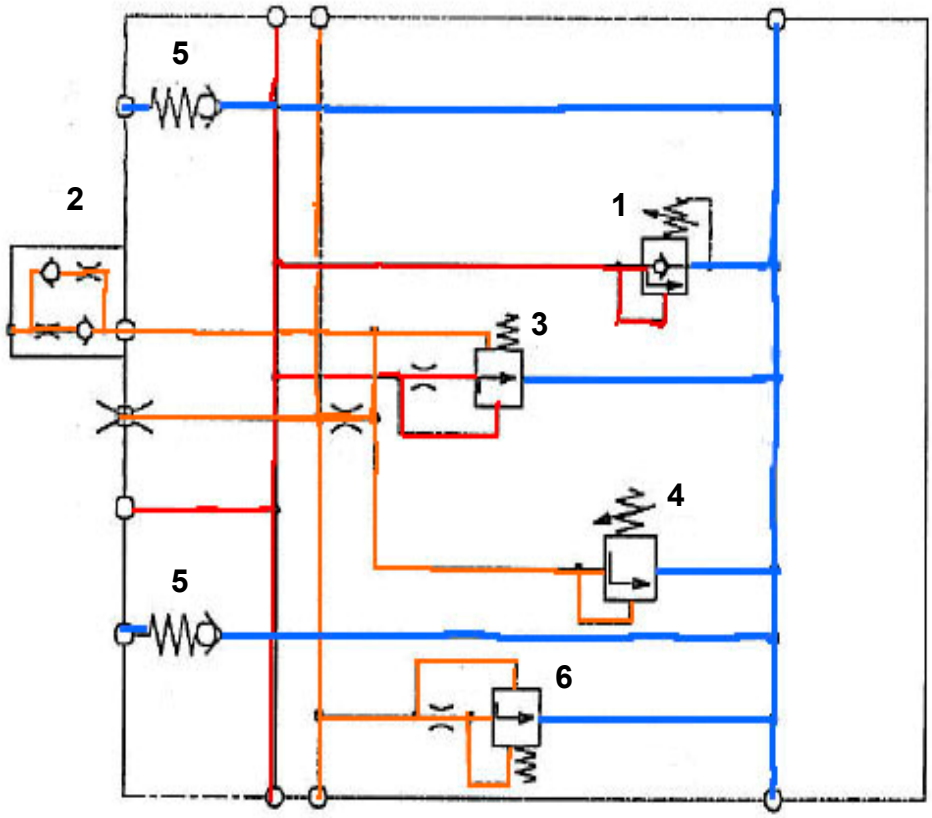
Main Valve Inlet Section



Main Valve inlet serves as inlet/outlet for oil to the valve along with many other important valve functions:

1. Primary Pressure relief – protects pump & valve
2. Load Sense Orifice Shuttle – Meters LS signal to the pump, drains signal in neutral
3. Flushing Valve – Allows flushing of valve with no LS signal.
4. Load Sense Drain Valve – Provides continuous drain of LS signal for stability
5. Tank/Cooler Check Valves – 2, located in ports “K” & “T”. Provides valve backpressure
6. Load Sense Relief – Primary system pressure control
7. Central Load Sense Orifice – prevents saturation of load sense relief and drain valves

Main Valve Inlet Section - Schematic



Main Valve inlet serves as inlet/outlet for oil to the valve along with many other important valve functions:

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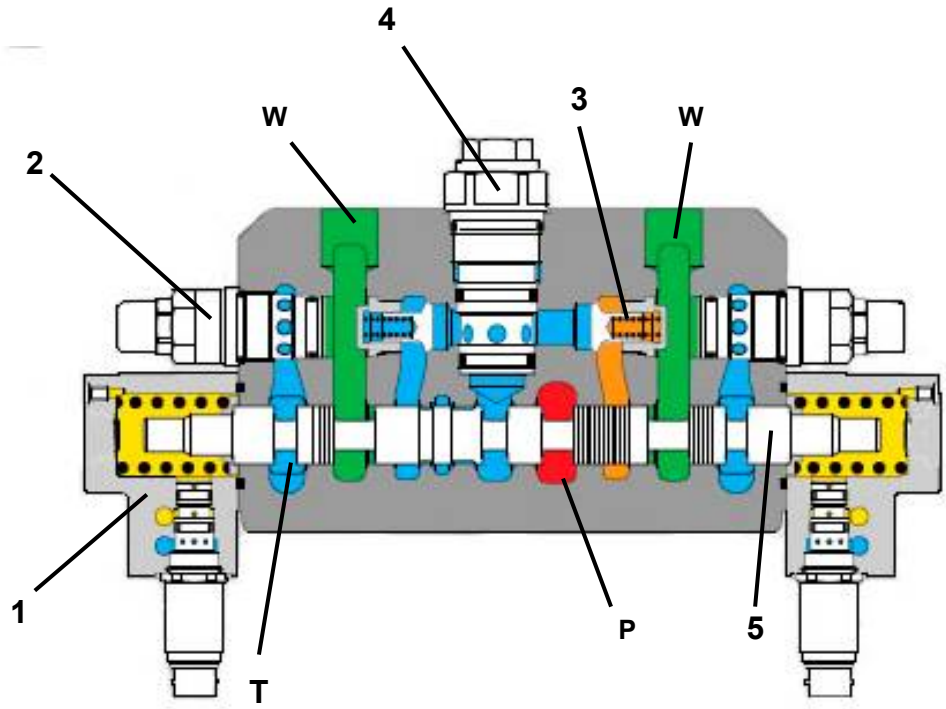
5. Tank/Cooler Check Valves – 2, located in ports “K” & “T”. Provides valve backpressure
6. Load Sense Relief – Primary system pressure control
7. Central Load Sense Orifice – prevents saturation of load sense relief and drain valves

Typical Main Valve Section



Typical Main Valve Cross-Section:

1 - End cap with proportional solenoid & damper orifice

2 - Work port relief/anti-cavitation check to protect work ports

3 - Load check holding valves between pressure core and work ports.

4 - Compensator spring and spool. Compensator meters oil between pump cavity and load sense when main spool is shifted

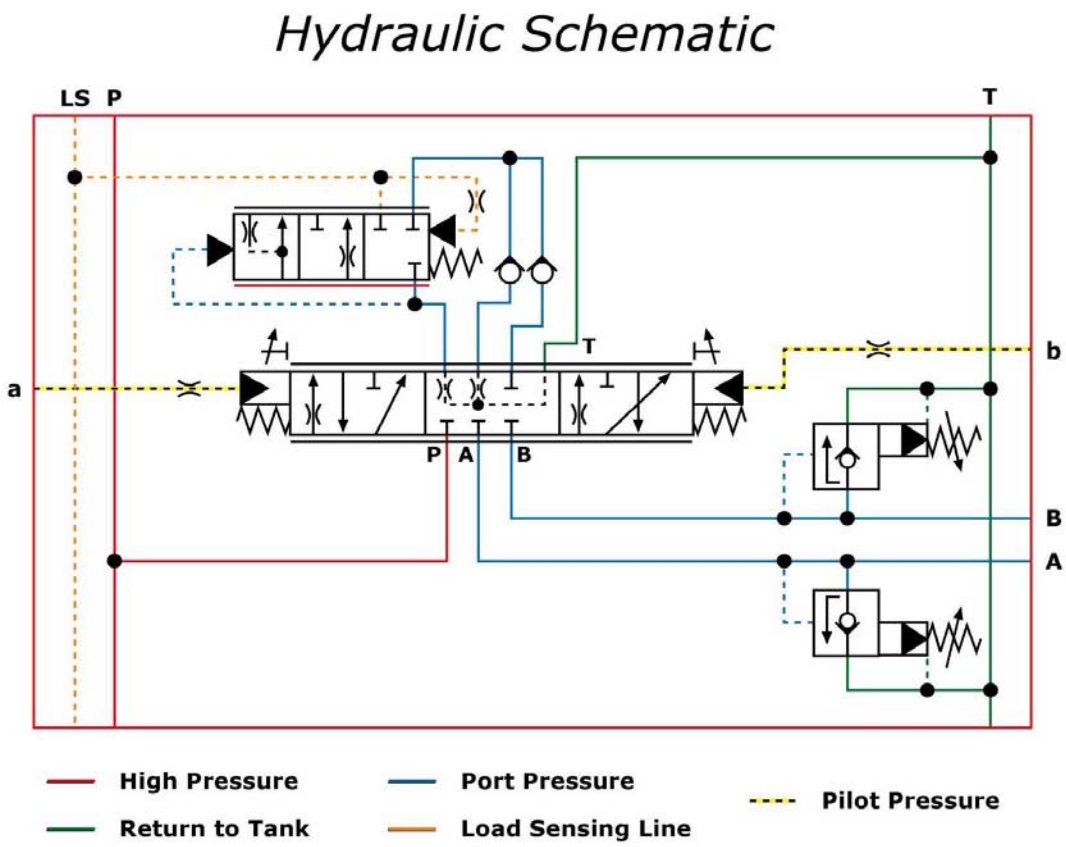
5 - Main spool controls flow from pump core to compensator and work ports.

T - Tank core

W - Work Ports

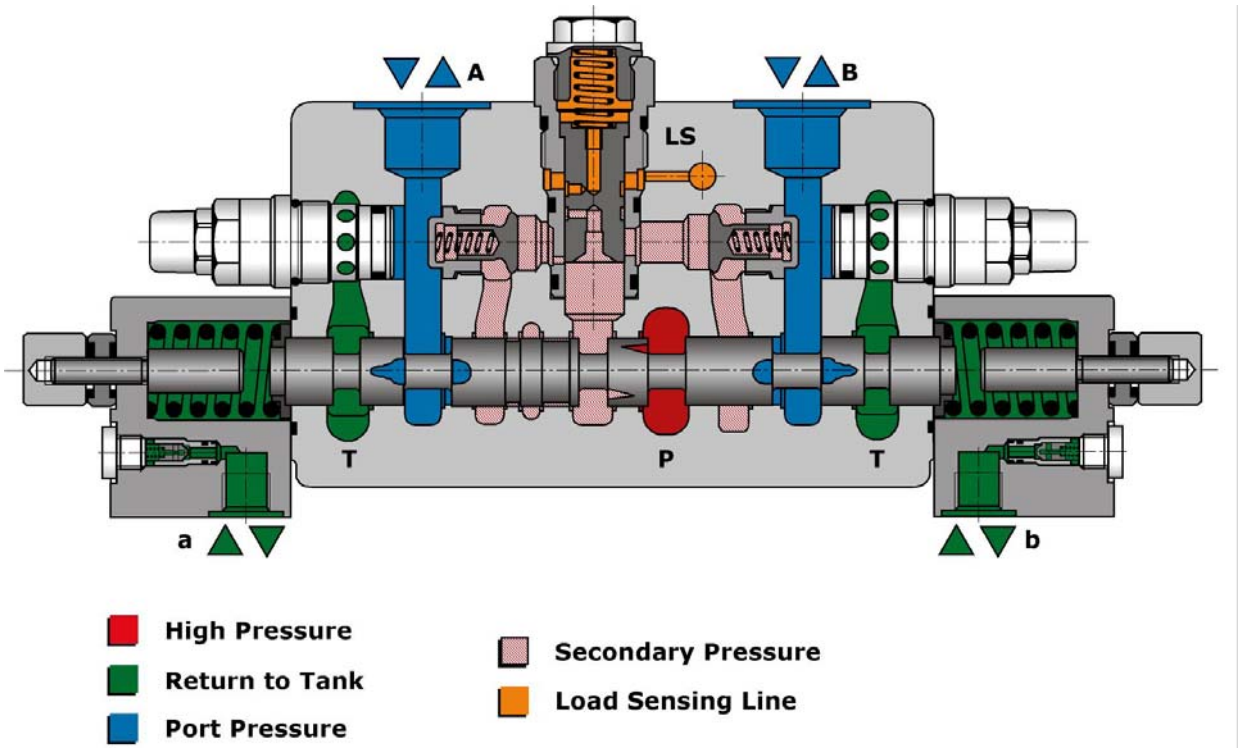
P - Pump/pressure cavity

Control Valve – Schematic View



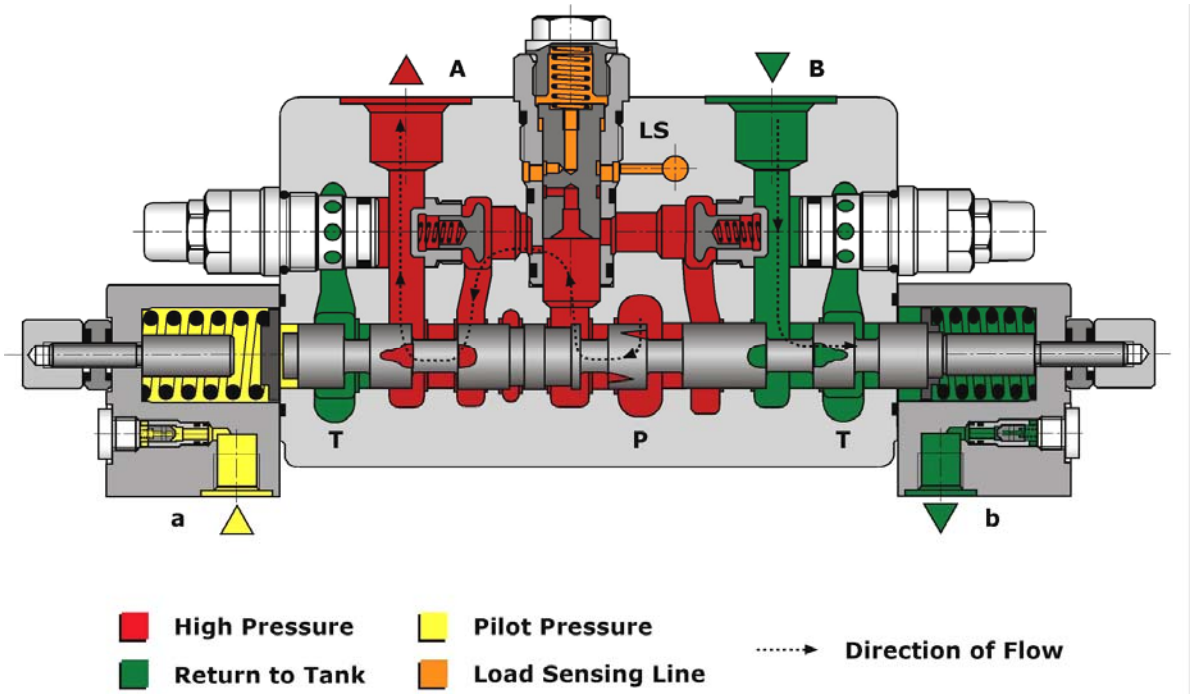
Schematic view of the control valve section. Components of the valve are noted.

Control Valve - Neutral



View of valve when spool is in neutral. Work ports are blocked, oil in pressure cavity is available to other sections. Load sense signal at compensator is higher than valve, compensator is in close position.

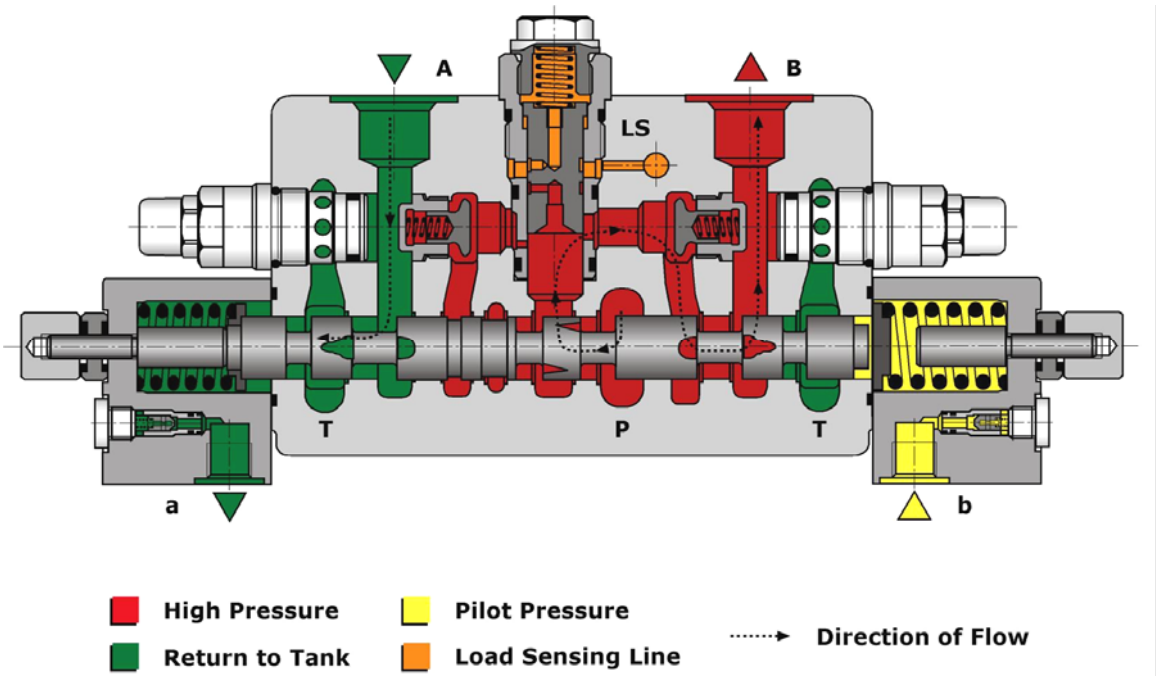
Control Valve – Shifted to “A” Port



Valve shifted for flow out “A” port. Pilot pressure at “a” end cap shifts spool. Oil from pressure cavity is metered across spool to compensator. Compensator works against spring and system load sense and meters oil across load check and out “A” port to work function. If valve pressure is greater than load sense & spring pressure, compensator moves to open position to signal load sense. As flow/pressure in valve changes, compensator maintains pressure drop across valve to work port and signals pump to maintain differential between pump and work port.

“B” port is drained to tank cavity of the valve.

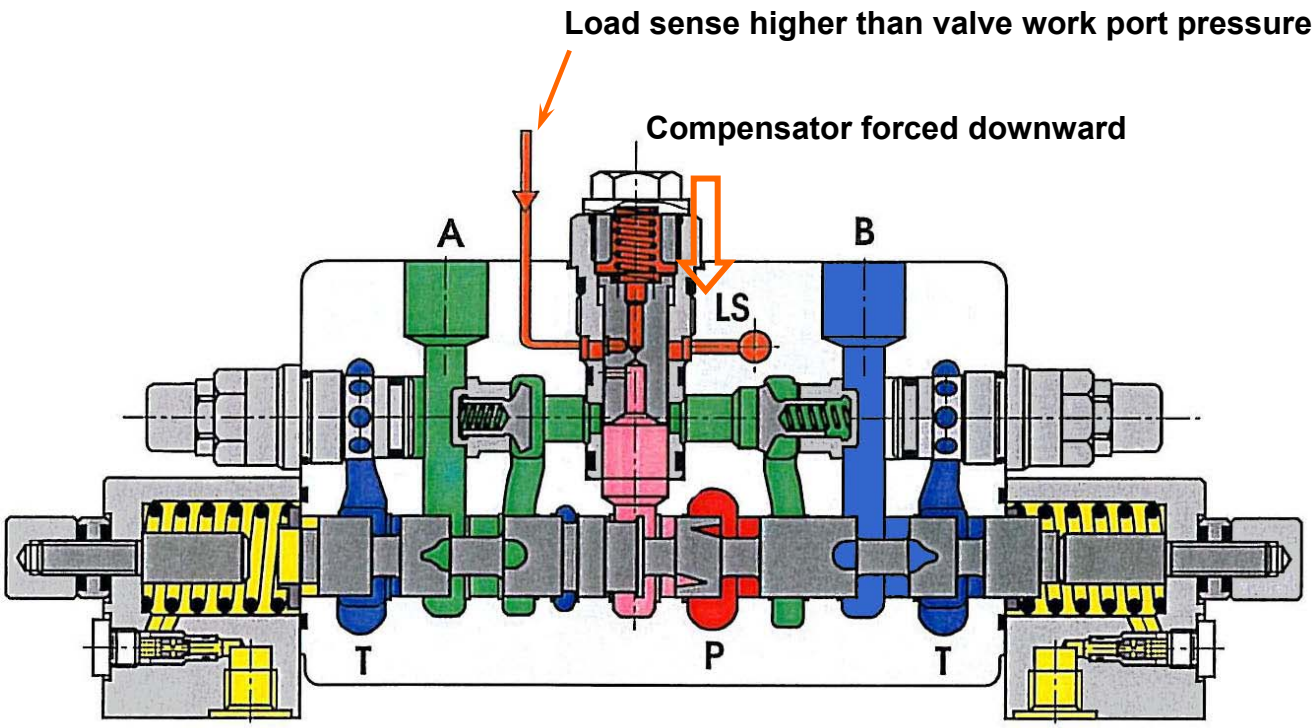
Control Valve – Shifted to “B” Port



Valve shifted for flow out “B” port. Pilot pressure at “b” end cap shifts spool. Oil from pressure cavity is metered across spool to compensator. Compensator works against spring and system load sense and meters oil across load check and out “A” port to work function. If valve pressure is greater than load sense & spring pressure, compensator moves to open position to signal load sense. As flow/pressure in valve changes, compensator maintains pressure drop across valve to work port and signals pump to maintain differential between pump and work port.

“A” port is drained to tank cavity of the valve.

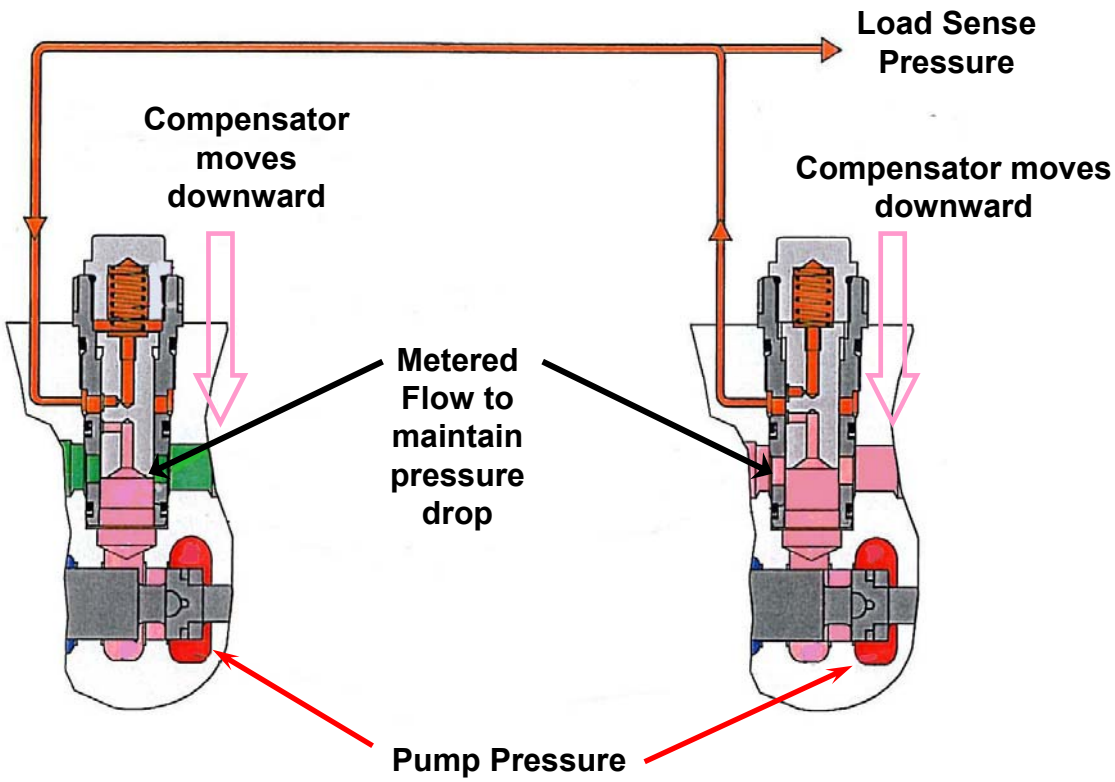
Section Operation, Multiple Functions



When multiple functions are operated, compensator works a bit different than previous slides. When multiple functions are used, LS pressure acts on compensator to force it downwards to meter oil from spool to work port causing additional pressure drop. Pressure drop across the spool from pressure cavity to compensator remains the same.

Multiple Function Operation – Load Sense

Flow Demand Greater than Pump Flow

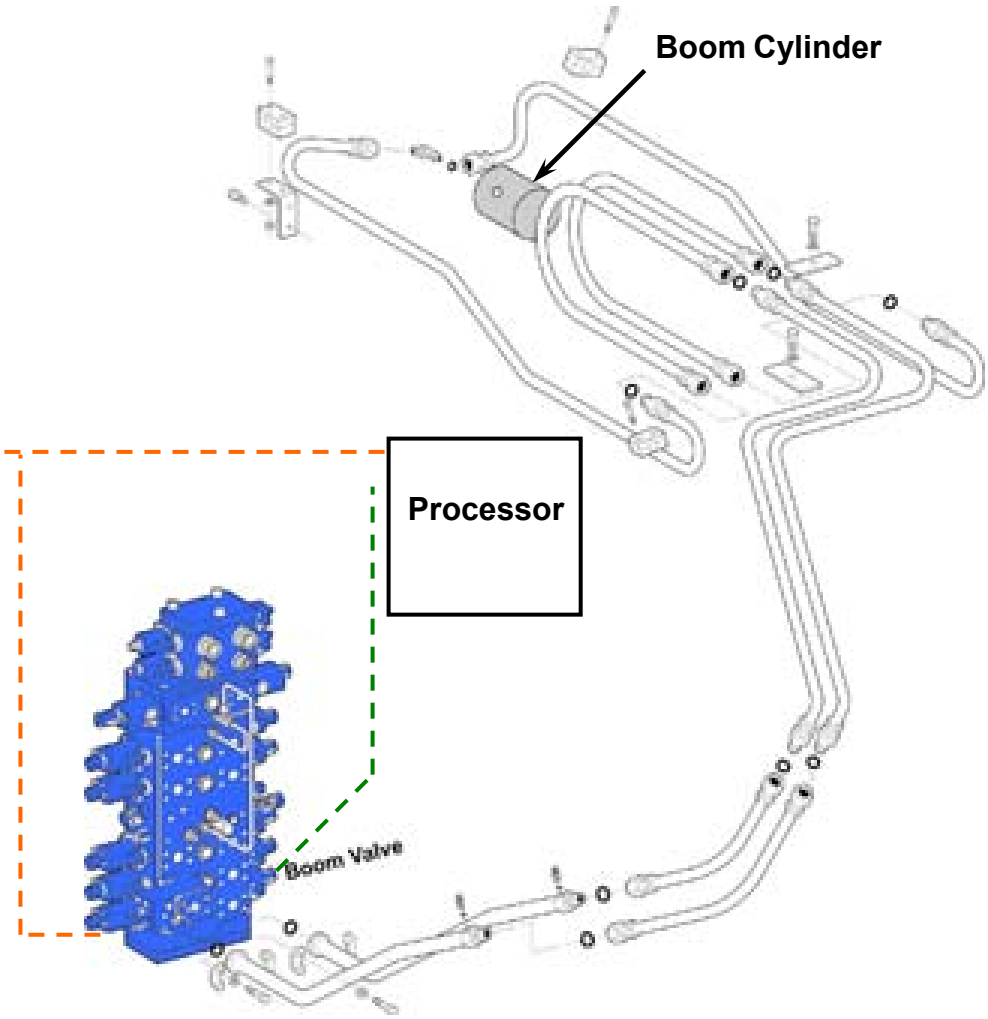


When demand for pump flow is greater than pump is able to produce (flow limit or horsepower cutoff), pressure drop at spool can not be maintained. Since all compensators are acted upon by highest pressure, compensators shift downward until pressure drop is maintained at compensator instead of spool.

Machine functions will slow proportionally. Functions will remain moving in proportion to operator input.

As system demand decreases and pump flow increases, the compensators will move back up and allow pressure drop to be controlled across the spool again.

Boom Cylinder Circuit

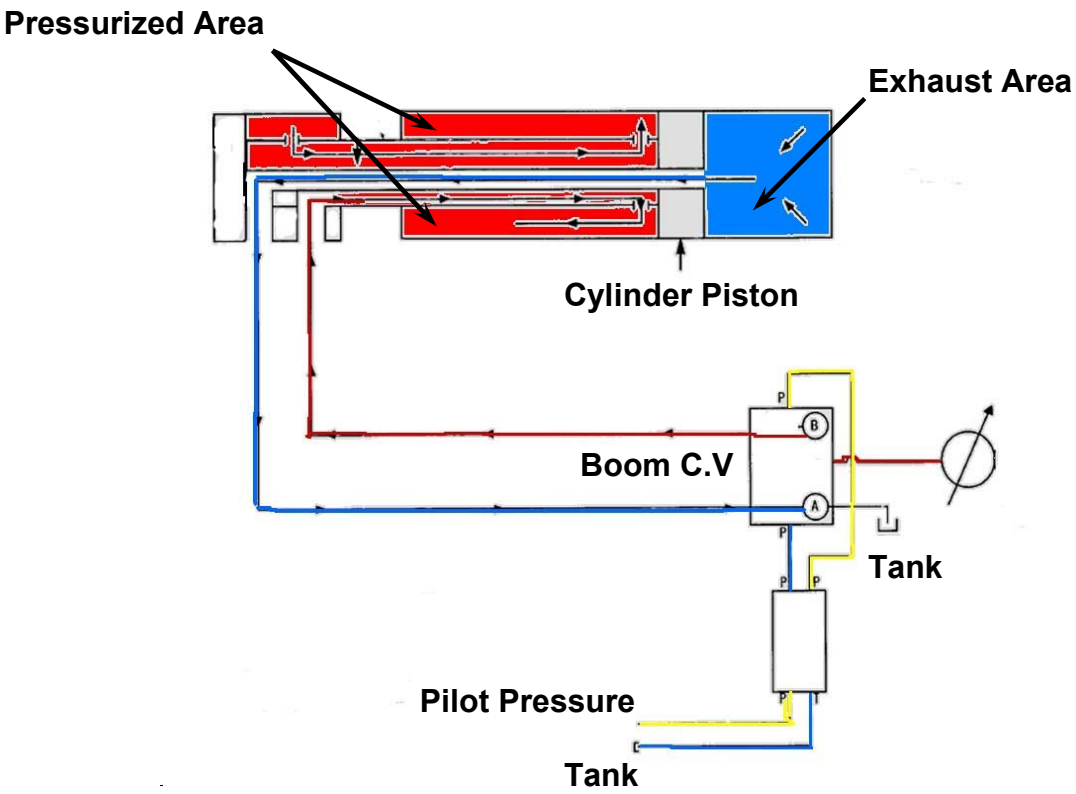


Boom valve directs oil into boom circuit to boom cylinder mounted at the rear of the main boom. Operator uses the joystick to direct boom to retract or extend.

Boom joystick signal at the processor is used to signal proportional solenoid at the boom valve at end cap. Pilot pressure at the end cap is used to shift the spool. When the spool is shifted, oil from the valve pump cavity is routed to the selected port across the spool. A load sense signal is generated and is used by the valve & pump to provide adequate flow for load conditions.

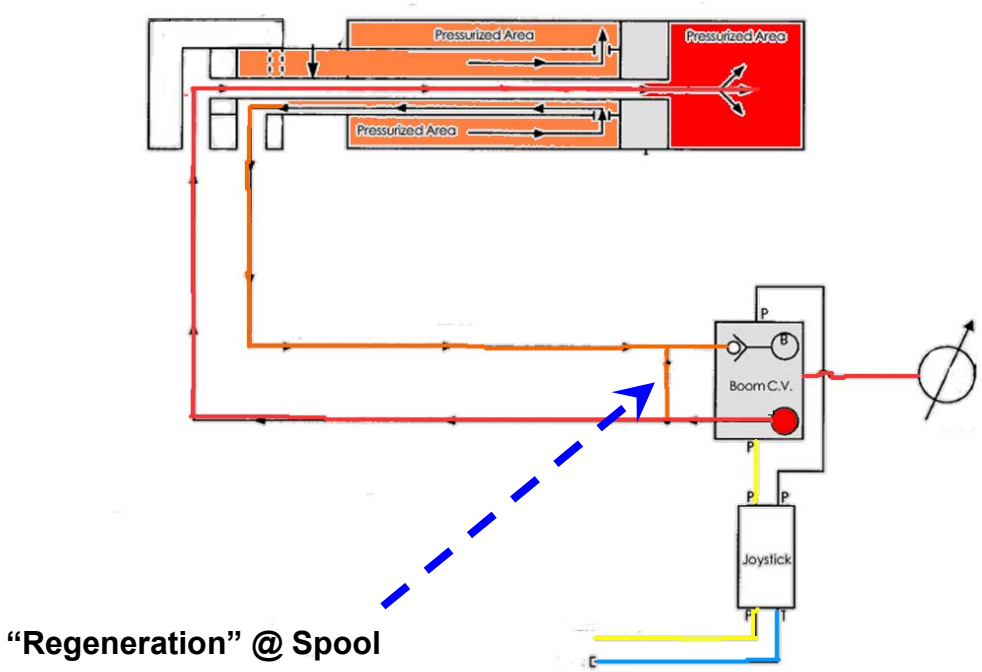
Oil is routed to the boom cylinder through a series of hoses and tubes from the boom valve to the boom cylinder.

Boom Retract Circuit Operation



During boom retract operation, control valve routes oil to rod side of boom cylinder to retract boom. Oil on base side is routed to tank through the control valve.

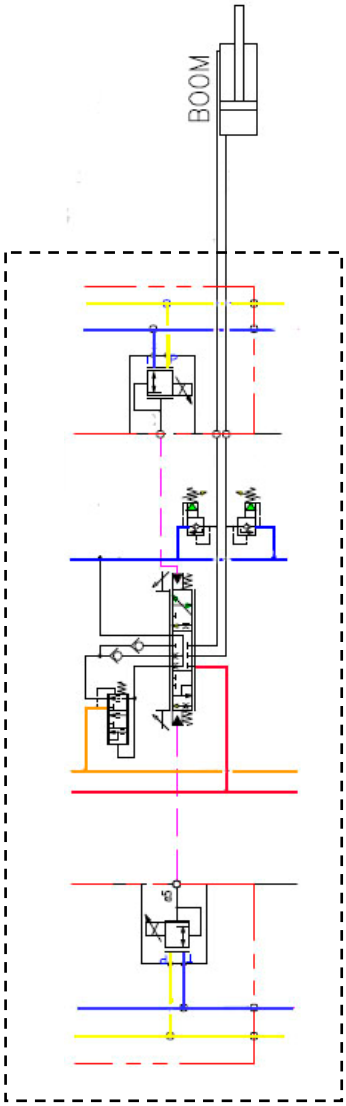
Boom Regeneration Circuit



“Regeneration” @ Spool

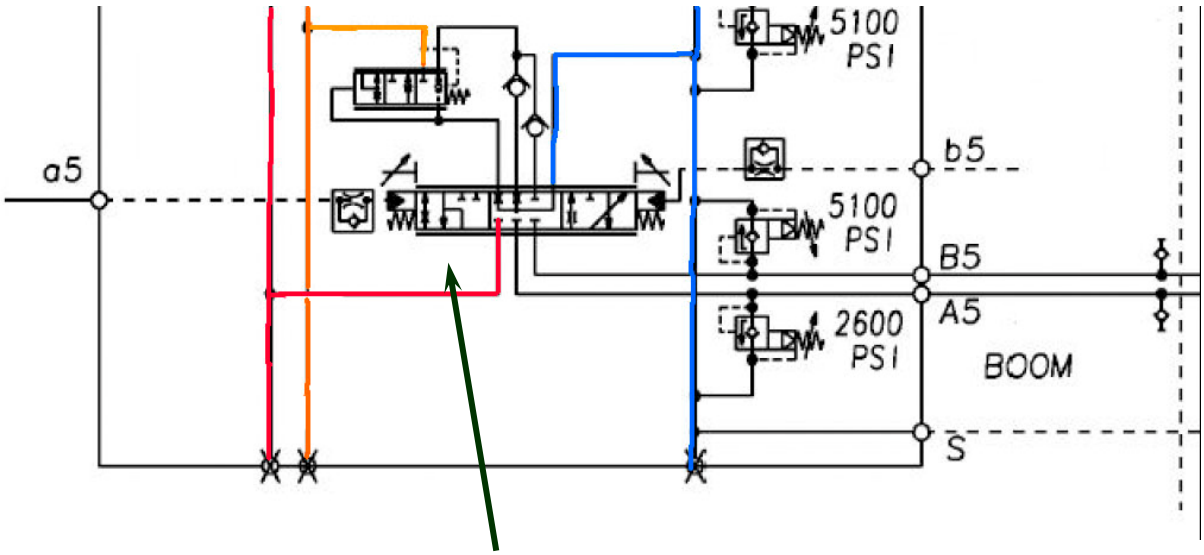
During boom extend function, control valve shifts to send oil to base end of cylinder. As cylinder extends, oil returns to control valve. The boom control valve uses a special spool that allows “regeneration” to occur. All oil returned from cylinder to valve is returned to base end. This gives fast boom out action. Cylinder runs at virtually same pressure on both sides of piston during boom out. Difference in surface area allows cylinder to extend.

