Hydraulic System Circuit Description

Section 04-01-04

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines, which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

Table of Contents

Scope of This Publication **5**
Customer Responsibilities and Warranty Advisories **5**
Safety **7**
Bucket Rollback Function **9**
Electrical Controls 9
Hydraulic Flow 9
Pilot System 10
Main Valves and Cylinders 10
VCU Logic 11
Bucket Dump Function **15**
Electrical Controls 15
Hydraulic Flow 15
Pilot System 15
Main Valves and Cylinders 16
VCU Logic 17
Hoist Up Function **23**
Electrical Controls 23
Hydraulic Flow 23
Pilot System 23
Main Valves and Cylinders 24
VCU Logic 25
Hoist Down / Return to Dig / Backdrag **29**
Electrical Controls 29
Hydraulic Flow 29
Pilot System 29
Main Valves and Cylinders 30
Hoist Down 31
Return to Dig (Automated) 31
Backdrag (Automated) 32
VCU Logic 32
Setting the Return to Dig Point 33
Steer Left and Auxiliary Steer Left **39**
Electrical Controls 39
Hydraulic Flow 39
Hydraulic System 40
VCU Logic 41
Auxiliary Steer Left 47

© 2019 Komatsu. All rights reserved.

Electric Controls....47
Hydraulic Controls....47
VCU Logic for Auxiliary Steering....48
Steer Right and Auxiliary Steer Right....53
Electrical Controls....53
Hydraulic Flow....53
Hydraulic System....54
VCU Logic....55
Auxiliary Steer Right....61
Electric Controls....61
Hydraulic Controls....61
VCU Logic for Auxiliary Steering....62
Hydraulic Oil Cooling Function....67
Electrical and VCU Logic Controls....67
Hydraulic Flow....67
Radiator Fan Control Function....71
Electrical and VCU Logic Controls....71
Exceptions to Normal Operation....72
Hydraulic Flow....73
Auxiliary Oil Cooler Control Function....77
Electrical and VCU Logic Controls....77
Hydraulic Oil Temperature....77
Exceptions....78
Hydraulic Flow....78
Auto Lube Control Function....81
Electrical and VCU Logic Controls....81
Automatic Controls....81
Manual Controls....82
Hydraulic Flow....83
Blower Fan Control Function....87
Electrical and VCU Logic Controls....87
Exceptions to Normal Operation....88
Hydraulic Flow....88
HPD Gear Box Functions....93
Electrical and VCU Logic Controls....93
Hydraulic Flow....93

© 2019 Komatsu. All rights reserved.

List of Figures

Figure 1. Bucket rollback circuit description (L1350) 13
Figure 2. Bucket rollback circuit description (L1850\L2350) 14
Figure 3. Bucket dump circuit description (L1350) 21
Figure 4. Bucket dump circuit description (L1850\L2350) 22
Figure 5. Hoist up circuit description (L1350) 27
Figure 6. Hoist up circuit description (L1850\L2350) 28
Figure 7. Hoist down circuit description (L1350) 35
Figure 8. Hoist down circuit description (L1850/L2350) 36
Figure 9. Return to dig/backdrag circuit description (L1350) 37
Figure 10. Return to dig/backdrag circuit description (L1850/L2350) 38
Figure 11. Steer left circuit description (L1350) 43
Figure 12. Steer left circuit description (L1850) 44
Figure 13. Steer left circuit description (L2350) 45
Figure 14. Auxiliary steer left circuit description (L1350) 49
Figure 15. Auxiliary steer left circuit description (L1850) 50
Figure 16. Auxiliary steer left circuit description (L2350) 51
Figure 17. Steer right circuit description (L1350) 57
Figure 18. Steer right circuit description (L1850) 58
Figure 19. Steer right circuit description (L2350) 59
Figure 20. Auxiliary steer right circuit description (L1350) 63
Figure 21. Auxiliary steer right circuit description (L1850) 64
Figure 22. Auxiliary steer right circuit description (L2350) 65
Figure 23. Hydraulic oil cooling circuit description (L1350) 69
Figure 24. Radiator fan control circuit description (Machines with Tier 1 or 2 Engine) 75
Figure 25. Radiator fan control circuit description (Machines with Tier 4 Engine) 76
Figure 26. Auxiliary oil cooler control circuit description 79
Figure 27. Auto lube/air conditioning circuit description 85
Figure 28. Blower fan control circuit description 91
Figure 29. HPD gearbox oil cooler control circuit description 95

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Scope of This Publication

HYDRAULIC CIRCUIT DESCRIPTIONS contains descriptions about the hydraulic circuits. It is essential that the operator(s) and technicians receive the following instructions and training before operating or performing any maintenance procedures on the machine.

Customer Responsibilities and Warranty Advisories

The P&H wheel loaders are warranted in accordance with the warranty policy provided with the machine. The recommended operating and maintenance procedures set forth shall be followed to ensure warranty coverage is not jeopardized. Failure to comply with recommended operating and maintenance procedures may void machine warranty.

Any questions or problems relating to warranty policy or administration should be directed to Komatsu Service Center. Include the model and serial number, in-service date of the machine, and hour meter reading. **We especially draw your attention to the following safety advisors.**

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Safety

This publication contains special instructions that pertain to safety, operation, maintenance, and repair of the machine. Listed below are the signal words and symbols that precede these instructions and their meanings:

⚠ DANGER

- **The danger label indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING

- **The warning label indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION

- **The caution label, used with the safety alert symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury (includes the safety alert symbol ⚠).**

CAUTION

- **The caution label (without safety alert symbol) is used to address practices not related to personal injury – only equipment damage.**

NOTICE

The NOTICE graphic is to indicate areas of importance to the reader that are not related to personal injury or machine damage.

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Bucket Rollback Function

The bucket rollback function is electric over hydraulic control which can be manually (Joystick or Roller Wheel) or automated controlled (Return to Dig or Kick Back).

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement or switch presses are converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit: Park brake switch must be in the “released pulled out” position. An LED light will change on the digital interface card when the switch position changes.
    - Limit: Bucket Angle derived from:
        - Bucket Cylinder Position Sensor
        - Lift Arm Position Sensor
- If no inhibit or limits are active, then the VCU outputs a command to the Rollback Pilot Solenoid channel on the Digital Interface Card.
- The Digital Interface Card then turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the PCP1 (Pilot Control Panel #1) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the proportional solenoid valve located on the hydraulic pilot control panel.

The amount of pilot oil pressure is dependent on the duty cycle of the PWM signal received at the solenoid valve. The duty cycle to “pressure out” is defined as part of the hoist and bucket calibration process.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

© 2019 Komatsu. All rights reserved.

Pilot System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the accessory pump.
- The oil is pressurized in the pump to an output pressure of 2500 psi.
- The pressurized oil flows into a manifold system and is distributed to the various circuits. The oil that is flowing to the pilot system is directed to a 2.5 GPM pressure compensated flow control valve.
- Once the oil passes the flow control, the oil enters a common manifold that the proportional solenoid valves are attached to. Proportional control valves include:
    - DB Dump Bucket
    - RB Rollback Bucket
    - HD Hoist Down
    - HU Hoist Up
- A 450 PSI relief valve is in parallel with the proportional control valves. This relief valve maintains a constant 450 PSI supply pressure for the proportional solenoid valves.
- When an electric PWM signal is given to the RB Proportional Solenoid, the proportional valve will start to open. The percentage of opening is directly proportional to the duty cycle of the PWM. As the cartridge begins to open, pilot oil is allowed through the proportional valve and is sent to the main control valve (HUSCO).
- At the same time that the pilot oil is flowing to the HUSCO valve, some of the pilot oil is sent to a check valve that is connected to the Greatest Pilot Command pressure transducer manifold. This transducer is common to the four proportional valves. It will report the highest commanded pilot pressure at any given time. Because this is a common manifold, the check valve is used to isolate the pilot pressure from back feeding into another pilot system. But because of this “OR” circuit, the oil would be trapped giving a retained maximum pilot pressure indication. To allow this trapped pressure to be bleed off, a .025” orifice is attached to the manifold and allows a slow drain of the pilot oil back to the hydraulic reservoir. Because of the size of the orifice, the drain has minimal affect on the actual pilot flow.
- The Greatest Pilot Command pressure transducer allows the operator or maintenance personnel to see the actual pilot pressure that is being sent to the HUSCO valve but is not actively used as a control feedback.

Main Valves and Cylinders

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the main pumps.
    - L-1350 has two main pumps.
    - L-1850, and L-2350 have three main pumps.
- The oil is pressurized in the pumps and is sent through check valves to the rear frame manifold. The pumps contain a pressure compensator to regulate main pump pressure.
- Pump flow is sent to the rear frame manifold. Depending on model, the pump flow may be straight through or combined in the rear frame manifold or the front main manifold.
- From the rear frame manifold, the flow is sent to the front frame manifold.
- From the front frame manifold, the flow is directed to the inlet of the main control valve(s) (HUSCO). This is an open center valve with two spools, the first of which is used for the bucket.

© 2019 Komatsu. All rights reserved.

- Located in the inlet port of the HUSCO valve is a relief valve. This relief valve will prevent over pressurizing the main valve if a failure in the pump pressure compensator occurs.
- When a bucket roll back command is sent electrically to the proportional control solenoid, pilot oil is applied to one end of the bucket spool. The bucket spool starts to move.
- As the spool moves, the oil that was flowing past the spool is restricted. As this restriction increase, pump pressure increases. At the same time that the return oil is restricted, the bucket base port is opened up to the load check valve. Any pressure that is in the bucket base port is applied to the load check valve. When the pump pressure is higher than the pressure on the load check, the load check opens and allows pump flow to flow through the bucket spool to the bucket base port.
- Parallel with the bucket base port, is a port relief / anti-void valve. The port relief will relieve pressure in the bucket base port if an external force on the bucket has caused the pressure to raise above the relief valve setting. This relief valve also will function as an anti-cavitation valve. If a void is pulled in the cylinder, the valve will open and allow hydraulic reservoir oil to be drawn back into the cylinder.
- As the oil passes out of the HUSCO valve, it flows through hoses and a manifold tube. From the manifold tube, the oil flows to the base of the bucket cylinder causing the cylinder to extend. Because the cylinder is double acting, the oil trapped in the rod side of the cylinder is expelled back through another set of hoses and another manifold tube.
- The bucket rod oil flows into the rod port on the HUSCO valve. When the bucket spool started to move, the bucket rod port was connected to the oil return galley in the HUSCO valve.
- The return oil flows through the HUSCO valve and out of the return port. The return port is connected to the front frame manifold.
- From the front frame manifold the return oil flows to the rear frame manifold. From the rear frame manifold, the oil is directed to the hydraulic reservoir return filter manifold.
- The oil passes through the return manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

Manual bleed down valves are in parallel with the bucket base and rod ports. These bleed downs are for manually relieving pressure in the bucket cylinder circuits for maintenance purposes.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs concerning machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Position Sensors
    - Lift Arm Position Sensor
    - Bell Crank Position Sensor
- Operator Commands
    - Joystick (manual)
    - Bucket Wheel (manual)
    - Return to Dig Switch (automated function)
    - Kick Back / Back Drag (automated function)

© 2019 Komatsu. All rights reserved.

- Function Inhibits
    - Park Brake Switch
    - Joystick failure
    - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the proportional pilot control solenoid valve that controls bucket rollback. This signal is a PWM output that will vary the opening and closing of the pilot control valve thus controlling the speed of the bucket roll back.

The VCU is continuously reading all of the inputs. When the operator initiates a bucket rollback command the following conditions are computed in the VCU before a command is sent out to the proportional pilot control valve.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Limits.

- Inhibit: The park brake switch must be in the “Park Brake Released” position (pulled out) for any bucket output command. If the park brakes are applied (switch pushed in) then the output to the proportional pilot control solenoid is not allowed. A message on the LINCS screen will notify the operator if a rollback function is commanded and the park brakes are applied, that “cannot rollback because park brake is applied”.

- Limits: Limits can be defined as being the mechanical end points of the bucket cylinder rod travel. Limits are calculated in the VCU by using the inputs from the position sensors. As the machine is operating, mechanical stops caused by geometrical changes in the lift arm, bucket, and bellcrank structures must be calculated. The programming in the VCU takes all of these different angles into account and automatically creates limits that prevent the bucket cylinders from mechanically reaching end of travel. These limits also are used to softly stop the bucket from hitting the rollback stops. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls:
    - Joystick and Roller Wheel (Manual): The operator can command a rollback function with either the right hand joystick pulled to the left or by the rolling the roller wheel toward the back of the joystick. If both the joystick command and the roller wheel command are the same, the VCU will select the largest command. If they are not the same (joystick commanding dump when wheel is commanding rollback for example) then the roller wheel will have priority.
    - Return to Dig (Automated): The return to dig function switch is used to return the bucket to a preset position. This is an automated control that may or may not cause the bucket to rollback. Wither the rollback command will be generated when this switch is pressed is totally dependent on the position of the bucket when the switch is pressed. If the bucket is dumped past the preset return to dig point then the VCU will send a signal to the proportional control solenoid and rollback will occur at the same time that the lift arms are also returning to the preset height.
    - Kick Back / Backdrag (Automated): The kick back can only be used when the bucket lip is dumped over past horizontal. If the operator wants the dumped bucket lip to be horizontal to the ground, pressing the kick back switch will cause the bucket to rollback and stop. This function is useful for leveling the bucket when the dump bucket teeth may strike a truck bed for example. If the lift arms are within just a few inches off of the ground when the switch is pressed, then the lift arms are put into a “float” condition. The bucket at this point will not level automatically so the operator can control bucket angle as he performs pit floor clean up.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

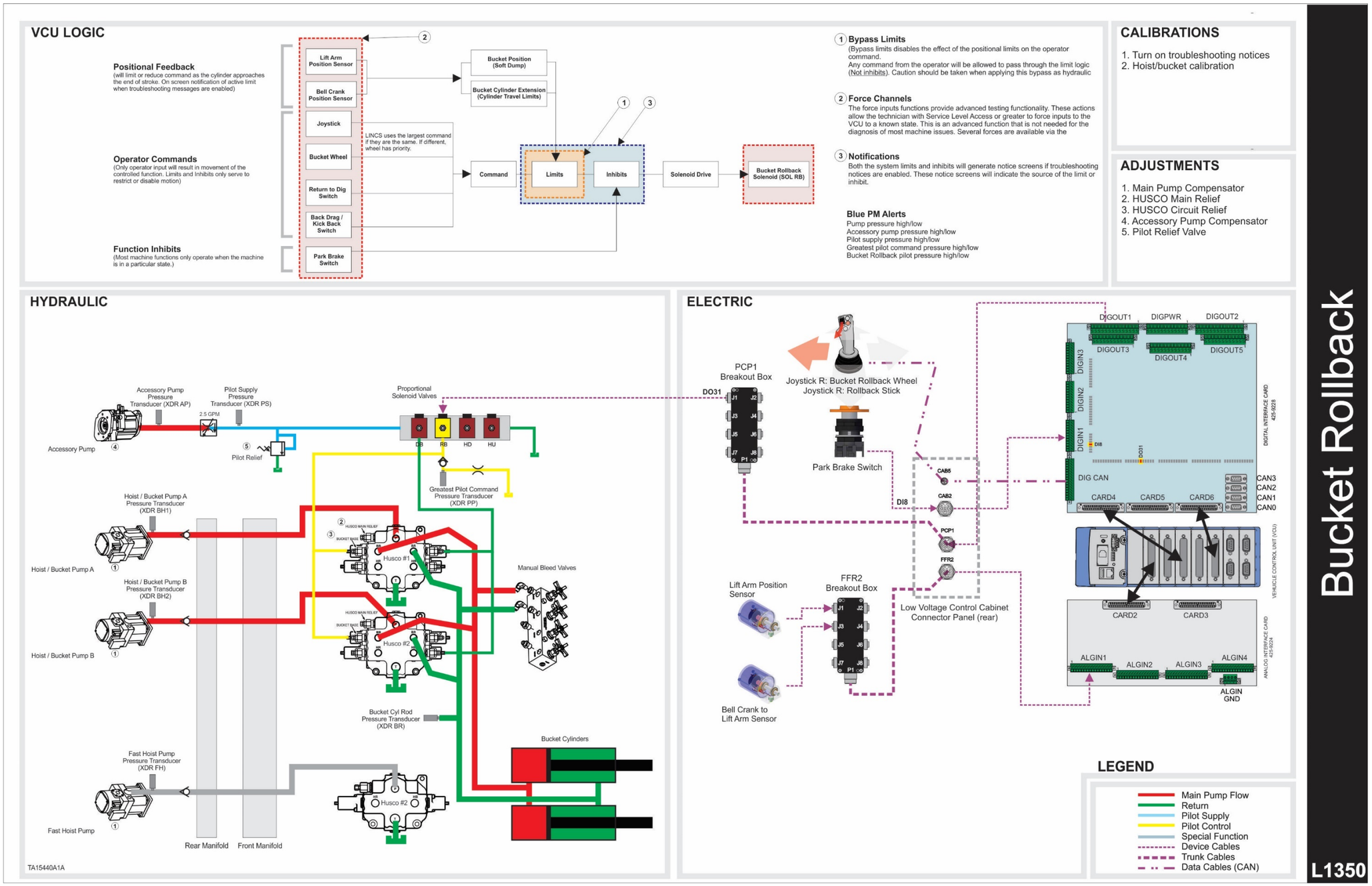


Figure 1. Bucket rollback circuit description (L1350)

© 2019 Komatsu. All rights reserved.

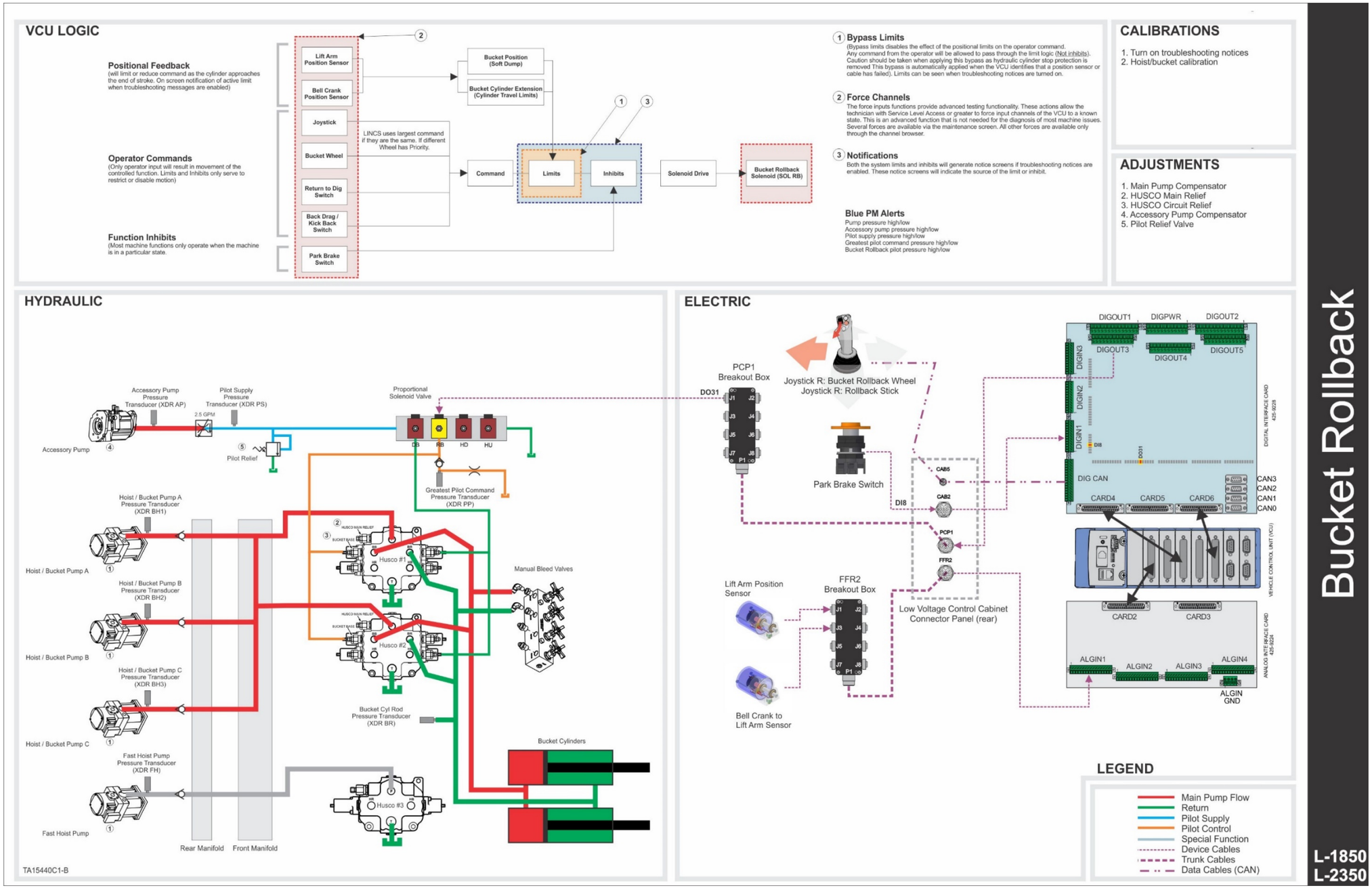


Figure 2. Bucket rollback circuit description (L1850\L2350)

© 2019 Komatsu. All rights reserved.

Bucket Dump Function

The bucket dump function is electric over hydraulic control which can be manually (Joystick or Roller Wheel) or automated controlled (Return to Dig).

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement or switch presses are converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit: Park brake switch must be in the “released pulled out” position. An LED light state will change on the digital interface card when the switch position changes.
    - Limit: Bucket Angle derived from:
        - Bucket Cylinder Position Sensor
        - Lift Arm Position Sensor
- If no inhibit or limits are active, the VCU outputs a command to the Dump Pilot Solenoid channel on the Digital Interface Card.
- The Digital Interface Card then turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the PCP1 (Pilot Control Panel #1) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the proportional solenoid valve located on the hydraulic pilot control panel.

The amount of pilot oil pressure is dependent on the duty cycle of the PWM signal received at the solenoid valve. The duty cycle to “pressure out” is defined as part of the hoist and bucket calibration process.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

Pilot System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the accessory pump.
- The oil is pressurized in the pump to an output pressure of 2500 psi.
- The pressurized oil flows into a manifold system and is distributed to the various circuits. The oil that is flowing to the pilot system is directed to a 2.5 GPM pressure compensated flow control valve.

© 2019 Komatsu. All rights reserved.

- Once the oil passes the flow control, the oil enters a common manifold that the proportional solenoid valves are attached to. Proportional control valves include:
    - DB Dump Bucket
    - RB Rollback Bucket
    - HD Hoist Down
    - HU Hoist Up
- A 450 psi relief valve is in parallel with the proportional control valves. This relief valve maintains a constant 450 psi supply pressure for the proportional solenoid valves.
- When an electric PWM signal is given to the DB Proportional Solenoid, the proportional valve will start to open. The percentage of opening is directly proportional to the duty cycle of the PWM. As the cartridge begins to open, pilot oil is allowed through the proportional valve and is sent to the main control valve (HUSCO).
- At the same time the pilot oil is flowing to the HUSCO valve, some of the pilot oil is sent to a check valve that is connected to the Greatest Pilot Command pressure transducer manifold. This transducer is common to the four proportional valves. It will report the highest commanded pilot pressure at any given time. Because this is a common manifold, the check valve is used to isolate the pilot pressure from back feeding into another pilot system. But because of this “OR” circuit, the oil would be trapped giving a retained maximum pilot pressure indication. To allow this trapped pressure to be bleed off, a .025” orifice is attached to the manifold and allows a slow drain of the pilot oil back to the hydraulic reservoir. Because of the size of the orifice, the drain has minimal affect on the actual pilot flow.
- The Greatest Pilot Command pressure transducer allows the operator or maintenance personnel to see the actual pilot pressure that is being sent to the HUSCO valve, but is not actively used as a control feedback.

Main Valves and Cylinders

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the main pumps.
    - L-1350 has two main pumps.
    - L-1850 and L-2350 have three main pumps.
- The oil is pressurized in the pumps and is sent through check valves to the rear frame manifold. The pumps contain a pressure compensator to regulate main pump pressure.
- From the front frame manifold, the flow is directed to the inlet of the main control valve(s) (HUSCO). This is an open center valve with two spools, the first of which is used for the bucket.

NOTICE

Both HUSCO valves (dual spool and single spool) function the same. For the following descriptions, only one valve will be referenced, but all the valves are functioning in parallel.

- Located in the inlet port of the HUSCO valve is a relief valve. This relief valve will prevent over pressurizing the main valve if a failure in the pump pressure compensator occurs.
- When a bucket dump command is sent electrically to the proportional control solenoid, pilot oil is applied to one end of the bucket spool. The bucket spool starts to move.
- As the spool moves, the oil that was flowing past the spool is restricted. As this restriction increase, pump pressure increases. At the same time that the return oil is restricted, the bucket rod port is opened up to the load check valve. Any pressure that is in the bucket rod port is applied to the load

© 2019 Komatsu. All rights reserved.

check valve. When the pump pressure is higher than the pressure on the load check, the load check opens and allows pump flow to flow through the bucket spool to the bucket rod port.

- Parallel with the bucket rod port, is a vented port relief / anti-void valve. The vent port on this relief valve allows for two different pressure settings to be obtained. The port relief will relieve pressure in the bucket rod port if an external force on the bucket has caused the pressure to raise above the relief valve setting. This relief valve also will function as an anti-cavitation valve. If a void is pulled in the cylinder, the valve will open and allow hydraulic reservoir oil to be drawn back into the cylinder.
    - Primary Relief setting: If the vent port on the relief valve is blocked, the primary pressure relief setting will be used.
    - Secondary Relief setting: The secondary relief setting is used whenever the lift arms are above the horizontal position (<5 degrees lift arm angle). If the vent port on the relief valve is opened to another lower setting relief valve, then the port pressure will be reduced to what the secondary relief setting is set at. On the machine, the vent port is connected to a solenoid (SOL SD). This solenoid is a normally open solenoid valve. If oil is allowed to flow through the solenoid cartridge, it flows to an 800 psi relief valve. This drops the bucket rod port pressure to a maximum of 800 psi.
- As the oil passes out of the HUSCO valve, it flows through hoses and a manifold tube. From the manifold tube, the oil flows to the rod port of the bucket cylinder causing the cylinder to retract. Because the cylinder is double acting, the oil trapped in the base side of the cylinder is expelled back through another set of hoses and another manifold tube.
- The bucket base oil flows into the base port on the HUSCO valve. When the bucket spool started to move, the bucket base port was connected to the oil return galley in the HUSCO valve.
- The return oil flows through the HUSCO valve and out of the return port. The return port is connected to the front frame manifold.
- From the front frame manifold the return oil flows to the rear frame manifold. From the rear frame manifold, the oil is directed to the hydraulic reservoir return filter manifold.
- The oil passes through the return manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

Manual bleed down valves are in parallel with the bucket base and rod ports. These bleed downs are for manually relieving pressure in the bucket cylinder circuits for maintenance purposes.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs concerning machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Position Sensors
    - Lift Arm Position Sensor
    - Bell Crank Position Sensor
- Operator Commands
    - Joystick
    - Bucket Wheel
    - Return to Dig Switch (automated function)

© 2019 Komatsu. All rights reserved.

