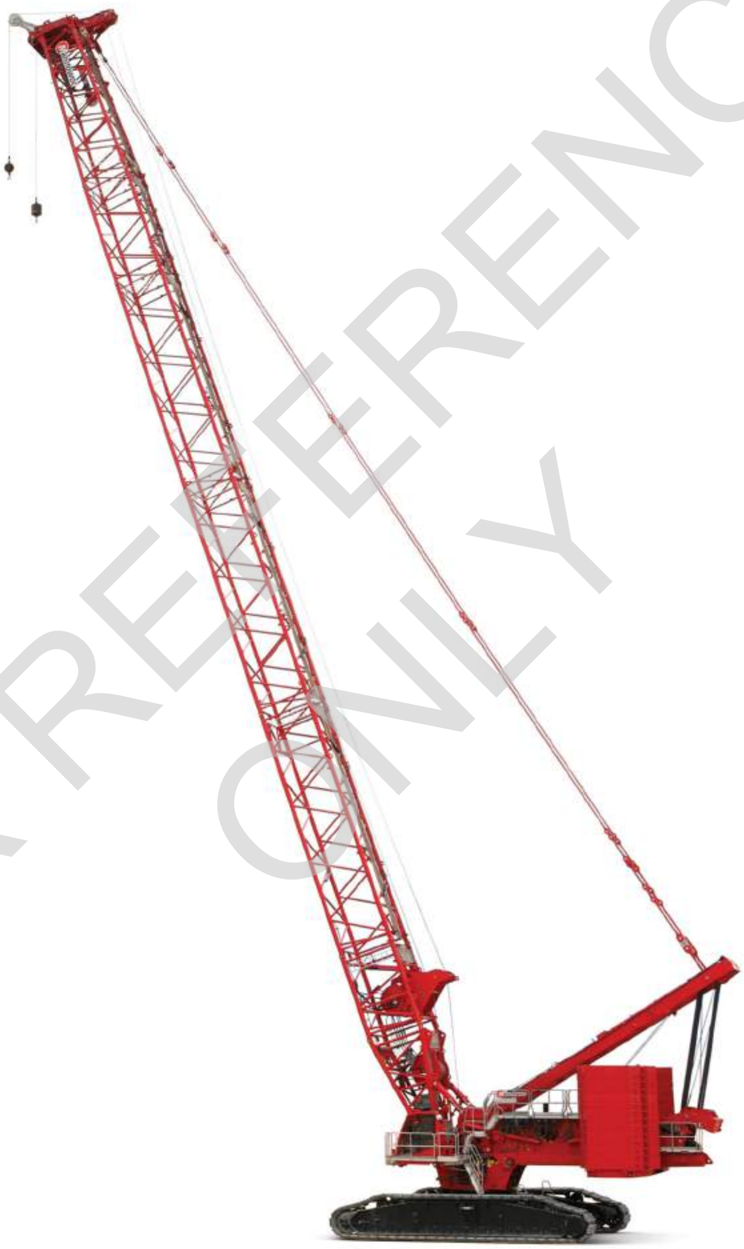
Manitowoc MLC650

Service/Maintenance Manual



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WARNING

California Proposition 65

Breathing diesel engine exhaust exposes you to chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

Always start and operate the engine in a well-ventilated area.

If in an enclosed area, vent the exhaust to the outside.

Do not modify or tamper with the exhaust system.

Do not idle the engine except as necessary.

For more information, go to www.P65warnings.ca.gov/diesel

Batteries, battery posts, terminals, and related accessories can expose you to chemcials, including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. Wash hands after handling. For more information, go to www.P65warnings.ca.gov

California Spark Arrestor

Operation of this equipment may create sparks that can start fires around dry vegetation. A spark arrestor may be required. The owner/ operator should contact local fire agencies for laws or regulations relating to fire prevention requirements.

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SERVICE/MAINTENANCE MANUAL

This manual has been prepared for and is considered part of -

MLC650

Crane Model Number

XXXXXRef

Crane Serial Number

This manual is divided into the following sections:

NOTICE

The serial number of the crane and applicable attachments (luffing jib, VPC-MAX™) is the only method your Manitowoc dealer or the Manitowoc Crane Care Lattice Team has of providing you with correct parts and service information.

The serial number is located on a crane identification plate attached to the operator's cab and each attachment. Refer to the Nameplate and Decal Assembly Drawing in Section 2 of this manual for the exact location of the crane identification plate.

Always furnish serial number of crane and its attachments when ordering parts or discussing service problems with your Manitowoc dealer or the Manitowoc Crane Care Lattice Team.

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WARNING

To prevent death or serious injury:

- Avoid unsafe operation and maintenance.

  Crane and attachments must be operated and maintained by trained and experienced personnel. Manitowoc is not responsible for qualifying these personnel.
- Do not operate or work on crane or attachments without first reading and understanding instructions contained in Operator Information Manual and Service Manual supplied with crane and applicable attachments.
- Store Operator Information Manual and Service Manual in operator's cab.

  If Operator Information Manual or Service Manual is missing from cab, contact your Manitowoc dealer for a new one.

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1 2 3 4 5 6 7 8 9 10

THE ORIGINAL LANGUAGE OF THIS PUBLICATION IS ENGLISH

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SECTION 1
INTRODUCTION

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SECTION 1
INTRODUCTION

CONTINUOUS INNOVATION

Due to continuing product innovation, the information in this manual is subject to change without notice. If you are in doubt about any procedure, contact your Manitowoc Cranes dealer or the Manitowoc Crane Care Lattice Team.

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California Proposition 65!

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California Spark Arrestor!

Operation of this equipment may create sparks that can start fires around dry vegetation. A spark arrestor may be required. The owner/operator should contact local fire agencies for laws or regulations relating to fire prevention requirements.

SAFETY MESSAGES

The importance of safe operation and maintenance cannot be overemphasized. Carelessness or neglect on the part of operators, job supervisors and planners, rigging personnel, and job site workers can result in their death or injury and costly damage to the crane and property.

To alert personnel to hazardous operating practices and maintenance procedures, safety messages are used throughout the manual. Each safety message contains a safety alert symbol and a signal word to identify the hazard's degree of seriousness.

Safety Alert Symbol

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

Signal Words

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Used with the safety alert symbol, indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

The signal word CAUTION without the safety alert symbol identifies a hazardous situation which, if not avoided, could result in property damage.

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SAFE MAINTENANCE PRACTICES

WARNING

Safety Responsibility!

The importance of safe maintenance cannot be overemphasized. Carelessness and neglect on the part of maintenance personnel can result in their death or injury and costly damage to the crane or property.

Safety information in this publication is intended only as a guide to assist qualified maintenance personnel in safe maintenance. Manitowoc cannot foresee all hazards that will arise in field. Safety remains the responsibility of maintenance personnel and the crane owner.

Read This Manual

To ensure safe and proper operation of Manitowoc cranes, they must be maintained according to the instructions contained in this manual.

Authorized Repair Personnel Only

Crane maintenance and repair must be performed by personnel who by reason of training and experience are thoroughly familiar with the crane's operation and required maintenance. These personnel must read the MLC650 Operator Manual and the MLC650 Service/Maintenance Manual before attempting any maintenance procedure. If there is any question regarding maintenance procedures or specifications, contact your Manitowoc dealer for assistance.

Training/qualification of maintenance personnel is the responsibility of the crane owner.

Basic Crane Maintenance Safety

The following precautions are basic practices. Detailed precautions and warnings are in the relevant procedures in this manual. Be sure to read all information in this manual that is relevant to the maintenance to be performed.

Before Starting a Maintenance Procedure

Perform the following actions (as applicable) before starting a maintenance procedure:

- Park the crane where it will not interfere with other equipment or operations.
- Lower all loads to the ground or otherwise secure them against movement.
- Lower the boom onto blocking at ground level, if possible, or otherwise secure the boom so that it cannot drop unexpectedly.
- Move all controls to OFF and secure all functions against movement by applying or engaging all brakes, pawls, or other locking devices.
- Stop the engine and render the starting means inoperative. This can be done by following your organization's tagout procedure.
- Place a warning sign at the start controls to alert other personnel that the crane is being serviced and the engine must not be started. Do not remove the sign until it is safe to return the crane to service.
- Wear clothing that is relatively tight and belted.
- Wear appropriate eye protection and an approved hard hat.
- Do not attempt to maintain or repair any part of the crane while the engine is running, unless it is absolutely necessary.

  If the engine must be running while the crane is being serviced, observe the following:

  - Maintain constant verbal communication between the person at the controls and the person performing the maintenance or repair procedure.
  - Keep your clothing and all parts of your body away from moving parts.

Precautions While Working on the Crane

- Never climb onto or off a moving crane. Climb onto and off the crane only when it is parked and only with the operator's permission.

  To climb onto and off the crane, use both of your hands and also use the handrails, steps, and ladders that are provided.

  Use hand lines or hoists to lift tools and other equipment that cannot be carried in pockets or tool belts.
- The boom and gantry are not intended for use as ladders. Do not attempt to climb the lattice work of the boom or gantry. If the boom or gantry is not equipped with an approved ladder, lower it before performing maintenance or repair procedures.
- Store tools, oil cans, spare parts, and other necessary equipment in tool boxes. Do not allow these items to lie around loose in the operator's cab or on the walkways and stairs.
- Pinch points are impossible to eliminate. Watch for them closely.
- Do not attempt to lift heavy components by hand. Use a hoist, jacks, or blocking to lift components.
- Never handle the wire rope with bare hands. Always wear heavy-duty gloves to prevent being cut by broken wires.

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Stored Energy Safety Precautions

- Do not remove an actuating cylinder until the actuated part has been securely restrained against movement.
- Pressurized air, coolant, and hydraulic oil can cause serious injury. Make sure all air, coolant, and hydraulic lines, fittings, and components are tight and serviceable.

Do not use your hands to check for air and hydraulic oil leaks:

  - Use a soap-and-water solution to check for air leaks (apply to fittings and lines and watch for bubbles).
  - Use a piece of cardboard or wood to check for coolant and hydraulic oil leaks.

- Relieve pressure before disconnecting air, coolant, and hydraulic lines and fittings.
- Use extreme care when handling coiled pendants. Stored energy can cause coiled pendants to uncoil quickly with considerable force.
- When inflating tires, use a tire cage, a clip-on inflator, and an extension hose that permits standing well away from tire.
- Do not remove the radiator cap while the coolant is hot or under pressure. Stop the engine, wait until the pressure drops and coolant cools, then slowly remove the cap.
- Avoid a battery explosion—do not smoke while performing battery maintenance and do not short across the battery terminals to check its charge.
- Read the safety information in the battery manufacturer's instructions before attempting to charge a battery.

Chemical Handling Precautions

- Avoid battery acid contact with skin and eyes. If contact occurs, flush the area with water and immediately consult a doctor.

Fire Hazard Precautions

- Stop the engine before refueling the crane.
- Do not smoke or allow open flames in the refueling area.
- When using a fuel can, use a safety-type can with an automatic closing cap and flame arrestor.
- Hydraulic oil can also be flammable. Do not smoke or allow open flames in the area when filling hydraulic tanks.
- Only use cleaning solvents which are nonvolatile and nonflammable.
- Do not store flammable materials on the crane.
- Use care while welding or burning on the crane. Cover all hoses and components with nonflammable shields or blankets to prevent a fire or other damage.
- Keep the crane clean. Accumulations of dirt, grease, oil, rags, paper, and other waste will not only interfere with safe operation and maintenance, but also create a fire hazard.

Welding Hazard Avoidance

- Welding—To prevent damage to the crane parts (bearings, cylinders, swivels, slewing ring, computers, etc.), perform the following steps before welding on the crane.

  a. Turn the battery disconnect switch to the OFF position.

  b. Disconnect all the cables from the batteries. Make sure to disconnect the negative cable first.

  c. Disconnect the output cables at the engine junction box.

  d. Disconnect all cable connectors from nearby control modules.

  e. Attach a ground cable from the welder directly to the part being welded and as close to the weld as possible.

  Do not weld on the engine or the engine-mounted parts (per engine manufacturer).

- Disconnect and lock out the power supply switch before attempting to service high-voltage electrical components and before entering tight areas (such as carbody openings) containing high voltage components.

Maintain Structural Integrity of the Crane

- When assembling and disassembling booms, jibs, or masts on the ground (with or without the support of boom rigging pendants or straps), securely block each section to provide adequate support and alignment.

Do not go under the boom, jib, or mast sections while connecting bolts or pins are being removed.

- Unless authorized in writing by Manitowoc, do not alter the crane in any way that affects the crane's performance (to include welding, cutting, or burning of structural members or changing pressures and flows of air/hydraulic components). Doing so will invalidate all warranties and capacity charts and make the crane owner/user liable for any resultant accidents.

FOR REFERENCE ONLY

Returning Crane to Service

- Do not return the crane to service until:
  - All guards and covers have been reinstalled.
  - Trapped air has been bled from hydraulic systems.
  - Safety devices have been reactivated.
  - All tools and maintenance equipment have been removed.
- Perform a function check to ensure proper operation at the completion of the maintenance or repair.

PROTECTION OF THE ENVIRONMENT

WARNING

Environmental Damage!

Dispose of waste properly! Improperly disposing of waste can cause environmental damage.

Potentially harmful waste used in Manitowoc cranes includes—but is not limited to—oil, fuel, grease, coolant, air conditioning refrigerant, filters, batteries, and cloths that have come into contact with harmful substances.

Handle and dispose of waste according to local, state, and federal environmental regulations.

When filling and draining crane components, do not pour waste fluids onto the ground, down any drain, or into any source of water. Observe the following:

- Always drain waste fluids into leak-proof containers that are clearly marked with what they contain.
- Always fill or add fluids with a funnel or a filling pump.
- Immediately wipe up any spills.

IDENTIFICATION AND LOCATION OF MAJOR COMPONENTS

See Figure 1-1 and Figure 1-2 for locations of the crane's major components.

See Section 2: Hydraulics in this service manual for locations of the following:

- Hydraulic pumps
- Hydraulic motors
- Transducer manifold
- Hydraulic valve assemblies

See Section 3: Electrical for locations of the electronic control modules.

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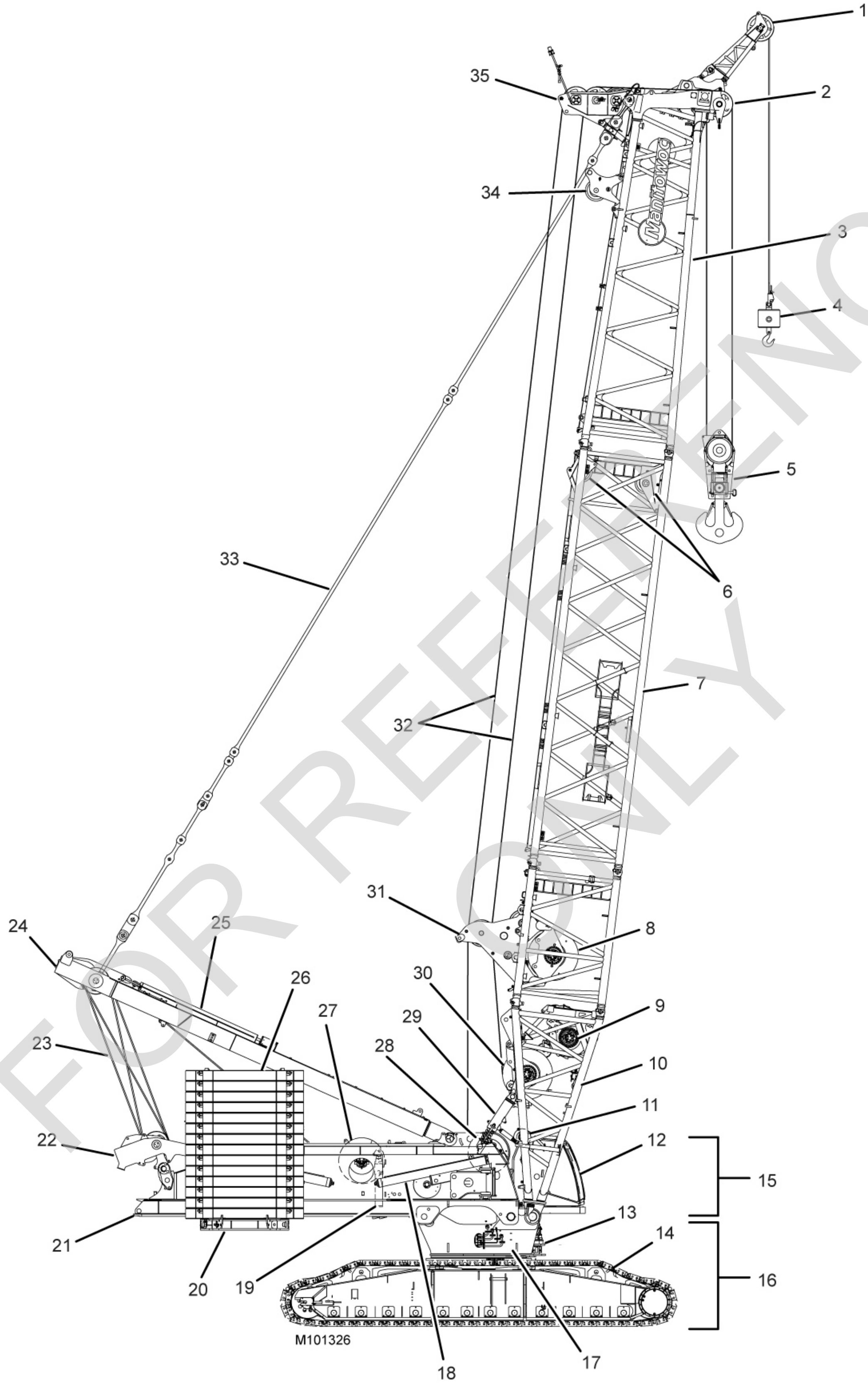