Boom Circuit Schematic



Schematic view of the boom circuit. The control valve is slightly different schematically due to the regeneration circuit. The different control valve schematic is shown in the next slide

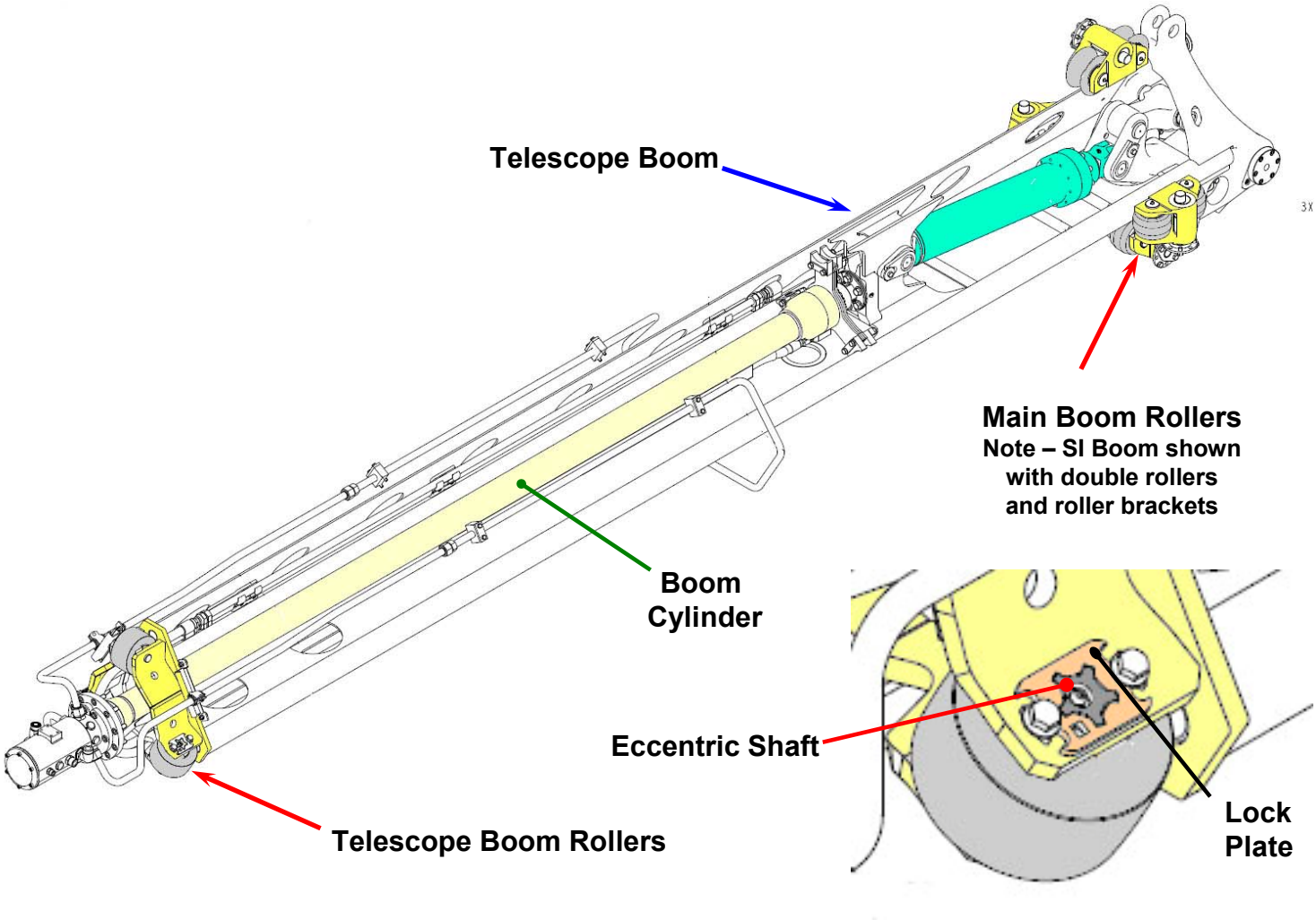
Boom Valve Schematic



Note symbol for regeneration

Boom valve is different than other control valves. Boom circuit uses “regeneration” to achieve boom out speed. Note the difference in the schematic!

Boom Circuit and Rollers

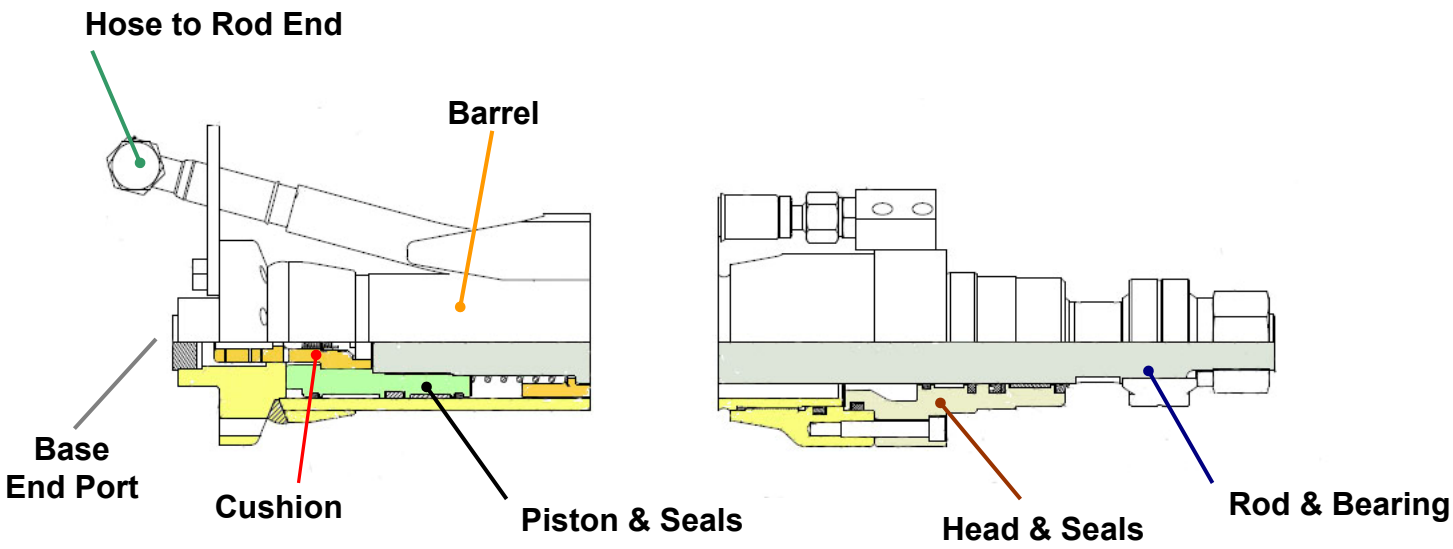


Boom cylinder is attached to main boom and telescope boom. Movement of boom cylinder extends or retracts telescope boom. Telescope boom rides on rollers attached to back of telescope boom and front of main boom.

Rollers use eccentric shafts to adjust boom to center telescope and take up looseness in rollers. The amount of rollers used depends on machine size and application.

A lock plate is provided to lock the eccentric shafts after roller adjustment. Bolts are used to retain the lock plate to the booms.

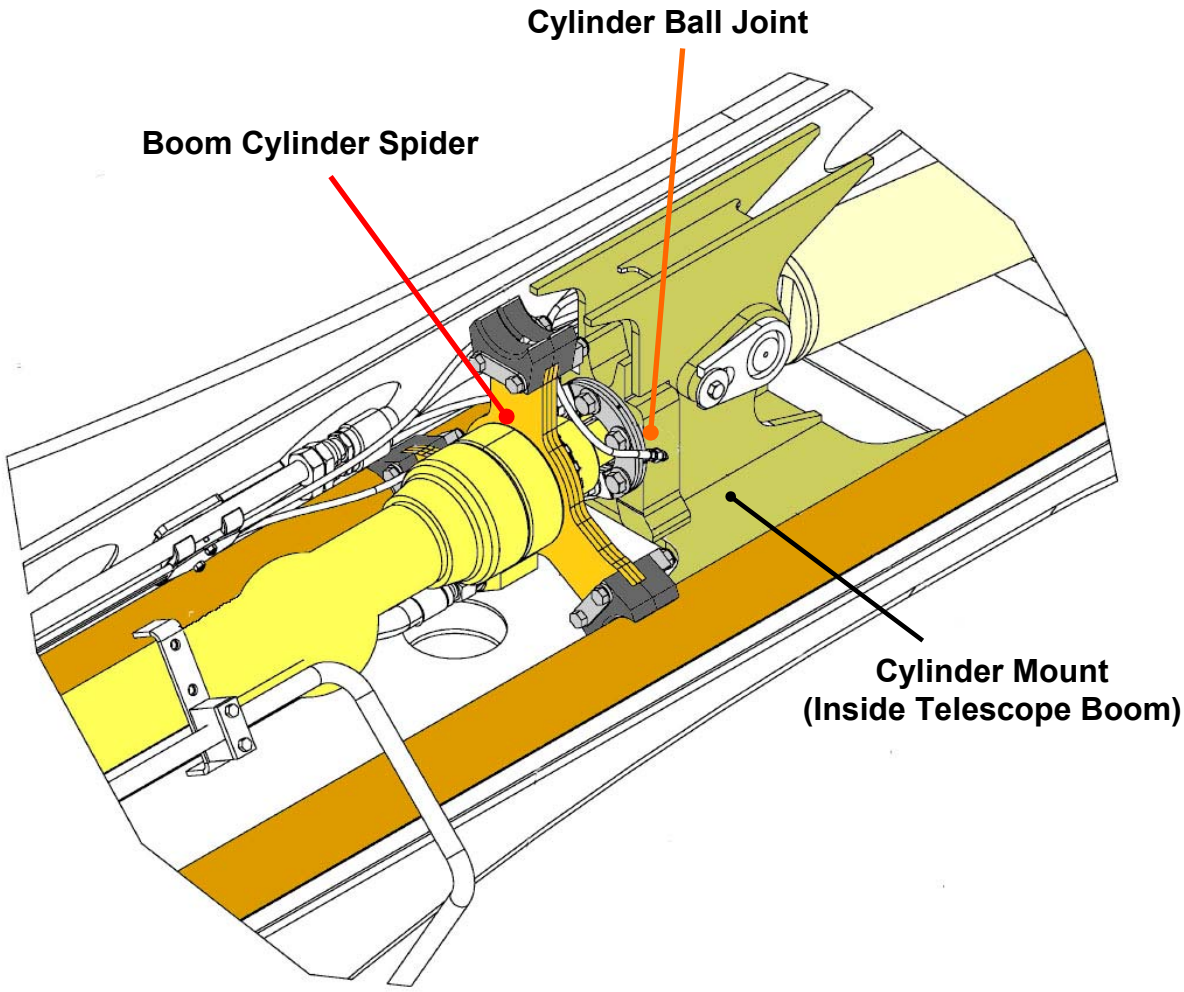
Boom Cylinder



Boom cylinder is a double acting cylinder. It has 2 cushions to dampen cylinder stop at each end of stroke. Rod side cushion is spring loaded sliding valve, base end cushion is a plunger type cushion retained by the piston. A spring & check ball in the plunger allows fast start for boom extend. Piston is threaded onto the rod. Cylinder barrel bolts to the main boom. Rod end has a spherical bearing attached to telescope boom to allow tilt action.

Seals and bearings are provided for sealing and support of piston. Head has seals to prevent leakage of hydraulic fluid at cylinder head. Piston is threaded onto the rod for retention. Head is retained in barrel by cap screws.

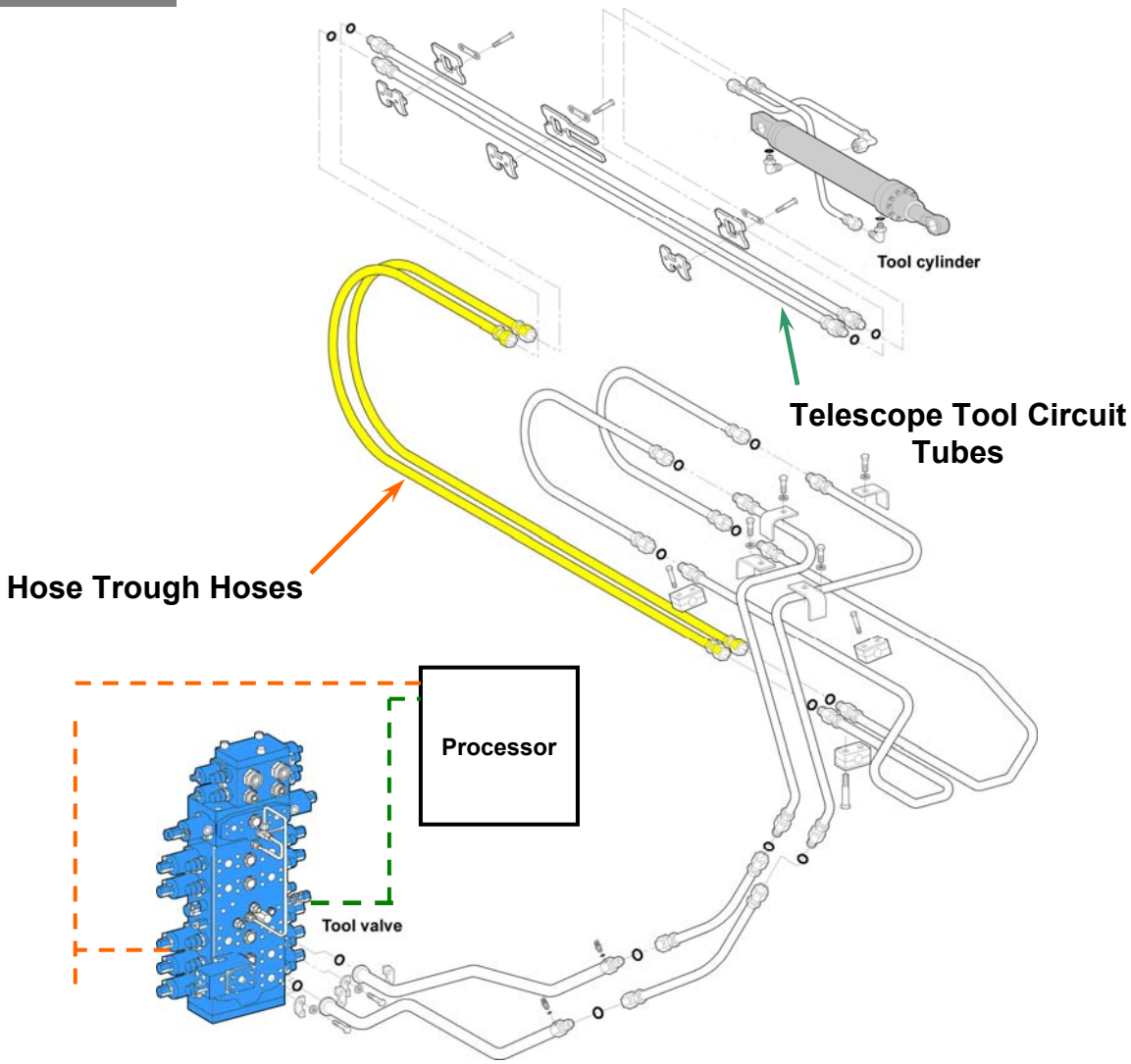
Boom Cylinder Support



Boom cylinder has a support on the barrel end. The support (spider) consists of 3 arms with wear pads that ride on the telescope boom pipe. The wear pads do require lubrication.

The boom cylinder rod and tool cylinder both attach to the telescope boom at the cylinder mount. The tool cylinder is pinned to the telescope boom, the boom cylinder is attached using a spherical bearing to allow boom tilt.

Tool Circuit

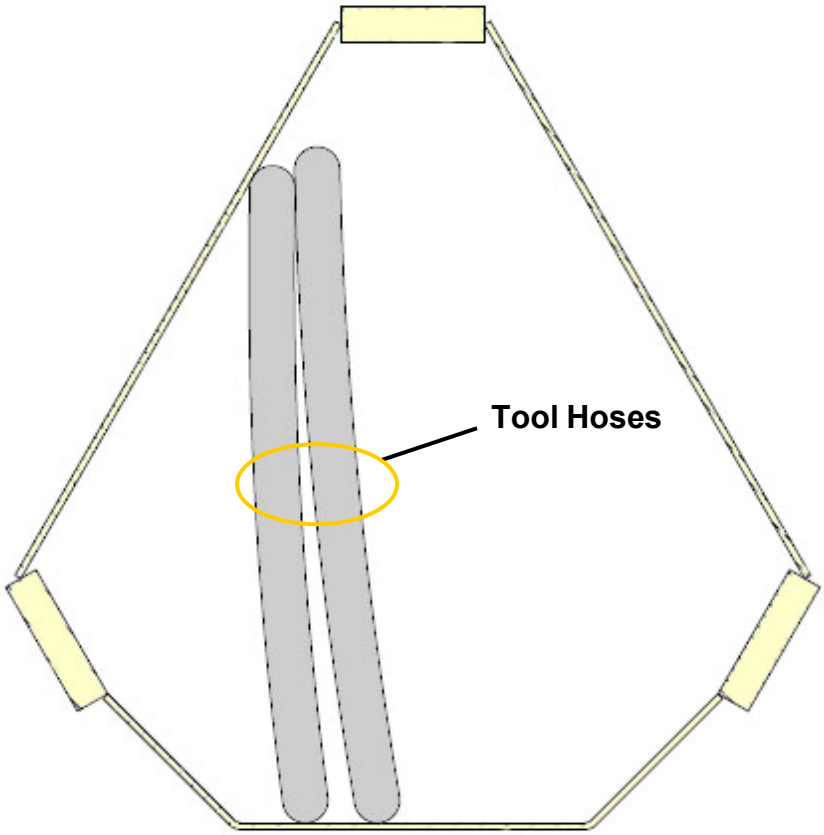


Tool valve directs oil into tool circuit to tool cylinder mounted at the front of the telescope boom. Operator uses the joystick to direct tool to retract (open) or extend (close).

Tool joystick signal at the processor is used to signal proportional solenoid at the boom valve at end cap. Pilot pressure at the end cap is used to shift the spool. When the spool is shifted, oil from the valve pump cavity is routed to the selected port across the spool. A load sense signal is generated and is used by the valve & pump to provide adequate flow for load conditions.

Oil is routed to the tool cylinder through a series of hoses and tubes from the tool valve to the tool cylinder. Hose trough hoses in the main boom along with tubes in the telescope boom allow for boom movement.

Tool Hoses in Hose Trough



Main Boom Cross Section Showing Hose Trough Area

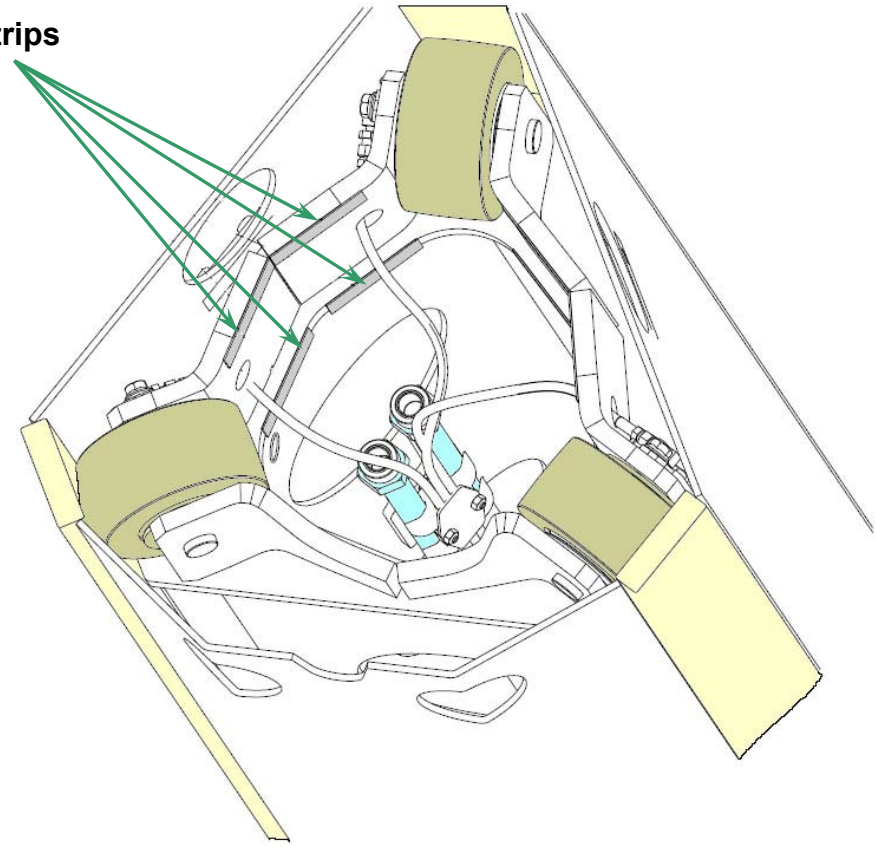
Tool hoses are shown inside main boom and hose trough. Hoses are attached to tubing at the tilt ring area of main boom and tubing inside the telescope. The hoses move with the telescope boom.

Tool hose alignment is as follows:

1. Install each hose to proper tube inside of telescope boom and torque to spec.
2. Set telescope boom so rear of telescope boom end is at 74” +/- 1” (1880 mm +/- 25 mm) distance from front plate of main boom.
3. Connect the hoses to tubes under main boom. Do not tighten until hoses are aligned.
4. Rotate the outside hose until the top of the hose loop contacts the inside of the main boom side plate. Torque to spec.
5. Rotate the inside hose end until the top of he hose loop contacts the outside hose. Torque the inside hose end to spec.

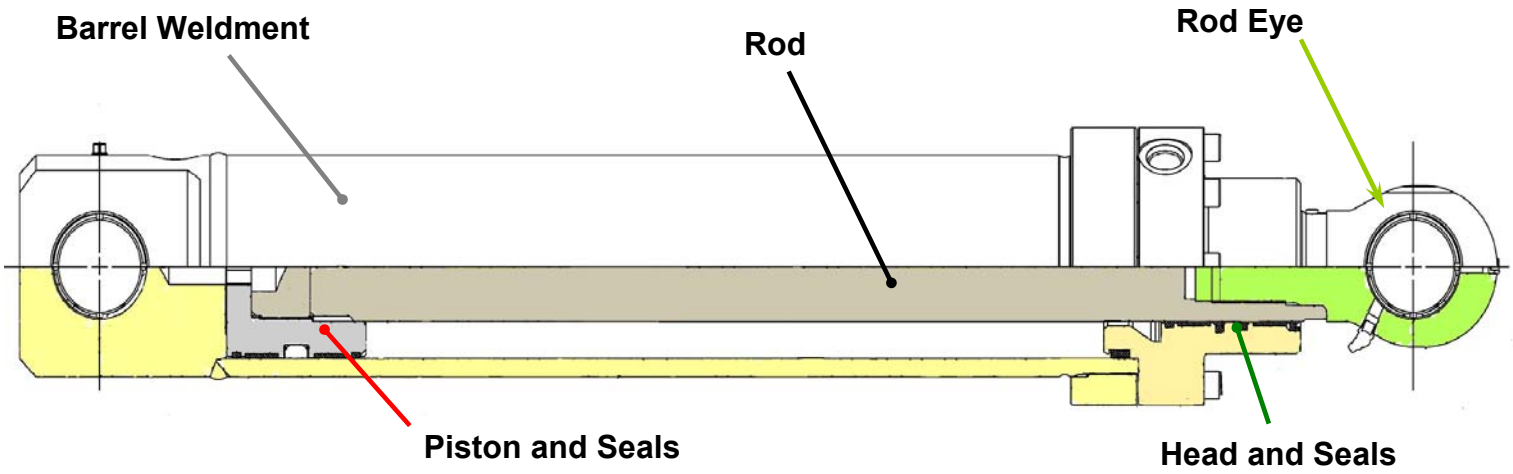
Tool Hose Wear Strips

Tool Hose Wear Strips



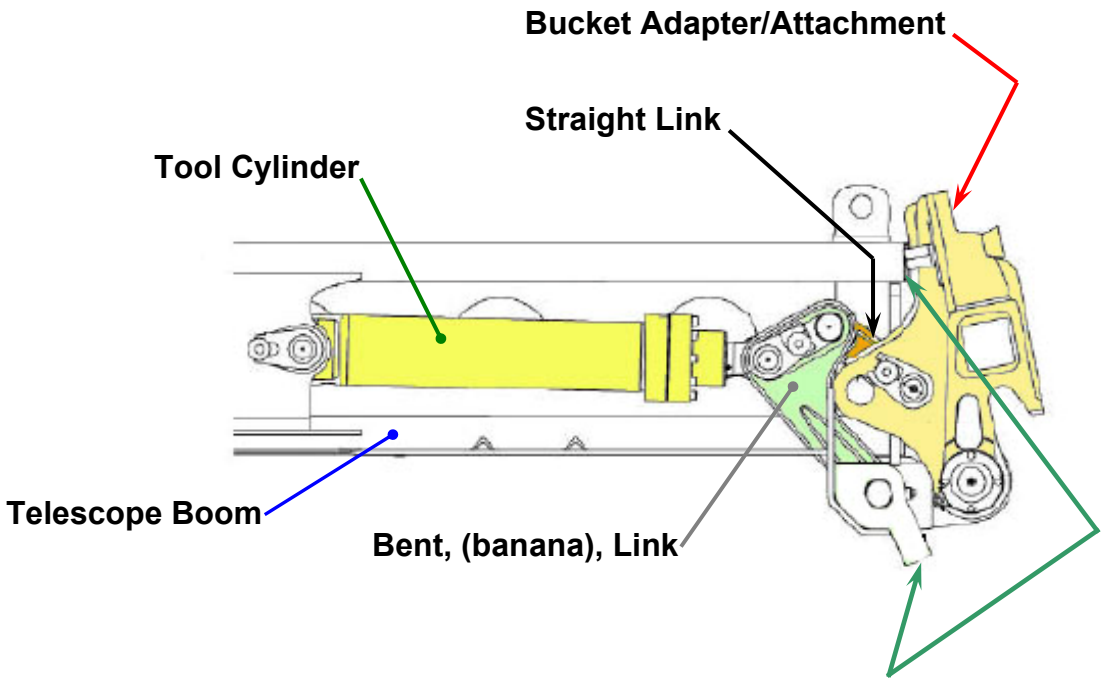
Wear strips are provided in back of the telescope boom to prevent chafing of the tool hoses. Wear strips be checked and replaced as needed when replacing tool hoses.

Tool Cylinder



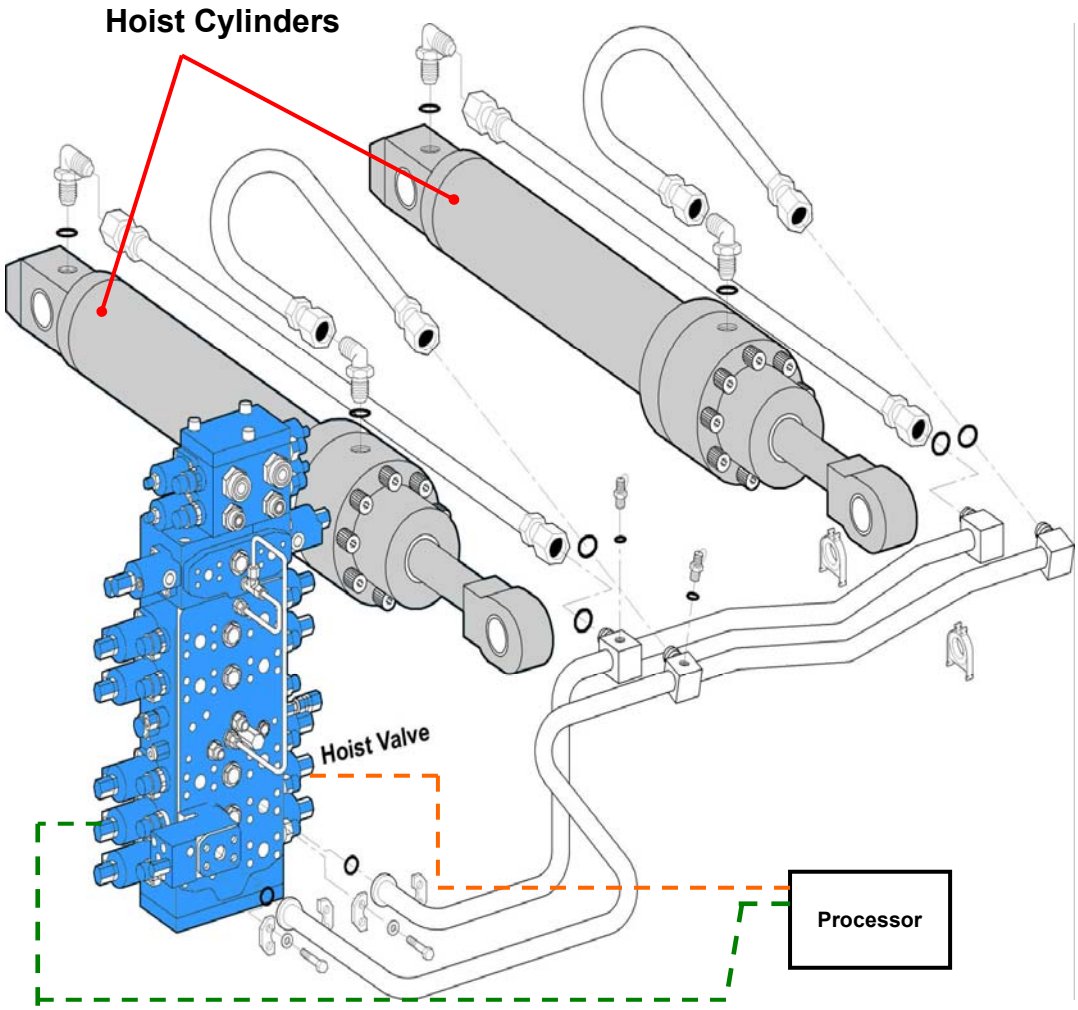
Tool cylinder is a double acting cylinder. Piston is threaded onto the rod. Rod eye is also threaded into the rod. Head is retained into the barrel using cap screws. Piston has seals and wear rings for high pressure, rod seals are to seal rod area from leakage. A dust seal is provided to reduce dirt being drawn into cylinder.

Tool @ Boom End



Tool cylinder at boom end moves the tool (bucket) through linkage. Tool cylinder is attached at the base end to the telescope boom. Rod end attaches to the bent link, which moves the bucket adapter through the straight link. Buckets attach to bucket adapter using wedge bolts to retain bucket to bucket adapter.

Hoist Circuit



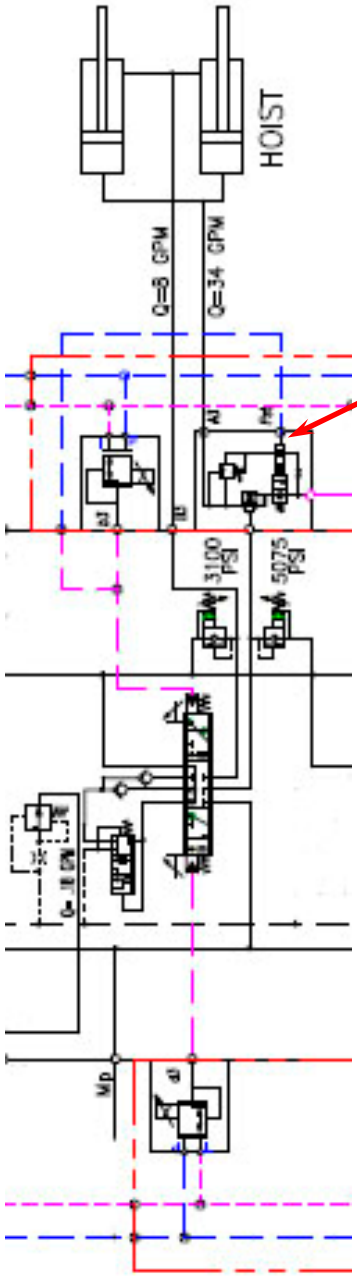
Hoist valve directs oil into hoist circuit to hoist cylinders mounted to frame and acting on cradle. Operator uses the joystick to direct hoist to retract (lower) or extend (raise).

Hoist joystick signal at the processor is used to signal proportional solenoid at the boom valve at end cap. Pilot pressure at the end cap is used to shift the spool. When the spool is shifted, oil from the valve pump cavity is routed to the selected port across the spool. A load sense signal is generated and is used by the valve & pump to provide adequate flow for load conditions.

Oil is routed to the hoist cylinder through a series of hoses and tubes from the hoist valve to the hoist cylinders.

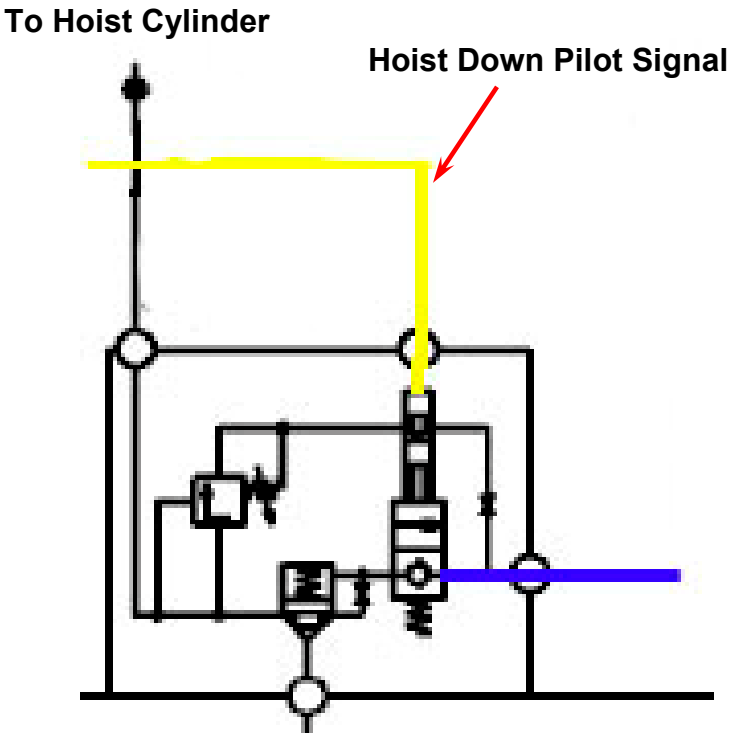
Hoist lock valve prevents excess cylinder drift.