  - Kick Back / Back Drag (automated function)

- Function Inhibits
  - Park Brake Switch
  - Joystick failure
  - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the proportional pilot control solenoid valve that controls bucket rollback. This signal is a PWM output that will vary the opening and closing of the pilot control valve thus controlling the speed of the bucket roll back.

The VCU is continuously reading all of the inputs. When the operator initiates a bucket dump command the following conditions are computed in the VCU before a command is sent out to the proportional pilot control valve.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Inhibits and Limits.

- Inhibit: The park brake switch must be in the “Park Brake Released” position (pulled out) for any bucket output command. If the park brakes are applied (switch pushed in) then the output to the proportional pilot control solenoid is not allowed. A message on the LINCS screen will notify the operator if a dump function is commanded and the park brakes are applied: “cannot dump because park brake is applied”.

- Limits: Limits can be defined as being the mechanical end points of the bucket cylinder rod travel. Limits are calculated in the VCU by using the inputs from the position sensors. As the machine is operating, mechanical stops caused by geometrical changes in the lift arm, bucket, and bellcrank structures must be calculated. The programming in the VCU takes all of these different angles into account and automatically creates limits that prevent the bucket cylinders from mechanically reaching end of travel. These limits also are used to softly stop the bucket from hitting the dump stops. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls:
  - Joystick and Roller Wheel (Manual): The operator can command a dump function with either the right hand joystick pushed to the right or by the rolling the roller wheel toward the front of the joystick. If both the joystick command and the roller wheel command are the same, the VCU will select the largest command. If they are not the same (joystick commanding dump when wheel is commanding rollback for example) then the roller wheel will have priority.
  - Return to Dig (Automated): The return to dig function switch is used to return the bucket to a preset position. This is an automated control that may or may not cause the bucket to dump. Wither the dump command will be generated when this switch is pressed is totally dependent on the position of the bucket when the switch is pressed. If the bucket is rolled back past the preset return to dig point then the VCU will send a signal to the proportional control solenoid and dump will occur at the same time that the lift arms are also returning to the preset height.
  - Kick Back / Backdrag (Automated): The kick back can only be used at when the bucket lip is dumped over past horizontal. If the kick back switch is pressed, the LINCS screen will report that “kick back function not allowed because bucket is rolled back”. If the lift arms are within just a few inches off of the ground when the switch is pressed, then the lift arms are put into a “float” condition. The bucket at this point will not level automatically so the operator can control bucket angle as he performs pit floor clean up.

- Secondary Dump Relief: The VCU also uses the lift arm position sensor to determine when to turn off the solenoid in the bucket secondary dump relief circuit. If the lift arms are below horizontal (5 degrees), solenoid SD is energized. As the lift arms move above the horizontal (> 5 degrees, the

© 2019 Komatsu. All rights reserved.

solenoid SD is de-energized. The secondary dump relief valve prevents damage from occurring to the lift arms or bucket cylinders when the bucket has been dumped a minimal height and the dump stops have contacted the bellcranks. If a hoist command is then given, the bucket cylinder is mechanically locked and the rod pressure must be relieved to allow the cylinder to extend.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

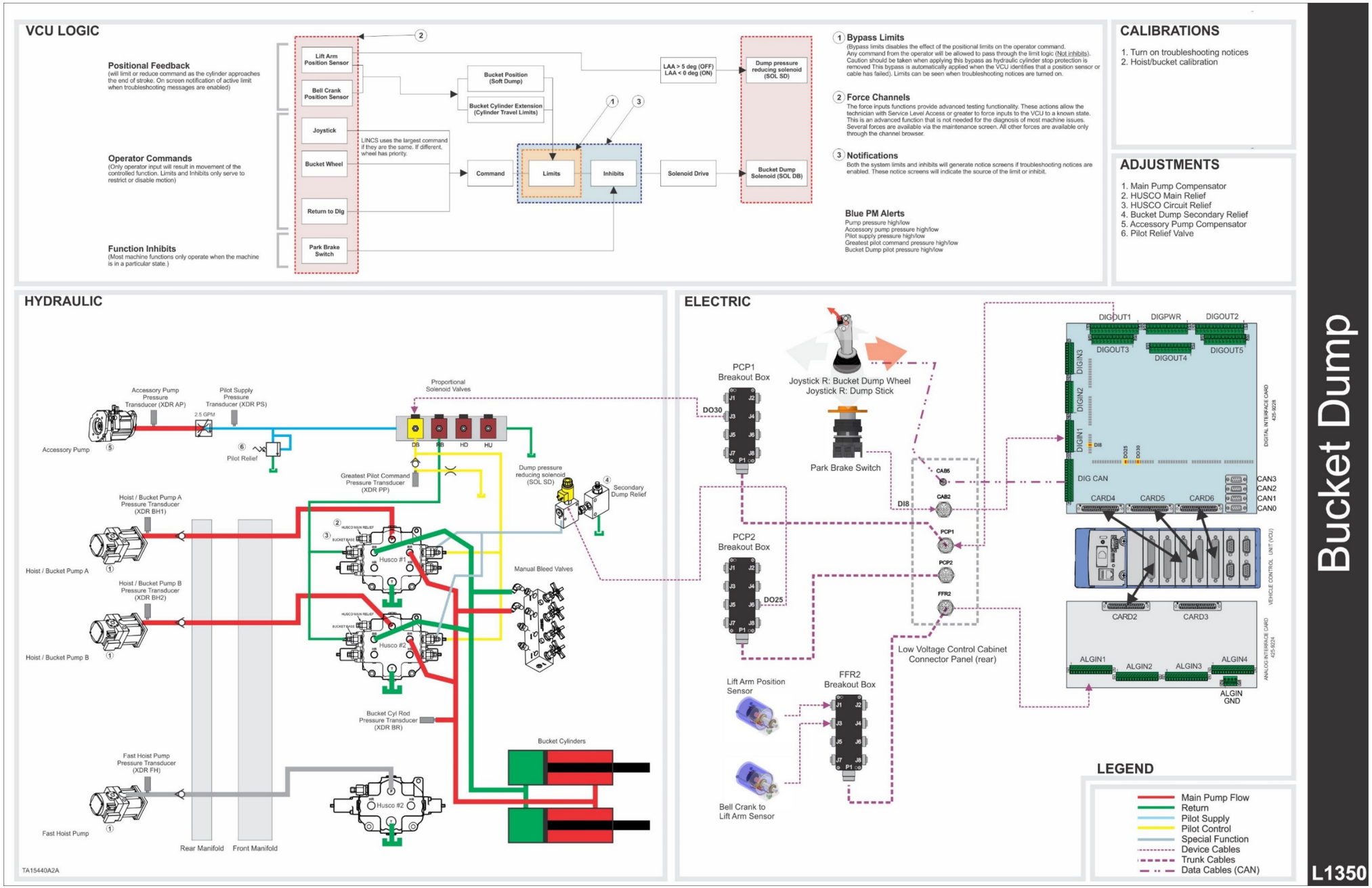


Figure 3. Bucket dump circuit description (L1350)

© 2019 Komatsu. All rights reserved.

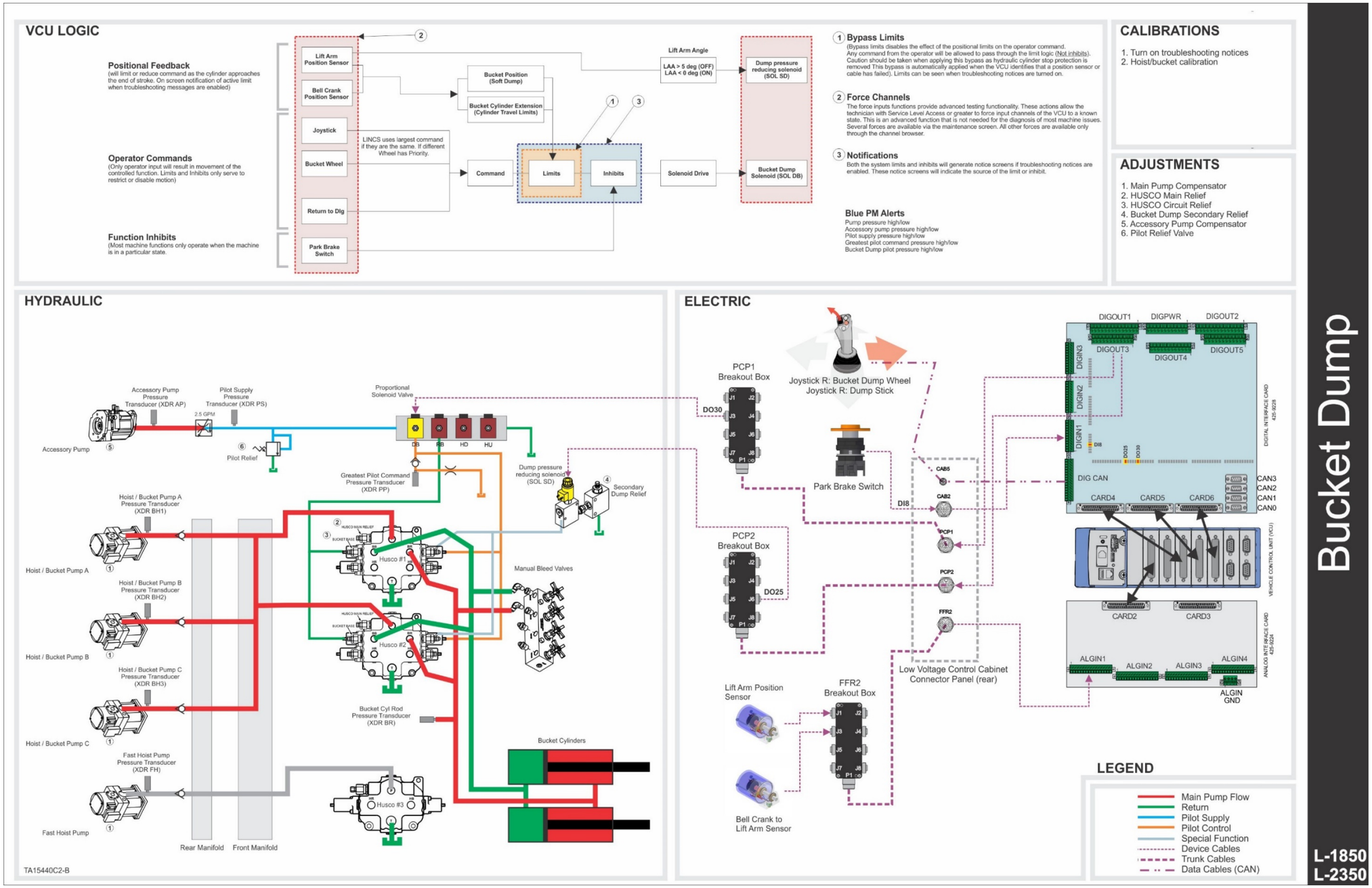


Figure 4. Bucket dump circuit description (L1850\L2350)

© 2019 Komatsu. All rights reserved.

Hoist Up Function

The hoist up function is electric over hydraulic control which can be manually (Joystick) or automated controlled (Hoist Detent).

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement or switch presses are converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit: Park brake switch must be in the “released pulled out” position. An LED light state will change on the digital interface card when the switch position changes.
    - Limit: Derived from Lift Arm Position Sensor
- If no inhibit or limits are active, then the VCU outputs a command to the Hoist Up Pilot Solenoid channel on the Digital Interface Card.
- The Digital Interface Card then turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the PCP1 (Pilot Control Panel #1) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the proportional solenoid valve located on the hydraulic pilot control panel.

The amount of pilot oil pressure is dependent on the duty cycle of the PWM signal received at the solenoid valve. The duty cycle to pressure out is defined as part of the hoist and bucket calibration process.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

Pilot System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the accessory pump.
- The oil is pressurized in the pump to an output pressure of 2500 psi.
- The pressurized oil flows into a manifold system and is distributed to the various circuits. The oil that is flowing to the pilot system is directed to a 2.5 GPM pressure compensated flow control valve.
- Once the oil passes the flow control, the oil enters a common manifold that the proportional solenoid valves are attached to. Proportional control valves include:

© 2019 Komatsu. All rights reserved.

  - DB Dump Bucket
  - RB Rollback Bucket
  - HD Hoist Down
  - HU Hoist Up

- A 450 psi relief valve is in parallel with the proportional control valves. This relief valve maintains a constant 450 psi supply pressure for the proportional solenoid valves.

- When an electric PWM signal is given to the HU Proportional Solenoid, the proportional valve will start to open. The percentage of opening is directly proportional to the duty cycle of the PWM. As the cartridge begins to open, pilot oil is allowed through the proportional valve and is sent to the main control valve (HUSCO).

- At the same time that the pilot oil is flowing to the HUSCO valve, some of the pilot oil is sent to a check valve that is connected to the Greatest Pilot Command pressure transducer manifold. This transducer is common to the four proportional valves. It will report the highest commanded pilot pressure at any given time. Because this is a common manifold, the check valve is used to isolate the pilot pressure from back feeding into another pilot system. But because of this “OR” circuit, the oil would be trapped giving a retained maximum pilot pressure indication. To allow this trapped pressure to be bleed off, a .025” orifice is attached to the manifold and allows a slow drain of the pilot oil back to the hydraulic reservoir. Because of the size of the orifice, the drain has minimal affect on the actual pilot flow.

- The Greatest Pilot Command pressure transducer allows the operator or maintenance personnel to see the actual pilot pressure that is being sent to the HUSCO valve but is not actively used as a control feedback.

Main Valves and Cylinders

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the main pumps.
  - L-1350 has two main pumps and one fast hoist pump.
  - L-1850 and L-2350 have three main pumps and one fast hoist pump.
- The pumps contain a pressure compensator to regulate main pump pressure.
- The flow from the fast hoist pump is passed through.
- From the rear frame manifold, the pump flows are sent to the front frame manifold.
- From the front frame manifold, the main pumps flow is directed to the inlet of the main control valves (HUSCO).
  - Main HUSCO valve: The main pumps flow to this valve. This valve has two spools and is an open center valve design. The first spool used for the bucket functions and the second spool is used for the hoist functions.
  - Fast Hoist HUSCO valve: The fast hoist pump is directed to the inlet of the fast hoist main valve. This valve is a single spool design with only hoist functions.

NOTICE

Both HUSCO valves (dual spool and single spool) function the same. For the following descriptions, only one valve will be referenced, but all the valves are functioning in parallel.

© 2019 Komatsu. All rights reserved.

- Located in the inlet port of the HUSCO valve is a relief valve. This relief valve will prevent over pressurizing the main valve if a failure in the pump pressure compensator occurs.
- When a hoist up command is sent electrically to the proportional control solenoid, pilot oil is applied to one end of the hoist spool. The hoist spool starts to move.
- As the spool moves, the oil that was flowing past the spool is restricted. As this restriction increase, pump pressure increases. At the same time that the return oil is restricted, the hoist base port is opened up to the load check valve. Any pressure that is in the hoist base port is applied to the load check valve. When the pump pressure is higher than the pressure on the load check, the load check opens and allows pump flow to flow through the hoist spool to the hoist base port.
- Parallel with the hoist base port, is a port relief / anti-void valve. The port relief will relieve pressure in the hoist base port if an external force on the bucket has caused the pressure to raise above the relief valve setting. This relief valve also will function as an anti-cavitation valve. If a void is pulled in the cylinder, the valve will open and allow hydraulic reservoir oil to be drawn back into the cylinder.
- As the oil passes out of the HUSCO valve, it flows through hoses and a manifold tube.
- The oil flows through the manifold tube through hoses and then to the float valve. The float valve is located on top of each hoist cylinder. The oil flows through the float valve and then is directed to the hoist cylinder base port. Because the cylinder is double acting, the oil trapped in the rod port side of the cylinder is expelled back through the float valve, then through a set of hoses and another manifold tube.
- The hoist rod oil flows into the rod port on the HUSCO valve. When the hoist spool started to move, the hoist rod port was connected to the oil return galley in the HUSCO valve.
- The return oil flows through the HUSCO valve and out of the return port. The return port is connected to the front frame manifold.
- From the front frame manifold the return oil flows to the rear frame manifold. From the rear frame manifold, the oil is directed to the hydraulic reservoir return filter manifold.
- The oil passes through the return manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

Manual bleed down valves are in parallel with the hoist base and rod ports. These bleed downs are for manually relieving pressure in the hoist cylinder circuits for maintenance purposes.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs controlling machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Lift Arm Position Sensor
- Operator Commands
    - Joystick
    - Hoist Detent Switch (automated function)
    - Alternate Height (automated function)
    - Return to Dig (automated function)

© 2019 Komatsu. All rights reserved.

- Function Inhibits
    - Park Brake Switch
    - Joystick failure
    - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the proportional pilot control solenoid valve that controls hoist up. This signal is a PWM output that will vary the opening and closing of the pilot control valve thus controlling the speed of the hoist up function.

The VCU is continuously reading all of the inputs. When the operator initiates a hoist up command the following conditions are computed in the VCU before a command is sent out to the proportional pilot control valve.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Inhibits and Limits.

- Inhibit: The park brake switch must be in the “Park Brake Released” position (pulled out) for any hoist output command. If the park brakes are applied (switch pushed in) then the output to the proportional pilot control solenoid is not allowed. A message on the LINCS screen will notify the operator if a hoist function is commanded and the park brakes are applied, that “cannot hoist because park brake is applied”.

- Limits: Limits can be defined as being the mechanical end points of the hoist cylinder rod travel. Limits are calculated in the VCU by using the inputs from the position sensors. As the machine is operating, mechanical stops must be calculated. The programming in the VCU takes the position reading from the lift arm position sensor and automatically creates limits that prevent the hoist cylinders from mechanically reaching end of travel. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls:
    - Joystick (Manual): The operator can command a hoist function by pulling back on the right hand joystick.
    - Hoist Up Detent (Automated): The hoist up detent function switch is used to command the hoist to maximum allowable height or to an operator determined height (Alternate Height Switch). This is an automated control. The operator can cancel this command by re-applying a hoist up command with the joystick.
    - Alternate Height Switch (Automated): The alternate height switch (located on the operator’s key pad) allows the operator to set the hoist detent stop point to an “alternate” height. The operator must hoist to the desired stopping point and then activate the switch on the key pad. To store a new stop point, the key pad button should be pressed and held for two seconds for the VCU to set the new stop point. A momentary push of the switch will cycle the function on and off.
    - Return to Dig (Automated): The return to dig function switch is used to return the bucket to a preset height and position. This is an automated control that will return the bucket to a preset height and angle. If the lift arms are below the preset height, the lift arms lift, returning the bucket to the desired height.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

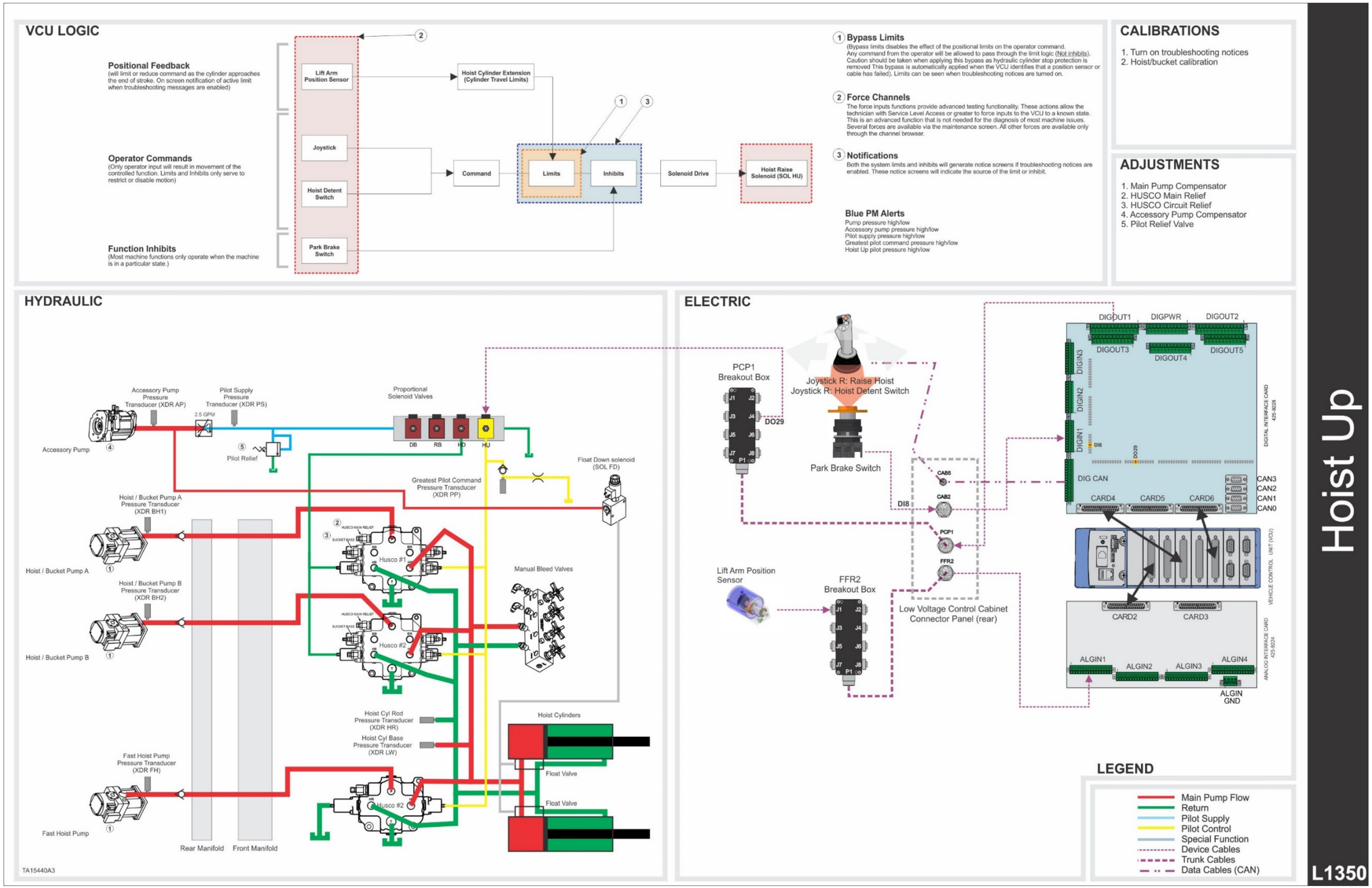


Figure 5. Hoist up circuit description (L1350)

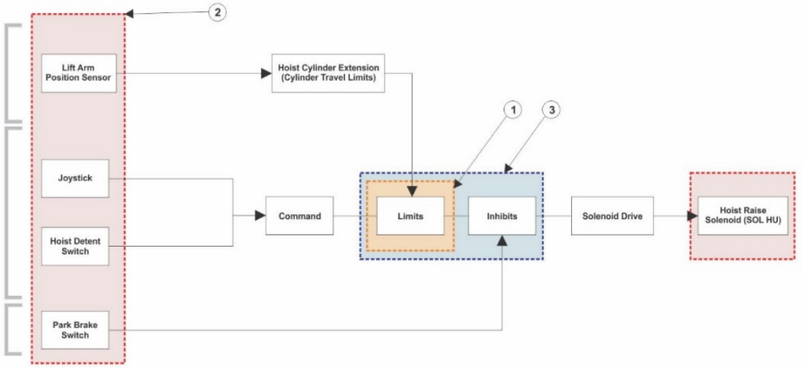
© 2019 Komatsu. All rights reserved.

VCU LOGIC

Positional Feedback
(will limit or reduce command as the cylinder approaches the end of stroke. On screen notification of active limit when troubleshooting messages are enabled)

Operator Commands
(Only operator input will result in movement of the controlled function. Limits and Inhibits only serve to restrict or disable motion)

Function Inhibits
(Most machine functions only operate when the machine is in a particular state.



1 Bypass Limits
(Bypass limits disables the effect of the positional limits on the operator command. Any command from the operator will be allowed to pass through the limit logic (Not inhibits). Caution should be taken when applying this bypass as hydraulic cylinder stop protection is removed This bypass is automatically applied when the VCU identifies that a position sensor or cable has failed). Limits can be seen when troubleshooting notices are turned on.

2 Force Channels
The force inputs functions provide advanced testing functionality. These actions allow the technician with Service Level Access or greater to force input channels of the VCU to a known state. This is an advanced function that is not needed for the diagnosis of most machine issues. Several forces are available via the maintenance screen. All other forces are available only through the channel browser.

3 Notifications
Both the system limits and inhibits will generate notice screens if troubleshooting notices are enabled. These notice screens will indicate the source of the limit or inhibit.