Item	Description
1	Upper Boom Point
2	Lower Boom Point
3	Boom Top
4	Weight Ball
5	Load Block
6	Rope Guide
7	12M Heavy Insert
8	Drum 2 (main hoist) (optional)
9	Drum 6 (luffing hoist)
10	Boom Butt
11	Drum 0 (rigging winch)
12	Operator Cab
13	Swing Drive / Carbody
14	Crawler Assembly
15	Upperworks
16	Lowerworks
17	Adapter Frame
18	Jacking Cylinder
19	Mast- Assist Arms
20	VPC Tray
21	Rotating Bed
22	Gantry
23	Wire Rope
24	Live Mast
25	Self-Assembly Cylinder
26	Counterweight Box (as required)
27	Drum 4 (boom hoist/ mast hoist)
28	Drum 3 (whip hoist)
29	Boom Stop
30	Drum 1 (main hoist)
31	Wire Rope Guide
32	Load Lines
33	Boom Straps
34	Luffing Jib Rope Guide
35	Wire Rope Guide

FOR REFERENCE ONLY

FIGURE 1-1

Item	Description
1	Live Mast Sheaves
2	Self-Assembly Cylinder
3	Live Mast Links/Straps
4	Drum 4 (boom hoist/mast hoist)
5	Mast Raising Cylinder
6	Fuel Tank
7	Drum 3 (whip hoist)
8	Boom Stop Switch
9	Cab
10	Inboard Tread Slack Adjustment
11	Carbody/Crawler Pin Puller
12	Boom Hinge Pin
13	Swing Drive Non-VPC (qty 2) VPC and VPC-MAX (qty 3)
14	Adapter Frame/Rotating Bed Pin Puller
15	Crawler Drive
16	Crawler
17	Intermediate Roller
18	Turntable Bearing
19	Adapter Frame
20	Outboard Tread Slack Adjustment
21	Rotating Bed/Adapter Frame Pin Puller
22	Rotating Bed Jacking Cylinder
23	Gear Rack
24	Counterweight Tray
25	Counterweight Box (as required)
26	VPC Drive
27	VPC Roller
28	Backhitch Link
29	Gantry
30	Gantry Sheaves
31	Live Mast

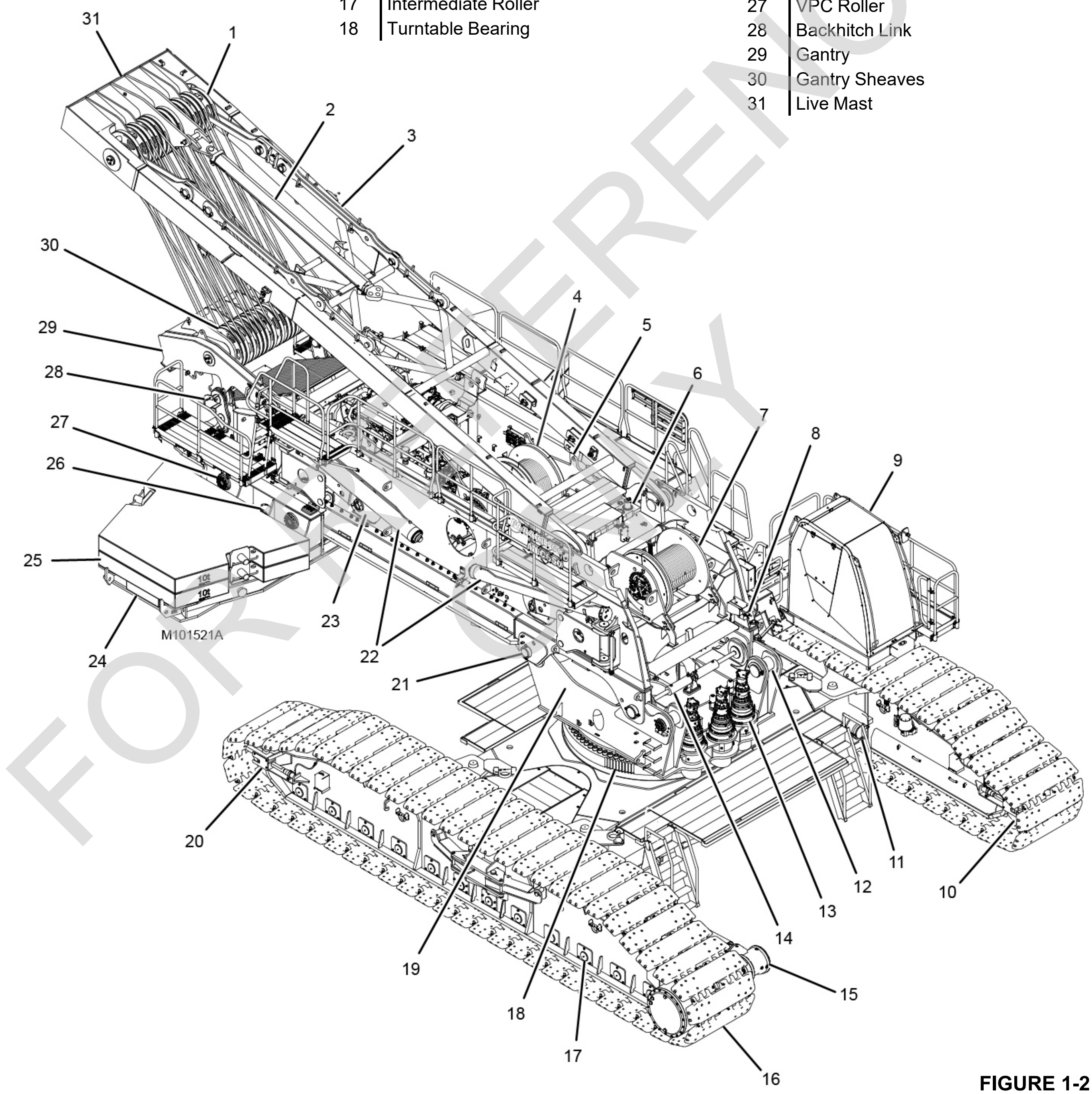

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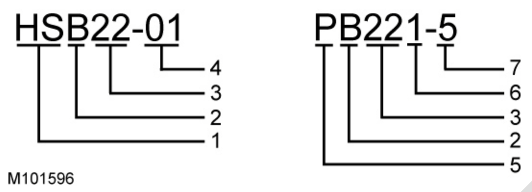
FIGURE 1-2

Solenoid Valve Identification

Each hydraulic valve solenoid is assigned a solenoid number used in Manitowoc Cranes training classes (Table 1-1). The pin number corresponds to the control module connector pin number, as represented in the electrical schematics.

The control module information contained in each solenoid or pin number is illustrated in Figure 1-3. In this example, for the right rear carbody jack raise solenoid, the following information is contained:

- Control module resides on CAN Bus B
- Control module index is 22
- Control module digital output is ODH3A-01
- Control module output signal is at pin 5, connector KS-1



Item	Description
1	Hydraulic Solenoid Reference Designator
2	CAN Bus (- = controller resides on multiple buses)
3	CAN Bus Index
4	Digital Output Number
5	Connector Reference Designator
6	Connector Number (1 = KS1, 2 = KS2)
7	Pin Number

FIGURE 1-3

Table 1-1. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSB22-01	Right Rear Carbody Jack Raise	PB221-5
HSB22-02	Right Rear Carbody Jack Lower	PB221-6
HSB11-04	Left Crawler/Carbody Pin Puller Extend	PB112-22
HSB11-05	Left Crawler/Carbody Pin Puller Retract	PB112-5
HSB11-06	Right Crawler/Carbody Pin Puller Extend	PB112-15
HSB11-07	Right Crawler/Carbody Pin Puller Retract	PB112-14
HSB11-15	Remote/Manual Jacking Selector Valve	PB112-7
HSB11-23	Left Front Carbody Jack Raise	PB111-1
HSB11-24	Left Front Carbody Jack Lower	PB112-12
HSB11-25	Right Front Carbody Jack Raise	PB111-15
HSB11-26	Right Front Carbody Jack Lower	PB111-42
HSB11-27	Left Rear Carbody Jack Raise	PB111-28
HSB11-28	Left Rear Carbody Jack Lower	PB111-2
HS-10-03	Rear Frame Pin Pusher Extend	P-102-2
HS-10-04	Rear Frame Pin Pusher Retract	P-102-22
HS-10-11	Cab Tilt Up	P-102-24
HS-10-12	Cab Tilt Down	P-102-25
HS-10-13	Left Track/Drum 1 Diverter	P-102-6
HS-10-14	Right Track/Drum 2 Diverter	P-102-16
HS-10-15	Drum 1/Drum 6 Diverter	P-102-7
HS-10-16	Drum 3/Drum 2 Diverter	P-102-26
HS-10-23	Left Front Jack Extend	P-101-1
HS-10-24	Left Front Jack Retract	P-102-12
HS-10-25	Right Front Jack Extend	P-101-15
HS-10-26	Right Front Jack Retract	P-101-42
HS-10-27	Left Rear Jack Extend	P-101-28
HS-10-28	Left Rear Jack Retract	P-101-2
HSC11-02	Drum 1 Left Brake Release	PC112-21

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Table 1-1. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSC11-06	Drum 2 Left Brake Release	PC112-15
HSC11-07	Drum 6 Pawls In	PC112-14
HSC11-08	Drum 6 Pawls Out	PC112-4
HSC11-09	Drum 6 Brake Release	PC112-3
HSC11-12	Drum 5 Pawls In	PC112-25
HSC11-13	Drum 5 Pawls Out	PC112-6
HSC11-14	Drum 5 Left and Right Brake Releases	PC112-16
HSC30-03	Drum 3 Right Brake Release	PC302-24
HSC30-05	Swing Brake Release	PC302-25
HSC30-07	Travel Brake Release	PC302-7
HSC30-11	Front Frame Pin Pusher Extend	PC302-27
HSC30-12	Front Frame Pin Pusher Retract	PC302-9
HSC30-16	Left Mast Cylinder PSI Reducing	PC302-29
HSC30-17	Right Mast Cylinder PSI Reducing	PC302-19
HSC30-18	Self-Assembly Cylinder Extend	PC301-5
HSC30-19	Self- Assembly Cylinder Retract	PC301-6
HSC30-20	Mast Raise	PC301-7
HSC30-21	Mast Lower	PC301-8
HSC31-03	VPC Actuator Brake	PC312-24
HSC31-04	VPC1/VPC2 Diverter	PC312-6
HSC31-05	VPC Tray Brake	PC312-25
HSC31-10	Left Cylinder Stowage Extend	PC312-8
HSC31-11	Left Cylinder Stowage Retract	PC312-27
HSC31-12	Right Cylinder Stowage Extend	PC312-9
HSC31-13	Right Cylinder Stowage Retract	PC312-28
HSC31-14	Right Rear Jack Extend	PC312-18
HSC31-15	Right Rear Jack Retract	PC312-10
HSC31-18	Rigging Winch Spool In	PC311-5
HSC31-19	Rigging Winch Spool Out	PC311-6
HSC32-02	Drum 4 Pawls Out	PC322-5
HSC32-03	Drum 4 Pawls In	PC322-24

Table 1-1. Hydraulic Solenoid Identification

Solenoid Number	Description	Pin Number
HSC32-04	Drum 4 Right Brake Release	PC322-6
HSC33-11	Left Mast Cylinder Directional Control	PC332-27
HSC33-12	Right Mast Cylinder Directional Control	PC332-9
HSC34-17	Cooler Fan Pump	PC342-19
HSC35-02	VPC Actuator Pin Extend	PC352-5
HSC35-03	VPC Actuator Pin Retract	PC352-24
HSC35-09	Beam/Foot Upper Pin Extend	PC352-17
HSC35-10	Beam/Foot Upper Pin Retract	PC352-8
HSC35-11	Beam/Foot Lower Pin Extend	PC352-27
HSC35-12	Beam/Foot Lower Pin Retract	PC352-9
HSD01-07	Main Right Strut Collapse	PD011-2
HSD01-02	Main Left Strut Collapse	PD011-7
HSD01-08	Jib Stop Cylinder Collapse	PD011-15

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SECTION 2
HYDRAULIC SYSTEM

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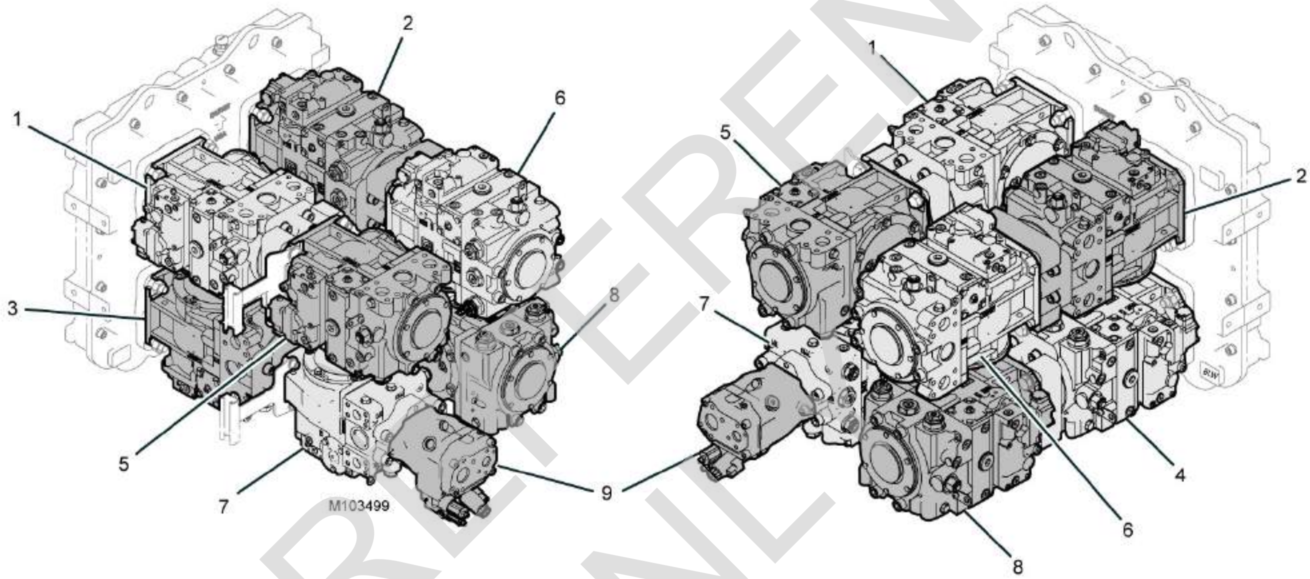
SECTION 2
HYDRAULIC SYSTEM

HYDRAULIC SYSTEM OVERVIEW

This section provides a physical description and general functional overview of the major hydraulic components. The detailed description of the control and operation using these components to form working circuits can be found in the appropriate functional sections of this manual.

Hydraulic Pump Locations

There are nine hydraulic pumps driven by the engine. Figure 2-1 illustrates the location of these pumps within the engine and pump assembly and the motors and cylinders that each drives. Diverter valves allow some pumps to drive multiple functions as well as combine pump flows from multiple pumps to drive a single function.



Item	Description
1	Pump 1—Drums 1 and 6
2	Pump 2—Drums 2 and 3
3	Pump 3—Drum 1 and Left Travel
4	Pump 4—Drum 2 and Right Travel
5	Pump 5—Drum 4
6	Pump 6—Drum 5
7	Pump 7—VPC Tray and Beam
8	Pump 8—Swing
9	Pump 9—Accessories

FIGURE 2-1

FOR REFERENCE ONLY

HYDRAULIC PUMP IDENTIFICATION

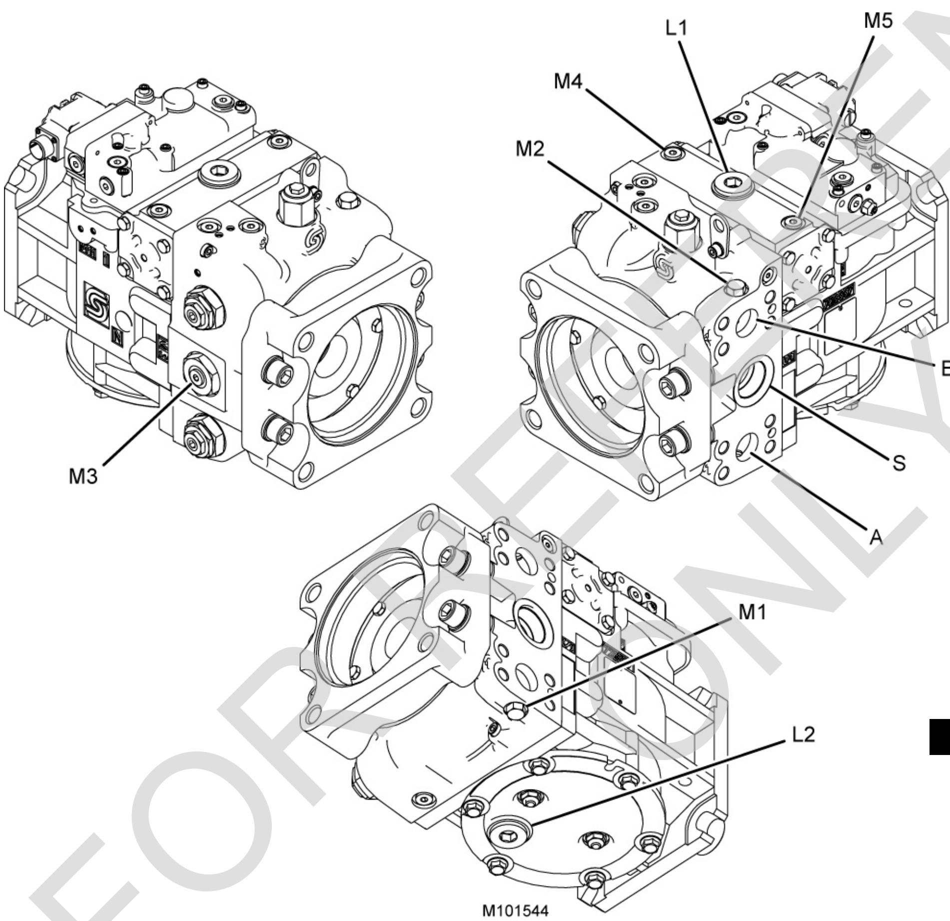
Pumps 1, 2, and 4

Pumps one, two, and four (Figure 2-2) are bidirectional variable-displacement pumps. Pump direction and displacement is controlled by an electronic displacement control (EDC).

Pump one provides flow to either drum one or six. A diverter valve, driven by CCM—10, provides pump flow to the drum commanded by the control system. The EDC is driven by the IOLC32 control module.