Hoist Schematic



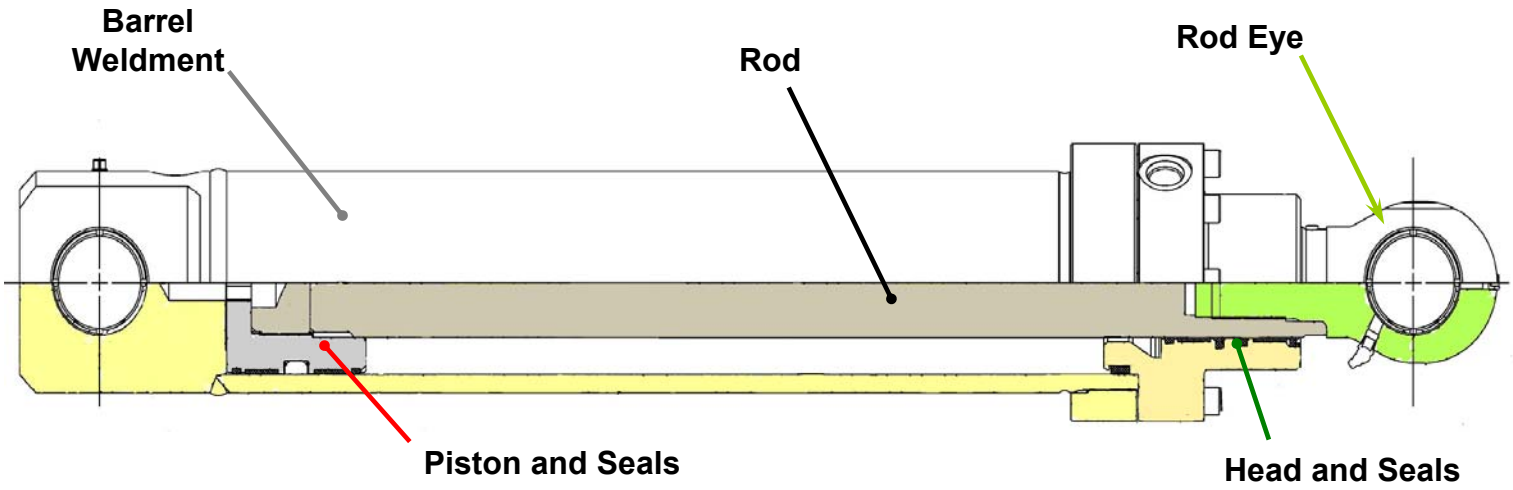
Schematic View of Hoist Circuit.

Hoist Lock Valve



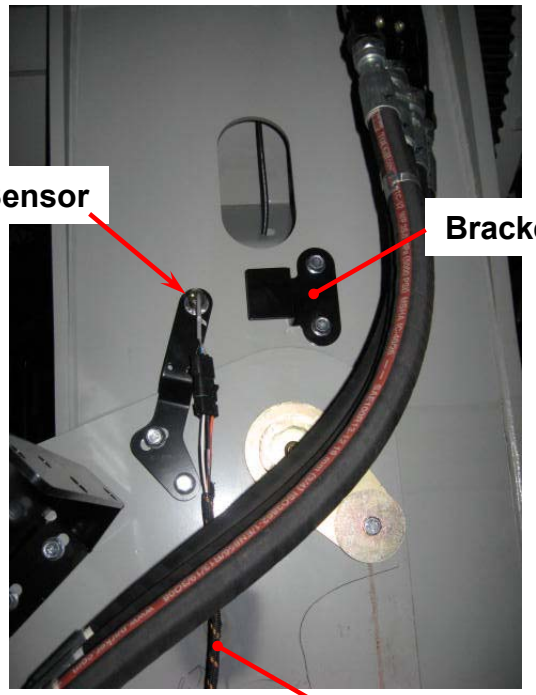
Hoist lock valve is supplied on "A" port of valve. Hoist lock is used to prevent excess drift of hoist circuit when hoist is not active. Spool is shifted by pilot pressure to allow hoist movement during hoist down. Spool works with check valve to control hoist down oil flow. Relief valve is provided to prevent overpressure of circuit.

Hoist Cylinder



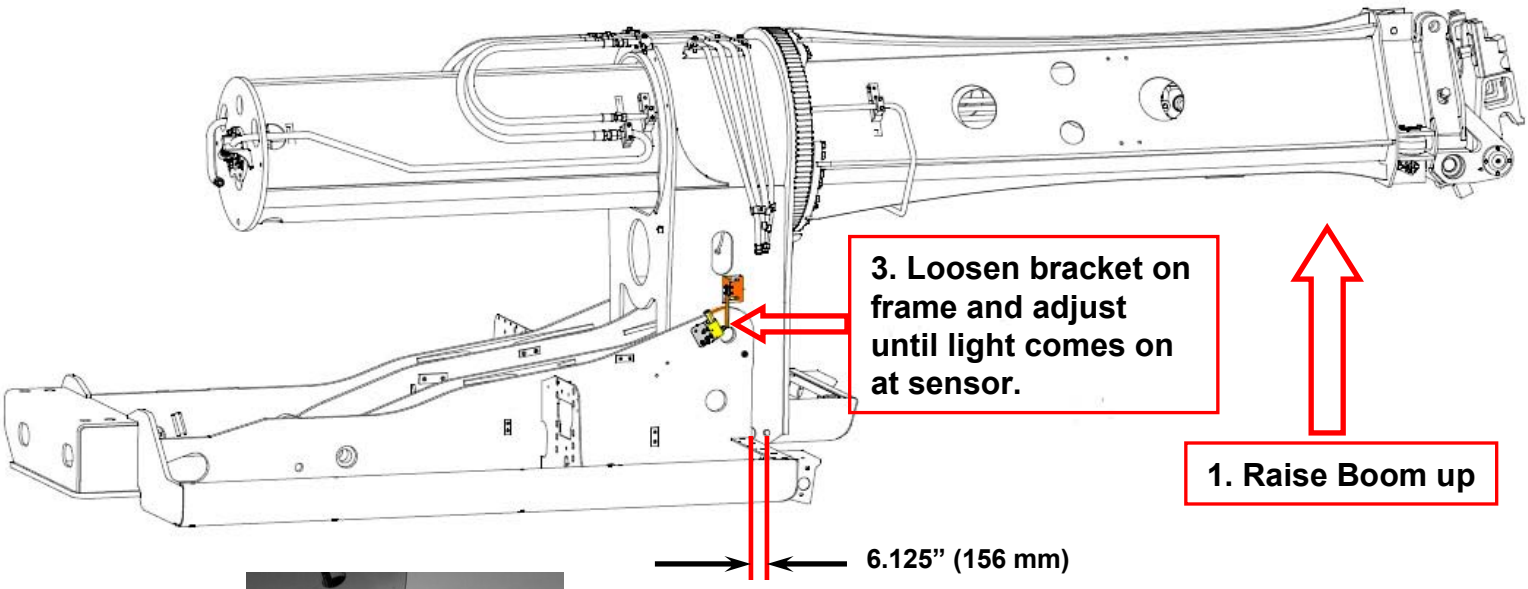
Hoist cylinders are double acting cylinders. Piston is threaded onto the rod. Rod eye is also threaded into the rod. Head is retained into the barrel using cap screws. Piston has seals and wear rings for high pressure, rod seals are to seal rod area from leakage. A dust seal is provided to reduce dirt being drawn into cylinder.

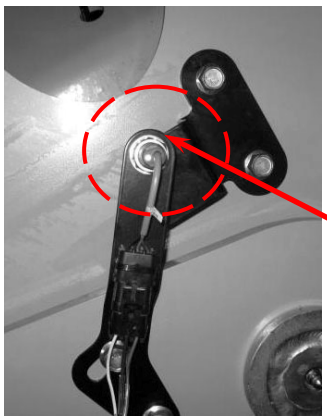
Hoist Up Cushion Circuit



Hoist up has a cushion circuit provided. A sensor on side of frame signals the processor to limit hoist up pilot pressure as hoist is raised to the up stop. When bracket on boom cradle passes the sensor on frame, hoist up pilot pressure is reduced to 200 psi to limit hoist up speed as it comes against hoist up boom stop.

Hoist Cushion Adjustment



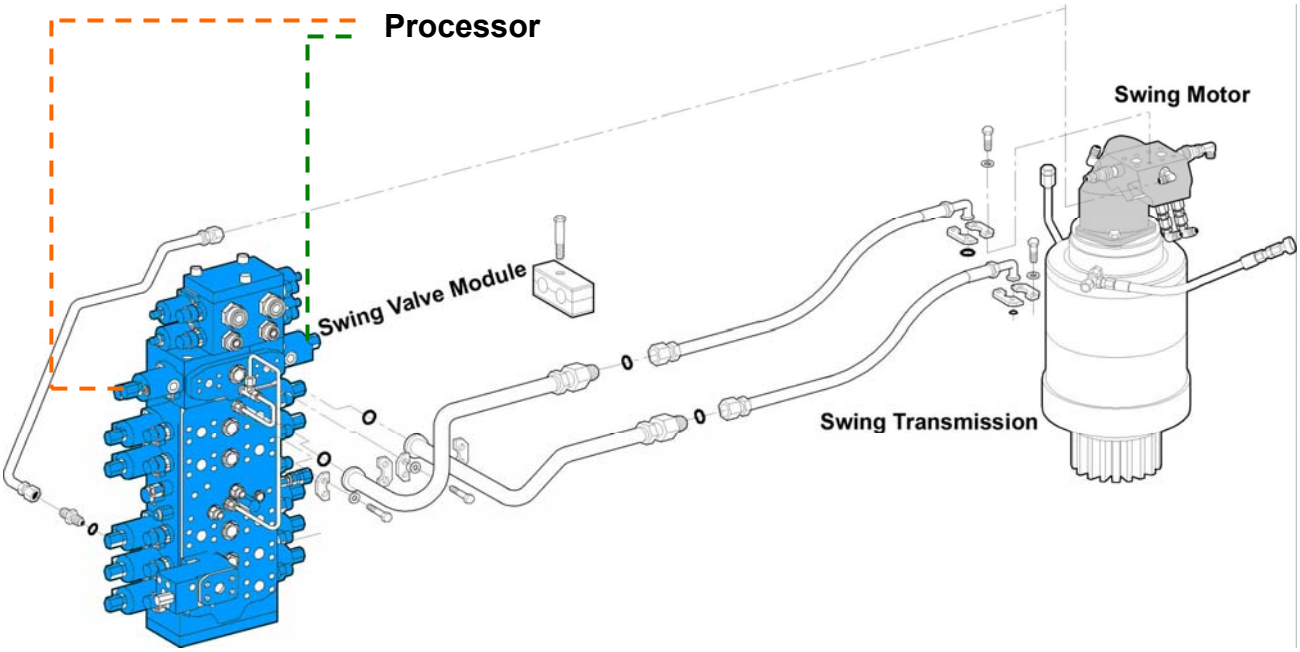


2. When distance from front of frame to center of hoist pin matches the above dimension.

Note light on at end of sensor

Hoist cushion circuit requires mechanical adjustment to work correctly. Follow the above steps to adjust correctly. Note, the key must be on while doing this adjustment.

Swing Circuit



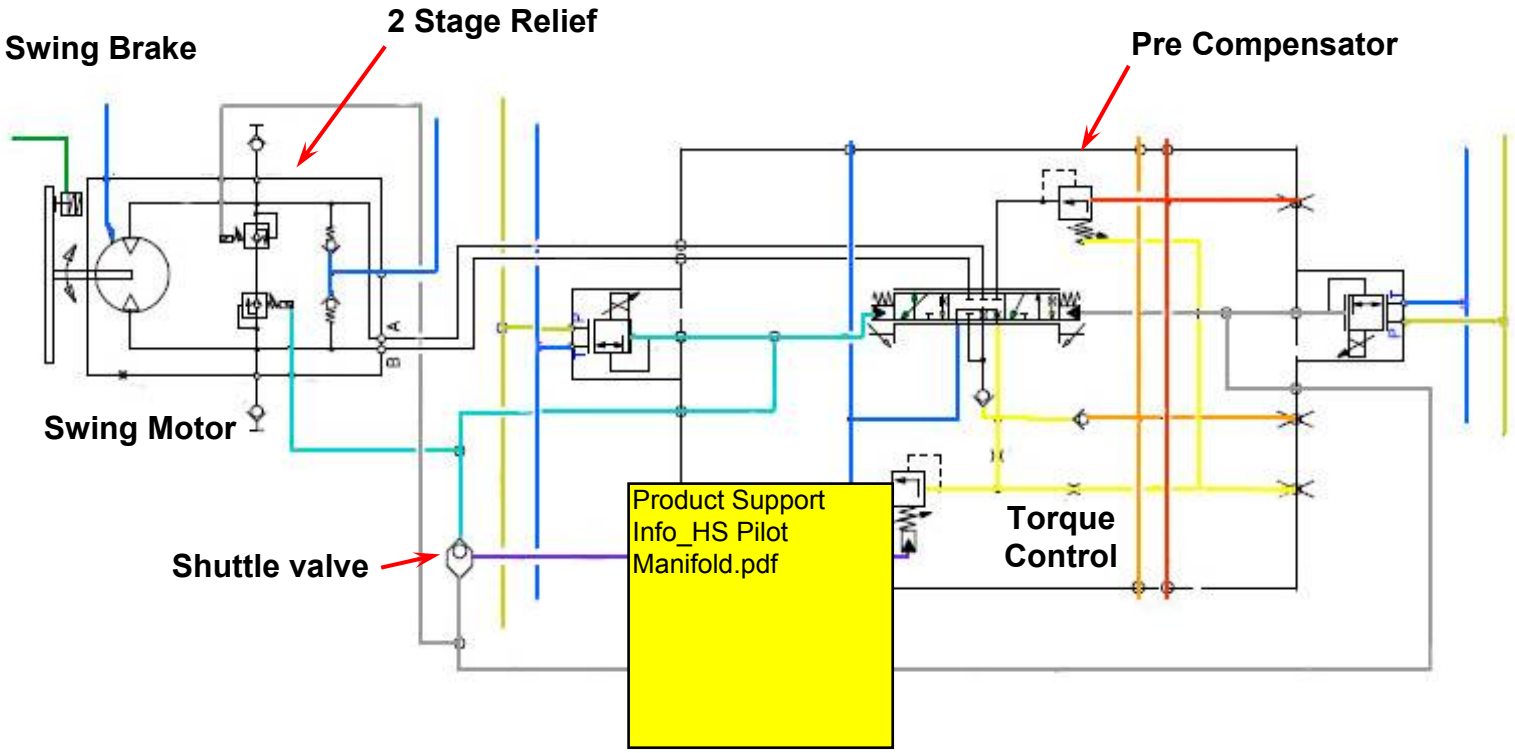
Swing valve module directs oil into swing circuit to swing motor mounted on swing transmission. Operator uses joystick to direct swing to rotate upper structure clockwise or counterclockwise.

Swing joystick signal at the processor is used to signal proportional solenoid at the boom valve at end cap. Pilot pressure at the end cap is used to shift the spool. When spool is shifted, oil from the pump cavity is routed to the selected port across the spool. A load sense signal is generated and used by valve and pump to provide adequate flow for load conditions. A check valve in the swing module load sense gives priority to load sense signal for swing circuit.

Oil is routed to the motor through hoses and tubes.

2 stage relief at valve controls swing pressure (torque). 2 stage relief valves at motor provide high pressure for swing, low pressure for stop (cushioning)

Swing Circuit Schematic



Swing circuit schematic is shown. Swing circuit has reliefs and other components added to allow swing control and cushioning.

Swing valve uses a “torque control” relief to provide smooth control of swing circuit during operation. Dual stage reliefs at the swing motor, provide high pressure to swing and lower pressure to provide cushion while stopping swing.

A parking brake is part of the swing circuit to hold machine from movement when swing is not activated.

2 Stage Relief - Swing

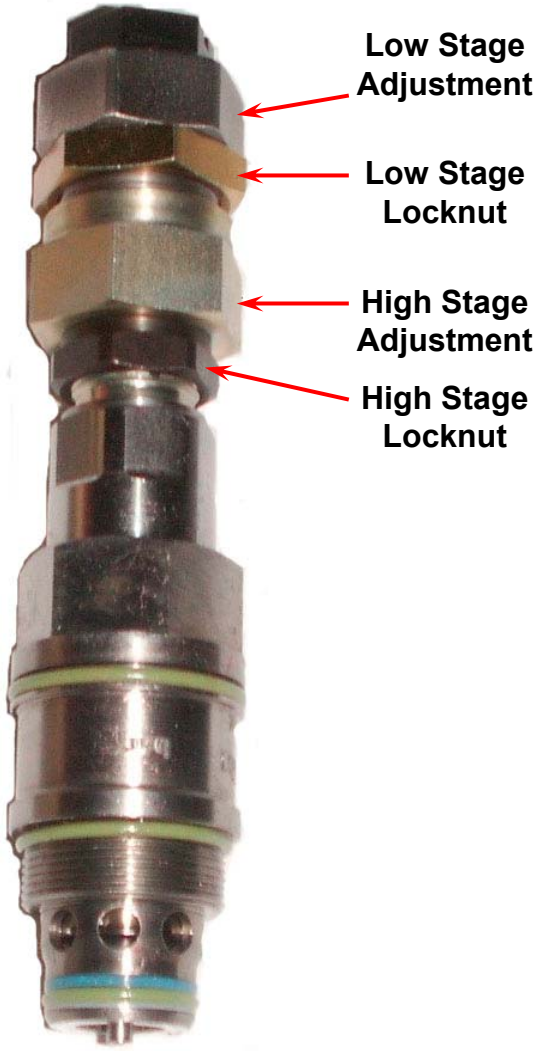
Swing circuit uses 3 - 2 stage relief valves. A 2 stage relief valve allows low pressure using a spring setting only and high pressure when using an external pilot pressure and spring setting.

The swing valve has a 2 stage relief installed in the valve body. The relief acts on the swing valve load sense pressure. Low stage is used for swing begin point. When pilot pressure is applied externally from the valve end caps, high stage controls the maximum swing pressure.

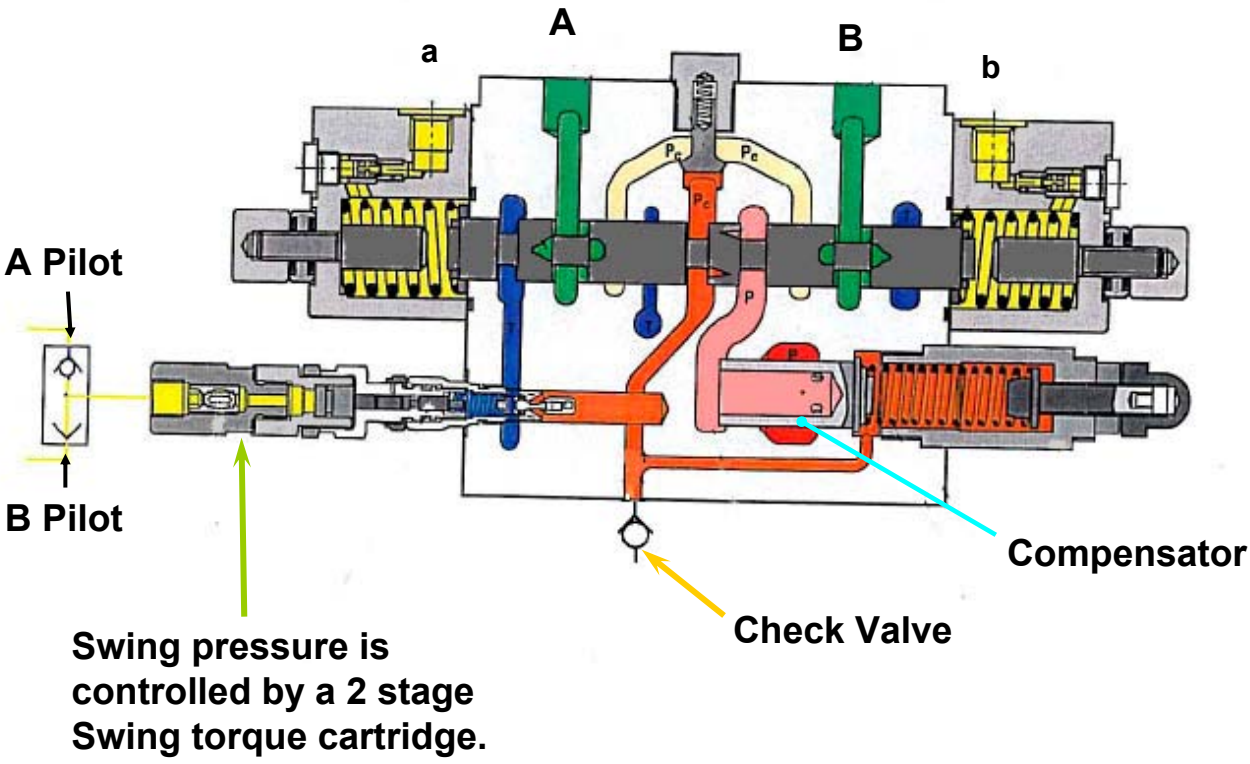
Swing motor has 2 – 2 stage relief valves installed acting on A & B port of the motor. While swinging with pilot pressure applied, the high stage acts as a circuit or port relief to protect swing from spikes.

For controlling the swing stop (cushion), the low stage of the swing motor relief is used to control dynamic braking to slow the excavator swing to a smooth stop

The 2 stage relief valves require use of 2 wrenches for adjustment. Always use a wrench on the adjustment nut to prevent movement while loosening or tightening the lock nut!



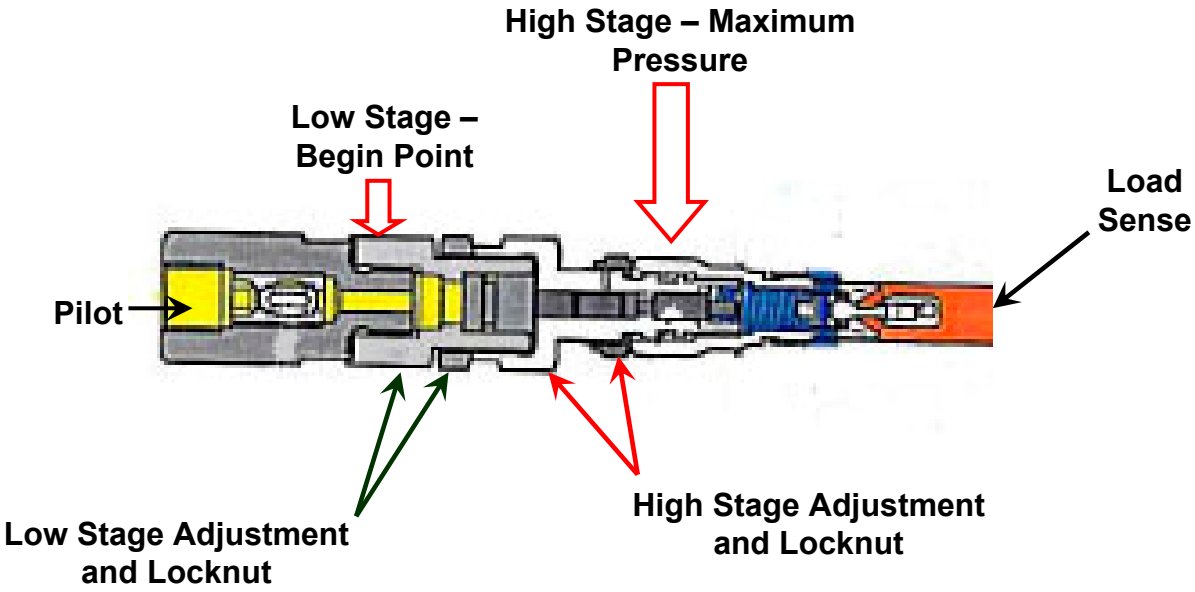
Swing Valve Module



Swing module is a bolt on valve that is pre compensated. Check valve between swing and main valve allows swing priority.

Swing will have reduced flow when total system requirements exceed pump output based upon Valve load sense signal.

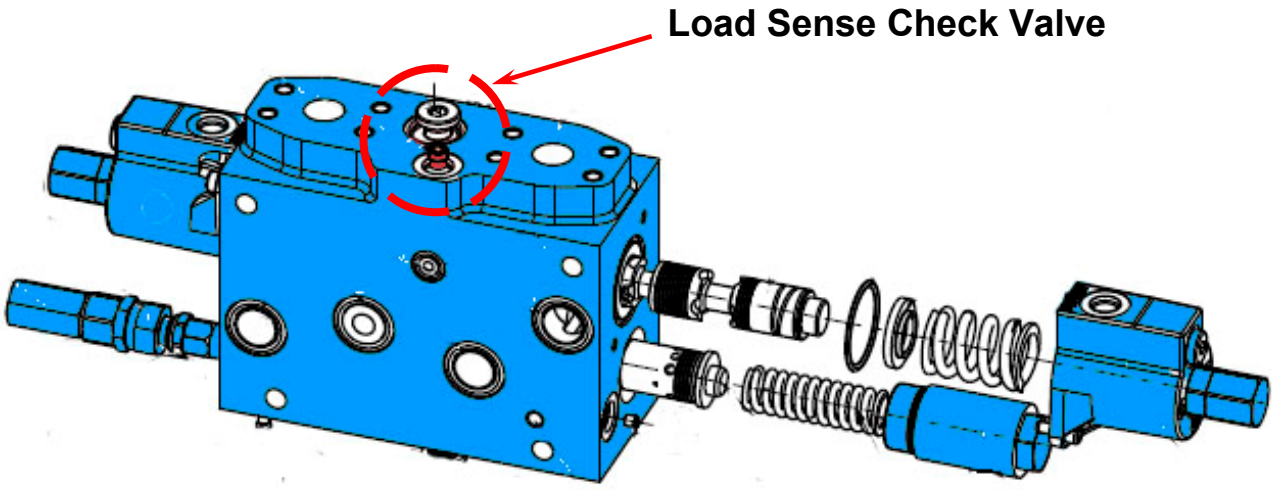
Swing Torque Cartridge



Swing torque cartridge is located in load sense passage of swing valve. It is a dual stage relief used for setting swing begin point and swing maximum working pressure. Low stage controls swing begin point, high pressure stage sets swing maximum working pressure.

When adjusting swing torque cartridge, use of 2 wrenches is always required. One wrench is used to loosen and tighten the locknuts, the other is used to adjust the relief and hold the adjustment while loosening/tightening the lock nut.

Swing Valve Load Sense Check



Swing Valve Module has a check valve for priority circuit. Check valve is used to isolate main valve load sense from swing valve when swing is not used. If check valve is stuck open, load sense of machine will be weak until swing circuit is used.

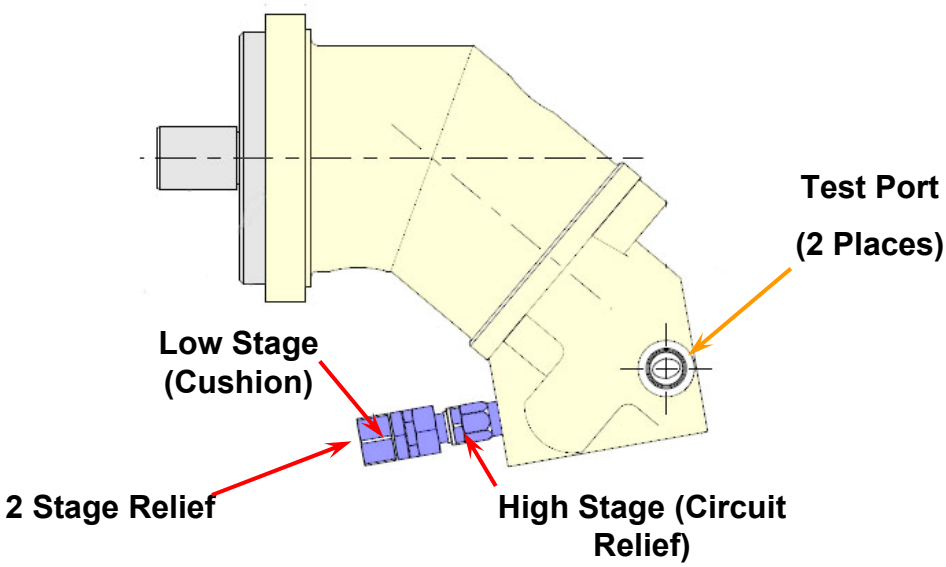
Swing Motor

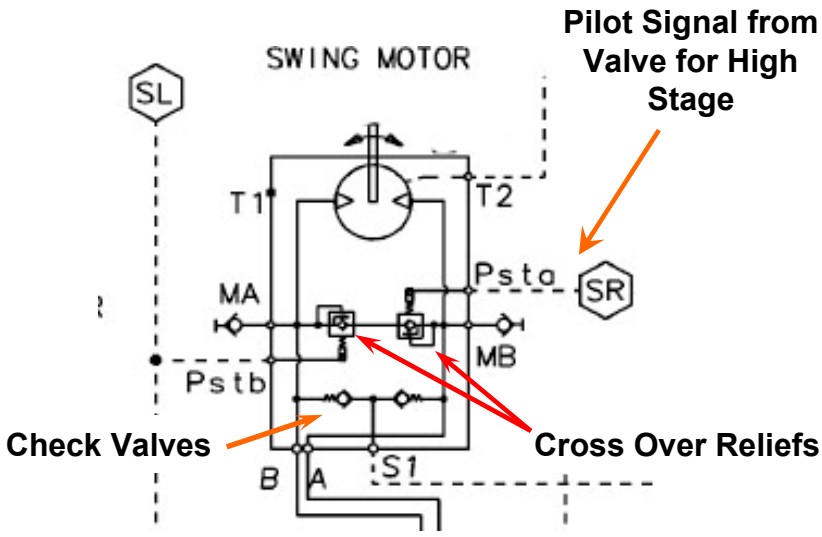
Swing motor is a bent axis piston motor. Crossover relief valves provide “cushioning” for swing stop. Dual stage reliefs are used to provide high pressure for swing, lower pressure to stop. Check valves in the motor end cover are used to prevent cavitation during the stop.

The dual stage reliefs have a high pressure setting that uses a spring setting and pilot pressure from the swing valve. The high pressure stage is set above the swing regulator high stage to provide circuit protection

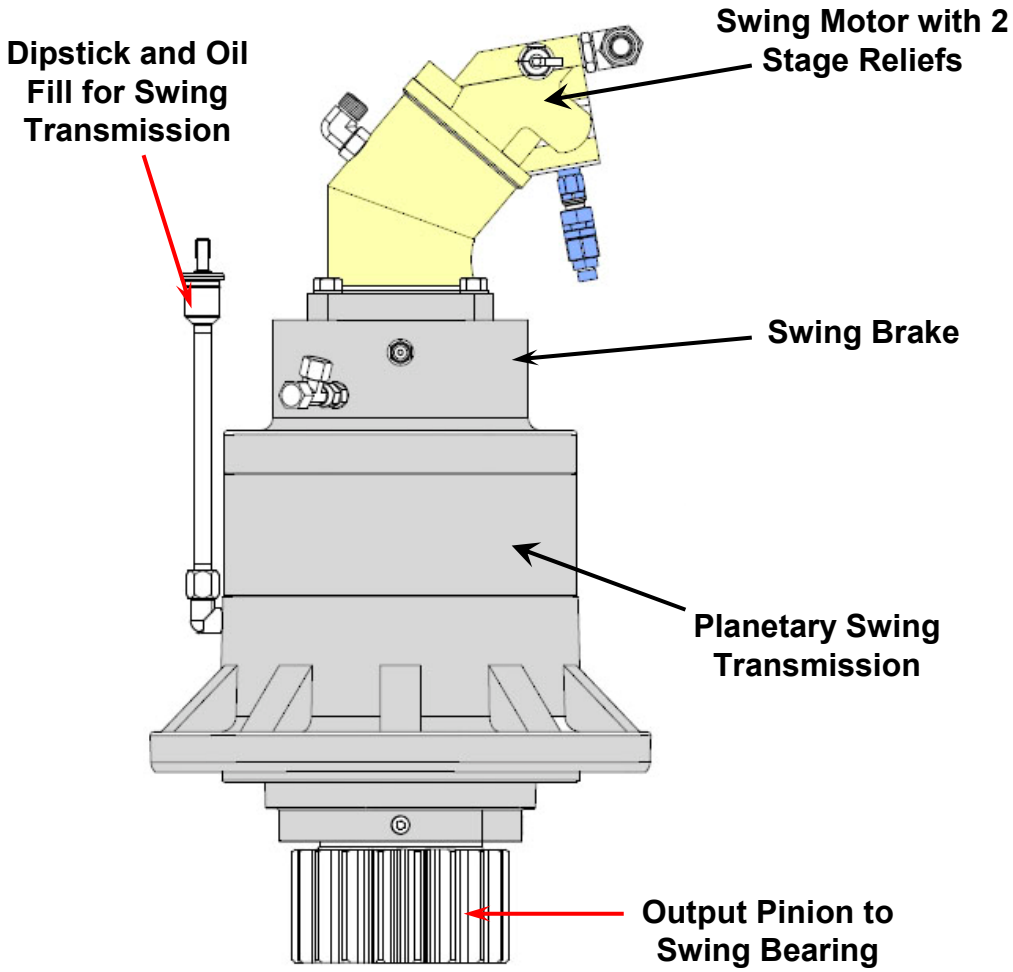
The dual stage relief low setting is used for cushioning the stop. This is the dynamic brake setting. The static holding brake is mechanical and is separate from the motor.

Bent Axis Piston Motor





Swing Drive Assembly



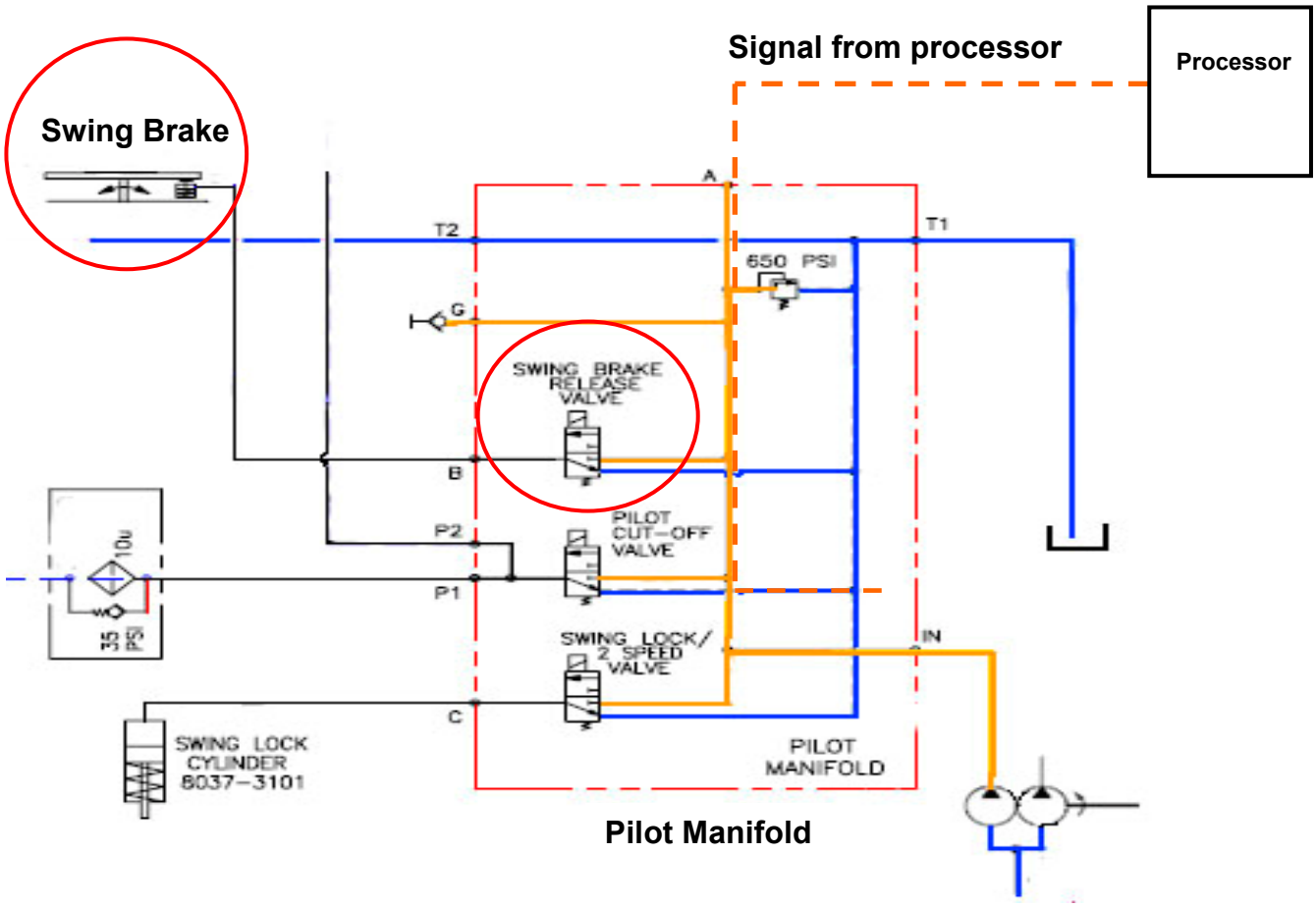
Swing circuit drives swing rotation through the swing drive assembly. Swing drive assembly consists of swing motor, swing brake, and planetary swing transmission.