Blue PM Alerts
Pump pressure high/low
Accessory pump pressure high/low
Pilot supply pressure high/low
Greatest pilot command pressure high/low
Hoist Up pilot pressure high/low

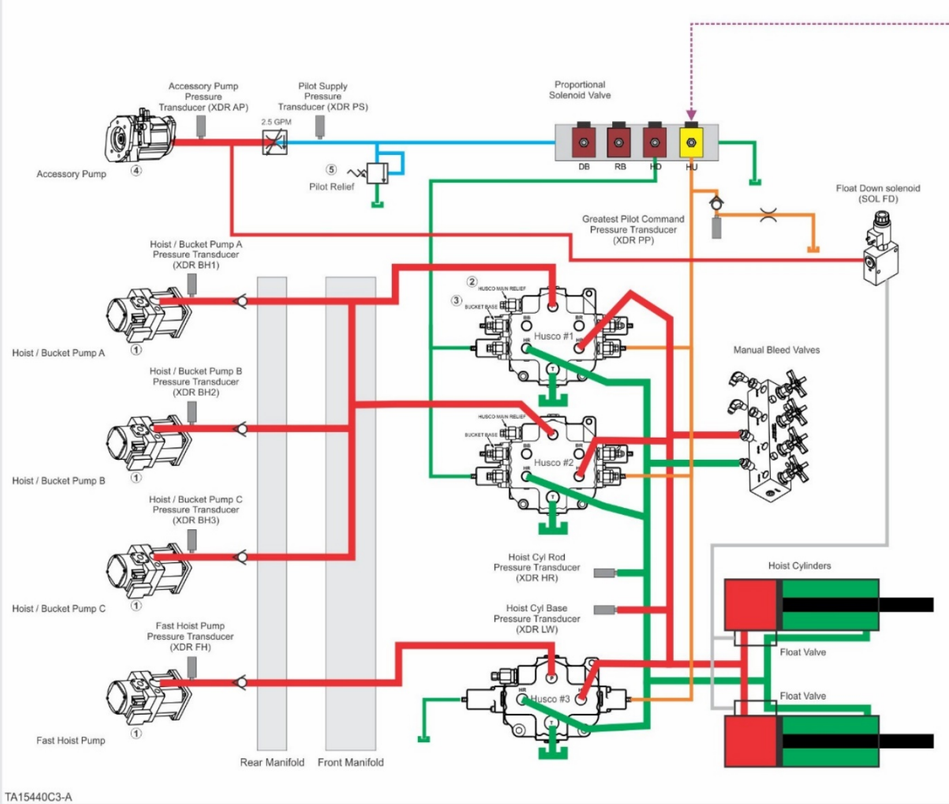
CALIBRATIONS

1. Turn on troubleshooting notices
2. Hoist/bucket calibration

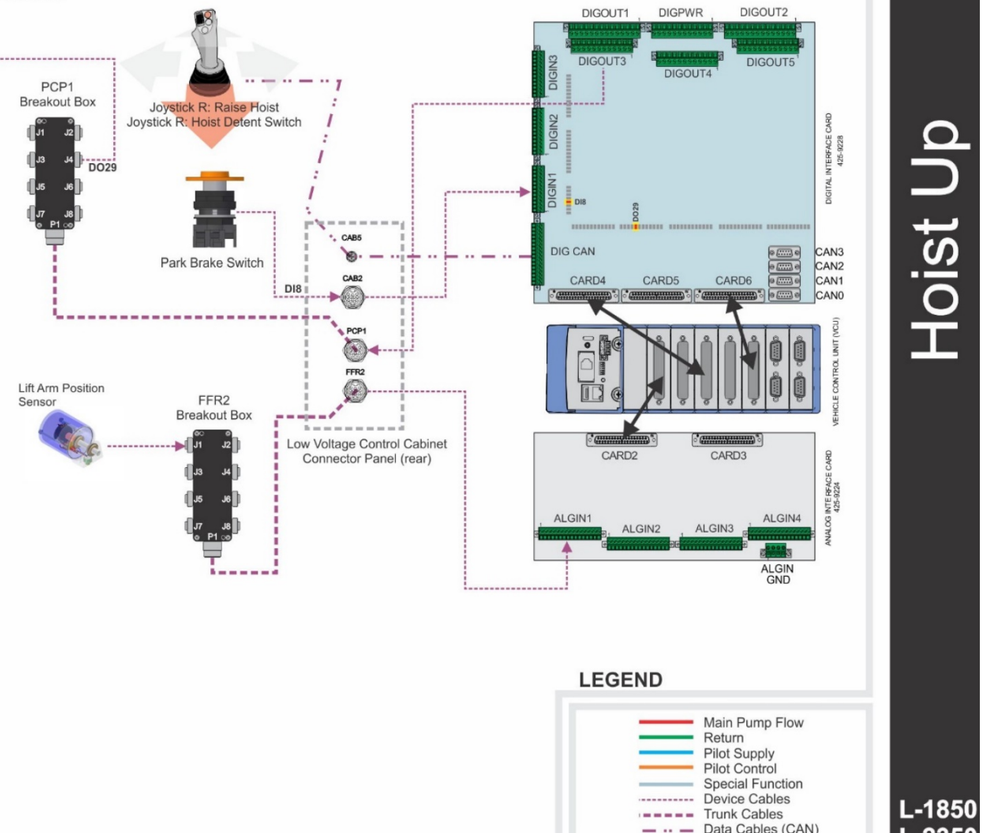
ADJUSTMENTS

1. Main Pump Compensator
2. HUSCO Main Relief
3. HUSCO Circuit Relief
4. Accessory Pump Compensator
5. Pilot Relief Valve

HYDRAULIC



ELECTRIC



LEGEND

- Main Pump Flow
- Return
- Pilot Supply
- Pilot Control
- Special Function
- Device Cables
- Trunk Cables
- Data Cables (CAN)

Hoist Up

L-1850 L-2350

Figure 6. Hoist up circuit description (L1850\L2350)

© 2019 Komatsu. All rights reserved.

Hoist Down / Return to Dig / Backdrag

The hoist down function is electric over hydraulic control which can be manually (Joystick) or automated controlled (Return to Dig or Backdrag).

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement or “switch presses” are converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit. Park brake switch must be in the “released pulled out” position. An LED light state will change on the digital interface card when the switch position changes.
    - Limit. Derived from Lift Arm Position Sensor
- If no inhibit or limits are active, the VCU outputs a command to the Hoist Down Pilot Solenoid channel on the Digital Interface Card.
- The Digital Interface Card turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the PCP1 (Pilot Control Panel #1) breakout box. A LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the proportional solenoid valve located on the hydraulic pilot control panel.

The amount of pilot oil pressure is dependent on the duty cycle of the PWM signal received at the solenoid valve. The duty cycle to pressure out is defined as part of the hoist and bucket calibration process.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

Pilot System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the accessory pump.
- The oil is pressurized in the pump to an output pressure of 2500 psi.
- The pressurized oil flows into a manifold system and is distributed to the various circuits. The oil that is flowing to the pilot system is directed to a 2.5 GPM pressure compensated flow control valve.
- Once the oil passes the flow control, the oil enters a common manifold to which the proportional solenoid valves are attached. Proportional control valves are labeled as such on the fluid power diagram:

© 2019 Komatsu. All rights reserved.

  - DB Dump Bucket
  - RB Rollback Bucket
  - HD Hoist Down
  - HU Hoist Up

- A 450 psi relief valve is in parallel with the proportional control valves. This relief valve maintains a constant 450 psi supply pressure for the proportional solenoid valves.

- When an electric PWM signal is sent to the HD Proportional Solenoid, the proportional valve will start to open. The percentage of opening is directly proportional to the duty cycle of the PWM. As the cartridge begins to open, pilot oil is allowed through the proportional valve and is sent to the main control valve (HUSCO).

- At the same time that the pilot oil is flowing to the HUSCO valve, some of the pilot oil is sent to a check valve that is connected to the Greatest Pilot Command pressure transducer manifold. This transducer is common to the four proportional valves. It will report the highest commanded pilot pressure at any given time. Because this is a common manifold, the check valve is used to isolate the pilot pressure from back feeding into another pilot system. But because of this “OR” circuit, the oil would be trapped giving a retained maximum pilot pressure indication. To allow this trapped pressure to be bled off, a .025” orifice is attached to the manifold. The orifice allows a slow drain of the pilot oil back to the hydraulic reservoir. Because of the size of the orifice, the drain has minimal affect on the actual pilot flow.

- The Greatest Pilot Command pressure transducer allows the operator or maintenance personnel to see the actual pilot pressure that is being sent to the HUSCO valve but is not actively used as a control feedback.

Main Valves and Cylinders

- Hoist Down Flow
  - Hydraulic oil flows from the hydraulic reservoir to the inlet of the main pumps.
    - L-1350 has two main pumps and one fast hoist pump.
    - L-1850 and L-2350 have three main pumps and one fast hoist pump.
  - The pumps contain a pressure compensator to regulate main pump pressure.
  - The flow from the fast hoist pump is passed through the fast hoist valve.
  - From the rear frame manifold, the pump flows are sent to the front frame manifold.
  - From the front frame manifold, the main pump(s) flow is directed to the inlet of the main control valves (HUSCO).
    - Main HUSCO valve. The main pumps flow to this valve. This valve has two spools and is an open center valve design. The first spool is used for the bucket functions and the second spool is used for the hoist functions.
    - Fast Hoist HUSCO valve. The fast hoist pump is directed to the inlet of the fast hoist main valve. This valve is a single spool design with only hoist functions.

NOTICE

In hoist down/float, only the two main HUSCO valves operate. The fast hoist HUSCO spool does not move.

© 2019 Komatsu. All rights reserved.

Hoist Down

- Located in the inlet port of the HUSCO valve is a relief valve. This valve will prevent over pressurizing the main valve if a failure in the pump pressure compensator occurs.
- When a hoist down command is sent electrically to the proportional control solenoid, pilot oil is applied to one end of the hoist spool. The hoist spool starts to move.
- As the spool moves, the oil that was flowing past the spool is restricted. As this restriction increase, pump pressure increases. At the same time the return oil is restricted, the hoist rod port is opened to the load check valve. Any pressure in the hoist rod port is applied to the load check valve. When the pump pressure is higher than the pressure on the load check, the load check opens and allows pump flow to flow through the hoist spool to the hoist rod port.
- Parallel with the hoist rod port, is a port relief / anti-void valve. The port relief will relieve pressure in the hoist rod port if an external force on the bucket has caused the pressure to raise above the relief valve setting. This relief valve also will function as an anti-cavitation valve. If a void is pulled in the cylinder fluid, the valve will open and allow hydraulic reservoir oil to be drawn back into the cylinder.
- As the oil passes out of the HUSCO valve, it flows through hoses and a manifold tube.
- The oil flows through the manifold tube through hoses and then to the float valve. The float valve is located on top of each hoist cylinder. The oil flows through the float valve and then is directed to the hoist cylinder rod port. Because the cylinder is double acting, the oil trapped in the base port side of the cylinder is expelled back through the float valve, then through a set of hoses and another manifold tube.
- The hoist base oil flows into the base port on the HUSCO valve. When the hoist spool started to move, the hoist base port was connected to the oil return galley in the HUSCO valve.
- The return oil flows through the HUSCO valve and out of the return port. The return port is connected to the front frame manifold.
- From the front frame manifold the return oil flows to the rear frame manifold. From the rear frame manifold, the oil is directed to the hydraulic reservoir return filter manifold.
- The oil passes through the return manifold and through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

Return to Dig (Automated).

- The return to dig function has the same oil flow as described in “Hoist Down” function. However, when the return to dig function is commanded, the VCU commands a much higher pilot pressure than hoist down. The increased pilot pressure is required to move the HUSCO hoist spool to a fourth position. This fourth position changes the fluid flow internal to the HUSCO valve in the following way.
    - The open center return oil is partial blocked, slightly increasing pump pressures. This increase of pump pressure reduces cavitation that may occur when the hoist cylinders are retracted quickly.
    - The hoist base port, the hoist rod port, and the return ports are connected together. This allows the oil from the base of the hoist cylinder to flow to the rod side of the hoist cylinder very rapidly. The oil that is displaced by the rod diameter is returned to the hydraulic reservoir. This rapid retraction of the hoist cylinders has typically been referred to as a “float” position.
    - The float valve is located on top of each hoist cylinder. In the return to dig function, the base and rod ports are connected internally in the float valve. When SOL FD is energized, pilot oil

© 2019 Komatsu. All rights reserved.

from accessory pump is sent to the logic element in the float valve, the logic element opens. This allows base oil to flow rapidly between the base and rod ports of the cylinder.

- In the return to dig function, bucket leveling and rapid hoist cylinder retraction is occurring at the same time. As the bucket approaches the preset return to dig position, the pilot pressures are reduced and a smooth controlled stop of the lift arms and bucket is achieved.

Backdrag (Automated).

- The backdrag function only functions when the lift arms are very close to the ground. Backdrag is a function that is used when the operator wants the lift arms to “float” on the ground when doing pit clean up. When the back drag switch is pressed, the VCU will send a high hoist down, pilot down command to the HUSCO valves.
    - The open center return oil is partial blocked slightly increasing pump pressures.
    - The hoist base port, the hoist rod port, and the return ports are connected together. The lift arms in this condition are allowed to “float” up and down while the bucket moves across the pit floor. Any hoist command (hoist up or hoist down) will cancel this command.
    - The float valve is located on top of each hoist cylinder. During the Backdrag function, the base and rod ports are connected internally of the float valve. This allows base oil to flow rapidly between the base and rod ports of the cylinder.

Manual bleed down valves are in parallel with the hoist base and rod ports. These bleed downs are for manually relieving pressure in the hoist cylinder circuits for maintenance purposes. The manual bleed down valve assembly is located inside the front frame.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs concerning machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Lift Arm Position Sensor
- Operator Commands
    - Joystick
    - Hoist Detent Switch (automated function)
    - Alternate Height (automated function)
- Function Inhibits
    - Park Brake Switch
    - Joystick failure
    - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the proportional pilot control solenoid valve that controls hoist down. This signal is a PWM output that will vary the opening and closing of the pilot control valve thus controlling the speed of the hoist down function.

The VCU is continuously reading all of the inputs. When the operator initiates a hoist up command the following conditions are computed in the VCU before a command is sent out to the proportional pilot control valve.

© 2019 Komatsu. All rights reserved.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Inhibits and Limits.

- Inhibit. The park brake switch must be in the “Park Brake Released” position (pulled out) for any hoist output command. If the park brakes are applied (switch pushed in) then the output to the proportional pilot control solenoid is not allowed. A message on the LINCS screen will notify the operator if a hoist down function is commanded and the park brakes are applied: “cannot hoist down because park brake is applied”.

- Limits. Limits can be defined as being the mechanical end points of the hoist cylinder rod travel. Limits are calculated in the VCU by using the inputs from the position sensors. As the machine is operating, mechanical stops must be calculated. The programming in the VCU takes the position reading from the lift arm position sensor and automatically creates limits that prevent the hoist cylinders from mechanically reaching end of travel. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls.

    - Joystick (Manual). The operator can command a hoist function by pulling on the right hand joystick.
    - Return to Dig (Automated). The return to dig function switch is used to command a preset bucket position. Under normal operation, this command is selected when the lift arms are high in the air. If this occurs, a high hoist down command is sent to the proportional pilot control valve. This causes the hoist cylinders to retract quickly. This is an automated control. The operator can cancel this command by applying a hoist down command with the joystick.

Setting the Return to Dig Point

- The operator must place the bucket in the desired stopping point and then activate the switch on the key pad. To store a new Return to Dig point, the key pad button should be pressed and held for two seconds for the VCU to set the new point. A momentary push of the switch will cycle the function on and off.

- Backdrag (Automated). The Backdrag function will only work when the bucket is very close to the ground. The Backdrag function will allow the bucket to “float” on the ground during pit clean up. The Backdrag function can be cancelled by applying a hoist up or down command.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

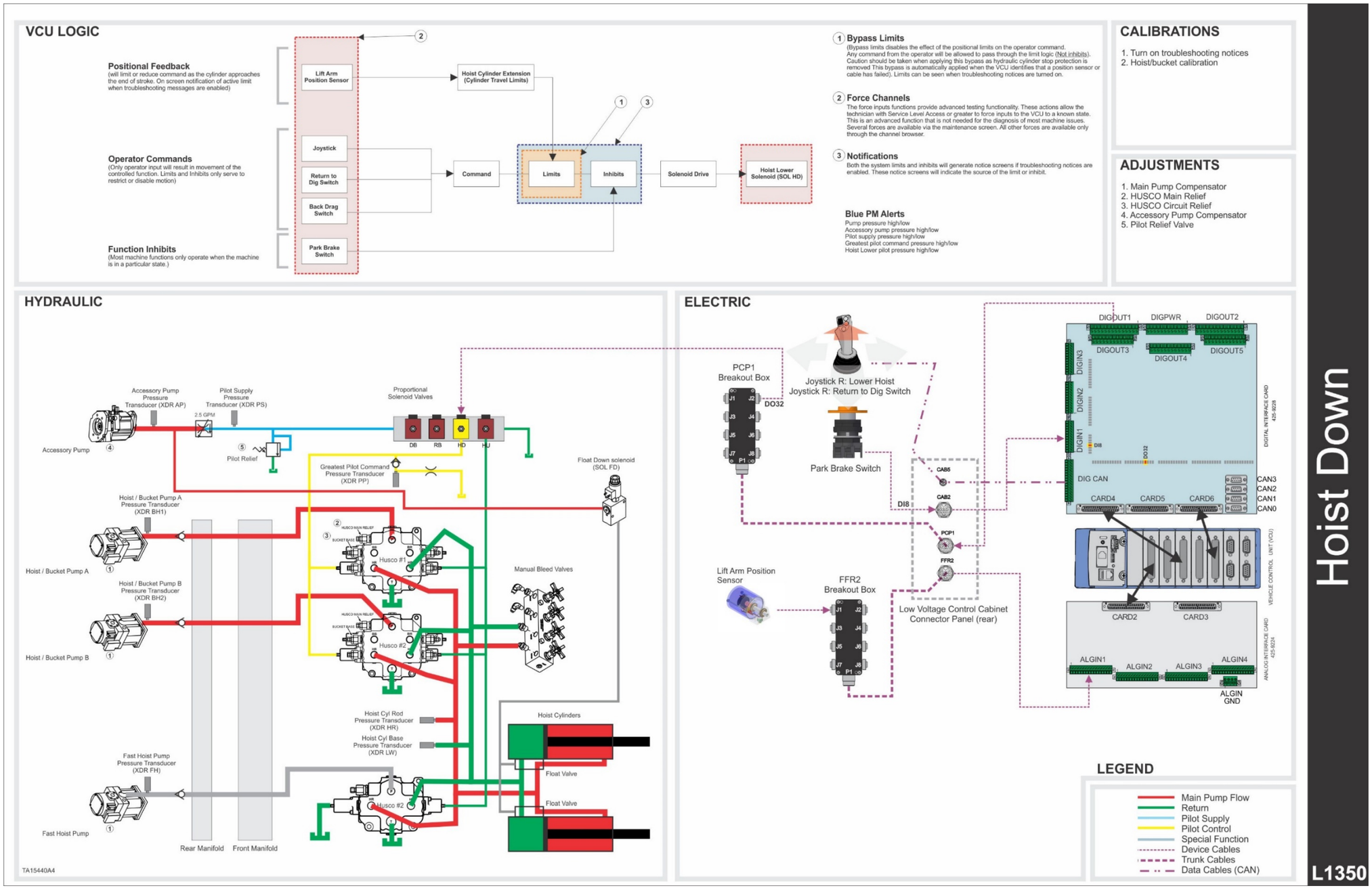


Figure 7. Hoist down circuit description (L1350)

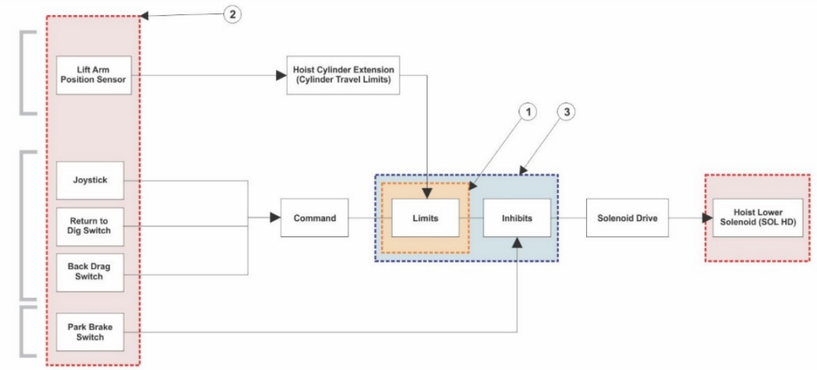
© 2019 Komatsu. All rights reserved.

VCU LOGIC

Positional Feedback
(will limit or reduce command as the cylinder approaches the end of stroke. On screen notification of active limit when troubleshooting messages are enabled)

Operator Commands
(Only operator input will result in movement of the controlled function. Limits and Inhibits only serve to restrict or disable motion)

Function Inhibits
(Most machine functions only operate when the machine is in a particular state.



1 Bypass Limits
(Bypass limits disables the effect of the positional limits on the operator command. Any command from the operator will be allowed to pass through the limit logic (Not inhibits). Caution should be taken when applying this bypass as hydraulic cylinder stop protection is removed This bypass is automatically applied when the VCU identifies that a position sensor or cable has failed). Limits can be seen when troubleshooting notices are turned on.

2 Force Channels
The force inputs functions provide advanced testing functionality. These actions allow the technician with Service Level Access or greater to force input channels of the VCU to a known state. This is an advanced function that is not needed for the diagnosis of most machine issues. Several forces are available via the maintenance screen. All other forces are available only through the channel browser.

3 Notifications
Both the system limits and inhibits will generate notice screens if troubleshooting notices are enabled. These notice screens will indicate the source of the limit or inhibit.

Blue PM Alerts
Pump pressure high/low
Accessory pump pressure high/low
Pilot supply pressure high/low
Greatest pilot command pressure high/low
Hoist Lower pilot pressure high/low

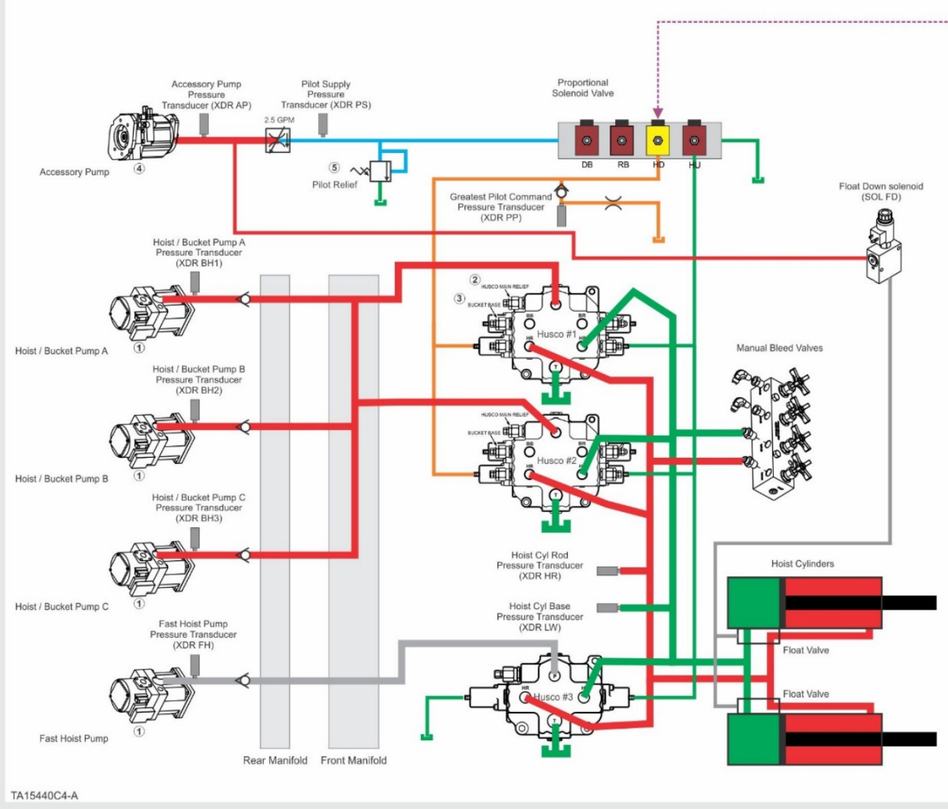
CALIBRATIONS

1. Turn on troubleshooting notices
2. Hoist/bucket calibration

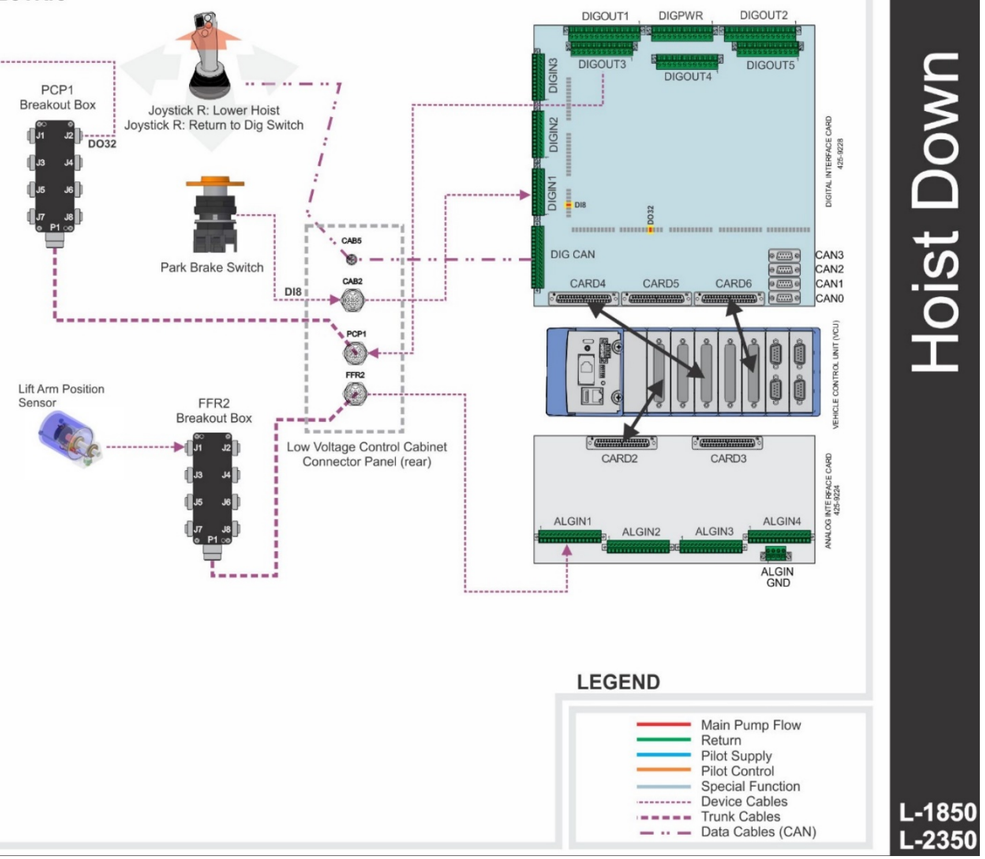
ADJUSTMENTS

1. Main Pump Compensator
2. HUSCO Main Relief
3. HUSCO Circuit Relief
4. Accessory Pump Compensator
5. Pilot Relief Valve

HYDRAULIC



ELECTRIC



Hoist Down

L-1850
L-2350

Figure 8. Hoist down circuit description (L1850/L2350)

© 2019 Komatsu. All rights reserved.

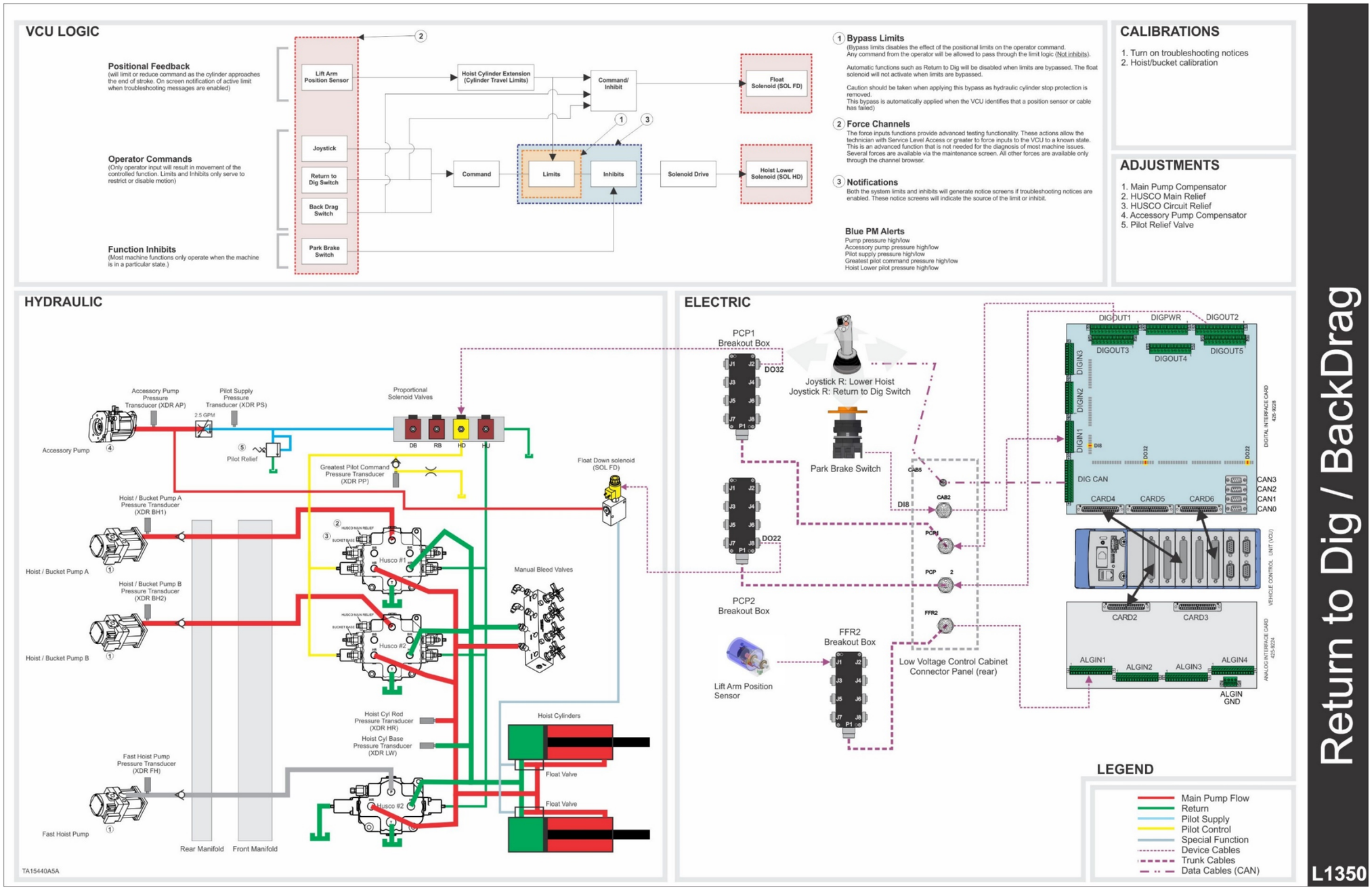


Figure 9. Return to dig/backdrag circuit description (L1350)

© 2019 Komatsu. All rights reserved.