Pump two provides flow to either drum two or three. A diverter valve, driven by CCM—10, provides pump flow to the drum commanded by the control system. The EDC is driven by the IOLC32 control module.

Pump four provides flow to either drum two or the right travel motors. A diverter valve, driven by CCM—10, provides pump flow to either drum two or the right travel motors, as commanded by the control system. The EDC is driven by the IOLC32 control module.



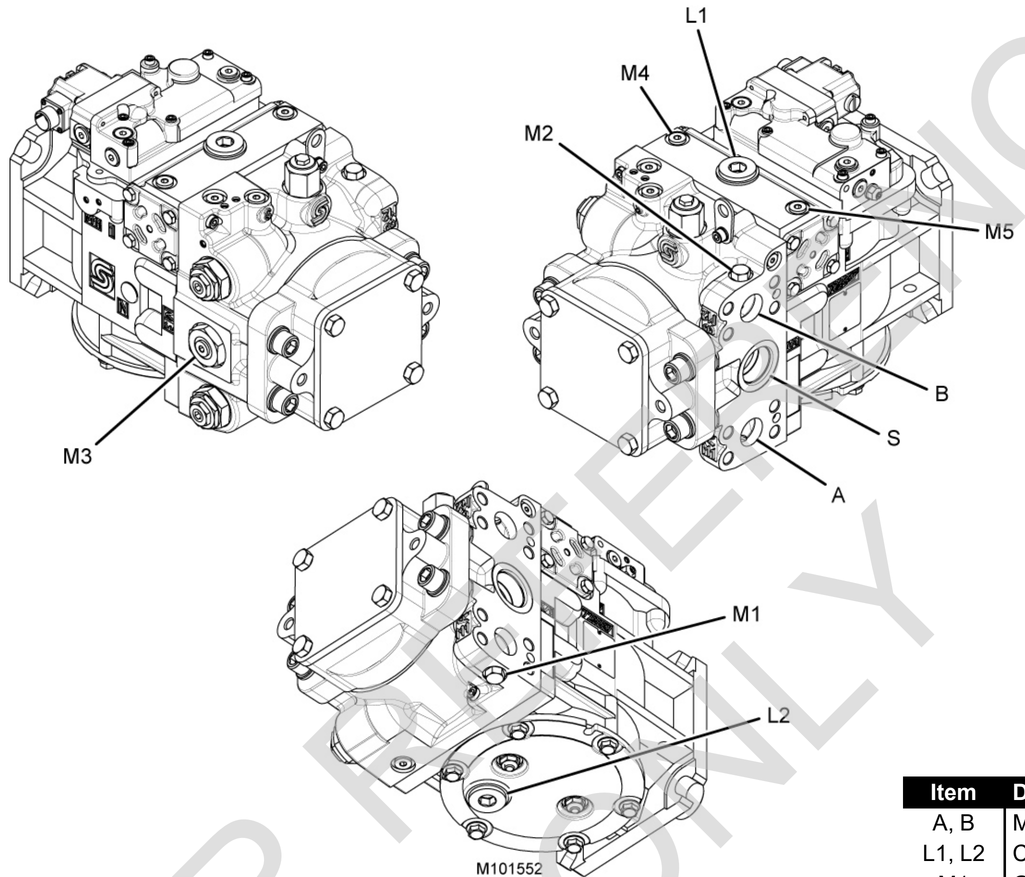
Item	Description
A, B	Main Pressure Lines
L1, L2	Case Drain Ports
M1	Gauge Port—A
M2	Gauge Port—B
M3	Gauge Port—Charge Pressure
M4, M5	Gauge Ports—Servo Pressure
S	Suction Line—Charge Pump

FIGURE 2-2

FOR REFERENCE ONLY

Pump 3

Pump three (Figure 2-3) is a bidirectional variable-displacement pump providing flow to either drum one or the left travel motors. A diverter valve, driven by CCM—10, provides pump flow to either drum one or the left travel motors, as commanded by the control system. Pump direction and displacement is controlled by an electronic displacement control (EDC), driven by the IOLC32 control module.



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Item	Description
A, B	Main Pressure Lines
L1, L2	Case Drain Ports
M1	Gauge Port—A
M2	Gauge Port—B
M3	Gauge Port—Charge Pressure
M4, M5	Gauge Ports—Servo Pressure
S	Suction Line—Charge Pump

FIGURE 2-3

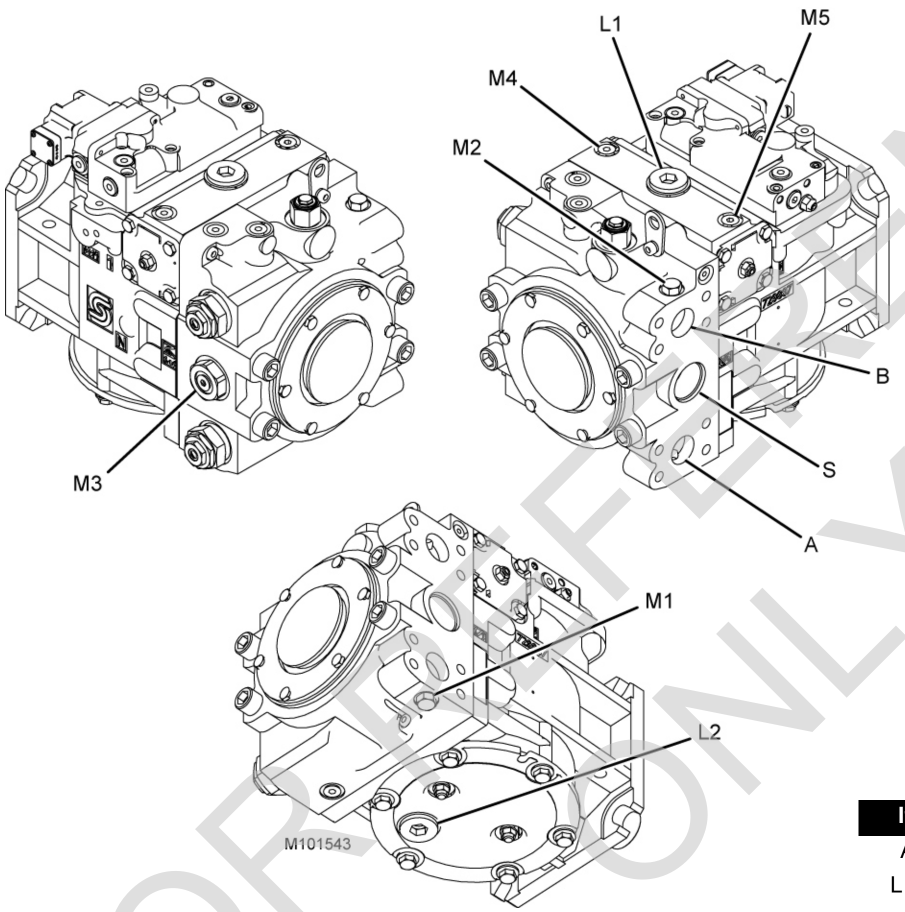
Pumps 5, 6, and 8

Pumps five, six, and eight (Figure 2-4) are bidirectional variable-displacement pumps. Pump direction and displacement is controlled by an electronic displacement control (EDC).

Pump five provides flow to drum four. The EDC is driven by the IOLC33 control module.

Pump six provides flow to drum five. The EDC is driven by the IOLC33 control module.

Pump eight provides flow to the swing motors. Pump direction and displacement is controlled by an EDC, driven by the IOLC33 control module.



Item	Description
A, B	Main Pressure Lines
L1, L2	Case Drain Ports
M1	Gauge Port—A
M2	Gauge Port—B
M3	Gauge Port—Charge Pressure
M4, M5	Gauge Ports—Servo Pressure
S	Suction Line—Charge Pump

FIGURE 2-4

FOR REFERENCE ONLY

Pump 7

Pump seven (Figure 2-5) is a bidirectional variable-displacement pump providing flow to either the variable position counterweight (VPC) tray or beam motors. A diverter valve, driven by IOLC31, provides pump flow to either the tray or beam motors, as commanded by the control system. Pump direction and displacement is controlled by an electronic displacement control (EDC), driven by the IOLC33 control module.

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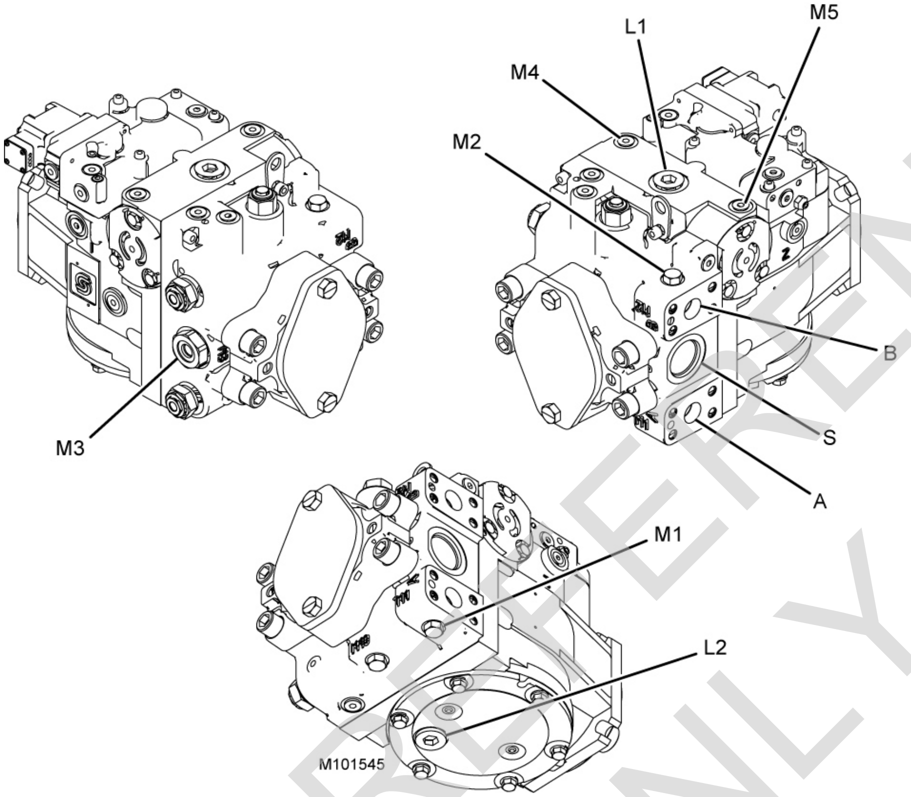
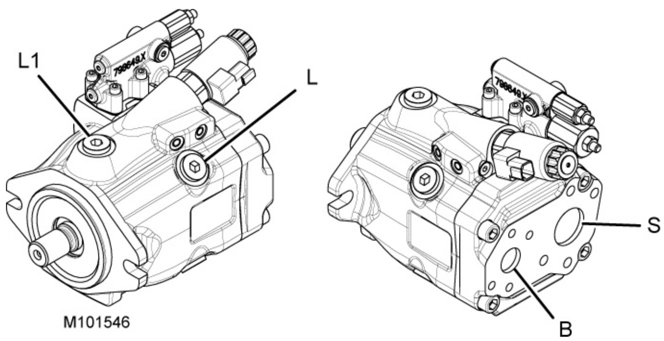


Item	Description
A, B	Main Pressure Lines
L1, L2	Case Drain Ports
M1	Gauge Port—A
M2	Gauge Port—B
M3	Gauge Port—Charge Pressure
M4, M5	Gauge Ports—Servo Pressure
S	Suction Line—Charge Pump

FIGURE 2-5

Pump 9

Pump nine (Figure 2-6) is a unidirectional variable-displacement pump providing flow to the accessories. The displacement is controlled by a proportional solenoid valve, driven by the IOLC34 control module.



Item	Description
B	Outlet Port
L, L1	Case Drain Ports
S	Suction Port

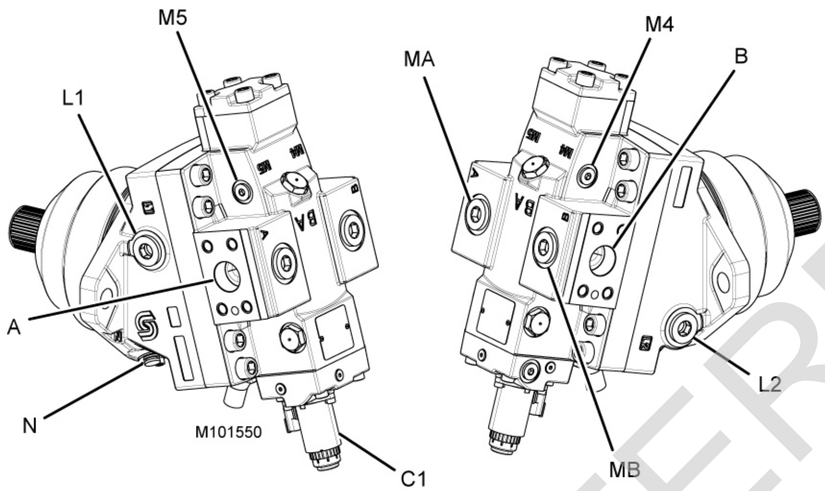
FIGURE 2-6

HYDRAULIC MOTOR IDENTIFICATION

Variable Displacement Motors

Drum 1, 2, and 4 Motors

Drum one, two, and four motors (Figure 2-7) are bidirectional variable-displacement motors. Motor displacement is controlled by an electronic motor controller. Electronic control of drum motors one and two is provided by the CCMCII control module. Electronic control of the drum 4 motor is provided by the IOLC34 control module.



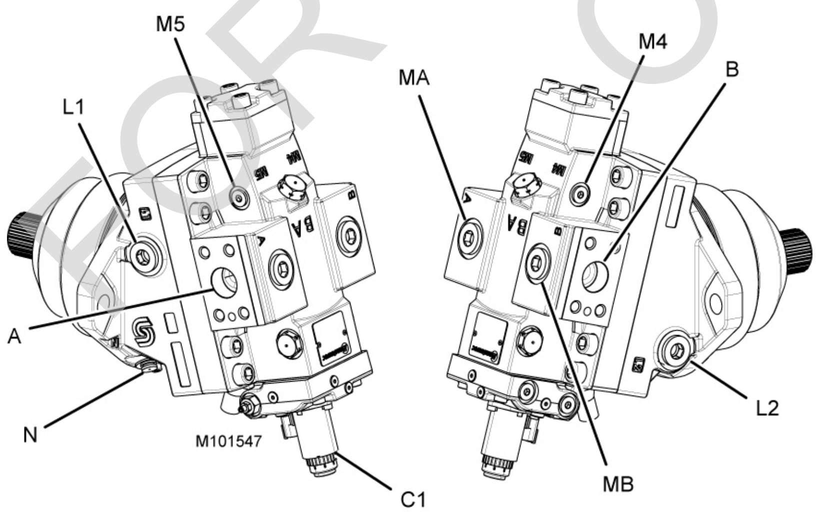
Item	Description
A, B	System Pressure Lines
C1	Solenoid
L1, L2	Drain Ports
MA, MB	Gauge Ports—System Pressure
M4, M5	Gauge Ports—Servo Pressure
N	Speed Sensor

FIGURE 2-7

Drum 3 and 6 Motors

Drum three and six motors (Figure 2-8) are bidirectional variable-displacement motors. Motor displacement is controlled by an electronic motor controller. Electronic control of drum motors three and six is provided by the following control modules:

- IOLC30—Drum Three
- CCMCII—Drum Six



Item	Description
A, B	System Pressure Lines
C1	Solenoid
L1, L2	Drain Ports
MA, MB	Gauge Ports—System Pressure
M4, M5	Gauge Ports—Servo Pressure
N	Speed Sensor

FIGURE 2-8

FOR REFERENCE ONLY

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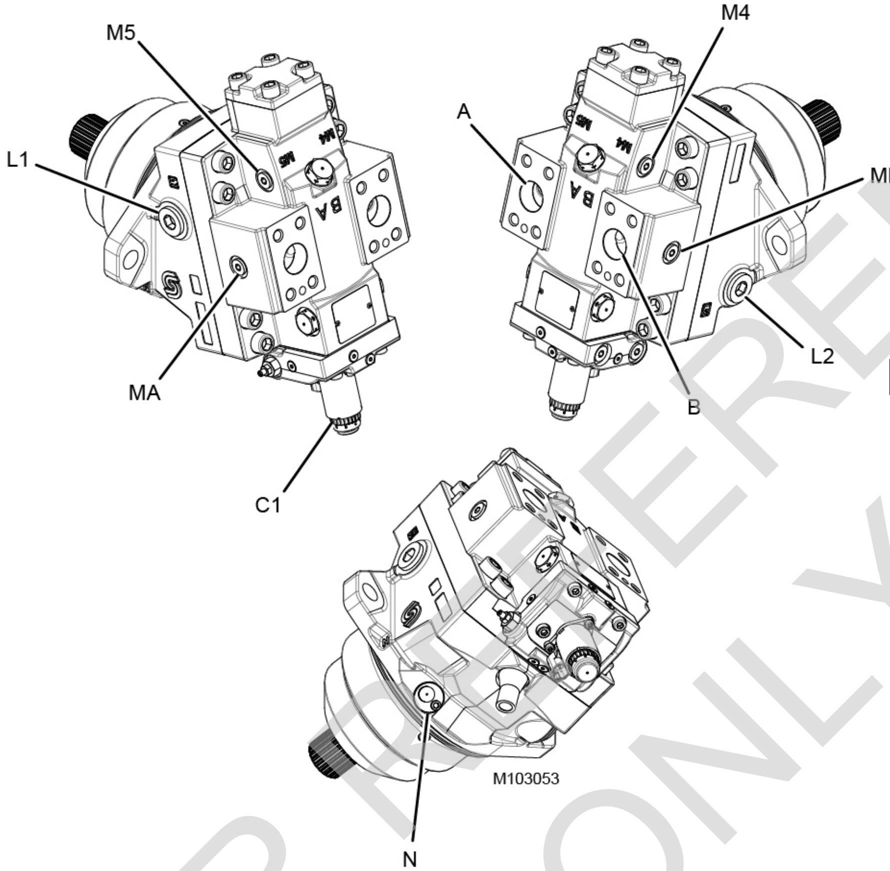
Drum 5 Motor—VPC-MAX^{TM} Boom Hoist Motor

Drum five motor (Figure 2-9) is a bidirectional variable-displacement motor. Motor displacement is controlled by an electronic motor controller. Electronic control of the drum five motor is provided by the IOL30 control module.