Swing motor not only provides drive for swing drive assembly, but also provides dynamic stopping of the swing (cushion). Relief valves in the swing motor provide high pressure circuit protection and low pressure cushion for dynamic stopping.

Swing brake is a spring set, hydraulic release disc brake. It is used as a holding brake only for the swing circuit and not a dynamic stopping brake.

Swing transmission is a 2 stage planetary gearbox to provide gear reduction the output pinion. Output pinion drives the upper to swing by engaging teeth on the swing bearing. Swing transmission has provision to check and add oil and requires regular oil changes.

Swing Brake Operation



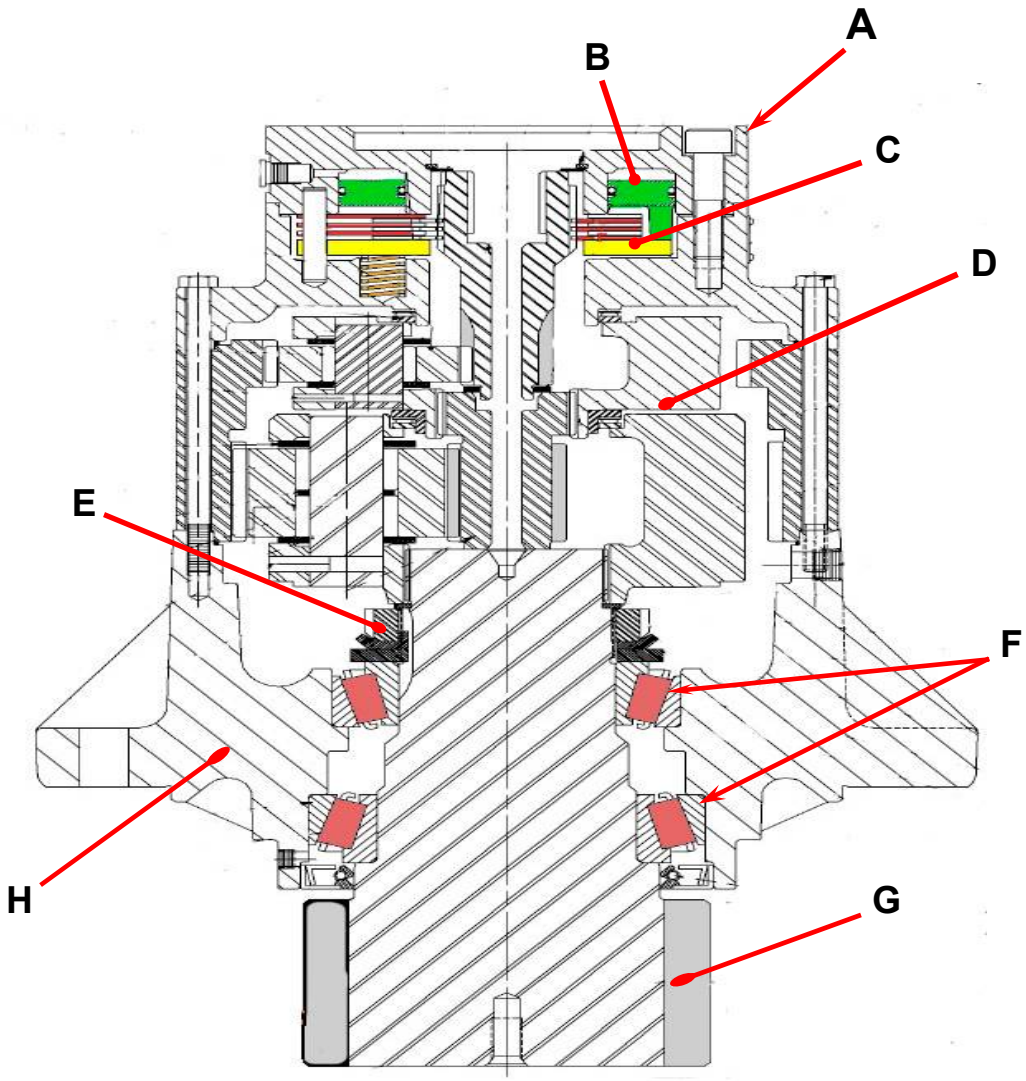
Swing brake is located on swing transmission. The swing brake is a “parking brake” used to hold the machine swing when the swing circuit is not being used. It is not a dynamic brake for stopping.

Swing brake is a spring apply, hydraulic release brake. It is a multi disc brake running in oil.

Swing brake is released when a signal from the processor is sent to the swing brake solenoid valve on the pilot manifold in response to the operator using the swing circuit

When the operator stops using the swing circuit, the processor uses a time delay to allow the swing to stop dynamically with the swing motor hydraulics before the swing brake is allowed to set.

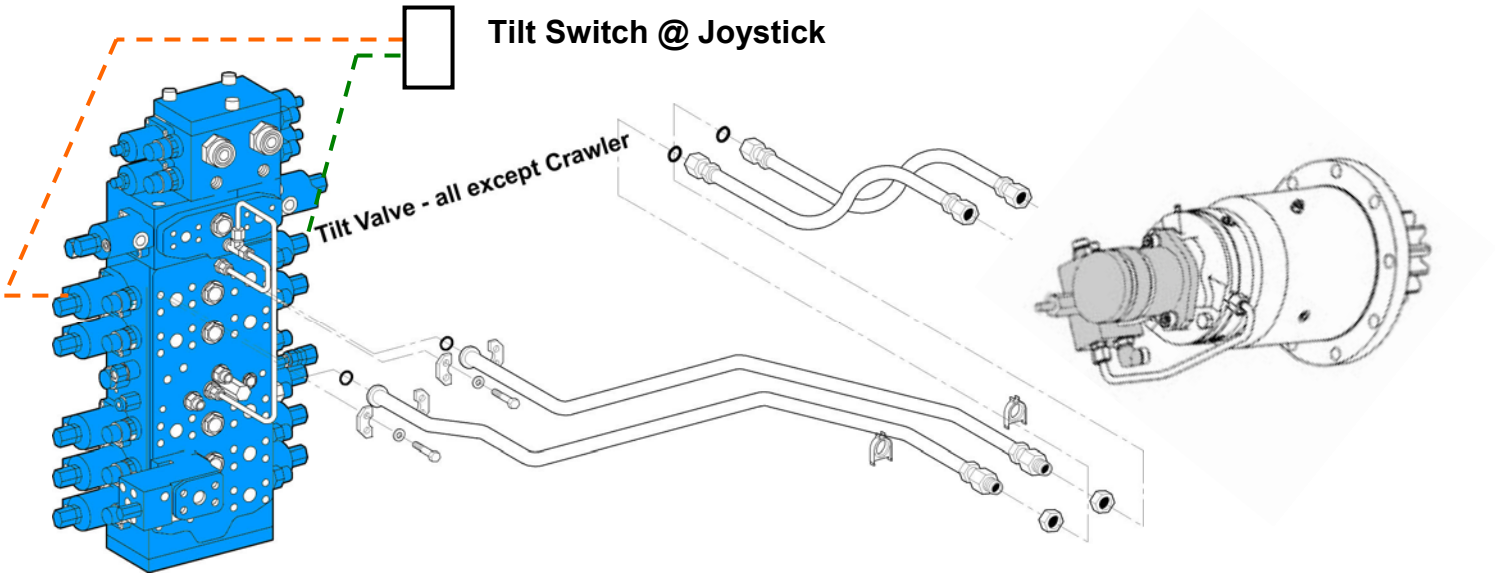
Swing Transmission & Brake



Swing transmission and brake is an assembly located in the center frame area. Transmission is filled with oil for lubrication. It consists of several major components:

A. Brake
B. Piston
C. Pressure plate
D. Double reduction gear sets
E. Locknut
F. Bearings
G. Output pinion
H. Housing

Tilt Circuit – HS & Rough Terrain



Tilt valve directs oil into tilt circuit to tilt motor mounted on tilt transmission. Operator uses the rocker button on joystick to direct tilt to rotate.

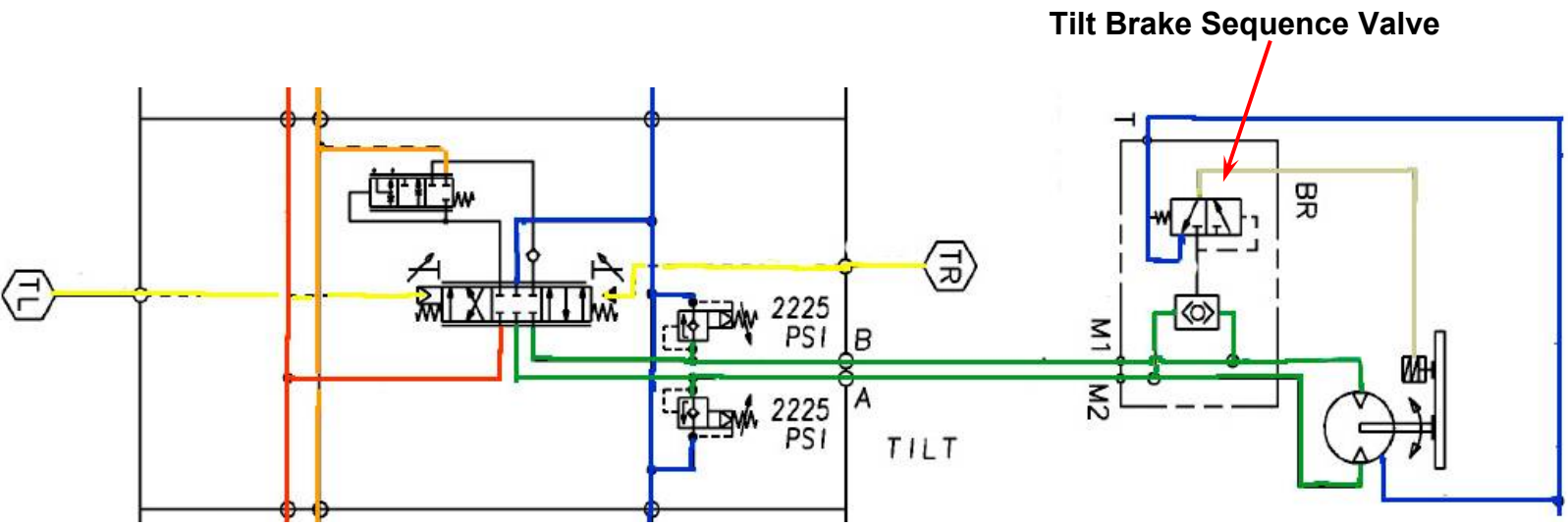
Tilt rocker buttons shifts the tilt valve at end cap using pilot pressure. When the spool is shifted, oil from the valve pump cavity is routed to the selected port across the spool. A load sense signal is generated and is used by the valve & pump to provide adequate flow for load conditions.

A rheostat is provided to control tilt speed. A tilt override button allows for override of tilt speed for fast tilt.

Oil is routed to the tilt motor through a series of hoses and tubes from the tilt valve to the tilt motor.

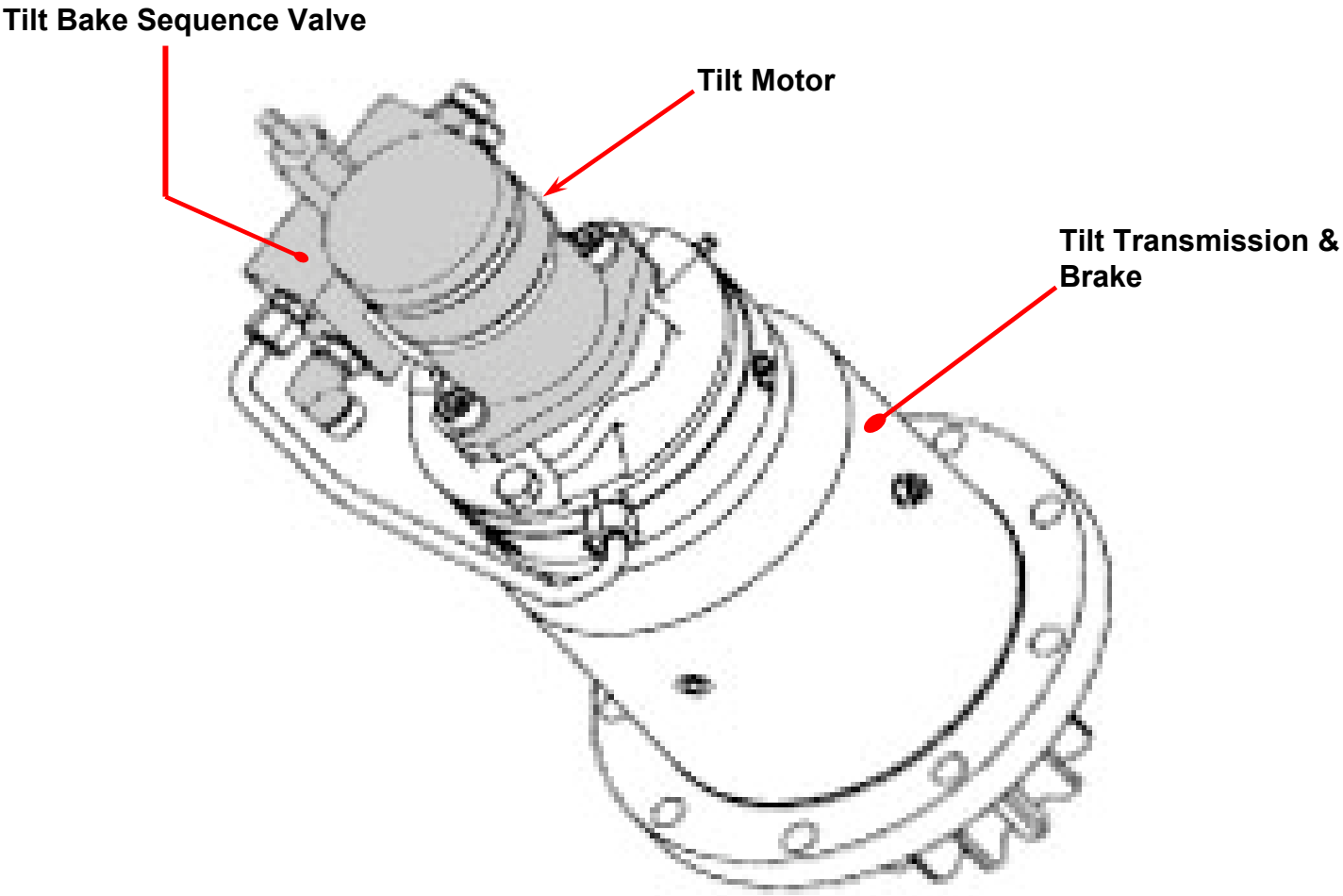
Tilt brake is released by tilt sequence valve attached to tilt motor.

Tilt Circuit Schematic

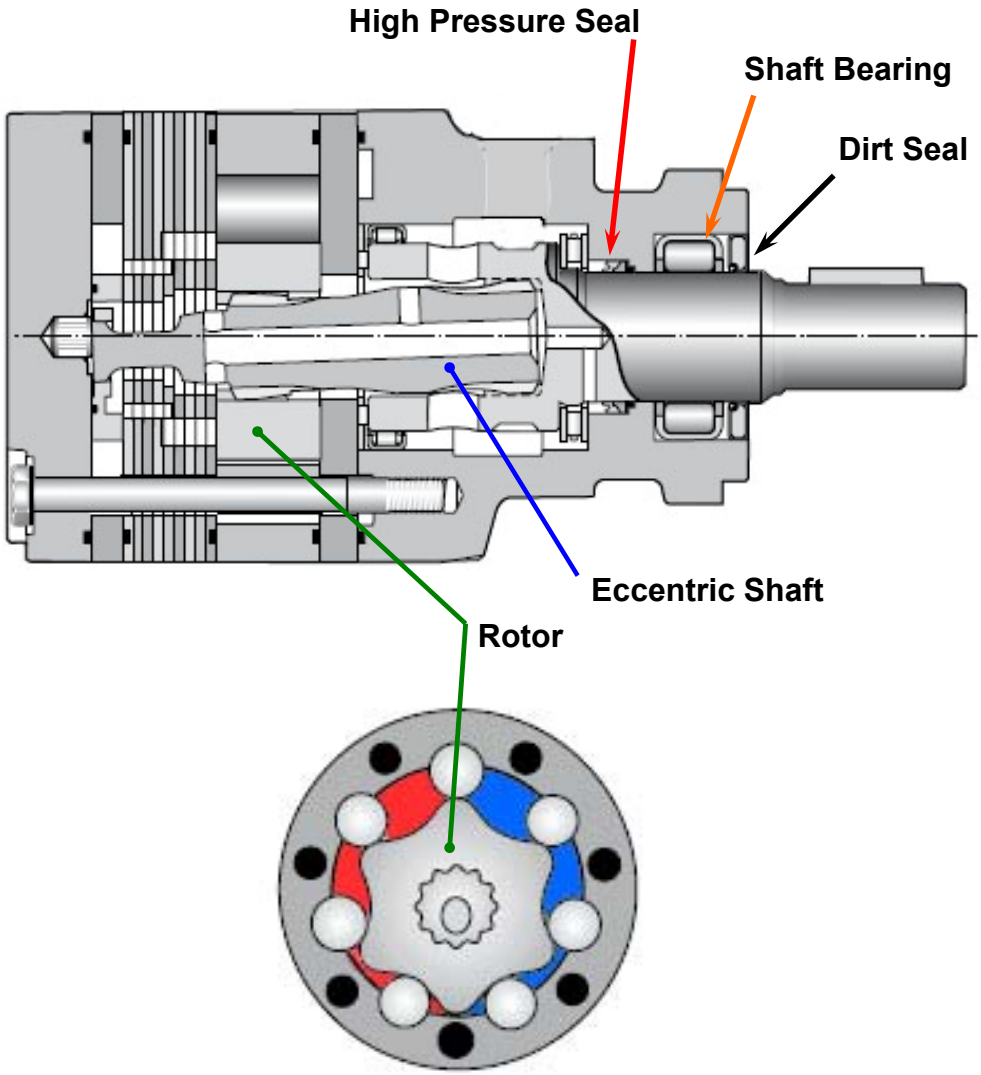


Schematic of tilt circuit. Note circuit has a tilt brake that is released by the tilt brake sequence valve located on the tilt motor itself.

Tilt Drive Assembly

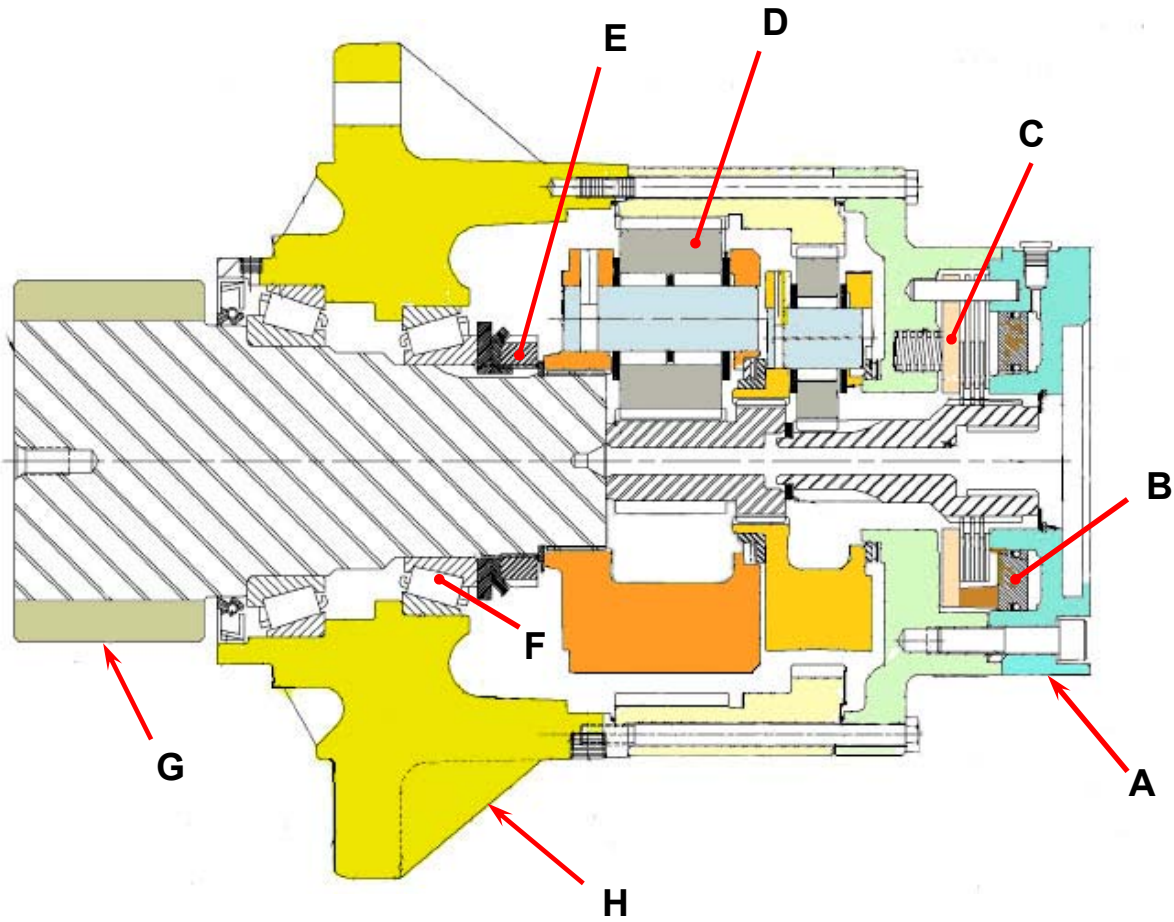


Tilt Motor



Tilt on standard machines uses a “gerotor” type motor to drive tilt transmission. Gerotor motor provides high torque, low speed output to drive boom tilt.

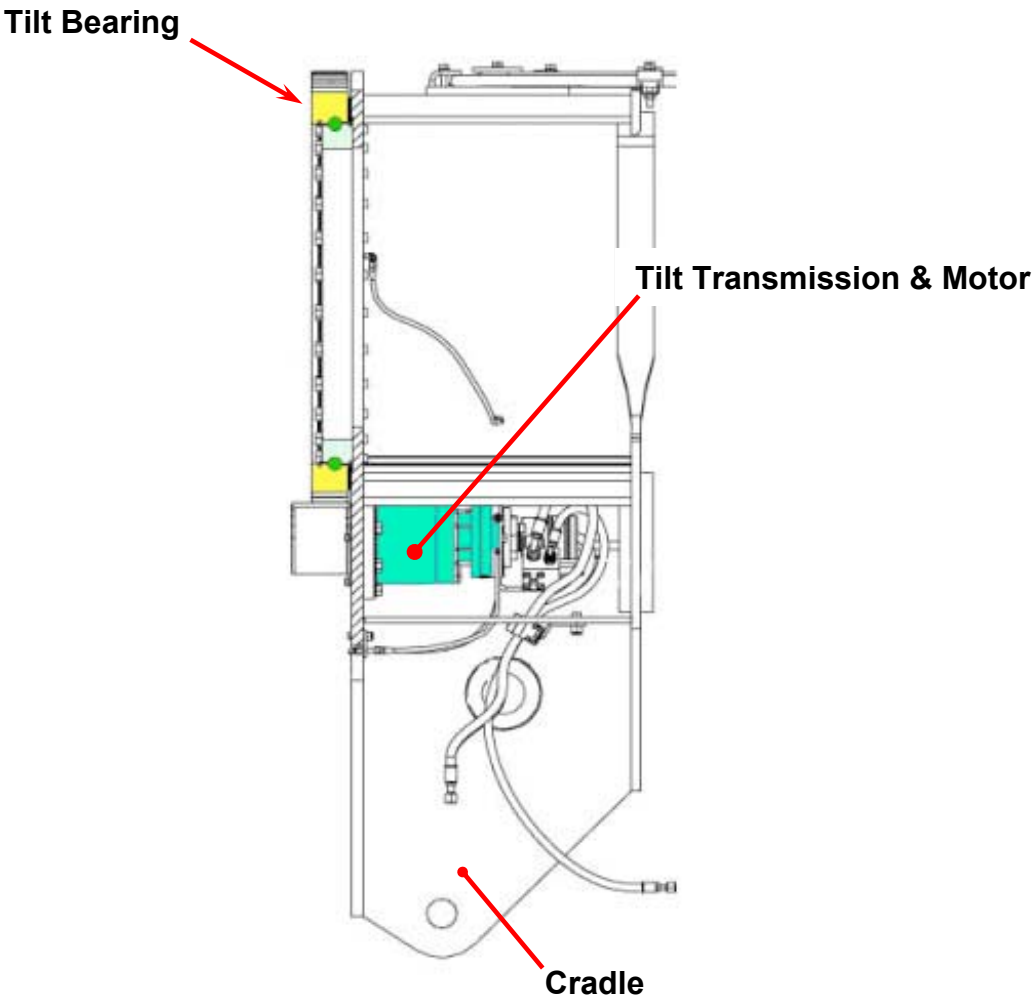
Tilt Transmission & Brake



Tilt Transmission & Brake Assembly:

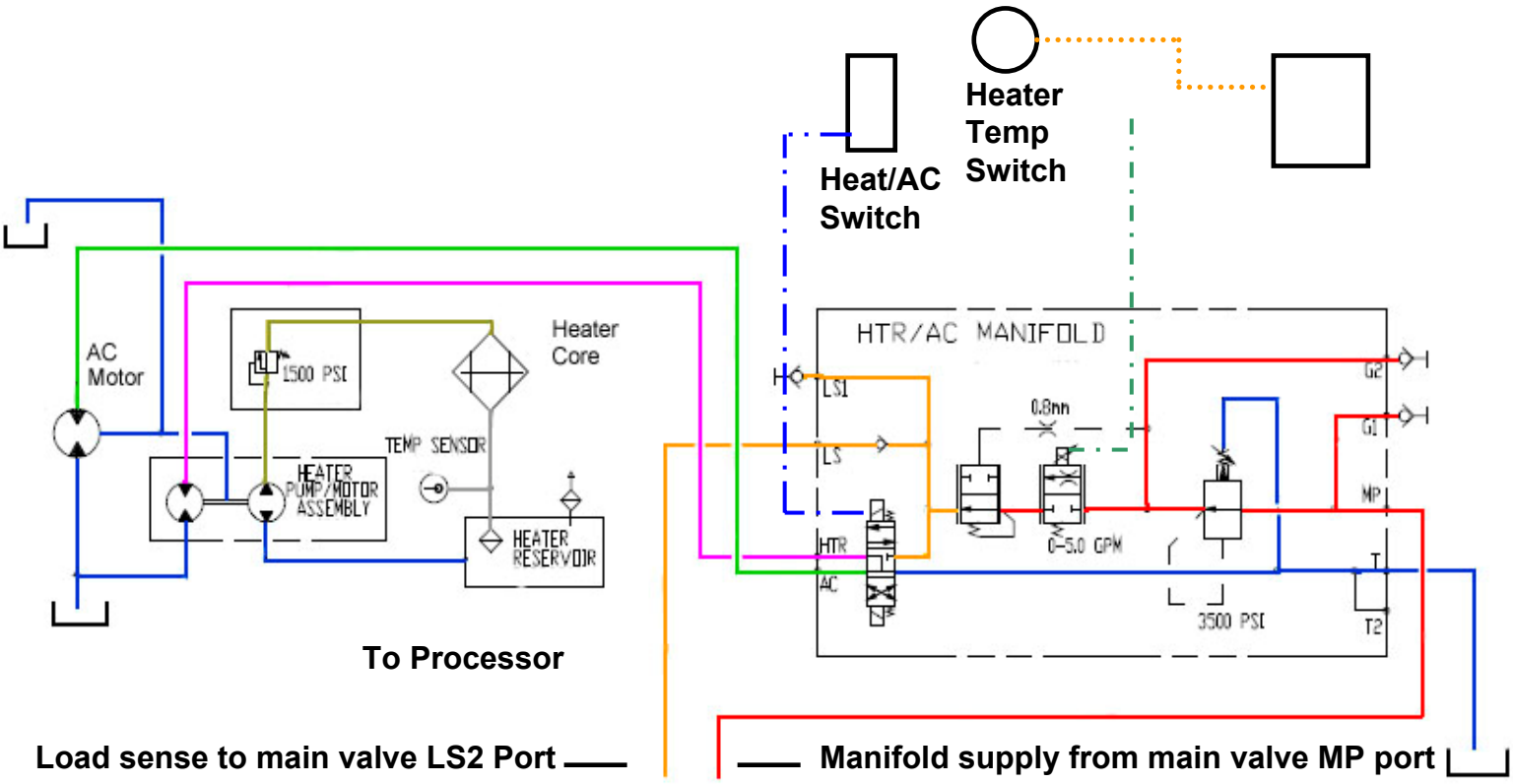
A - Brake
B - Piston
C - Pressure plate
D - Double reduction gear sets
E - Locknut
F - Bearings
G - Output pinion
H - Housing

Tilt Drive and Cradle



Tilt drive and motor are located inside cradle. Pinion drives gear on tilt bearing mounted to cradle. Boom assembly bolts into tilt bearing. On standard machines, a stop is provided. On machines with optional 360° tilt, no stop is provided. Open gear teeth require lubrication with open face gear lubricant.

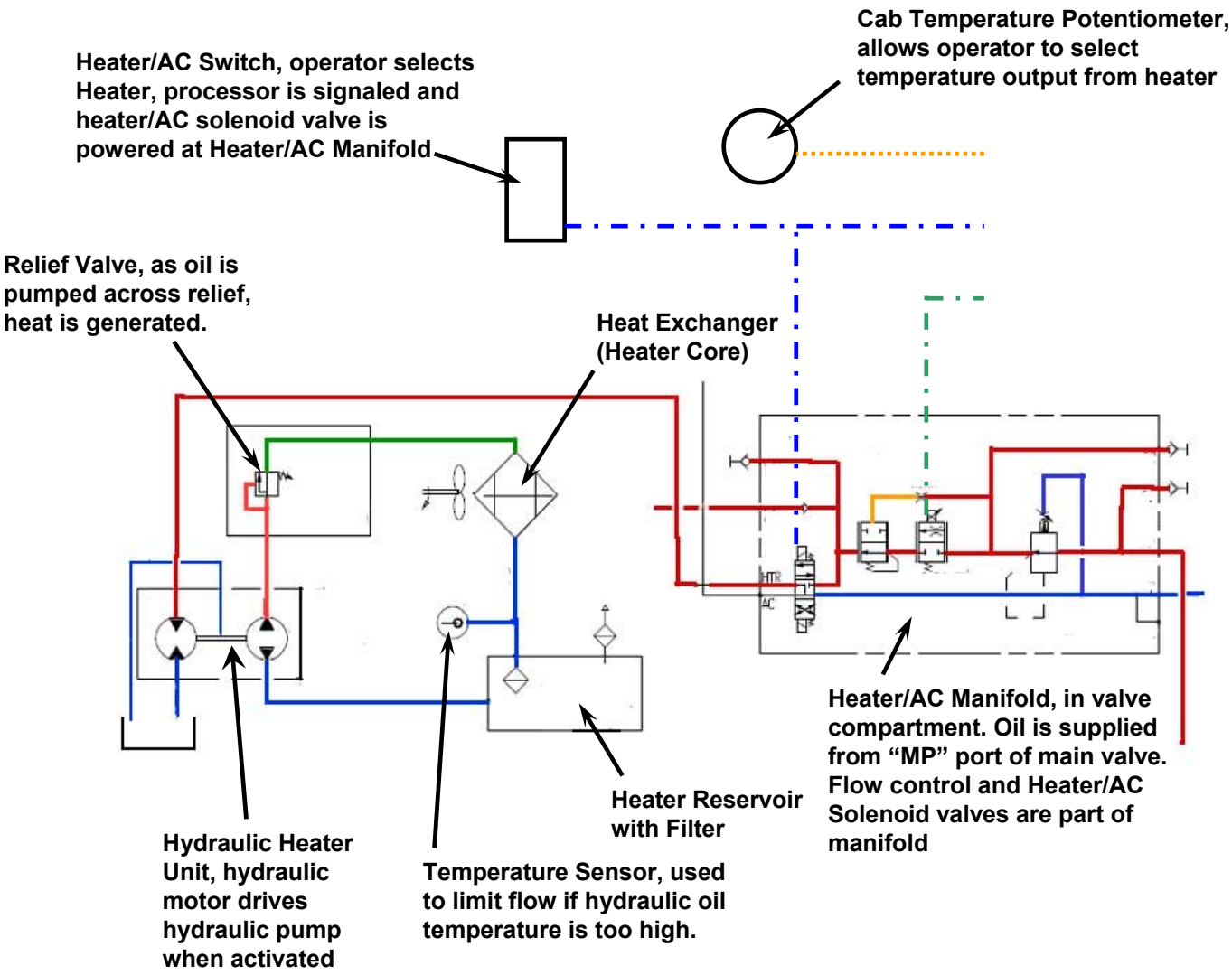
Climate Control Circuit



Climate control circuit is shown. A heater/AC manifold is part of the pilot valve tray. Heater/AC manifold controls heater/AC flow and operating pressure. A double solenoid valve controls heat or AC circuit operation. Processor settings limit flow to heater/AC circuit, switch in operator's cab controls selection of heat or AC operation.

AC system is powered by a hydraulic motor driving the AC compressor. Heater circuit has a motor driving a pump. Oil is forced across a relief valve to generate heat that is released at the heater core to heat the cab.