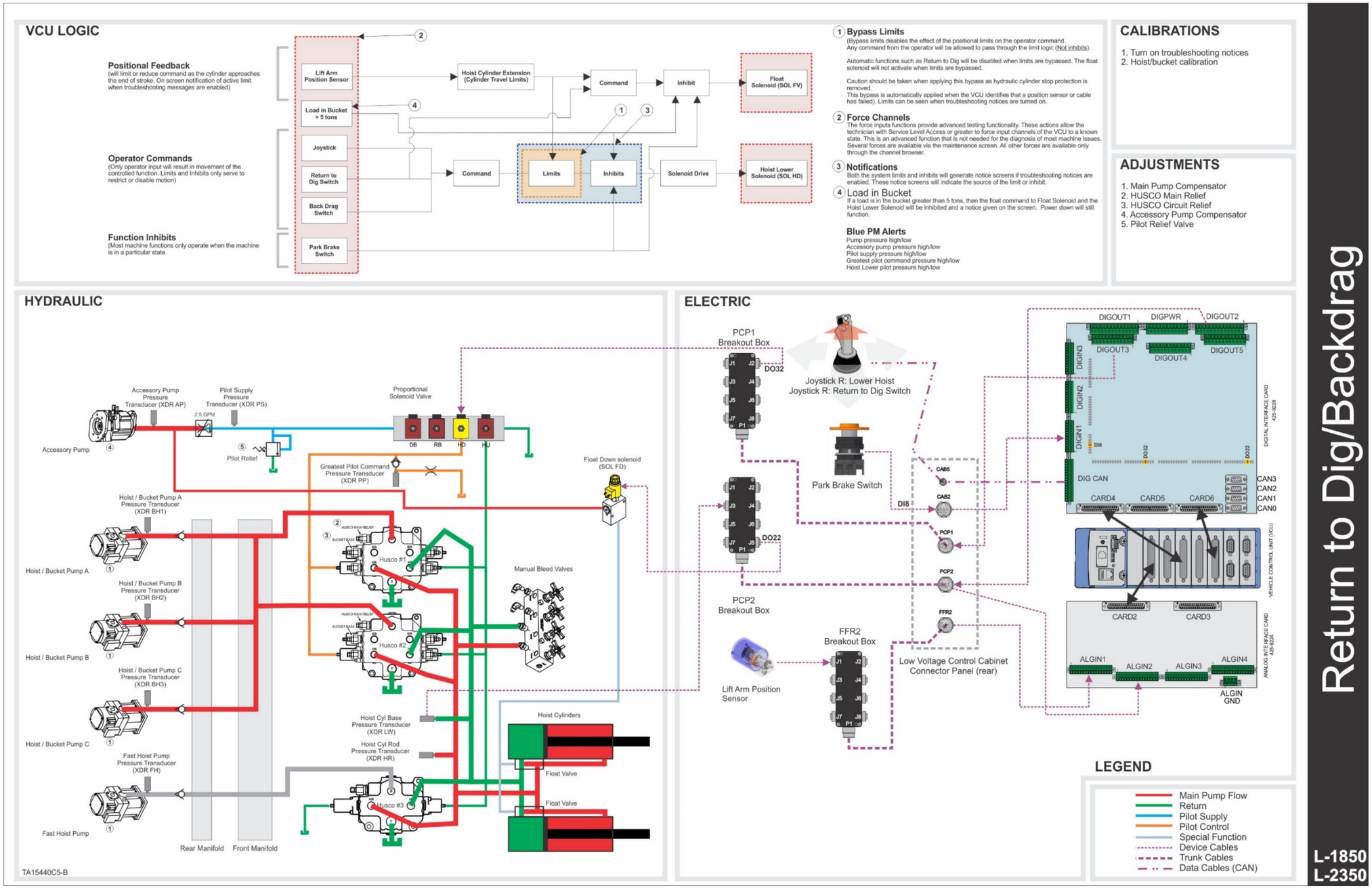


Figure 10. Return to dig/backdrag circuit description (L1850/L2350)

© 2019 Komatsu. All rights reserved.

Steer Left and Auxiliary Steer Left

The Steer left function is electric over hydraulic control which is manually controlled.

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement is converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit: Park brake switch must be in the “released pulled out” position. An LED light state will change on the digital interface card when the switch position changes.
    - Limit: Steering Position Sensor
- If no inhibit or limits are active, then the VCU outputs a command to the Steering Interface Card channel on the Digital Interface Card.
- The Digital Interface Card then turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the RFF2 (Rear Frame Front #2) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the steering interface card (located on the rear frame right hand side wall). The interface card conditions the signal for use by the PVG 32 pilot control valve.
- The PVG 32 pilot control valve requires a 24 volt power supply. The output of the Steering Interface Card is ½ the supply voltage for “neutral” or no steer command. The output of the steering interface card for left steer will vary from ½ supply volts to ¾ supply volts.
- Internal to the PVG 32 valve is a control card. This control card uses the 24 volt supply to power to four proportional control solenoids. These solenoids when powered, direct pilot oil in the PVG 32 valve to control a directional spool.

The amount of pilot oil pressure is dependent on the steering interface control voltage range received by the PVG 32. This is a fixed value with no adjustments possible.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

© 2019 Komatsu. All rights reserved.

Hydraulic System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the Steering pump. The pump is a tandem variable displacement axial piston style pump or two (2) axial piston pumps in parallel
    - (L-2350 only).
- The oil is pressurized in the pumps and flows out to check valves located on a manifold. At the manifold flows from the two pumps are combined and then sent to the HP port on the main flow amplifier valve (DANFOSS).
- The pressurized oil flows into the HP (High Pressure) port and is directed to the Priority spool. The priority spool in this system does not function. The oil flows across the spool and is directed to the load check valve. A very small amount of oil passes through the priority spool and is passed to the P (Pilot) output port on the DANFOSS valve.
- The P port on the DANFOSS valve is connected to the P (Pilot) port on the PVG 32 Pilot Control Valve. The P port on the PVG 32 has a pressure relief pressure reducing valve, and a direct connection to the directional spool (three position closed center). The pressure relief valve is set at 4000 psi and control maximum inlet pressure to the PVG 32 valve. The pressure reducing valve further controls the pilot to a set 200 psi. This is the pilot oil that will be used by the four solenoid valves for control of the directional spool internal to the PVG 32 valve.
- When a left steer command is given, two of the four solenoids will open. One of the solenoids will direct the 200 psi pilot oil to the end of the directional spool. The other solenoid valve will allow the oil on the other end of the directional spool to be returned back to tank through the T (Hydraulic Reservoir “Tank”). This allows the directional spool to start moving.
- As the directional spool in the PVG 32 moves, some of the main pilot oil is directed across the spool and is outputted through the B (Left) pilot oil port. This oil is directed to the L (Left) pilot oil port on the DANFOSS valve. At the same time that the B port is receiving oil, some of the oil is also directed through an orifice and to a shuttle valve. The shuttle valve passes the oil to another orifice and then to the LS (Load Sense) port. The LS port is connected to the LS Port on the axial piston pump compensator valve assembly
- The compensator valve assembly on the pump has load sensing flow and pressure regulating functions. The pump flow is set at maximum until the maximum pump pressure is achieved. At that time, the flow is reduced to a very nominal amount of flow at maximum pressure.

NOTICE

The Main Relief valve in the DANFOSS Steering valve is screwed completely in. Steering pump pressure is controlled by the pressure compensator.

- The pilot oil received at the L port on DANFOSS valve is directed to one end of the directional spool (three position closed center). The direction spool will start to move. As this spool moves, some of the pilot oil flows through the directional spool and is used to shift the flow amplifier spool. At the same time that these two spools are moving, the oil in the LS line is directed to the priority spool. This oil causes the priority spool to send most of the oil to the flow amplifier spool. The quantity of oil sent to the flow amplifier spool depends on the amount of the steering command from the operator.
- In the flow amplifier spool, the pilot oil from the L port is combined with the main pump flow. This oil then passes through the flow amplifier spool and is directed to the directional spool.
- At the directional spool, the oil is sent out to CL (cylinder left) port, to the steering cylinders. The cylinders are connected in a crossed plumbed configuration. The right hand cylinder’s base port is connected to the left cylinder’s rod port. And the right hand cylinder’s rod port is connected to the left cylinder’s base port. Thus, in a left turn the base of the right hand cylinder is extending while the left

© 2019 Komatsu. All rights reserved.

hand cylinder is retracting. The cylinders are double acting and the return oil is directed back to DANFOSS valve to the CR (cylinder right) port.

NOTICE

Both of the cylinder ports (CL and CR) have shock and suction valves in parallel with ports. The shock and suction valves serve as cylinder protection only and do not normally operate. The overload relief is set at 4000 PSI. And the anti-cavitation valves provide oil if voids develop in the cylinder because of outside forces.

- The returning oil from the steering cylinders is directed across the directional spool through a 75 psi back pressure valve and then exits the DANFOSS valve at the HT (Hydraulic Reservoir “Tank”) port.
- From the HT port the oil flows back to the hydraulic reservoir return manifold.
- The oil passes through the return manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs concerning machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Steer Position Sensor
- Operator Left Joystick Command
- Function Inhibits
    - Park Brake Switch
    - Joystick failure
    - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the steering interface card. This signal is a PWM output that will vary the duty cycle thus controlling the steering interface card output command to the PVG 32 control valve. By varying the output command signal level, the speed of the steering is controlled.

The VCU is continuously reading all of the inputs. When the operator initiates a left steer command, the following conditions are computed in the VCU before a command is sent out to the steering interface card.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Limits.

- Inhibit: The park brake switch must be in the “Park Brake Released” position (pulled out) for any steering output command. If the park brakes are applied (switch pushed in) then the output to the steering interface card is not allowed. A message on the LINCS screen will notify the operator if a steering function is commanded and the park brakes are applied, that “cannot steer because park brake is applied”.

© 2019 Komatsu. All rights reserved.

- Limits: Limits can be defined as being the mechanical end points of the steering cylinders rod travel. Mechanically the front and rear frame will contact each other before the steering cylinders are at their maximum extension and retraction. Limits are therefore calculated in the VCU by using the input from the steering position sensor. The steering calibration programming in the VCU takes these different frame contact angles into account and automatically creates limits that prevent the steer cylinders from mechanically forcing the frame together. These limits also are used to softly stop the frames from hitting the steering stops. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls: The operator's left hand joystick controls steering. When the joystick is pushed left (away from the operator) a left steer command is initiated. If no inhibits or limits are active, the left steer command is generated.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

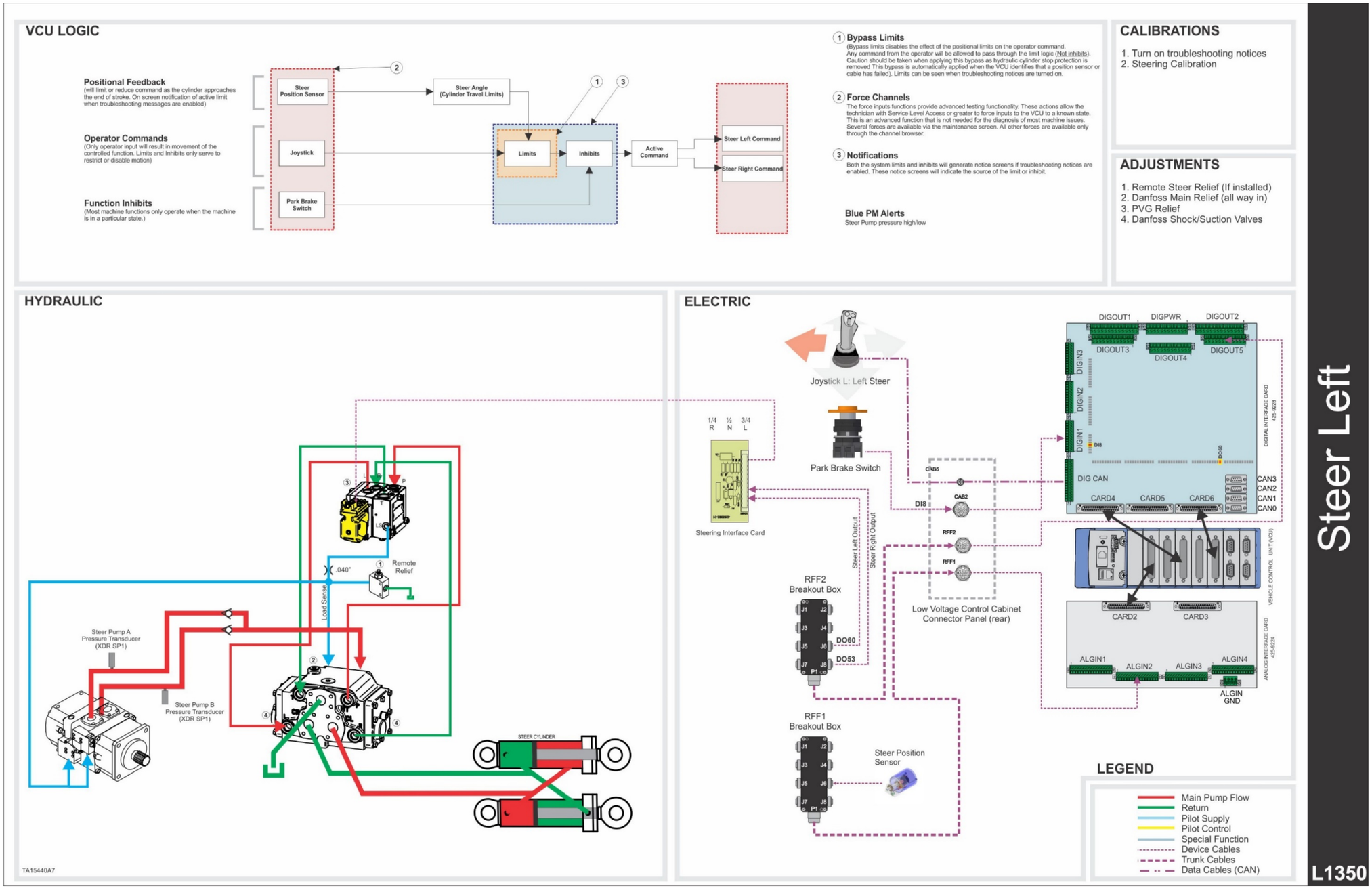


Figure 11. Steer left circuit description (L1350)

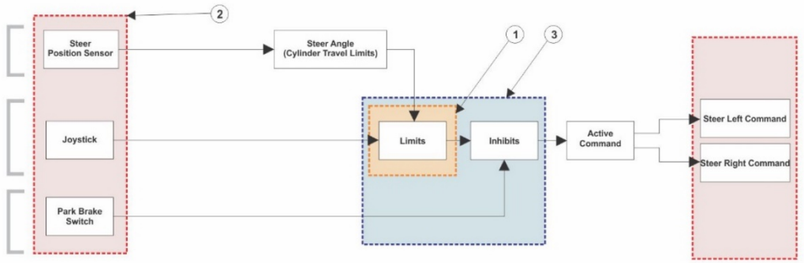
© 2019 Komatsu. All rights reserved.

VCU LOGIC

Positional Feedback
(will limit or reduce command as the cylinder approaches the end of stroke. On screen notification of active limit when troubleshooting messages are enabled)

Operator Commands
(Only operator input will result in movement of the controlled function. Limits and Inhibits only serve to restrict or disable motion)

Function Inhibits
(Most machine functions only operate when the machine is in a particular state.



1 Bypass Limits
(Bypass limits disables the effect of the positional limits on the operator command. Any command from the operator will be allowed to pass through the limit logic (Not inhibits). Caution shouldbe taken when applying this bypass as hydraulic cylinder stop protection is removed. This bypass is automatically applied when the VCU identifies that a position sensor or cable has failed). Limits can be seen when troubleshooting notices are turned on.

2 Force Channels
The force inputs/outputs functions provide advanced testing functionality. These actions allow the technician with Service Level Access or greater to force either inputs or internal channels of the VCU to a known state. This is an advanced function that is not needed for the diagnosis of most machine issues. Several forces are available via the maintenance screen. All other forces are available only through the channel browser.

3 Notifications
Both the system limits and inhibits will generate notice screens if troubleshooting notices are enabled. These notice screens will indicate the source of the limit or inhibit.

Blue PM Alerts
Steer Pump pressure high/low

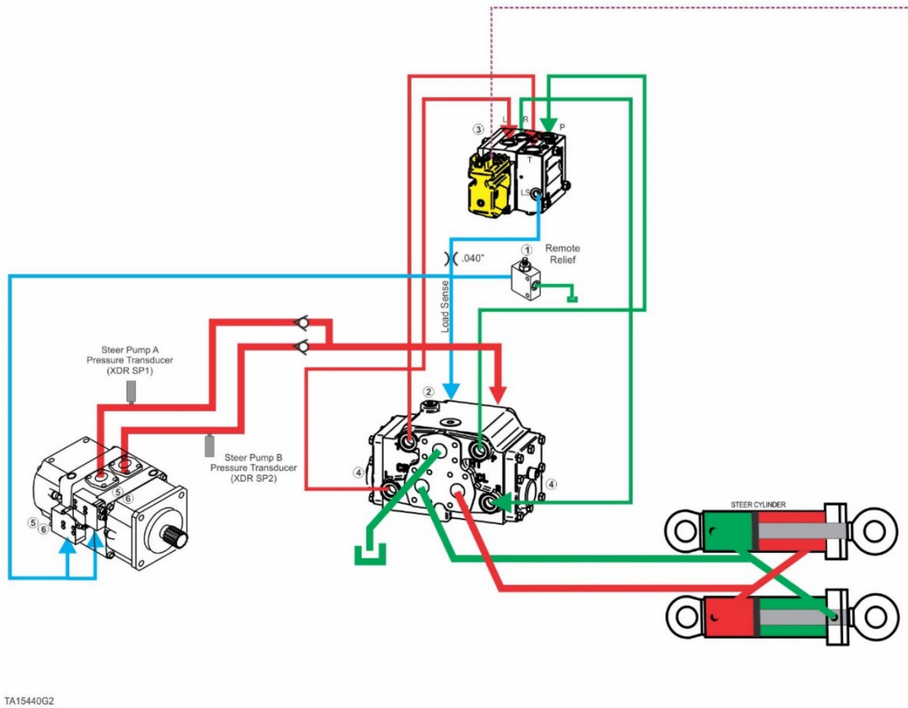
CALIBRATIONS

1. Turn on troubleshooting notices
2. Steering Calibration

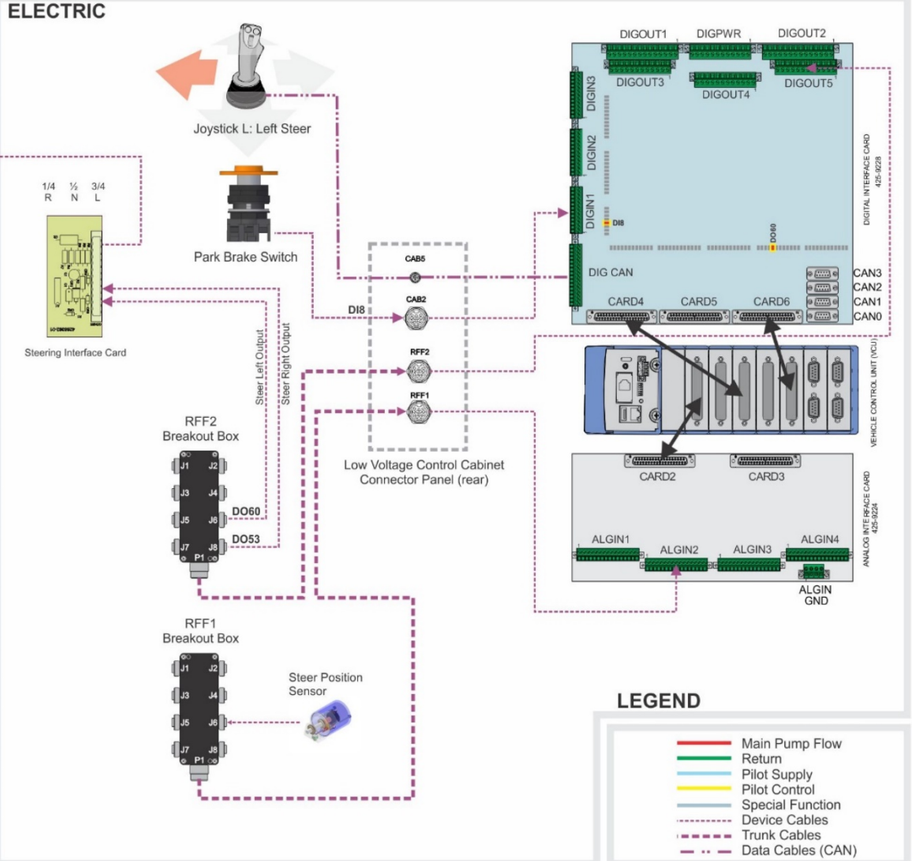
ADJUSTMENTS

1. Remote Steer Relief (If Installed)
2. Danfoss Main Relief (all way in)
3. PVG Relief
4. Danfoss Shock/Suction Valves
5. Stand-by Adjustment
6. Compensator Adjustment

HYDRAULIC



ELECTRIC



LEGEND

- Main Pump Flow
- Return
- Pilot Supply
- Pilot Control
- Special Function
- Device Cables
- Trunk Cables
- Data Cables (CAN)

Steer Left

L1850

Figure 12. Steer left circuit description (L1850)

© 2019 Komatsu. All rights reserved.

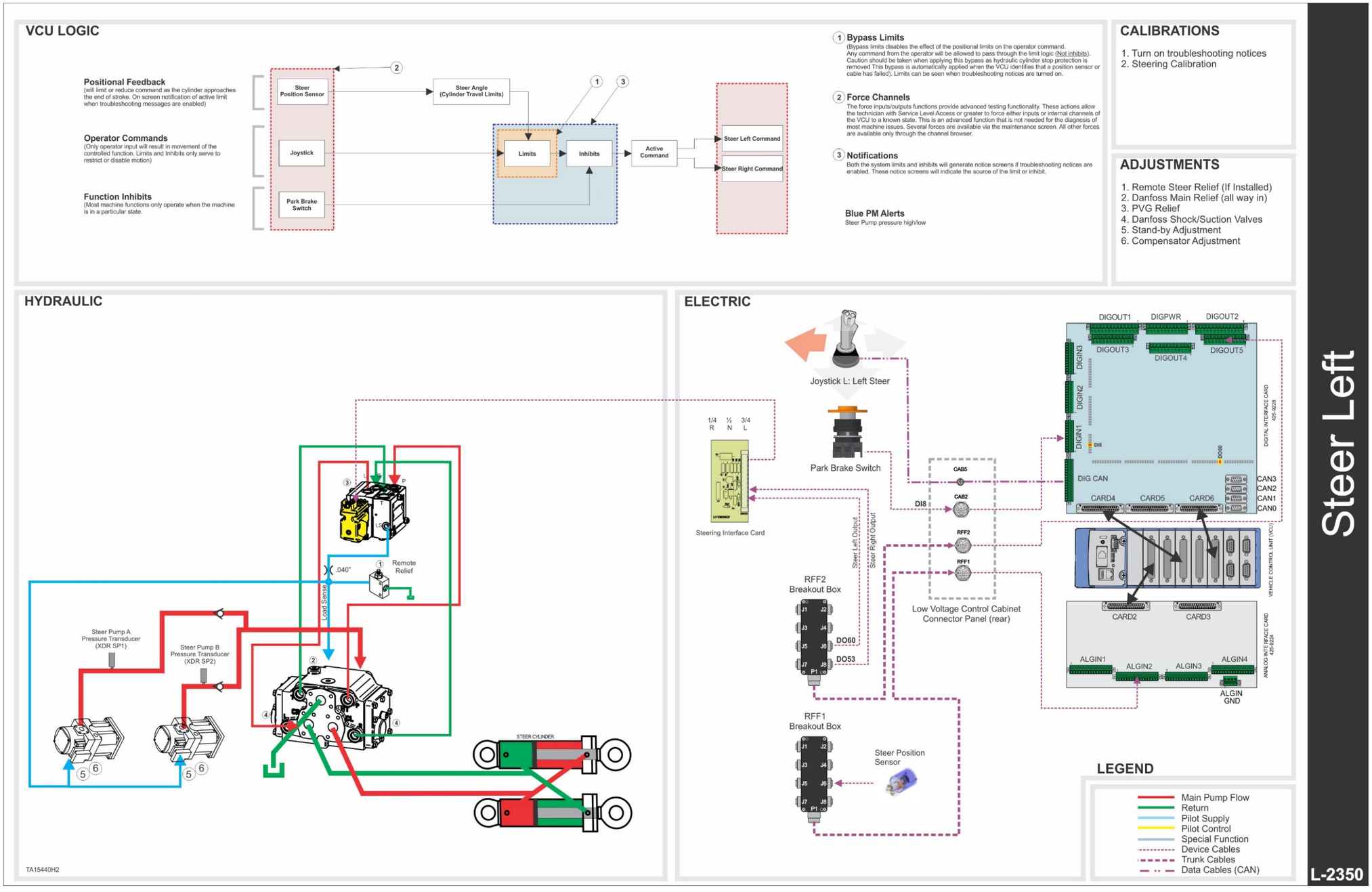


Figure 13. Steer left circuit description (L2350)

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Auxiliary Steer Left

Auxiliary steering is optional. Auxiliary steering pump pressure is delivered by two 24 volt electric pumps. These electric pumps are designed to provide steering control to maneuver to a safe stop point. These electric pumps are NOT designed for normal operation of the machine.

Electric Controls

The electric controls are basically the same as described above. Only the differences are described here. If the auxiliary steering option has been installed, the following additional items will be on the machine.