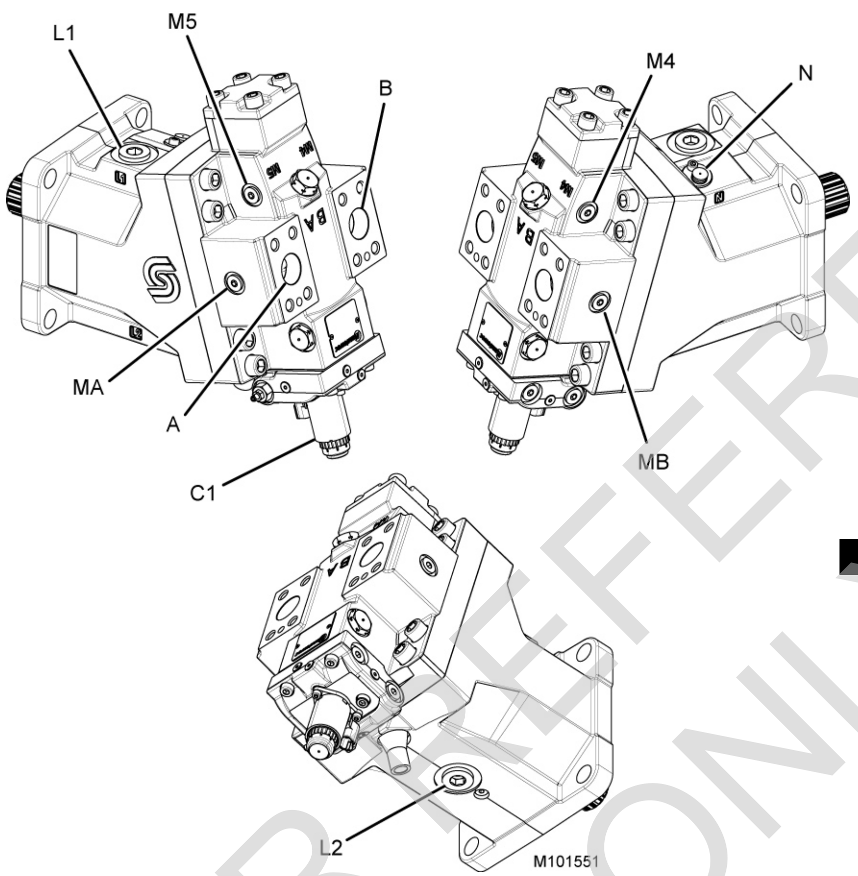
Item	Description
A, B	System Pressure Lines
C1	Solenoid
L1, L2	Drain Ports
MA, MB	Gauge Ports—System Pressure
M4, M5	Gauge Ports—Servo Pressure
N	Speed Sensor

FIGURE 2-9

FOR REFERENCE ONLY

Travel Motor

The travel motors (Figure 2-10) are bidirectional variable-displacement motors. Motor displacement is controlled by an electronic motor controller. Electronic control of the travel motors is provided by the IOSB22 control module.



Item	Description
A, B	System Pressure Lines
C1	Solenoid
L1, L2	Drain Ports
M4, M5	Gauge Port—Servo Pressure
MA, MB	Gauge Port—System Pressure
N	Speed Sensor

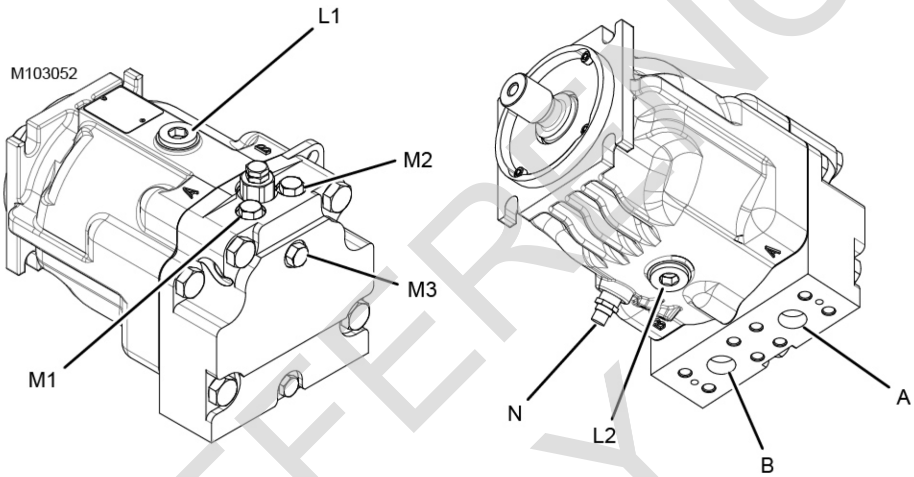
FIGURE 2-10

FOR REFERENCE ONLY

Fixed Displacement Motors

The following motors (Figure 2-11) are bidirectional fixed displacement motors.

- Swing Motor
- Variable Position Counterweight (VPC) Tray Motor
- VPC-MAX Trolley Actuator Motor



Item	Description
A, B	System Pressure Lines
L1, L2	Drain Ports
M1, M2	Gauge Ports—System Pressure
M3	Charge Flush Port
N	Speed Sensor

FIGURE 2-11

FOR REFERENCE ONLY

MANIFOLD IDENTIFICATION

Pressure Transducer and Accessories Manifold

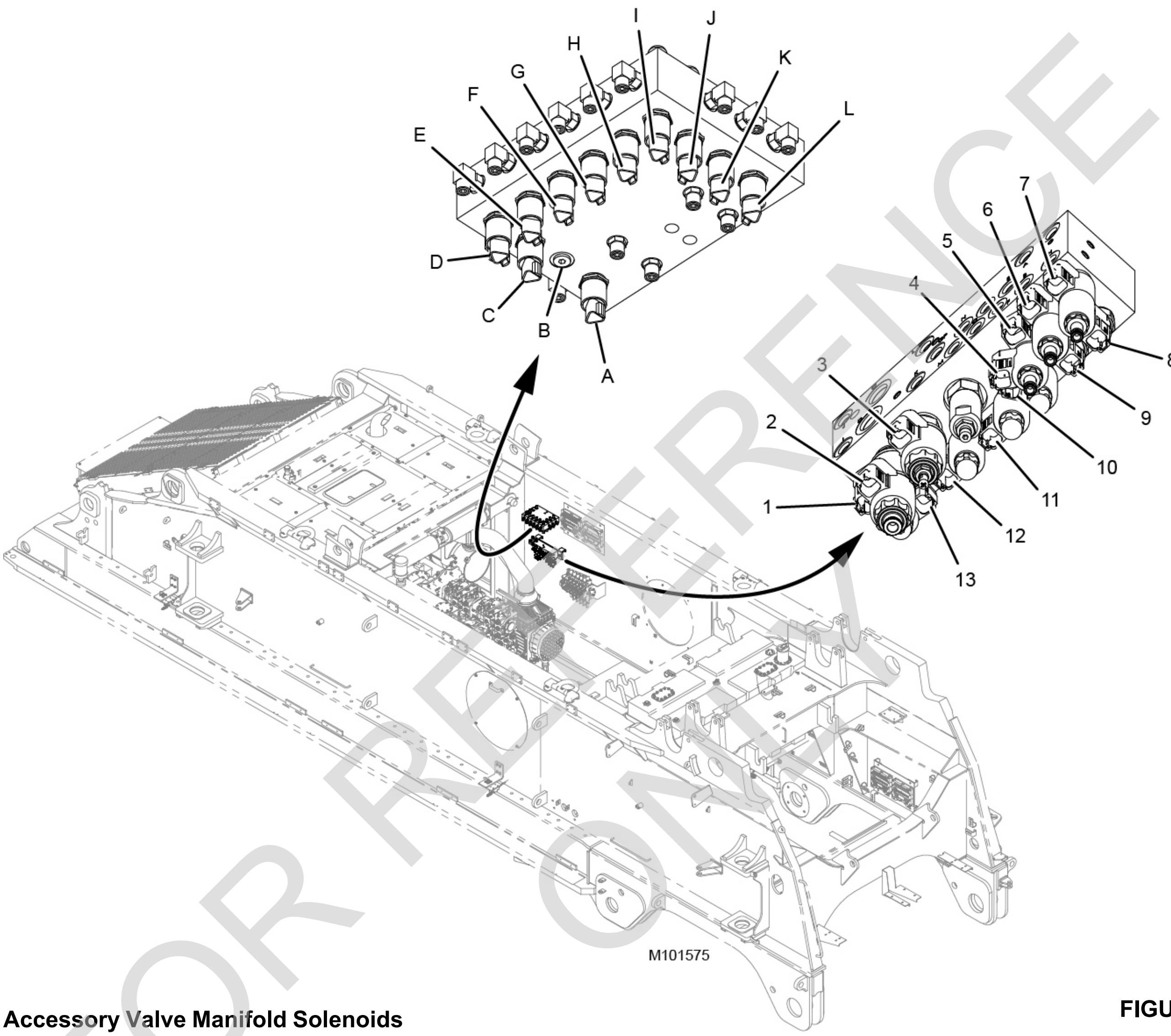


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FIGURE 2-12

Accessory Valve Manifold Solenoids

Item	Description
1	Rotating Bed Pin Puller—Retract
2	Rotating Bed Pin Puller—Extend
3	Accessory Pressure Proportional Control
4	Cab Tilt—Extend
5	Cab Tilt—Retract
6	Right Cylinder Stowage—Extend
7	Left Cylinder Stowage—Extend
8	Left Cylinder Stowage—Retract
9	Right Cylinder Stowage—Retract
10	Drum2/Drum 3 Diverter
11	Right Travel Drum 2 Diverter
12	Drum 1/Drum 6 Diverter
13	Left Travel Drum 1 Diverter

Pressure Transducer Manifold

Item	Description
A	Left Travel/Drum 1 Up—Pump 3 Pressure Transducer
B	N/A
C	Drum 1/Luffing Up—Pump 1 Pressure Transducer
D	VPC Retract—Pump 7 Pressure Transducer
E	VPC Extend—Pump 7 Pressure Transducer
F	Drum 4 Up—Pump 5 Pressure Transducer
G	Drum 3/Drum 2 Up—Pump 2 Pressure Transducer
H	Swing Right—Pump 8 Pressure Transducer
I	Swing Left—Pump 8 Pressure Transducer
J	Accessory Pressure—Pump 9 Pressure Transducer
K	Drum 5 Up—Pump 6 Pressure Transducer
L	Right Travel/Drum 2—Pump 4 Pressure Transducer

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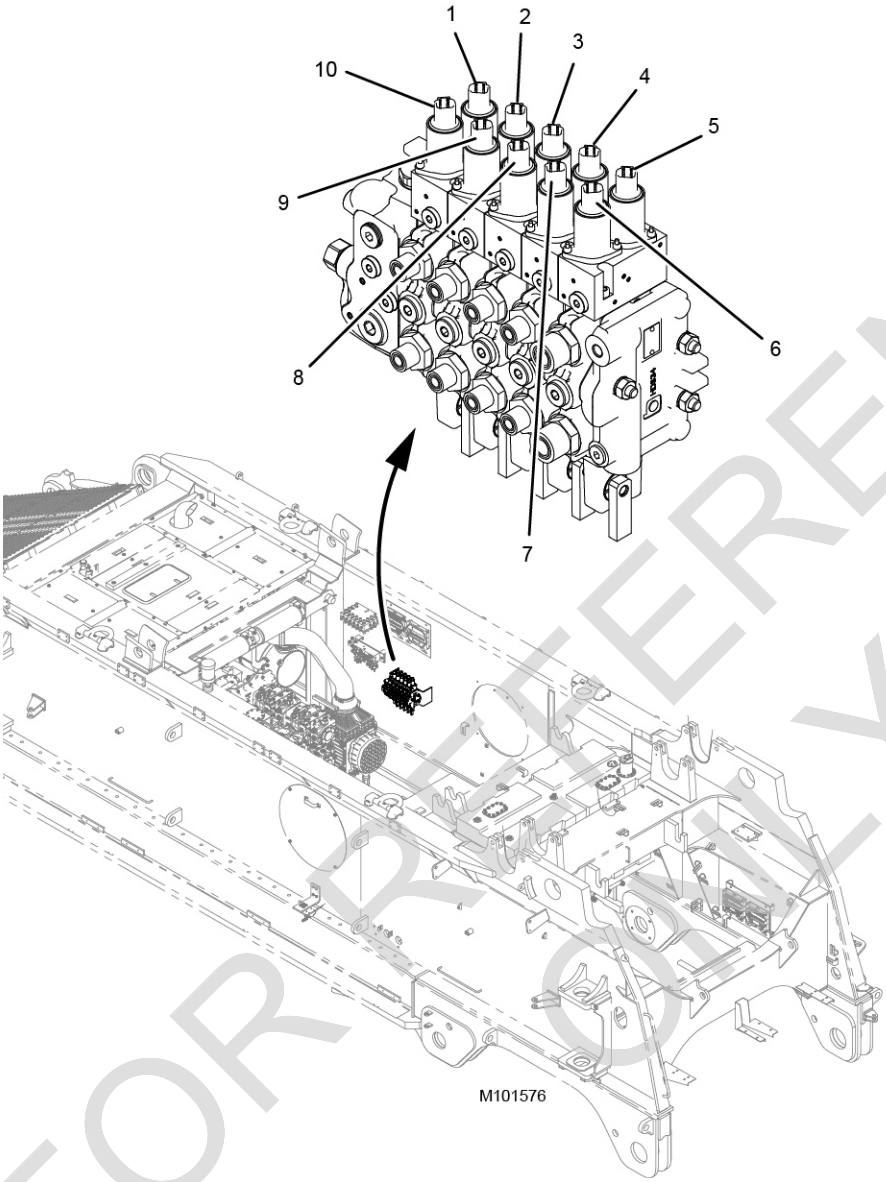
Upperworks Jacking and Rigging Winch Valve Assembly

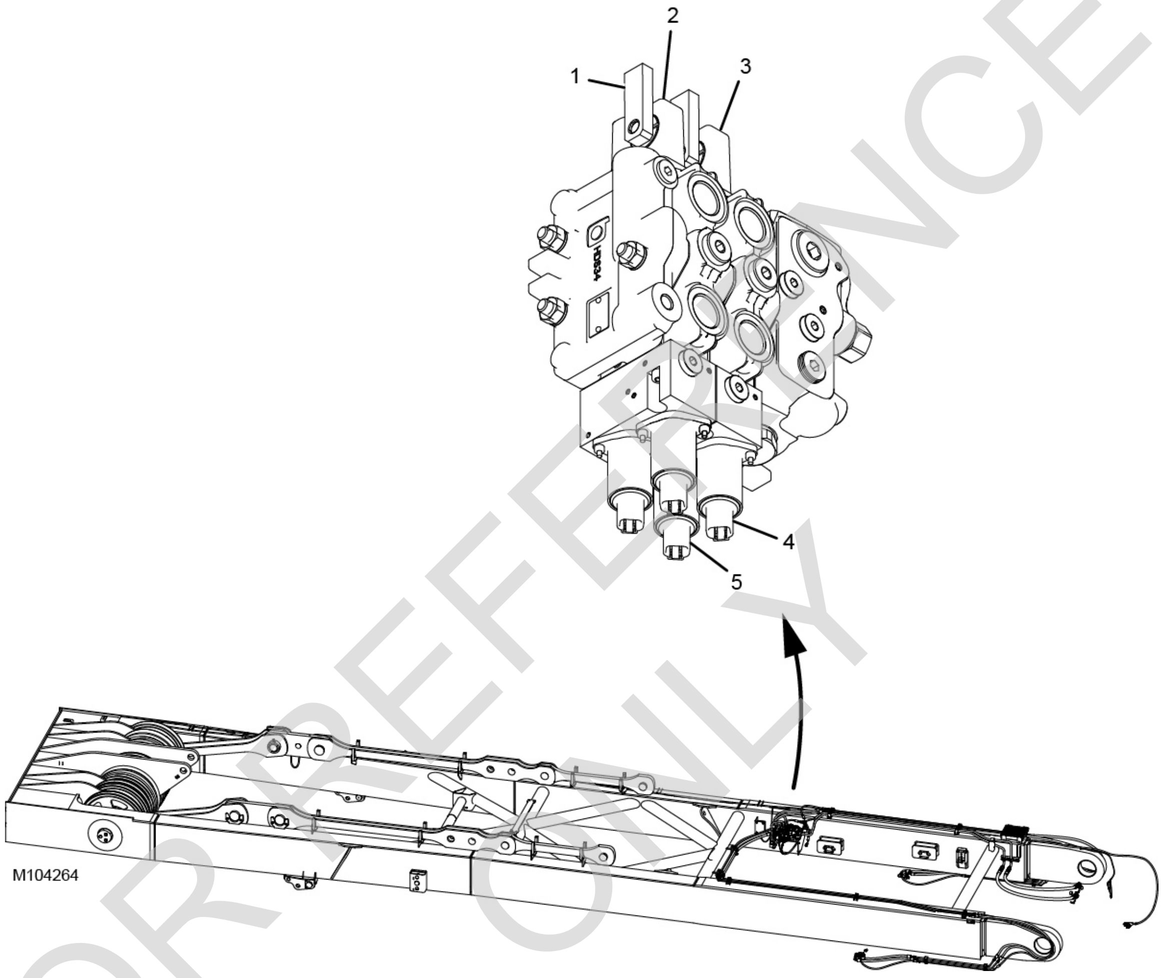


Item	Description
1	Left Rear Jack—Extend
2	Right Rear Jack—Extend
3	Right Front Jack—Extend
4	Left Front Jack—Extend
5	Rigging Winch—Spool Out
6	Rigging Winch—Spool In
7	Left Front Jack—Retract
8	Right Front Jack—Retract
9	Right Rear Jack—Retract
10	Left Rear Jack—Retract