Heater Circuit Schematic

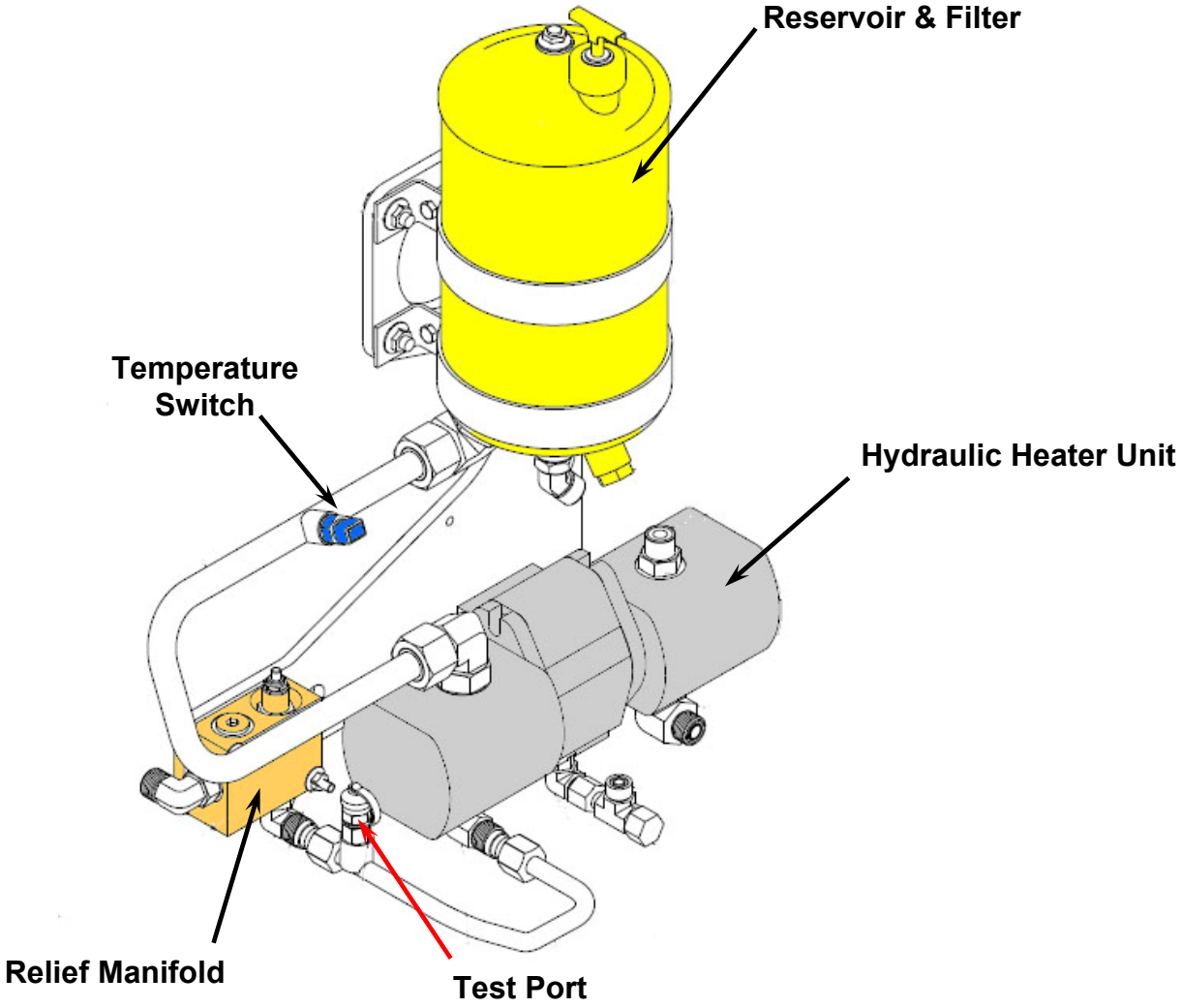


Heater circuit uses a hydraulic motor to drive a pump. Pump delivers oil to a relief valve to generate heat. Heat is given off at heat exchanger (heater core) in cab. Oil for the heater circuit is contained in a reservoir and requires replacing yearly.

Hydraulic motor for heater unit is driven from the Heater/AC manifold. Speed for heater is set using the AC drive speed. When heater is on, speed of heater can be reduced by the temperature switch (potentiometer) in operator's cab or by temperature sensor on return line to heater reservoir detecting higher than allowable return oil temperature.

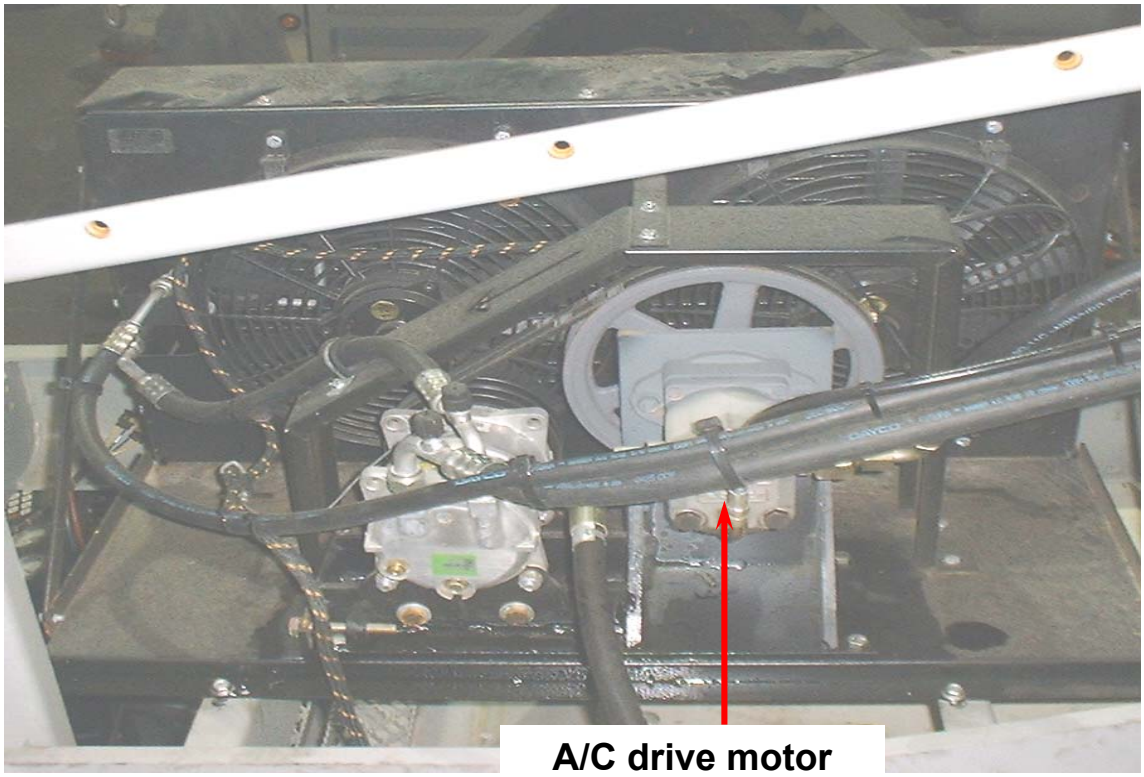
Fan at the heater core moves warmed air through cab via the plenum at the rear and separate ducts under LH arm rest and at front of console.

Hydraulic Heater Unit



Hydraulic Heat generator is mounted behind operator's cab. It consists of a reservoir, hydraulic heater unit, relief manifold, and heater core in the cab to release heat generated into cab.
The hydraulic heater unit is a pump/motor unit that powers the system. The motor is driven with oil from the heater/AC manifold. The motor drives the pump, which pumps the oil through the heater system.
As the oil leaves the pump, it goes through a manifold with a relief valve. As the oil goes over the relief valve, heat is generated. The heated oil is pumped to the heater core. At the heater core, heat in the oil is transferred to the air flow from heater fan to warm the cab.
The reservoir is used to store and condition the oil. A filter is provided to clean the oil as it returns from the heater core.
A temperature switch is provided to reduce flow if the hydraulic oil gets to warm.

A/C unit - Optional



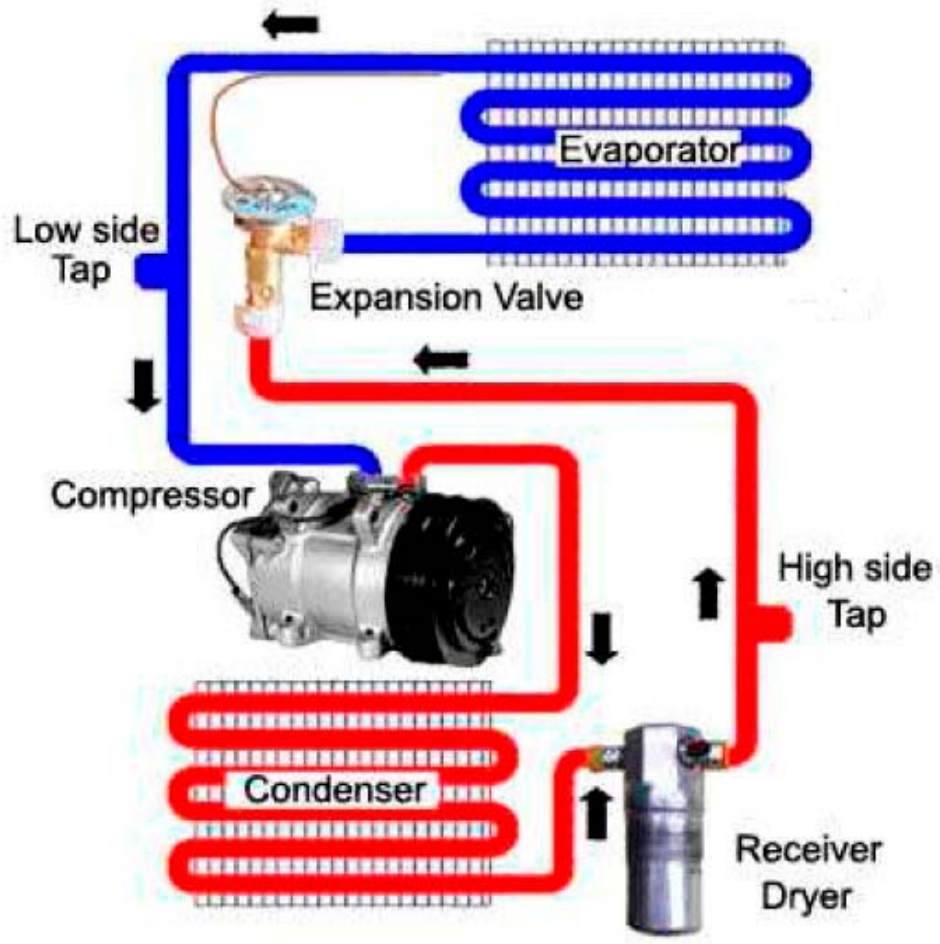
A/C drive motor
2000 - 2150 Rpm's

A/C unit consists of a hydraulic motor, compressor, dryer, and condenser. It is mounted on the LH side of the machine.

The evaporator is part of the heater assembly located in the cab.

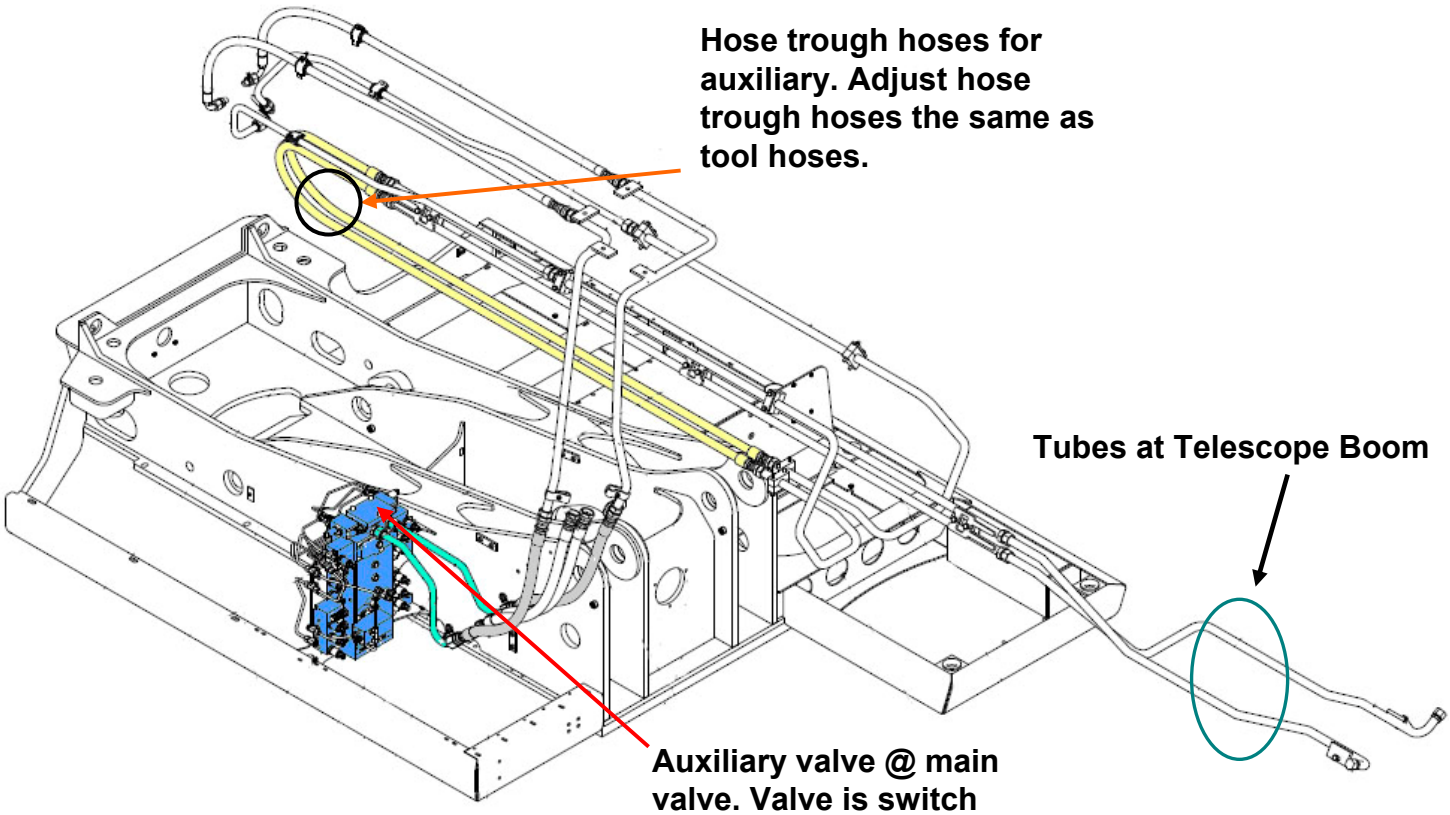
Motor receives oil from the A/C port of the A/C/Heater manifold. Motor drives the compressor through a belt.

Basic AC System Operation



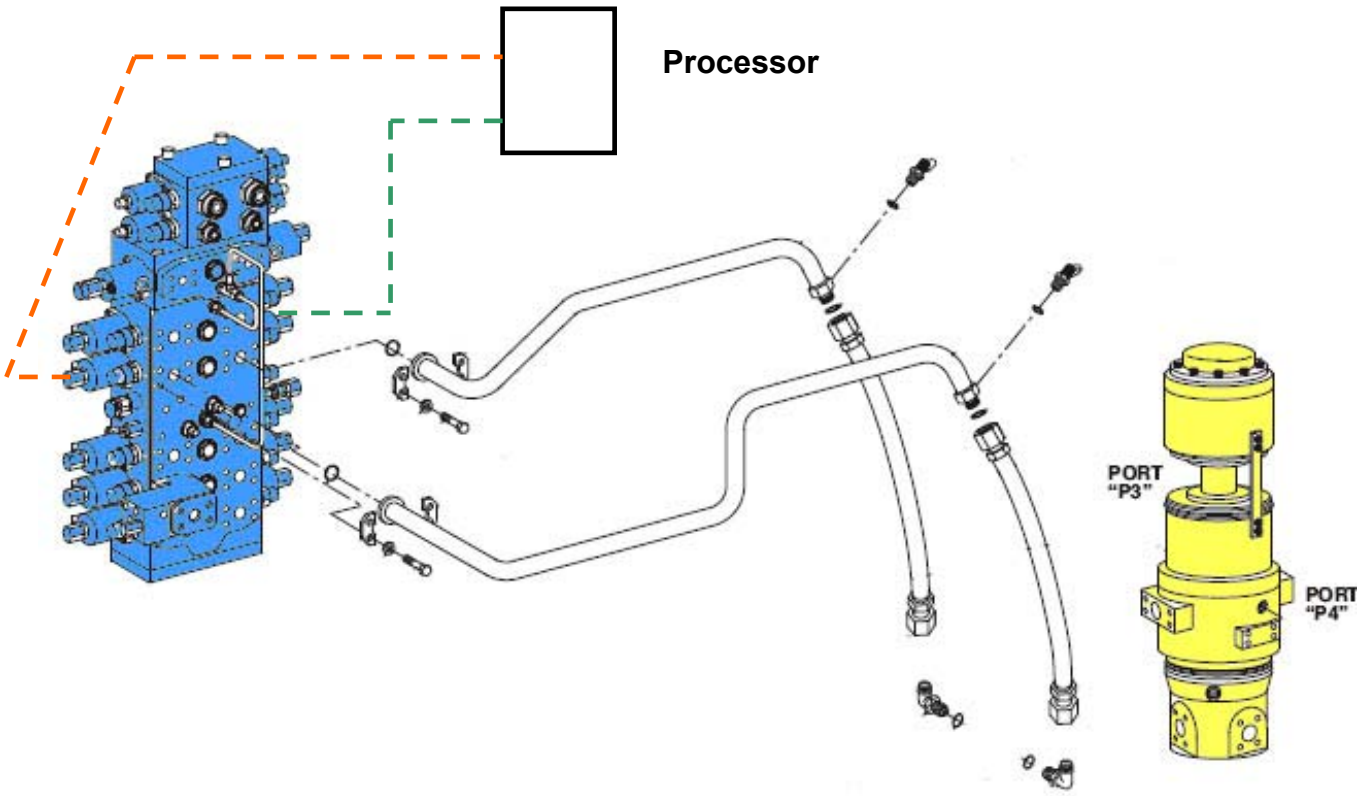
AC system uses a conventional air conditioning system. The AC compressor is driven by the hydraulic motor. The system uses R134a refrigerant and contains 3 lb. (1.4 kg) of refrigerant.
The compressor is belt driven by a hydraulic motor. Compressor pumps refrigerant through the system.
Condenser is after the compressor. Heat carried by the refrigerant gas is cooled and leaves as a liquid.
Receiver dryer is used on the high side of the system. Receiver dryer separates gas from the liquid and also removes dirt & moisture.
The expansion valve is used to regulate the flow of the liquid refrigerant into the evaporator. It sense temperature and pressure while regulating refrigerant flow.
The evaporator is located in the cab. The liquid refrigerant absorbs heat as it passed through the evaporator and expands into a gas. The gas goes to the suction side of the compressor to repeat the process

Auxiliary Circuit



Optional auxiliary circuit is available. Auxiliary is switch operated from the joystick or floor and activates auxiliary valve at main control valve. Oil is supplied to boom end through hose trough hoses within the boom and tubing to end of telescope boom.

Remote Travel Circuit - Upper



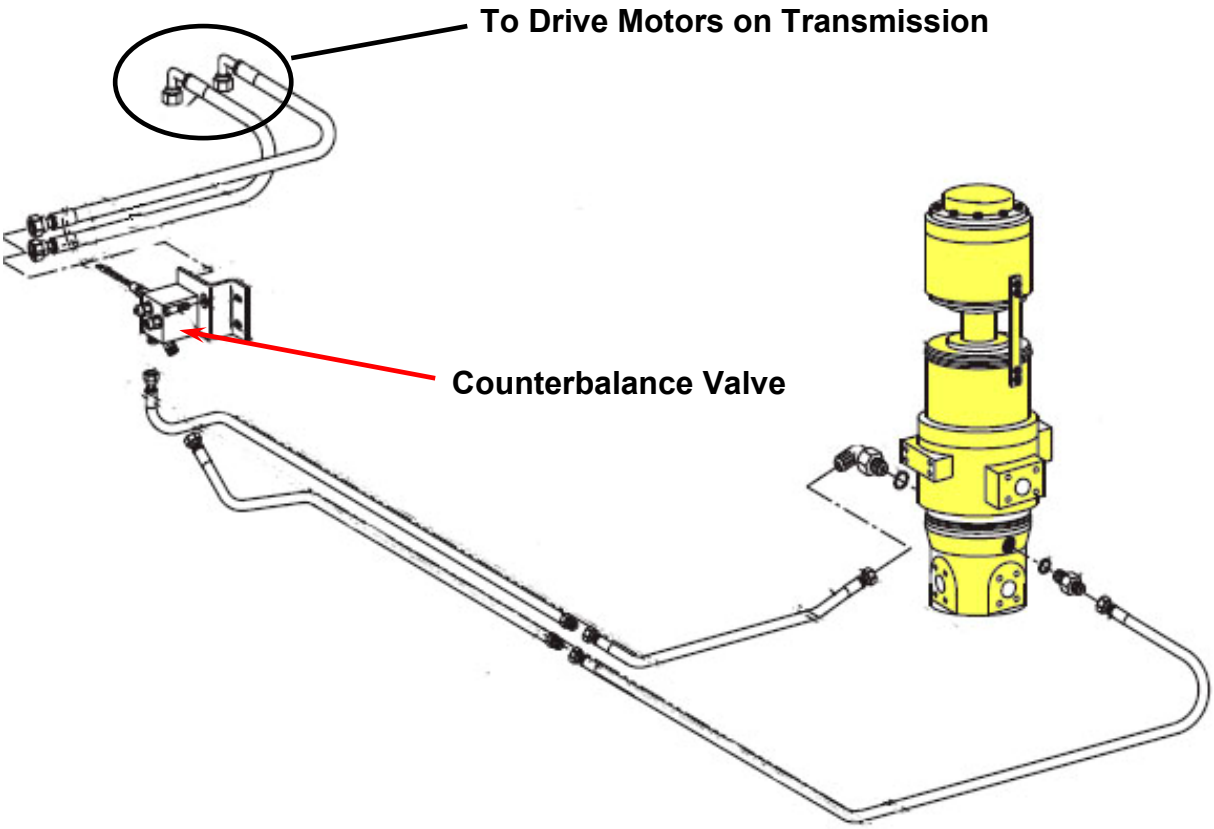
Highway speed propel valve direct oil into the propel circuit to center pin on upper structure. From center pin, oil is directed to the drive motor on the undercarriage (next slide). Operator uses foot pedal to signal processor. Processor signals the control valve to shift to send oil to the chassis drive motors for forward or reverse drive direction.

Propel valve is shifted with pilot pressure at end cap. When spool is shifted, oil from the valve pump cavity is routed to the selected port across the spool. A load sense signal is generated and is used by the pump & valves to provide adequate flow for the load conditions.

Oil is routed to the center pin and drive motor through a series of hoses and tubes from the valves, to center pin, to motors.

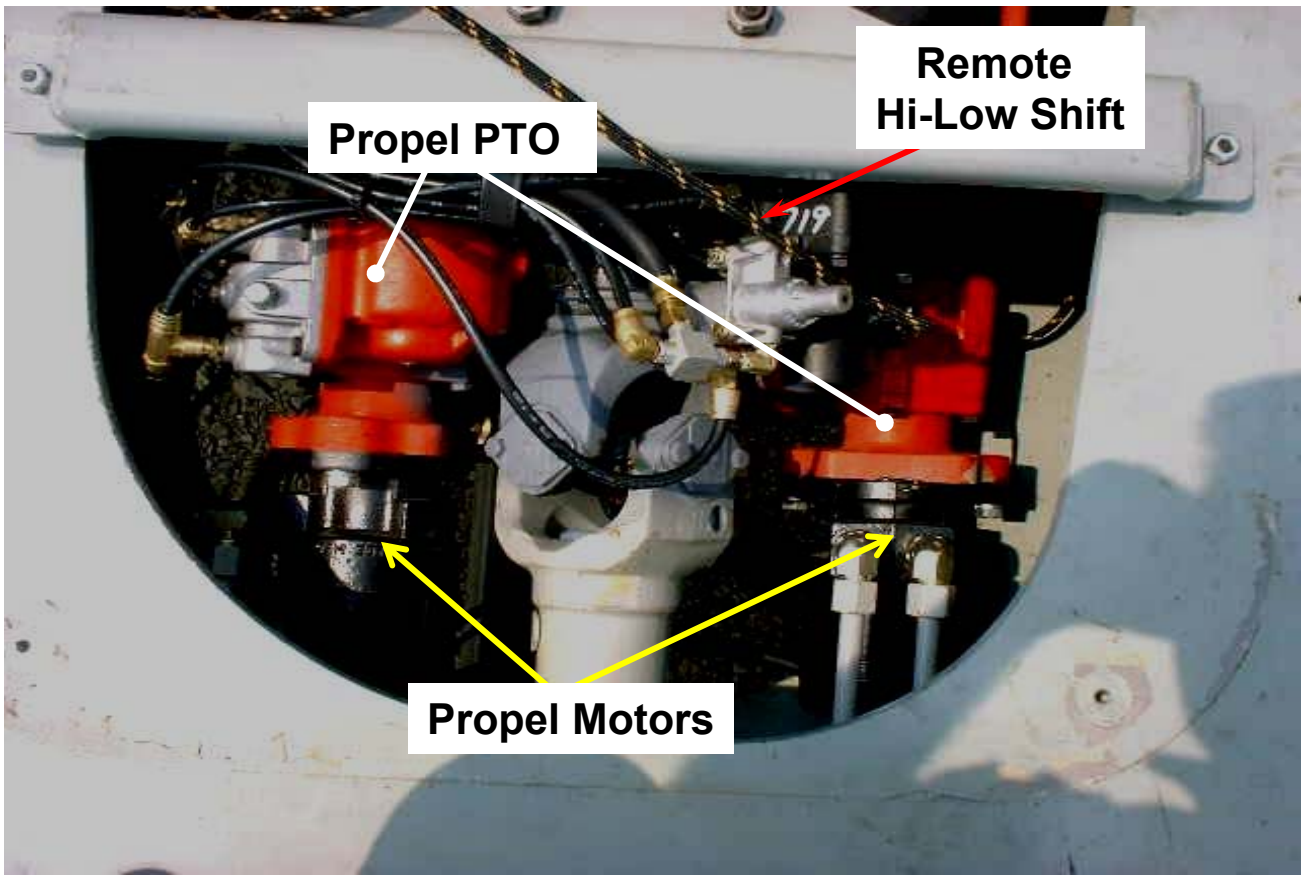
Processor also is used to release chassis brakes when travel pedal is depressed

Remote Travel Circuit - Chassis



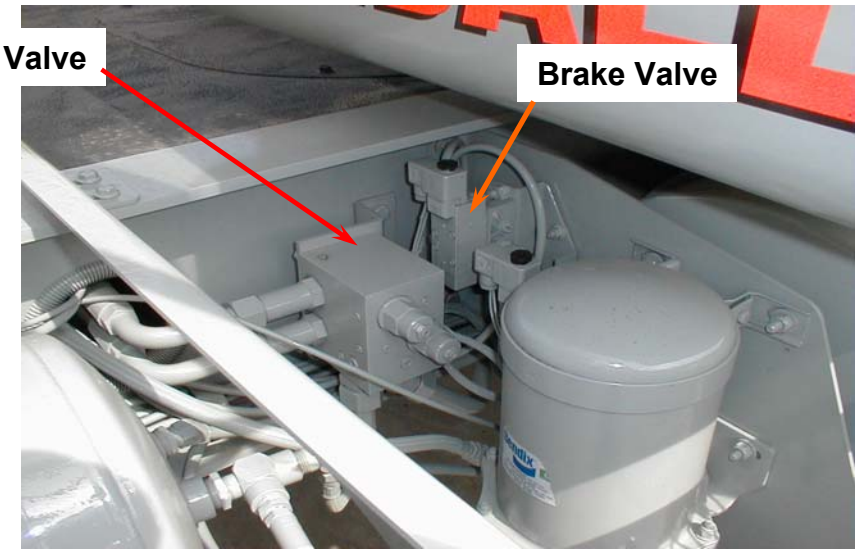
The remote propel circuit on the chassis goes from the centerpin to counterbalance valve then to the remote drive motors mounted on the centerpin. The remote drive motors provide mechanical drive through the transmission and axles to move the undercarriage from the excavator.

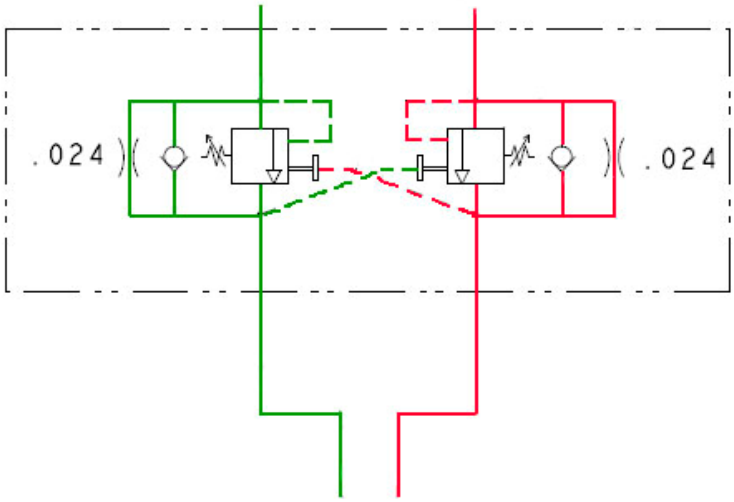
Propel Motors & PTO's



Close-up view of Remote Motors and PTO's. Range shift cylinder for transmission is also shown

Remote Drive Counterbalance Valve



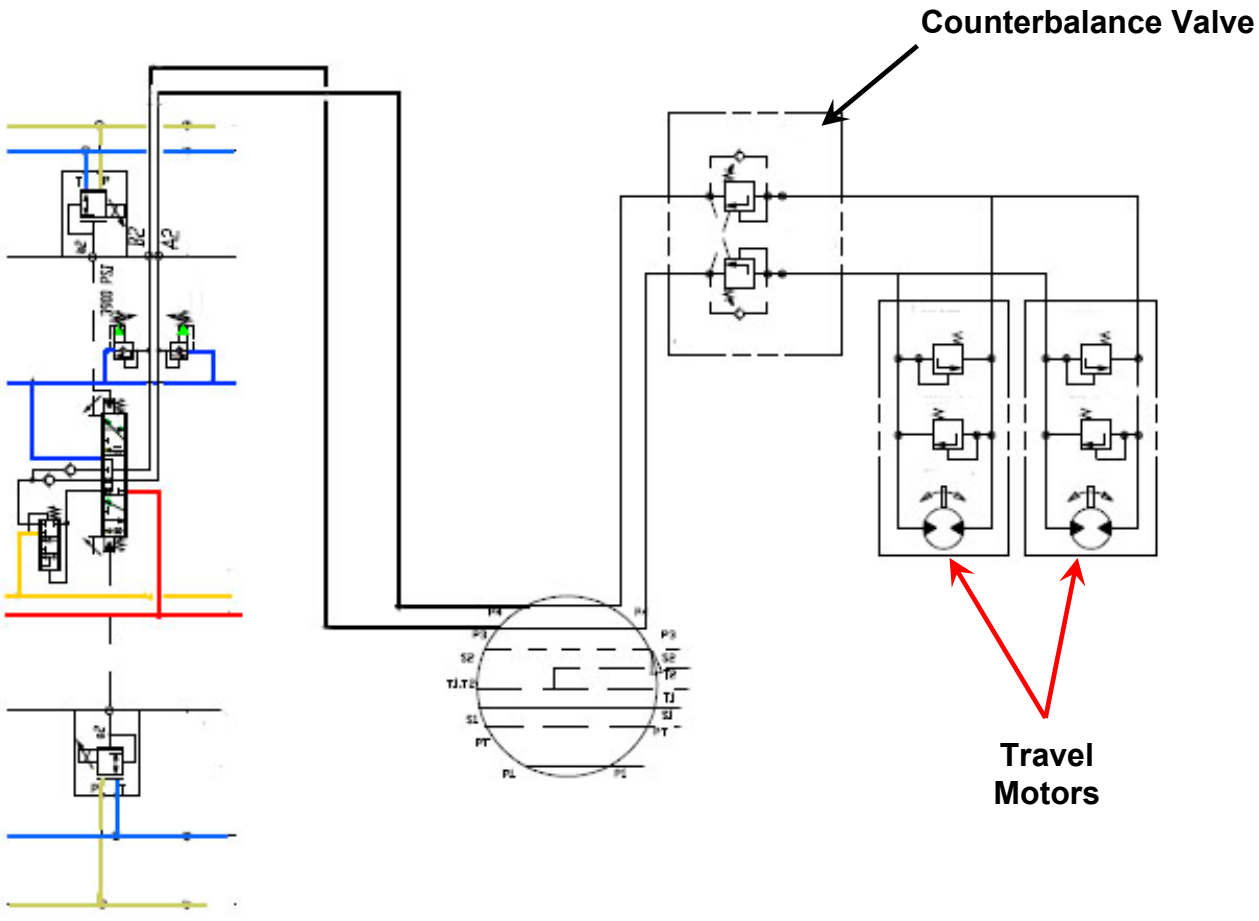


Counterbalance Valve is installed on LH side of chassis near the fuel tank. Brake valve for dig & upperstructure parking brake is also installed near the counterbalance valve.

Counterbalance valve is used to prevent overspeed of the remote travel circuit and provide hydraulic braking to the remote travel circuit. 2 cartridges are provided that sense circuit pressure on both sides of the valve to provide braking/throttling of the circuit during operation. Check valves that are part of the cartridge allow free flow to the motor and restricted flow on return.

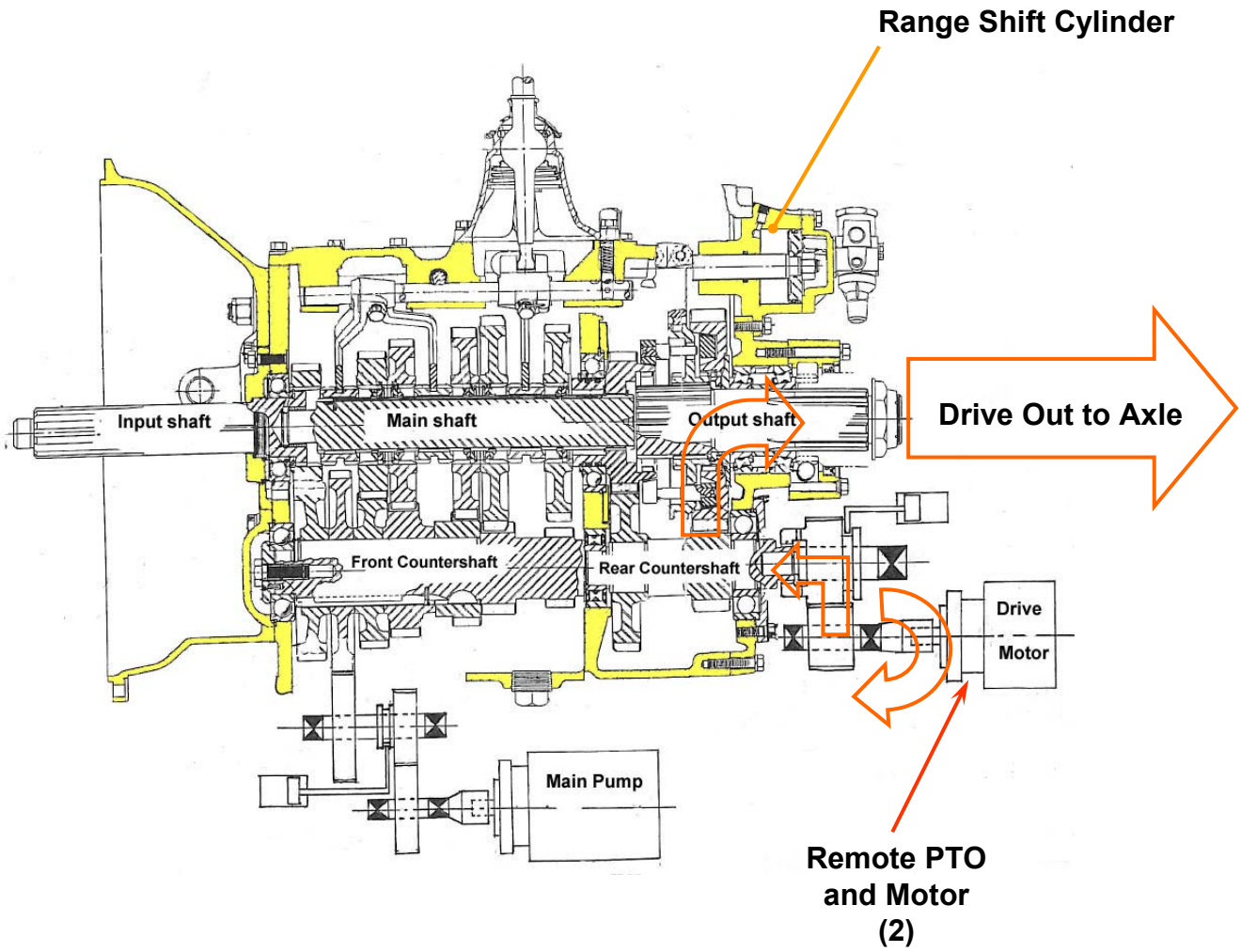
Current counterbalance valves are “vented” with orifices to provide smoother stopping. Early machines did not have vented counterbalance valves.