- Pressure switch: A 30 psi pressure switch (PS AS) is added to the outlet of the steering pump. This switch is a normally closed switch which opens on pressure rise. If the switch closes during normal operation, this indicates a loss of steering pressure.
- Circuit Relay: A circuit relay (CR AS) is used to control the motor start relays that control 24 VDC to the electric pumps. The CR AS relay solenoid is connected to the Breakout Box RFF2 (Rear Frame Front #2). This solenoid is controlled by the VCU channel Aux Steer Enable. For this channel to be active the following items must be meet:
    - Park Brake Switch in the released (pull out) position
    - Steering Pump Supply Pressure less than 30 psi (indicating steering pump failure)
    - Engine Running
    - Steering Commanded
- Motor Start Relays: The Motor Start Relays (SOL AS1 and SOL AS2) connect 24 volt battery voltage to the electric pump assemblies. Solenoids SOL AS1 and SOL AS2 will be energized when the VCU energizes the CR AS relay. Also connected in parallel with SOL AS1 and SOL AS2 is the hydraulic control solenoid SOL AS.

Hydraulic Controls

Auxiliary Steering provides a lower pressure alternate supply of oil to the DANFOSS steering valve. Hydraulically, from the DANFOSS HP port the steering controls and flows are identical to the above description. The differences in components and oil flow are as follows:

- Two electrically driven pumps receive oil from the hydraulic reservoir. The pumps pressurize the oil to a maximum of 2000 PSI. The pumps motors are energized only when a steer command is given. The outlet of the each pump has a check valve. The oil flows through the check valve and into the steering manifold.
- As the oil flows out of the steering manifold, it passes through another check valve and is directed to the HP port on the flow amplifier valve. Once the oil is at the HP port, the oil flows are identical to the description above.
- The Auxiliary steer relief valve is connected to the steering manifold. The steering relief valve is a vented relief valve that that regulates the maximum pump output pressure to 2000 psi. The vent line from the relief valve is run through a normally open solenoid valve (SOL AS). When this solenoid is open (de-energized), the pump output pressure will be around 300 psi.
- Solenoid AS is energized any time that a steering command has been given. When the solenoid is energized, the relief vent oil is blocked which raises the pump output pressure to 2000 psi.

© 2019 Komatsu. All rights reserved.

VCU Logic for Auxiliary Steering

For the Auxiliary steering to function there are several conditions that must be met:

- Engine must be running for more than 15 seconds
- Steering Supply pressure switch must be closed
- Joystick must be commanding a steering command
- Machine must be moving above .5 mph

If the steering pressure supply switch indicates that a loss of steering pump pressure has occurred, a RED alarm is generated. If the machine is sitting still when the alarm occurs the engine will be shut down and the park brakes will be applied. If the machine is rolling when the alarm occurs, a RED shut down sequence will be started. The machine will be brought to a stop and the engine stopped.

© 2019 Komatsu. All rights reserved.

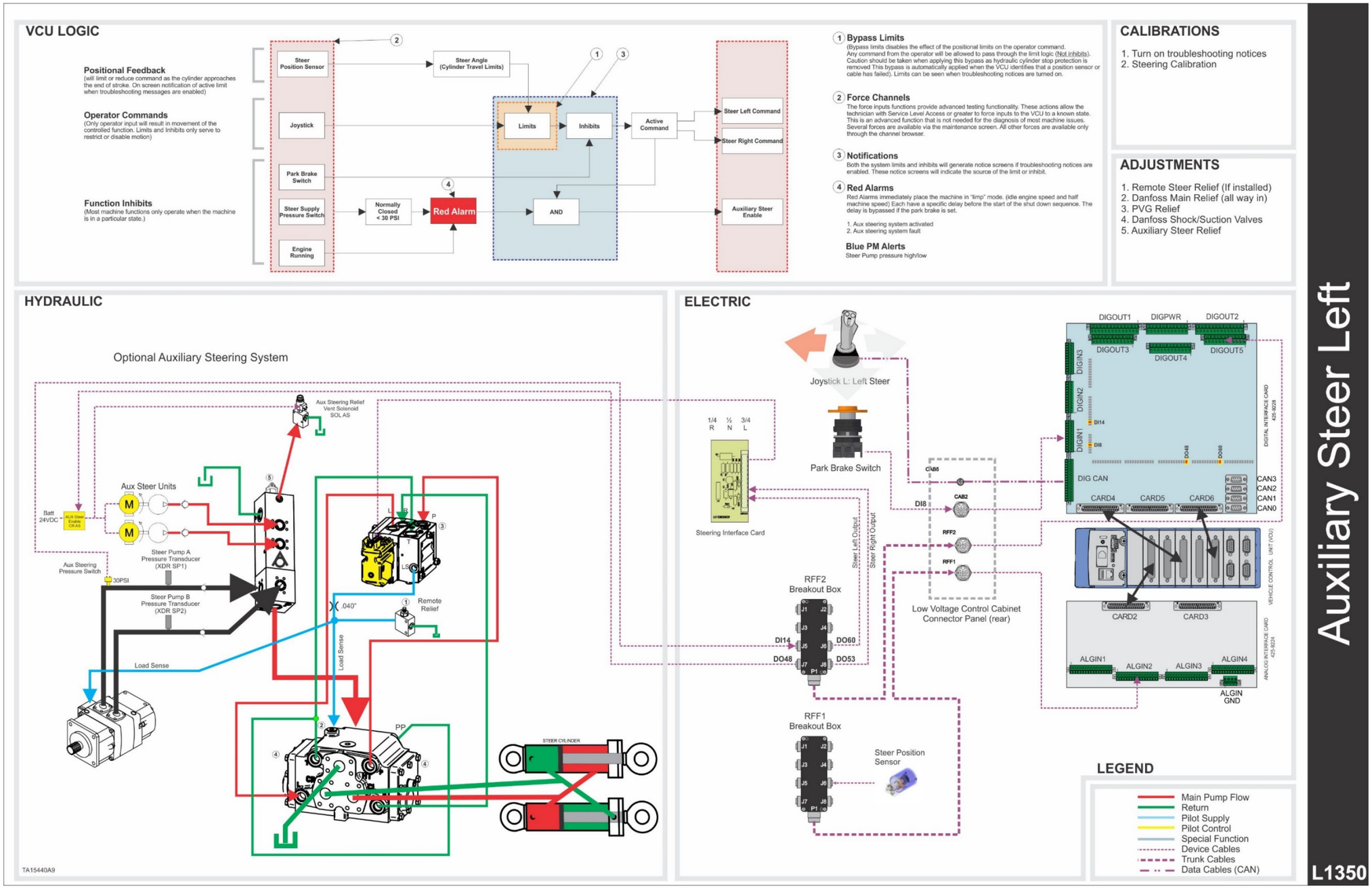


Figure 14. Auxiliary steer left circuit description (L1350)

© 2019 Komatsu. All rights reserved.

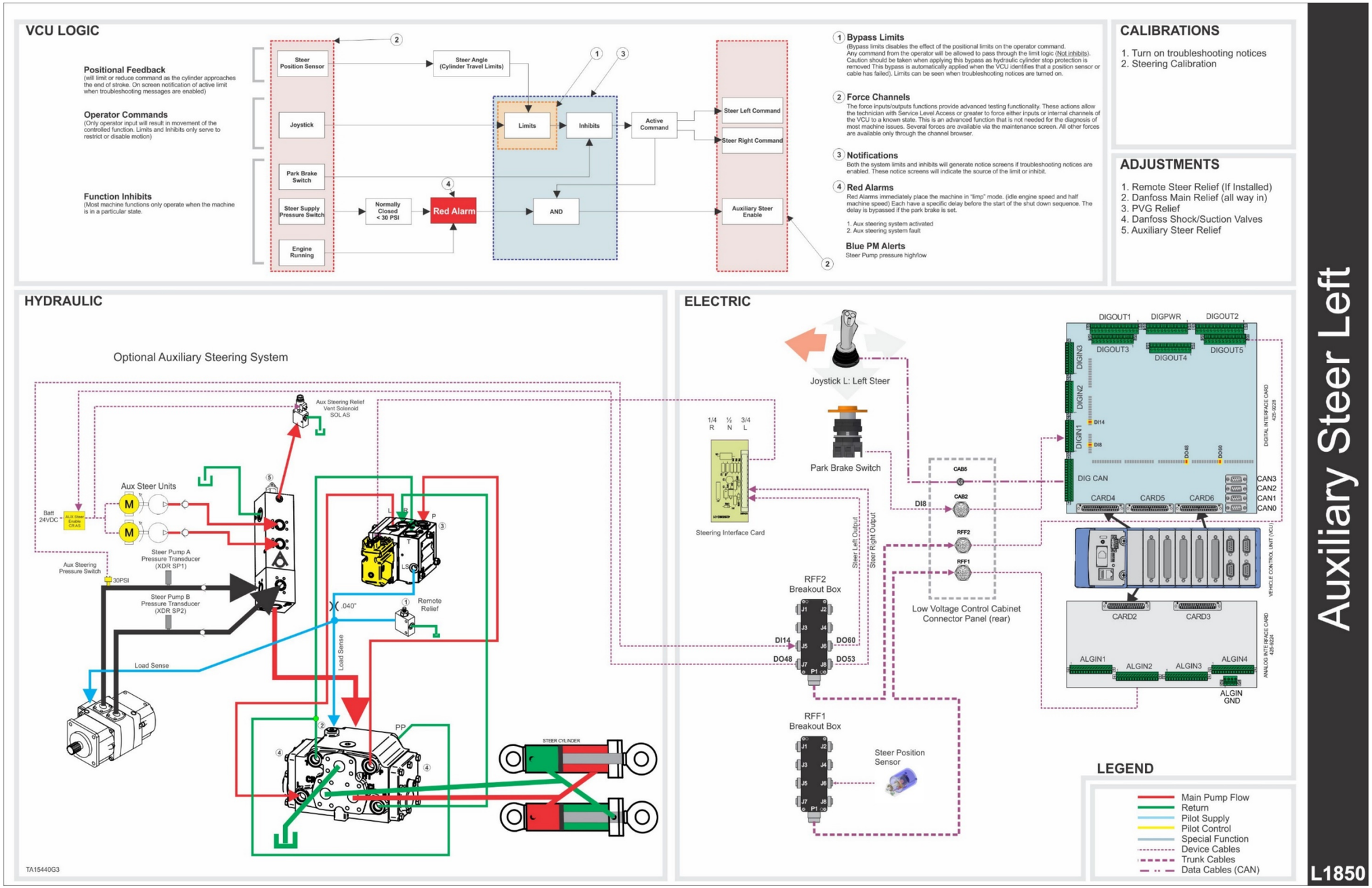


Figure 15. Auxiliary steer left circuit description (L1850)

© 2019 Komatsu. All rights reserved.

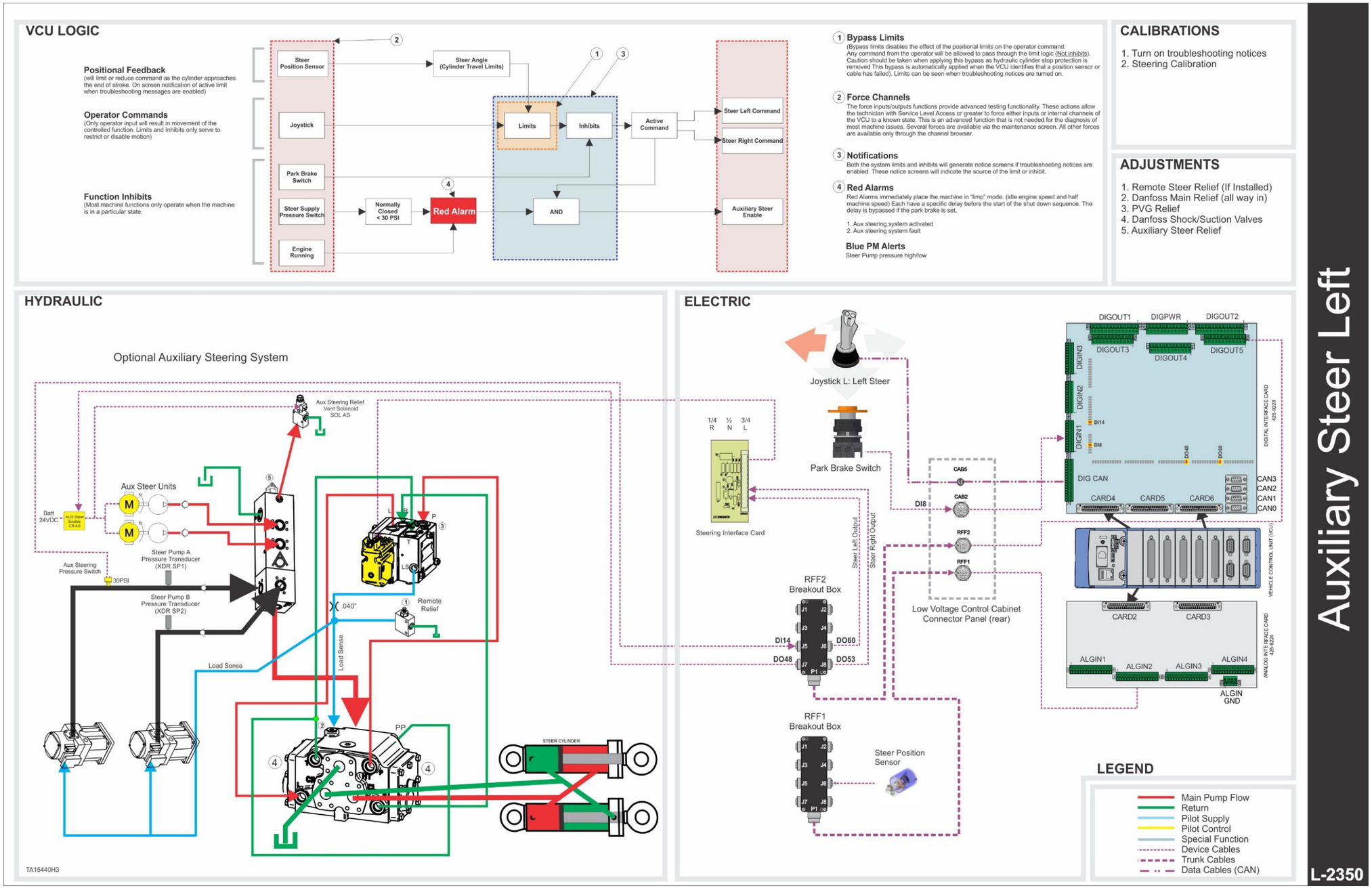


Figure 16. Auxiliary steer left circuit description (L2350)

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Steer Right and Auxiliary Steer Right

The Steer right function is electric over hydraulic control which is manually controlled.

Electrical Controls

When a joystick command is made, the signal flow is as follows:

- Joystick movement is converted to a CAN message in the joystick.
- The CAN message is sent to the Digital Interface Card via a CAN cable from the joystick to the Low Voltage Cabinet connector panel.
- The CAN message is passed through the Digital Interface Card to the Vehicle Control Unit (VCU).
- The VCU looks at any inhibit or limits that will prevent the requested joystick command from being carried out. (Inhibit and Limits are discussed in the VCU Logic section)
    - Inhibit: Park brake switch must be in the “released pulled out” position. An LED light state will change on the digital interface card when the switch position changes.
    - Limit: Steering Position Sensor
- If no inhibit or limits are active, then the VCU outputs a command to the Steering Interface Card channel on the Digital Interface Card.
- The Digital Interface Card then turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the RFF2 (Rear Frame Front #2) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.
- Flows through the break out box to the steering interface card (located on the rear frame right hand side wall). The interface card conditions the signal for use by the PVG 32 pilot control valve.
- The PVG 32 pilot control valve requires a 24 volt power supply. The output of the Steering Interface Card is ½ the supply voltage for “neutral” or no steer command. The output of the steering interface card for right steer will vary from ½ supply volts to 1/4 supply volts.
- Internal to the PVG 32 valve is a control card. This control card uses the 24 volt supply to power to four proportional control solenoids. These solenoids when powered, direct pilot oil in the PVG 32 valve to control a directional spool.

The amount of pilot oil pressure is dependent on the steering interface control voltage range received by the PVG 32. This is a fixed value with no adjustments possible.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

© 2019 Komatsu. All rights reserved.

Hydraulic System

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the Steering pump. The pump is a tandem variable displacement axial piston style pump.

- The oil is pressurized in the pumps and flows out to check valves located on a manifold. At the manifold flows from the two pumps are combined and then sent to the HP port on the main flow amplifier valve (DANFOSS).

- The pressurized oil flows into the HP (High Pressure) port and is directed to the Priority spool. The priority spool in this system does not function. The oil flows across the spool and is directed to the load check valve. A very small amount of oil passes through the priority spool and is passed to the P (Pilot) output port on the DANFOSS valve.

- The P port on the DANFOSS valve is connected to the P (Pilot) port on the PVG 32 Pilot Control Valve. The P port on the PVG 32 has a pressure relief pressure reducing valve, and a direct connection to the directional spool (three position closed center). The pressure relief valve is set at 4000 PSI and control maximum inlet pressure to the PVG 32 valve. The pressure reducing valve further controls the pilot to a set 200 PSI. This is the pilot oil that will be used by the four solenoid valves for control of the directional spool internal to the PVG 32 valve.

- When a right steer command is given, two of the four solenoids will open. One of the solenoids will direct the 200 PSI pilot oil to the end of the directional spool. The other solenoid valve will allow the oil on the other end of the directional spool to be returned back to tank through the T (Hydraulic Reservoir “Tank”). This allows the directional spool to start moving.

- As the directional spool in the PVG 32 moves, some of the main pilot oil is directed across the spool and is outputted through the A (Right) pilot oil port. This oil is directed to the R (Right) pilot oil port on the DANFOSS valve. At the same time that the A port is receiving oil, some of the oil is also directed through an orifice and to a shuttle valve. The shuttle valve passes the oil to another orifice and then to the LS (Load Sense) port. The LS port is connected to the LS Port on the axial piston pump compensator valve assembly

- The compensator valve assembly on the pump has load sensing flow and pressure regulating functions. The pump flow is set at maximum until the maximum pump pressure is achieved. At that time, the flow is reduced to a very nominal amount of flow at maximum pressure.

NOTICE

The Main Relief valve in the DANFOSS Steering valve is screwed completely in. Steering pump pressure is controlled by the pressure compensator.

- The pilot oil received at the R port on DANFOSS valve is directed to one end of the directional spool (three position closed center). The direction spool will start to move. As this spool moves, some of the pilot oil flows through the directional spool and is used to shift the flow amplifier spool. All of the oil is sent to the flow amplifier spool. The quantity of oil sent to the flow amplifier spool depends on the amount of the steering command from the operator.

- In the flow amplifier spool, the pilot oil from the R port is combined with the main pump flow. This oil then passes through the flow amplifier spool and is directed to the directional spool.

- At the directional spool, the oil is sent out to CR (cylinder right) port, to the steering cylinders. The cylinders are connected in a crossed plumbed configuration. The left hand cylinder’s base port is connected to the right cylinder’s rod port. And the left hand cylinder’s rod port is connected to the right cylinder’s base port. Thus, in a right turn the base of the left hand cylinder is extending while the right hand cylinder is retracting. The cylinders are double acting and the return oil is directed back to DANFOSS valve to the CL (cylinder left) port.

© 2019 Komatsu. All rights reserved.

NOTICE

Both of the cylinder ports (CL and CR) have shock and suction valves in parallel with ports. The shock and suction valves serve as cylinder protection only and do not normally operate. The overload relief is set at 4000 PSI. And the anti-cavitation valves provide oil if voids develop in the cylinder because of outside forces.

- The returning oil from the steering cylinders is directed across the directional spool through a 75 PSI back pressure valve and then exits the DANFOSS valve at the HT (Hydraulic Reservoir “Tank”) port.
- From the HT port the oil flows back to the hydraulic reservoir return manifold.
- The oil passes through the return manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

VCU Logic

The VCU (vehicle control unit) contains the principle computer, memory hardware, and software for the control of the machine. The VCU also contains the interface cards which provide inputs and outputs concerning machine operation.

The VCU receives several inputs from the machine and operator. These inputs are:

- Steer Position Sensor
- Operator Right Joystick Command
- Function Inhibits
    - Park Brake Switch
    - Joystick failure
    - CAN Bus failure

Based on these inputs, the VCU outputs the control signal for the steering interface card. This signal is a PWM output that will vary the duty cycle thus controlling the steering interface card output command to the PVG 32 control valve. By varying the output command signal level, the speed of the steering is controlled.

The VCU is continuously reading all of the inputs. When the operator initiates a right steer command, the following conditions are computed in the VCU before a command is sent out to the steering interface card.

NOTICE

If the function is not operating properly, troubleshooting notices in the LINCS menu must be turn ON to display causes for Limits.

- Inhibit: The park brake switch must be in the “Park Brake Released” position (pulled out) for any steering output command. If the park brakes are applied (switch pushed in) then the output to the steering interface card is not allowed. A message on the LINCS screen will notify the operator if a steering function is commanded and the park brakes are applied, that “cannot steer because park brake is applied”.
- Limits: Limits can be defined as being the mechanical end points of the steering cylinders rod travel. Mechanically the front and rear frame will contact each other before the steering cylinders are at their maximum extension and retraction. Limits are therefore calculated in the VCU by using the input from

© 2019 Komatsu. All rights reserved.

the steering position sensor. The steering calibration programming in the VCU takes these different frame contact angles into account and automatically creates limits that prevent the steering cylinders from mechanically forcing the frame together. These limits also are used to softly stop the frames from hitting the steering stops. These limits can be viewed when troubleshooting notices are turned on.

- Operator controls: The operator's left hand joystick controls steering. When the joystick is pulled right (away from the operator) a right steer command is initiated. If no inhibits or limits are active, the right steer command is generated.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

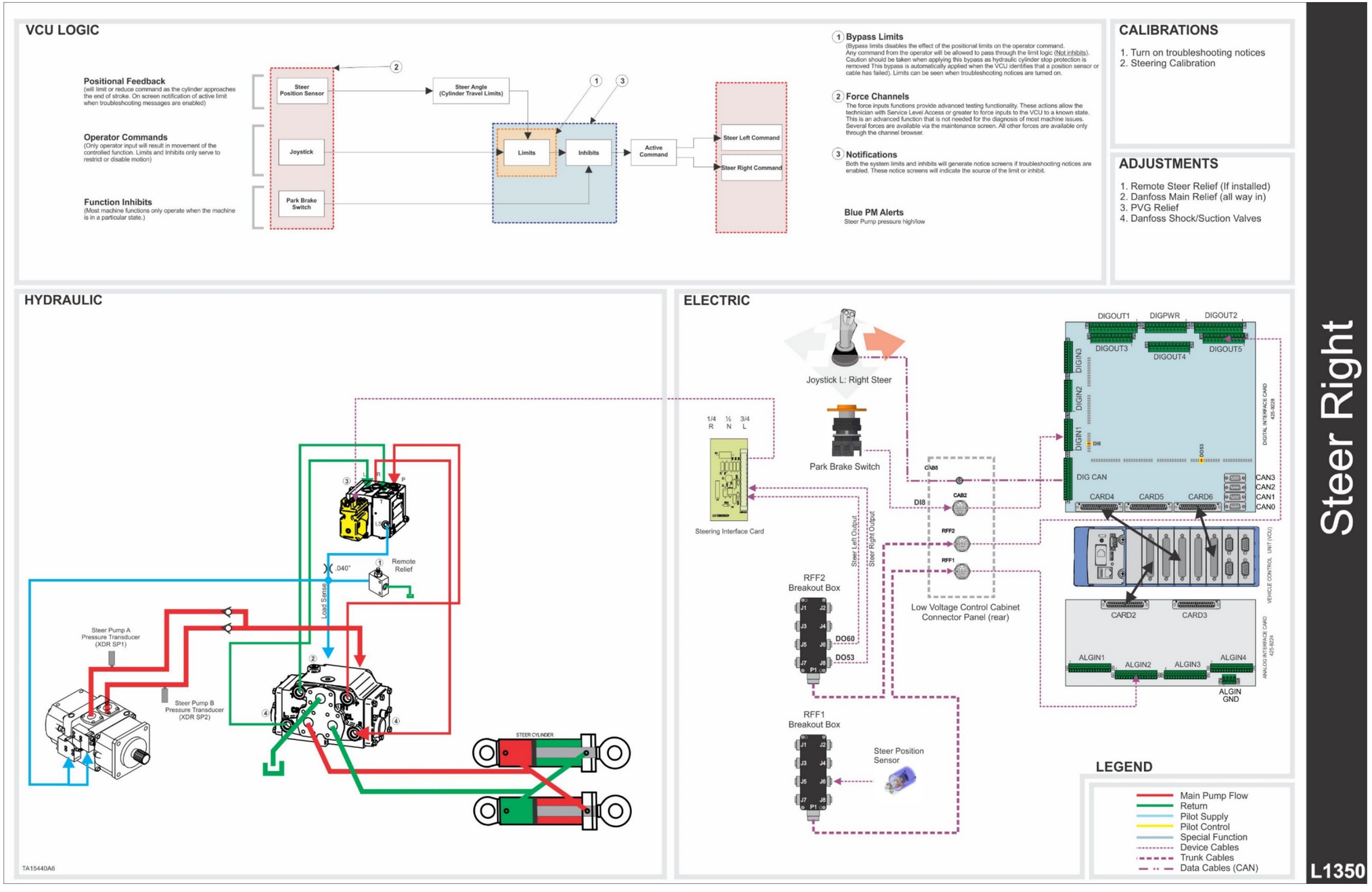


Figure 17. Steer right circuit description (L1350)

© 2019 Komatsu. All rights reserved.