FIGURE 2-13

FOR REFERENCE ONLY

Mast Assist and Self-Assembly Cylinder Valve Assembly



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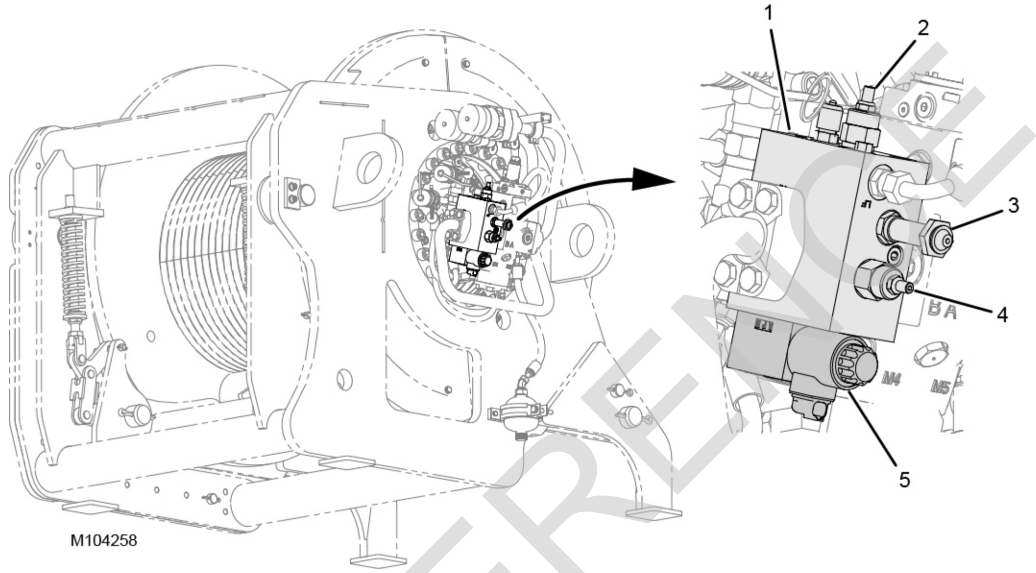
Item	Description
1	Directional Control Lever
2	Assembly Cylinder
3	Mast Raise Cylinder
4	A Coil
5	B Coil

FIGURE 2-14

Drum Brakes Release Manifold and Solenoid Valves

Drums 1, 2, 3, 4 and 6

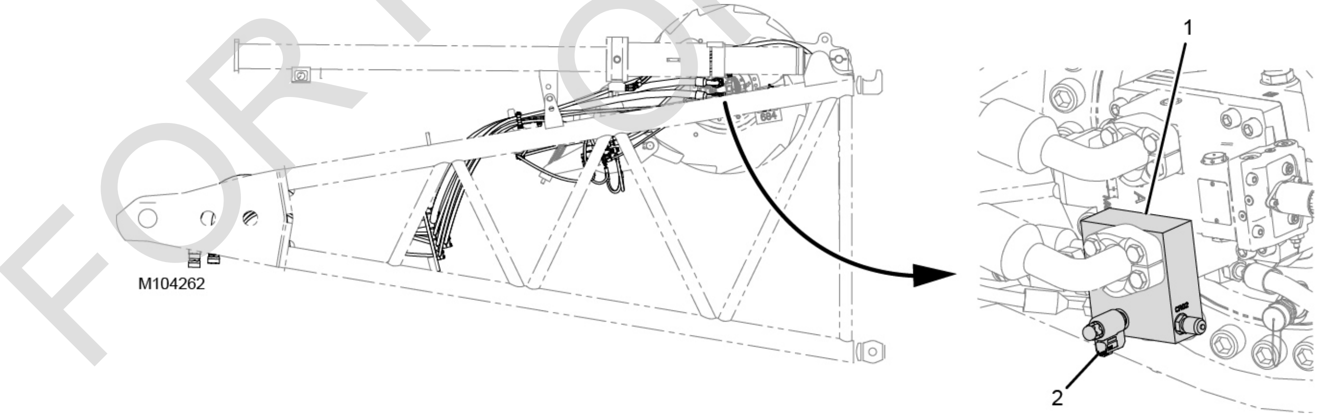


Drum 3 shown. Other drums similar.

Item	Description
1	Drum Brake Release Manifold
2	Flow Control
3	Poppet Solenoid Valve
4	Sequence Valve
5	Directional Control Solenoid

FIGURE 2-15

Drum 5



Item	Description
1	Drum Brake Release Manifold
2	Directional Control Solenoid

FIGURE 2-16

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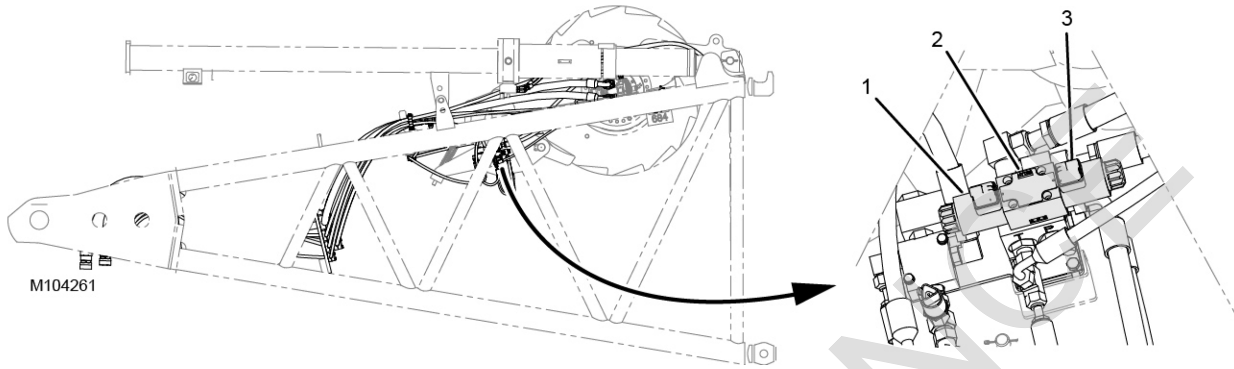
Pawl Control Manifold

Drums 4, 5, and 6



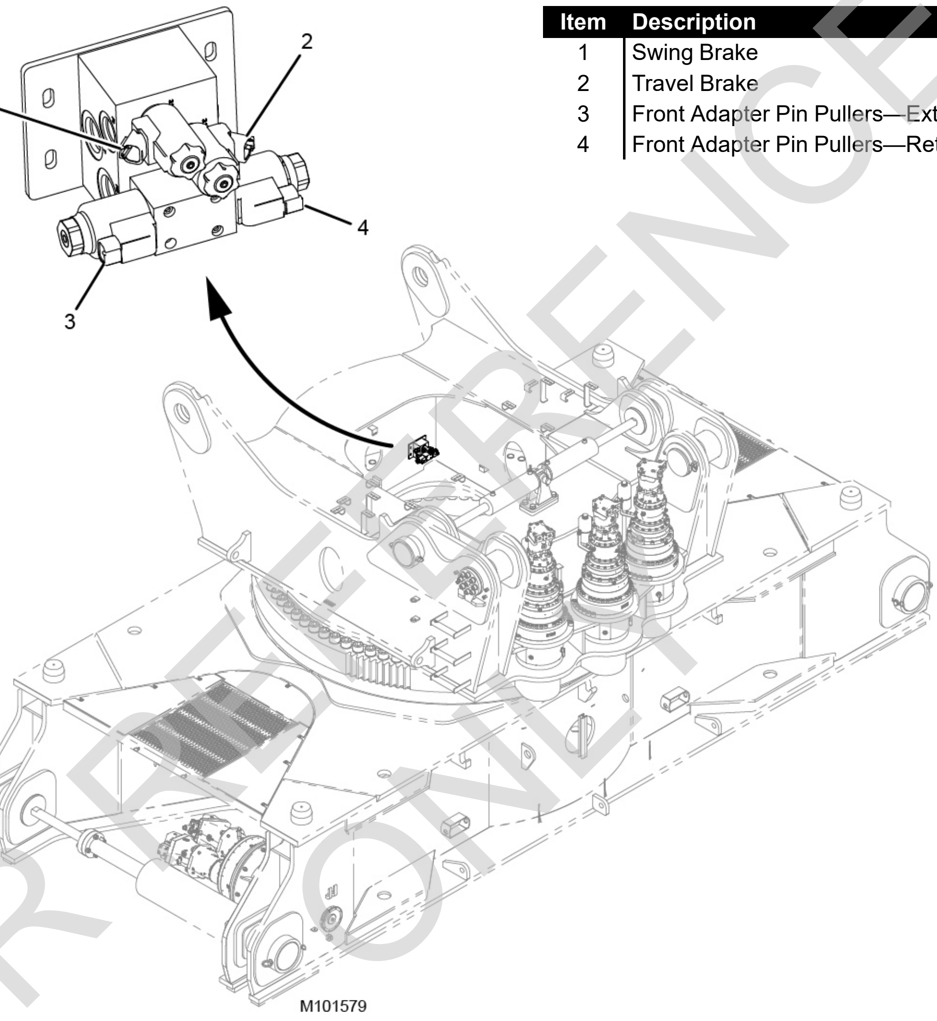
Drum 5 shown. Other drums similar.

Item	Description
1	Solenoid A—Retracts Pawl Assembly Cylinder Rod
2	Pawl Control Manifold
3	Solenoid B—Extends Pawl Assembly Cylinder Rod

FIGURE 2-17

FOR REFERENCE ONLY

Swing Brake, Travel Brake, and Front Adapter Pin Pusher Valve Assembly



Item	Description
1	Swing Brake
2	Travel Brake
3	Front Adapter Pin Pullers—Extend
4	Front Adapter Pin Pullers—Retract

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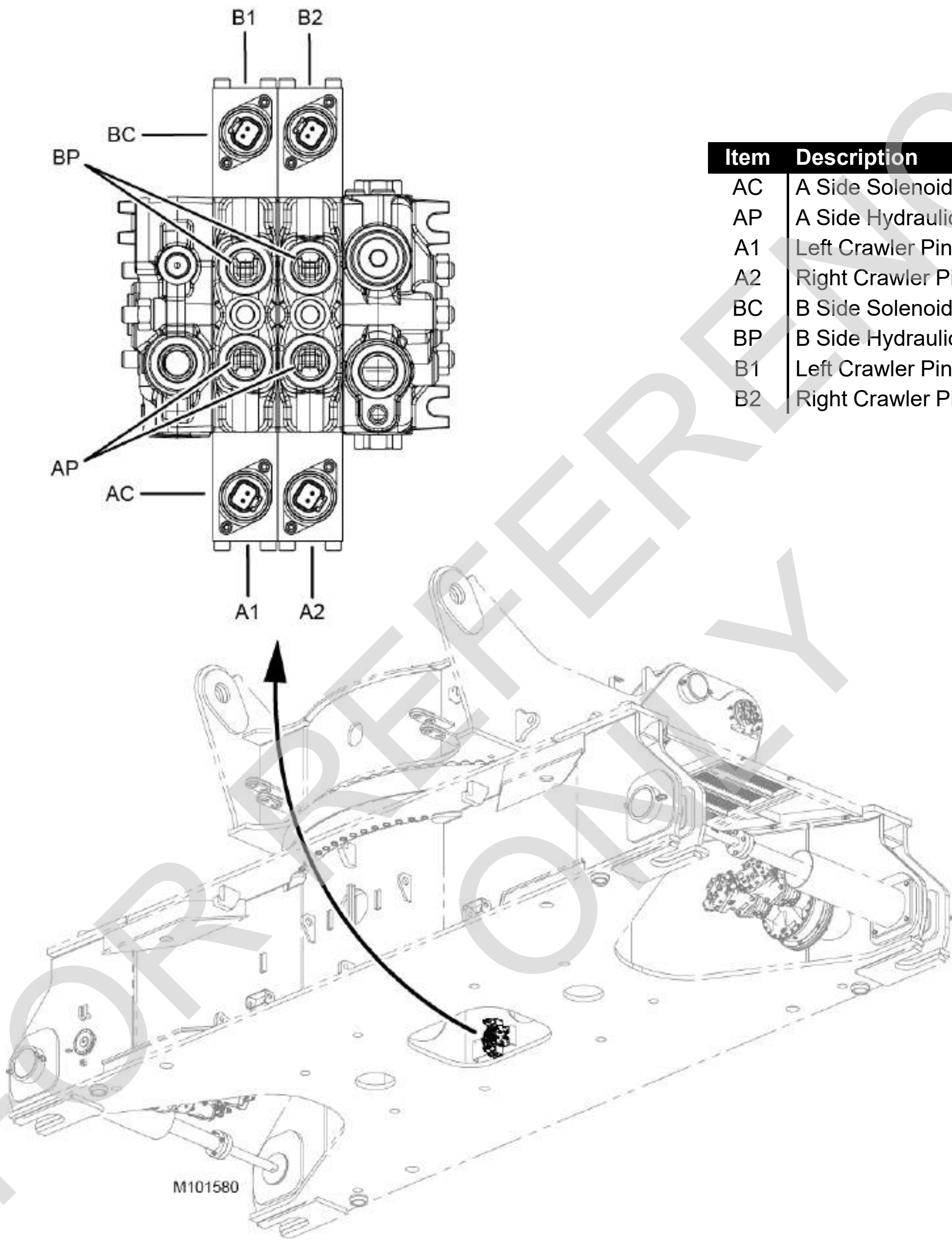
FIGURE 2-18

Lower Accessories Valve Assembly (Without Jacking Valve)

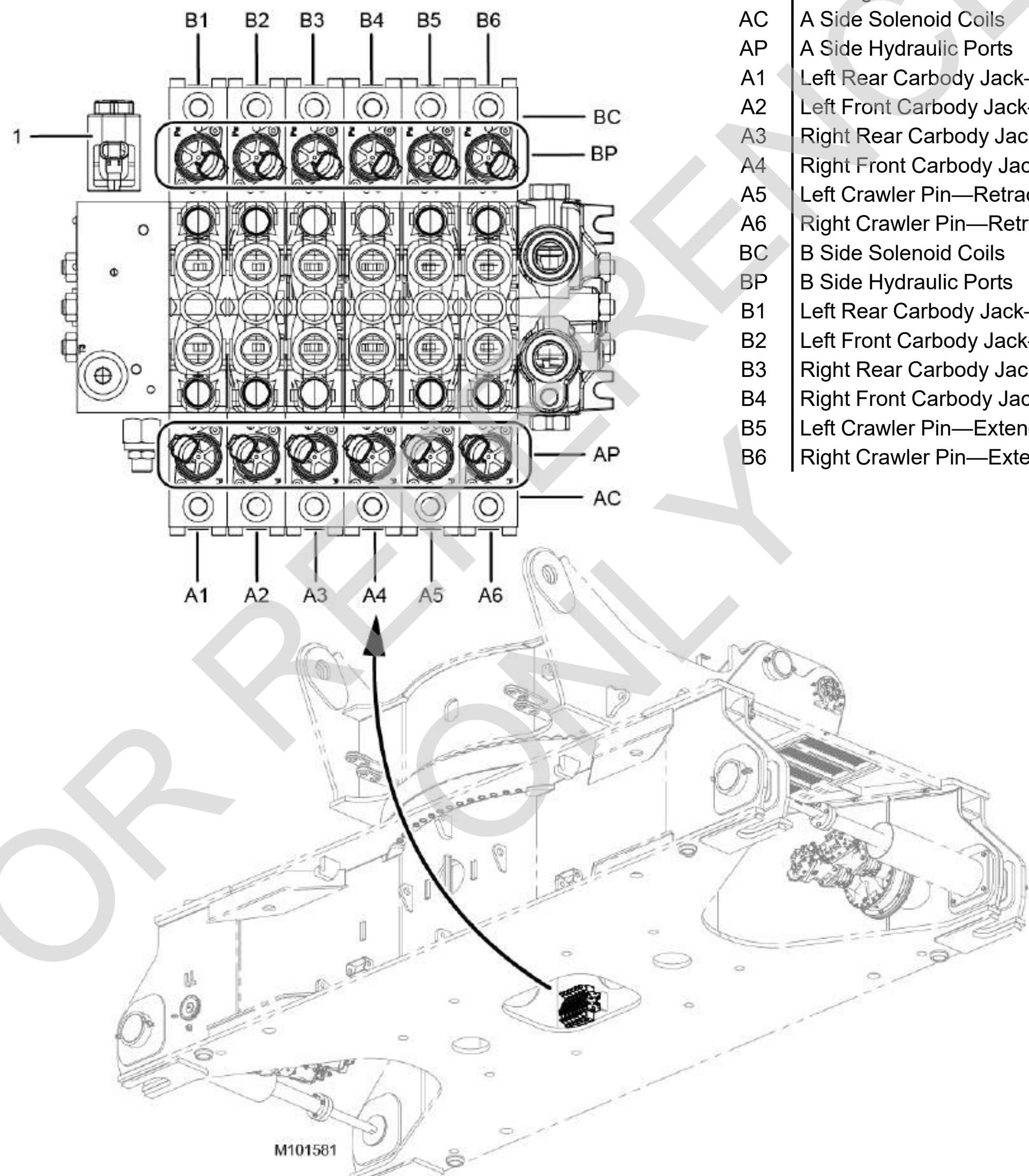


Item	Description
AC	A Side Solenoid Coils
AP	A Side Hydraulic Ports
A1	Left Crawler Pin—Retract
A2	Right Crawler Pin—Retract
BC	B Side Solenoid Coils
BP	B Side Hydraulic Ports
B1	Left Crawler Pin—Extend
B2	Right Crawler Pin—Extend

FIGURE 2-19

FOR REFERENCE ONLY

Lower Accessories Valve Assembly (With Jacking Valve)



Item	Description
1	Jacking Selector Valve
AC	A Side Solenoid Coils
AP	A Side Hydraulic Ports
A1	Left Rear Carbody Jack—Extend
A2	Left Front Carbody Jack—Extend
A3	Right Rear Carbody Jack—Extend
A4	Right Front Carbody Jack—Extend
A5	Left Crawler Pin—Retract
A6	Right Crawler Pin—Retract
BC	B Side Solenoid Coils
BP	B Side Hydraulic Ports
B1	Left Rear Carbody Jack—Retract
B2	Left Front Carbody Jack—Retract
B3	Right Rear Carbody Jack—Retract
B4	Right Front Carbody Jack—Retract
B5	Left Crawler Pin—Extend
B6	Right Crawler Pin—Extend

FIGURE 2-20

FOR REFERENCE ONLY

HYDRAULIC SYSTEM SPECIFICATIONS

Table 2-1. Hydraulic Specifications

Function	Speed [1] rpm	Pump Number	Pump Port	Pump Pressure 1 [2] bar (psi)	Charge Pressure bar (psi)
Drum 1 Hoist Up	39 to 44	1	A	420 (6090)	24 (348)
		3			
Drum 1 Hoist Down	37 to 41	1	B		
		3			
Drum 2 Hoist Up	39 to 44	2	A		
		4			
Drum 2 Hoist Down	37 to 41	2	B		
		4			
Drum 3 Hoist Up	39 to 44	2	A		
Drum 3 Hoist Down	37 to 41		B		
Drum 4 Hoist Up	17 to 19	5	A		
Drum 4 Hoist Down	16 to 18		B		
Drum 5 Hoist Up	25 to 28	6	A		
Drum 5 Hoist Down	24 to 26		B		
Drum 6 Hoist Up	25 to 28	1	A		
Drum 6 Hoist Down	24 to 26		A		
Swing Left—Liftcrane	1.3	8	A		
Swing Right—Liftcrane			B		
Swing Left—VPC-MAX	0.87		A		
Swing Right—VPC-MAX			B		
VPC Tray Rearward	N/A	7	A		
VPC Tray Forward			B		
VPC Beam Rearward			A		
VPC Beam Forward			B		
Right Travel Reverse	6.3 at tumbler	4	A		
Right Travel Forward			B		
Left Travel Reverse		3	A		
Left Travel Forward			B		
Accessories	N/A	9	B	30 (435)	N/A

Notes	
1	Speeds based on engine at high idle, no load (no rope on drums), and handles moved fully forward or back. Speeds can very plus or minus 5%.
2	Controlled by multi-function valves in each pump.