Remote Drive Circuit



The counter balance valve and remote propel motors. Oil enters from either the A or B (forward or reverse) ports. Once it enters the valve the switch closes sending a signal to the brake release valve as well as the travel alarms. The oil then passes through the actual counter balance valves and goes on to the propel motors. The RH side motor is larger as it has an additional set of counterbalance valves contained within it. Though they LOOK like reliefs, the CB valves are NOT adjustable. Motors share common pressure and return lines.

Remote Drive @ Transmission

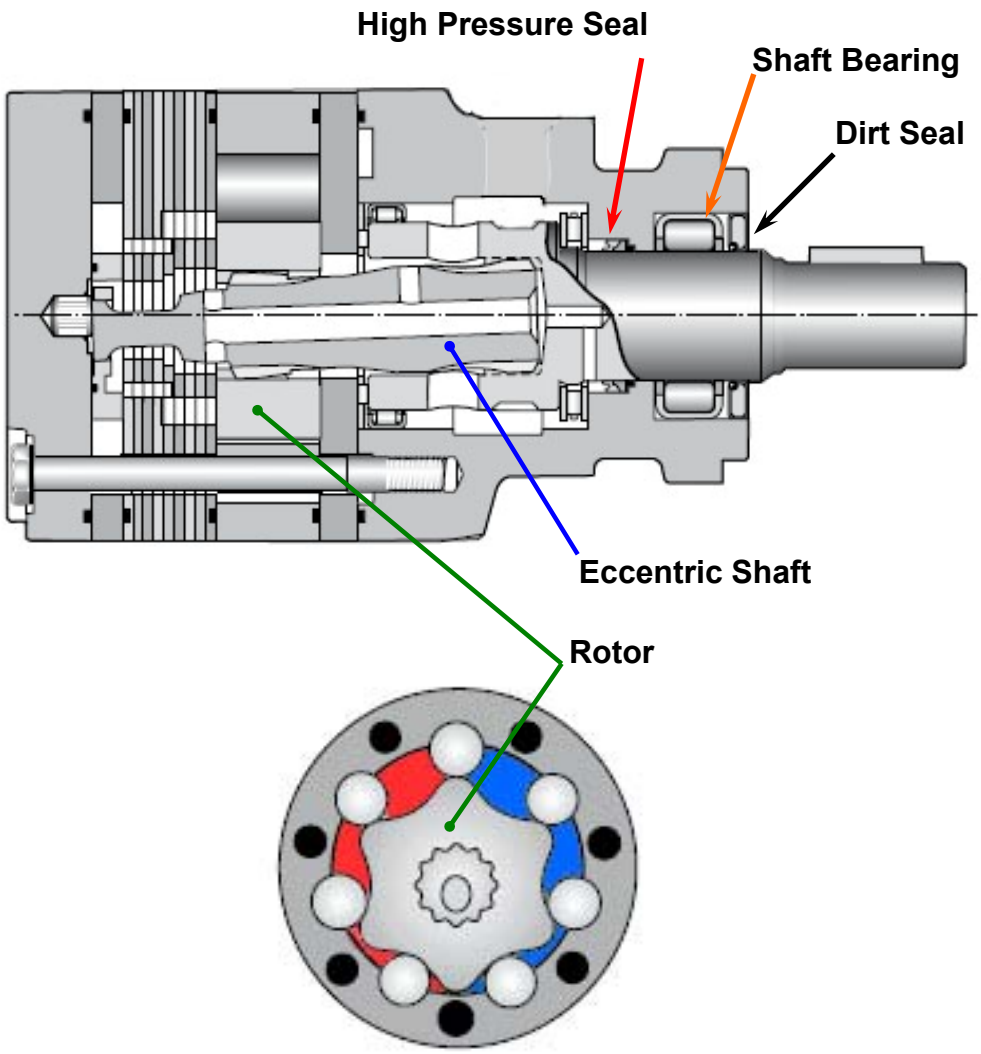


Remote drive of the undercarriage in remote operation uses 2 Remote PTO's, 2 Drive Motors, and the auxiliary box of the main transmission.

When oil from remote drive valve reaches drive motors, the Remote PTO's are driven by the Remote motors. The Remote PTO's drive into the transmission auxiliary box and drive out to the axles to propel the excavator.

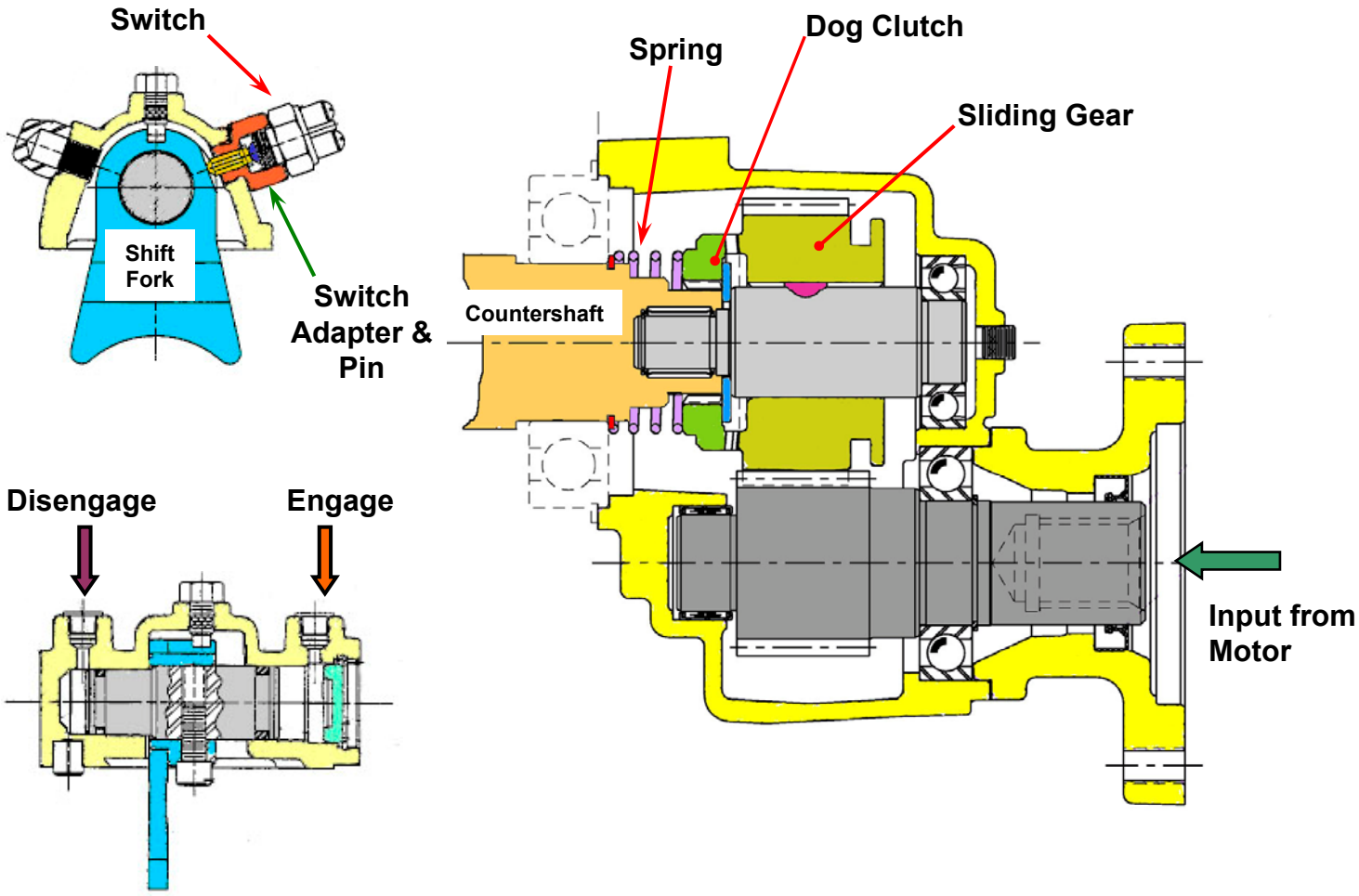
The range shift cylinder is used to provide 2 speed selection from the excavator cab. Remote gear change uses an air valve to shift the range cylinder. Remote gear change should only be made when machine is not moving and remote drive is not activated.

Remote Drive Motor



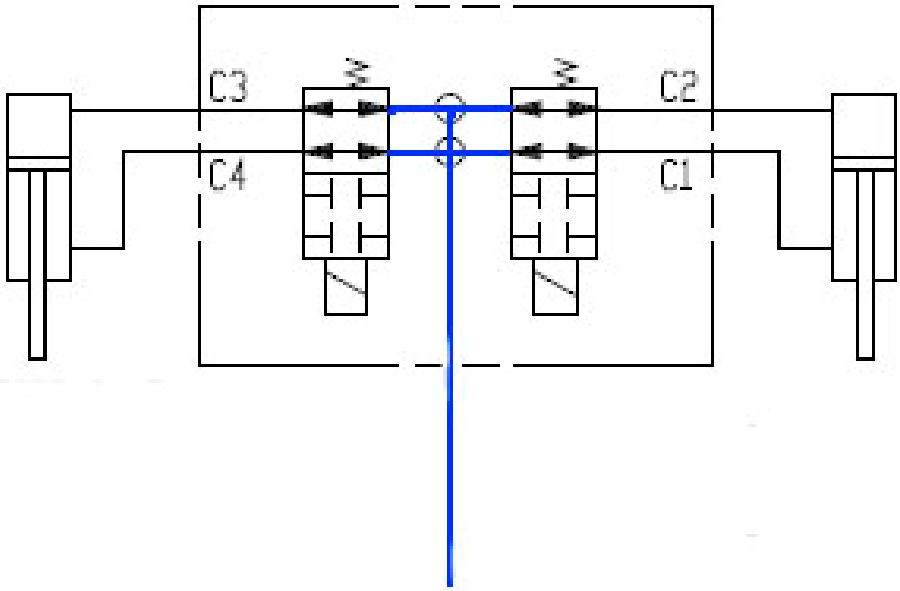
Remote drive uses a “gerotor” type motor to drive transmission and drive train during remote operation. Gerotor motor provides high torque, low speed output to drive boom tilt. Late remote drive motors on Series III machines have 2 external circuit relief valves.

Remote PTO



2 remote PTO's are attached to back of transmission. They provide mechanical connection between remote drive motor and chassis drive line. PTO is air shift for engage & disengage. Switch triggered by a pin acting against shift fork signals shift rail movement of PTO. PTO engages transmission countershaft through dog clutch that uses a spring to maintain contact.

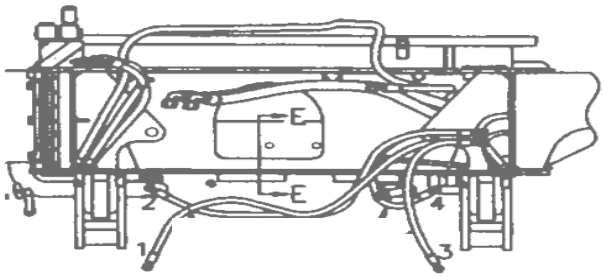
Front Suspension Lock Valve Circuit

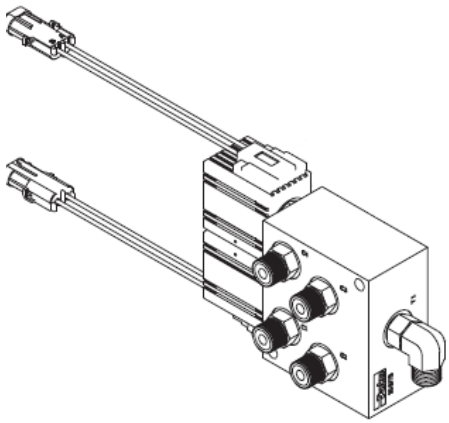


Suspension Lock Valve is air-controlled from front-brake relay valve. Air signal releases solenoids allowing front springs to move. Pilot oil is supplied for make-up purposes.

Lock circuit only works in remote control. During travel mode, axle is free to move.

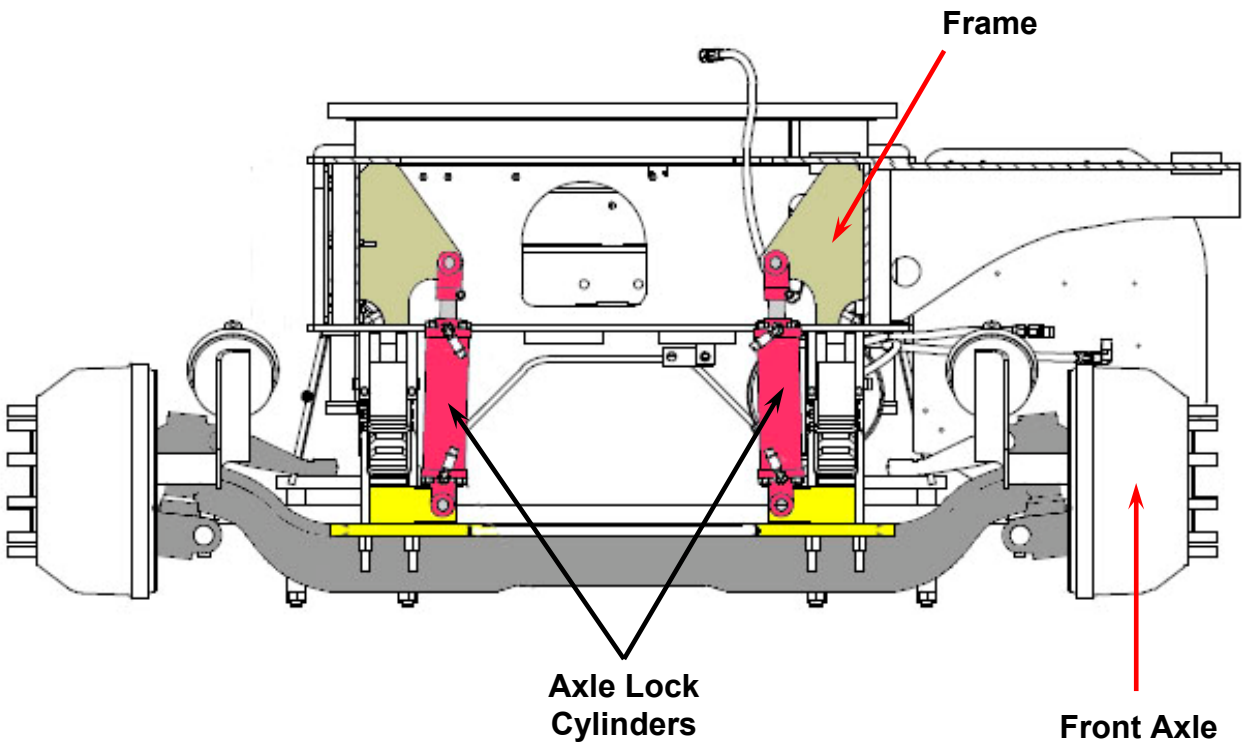
Lock Valve - Stabilizers





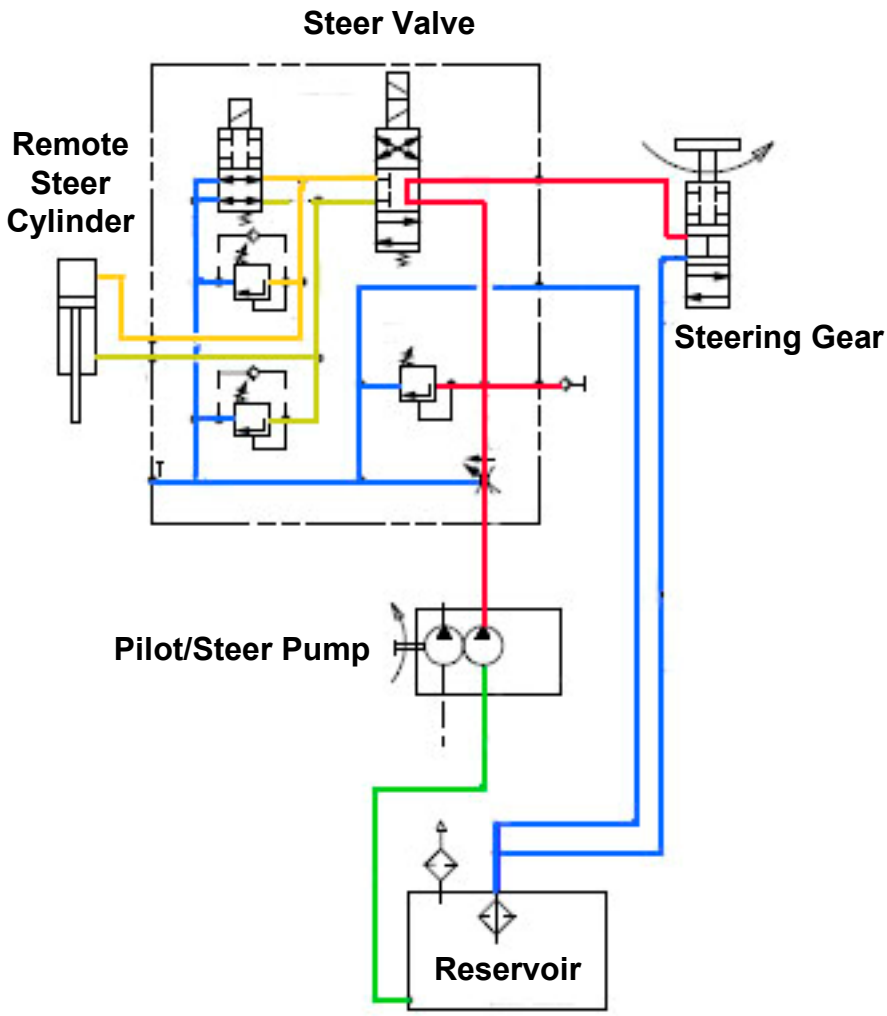
Lock valve is located on LH inner frame rail near engine. Air solenoids are used to lock and unlock the stabilizers cylinders when in remote.

Axle Lock Cylinders



Axle lock cylinders attach to frame and front axle. When lock valve is engaged in remote operation, oil can't be vented from cylinders. When the cylinders are locked, movement of the front axle is restricted to improve stability while digging. Axle lock disengages when traveling in remote mode or when machine is switched to chassis travel mode.

Steering Circuit



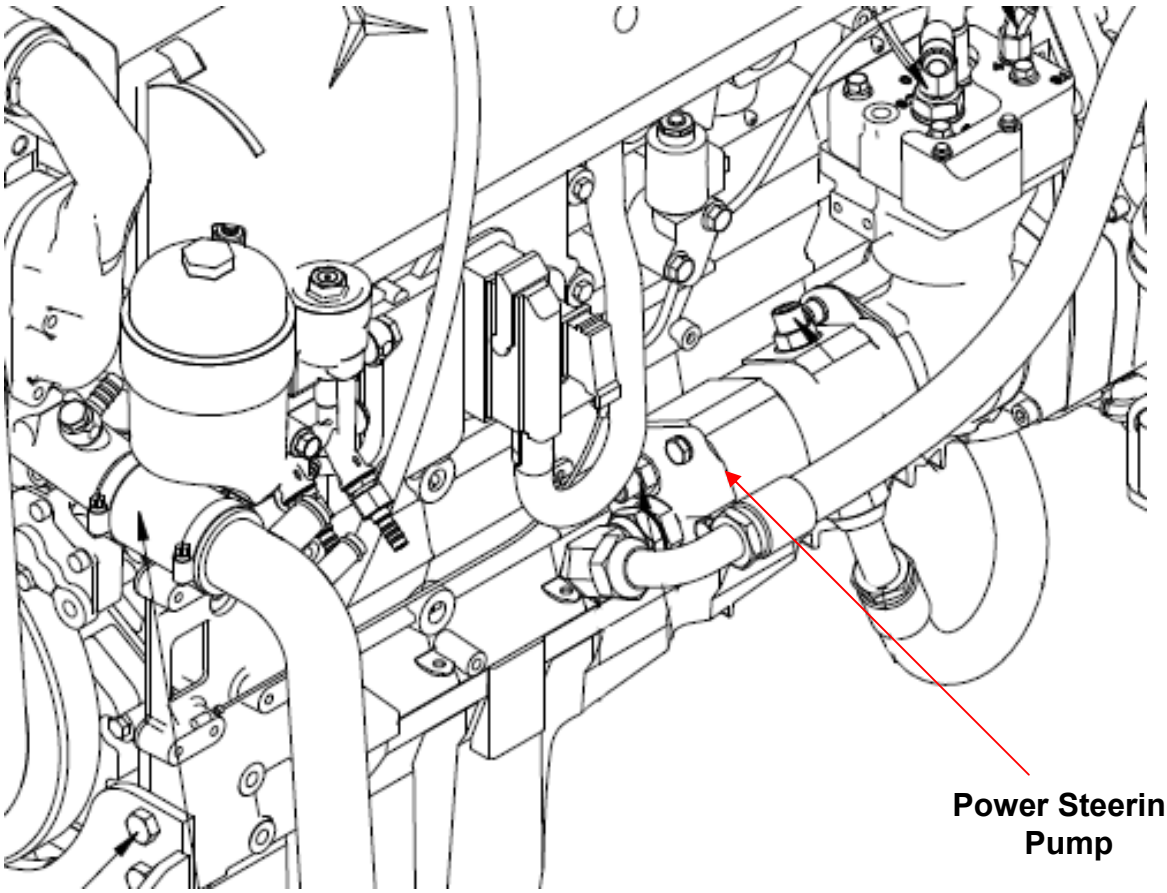
Steering circuit schematic is shown. Steering is used in highway speed and remote operation.

Steering pump is engine driven. A steering valve is mounted on the chassis frame to allow for steering in travel mode and remote mode. Electric solenoids are used to shift between modes and provide steering action in remote.

Chassis steering gear is used in both modes. Steering cylinder is used for remote mode only.

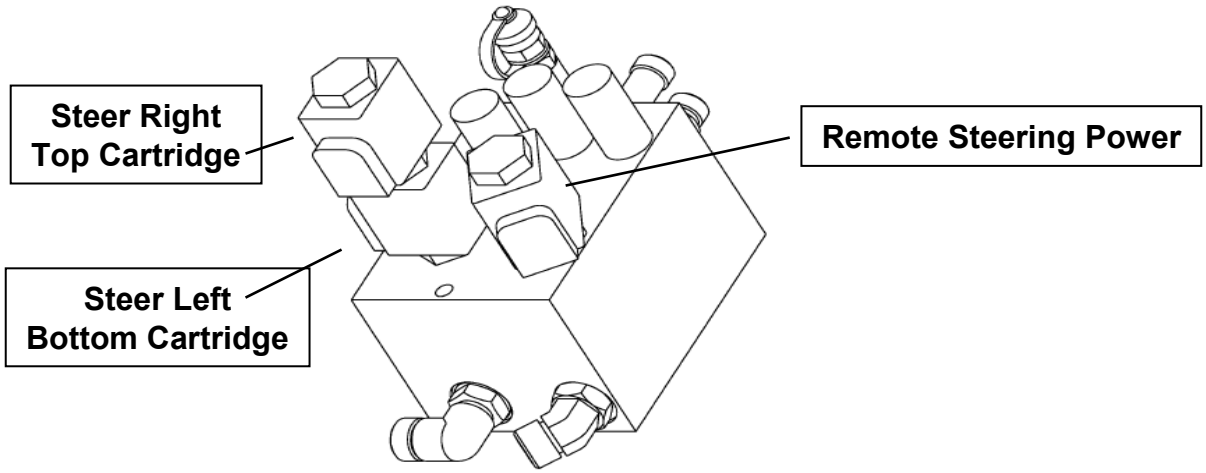
Chassis steering valve

Power Steering Pump



Steering pump is driven by the air compressor auxiliary drive. Power steering pump is in tandem with the pilot pump. Pumps must always have the air bled from the pump before initial start up.

Steering Valve



Steering valve is located on RH side of chassis on the frame rail. The valve can be accessed once the chassis hood is opened. Steering valve controls power steering pressure and change over from highway steering to remote steering. Remote steering uses the chassis power steering plus a steering cylinder to provide remote steering.

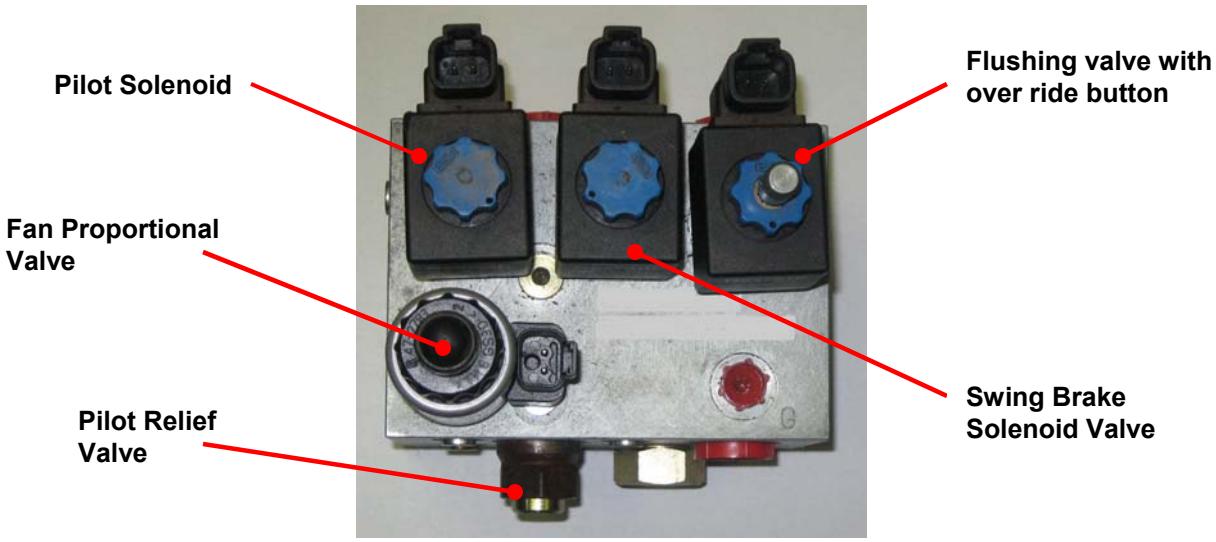
GRADALL Product Support Information

Subject: Pilot Manifold (80533012) Information
Affected Model: XL3100-III, XL4100-III, XL5100-III
Affected Units: All machines of the affected models

The subject machines have a pilot manifold located in the valve compartment. This service information provides important information about the function of pilot manifold valves.

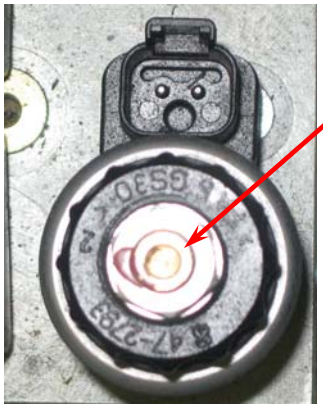
Corrective Action: To clarify features and operation of the pilot manifold (80533012), please provide your service personnel and ***GRADALL*** Excavator customer service personnel with this service information. Important information about features and operation of the pilot manifold will be detailed in this service information.

GRADALL On Highway Series III models utilize a pilot manifold (P/N 80533012) located in the excavator valve compartment. The pilot manifold provides oil to important functions of the machine. See machine hydraulic schematic for more details.



Pilot Solenoid – a normally closed electrically operated solenoid valve. When energized, valve cartridge allows pilot oil into the machine pilot system which is used to shift the control valve spools, release swing brake and other functions. Pilot solenoid is controlled by the control cut out lever in the operator's cab.

Fan Proportional Valve – a normally closed electrical proportional solenoid/relief valve that meters oil to the cooling fan circuit through port "CF" when energized. Excess oil is returned to tank through port "EF". The fan proportional solenoid valve receives its signal from the processor. A temperature sensor located in the tank return line at the main valve signals the processor. The fan proportional valve has a plastic cap that covers an adjustment screw and locknut. The adjustment is paint sealed when the valve is built. This adjustment is NOT to be changed. If it is altered, the fan circuit may become unstable leading to possible hydraulic cooling problems and component damage.



Adjustment screw and locknut.
DO NOT ADJUST!

Pilot Relief Valve – is used to limit pressure in the pilot circuit. Pilot relief is adjustable. Refer to final test sheets for your model for correct setting. Oil that is relieved goes to tank through the "L" port of the pilot manifold.

Swing Brake Solenoid Valve – is a normally closed electrically operated solenoid valve. When energized, valve cartridge allows oil at pilot pressure into the swing brake valve. Swing brake solenoid valve is controlled from the processor when the swing circuit is activated by the operator from the joystick.

Flushing valve with override button – a normally open solenoid valve used to provide flushing flow to the main valve during highway speed operation. Flushing oil goes to the main valve through the "S" port on the pilot manifold. During excavator (remote) operation, flushing valve closes electrically with a signal from the processor. When closed, the oil is directed to the cooling fan and pilot circuit.

In case of a failure of the solenoid coil or electrical signal to the flushing valve, an over ride button is located in the valve portion of the flushing valve. To actuate, depress the plunger and rotate ¼ turn to lock. This should ONLY be activated if the flushing valve is inoperative in excavator (remote) mode. This will allow the cooling fan and pilot circuit to operate. Before switching machine to travel mode, the over ride button must be unlocked. If left activated in highway speed operation, serious damage may occur to the fan circuit and pilot pump located on the undercarriage.

To prevent inadevertent operation of the flushing valve over ride button, ***GRADALL*** began installing a red tie wrap (P/N 80433150) on the over ride button. Production start of the change began with XL300-III, 3120000169 and XL4100-III, 4100000350. This tie wrap is NOT to be removed unless required to use over ride button. Note, machines in factory inventory built before the production change have also been updated to include the tie wrap prior to shipment.

GRADALL Product Support Information

Subject: Series III Boom Circuit Speed

Affected Model: All Series III ***GRADALL*** Hydraulic Excavators

Affected Units:

Boom circuit cycle times should always be set to specifications as provided by ***GRADALL*** in the service manual. Failure to set boom circuit cycle times to specification may result in specific problems that could lead to potential boom cylinder and other hydraulic component damage.

Results of faster cycle times in the boom circuit may cause the following:

- Erosion of the piston seals and backup rings
- Serious damage to the boom cylinder due the boom cylinder cushions not being able to slow the cylinder from the faster boom circuit speeds.
- Higher than normal hydraulic system temperatures
- Inconsistent load sharing by the hydraulic system

Corrective Action: If you are aware of a machine that has had the boom circuit speed set faster than factory specifications, the speed must be readjusted to current factory specification. Any adjustment to boom cycle speed needs to be performed with the hydraulic oil at operating temperature (120° F, 49° C), engine running at high idle, and the boom level. Adjusting the boom circuit cycle times requires the use of a stop watch and one of the following tools: BB3 Handheld analyzer, Bodem Software and Laptop, or Bodas Software and Laptop. Boom circuit speed settings are found in Parameter tree 1, I set.

The current specifications for boom circuit cycle times are as follows:

Model	**Boom Out** (Seconds)	**Boom In** (Seconds)
XL3100-III, XL3200-III, XL3300-III	4.8 - 5.2	5.0 - 5.4
XL3210-III, X3310-III	7.6 - 8.2	7.6 - 8.2
XL4100-III, XL4200-III, XL4300-III	4.8 - 5.2	5.2 - 5.8
XL4210-III, XL4310-III	8.0 - 8.6	8.0 - 8.6
XL5100-III, XL5200-III, XL5300-III	5.8 - 6.5	5.4 - 6.5
XL5210-III, XL5310-III	8.7 - 9.3	8.7 - 9.3

Thank You!

This presentation on Highway Speed Series III Hydraulic System Operation has been provided by *GRADALL* and your *GRADALL* dealer.

GRADALL

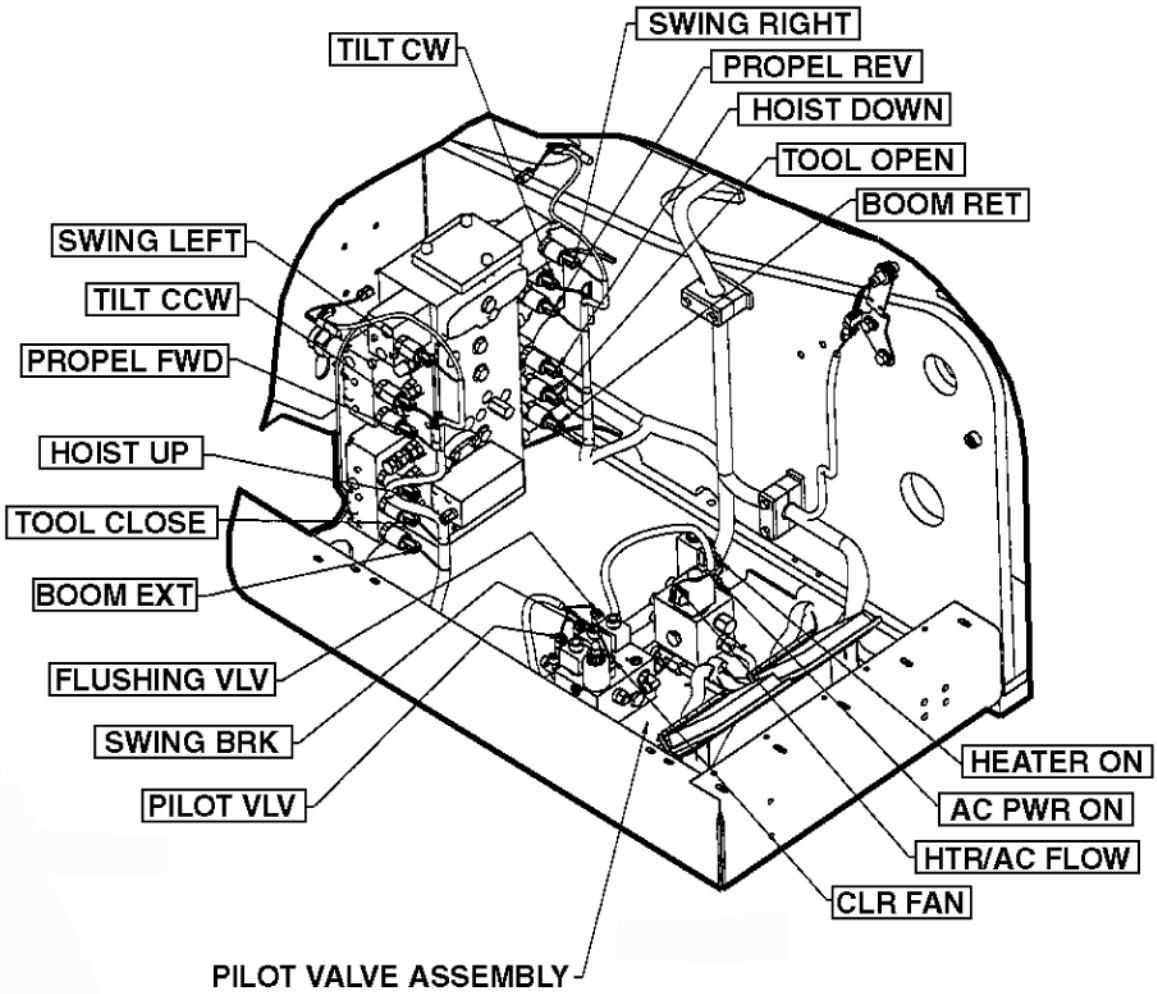
ON – HIGHWAY

XL SERIES II

HYDRAULIC PRESSURE ADJUSTMENT

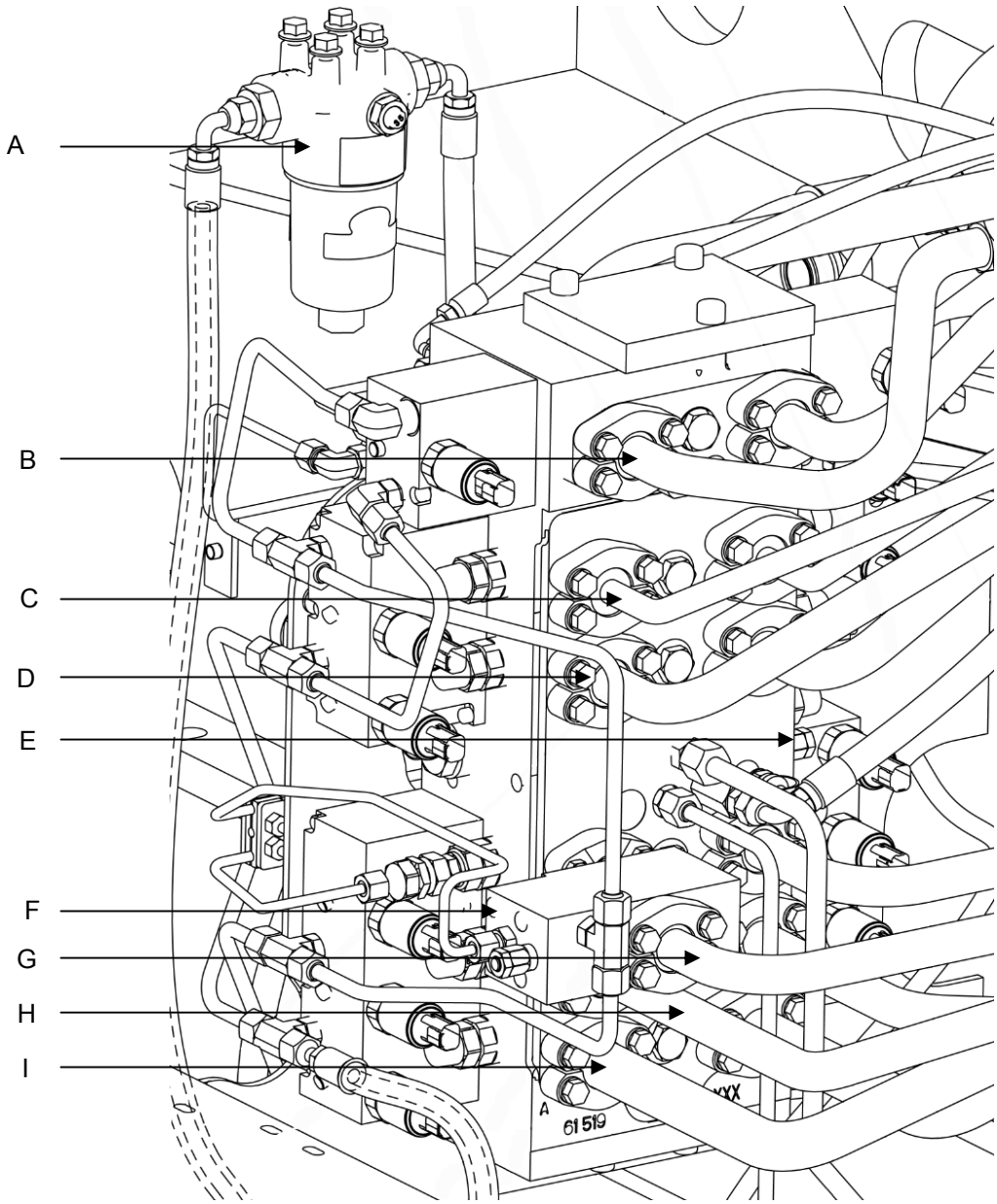
GRADALL
406 Mill Avenue S.W.
New Philadelphia, Ohio 44663, USA
Telephone (330) 339-2211
Fax (330) 339-3579

NOTE: See hydraulic system set-up procedure for detailed system adjustment if required.
*Pressure test to be performed with oil at operating temp. and engine running full throttle
**Pressures correspond to regulator compensator setting or loadsense line relief.
***Specified pressures of these reliefs correspond to 1/2 GPM flow.
****Values to be measured with the cooling fan off, heater off, and air conditioning off.
*****To be tested after operating time test is conducted.