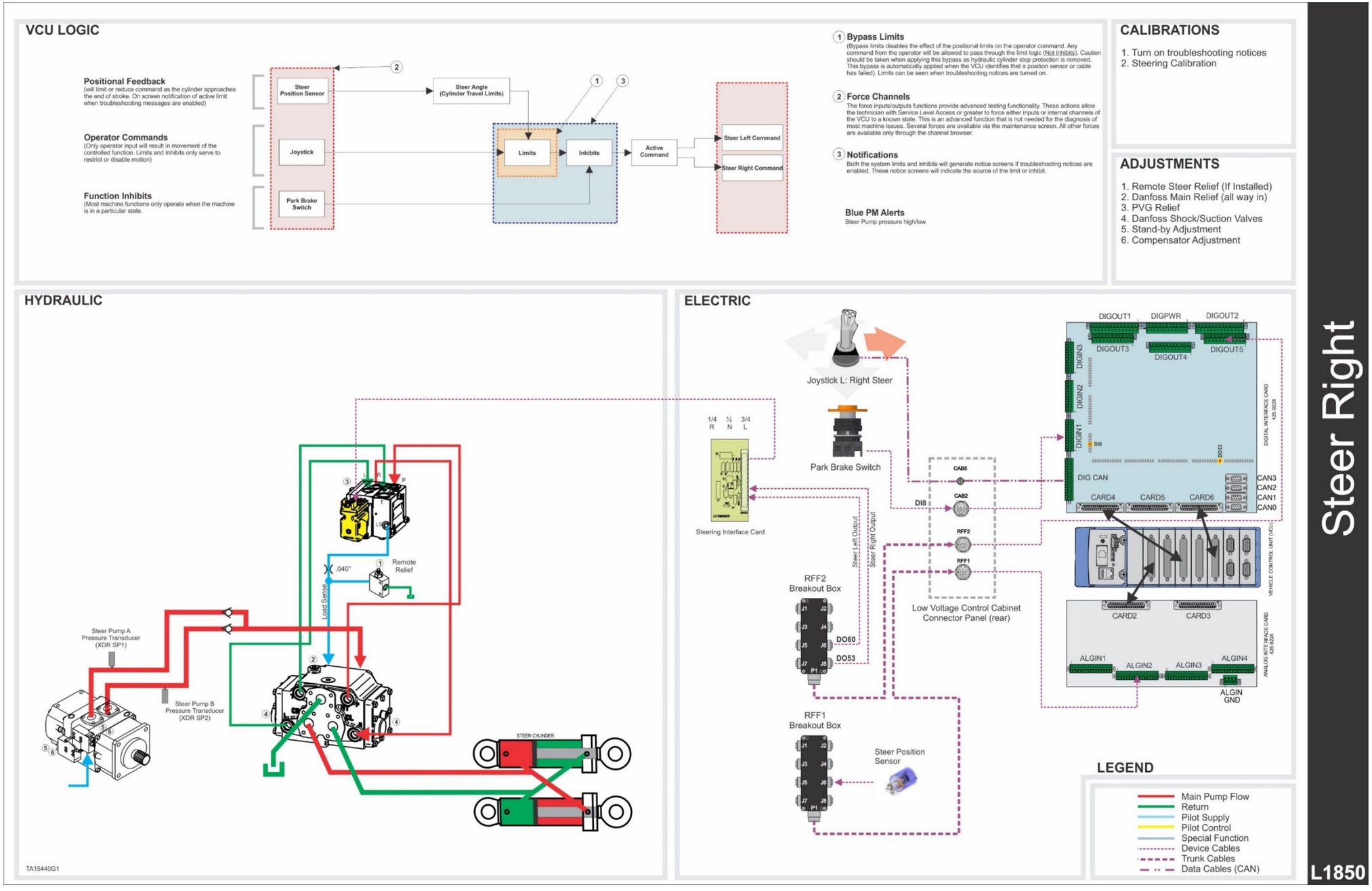


Figure 18. Steer right circuit description (L1850)

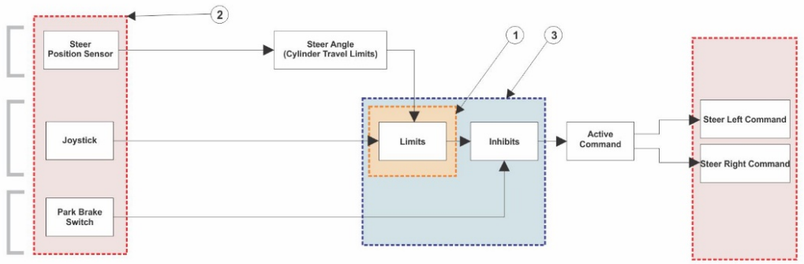
© 2019 Komatsu. All rights reserved.

VCU LOGIC

Positional Feedback
(will limit or reduce command as the cylinder approaches the end of stroke. On screen notification of active limit when troubleshooting messages are enabled)

Operator Commands
(Only operator input will result in movement of the controlled function. Limits and Inhibits only serve to restrict or disable motion)

Function Inhibits
(Most machine functions only operate when the machine is in a particular state.



1 Bypass Limits
(Bypass limits disables the effect of the positional limits on the operator command. Any command from the operator will be allowed to pass through the limit logic (Not inhibits). Caution should be taken when applying this bypass as hydraulic cylinder stop protection is removed This bypass is automatically applied when the VCU identifies that a position sensor or cable has failed). Limits can be seen when troubleshooting notices are turned on.

2 Force Channels
The force inputs/outputs functions provide advanced testing functionality. These actions allow the technician with Service Level Access or greater to force either inputs or internal channels of the VCU to a known state. This is an advanced function that is not needed for the diagnosis of most machine issues. Several forces are available via the maintenance screen. All other forces are available only through the channel browser.

3 Notifications
Both the system limits and inhibits will generate notice screens if troubleshooting notices are enabled. These notice screens will indicate the source of the limit or inhibit.

Blue PM Alerts
Steer Pump pressure high/low

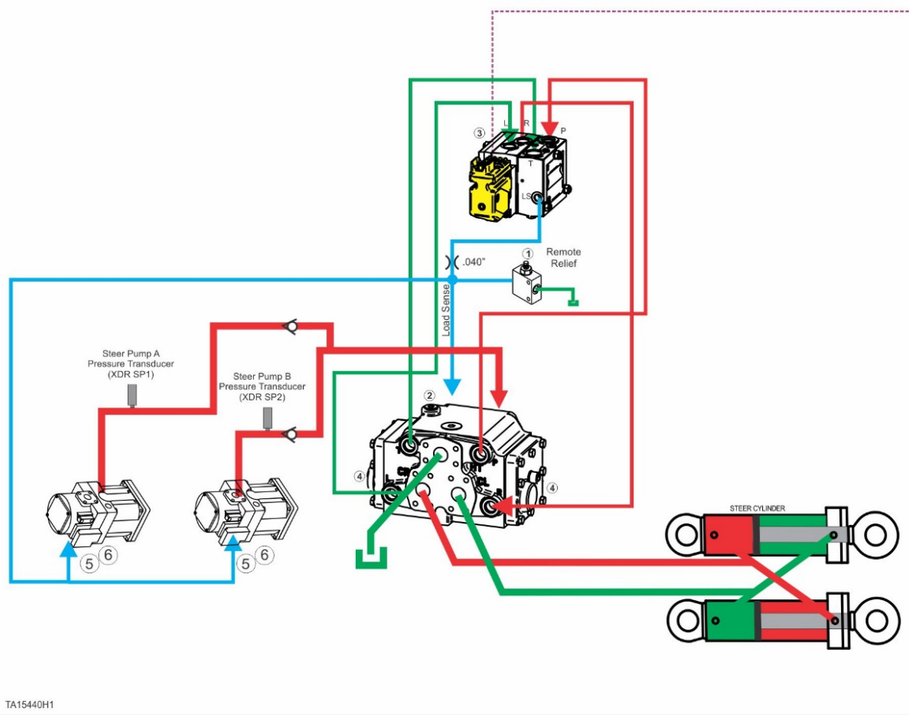
CALIBRATIONS

1. Turn on troubleshooting notices
2. Steering Calibration

ADJUSTMENTS

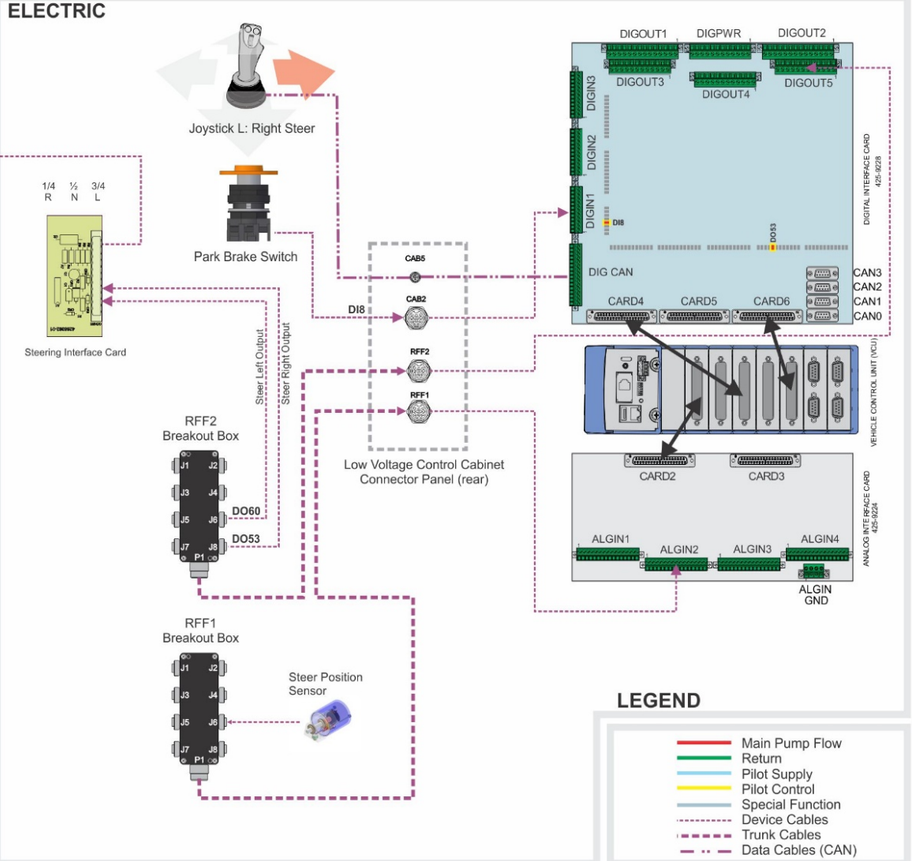
1. Remote Steer Relief (If Installed)
2. Danfoss Main Relief (all way in)
3. PVG Relief
4. Danfoss Shock/Suction Valves
5. Stand-by Adjustment
6. Compensator Adjustment

HYDRAULIC



TA15440H1

ELECTRIC



LEGEND

- Main Pump Flow
- Return
- Pilot Supply
- Pilot Control
- Special Function
- Device Cables
- Trunk Cables
- Data Cables (CAN)

Steer Right

L-2350

Figure 19. Steer right circuit description (L2350)

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Auxiliary Steer Right

Auxiliary steering is optional. Auxiliary steering pump pressure is delivered by two 24 volt electric pumps. These electric pumps are designed to provide steering control to maneuver to a safe stop point. These electric pumps are NOT designed for normal operation of the machine.

Electric Controls

The electric controls are basically the same as described above. Only the differences are described here. If the auxiliary steering option has been installed, the following additional items will be on the machine.

- Pressure switch: A 30 PSI pressure switch (PS AS) is added to the outlet of the steering pump. This switch is a normally closed switch which opens on pressure rise. If the switch closes during normal operation, this indicates a loss of steering pressure.
- Circuit Relay: A circuit relay (CR AS) is used to control the motor start relays that control 24 VDC to the electric pumps. The CR AS relay solenoid is connected to the Breakout Box RFF2 (Rear Frame Front #2). This solenoid is controlled by the VCU channel Aux Steer Enable. For this channel to be active the following items must be meet:
    - Park Brake Switch in the released (pull out) position
    - Steering Pump Supply Pressure less than 30 PSI (indicating steering pump failure)
    - Engine Running
    - Steering Commanded
- Motor Start Relays: The Motor Start Relays (SOL AS1 and SOL AS2) connect 24 volt battery voltage to the electric pump assemblies. Solenoids SOL AS1 and SOL AS2 will be energized when the VCU energizes the CR AS relay. Also connected in parallel with SOL AS1 and SOL AS2 is the hydraulic control solenoid SOL AS.

Hydraulic Controls

Auxiliary Steering provides a lower pressure alternate supply of oil to the DANFOSS steering valve. Hydraulically, from the DANFOSS HP port the steering controls and flows are identical to the above description. The differences in components and oil flow are as follows:

- Two electrically driven pumps receive oil from the hydraulic reservoir. The pumps pressurize the oil to a maximum of 2000 PSI. The pumps motors are energized only when a steer command is given. The outlet of the each pump has a check valve. The oil flows through the check valve and into the steering manifold.
- As the oil flows out of the steering manifold, it passes through another check valve and is directed to the HP port on the flow amplifier valve. Once the oil is at the HP port, the oil flows are identical to the description above.
- The Auxiliary steer relief valve is connected to the steering manifold. The steering relief valve is a vented relief valve that that regulates the maximum pump output pressure to 2000 psi. The vent line from the relief valve is run through a normally open solenoid valve (SOL AS). When this solenoid is open (de-energized), the pump output pressure will be around 300 psi.
- Solenoid AS is energized any time that a steering command has been given. When the solenoid is energized, the relief vent oil is blocked which raises the pump output pressure to 2000 psi.

© 2019 Komatsu. All rights reserved.

VCU Logic for Auxiliary Steering

For the Auxiliary steering to function there are several conditions that must be met:

- Engine must be running for more than 15 seconds
- Steering Supply pressure switch must be closed
- Joystick must be commanding a steering command
- Machine must be moving above .5 mph

If the steering pressure supply switch indicates that a loss of steering pump pressure has occurred, a RED alarm is generated. If the machine is sitting still when the alarm occurs the engine will be shut down and the park brakes will be applied. If the machine is rolling when the alarm occurs, a RED shut down sequence will be started. The machine will be brought to a stop and the engine stopped.

© 2019 Komatsu. All rights reserved.

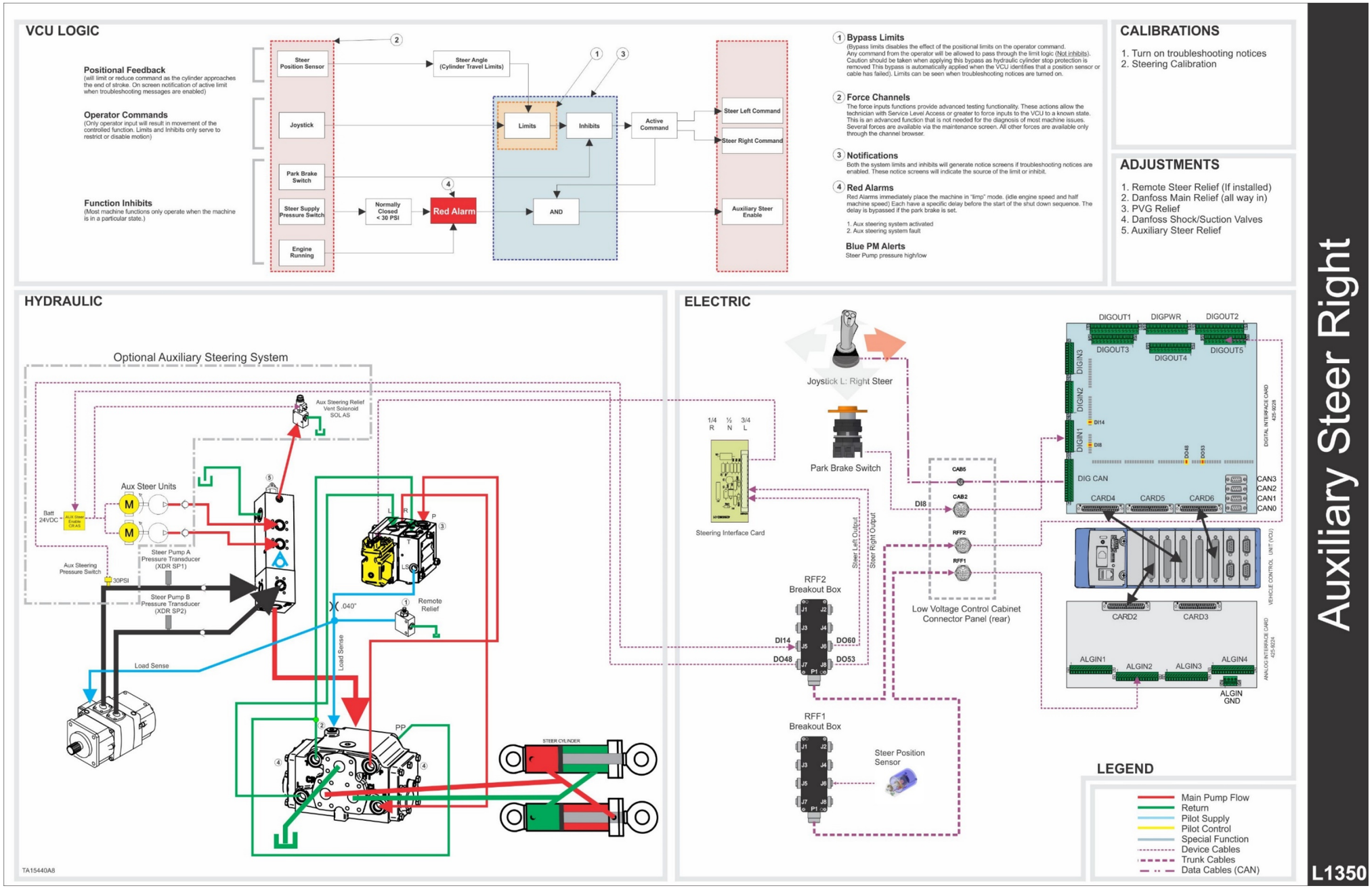


Figure 20. Auxiliary steer right circuit description (L1350)

© 2019 Komatsu. All rights reserved.

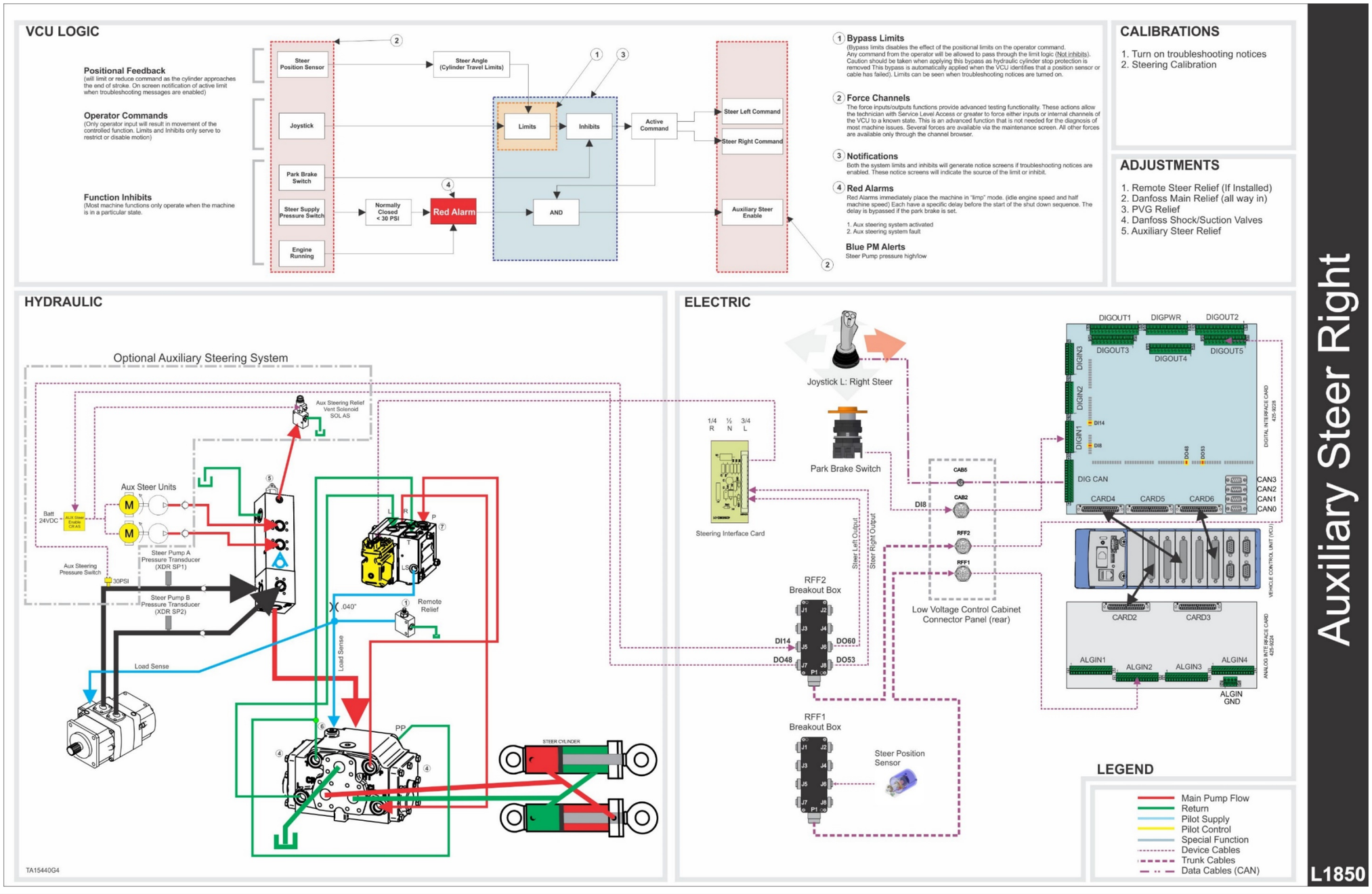


Figure 21. Auxiliary steer right circuit description (L1850)

© 2019 Komatsu. All rights reserved.

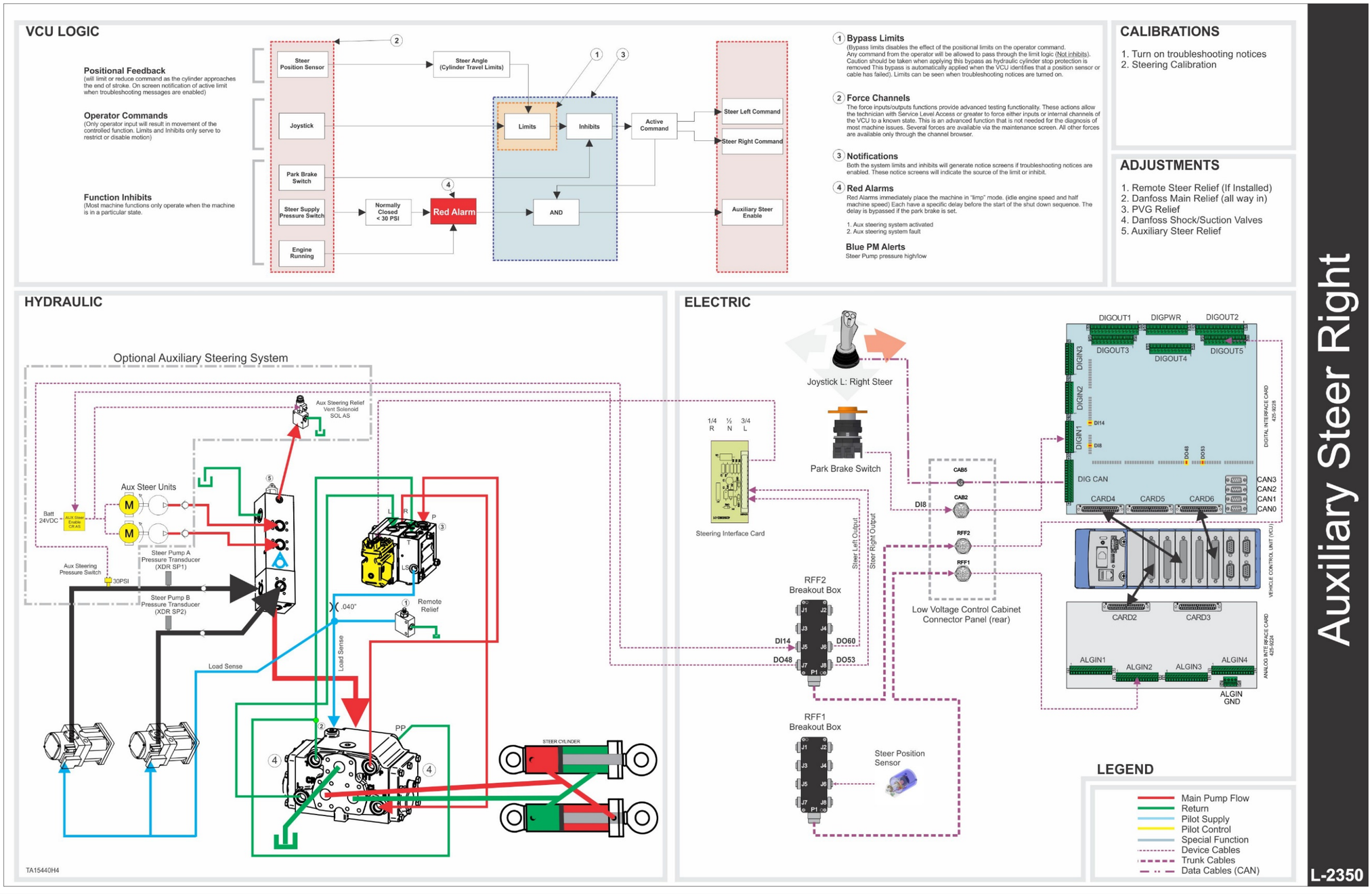


Figure 22. Auxiliary steer right circuit description (L2350)

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Hydraulic Oil Cooling Function

The hydraulic oil cooling function is electric over hydraulic control which is a fully automatic system.

Electrical and VCU Logic Controls

The bucket and hoist control functions are extremely sensitive to the viscosity change in the hydraulic oil due to temperature variations. Therefore it is very important that the hydraulic oil remain as close to a constant 140°F temperature during operation.

- A hydraulic reservoir temperature sensor is located in the hydraulic reservoir below the normal oil level. This temperature sensor is a 4 to 20 ma sensor.
    - This sensor is used for control of the oil cooler bypass circuit
    - This sensor is used for determining alarm points for Hydraulic temperature.
        - High temperature set point
        - Critically High temperature point.
        - Also used by Radiator Fan control Logic
- The temperature sensor is attached to breakout box RFF1 (Rear Frame Front #1). The breakout box is attached via a trunk cable to the back of the Low Voltage Control Cabinet (LVCC). From this junction point, the output of the temperature sensor is passed to the Analog Interface Card.
- The temperature signal is conditioned on the Analog Interface Card and then passed to the VCU where the temperature is monitored.
- If the hydraulic oil temperature is too low or too high, the VCU will output a command voltage to the Digital Interface Card that will either turn on or turn off an output to the Oil Cooler Bypass Solenoid (SOL OB). If the oil is below 140° F degrees, then the Solenoid will receive a 24 volt output from the Digital Interface Card. (An LED will illuminate if 24 VDC is being sent from the digital interface card) If the oil is above 145° F degrees then the output will be turned off 0 VDC. The signal passes from the card and is directed to the Turck cable RFF3 (Rear Frame Front #3). From the trunk cable, the signal flow to a breakout box.
- From the breakout box, the solenoid coil on the Oil cooler bypass is connected.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

- The Oil Cooler Circulation Pump (Circulation Pump) receives its oil from the hydraulic reservoir. The pumps sole function is to circulate oil from the hydraulic reservoir to the oil cooler and back to the reservoir. Located between the Circulation Pump and the Oil Cooler is an oil cooler control valve.
- The oil cooler control valve is a modulating unloader valve. The sole purpose of the oil cooler control valve is to protect the oil cooler from extreme pressure spikes that may damage the oil cooler. The oil cooler control valve is a pilot unloading valve. As oil enters into the valve, the circulation pump flow is combined with the return oil from the Engine Radiator Fan. This combining of these two flows result in a significant amount of oil flowing through the Oil Cooler.

© 2019 Komatsu. All rights reserved.

NOTICE

The blower motor oil return is also directed to the oil cooler. All of these flows are combined at the oil cooler control valve.

- On the inlet port of the oil cooler control valve is a .062” orifice. This orifice sets up the unloader function of the valve. Past the .062” orifice, the oil is used to assist the spring side of the unloader valve. From this port, this pilot oil is directed to a pressure regulating check valve (100 psi). Located in parallel with the 100 psi check valve is a NC solenoid valve (SOL OB).
- When the solenoid valve SOL OB is de-energized, the pressure is regulated to approximately 105 to 120 psi oil cooler inlet pressure depending on oil viscosity, temperature, and radiator fan speed.
- When the solenoid valve SOL OB is energized (oil is cooler than 140°F), the pilot oil will flow around the 100 psi check valve and the flow of the oil through the oil cooler should be reduced, causing the hydraulic reservoir temperature to increase.
- Because of the pilot flow going over either the 100 psi check valve or the SOL OB valve, the unloader valve will open and will regulate the amount of flow that is sent to the oil cooler. Once the oil passes through the oil cooler, the oil is then returned to the oil cooler control valve. The return oil then flows through the valve and is returned back to the hydraulic reservoir.