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HYDRAULIC SYSTEM MAINTENANCE

Only experienced technicians, trained in the operation of this crane and its hydraulic system, shall perform the procedures described in this section. The technicians shall read, understand, and comply with the instructions in this section and to the display screen instructions in the Manitowoc MLC650 Main Display Operation F2267.

Contact your Manitowoc Cranes dealer for an explanation of any procedure not fully understood.

Safety

Lower or securely block hydraulically operated attachments and loads before servicing. Do not rely on controls to support attachments or loads.

Stop the engine and relieve hydraulic pressure to zero before servicing or disconnecting any part of the hydraulic system. After stopping the engine, operate the controls in both directions to relieve pressure.

Before servicing the hydraulic system, attach a warning sign to the engine start controls to warn other personnel not to start the engine.

Do not perform hydraulic system maintenance, adjustment, or repair procedures unless authorized to do so. And then, make sure all applicable instructions have been read and are thoroughly understood.

Do not alter specified pressure settings. Higher than specified pressures can cause structural or hydraulic failure. Lower than specified pressures can cause loss of control.

Never check for hydraulic leaks with your hands. Pressurized oil can penetrate the skin, causing serious injury. Oil escaping from a small hole can be nearly invisible. Check for leaks with a piece of cardboard or wood.

Storing and Handling Oil

- Store oil drums in a clean, cool, and dry location. Avoid outdoor storage.
- Store oil drums on their side and cover them to prevent water and dirt from collecting on them.
- When handling drums and transfer containers, use care to avoid damage that can cause leaks and entry of dirt or water into the oil.
- Before opening a drum, carefully clean the top of it. Also clean the faucet or pump to remove oil from the drum.
- Only use clean transfer containers.
- Do not take oil from storage until the oil is needed. If the oil cannot be used immediately, keep the transfer container tightly covered.

Storing and Handling Parts

- Store new parts (valves, pumps, motors, hoses, tubes) in a clean, dry indoor location.
- Do not unpack parts or remove port plugs until the parts are needed.
- Once unpacked, carefully inspect each part for damage that may have occurred during shipping. Remove all shipping material from the ports of parts before installing them.
- Fittings, hoses, and tubes that are not equipped with shipping caps or plugs must be carefully cleaned before they are used. Flush the fittings, hoses, and tubes with clean hydraulic oil, then seal all openings until use at assembly.
- Do not use rags to plug openings. Use clean plastic shipping plugs and caps.

Inspecting the Hydraulic System

The damaging effects of dirt, heat, air, and water in the hydraulic system can only be prevented by regular, thorough inspection of the system.

The frequency of inspection depends on operating conditions and experience with the system. The more often the system is inspected and deficiencies corrected, the less likely the system will malfunction.

A good inspection program will:

- Keep accurate records so future maintenance needs can be projected.
- Check the hydraulic oil level daily when the oil is cold by looking at the hydraulic tank display on the information screen in the cab.

NOTE: The full levels given are for an assembled crane with the cylinders in their ready-to-work positions:

- Full Cold Level—Screen reads 92%
- Full Hot Level—Screen reads 100%

NOTE: Do not fill tank to 100%. Oil will flow out of the breather.

If the oil level drops to 53%, a fault alarm sounds and the fault Hydraulic Fluid Low icon appears in the Main Display Alerts bar. Fill the tank immediately.

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- Fill the tank by pumping oil through the power fill coupling with an owner-supplied portable pump or by pouring oil into the manual fill tube. See step 14 in Changing the Hydraulic Oil on page 2-24.

NOTE: Do not fill the tank through the breather port. The hydraulic system could be contaminated from unfiltered oil.

Open the air valve to release pressure before filling through the manual fill tube.

- Only use approved hydraulic oil in the system. See Section 9 in this manual or the Lubrication Guide.
- Replace the desiccant breather cartridge with a new one when all desiccant beads turn dark green (they are gold when new). See Replacing the Desiccant Breather Cartridge on page 2-22.
- Clean the exterior of the system often. Do not let dirt accumulate on or around any part of the system.

WARNING

Skin Contact Hazard!

High-pressure hydraulic oil can puncture skin, causing serious injury.

Do not use your hands to check for hydraulic oil leaks. Use a piece of cardboard. If injured, seek medical help immediately. Surgery is required to remove the hydraulic oil.

- Check for external leaks using a piece of cardboard. Leaks are not only unsafe, but they also attract dirt, and in some cases, allow air and water to enter system. Do not return leaked oil back to the hydraulic tank.
- Look for oil leaking from fittings and from between parts that are bolted together. Tighten loose fittings and attaching bolts. Do not over tighten. If leakage persists at these points, replace the seals or gaskets.
- Look for oil leaking from the pump and motor shaft ends, from valve spool ends, and from cylinder shaft ends. Replace the seal if leakage is found.
- Replace tubes that are cracked, kinked, or bent.
- Replace hoses that are cracked, split, or abraded.
- Listen to the pumps and motors for unusual noises. A high-pitched whine or scream can indicate that air is being drawn into the pump or motor.

  An air leak can be pinpointed by flooding the inlet fitting, hose, or tube with oil. If there is an air leak, the oil will cause a noticeable reduction in noise.

  Correct the cause for any air leak, or the pump or motor will be ruined.

NOTE: A high-pitched whine or scream from a pump can also indicate cavitation (pump being starved of oil). This condition is caused by:

- Collapsed or plugged suction line
- Wrong oil (viscosity too high)

- Look for signs of overheating: heat peeled parts, burned and scorched oil odor, and darkening and thickening of oil.
- If the oil temperature in the tank rises above 85°C (185°F) or drops below 15°C (59°F), a fault alarm sounds and the fault Hydraulic Fluid Temperature icon appears in the Main Display Alerts bar.

- Have the hydraulic oil analyzed at regular intervals to determine the condition of the oil and the extent of system contamination. By having the oil analyzed on a regular basis, an oil change interval meeting your operating conditions can be established.

  Contact your oil supplier for the availability of oil analysis services and the steps that should be taken to obtain these services.

Inspecting and Replacing Hydraulic Hoses

CAUTION

Hydraulic Component Damage!

Do not alter hydraulic system specifications given in this section without approval of the Manitowoc Crane Care Lattice Team.

Damage to hydraulic components and improper operation of crane can occur if specifications are altered.

CAUTION

Burn Hazard!

Serious injury can occur. Oil in hydraulic tank may be under pressure and extremely hot.

Ensure that the hydraulic hose is depressurized before loosening any connections.

Periodic Inspection

Visually inspect all hydraulic hose assemblies every month or at 200 hours of service life for:

- Leaks at hose fittings or in hose
- Damaged, cut, or abraded cover
- Exposed reinforcement
- Kinked, crushed, flattened, or twisted hose

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- Hard, stiff, heat cracked, or charred hose
- Blistered, soft, degraded, or loose cover
- Cracked, damaged, or badly corroded fittings
- Fitting slippage on hose
- Other signs of significant deterioration

If any of these conditions exist, evaluate the hose assemblies for correction or replacement.

At the same service interval, visually inspect all other hydraulic components and valves for:

- Leaking ports
- Leaking valve sections or manifolds and valves installed into cylinders or onto motors
- Damaged or missing hose clamps, guards, or shields
- Excessive dirt and debris around hose assemblies

If any of these conditions exist, address them appropriately.

Periodic Replacement

Hydraulic hose assemblies operating in zone C (Table 2-2) should be replaced after 8,000 hours of service life.

Hydraulic hose assemblies operating in zones A and B with high ambient temperatures and high duty circuits could see hose service life reduced by 40% to 50%. High duty circuits can include, but are not limited to, hoist(s), boom lift, swing, travel, pump suction and discharge to directional valves, and directional valve return to reservoir. Replace hoses operating in zones A and B after 4,000 to 5,000 hours of service life.

Hydraulic hose assemblies operating in zones D and E, should expect a degrade of mechanical properties. Long-term exposure to these cold temperatures will negatively impact service life. Cold temperatures shorten hose life. Therefore, frequent inspection is required.

Table 2-2. Climate Zone Classifications

Zone	Description
A	Tropical Moist: All months average above 18°C (65°F). Latitude: 15° to 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° to 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° to 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° to 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° to 75° N & S

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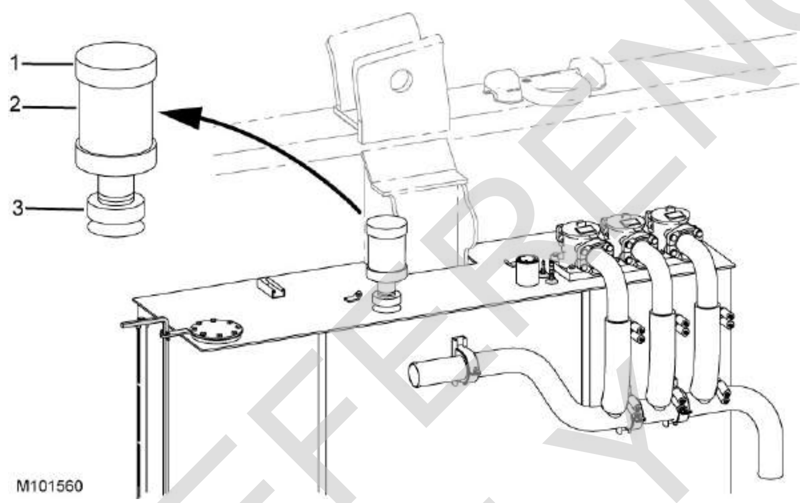
Replacing the Desiccant Breather Cartridge

See Figure 2-21 for the following procedure.

1. Unscrew the breather cartridge (2) from the hydraulic tank fitting (3).
2. Unscrew the reusable cap (1) from the breather cartridge and dispose of the used breather cartridge properly. Do not discard the cap.
3. Remove the protective caps from the top and bottom of the new breather cartridge.
4. Hand tighten the reusable cap to the new breather cartridge.
5. Hand tighten the breather cartridge to the hydraulic tank fitting.



Item	Description
1	Reusable Cap
2	Breather Cartridge
3	Hydraulic Tank Fitting

FIGURE 2-21

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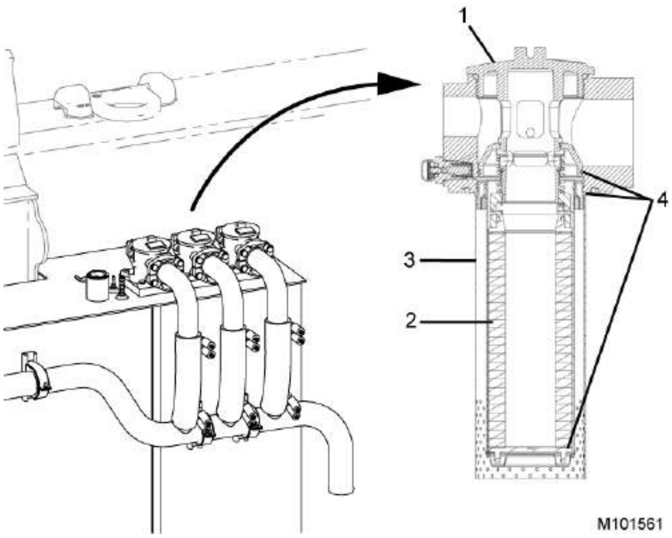
Replacing the Return Filters

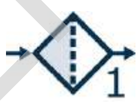


Item	Description
1	Filter Cap
2	Filter Element
3	Filter Body
4	O-ring (qty 3)

FIGURE 2-22

This crane has three filters that filter all oil returning to the hydraulic oil tank.

If a return filter is dirty, a fault alarm comes on and a fault symbol appears on active display. The Hydraulic Filter icon and corresponding filter number 1 appear on the fault display.



Replace all three return filter elements if the fault appears and at each oil change interval.

NOTE: It is normal for the alert to come on at startup when the oil is cold. If the filter is not plugged, the alert will turn off after the hydraulic oil warms up.

WARNING

Burn Hazard!

Hydraulic oil may be under pressure and extremely hot and can cause severe burns if contact is made.

Hot oil can escape when removing the filter cover or fill plug. Allow the hydraulic system to cool and relieve pressure at the air valve in the tank before servicing.

CAUTION

Avoid Hydraulic System Damage!

Original equipment manufacturers' filter elements—available from the Manitowoc Cranes dealer—must be used on this crane. Substituting with any other brand or type of filter element is not allowed.

Filter elements made by other manufacturers may collapse under pressure. This action will allow unfiltered oil to be drawn into the hydraulic system. Pumps, motors, and valves can be destroyed.

Manitowoc will reject warranty claims for damaged hydraulic components if the proper hydraulic filter elements are not used.

Do not attempt to clean or reuse elements.

Do not operate the crane without filter elements installed.

To replace the return filters, perform the following procedure.

See Figure 2-22 for the following procedure.

1. Stop the engine.
2. Clean the outsides of the three filter heads in the areas around filter caps (1).
3. Remove the three filter caps using care not to damage the O-rings.

NOTE: The filter caps have hexagon studs for easy removal.

4. Twist and pull the three filter elements (2) to remove them from the three filter bodies (3).
5. Lubricate the O-ring (4) at both ends of the three new elements with clean hydraulic oil and install the new elements over the stems in the three filter bodies.
6. If necessary, replace any damaged O-rings in the filter caps.
7. Inspect and lubricate the O-rings of the three filter caps with clean hydraulic oil.
8. Install the three filter caps onto the filter housings and securely tighten.
9. Start the engine and allow the hydraulic system to reach normal operating temperature.
10. Check the filter caps and return lines for leaks and service as required.
11. Stop the engine.
12. Check the hydraulic tank level and fill as required. See Changing the Hydraulic Oil on page 2-24.

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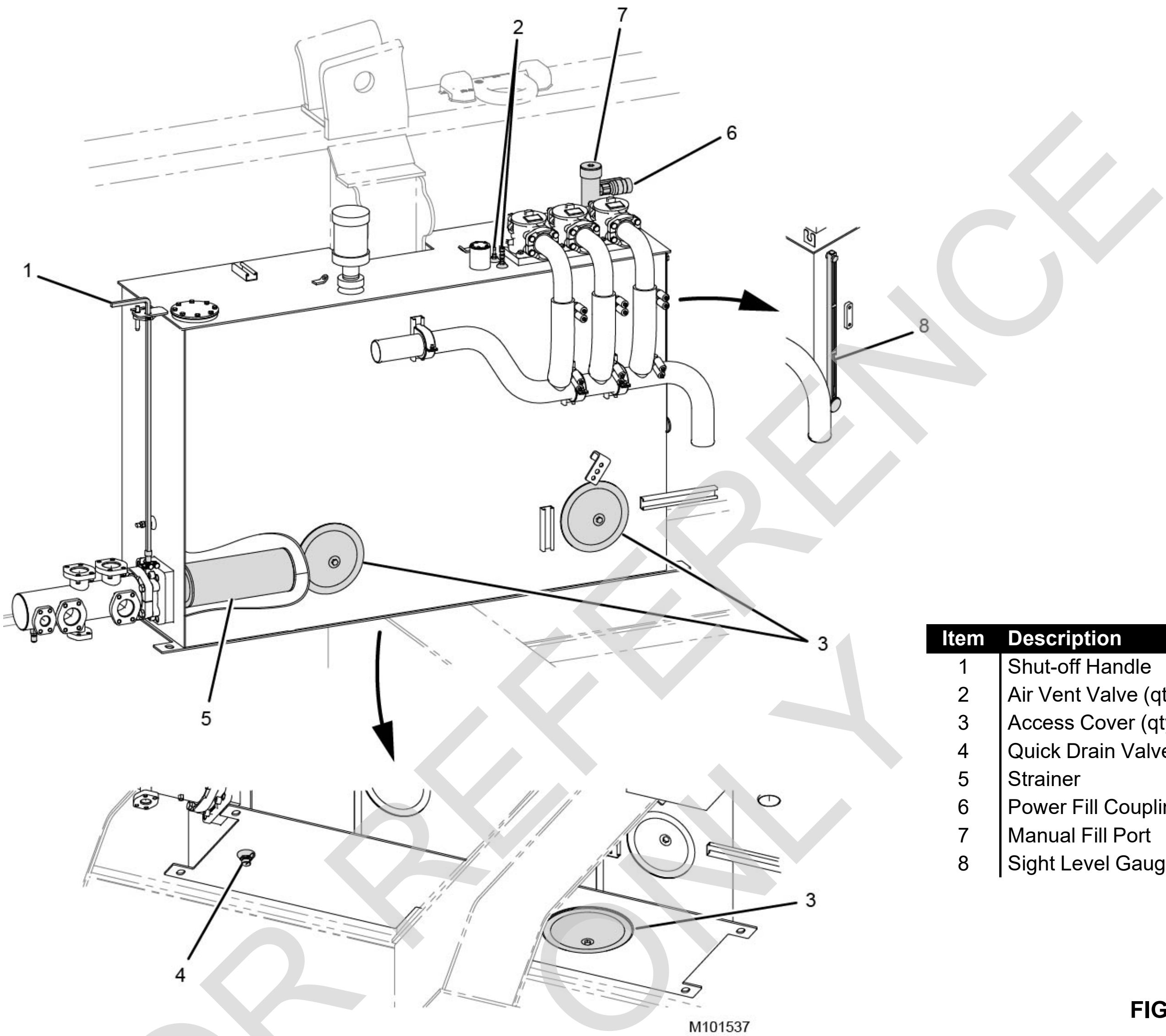
Changing the Hydraulic Oil



Item	Description
1	Shut-off Handle
2	Air Vent Valve (qty 2)
3	Access Cover (qty 3)
4	Quick Drain Valve
5	Strainer
6	Power Fill Coupling
7	Manual Fill Port
8	Sight Level Gauge

FIGURE 2-23

FOR REFERENCE ONLY

See Figure 2-23 for the following procedure.