Control Valve Call Outs

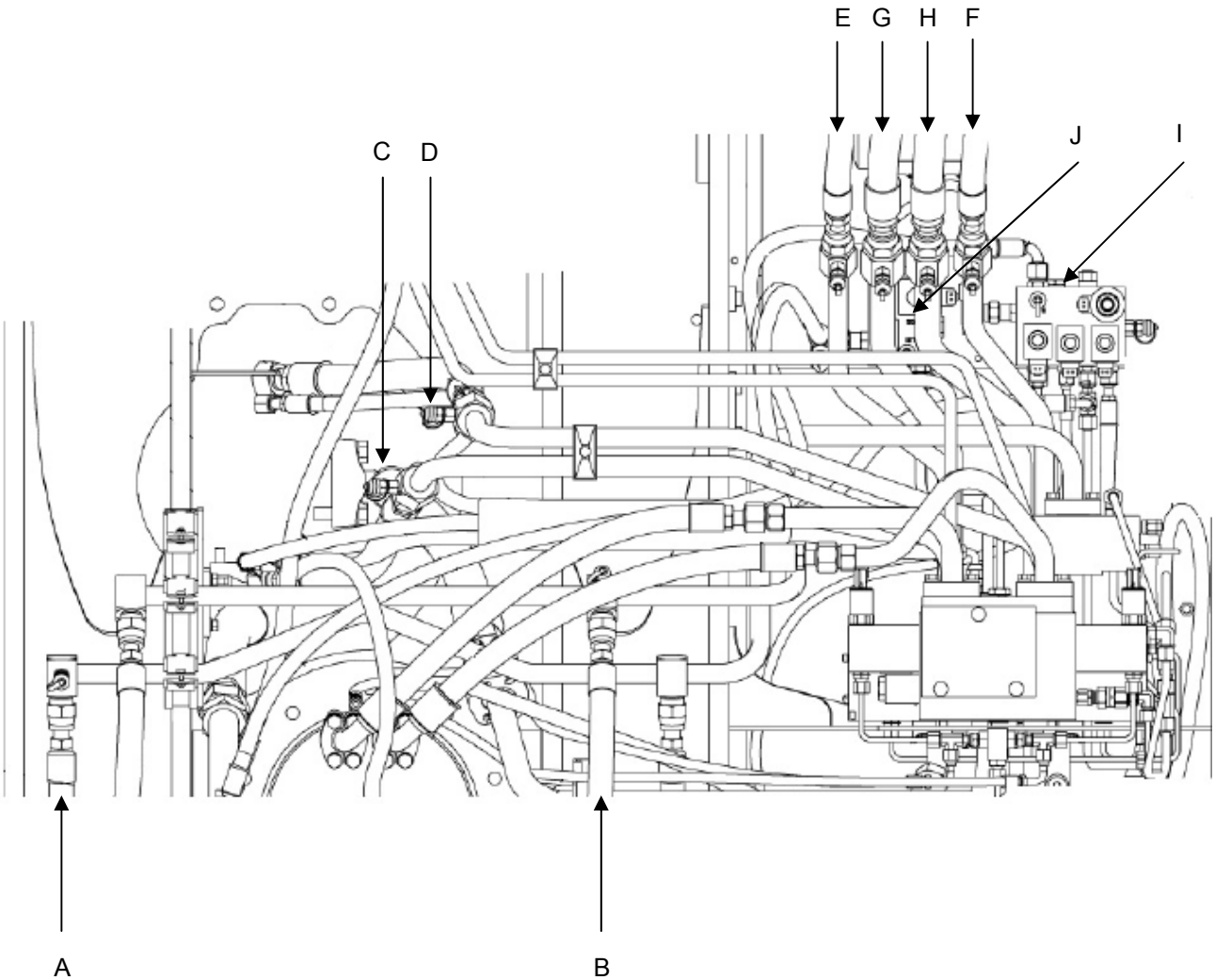
(A) Pilot Filter
(B) Swing Section
(C) Tilt section
(D) Propel Section
(E) Pump Setting Relief
(F) Anti-Drift Valve
(G) Hoist Section
(H) Tool Section
(I) Boom Section



Test Fitting Call Outs

This is looking down into the boom cradle area.
The front of the machine can be referenced as the top of the page.

(A) Hoist
(B) Hoist
(C) Propel
(D) Propel
(E) Tool
(F) Tool
(G) Boom
(H) Boom
(I) Pilot Manifold
(J) A/C Heat Manifold (can not be seen from this angle)



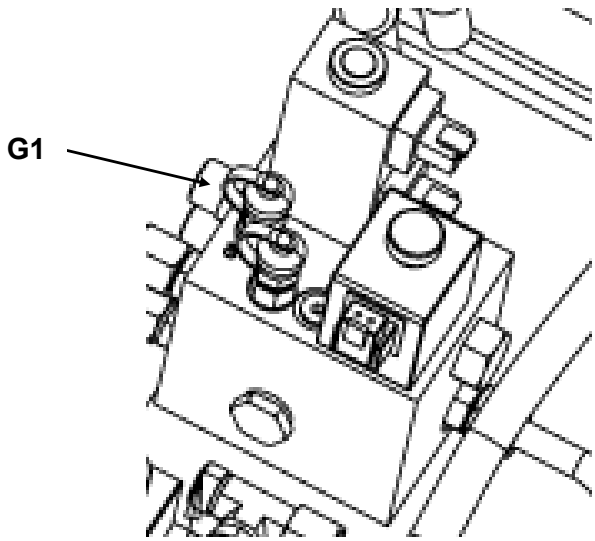
Flushing Pressure

Flushing circuit is used to make sure that the control valve stays full of oil, which prevents cavitation and provides cooling and lubrication.

Checking flushing pressure connect gage to the G1 port at the Heater/AC Manifold.

Check pressure with safety lever up no functions operating and engine at high idle. Including that the hydraulic cooling fan is not operating and the Heater/ AC are both off.

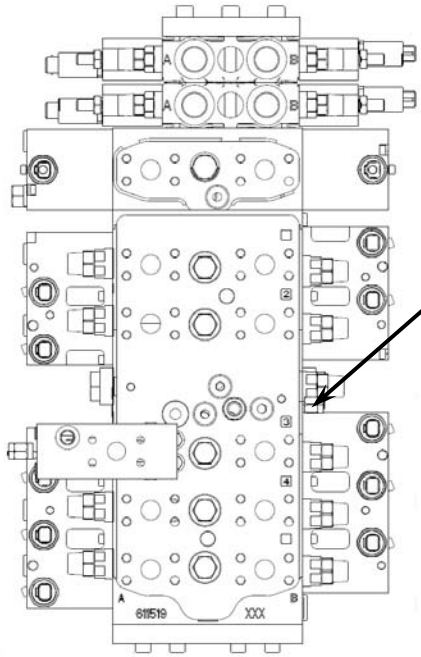
Refer to check sheet for specific model pressures.



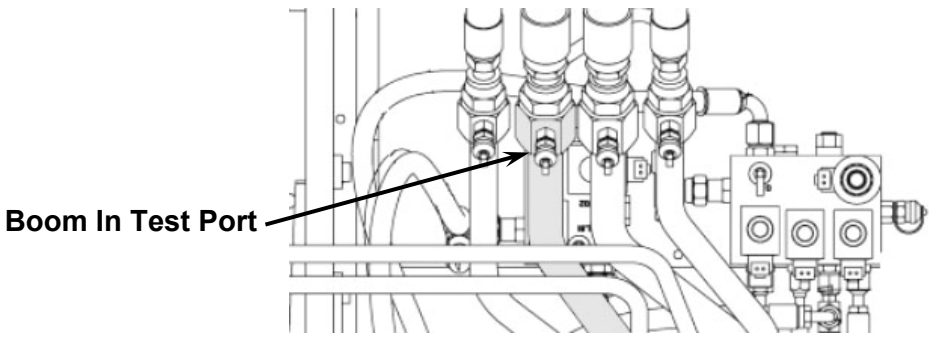
4. Load Sense, (Main), Pressure

Tools Required:

Digital Gauge Kit (Gradall P/N 80404127)
Normal Mechanics Hand tools



Load sense relief valve acts on load sense signal to pump. Load sense relief setting is the operating pressure for the hydraulic system and is considered the “main relief valve”. After any adjustment is made, tighten the locknut and verify setting was not changed as a result of tightening the locknut.



1. Install digital gauge and hose on Boom In Test port.

2. With hydraulic oil at operating temperature (120° F+, 49° C+), run engine at full RPM, and fully retract boom until it bottoms.

3. Gauge reading will be “load sense pressure”. If load sense pressure is incorrect, adjust load sense relief as required to achieve correct load sense pressure. Turn relief in to raise pressure, out to lower pressure.

Load Sense Relief Setting (All Models)	4900 – 5000 psi (338 – 344 Bar)

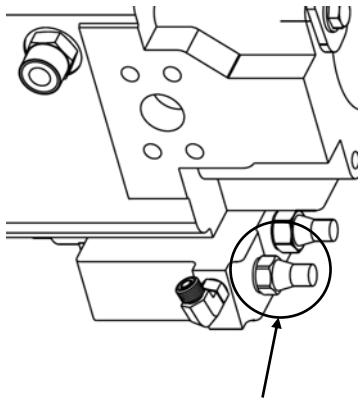
Pump Differential

Check differential pressure, usage of digital gauges is recommended for a more accurate pressure reading.

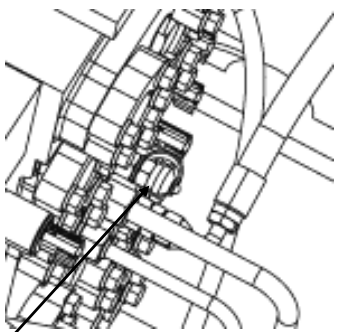
Connect a high pressure gauge at the G1 port on the Heater/AC manifold valve. A second high pressure gauge to the MLS port on the front of the control valve.

With the gauges connected to the G1 and MLS test ports and the engine operating at high idle. The Hydraulic cooler fan not operating and the Heater/AC off, extend the boom and stall record readings. Difference between G1 & MLS refer to chart for specific model.

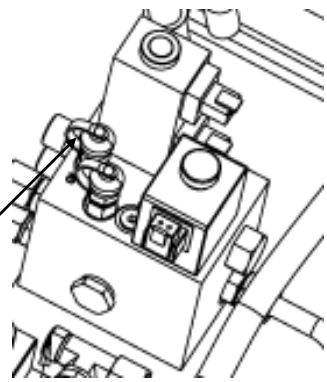
Remove the cap. Loosen the jam nut and turn the allen screw in to increase the setting and out to decrease the setting.



Pump Adjustment



MLS

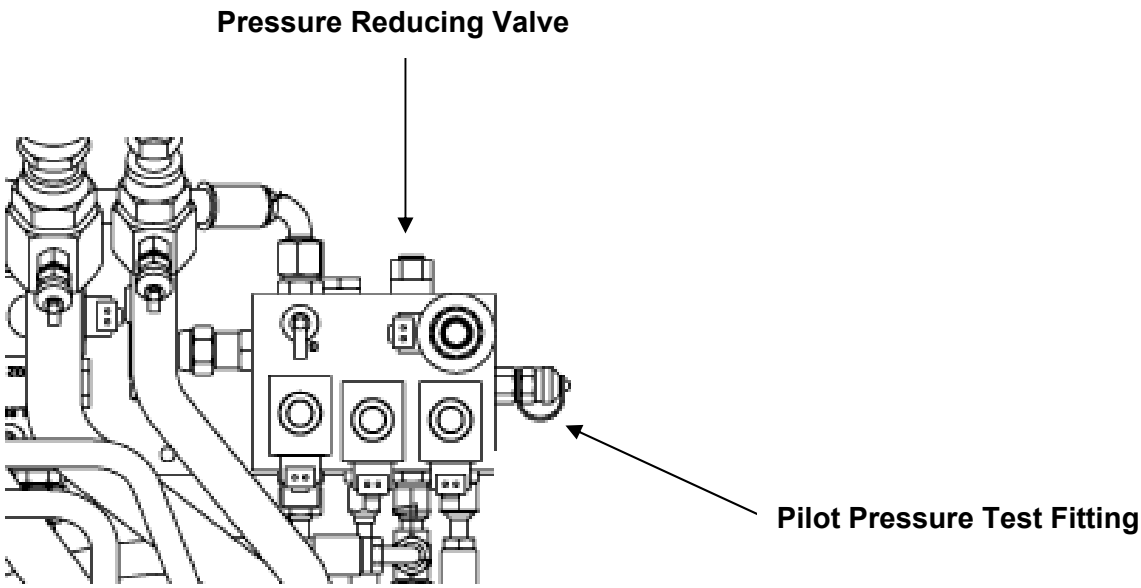


G1

Joystick Pilot Pressure

Checking the pilot pressure use a lower pressure gauge. The pressure operates the controls spool movement.

The for the correct pilot pressure refer to chart for specific model settings.

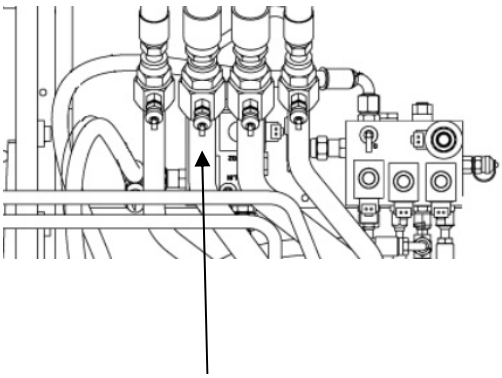


Boom Circuit (Retract)

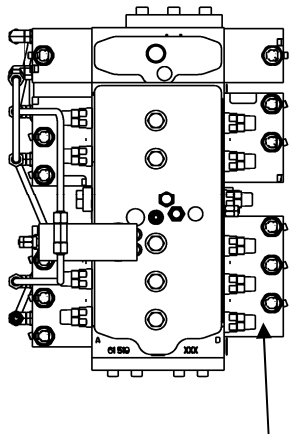
Retracting the boom, the reading is the load sense line relief pressure not the circuit relief pressure. Refer to chart for specific model. It will be required to increase the pump setting (load sense line relief) to achieve the correct reading for the retract circuit.

Once the load sense line relief setting has been increased, retract the boom and stall. The reading for the boom retract refer to chart for specific model. If an adjustment is required, screw the port relief in to increase the setting and out to decrease. Once the correct setting has been achieved, reset the load sense line relief using the chart for the specific model.

Note: The boom retract port relief is high then load sense line relief. If port relief needs adjustment you need to raise the load sense line relief. After port relief adjustment is made refer back to Pump Setting section to readjust the load sense line relief.



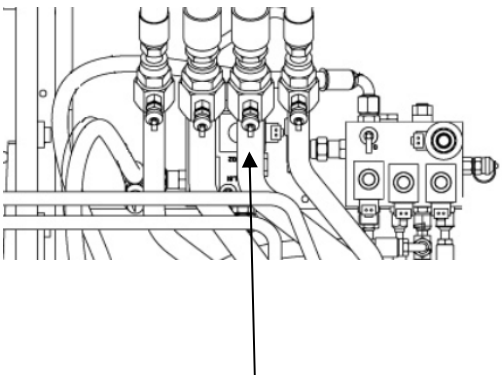
Boom Retract



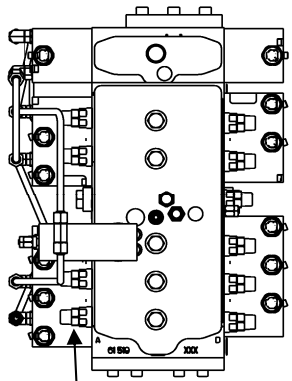
Boom Retract (Inside Relief)

Boom Circuit (Extend)

Checking the extend circuit, run the boom all the way out and stall. Refer to the chart for specific model pressure setting. If an adjustment is required, screw the port relief in to increase the setting and out to decrease.



Boom Extend

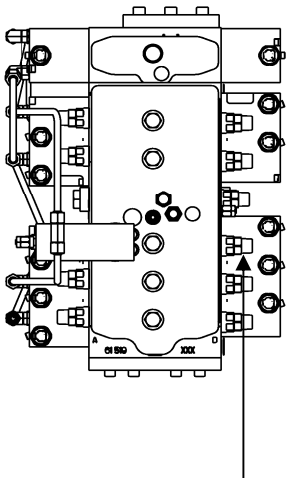


Boom Extend
(Outside Relief)

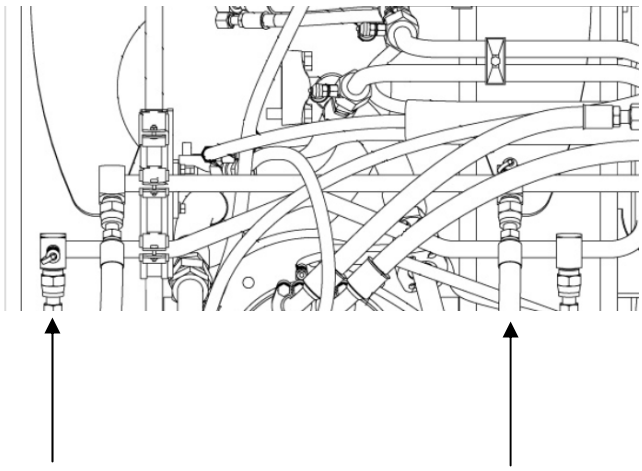
Hoist Circuit (Down)

Checking the hoist down circuit, connect high pressure gauge to the test fitting at the cylinder. Checking the down (retracted) side of the circuit, place the bucket against the ground and stall the circuit. Refer to chart for specific model.

If an adjustment is required, screw the port relief in to increase the setting and out to decrease.



Hoist Down Port Relief (Inside Relief



Hoist Up

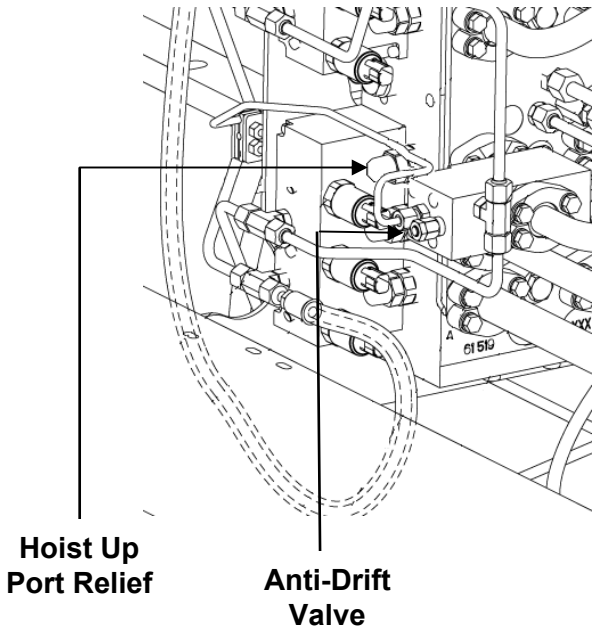
Hoist Down

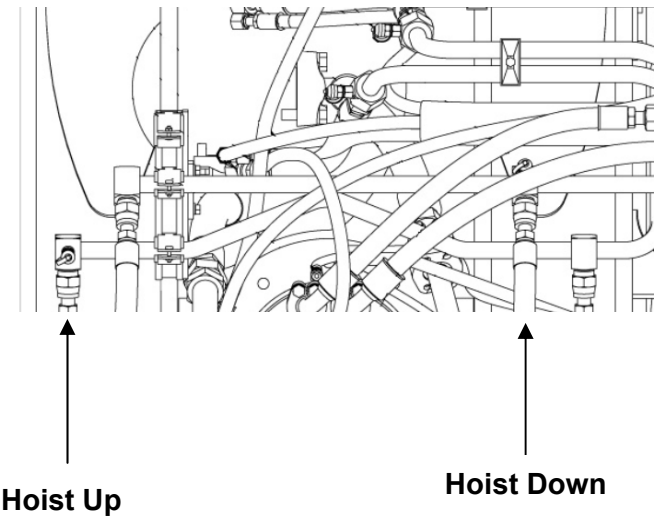
Hoist Circuit (Up and Holding Valve)

Connect a gauge on the hoist (extend) up circuit test fitting. Use the largest bucket, fill it completely, lift the bucket off the ground to the level piston. Extend the boom cylinder out slowly. Watch the gauge the pressure will increase slowly to (refer to chart for specific model pressure). Once it reaches the above pressure the boom will start falling slowly. You are looking at is the zero leak valve (holding valve). To see the hoist up circuit pressure keep extending the boom out once the pressure reaches (refer to chart for specific model pressure) the boom will fall faster this is the hoist up pressure.

If adjustment is need let the boom settle on the ground make adjustments and perform test again.

Note: The hoist up port relief is high then load sense line relief. If port relief needs adjustment you need to raise the load sense line relief. After port relief adjustment is made refer back to Pump Setting section to readjust the load sense line relief.



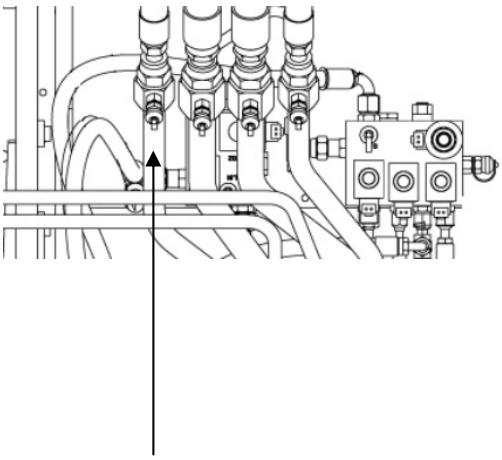


Tool Circuit

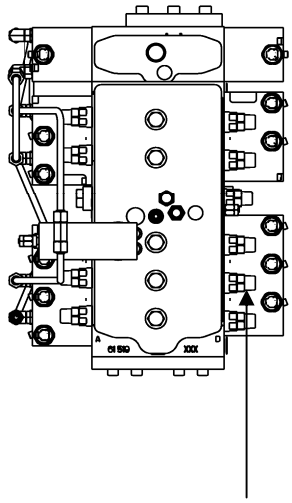
Testing the tool circuit, install a set of high pressure gauges into the first and fourth lines. The most inside line is for tool retract (open). When testing the tool circuit, turn the load sense valve in so that the setting is higher than the circuit. Remember that the circuit is higher then the load sense adjustment.

Stall the circuit out the tool circuit you will read pump setting of refer to chart for specific model. Circuit pressure is higher referring to chart for specific model pressure. When adjustment is needed you need to refer to the pump setting section for correct procedure.

Note: The tool port relief's are high then load sense line relief. If port relief needs adjustment you need to raise the load sense line relief. After port relief adjustment is made refer back to Pump Setting section to readjust the load sense line relief.



Tool Open



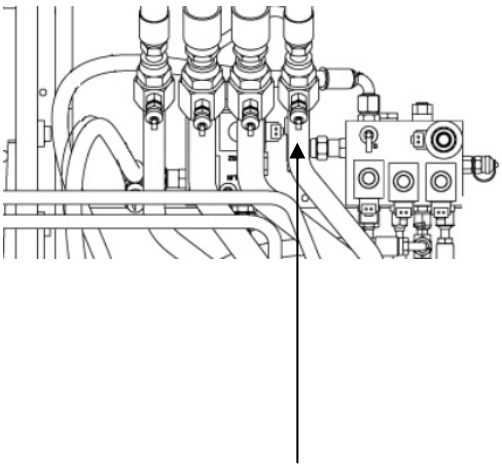
Tool Open
Inside Relief

Tool Circuit

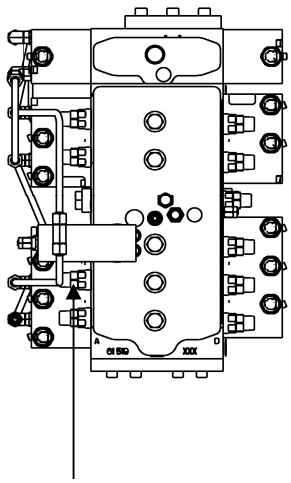
Testing the tool circuit, install a set of high pressure gauges into the first and fourth lines. The most inside line is for tool extend (close). When testing the tool circuit, turn the load sense valve in so that the setting is higher than the circuit. Remember that the circuit is higher then the load sense adjustment.

Stall the circuit out the tool circuit you will read pump setting of refer to chart for specific model. Circuit pressure is higher referring to chart for specific model pressure. When adjustment is needed you need to refer to the pump setting section for correct procedure.

Note: The tool port relief's are high then load sense line relief. If port relief needs adjustment you need to raise the load sense line relief. After port relief adjustment is made refer back to Pump Setting section to readjust the load sense line relief.



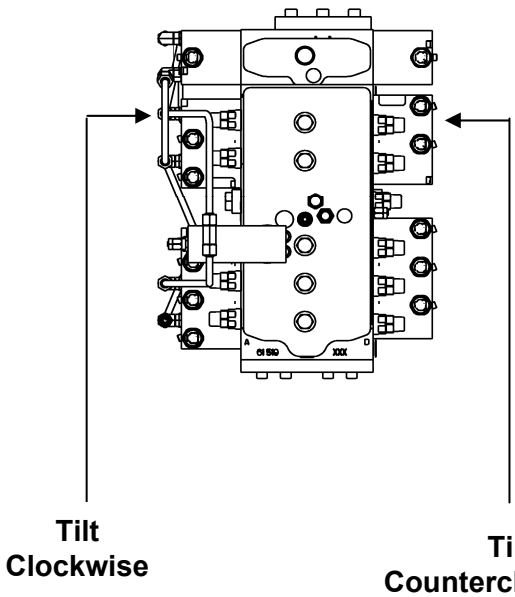
Tool Close

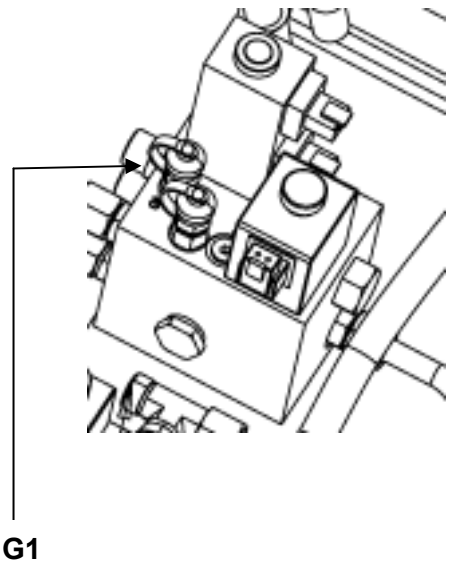


Tool Close
Outside Relief

Tilt Circuit

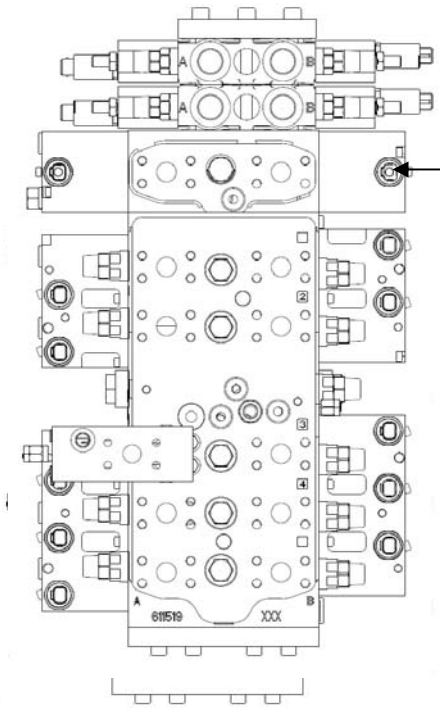
Checking the tilt circuit connect gauge to the G1 port on the Heater/ AC manifold. Operate tilt in both directions stalling against stop. Refer to chart for specific model pressures.



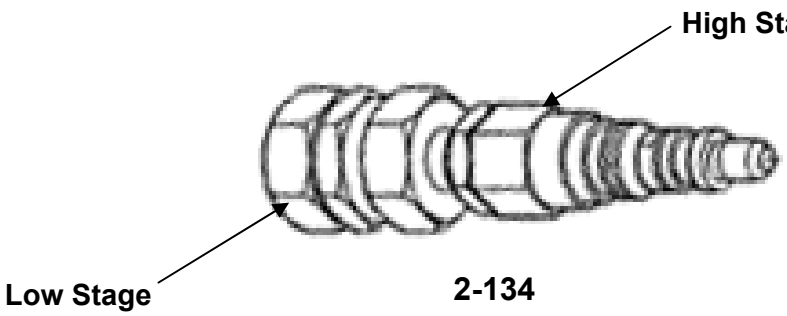


Swing Circuit Adjustment/Setting Procedure

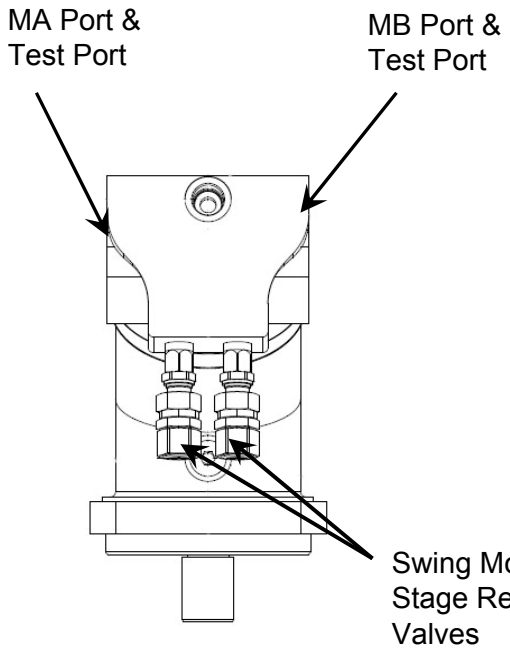
Tools Required:
Digital Gauge Kit (Gradall P/N 80404127)
ORS Plug -4 (Gradall P/N 84714016)
ORS Cap -4 (Gradall P/N 84714012)
Normal Mechanics Hand tools
If swing parameters require adjustment:
Any one of the three analysis/scan tools:
BB3 Handheld (NLA)
Bodem Software (NLA)
Bodas Software (Gradall P/N 80414109)
Cables for Machine Interface (Gradall P/N 80364206)
Laptop capable of running Bodem or Bodas
Stopwatch



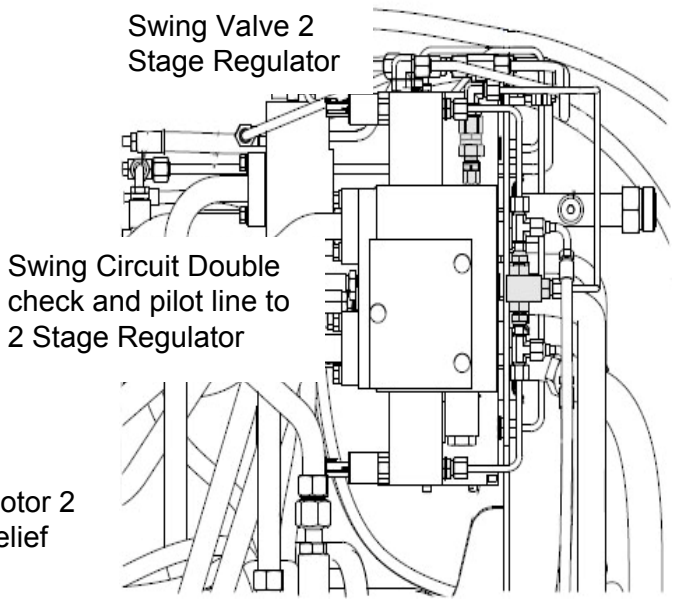
Swing circuit uses 3 - 2 stage relief valves to limit pressures in the swing circuit. The swing valve has a 2 stage Swing Regulator that controls swing begin (low stage) and maximum operating pressure (high stage). The motor has 2 – 2 stage relief valves that protect the swing circuit from pressure spikes (high stage) and provide swing cushion (stop) (low stage).



When adjusting any of the relief valves in the swing circuit, it is **necessary** to use 2 wrenches during loosening, adjusting, or tightening. Use of a single wrench will cause incorrect pressure readings, change in pressure setting, or even damage to the relief valve. After any adjustment is made, verify pressure is still correct after tightening locknut.



Swing Motor is located on swing transmission under the boom on the main frame



Main Valve is located under valve cover on right hand side of excavator

1. Assemble 2 gauge hoses together with connector from gauge kit. Place digital gauge in cab, route hose on machine to avoid being caught in the boom cradle. Attach a gauge to swing motor MA port at test port.