NOTICE

If the optional Auxiliary Oil Cooler is installed, the inlet and outlet of the auxiliary oil cooler is plumbed in parallel with the main oil cooler.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

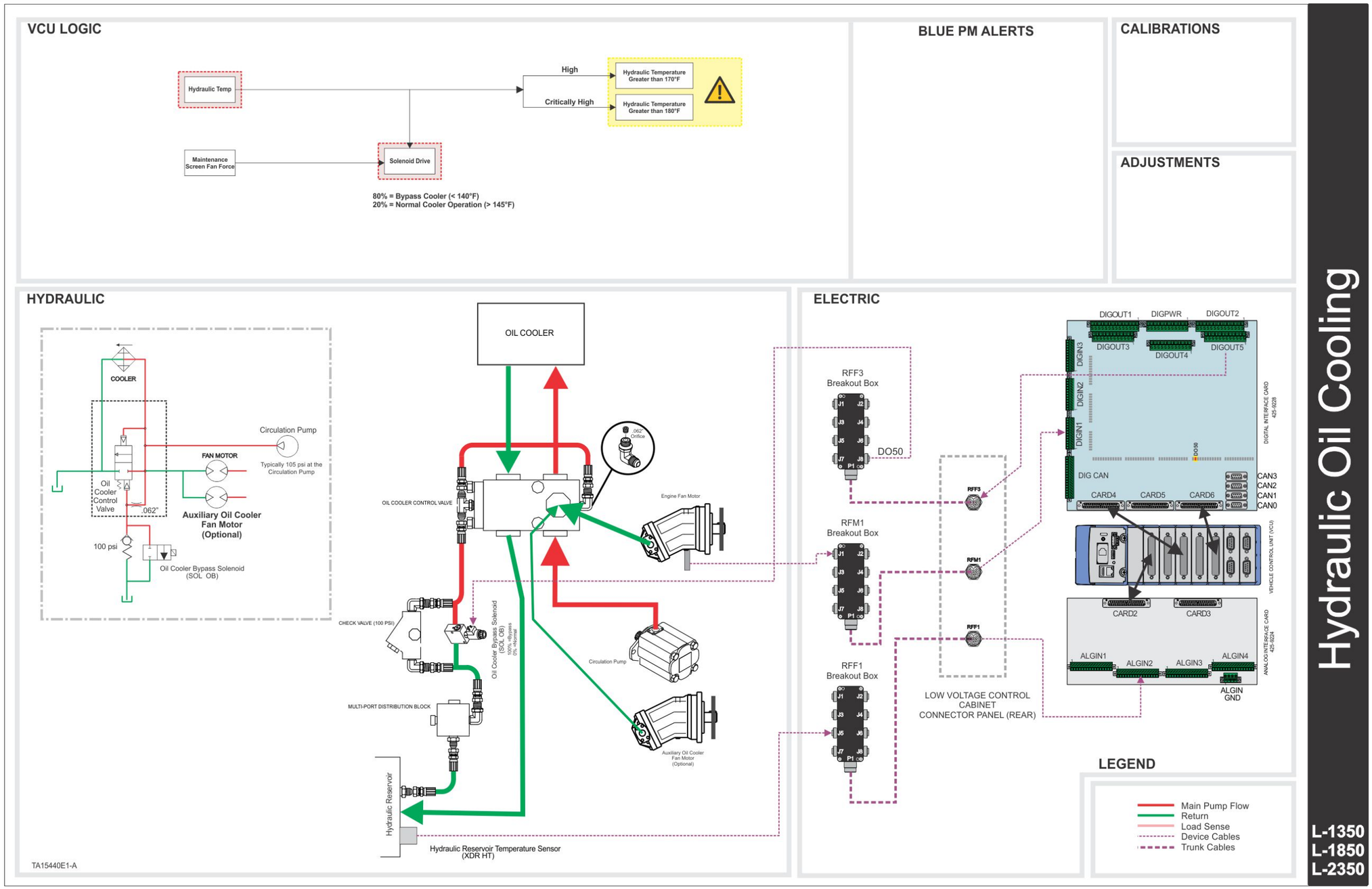


Figure 23. Hydraulic oil cooling circuit description (L1350)

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Radiator Fan Control Function

The radiator Fan Control function is electric over hydraulic control which is a fully automatic system.

Electrical and VCU Logic Controls

The radiator fan is used to cool several different components. These include:

- Hydraulic Oil Temperature
    - A hydraulic reservoir temperature sensor is located in the hydraulic reservoir below the normal oil level. This temperature sensor is a 4 to 20 ma sensor.
        - This sensor is used for control of the oil cooler bypass circuit
        - This sensor is used for determining alarm points for Hydraulic temperature.
            - High temperature set point
            - Critically High temperature point.
            - Used by Radiator Fan control logic
            - Used by the Auxiliary Oil Cooler control logic (optional)
    - The temperature sensor is attached to breakout box RFF1 (Rear Frame Front #1). The breakout box is attached via a trunk cable to the back of the Low Voltage Control Cabinet (LVCC). From this junction point, the output of the temperature sensor is passed to the Analog Interface Card.
    - The temperature signal is conditioned on the Analog Interface Card and then passed to the VCU where the temperature is monitored.
- Engine Coolant
    - The engine coolant temperature is monitored by the engine control system.
    - The information is passed through the CAN Bus to the Low Voltage Control Cabinet.
    - This information is then directed to the Digital Interface Card and then passed through to the VCU.
- Engine Fuel (Engine type and manufacture dependent)
    - The engine fuel temperature is monitored by the engine control system.
    - The information is passed through the CAN Bus to the Low Voltage Control Cabinet.
    - This information is then directed to the Digital Interface Card and then passed through to the VCU.
- Engine Intercooler (Engine type and manufacture dependent)
    - The engine inlet air temperature is monitored by the engine control system.
    - The information is passed through the CAN Bus to the Low Voltage Control Cabinet.
    - This information is then directed to the Digital Interface Card and then passed through to the VCU.
- HPD Gear Box Oil Temperature
    - A HPD oil temperature sensor is located in the control valve assembly located below the bottom of the HPD gear box assembly. This temperature sensor is a 4 to 20 ma sensor.
        - This sensor is used to monitor the HPD gear box oil temperature.
        - This sensor is used for determining alarm points for HPD Gear Box temperature.
            - High temperature set point
            - Critically High temperature point.

© 2019 Komatsu. All rights reserved.

  - The temperature sensor is attached to breakout box RFF4 (Rear Frame Front #4). The breakout box is attached via a trunk cable to the back of the Low Voltage Control Cabinet (LVCC). From this junction point, the output of the temperature sensor is passed to the Analog Interface Card.
  - The temperature signal is conditioned on the Analog Interface Card and then passed to the VCU where the temperature is monitored.

- IGBT Temperatures

  - All of the IGBT's temperatures are monitored. The IGBT with the highest temperature will be used as the controlling device. All of the information from the IGBT's is communicated to the VCU via the CAN Bus system.
  - The CAN Bus data is sent out from the individual convertor panels.
  - The Can Bus is connected to the back of the Low Voltage Control Cabinet (LVCC) and then is passed to the Digital Interface Card.
  - The Digital Interface Card passes the data through to the VCU.

The machine is constantly monitoring these items and looking for the one component that in its range of temperature has the greatest demand for cooling. A component may be at lower temperature than another component yet it is at the high end of its temperature range. If this is the case, that component will become the controlling temperature device that determines what the minimum radiator fan speed will be.

- If a component requires additional cooling, the VCU will output a PWM signal to increase the radiator fan speed. This signal is sent to the Digital Interface Card.

- Then the Digital Interface Card turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the RFF2 (Rear Frame Front #2) breakout box. An LED light state will change on the digital interface card when the PWM signal is sent.

- The PWM signal is delivered to the Radiator Fan Control Solenoid. The Solenoid valve is normally closed. The lesser the duty cycle of the PWM, the faster the fan will turn. If the PWM signal is off, the fan will be at its highest speed.

NOTICE

The VCU is also monitoring the Fan Speed Sensor. This speed sensor is not used as a feedback device to control normal operating rpm of the fan. However, in event that an overspeed is detected then the engine is driven lol engine speed and alerts the operator. It is only used to alert the operator that fan speed has been detected above a setpoint.

- **L-1350/1850/2350 with an 8 blade fan >870 RPM.**

- **L-1850/2350 with an 11 blade fan >800 RPM, without composite fan blades.**

- **L-1850 with an 11 blade fan >850 RPM with composite fan blades.**

- **L-2350 with an 11 blade fan >900 RPM with composite fan blades.**

Exceptions to Normal Operation

Exceptions to normal operations listed above occur if the machine is in "dynamic retard" for an extended period of time. Under normal operation, the energy generated in dynamic retard is all used by feeding the energy back into the engine. However, for long down-hill tramming, if the engine cannot use all of the energy then the excess energy is feed to the braking grids located on the back of the radiator. In this condition, the fan speed will be driven to its highest speed setting to provide cooling for the retarding grids.

© 2019 Komatsu. All rights reserved.

Other exceptions: **Maintenance or higher security is required for these items.** If the machine has been placed into certain testing modes then the radiator fan will be driven to its highest speed. These testing modes are:

- Load Bank: Load Bank testing is used for calculating engine horse power. The load bank mode will be putting energy through the braking grids (a known resistance) and engine horse power load can be calculated.
- Radiator Fan Set Up: During radiator fan set up, the solenoid can be forced high or low. If the Auxiliary Oil Cooler option is installed, the Auxiliary Oil Cool Fan Control Solenoid (SOL AF) is also forced high or low at the same time.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

- **Machines with Tier 1 or 2 Engine:** The Fan Pump / Blower Pump (FP/BP) is a tandem variable axial piston pump. It receives its oil from the hydraulic reservoir. The Fan pump sole function is to deliver oil from the hydraulic reservoir to the hydraulically driven radiator fan motor. This pumps output flow is regulated by the Load Sense (LS) circuit.
- **Machines with Tier 4 Engine:** Each of two (2) Fan Pumps (FP) is a variable axial piston pump. The two pumps work in parallel to provide flow to the radiator fan. Each receives its oil from the hydraulic reservoir. Each of the fan pumps sole function is to deliver oil from the hydraulic reservoir to the hydraulically driven radiator fan motor. Each of the pumps output flow is regulated by the Load Sense (LS) circuit.
- The radiator fan pumps provide flow of the hydraulic oil to the radiator fan motor. The flow of oil from the pumps is directed to a common manifold where the two pump flows will be combined. The manifold has two check valves that are located on each inlet port on the manifold. The oil flow from each pump passes through these check valves. The purpose of the check valves is to prevent back flow through one of the pumps, should a pump fail.
- Once the oil from the two pumps is combined in the manifold, it is then directed to the radiator fan motor. The radiator fan motor has a pusher type fan assembly mounted on it. An externally mounted anti-cavitation check valve is located between the motor inlet and outlet ports.
- The outlet of the motor is sent to the outlet port of the oil cooler control valve. If the return oil pressure is low, then the oil will flow through the oil cooler and then back to the return port on the oil cooler control valve. If the return pressure is high, then the motor's return oil is passed directly through the oil cooler control valve and it is then directed back to the hydraulic reservoir filter manifold.
- The oil passes through the reservoir filter manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.
- The Load Sense (LS) port on the pump is connected with a remote relief and a proportional solenoid cartridge (Radiator Fan Control Solenoid (SOL RF)). Both of these control devices are in parallel.
    - The remote relief is used to control the maximum speed of the radiator fan by controlling the maximum flow output of the pump.
    - The Radiator Fan Control Solenoid (SOL RF) is a normally closed proportional control solenoid. If the solenoid is being fully energized (maximum PWM signal) then the radiator fan speed is low. If the solenoid is de-energized (no PWM signal) then the radiator fan speed is

© 2019 Komatsu. All rights reserved.

high (using the remote relief pressure setting). If the PWM signal is being varied, then the radiator fan speed will be regulated to some speed between slow and fast.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

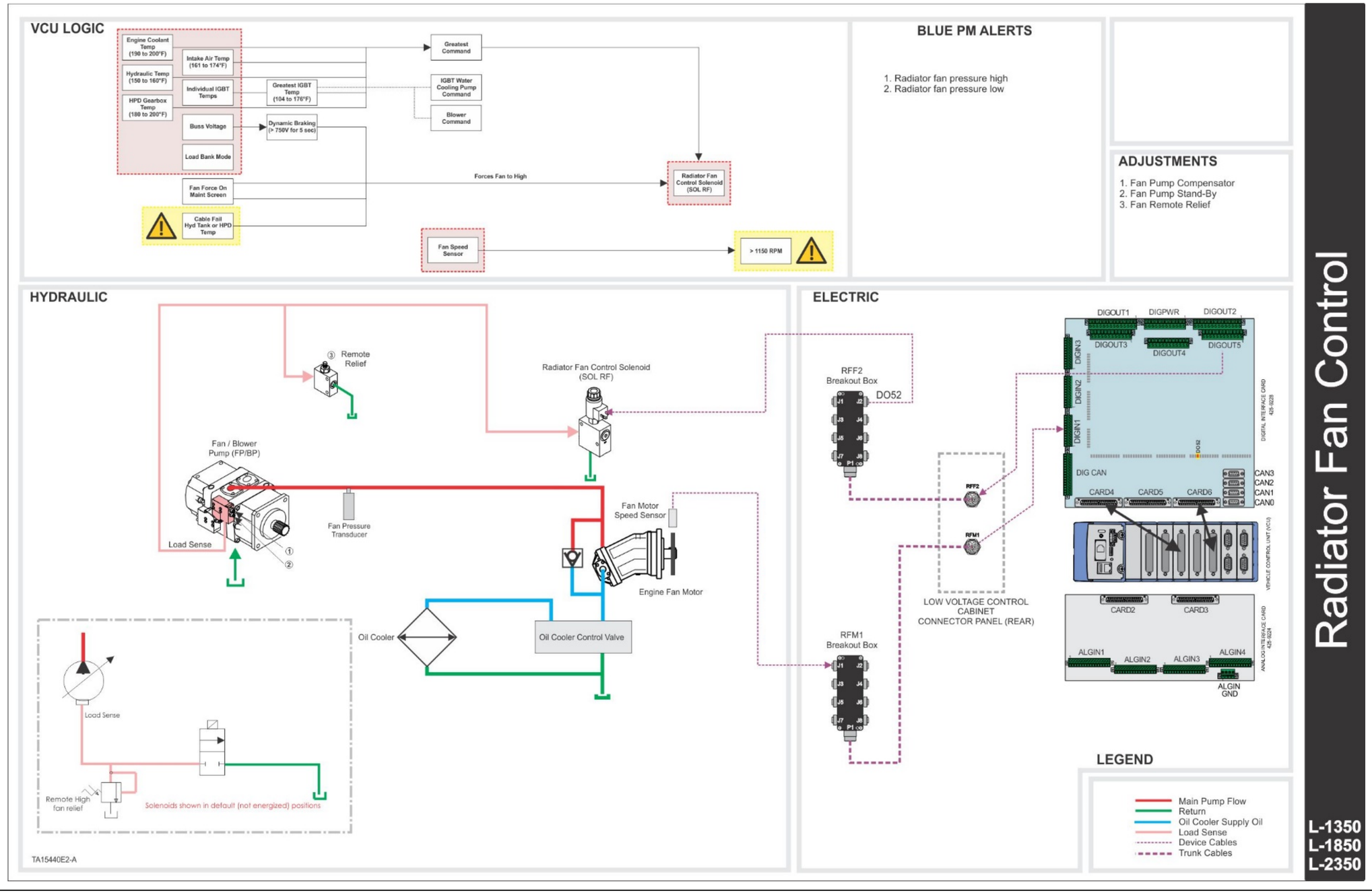


Figure 24. Radiator fan control circuit description (Machines with Tier 1 or 2 Engine)

© 2019 Komatsu. All rights reserved.

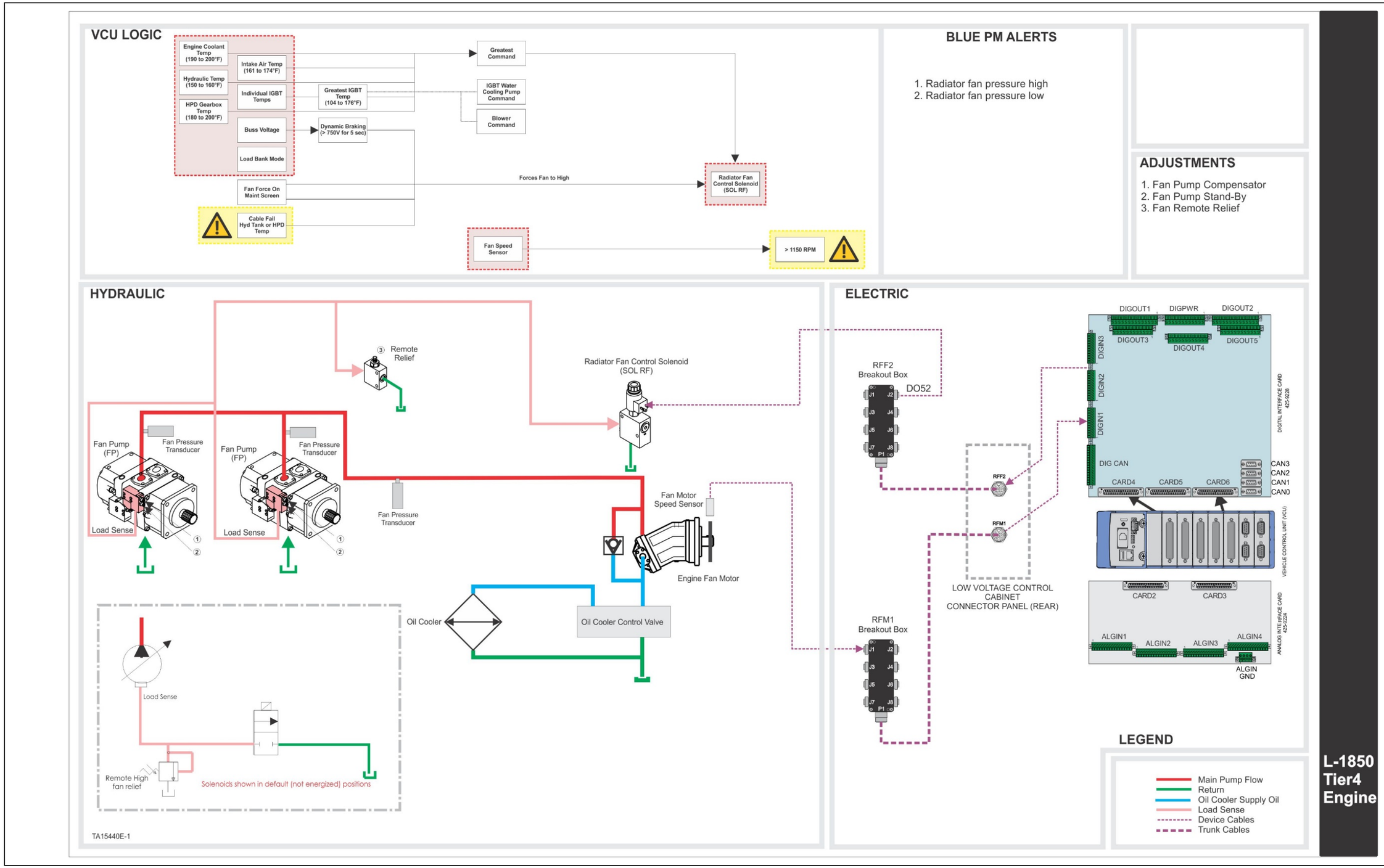


Figure 25. Radiator fan control circuit description (Machines with Tier 4 Engine)

© 2019 Komatsu. All rights reserved.

Auxiliary Oil Cooler Control Function

The radiator Auxiliary oil Cooler Control function is electric over hydraulic control which is a fully automatic system.

Electrical and VCU Logic Controls

The Auxiliary Oil cooler is used to provide additional oil cooling capabilities. The hydraulic oil temperature sensor is the control input to this system.

Hydraulic Oil Temperature

- A hydraulic reservoir temperature sensor is located in the hydraulic reservoir below the normal oil level. This temperature sensor is a 4 to 20 ma sensor.
    - This sensor is used for control of the oil cooler bypass circuit
    - This sensor is used for determining alarm points for Hydraulic temperature.
        - High temperature set point
        - Critically High temperature point.
        - Used by Radiator Fan control logic
        - Used by the Auxiliary Oil Cooler control logic (optional)
- The temperature sensor is attached to breakout box RFF1 (Rear Frame Front #1). The breakout box is attached via a trunk cable to the back of the Low Voltage Control Cabinet (LVCC). From this junction point, the output of the temperature sensor is passed to the Analog Interface Card.
- The temperature signal is conditioned on the Analog Interface Card and then passed to the VCU where the temperature is monitored.
- The machine is constantly monitoring the hydraulic oil temperature. If the reported hydraulic temperature is below 150°F then the VCU will output a 100% PWM duty cycle signal to the Aux Fan Sol channel on the Digital Interface Card. This is because the Auxiliary Fan Sol is a normally open cartridge.
- If the hydraulic oil requires additional cooling (hydraulic oil temperature is above 150°F degrees), then the VCU will stop outputting a PWM signal. This causes the Auxiliary Fan Solenoid (SOL AF) to run the Auxiliary Oil Cooler Fan Motor. This signal is sent to the Digital Interface Card.
- Then the Digital Interface Card turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the RFF1(Rear Frame Front #1) breakout box. A LED light state will change on the digital interface card when the PWM signal is sent.
- The PWM signal is delivered to the Auxiliary Oil Cooler Control Solenoid (SOL AF). The Solenoid valve is normally closed. The lesser the duty cycle of the PWM, the faster the fan will turn. If the PWM signal is off, the fan will be at its highest speed.
- When the hydraulic oil temperature drops below 145°F degrees, then the VCU will re-output the 100% duty cycle PWM which will shut the Auxiliary Oil Cooler Fan back off.

© 2019 Komatsu. All rights reserved.

Exceptions

During the main radiator fan setup, maintenance and high security levels can force, via LINCS menus, the radiator fan to high or low. If the optional oil cooler is installed, it will also be controlled by LINCS.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

- The Auxiliary Oil Cooler Fan Pump (AFP) is a vane type pump mounted on the end of the Accessory and Steering pumps. It receives its oil from the hydraulic reservoir. The Auxiliary Oil Cooler Fan pump function is to deliver oil from the hydraulic reservoir to the hydraulically driven Auxiliary Oil Cooler Fan Motor.

- The Auxiliary Oil Cooler Fan pump pressurizes the hydraulic oil and directs it to the Auxiliary Oil Cooler fan motor. The fan motor has a pusher type fan assembly mounted on it. An externally mounted anti-cavitation checked valve is located between the motor inlet and outlet ports.

- Located in parallel with the inlet port of the motor are two control valves. These valves are:

    - Auxiliary Oil Cooler Fan Control Solenoid (SOL AF). This solenoid is normally closed. If the hydraulic oil temperature is below 150°F degrees the VCU commands this solenoid to be energized. If the SOL AF is energized, then the oil at the inlet of the fan motor will be allowed to be returned to the hydraulic reservoir and the fan motor will not turn. If the oil is above 150°F degrees then the VCU will command this solenoid to be de-energized causing the solenoid cartridge to be in its normally closed position. This causes the pump flow to be directed to the fan motor.
    - Auxiliary Oil Cooler Fan Motor Relief Valve: This relief valve is for controlling the maximum pressure the auxiliary oil cooler fan motor and pump can experience. The maximum relief pressure is 1700 psi. This will provide approximately 1600 rpm at sea level.

- The outlet of the motor is directed to a 100 psi back pressure check valve. This check valve helps reduce cavitation when the fan motor is turned off. The oil is then sent to the outlet port (hydraulic reservoir side) of the oil cooler control valve. The oil is then directed back to the hydraulic reservoir filter manifold.

- The oil passes through the hydraulic reservoir filter manifold, then through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

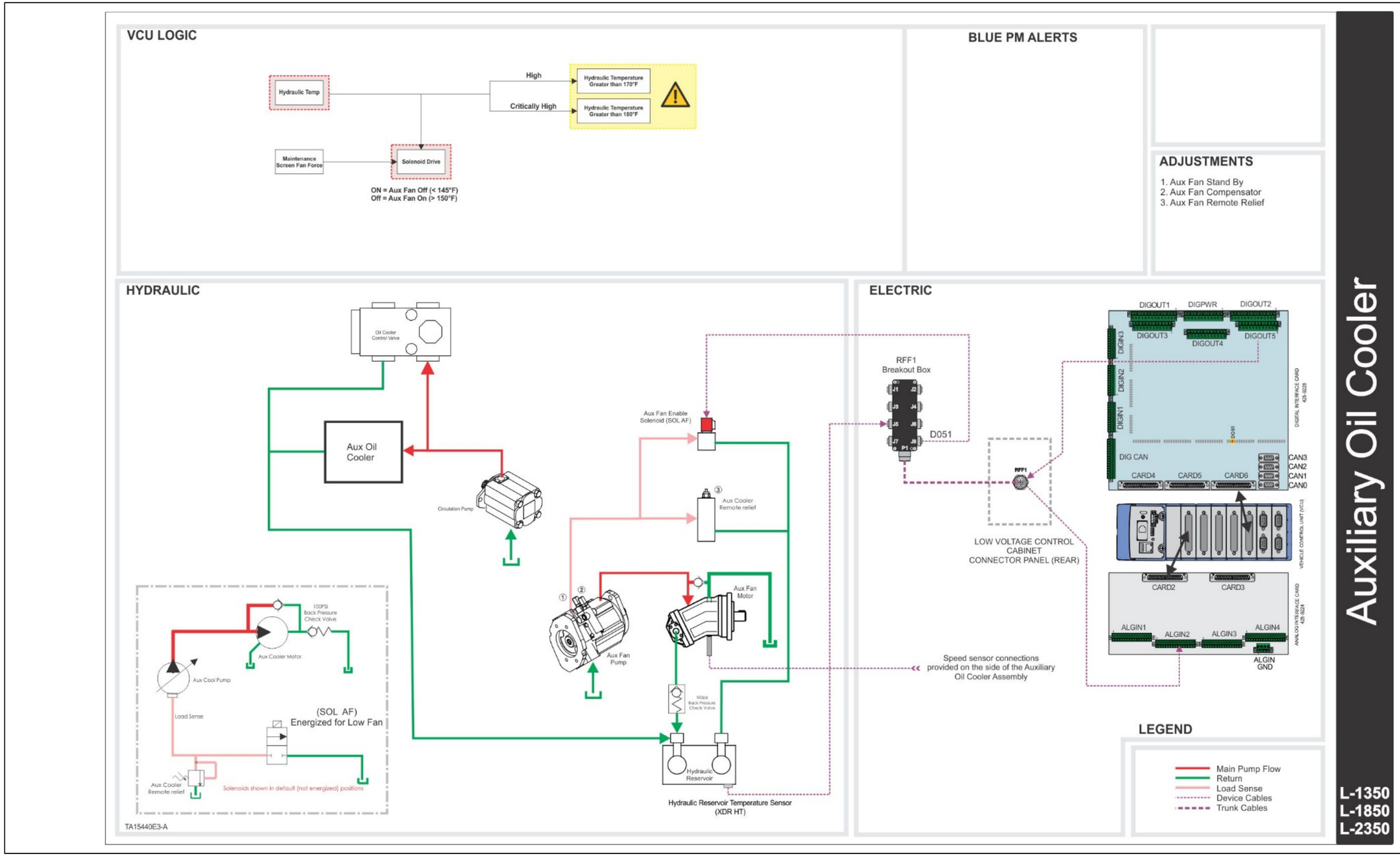


Figure 26. Auxiliary oil cooler control circuit description

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Auto Lube Control Function

The Auto Lube Control function is electric over hydraulic control which is a fully automatic system. The operator or service personnel can manual initiate an auto lube cycle.