Drain and fill the hydraulic tank according to the interval specified in the MLC650 lube guide, unless an alternate interval has been established through an oil analysis program.

1. Operate the crane until the hydraulic oil is at normal operating temperature. This will help prevent impurities from settling in the system.
2. Stop the engine.

WARNING

Burn Hazard!

Hydraulic oil may be under pressure and extremely hot and can cause severe burns if contact is made.

Hot oil can escape when removing the filter cover or fill plug. Allow the hydraulic system to cool and relieve pressure at the air valve in the tank before servicing.

3. Open the air vent valve (2) to allow air to enter into and escape from the hydraulic tank when draining and filling.

4. Put the free end of a hose, with a quick drain coupler, into a suitable container to catch the hydraulic oil. See Section 9 in this manual for the hydraulic system capacity.
5. Verify the shut-off handle (1) is in the OPEN position.
6. Screw the hose's quick drain coupler onto the hydraulic tank's quick drain valve (4) and drain the tank completely.
7. Unscrew the hose's quick drain coupler from the hydraulic tank's quick drain valve.
8. Remove the access covers (3) from the tank.

NOTE: Take care to prevent dust and wind-blown dirt from entering the tank while the access covers are off.

9. Clean out any sediment inside the tank.
10. Carefully inspect the strainer (5) for damaged or clogged holes and for sludge, gum, or lacquer formation. If necessary, clean the strainer.
    a. Using a wrench, remove the strainer from inside the tank.
    b. Soak the strainer in clean, nonflammable solvent. Brush off the outer surface of the strainer and flush it from the inside out. Discard the strainer if it is damaged.
    c. Securely reinstall the strainer.
11. Using new seals, securely fasten the access covers to the tank.
12. Replace the desiccant breather cartridge. See Replacing the Desiccant Breather Cartridge on page 2-22.
13. Replace the three return filter elements. See Replacing the Return Filters on page 2-23.

CAUTION

Contamination Hazard!

Do not fill the hydraulic tank through the breather opening or through the top of the return filter(s). Harmful contaminants will enter the hydraulic system. Damage to pumps and motors can occur.

14. Fill the tank through the power fill coupling (6) or manual fill port (7) to the Full Cold Level while watching hydraulic tank display on the information screen. Use the proper hydraulic oil. See Section 9 in this manual for hydraulic oil information.

NOTE: Do not fill the tank to 100%. Oil will flow out of the breather.

15. Close the air vent valve.
16. Start the engine and allow the hydraulic system to rise to normal operating temperature.
17. Check for leaks and correct them as required.
18. Stop the engine.
19. Check the tank level, and fill as required.

NOTE: If the hydraulic system was extremely dirty (gum or lacquer formation on parts indicated by erratic, jerky, or sluggish operation) repeat this Changing the Hydraulic Oil procedure after 48 hours of operation.

Servicing the Pumps

See Figure 2-24 for the following procedure.

It is not necessary to drain the hydraulic tank when servicing the hydraulic pumps. To service the pumps, move the hydraulic tank supply shut-off valve (1a) to the CLOSED position.

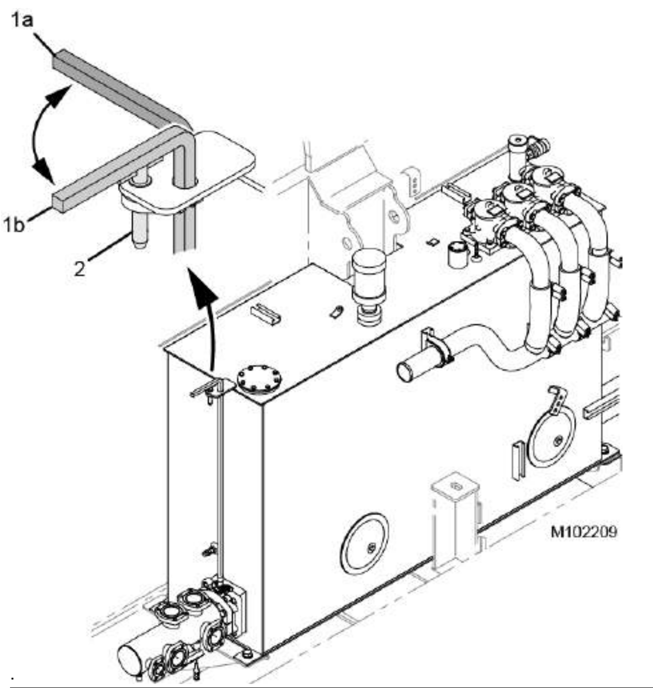
CAUTION

Avoid Damage to Pumps!

Open the hydraulic tank shut-off valve before starting the engine. Failing to perform this step will result in damage to the pumps from cavitation.

Move the hydraulic tank supply shut-off valve (1b) to the OPEN position after servicing the pumps and before starting the engine.

FOR REFERENCE ONLY



Item	Description
1a	Shut-Off Valve (closed)
1b	Shut-Off Valve (open)
2	Locking Pin (can be replaced with an owner-furnished padlock)

FIGURE 2-24

Replacing a Pressure Transducer

CAUTION

High-Pressure Oil Hazard!

High-pressure oil can exhaust from the pressure transducer ports and cause minor to moderate injury.

Do not attempt to remove a pressure transducer unless the proper procedure is performed.

Before replacing a pressure transducer, perform the following test steps and replace the transducer only if any of the test steps fail.

1. Perform the pressure transducer test. See Pressure Transducer Test on page 2-33.
2. Attach a hydraulic pressure gauge to the suspect pressure transducer line. See Pressure Transducer and Accessories Manifold on page 2-10 for pressure transducer identification.
3. If the gauge reads pressure greater than 0 bar (0 psi), bleed the corresponding system until the gauge reads 0 bar (0 psi).
4. Repeat the pressure transducer test.
5. Verify the output signal current at the transducer is 3.84 mA to 4.16 mA at 0 bar (0 psi).
6. Start the engine and run it at idle.

WARNING

Crush Hazard!

Keep all personnel clear of the parts that will move during the test. Serious injury can occur.

When actuating a hydraulic function to read a pilot pressure with a gauge, the associated parts will move when the function is actuated.

7. If testing a pilot pressure, actuate the function for the pressure being read.
8. Verify the gauge pressure and the pressure displayed at the Pressure Transducer Test screen are within the limits of Table 2-3.

Table 2-3. Transducer/Gauge Pressure Agreement

Pressure Type	Pressure
Pilot	± 3 bar (43.5 psi)
System	± 3 bar (43.5 psi)

To replace a pressure transducer, perform the following procedure.

See Figure 2-24 for the following procedure.

1. Lower all loads to the ground.
2. Move all control handles to OFF and park all crane functions.
3. Shut off the engine.
4. Place a suitable container under the faulty pressure transducers to catch the draining oil.
5. Disconnect the electrical connector from the pressure transducer.
6. Slowly loosen the pressure transducer only enough to relieve pressure.
7. Remove the pressure transducer.
8. Install the new pressure transducer and connect the electrical connector.
9. Bleed the pressure transducer circuit.
   a. Connect a bleed line with a shut-off valve to the coupler on the pressure transducer manifold and place the end of the hose into a suitable container.
   b. Open the shut-off valve (1b).

FOR REFERENCE ONLY

c. With all control handles off, start and run the engine at low idle.

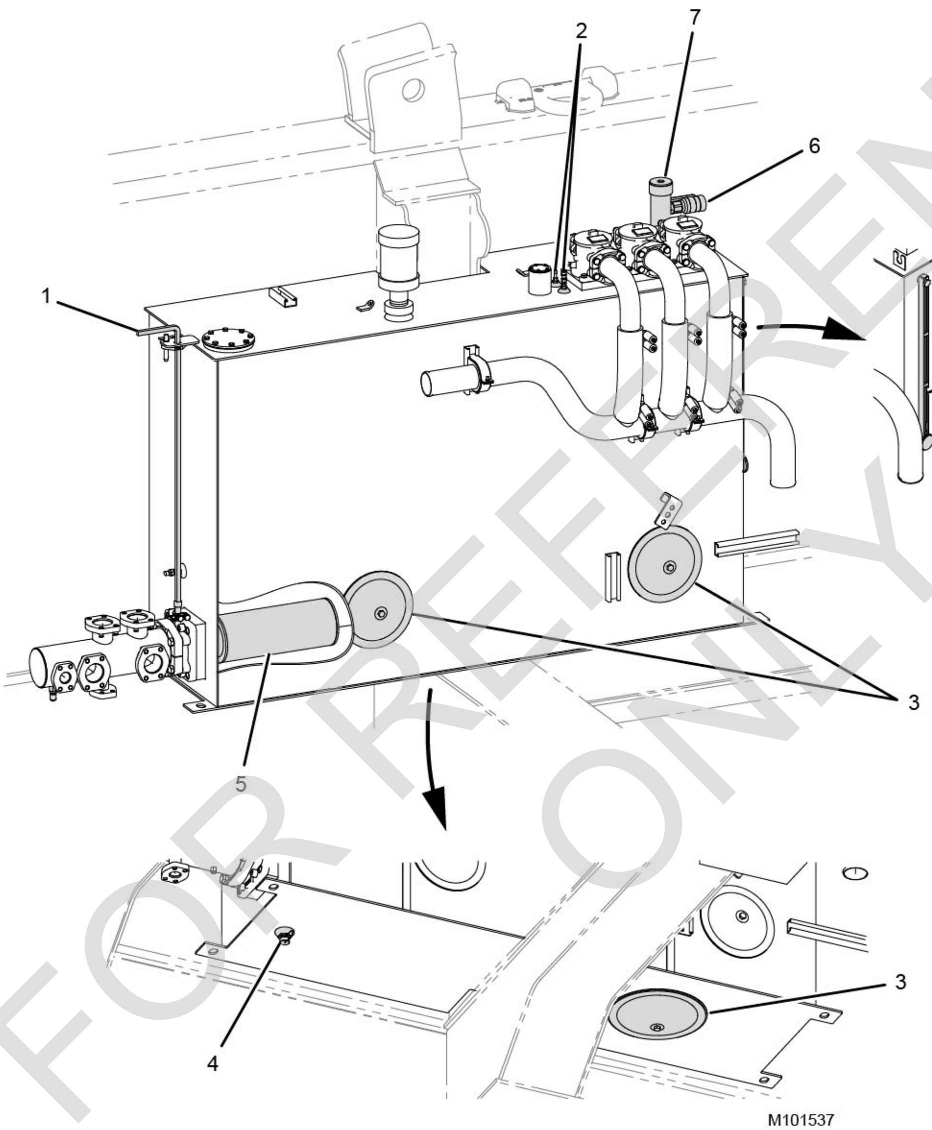
d. When clear oil flows from the bleed lines (no air bubbles in oil), close the shut-off valve (1a).

e. Shut off the engine.

f. Remove the bleed line from the coupler at the pressure transducer.

10. Perform the pressure transducer test. See Pressure Transducer Test on page 2-33.

SHOP PROCEDURES



Item	Description
1	Shut-off Valve
2	Air Vent Valve (qty 2)
3	Access Cover (qty 3)
4	Quick Drain Valve
5	Strainer
6	Power Fill Coupling
7	Manual Fill Port
8	Sight Level Gauge

FIGURE 2-25

FOR REFERENCE ONLY

Initial Hydraulic Oil Fill

See Figure 2-25 and see Hydraulic Motor Identification on page 2-6 for the following procedure.

The following procedure is used at the factory to fill the hydraulic system on a new crane. Use this procedure in the field only if the entire hydraulic system has been drained.

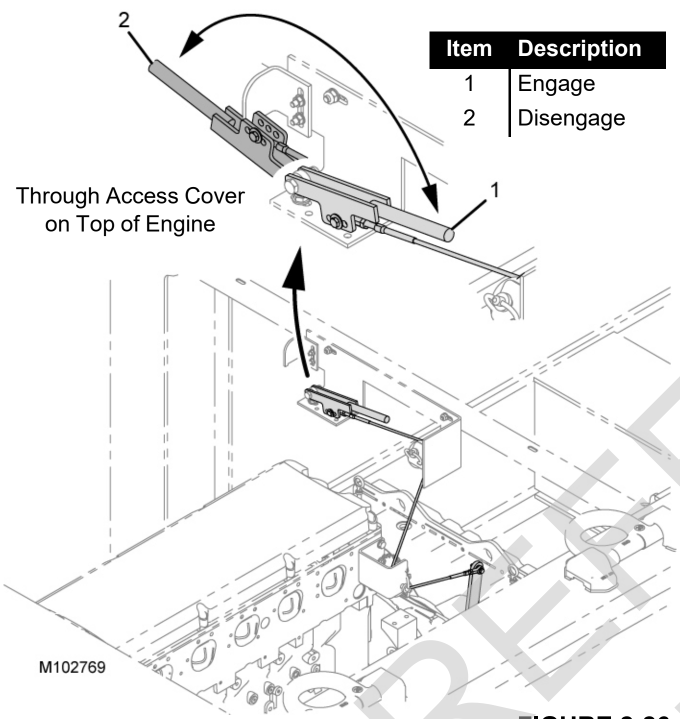
1. Fill each motor case with clean oil to the level of the case drain port as follows.

a. Disconnect the fittings at the case drain ports.

b. Fill each motor case to the level of the case drain port. Use a new hydraulic oil filtered through a 10-micron filter.

c. Reconnect the fittings.

2. Open the vent ports and remove the vent plugs from the suction manifold (Figure 2-27).
3. Open the hydraulic tank shut-off valve (1b) (Figure 2-24).
4. Make sure the hydraulic tank quick drain valve is closed (Figure 2-25).
5. At the engine, disengage the engine clutch (Figure 2-26).



Item	Description
1	Engage
2	Disengage

FIGURE 2-26

CAUTION

Avoid Engine Clutch Damage!

Observe the following precautions for the engine clutch:

- Decrease engine speed to idle before engaging or disengaging clutch.
- Do not run engine longer than 20 minutes with clutch disengaged.

See Figure 2-25 for the remaining steps.

6. Open the air vent valve on top of the tank to release pressure when filling through the manual fill port or power fill coupling.
7. Fill the tank manually through the manual fill port or by pumping oil through the power-fill coupling with an owner-supplied portable pump. Use new hydraulic oil filtered through a 10-micron filter.
8. Do not fill the tank through breather ports or the top of the return filter. The hydraulic system could be contaminated from unfiltered oil.
9. Securely install vent plugs and vent caps as soon as clear oil appears at each vent opening.
10. Fill to the Cold Full level on the hydraulic tank gauge.
11. If required, apply 0,20 to 0,34 bar (3 to 5 psi) owner-supplied air pressure to the air valve or coupler on the hydraulic tank.

    The tank breather allows 0,21 bar (3 psi) pressure to remain in the tank to force oil into the charge system.
12. Observe bleed ports as the charge system fills. Securely install vent caps when clear oil starts flowing from the bleed ports in the charge pressure suction manifold.

NOTE: It is extremely important to perform the bleed procedure described above in the field any time the system is drained completely.

13. Fill the pump cases at the return line cap in the return line until the manifold will not take any more oil.

    Use new hydraulic oil filtered through a 10-micron filter.
14. Install and securely tighten the return line cap as soon as clear oil appears.
15. Check for hydraulic leaks and correct if found.