2. With hydraulic oil at operating temperature (120° F+, 49° C+), place the bucket firmly on the ground in an area that is clear of personnel and obstructions. The following pressure checks will be made with boom firmly on the ground: Swing Begin Point (Swing regulator low stage); Swing Motor High Stage (High Stage Relief at MA & MB); and Swing Regulator Setting (Swing regulator high stage). All pressure checks are made with engine at high idle throttle setting.

3. Motor high stage reliefs are checked/set by raising swing regulator high stage setting above the motor high stage setting. Mark the swing regulator high stage before making any changes. Turn in (clockwise) and count turns until it lightly bottoms.

With gauge on MA test port, stall swing right to check swing motor high stage relief setting.

XL3000-III, XL4000-III Motor High Stage Setting - 4400 – 4600 psi (303 – 317 bar)
XL5000-III Motor High Stage Setting - 4700 – 4900 psi (324 – 338 bar)

Adjust high stage in (clockwise) to raise pressure, out (counterclockwise) to lower pressure.

When check/setting is complete on MA, move gauge line to MB port and test for left swing. Procedure and pressures are the same.
When swing motor high stage relief setting/check is complete, move gauge line to MA port, turn swing high stage regulator back (counterclockwise) to original position (count turns and align original marks).

4. Shut off engine, remove pilot line at Swing Regulator. Plug line with plug (84714016), loosely install cap (84714012) on fitting in swing regulator.

Start engine and stall swing right with joystick. Swing begin pressure should be 900 – 1100 psi (62 – 76 bar). Adjust low stage swing regulator in to raise pressure (clockwise) and out to lower pressure (counterclockwise). After setting low stage swing regulator, remove cap and plug and reinstall pilot line.

5. Swing regulator high stage setting is checked with gauge on MA port of swing motor and stall swing right. Correct high stage regulator setting is:

XL3000-III	2900 – 3100 psi (200 – 214 bar)
XL4000-III	4100 – 4300 psi (283 – 296 bar)
XL5000-III	4450 – 4550 psi (307 – 314 bar)

Turn swing high stage regulator in (clockwise) to raise pressure, out (counterclockwise) to lower pressure.

6. Swing right cushion (swing stop) adjustment is made at the MA port dual stage relief at the low stage adjustment. Raise boom off ground (must have a clear area to swing), swing left until full speed is achieved and release joystick. Watch gauge for maximum cushion pressure.

XL3000-III	2000 – 2200 psi (138 – 152 bar)
XL4000-III	2500 – 2700 psi (172 – 186 bar)
XL5000-III	2900 – 3100 psi (200 – 214 bar)

To adjust pressure, turn low stage on swing motor MA relief in (clockwise) to raise pressure, turn low stage out (counterclockwise) to lower pressure.

7. Swing left cushion (swing stop) adjustment is made at the MB port dual stage relief at the low stage adjustment. Repeat step 6 after moving gauge line to MB port, swing right at full speed and release joystick to read cushion pressure. Pressures and adjustment procedure is the same as step 6.

Note on swing cushion pressure adjustment – The swing cushion (swing stop) pressure has an allowable range that is acceptable for each model. As long as the pressure is within the range, it is acceptable. However, with swing cushion adjustment, it is very important that MA and MB port readings are within 50 psi of each other otherwise swing cushion (swing stop) will be inconsistent from right to left.

8. Swing begin is also controlled by the joystick Imin setting. The standard setting is 520 mA and is set using BB3, Bodem, or Bodas. Swing Imin is found in Iset 2 and must be set the same for left and right swing.

9. Swing speed is set by using the BB3 handheld, Bodem software, or Bodas software. Swing Imax is found in Iset 2. Swing Imax must be checked and set for both left and right swing speed.
Use the stopwatch to record swing speed in seconds. Swing speed should be set the same in both directions. Swing Imx setting might be different right to left, but the speed needs to be the same. Swing speed in seconds is shown below for each model.

	XL3100-III XL3200-III XL3300-III	XL3210-III XL3310-III	XL4100-III XL4200-III XL4300-III	XL4210-III XL4310-III	XL5100-III XL5200-III XL5300-III	XL5210-III XL5310-III
Swing Right 360° (Boom In or Out)	7.5 - 9.0	12.5 - 13.5	8.0 - 9.5	12.5 - 3.5	8.0 - 9.5	12.5 - 13.5
Swing Left 360° (Boom In or Out)	7.5 - 9.0	12.5 - 13.5	8.0 - 9.5	12.5 - 3.5	8.0 - 9.5	12.5 - 13.5

Propel Circuit Adjustment Procedure – Highway Speed

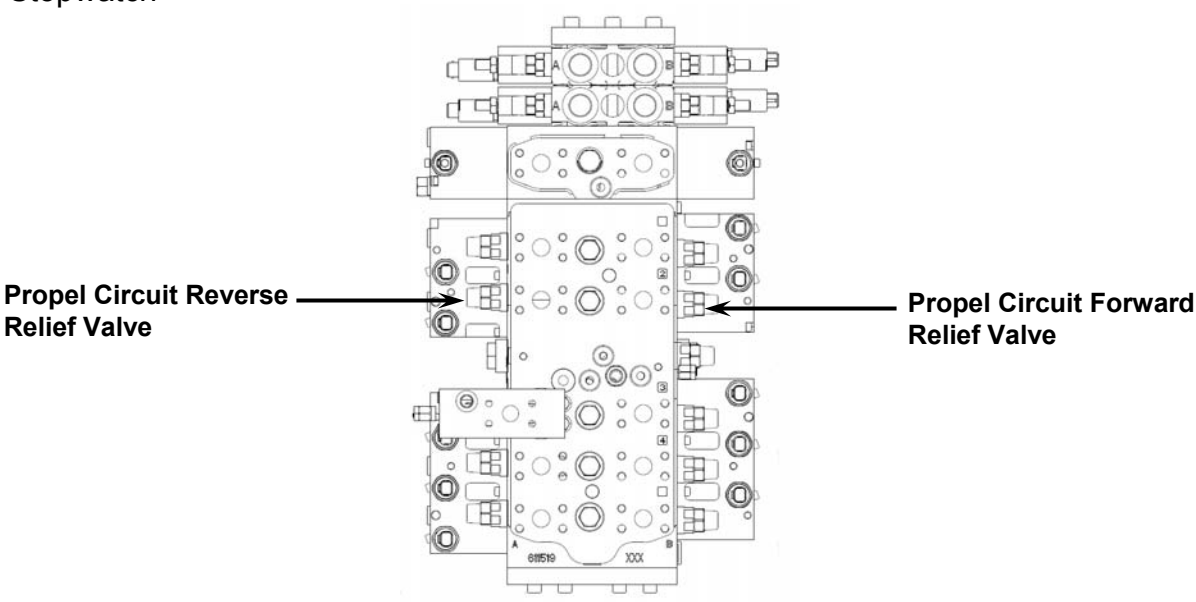
NOTE! This procedure is to be used for machines equipped with Eaton travel motor P/N 80733059 only. Starting serial number for production machines are as follows:

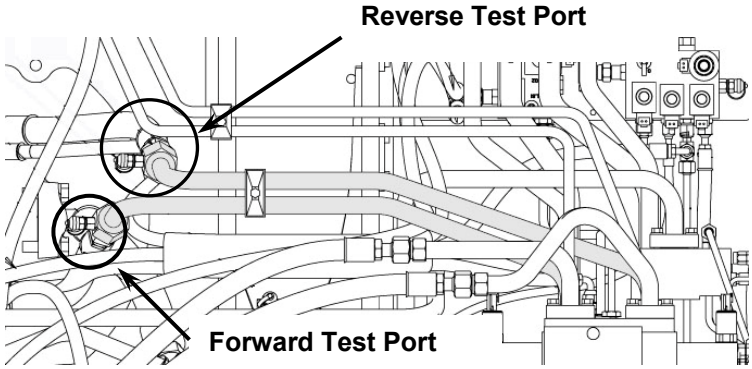
XL3100-III 4X2	3120000191
XL3100-III 4X4	3140000295
XL4100-III 6X4	4100000391
XL4100-III 6X6	4160000043
XL5100-III	5100000577

And any Series III machine retrofitted with Eaton travel motors built prior to the production start. If replacing the original travel motor 3160320 with the new Eaton motors, the travel circuit must be adjusted after motor installation.

Tools Required:

Digital Gauge Kit (Gradall P/N 80404127)
Normal Mechanics Hand tools
If propel speed parameters require adjustment:
BB3 Handheld (NLA)
Bodem Software (NLA)
Bodas Software (Gradall P/N 80414109)
Cables for Machine Interface (Gradall P/N 80364206)
Laptop capable of running Bodem or Bodas
Stopwatch





The propel circuit uses relief valves located in each propel valve port to control maximum travel pressure. Propel pressure is below load sense relief setting. Propel speed is controlled by Imax settings at the processor. Both travel motors have reliefs to provide pressure spike protection.

1. Install gauge and hose on forward test port. Shift remote travel to high speed position (RH console in upper cab, travel speed switch). Operate travel pedal to verify shift is made to high range. Engage parking brake on LH console after verifying transmission has shifted.

2. With hydraulic oil at operating temperature (120° F+, 49° C+) and engine running at full RPM, carefully depress travel pedal for forward operation. Stall propel circuit in forward and check propel circuit pressure. If incorrect, loosen locknut and adjust in (clockwise) to raise pressure, turn out (counterclockwise) to lower pressure. Tighten locknut and verify pressure has not changed due to tightening locknut.

   XL3100-III, XL4100-III, XL5100-III

   Propel Circuit Pressure (Forward & Reverse) 3350 – 3550 psi (231 – 244 Bar)

3. Move gauge line to reverse test port. With hydraulic oil at operating temperature (120° F+, 49° C+) and engine running at full RPM, carefully depress travel pedal for reverse operation. Stall propel circuit in reverse and check propel circuit pressure. If incorrect, loosen locknut and adjust in (clockwise) to raise pressure, turn out (counterclockwise) to lower pressure. Tighten locknut and verify pressure has not changed due to tightening locknut.

4. Propel circuit speed requires a level area that has a measured distance for machine travel to check speed in both forward and reverse. Measure a 100 ft. (30.5 m) distance and mark begin and end point.

5. Connect BB3 or laptop to data port in upper structure operator cab. Propel maximum speed parameters are found under Parameter Tree 1; I Set 3; travel fwd Imx and travel rev Imx.

6. Switch propel range to low speed position (RH console in upper cab, travel speed switch). Operate travel pedal to verify shift is made to low range. Verify parking brake is released on RH console in upper cab.

7. With hydraulic oil at operating temperature (120° F+, 49° C+) and engine running at full RPM, carefully depress travel pedal for forward operation and travel into

the measured distance. Begin timing travel speed with stopwatch at the beginning of the measured distance, stop the timing at end of the measured distance. Adjust travel fwd Imx as required for correct travel speed and save settings.

XL3100-III, XL4100-III, XL5100-III

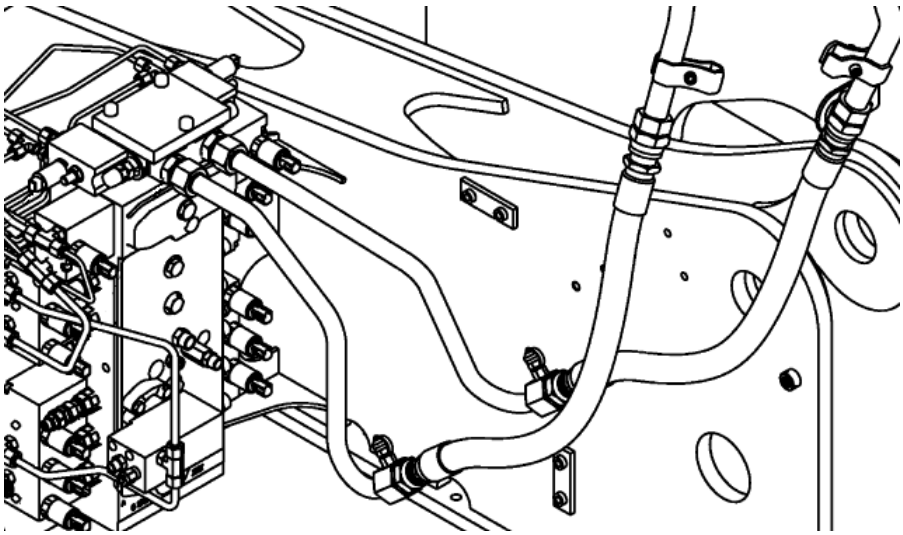
Propel Circuit Travel Speed (Forward & Reverse) (100 ft 30.5 m, 1st gear) (XL3100-III, XL4100-III, XL5100-III)	64 – 75 seconds

8. With hydraulic oil at operating temperature (120° F+, 49° C+) and engine running at full RPM, carefully depress travel pedal for reverse operation and travel into the measured distance. Begin timing travel speed with stopwatch at the beginning of the measured distance, stop the timing at end of the measured distance. Adjust travel rev Imx as required for correct travel speed and save settings

9. Travel speed forward and reverse should be as close as possible. Travel fwd Imx and travel rev Imx may not match, but the actual travel speed should be within 1 second of each other forward and reverse.

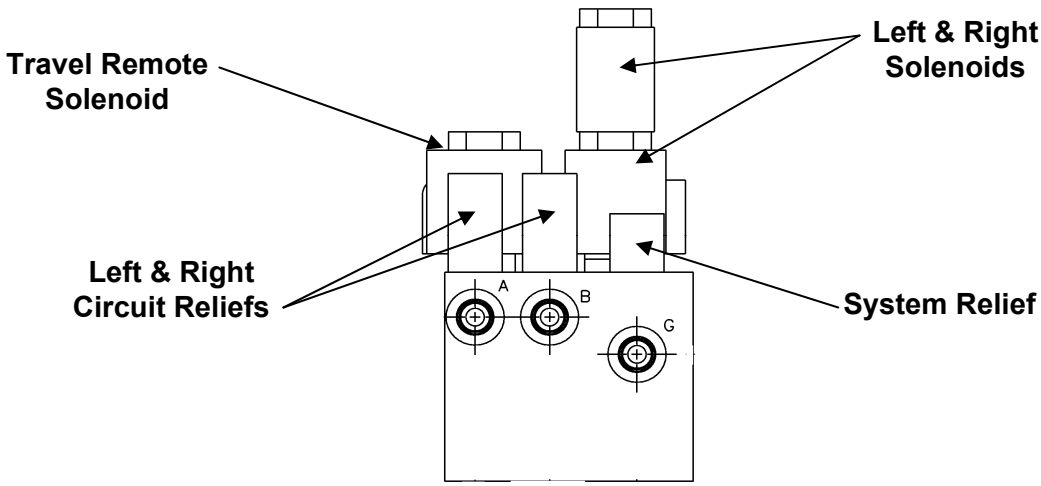
Auxiliary Circuit

Checking the auxiliary circuit connect gauges to test port pressure should be refer to chart for specific model pressure. The maximum flow out the auxiliary valve is 30 GPM.



Power Steering Circuit (Chassis)

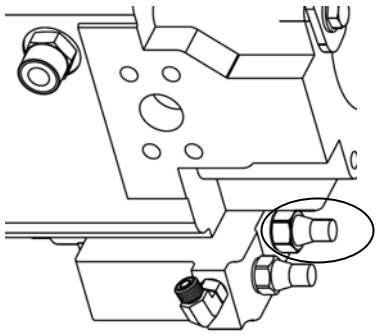
Remote steering has two directional relief as well as a system relief. System relief is set at 2000 PSI while the two directional relief's are set at 2350 PSI. Connect a gauge to the G port and stall in each direction you need to bring the system relief up to be able to read the circuit relief's for remote steer. The single coil solenoid assemble is use to change from travel to remote while the double stack solenoid is for left and right steer.



Drawdown - RPM

You are looking at the maximum engine draw down under extreme loads. It is best checked using a Minidiag Tool which is connected to the data link for the engine. But if not available piston the machine were you can see the lower dash panel.

Next make sure that you are in high range and the park brake is applied. Close the tool cylinder completely place the bucket on the ground. With the engine at full throttle stall the Propel and tool while you boom out and hoist up. Maximum tach reading should be 1725 – 1825 RPM'S.

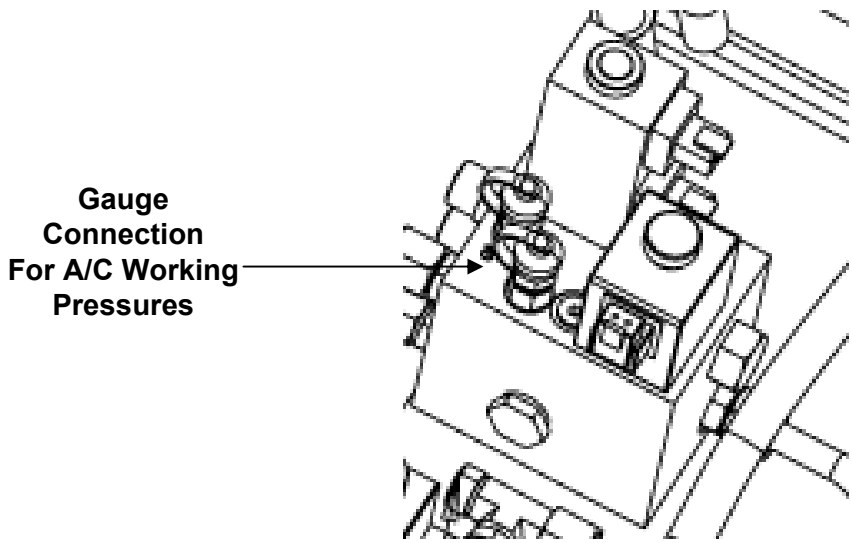


A/C & Heater Manifold

Checking the a/c heater manifold is connect a gauge that can handle system pressure. Once the a/c or heater circuit is engaged you will see a brief pressure spike of 3500 PSI. After the system settles the operating pressure will be around 1900 – 2200 PSI. Checking the for the correct speed of the a/c motor a photo tach is needed. With the engine at idle with all controls in neutral and the hydraulic at least 70 degrees F a/c drive motor speed should be 2000 – 2150 rpm's. If rpm's are slow connect the BB-3 in the upper cab follow menu to get to Select 4. I Set 3 you 100 % for maximum follow out of valve.

For use with BB 3 Section

Choose CONFIG/CAL (F1 key) at the main menu.
Then select 2. I Set. Boom in/out, Tool open/close min and max current settings are in this menu tree. Beginning of spool shift (metering) is determined by Imn setting. Maximum function speed is determined by Imx setting.
Select 3. I Set 2. Hoist up/down, Swing right/left min and max current settings are in this menu tree. Beginning of spool shift (metering) is determined by Imn setting. Maximum function speed is determined by Imx setting.
Select 4. I Set 3. Travel, heater, and oil cooling fan min and max current settings are in this menu tree. Note: Heater Imax also controls AC compressor speed.

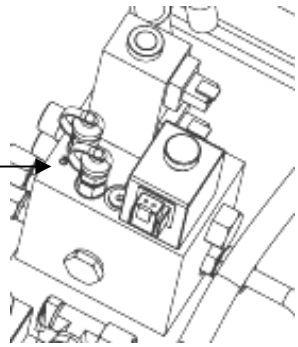


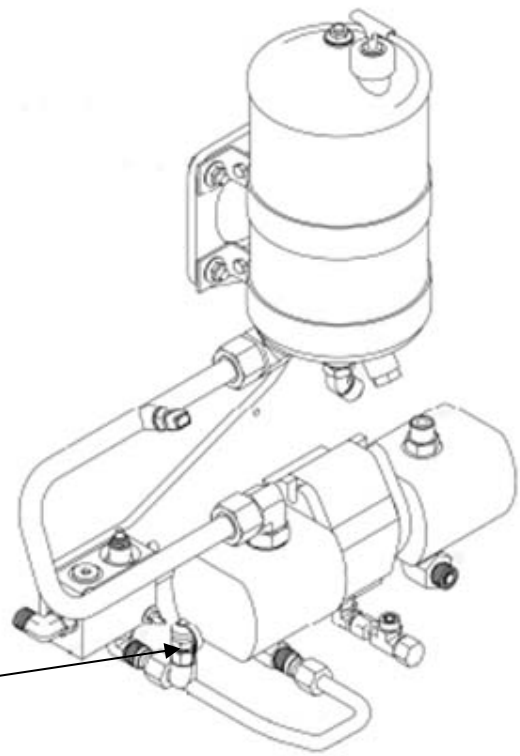
A/C & Heater Manifold

To check the heater circuit for the upper cab connect a gauge to the A/C Heat Manifold. With the a/c heat not operated gauge will read 3500 psi. Next connect a 1000 psi gauge at the heater relief cartridge. With the machine running at high idle place the heater switch to maximum temperature. Correct reading 1000 psi if more heat is needed turn the relief in which increases the heat from the unit.

(Note: The amount of flow for the heater drive motor is controlled at the a/c heat manifold. To make sure that the single solenoid which is proportional is opening fully. To check refer to the a/c drive motor speed on the pervious page)

Gauge Connection for A/C Working Pressures





Heater Relief Test Fitting

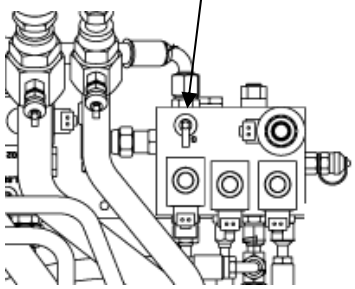
Upper Oil Cooler Fan

First you must have a BB-3 or the Bodem2 software to be able to adjust the cooler fan speed.

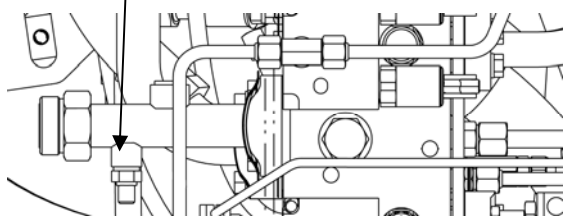
Connect a gauge to G port on pilot manifold. Engine idling adjust oil cooler fan Imn to 1000 mA. Heat the hydraulic oil to 150° F minimum. Unplug the temperature sensor to turn fan at max speed. Set engine speed to full throttle. Re-adjust oil cooler fan Imn value to achieve desired pressure. (refer to final test sheet)

If adjustment has been made to fan speed Imn save parameters.

"G" Port Pilot Manifold



Hydraulic Cooler Fan Temperature Sensor



GRADALL INDUSTRIES, INC.

80709005 FINAL MACHINE REPORT - MODELS 3100-III, 4100-III, 5100-III

INSPECTION CHECKLIST

SALES ORDER # SERIAL NUMBER DATE

ENGINE		**SHIFT CONTROL INTERLOCK WITH AIR SYSTEM AT OPERATING PRESSURE**		**MISCELLANEOUS**	
	Oil Level Full In Power Unit				Reservoir Oil Level
	Coolant Level & Proection to -30° F		From Chassis Cab: Place Transmission In Any Gear. Verify Starter Will Not Engage		Gear Lube in Swing Transmission
	Low Idle (675 - 775 RPM)				Swing Brake (Bleed)
	All Panel Guages Function		From Chassis Cab: Verify "Low Air", "Axle Diff", "Park Brake", "Neutral", "Main PTO", "Left PTO", "Right PTO", "Front Axle Drive", And "Interaxle Diff" Indicator Lights Illuminate When Key Is Moved To Start Position		Gear Lube in Tilt Transmission
	Oil Pressure, Engine At Operating Temp, No Load				Hoses In Boom not Twisted
					Hoses Clear of Interference and sharp edges
	Alternator Charging @ 13.3 - 14.7 V				All Cylinder Pins Locked
	Belt Alignment OK		From Chassis Cab: Return Transmission To Neutral And Follow Remote Control Procedure. With Mode Switch Set To Remote, Verify There Is No Response When Turning The Key To Run Or Start And No Indicator Lights Come On.		Attachments Fit Properly
	Heater/Defroster Works				Satisfactory Welds
	Air Cleaner Connections Tight				No Leaks
	Throw-out Bearing Release Gap .010" - .020"				Reservoir Filter Clean
					Hydraulic Oil in Swing Brake
	Battery Connections OK		From Upper Cab: Verify "Low Air", Hyd Fluid Level", "Hyd Fluid Temp" Indicator Lights Illuminate When Key Is Moved To Start Position		Cab Door Latches Hold
	The 3 DDC Indicator Lights Work (With Key Switch On, The 3 Lights Will Glow For Approximately 2 Seconds)				Window Moves Freely
					Window Latches Work
		TRAVEL/REMOTE MODE			Windshield Wiper & Washer OK
	No Engine Protection System Faults (With Switch On, An Active Fault Is Indicated By Either Glowing Red Engine Stop Light Or Yellow Check Engine Light. If there is Is a Fault, Contact DDC Rep.)		With Air Up, Machine Mode Switched To Remote, Upper Key On, Pump PTO Engaged, Dig Brakes Set, Engine Can Be Start/Stop From Upper Cab		Access Doors Aligned
					All Door Locks Work Properly
					Electronic Monitor Functions
			Front Wheel Drive (Where Applicable) A. Engaged When Selected (Light On) B. Disengaged When Not Selected (Light Off)		Control pattern switch works
					Hoist up cushion works properly
	Using MiniDiag Tool, Verify There Are No Active Fault Codes And That All Stored Fault Codes Are Cleared				Throttle Works Properly
			Diff. Lock Engaged (Light On) When Diff. Lock Selected		Auto idle switch works
					Bucket shake switch works
LUBRICATION			Travel Alarm works (FWD & REV), Remote And Travel Modes		Mode switch works
	Upperstructure Greased	**LIGHTS FUNCTION PROPERLY**			Radio works
	All Fittings Accept Grease		Brake/Turn/Tail Lights Work		Tilt Speed Override Switch Works
	Transmission Lube Level		Headlights (High & Low Beam) Work		Upper Horn Functions
	Front Drive Axle Lube Level		Turn Signals Work		Joysticks/Pedals Work Properly
	Rear Axle(s) Lube Level		Hazard Lights Work		Pilot On/Off & Starter Lockout Functions
STEERING/WHEELS			Back-up Lights Work		Chassis Horn Functions
	Tire Pressure Correct (Contact Eng Dept If Not Listed) 285/75R24.5 "G" = 100 PSI 385/65R22.5 "J" = 100 PSI		Clearance Lights Work		Swing Lights Work
			Work lights operate		Dig Brake Works (All Modes)
			Boom lights operate		Joystick Lockout Switch Works
	Steering Properly Adjusted				Brake Pressure Warning Light Works
	Power Steering Reservoir Oil Level Full				Fwd/Rev Selector Works
					Sheet Metal And Fiberglass Cover Condition OK
	Gearbox Poppets 1300 PSI Max @ Low Idle				Optional Equipment/Systems Operate Properly
	Wheel Stops Correct				
	Ball Joints Adjusted & Locked				
	Lug Nuts Torqued 425 - 450 ft-lb				

CHECKED BY: _____ DATE: _____

GRADALL INDUSTRIES, INC.

80709005 FINAL TEST REPORT - MODELS 3100-III, 4100-III, 5100-III

SALES ORDER # SERIAL NUMBER DATE

	PRESSURE TESTS - (ALL AT HIGH IDLE, HYD. OIL 100 DEG F MIN EXCEPT WHERE NOTED *). Standard Boom Configuration and 60" Ditching Bucket	**GAGE LOCATION**	**3100-III**	**4100-III**	**5100-III**	**ACTUAL**
1	**FLUSHING PRESSURE** (NO FUNCTIONS MOVING)	G1 (Heater/AC Manifold)	360-570			
2	**PUMP DIFFERENTIAL** (BOOM OUT BOTTOMED) *	G1 - LS (@ MAIN VALVE)	275-295			
3	**PILOT PRESSURE**	Pilot Valve A1	500-650			
4	**ENGINE SPEED** (RPM) - SET W/ BB-3 OR BODEM/BODAS SOFTWARE					
a	HIGH IDLE	BB-3 OR LAPTOP PC	1850 - 1950			
b	LOW IDLE	BB-3 OR LAPTOP PC	800 - 900			
5	**BOOM**					
a	CYLINDER RETRACTED (INSIDE RELIEF VALVE)	X @ VALVE	5075 - 5200			Not Factory Checked
b	LS CUTOFF SETTING - (CYLINDER RETRACTED) *	X @ VALVE	4900 - 5000			
c	CYLINDER EXTENDED (OUTSIDE RELIEF VALVE)	X @ VALVE	2575-2775			
6	**TRAVEL**					
a	STALL PROPEL WITH SERVICE BRAKE - FORWARD	X @ VALVE	3350-3550			
b	STALL PROPEL WITH SERVICE BRAKE - REVERSE	X @ VALVE	3350-3550			
7	**TILT**					
a	TILT MOTOR CCW (INSIDE RELIEF VALVE)	G1 (Heater/AC Manifold)	2450-2750			
b	TILT MOTOR CW (OUTSIDE RELIEF VALVE)	G1 (Heater/AC Manifold)	2450-2750			
8	**HOIST**					
a	CYLINDER RETRACTED (INSIDE RELIEF VALVE)	X @ VALVE	3075-3275			
b	LOCK VALVE SETTING (BOOM STARTS TO DRIFT W/ LOAD)	X @ VALVE	4650-4750			
c	HOIST DOWN PORT RELIEF (BOOM STARTS TO FALL W/ LOAD)	X @ VALVE	4800-4850	4800-4950	4800-4950	
9	**TOOL**					
a	EXTENDED (INSIDE RELIEF VALVE)	X @ VALVE	5075 - 5200			Not Factory Checked
b	RETRACTED (OUTSIDE RELIEF VALVE)	X @ VALVE	5075 - 5200			Not Factory Checked
10	**SWING**					
a	SWING REGULATOR PRESSURE - LOW STAGE *	MA (@ SWING MOTOR)	900-1100			
b	SWING REGULATOR PRESSURE - HIGH STAGE *	MA (@ SWING MOTOR)	2900-3100	4100-4300	4450-4550	
c	DYNAMIC BRAKING - RIGHT *	MA (@ SWING MOTOR)	2000-2200	2500-2700	2900-3100	
d	DYNAMIC BRAKING - LEFT *	MB (@ SWING MOTOR)	2000-2200	2500-2700	2900-3100	
11	**AUXILIARY** (OPTIONAL EQUIPMENT)					
a	INSIDE RELIEF VALVE	G1 (Heater/AC Manifold)	3000-3200			
b	OUTSIDE RELIEF VALVE	G1 (Heater/AC Manifold)	3000-3200			
12	**STEERING** (TURN WHEELS TO STOP & HOLD IN REMOTE OPERATION)	G @ STEERING VALVE	1950-2050			
15	**MAIN PUMP POWER SETTING** - ENGINE DRAWDOWN RPM (TOOL STALLED, HOIST UP AND BOOM OUT AT FULL SPEED) *	MONITOR	1725-1825			
16	**OIL COOLER FAN -** With Engine Idling, Adjust Oil Cooler Fan Imn to 1000 mA. Heat oil to 150°F minimum. Unplug Temp Sensor to Turn Fan At Max Speed. Set Engine At Full Throttle. Re-Adjust Oil Cooler Fan Imn Value To achieve Desired Pressure. Save Parameters.	Pilot Valve G	3450-3500			

ALL VALUES TO BE MEASURED WITH HEATER OFF AND AIR CONDITIONING OFF
* VALUES NOTED WITH * TO BE MEASURED WITH HYDRAULIC OIL TEMP 120-150 F

TESTED BY: DATE:

GRADALL INDUSTRIES, INC.

80709005 FINAL TEST REPORT - MODELS 3100-III, 4100-III, 5100-III

SALES ORDER # SERIAL NUMBER DATE

	CYCLE TIME TESTS - (ALL AT HIGH IDLE, HYD. OIL 120 DEG F MIN) Standard Boom Configuration and 60" Ditching Bucket	**3100-III**	**4100-III**	**5100-III**	**ACTUAL**
1	**BOOM OUT** (LEVEL)	4.8 - 5.2	4.8 - 5.2	5.8 - 6.5	
2	**BOOM IN** (LEVEL)	5.0 - 5.4	5.2 - 5.8	5.4 - 6.5	
3	**HOIST UP** (WITH BOOM IN RAISE FROM GROUND TO CUSHOIN SWITCH)	2.5 - 3.1	2.5 - 3.1	2.5 - 3.1	
4	**HOIST DOWN** (WITH BOOM IN LOWER FROM 30 DEG TO GROUND)	2.0 - 3.2	2.0 - 3.2	2.5 - 3.5	
5	**TOOL OPEN**	2.8 - 3.2	2.8 - 3.2	2.8 - 3.2	
6	**TOOL CLOSE**	2.6 - 3.8	2.6 - 4.2	2.6 - 4.2	
7	**SWING RIGHT 360 DEGREES** (BOOM IN OR OUT) (SWING Imin. Set to 520 mA)	7.5 - 9.0	8.0 - 9.5	8.0 - 9.5	
8	**SWING LEFT 360 DEGREES** (BOOM IN OR OUT) (SWING Imin. Set to 520 mA)	7.5 - 9.0	8.0 - 9.5	8.0 - 9.5	
9	**PROPEL FORWARD** (100 FT 1ST GEAR)	64-75	64-75	64-75	
10	**PROPEL REVERSE** (100 FT 1ST GEAR)	64-75	64-75	64-75	
11	**AIR CONDITIONER MOTOR SPEED RPM** (OPTIONAL EQUIPMENT)		2000 - 2150		

AFTER COMPLETING ALL PRESSURE SETTINGS AND CYCLE TIME SETTINGS, DIG MACHINE ON DIG PAD FOR 1 HOUR. RE-CHECK THE FOLLOWING SETTINGS: PILOT PRESSURE, PUMP DIFFERENTIAL, LS CUTOFF SETTING (BOOM RETRACTED), AND MAIN PUMP POWER SETTING (ENGINE DRAWDOWN). IF LOW, RE-ADJUST AS NECESSARY

ADDITIONAL TESTS

A	BRAKES & AIR SYSTEM		C	MISCELLANEOUS
	Chassis Parking Brake Holds on Ramp @ 11°			Hoist Up Cushion works Properly
	Air System Meets GTP-W-0145			High-Low Range Remote Travel Works Properly
	Preset Service Brakes Adjusted Properly			Boom Rollers Adjusted Properly
B	TRAVEL/REMOTE MODE			Tool Cylinder Rod Not Damaged
	Vehicle Speed 19 + 1 MPH (5th Gear, engine 2150-2250 RPM (Full Throttle))			Upper Park Brake Functions
	Brake Performance OK			AC Works Properly (If Equipped)
	Transmission Shifts Properly			Remote Controls Function (Oscillation Cylinders Lock, Brakes Set, Park Brake Sets, Low Air Warning)
	Front Wheel Drive Engaged when Selected (Light On)			
	Front Wheel Drive Disengaged When Front wheel Drive Not Selected (Light Off)			
	Differential Lock Engaged (Light On) when Diff. Lock Selected			Heater/Defroster Controls Function (Upper Heater Minimum 115°F @ Bottom Air Duct On Max Heat, Cab Door Closed)
				Verify That Upper Microprocessors Have No Active Fault Codes And That All Stored Fault Codes Are Cleared

TESTED BY: DATE:

80709005 SHIPPING INSPECTION CHECKLIST

GRADALL UPPER		GENERAL		MANUALS		REVISION
	All Machine Nameplates Applied		Machine Controls Set to SAE or Order Spec		Operator's Manual	
	All Inst. Plates Applied		Proper Operation Decal Displayed on Window		Parts Manual	
	Tool Kit in Machine		Paint & Appearance OK		Service Manual	
	No Paint on Cylinder Rods		All Decals Installed			
	No masking tape left on cylinder rods		Belly Pans Installed			
	Reservoir Level OK		Belly Pans Installed			
	Swing and Tilt Gears Lubed					
	Keys					
ENGINE						
	Coolant Level Correct					
	Engine Oil Correct					

SPECIAL ITEMS (LIST)

Inspected By:	Date

REV D EC 100011 GTB REMOTE TRAVEL PRESSURE ON TEST Sht2 WAS FOR XL3100 & XL4100 3750-3950, FOR XL5100 WAS 3900-4100