Electrical and VCU Logic Controls

Automatic Controls

The auto lube system automatically initiates an auto lube cycle timer any time the drive system is enabled. At the initialization of the drive system, a 150 second cycle time begins. The auto lube system can be set to run every 5, 10, or 15 minute intervals.

- The auto lube function is enabled when the operator enables the drive system. The drive system can be initiated one of two ways.
    - Throttle Switch: When the throttle switch (located on the operator's push button panel) is pushed, the engine will go from low to high throttle. The drive system is enabled at this time. With the drive enabled, the auto lube system will initiate a lube cycle.
        - The throttle switch on the push button panel is converted to a CAN Bus message. The CAN Bus is passed through the cab and delivered to the Low Voltage Control Cabinet (LVCC).
        - In the LVCC the CAN Bus is sent to the Digital Interface Card where it is passed through to the VCU
    - Drive Enable Switch: When the drive enable switch (located on the operator's push button panel) is pushed the drive system will be enabled even with the engine at low throttle. With the drive enabled, the auto lube system will initiate a lube cycle.
        - The Drive Enable switch on the push button panel is converted to a CAN Bus message. The CAN Bus is passed through the cab and delivered to the Low Voltage Control Cabinet (LVCC).
        - In the LVCC the CAN Bus is sent to the Digital Interface Card where it is passed through to the VCU
- The VCU will send out a signal to the Digital Interface Card to turn on the Auto Lube Solenoid (SOL AL).
- The Digital Interface Card then outputs a signal to the back of the LVCC. This signal is passed on down through a Trunk cable to the break out box FFR1 (Front Frame Rear #1).
- From the break out box FFR1 the Auto Lube Solenoid (SOL AL) is energized.
- Once SOL AL is energized, the auto lube will start to build pressure. A pressure transducer (XDR AL) is located in the rear frame, next to the grease injector bank. This pressure transducer is monitoring the grease pump output pressure to ensure it achieves greater than 2500 psi within the specified time limit.
- The Pressure Transducer (XDR AL) is connected to the break out box FFR1. Breakout box FFR1 is connected to the rear of the LVCC by a Trunk cable.
- In the LVCC the pressure transducer signal is sent to the Analog Interface Card. The signal is conditioned on the card and then sent on to the VCU
    - In the VCU the pressure is watched to make sure that the pressure does not achieve 2500 PSI in 5 seconds. If the pressure goes high in a short amount of time, this typically indicates

© 2019 Komatsu. All rights reserved.

the vent valve did not function properly on the last lube cycle. If the pressure indicates this type of failure, the VCU generates a yellow warning alarm (Auto Lube Short).

- The VCU monitors the pressure to ensure it has achieved at least 2500 psi within a specified time. If the pressure does not achieve this minimum pressure, the VCU generates a yellow warning alarm (Auto Lube Long).
- If 5 consecutive alarms are generated, then the VCU will give a red alarm indicating a failure in the grease system. This red alarm will shut the machine down.

Manual Controls

The auto lube system can be manually actuated if the engine is running. This can be accomplished by using one of the three manual lube switches located on the machine. These switches are located:

- Operator's Push Button Panel: An auto lube push button switch (momentary) is located on the operator's push button panel.
    - If the button is pressed while the drive system is enabled, then an auto lube cycle will be started.
    - If the button is pressed while the drive system is disabled, then the auto lube pump will only operate while the button is held pressed.
- Front Frame switch: A momentary push button switch is located in the front frame close to the Auto Lube grease barrel and pump.
    - If the button is pressed while the drive system is enabled, then an auto lube cycle will be started.
    - If the button is pressed while the drive system is disabled, then the auto lube pump will only operate while the button is held pressed.
        - The push button switch is connected to the break out box FFR1 (Front Frame Rear #1). From the FFR1 breakout box the signal is delivered to the rear of the Low Voltage Control Cabinet (LVCC).
        - In the LVCC the signal is sent to the Digital Interface Card. The Digital Interface Card then sends the signal to the VCU.
- Control Switch Panel: A momentary switch is located in the control switch panel located on the left rear of the machine by the principle boarding ladder.
    - If the switch is toggled while the drive system is enabled, then an auto lube cycle will be started.
    - If the switch is toggled while the drive system is disabled, then the auto lube pump will only operate while the button is held pressed.
        - The switch is mounted in the Control Switch Panel #1 (CSP1). The switch is connected to the Trunk cable connection that goes to the back of the rear of the Low Voltage Control Cabinet (LVCC).
        - In the LVCC, the signal is sent to the Digital Interface Card. The Digital Interface Card sends the signal to the VCU.
- The VCU sends out a signal to the Digital Interface Card to turn on the Auto Lube Solenoid (SOL AL)
- The Digital Interface Card then outputs a signal to the back of the LVCC. This signal is passed on down through a Trunk cable to the break out box FFR1 (Front Frame Rear #1).
- From the break out box FFR1 the Auto Lube Solenoid is energized.
    - If the drive system is NOT enabled, then the auto lube solenoid will only stay energized as long as the push buttons or toggle switch is held. Alarms may or may not be generated based on grease pump output pressure.

© 2019 Komatsu. All rights reserved.

- If the drive system was enabled, then the auto lube solenoid will complete a full automatic lube cycle.
  - Once SOL AL is energized, the auto lube will start to build pressure. A pressure transducer (XDR AL) is located in the rear frame on the inlet of the rear frame grease bank. This pressure transducer monitors the grease pump output pressure to ensure it achieves greater than 2500 psi within a specified time limit.
  - The Pressure Transducer (XDR AL) is connected to the break out box FFR1. Breakout box FFR1 is connected to the rear of the LVCC by a Trunk cable.
  - In the LVCC the pressure transducer signal is sent to the Analog Interface Card. The signal is conditioned on the card and then sent on to the VCU.
    - In the VCU the pressure is monitored to ensure the pressure does not achieve 2500 psi in five seconds. If the pressure goes high in a short amount of time, this typically indicates the vent valve did not function properly on the last lube cycle. If the pressure indicates this type of failure, then the VCU will generate a yellow warning alarm (Auto Lube Short).
    - The VCU monitors the pressure to ensure it has achieved at least 2500 psi in the specified time limit. If the pressure does not achieve this minimum pressure, the VCU generates a yellow warning alarm (Auto Lube Long).
      - If 5 consecutive alarms are generated, the VCU generates a red alarm indicating a failure in the grease system. This red alarm will shut the machine down.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps at engine speed.

- Hydraulic oil flows from the hydraulic reservoir to the inlet of the accessory pump.
- The oil is pressurized in the pump to an output pressure of 2500 psi.
- The pressurized oil flows into a manifold system and is distributed to the various circuits. The oil that is flowing to the auto lube system is directed to a 2.5 GPM pressure compensated flow control valve.
- From the flow control valve the oil is directed to the Auto Lube Pump Manifold.
- The Auto Lube Pump Manifold houses the Auto Lube Solenoid (SOL AL). This solenoid is a normally closed three way valve. When the solenoid is de-energized, supply oil is blocked while the pump and vent valve ports are vented back to the hydraulic reservoir.
- When SOL AL is energized, the supply oil flows through a pressure reducing valve (relief valve) and into a common manifold area.
  - There are three ports out of the manifold.
    - Port # 1 is for the manual pressure gauge for checking the pressure reducing valve (relief valve) setting.
    - Port # 2 is connected to a non-adjustable flow control. This flow control, controls the speed of the auto lube hydraulic motor. After the flow control the oil flows to the inlet of the motor.
      - As the pump motor rotates, the outlet oil is directed to a return manifold that is also located in the Auto Lube Pump Manifold.
    - Port # 3 is for the vent valve which is hydraulically pilot operated.
      - It is important that on the outlet of this port, a brass fitting with a very small orifice is installed. This orifice controls the opening and closing rate of the vent valve providing better operation of the vent valve.

© 2019 Komatsu. All rights reserved.

- When the auto lube system is turned off, Auto Lube Solenoid (SOL AL) is de-energized. Supply oil in the common manifold is vented back to the return manifold in the Auto Lube Pump manifold.
- When the auto lube system is turned off, Auto Lube Solenoid (SOL AL) is de-energized. Supply oil in the supply passage is vented to a return passage in the Auto Lube Pump manifold.
- The return oil is directed back to the filter return manifold on the hydraulic reservoir.
- From the return filter manifold the oil is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pump and the process starts again.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

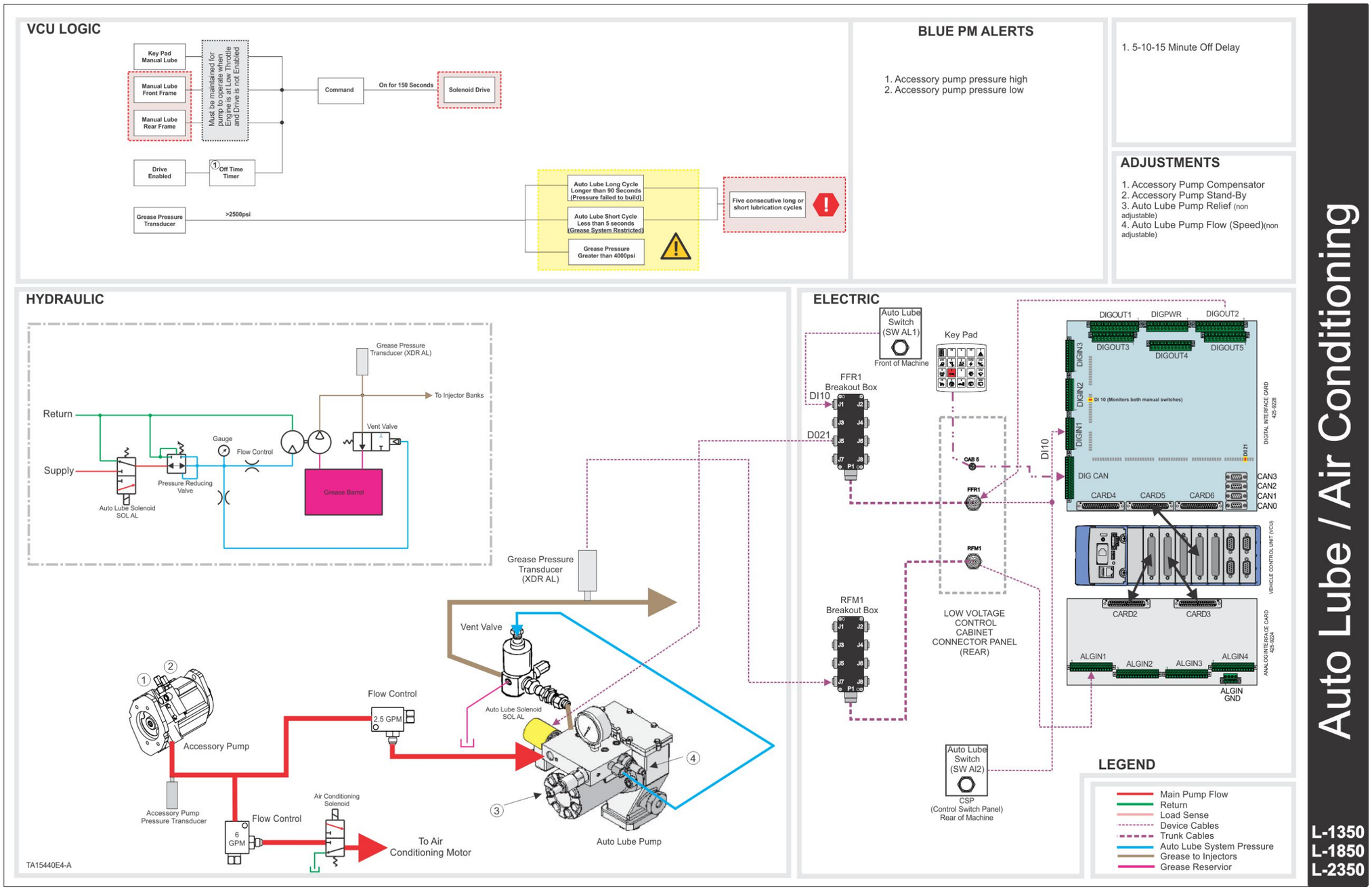


Figure 27. Auto lube/air conditioning circuit description

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

Blower Fan Control Function

The Blower Fan Control function is electric over hydraulic control which is a fully automatic system.

Electrical and VCU Logic Controls

The blower fan is used to air cool the SR Generator, four SR motors and some components inside the converter cabinet. During operation the component with the greatest cooling requirement will control the blower speed.

- SR Generator
    - The SR generator has three temperature sensors located in the stator. These temperature sensors are of a RTD type.
        - These sensors are used for controlling the blower fan speed.
        - These sensors are used for determining alarm points for SR Generator temperature.
            - High temperature set point
            - Critically High temperature point.
    - The temperature sensors are attached to the Generator Master Interface Card. On the card the sensor with the greatest temperature is determined and that information is converted to CAN Bus data.
        - The information is passed through the CAN Bus to the Low Voltage Control Cabinet.
        - This information is then directed to the Digital Interface Card and then passed through to the VCU.
- SR Motors (M1 thru M4)
    - The SR motors have three temperature sensors located in the stator. These temperature sensors are of a RTD type.
        - These sensors are used for controlling the blower fan speed.
        - These sensors are used for determining alarm points for each SR Motor temperature.
            - High temperature set point
            - Critically High temperature point.
    - The temperature sensors are attached to each Motor Interface Card located on the motor's converter panel. On the card the sensor with the greatest temperature is determined and that information is converted to CAN Bus data.
        - The information is passed through the CAN Bus to the Low Voltage Control Cabinet.
        - This information is then directed to the Digital Interface Card and then passed through to the VCU.
- IGBT Temperatures
    - All of the IGBT's temperatures are monitored. The IGBT with the highest temperature will be used as the controlling device. All of the information from the IGBT's is communicated to the VCU via the CAN Bus system.
    - The CAN Bus data is sent out from the individual convertor panels.
    - The Can Bus is connected to the back of the Low Voltage Control Cabinet (LVCC) and then is passed to the Digital Interface Card.
    - The Digital Interface Card passed the data through to the VCU.

The machine is constantly monitoring these items and looking for the one component that, in its range of temperature, has the greatest demand for cooling.

© 2019 Komatsu. All rights reserved.

- If a component requires additional cooling, the VCU outputs a pulse width modulated (PWM) signal to increase the blower fan speed. This signal is sent to the Digital Interface Card.
- Then the Digital Interface Card turns on a pulse width modulated (PWM) output that flows from the Digital Interface Card through the Low voltage control cabinet connector panel, and through the RFF5 (Rear Frame Front #5) breakout box. An LED light state changes on the digital interface card when the PWM signal is sent.
- The PWM signal is delivered to the Blower Fan Control Solenoid (SOL BF). The Solenoid valve is normally closed. The lesser the duty cycle of the PWM, the faster the fan turns. If the PWM signal is off, the fan will be at its highest speed.

NOTICE

The VCU is also monitoring the Blower Fan Speed Sensor. This speed sensor is not used as a feedback device. It is only used to monitor the blower speed.

Exceptions to Normal Operation

Maintenance or higher security is required for these items. If the machine is placed into certain testing modes, the blower fan will be driven to its highest speed. These testing modes are:

- Load Bank: Load Bank testing is used for calculating engine horse power. The load bank mode will be putting energy through the grids (a known resistance) and engine horse power load can be calculated.
- Blower Fan Setup: During radiator fan setup, the solenoid can be forced high or low.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps.

- The Fan Pump / Blower Pump (FP/BP) is a tandem variable axial piston pump. It receives its oil from the hydraulic reservoir. The Blower pump sole function is to deliver oil from the hydraulic reservoir to the hydraulically driven blower fan motor. This pump's output flow is regulated by the Load Sense (LS) circuit.
- The Blower pump pressurizes the hydraulic oil and directs it to the blower fan motor. The blower fan motor is connected to a centrifugal squirrel type fan assembly. An externally mounted anti-cavitation check valve is located between the motor inlet and outlet ports.
- The outlet of the motor is sent through a 100 PSI back pressure check valve. The 100 PSI back pressure check valve is used to help prevent cavitation when the blower fan speeds change. After the check valve, the oil is then directed back to the hydraulic reservoir filter manifold.
- The oil passes through the reservoir filter manifold and is passed through the return filters located internally to the hydraulic reservoir. After passing the return filters, the oil is ready to be pulled back through the pumps and the process starts again.
- The Load Sense (LS) port on the pump is connected with a remote relief and a proportional solenoid cartridge (Blower Fan Control Solenoid (SOL BF)). Both of these control devices are in parallel.
    - The remote relief is used to control the maximum speed of the blower fan by controlling the maximum flow output of the pump.

© 2019 Komatsu. All rights reserved.

- The Radiator Fan Control Solenoid (SOL BF) is a normally closed proportional control solenoid. If the solenoid is being fully energized (maximum PWM signal) then the blower fan speed is low. If the solenoid is de-energized (no PWM signal) then the blower fan speed is high (using the remote relief pressure setting). If the PWM signal is being varied, then the blower fan speed will be regulated to some speed between slow and fast.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

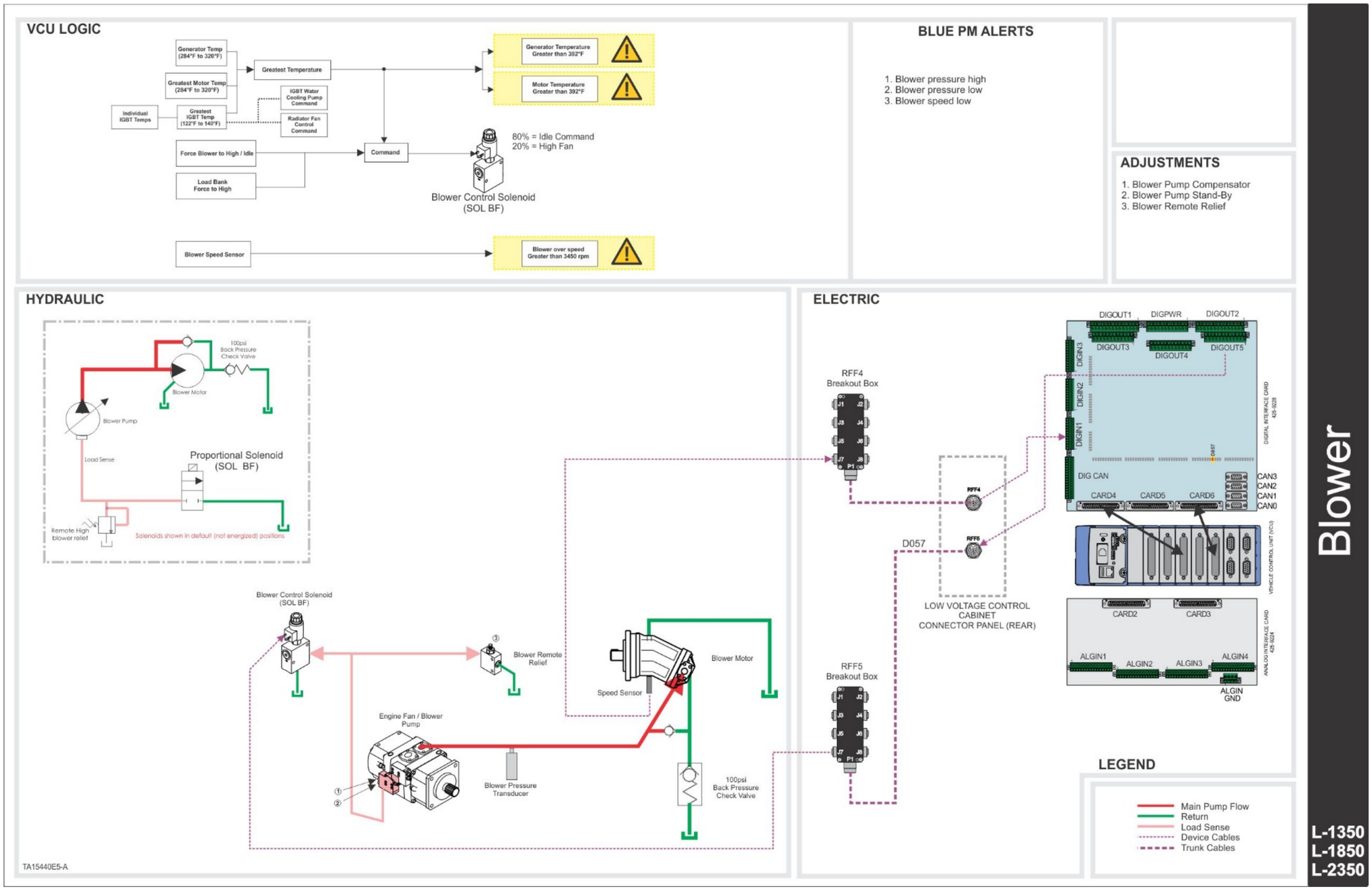


Figure 28. Blower fan control circuit description

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

HPD Gear Box Functions

The HPD Gear box has two sensors for monitoring. They are gear box oil circulation pressure and gear box oil temperature.

Electrical and VCU Logic Controls

Two sensors are used in the HPD (Hydraulic Pump Drive) gear box. They are a pressure transducer (XDR GP) and a temperature transducer (XDR GT). They are used to monitor the condition of the HPD gear box oil and generate alarms.

- Both the pressure transducer and the temperature transducers are connected to the break out box RFF4 (Rear Frame Front #4). The break out box is connected to the rear of the Low Voltage Control Cabinet (LVCC) by a Trunk cable.
- In the LVCC the two sensors signals are connected to the Analog Interface Card. The signals are conditioned and then sent to the VCU
- In the VCU, the signals are continuously monitored.
    - An over temperature will occur if the HPD Gear Box temperature is greater than 205°F degrees.
    - An under pressure alarm will occur if the oil pressure drops below 5 PSI.

Hydraulic Flow

Hydraulic Pump Drive (HPD) gear box is connected by a drive shaft to the SR Generator. The SR Generator is direct coupled to the engine. When the engine is started, the HPD gear box rotates all of the hydraulic pumps. The gear box circulation pump is attached to the hydraulic oil cooler circulation pump.

- HPD Gear box oil flows from the HPD Gear box reservoir to the inlet of the Gear Box circulation pump.
- The oil is pressurized in the pump to an output pressure of 200 psi max.
- The pressurized oil flows through a pressure filter and then into the gear box control valve where connections to the gear box oil cooler and a 200 psi pressure relief valve is located. The 200 psi relief valve prevents over pressurization of the gear box oil cooler.
- After the oil has flowed through the gear box oil cooler, the oil is directed into a manifold that houses the temperature pressure transducer and the pressure transducer. This manifold also has attached a 100 psi check valve that operates as a relief valve. Also from this manifold is attached a line (internal to the gear box) that supplies oil to a rail manifold.
- The rail manifold has spray nozzles that sprays the gear box oil into ports that direct the oil to the gear box gears bearings. The oil runs through the bearings and returns to the sump of the gear box to repeat the process.

Advanced users (service level access and higher) can force individual inputs and outputs for troubleshooting purposes.

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.

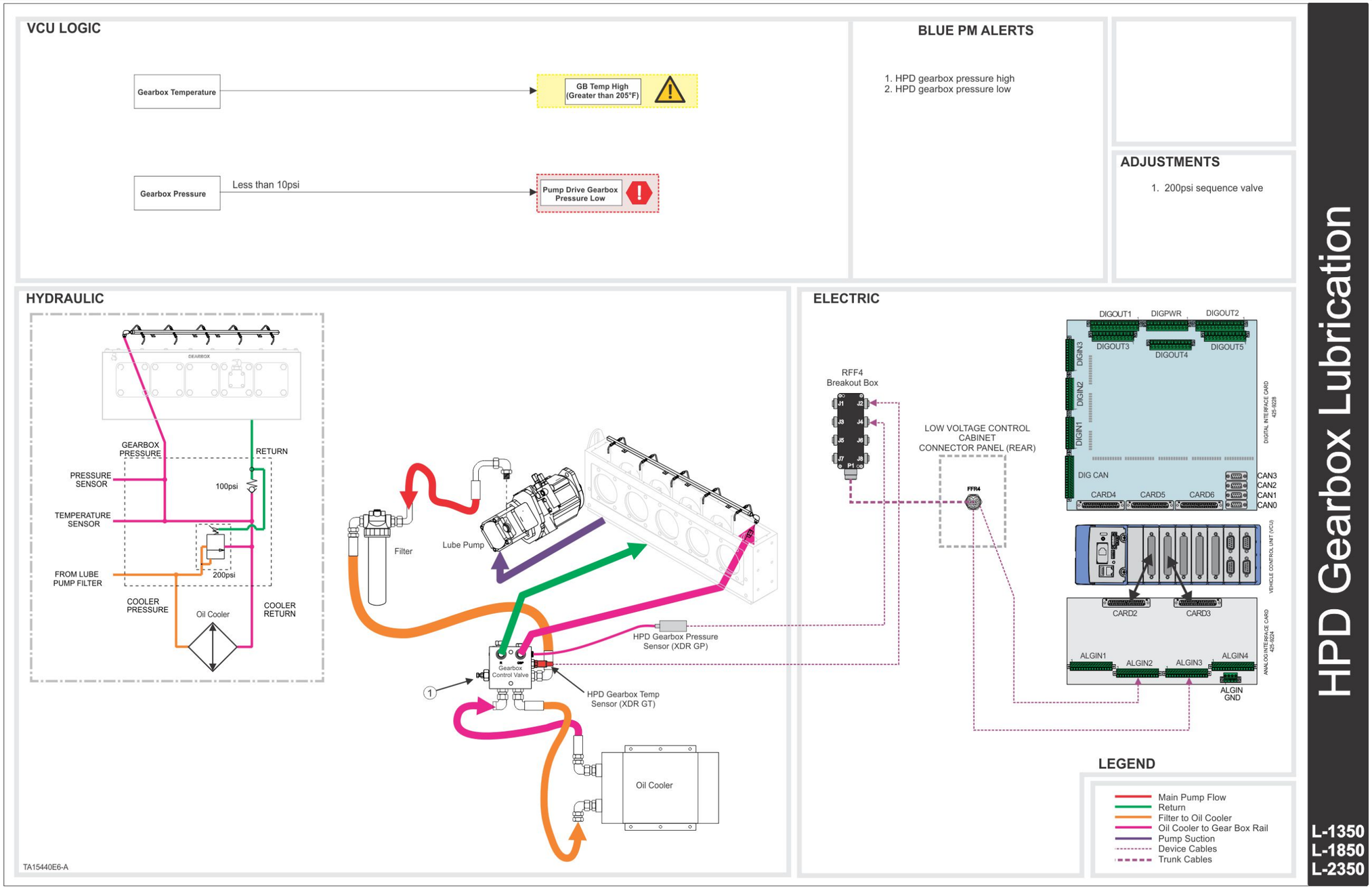


Figure 29. HPD gearbox oil cooler control circuit description

© 2019 Komatsu. All rights reserved.

This Page Intentionally Left Blank

© 2019 Komatsu. All rights reserved.