FOR REFERENCE ONLY

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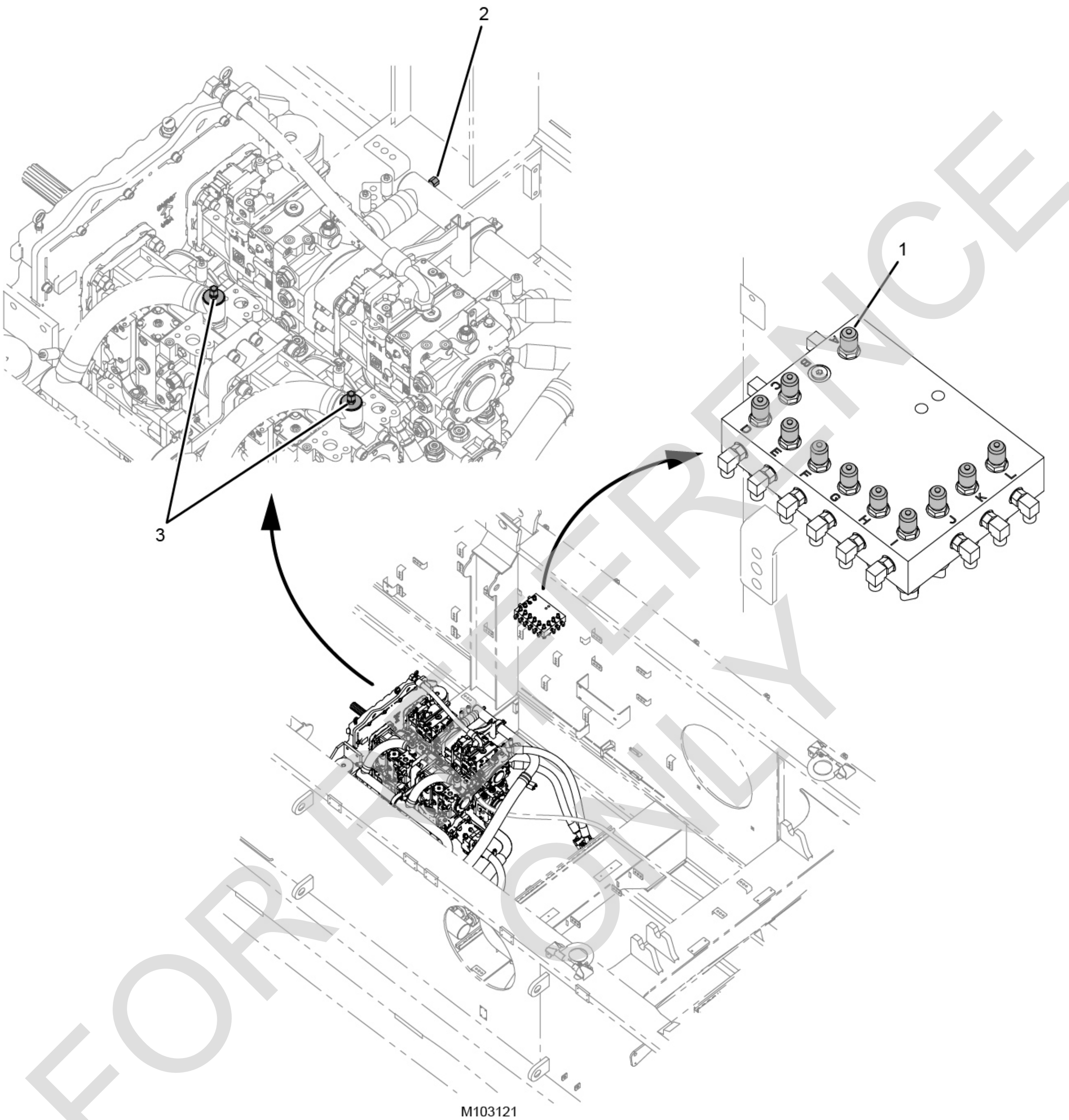
INITIAL HYDRAULIC SYSTEM STARTUP



Item	Description
1	Pressure Transducer Gauge Port
2	Vent Plug—Right Side Suction Manifold
3	Vent Plug—Top Left Side Suction Manifold

FIGURE 2-27

FOR REFERENCE ONLY

The following procedure is used at the factory to start a new crane engine for the first time. It is necessary to use this procedure in the field only if the entire hydraulic system has been drained.

This procedure requires two people, one to start the engine and monitor pressures on the diagnostic screens and one to monitor gauge pressure and check for leaks.

WARNING

Burn Hazard!

Oil in hydraulic tank may be under pressure and extremely hot. Hot oil can cause severe injury.

Hot oil can escape when you remove the stand pipe plug, filter cover, or breather. Relieve pressure through the air valve on the tank before servicing.

CAUTION

Avoid Damage to Hydraulic System!

If the hydraulic fluid low alarm comes on at any time during the startup procedure, add oil to the tank.

1. Before starting the engine, perform the Pressure Transducer Test on page 2-33.
2. Make sure the hydraulic tank shut-off valve is fully open (Figure 2-24).

NOTE: Pumps can be damaged from cavitation if step 2 is not performed.

3. At the engine, disengage the engine clutch (Figure 2-26).
4. Connect the bleed lines equipped with shut-off valves to each pressure transducer gauge port (1, Figure 2-27).
5. Open the shut-off valve in each bleed line. Use a suitable container to catch the oil.

CAUTION

Avoid Engine Clutch Damage!

Observe the following precautions for the engine clutch:

- Decrease engine speed to idle before engaging or disengaging the clutch.
- Do not run the engine longer than 20 minutes with the clutch disengaged.

6. Start the engine at the lowest possible speed and make necessary adjustments before engaging the clutch.
7. Slowly engage and disengage the clutch and check for charge pressure.
8. Bleed the pressure transducers.
   a. Observe the oil flowing from the bleed line at each pressure transducer.
   b. Close each bleed valve when a clear, steady stream of oil appears (no air bubbles in oil).
   c. If the oil does not flow from any bleed lines, determine the cause and correct.

CAUTION

Equipment Damage!

Check the pump pressures during the first 2 minutes of operation. If the pressure for any pump is not within the specified range, shut down the engine immediately to prevent pump damage. Troubleshoot to determine the cause of the problem.

9. On the control system diagnostic screens, check the pump pressures for load drums, boom hoist, swing, and travel pumps.
   a. Make sure the pressure reading for each pump is 22 to 25,5 bar (250 to 370 psi).
   b. If the pump pressures are not within specified range, stop the engine immediately. Determine the cause of the faulty pressure and correct.
10. Stop the engine.
11. Remove the bleed lines from the gauge couplers at each pressure transducer.
12. Start and run the engine at low idle.
13. With the engine at low idle, extend and retract all the cylinders three times—gantry cylinders, mast cylinders, back hitch pins, cab tilt, boom hinge pin, carbody jacks, and crawler pins.

    If the oil level drops to 53%, a fault alarm will come on and a fault symbol will appear on the active display. The HYDRAULIC FLUID LOW icon will appear on the control system crane display. Fill the tank immediately.
14. With the engine running at low idle, slowly cycle each crane function in both directions for at least 5 minutes to vent any remaining air from the hydraulic system.
15. Make sure all the crane functions operate in the proper direction in relation to the control handle movement.
16. Check for hydraulic leaks and correct the cause if found.
17. Stop the engine and the fill hydraulic tank to the proper level.
18. Perform the Controls Calibration on page 2-33.

FOR REFERENCE ONLY

2

Hydraulic Tests and Calibrations

Experienced technicians, trained in the operation of this crane and its hydraulic system, shall perform the procedures described in this section. The technicians shall read, understand, and comply with the instructions in this section and with the display screen instructions in the MLC650 Main Display Operation F2267.

Contact your Manitowoc Cranes dealer for an explanation of any procedure not fully understood.

The calibration and test procedures described in this section were made to the crane before it was shipped from the factory. These procedures must be performed by field personnel only when parts are replaced or when instructed by a Manitowoc Cranes dealer.

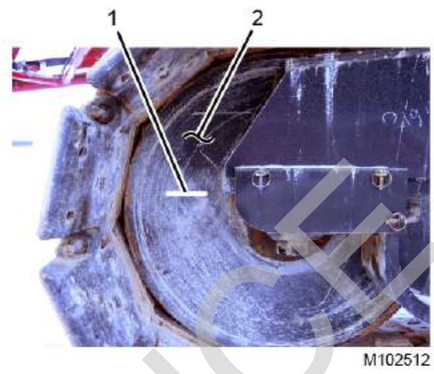
Travel Speed Test

See Figure 2-28 for the following procedure.

NOTE: Perform this check in an area where the crane can be traveled without interference.

An assistant is needed to count the rotations of the crawler rollers.

1. Apply a timing mark (1) on the inside faces of the crawler roller (2).
2. Start the engine and run at high idle.
3. Using the travel speed selection switch, select high speed travel.
4. Travel the crane forward at full speed for 1 minute while the assistant walks alongside the crane and counts the timing mark revolutions.
5. Verify the counted revolutions are within the limits specified in Table 2-1. If the counted rotations are not within the specified range, contact the Manitowoc Crane Care Lattice Team.
6. Travel the crane in reverse at full speed for 1 minute while the assistant walks along side the crane and counts the timing mark revolutions.
7. Verify the counted revolutions are within the limits specified in Table 2-1. If the counted rotations are not within the specified range, contact the Manitowoc Crane Care Lattice Team.



Item	Description
1	Timing Mark
2	Crawler Roller

FIGURE 2-28

Swing Speed Test

NOTE: Perform this check in an area where the crane can be swung without interference.

1. At the main display, navigate to the Swing Control Information screen. See the MLC650 Main Display Operation F2267 for detailed instructions on how to navigate to the screen.

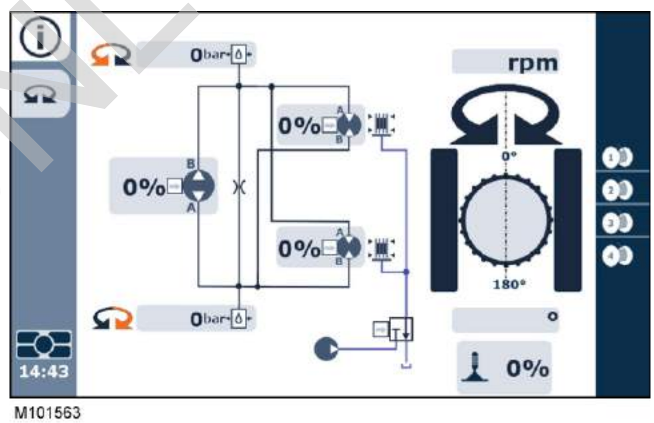


FIGURE 2-29

2. Start the engine and run at high idle.
3. Move the swing handle fully left.
4. At the Swing Diagnostic screen, verify the swing speed is within the limits of Table 2-1.
5. Return the swing handle to the center and allow the rotating bed to come to a stop.

FOR REFERENCE ONLY

6. Move the swing handle fully right.
7. At the Swing Diagnostic screen, verify the swing speed is within the limits of Table 2-1.
8. Return the swing handle to the center and allow the rotating bed to come to a stop.
9. Shut off the engine.

Pressure Transducer Test

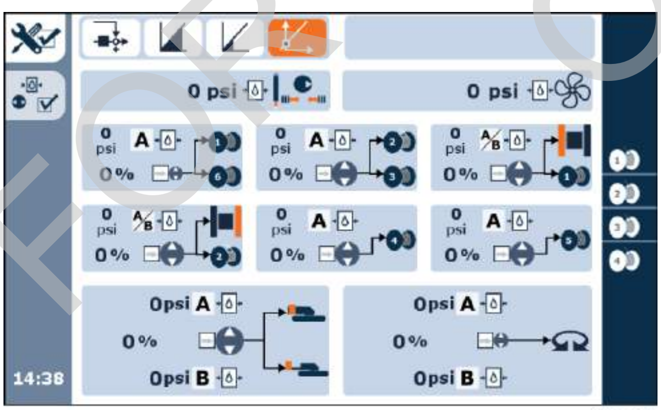
The pressure transducer test calculates the zero-pressure output level for each pressure transducer. It is only necessary to perform this procedure at the specified intervals or when the following events occur:

- A new pressure transducer is installed.
- A new control module that monitors pressure transducers is installed.
- Control software is updated.
- Pressure readings are in error.

NOTE: Be aware that if there is any residual pressure in the system during the calibration process, the display pressure reading in the cab may not reflect actual system pressure.

To test the pressure transducers, perform the following procedure.

1. Stop the engine and turn the ignition switch to the RUN position.
2. At the Main display, navigate to the Hydraulic Test screen and select the Pressure Transducer Test (Figure 2-30). See the MLC650 Main Display Operation F2267 for detailed instructions on how to navigate to the screen and run the test.



M101572
FIGURE 2-30

3. When the pressure transducer test completes, verify no pressure transducer icons are highlighted in red. If any pressure transducer icons appear in red, troubleshoot the corresponding transducers to determine the fault cause.

NOTE: The cause of a failed pressure transducer test or faulty display pressure reading may not be the pressure transducer. The cause of the fault could be trapped air or hydraulic pressure in the system during the pressure transducer test.

Controls Calibration

Controls calibration calculates the pump threshold command level for the following functions:

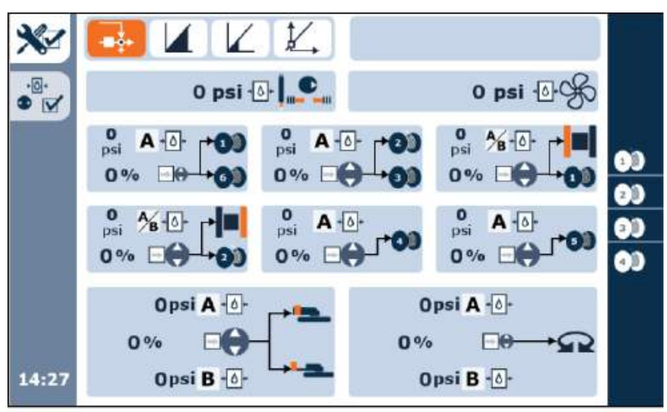
- Drums
- Swing
- Travel
- VPC tray and beam

Perform this calibration when:

- A new pump, motor, or sensor is installed
- Control software is updated
- A new control module is installed
- Operation indicates that the threshold is in error:
  - Excessive handle motion or time is required to initiate motion.
  - The inability to start motion smoothly is detected.

Perform the following procedure for the controls calibration.

1. Apply all park brakes using the switches on the control console.
2. Start and run the engine at high idle.
3. At the Main display, navigate to the Hydraulic Test screen and start the Controls Calibration Test (Figure 2-31). See the MLC650 Main Display Operation F2267 for detailed instructions on how to navigate to the screen and run the test.



M101569
FIGURE 2-31

4. Verify no pump icons are highlighted in red. Troubleshoot failed circuits to determine the fault cause.

FOR REFERENCE ONLY

High Pressure Test

WARNING

Skin Contact Hazard!

High-pressure hydraulic oil can puncture skin, causing serious injury.

If injured, seek medical help immediately. Surgery is required to remove the hydraulic oil.

The high pressure test checks the ability of all primary crane functions to reach and hold high pressure. This test generally is used only as a shop procedure on new cranes. It can also be used as a quick way to test hydraulic components in the primary hydraulic circuits.

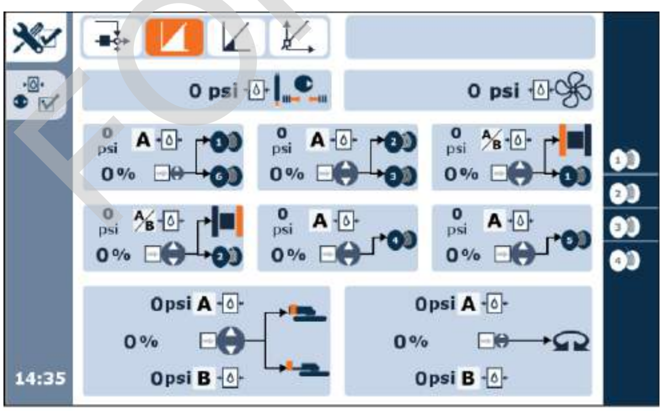
This test generates maximum pressure in the main hydraulic circuits. Only perform this high pressure test when absolutely necessary and by a qualified service technician.

Defective brakes may allow unintended motion during the test. Move the crane to an area where such motion is not a hazard. Be prepared to stop the engine if unintended motion occurs.

Use a signal person to monitor functions the operator cannot see.

Perform the following procedure for the high pressure test.

1. Apply all park brakes using the switches on the control console.
2. Start and run the engine at high idle.
3. At the Main display, navigate to the High Pressure Test screen and start the High Pressure Test (Figure 2-32). See the MLC650 Main Display Operation F2267 for detailed instructions on how to navigate to the screen and run the test.



M101570

FIGURE 2-32

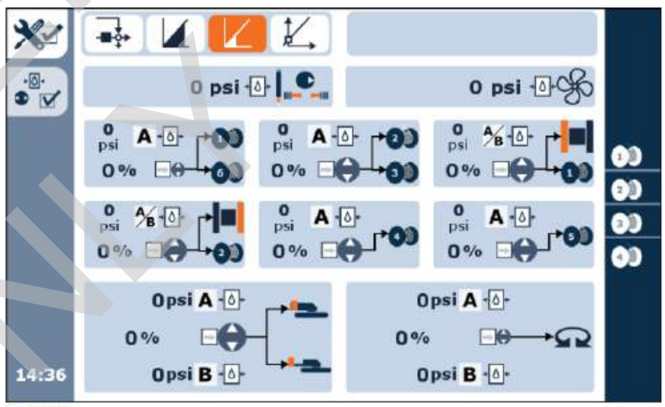
Maximum pressure levels must be reached within a specific pump command range during this test. Any pump requiring a command in excess of this range, or failing to generate maximum pressure, is highlighted in red. Troubleshoot the failed circuit to determine the cause of any failures.

Charge Pressure Test

The charge pressure test checks the ability of all primary crane functions to build proper charge pressure. This test generally is used only as a shop procedure on new cranes. It can also be used as a quick way to test hydraulic components in the primary hydraulic circuits.

Perform the following procedure for the charge pressure test.

1. Apply all park brakes using the switches on the control console.
2. Start and run the engine at low idle.
3. At the Main display, navigate to the High Pressure Test screen and start the Charge Pressure Test (Figure 2-33). See the MLC650 Main Display Operation F2267 for detailed instructions on how to navigate to the screen and run the test.



M101571

FIGURE 2-33

Charge pressure levels must be within a specified range during this test. Any pump that failed to maintain charge pressure within a specified range is highlighted in red. Troubleshoot the failed circuit to determine the cause of the failures.

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Drum Brake Test

Perform an operational test of each brake weekly.

NOTE: See system pressure specifications in Table 2-1

The electrical connector must be disconnected at the brake solenoid valves to stall the crane functions during the test.

1. At the pilot brake and pawl manifold, disconnect the electrical connector from the solenoid for the brake being checked.
2. Start and run the engine at low idle.
3. Turn off the park switch on the control console for the function being checked.
4. At the display, navigate to the diagnostic screen for the function being checked (see the MLC650 Main Display Operation F2267 for display navigation instructions).

CAUTION

Overheating Hazard!

Do not stall any function for more than 5 seconds. Damage from overheating can occur to the system components.

WARNING

Falling Load/Moving Crane Hazard!

If a disc brake slips when the drum brake test is performed, repair or replace it before placing the crane back into service. Loads could fall or the crane could move if the brakes are not operating properly, causing serious injury.

See the corresponding motor or gearbox manufacturer's manual for disc brake repair instructions.

NOTE: For the front or rear load drum, make sure free-fall is off.

Monitor the system pressure and pump command while moving the control handle.

5. Slowly move the control handle for the function being checked and verify the following:
   - Specified system pressure is reached before 50% of the pump command is reached.
   - The brake does not slip.

NOTE: If the brake fails to meet these criteria, it must be repaired or replaced and retested before operating with a load.

6. Turn on the park switch on the control console for the function being checked.
7. Shut off the engine.
8. At the pilot brake and pawl manifold, reconnect the electrical connector to the solenoid of the brake that was checked.

Swing Brake Test

Perform an operational test of the swing brake weekly in an area where the crane can be swung without interference.

NOTE: See system pressure specifications in Table 2-1.

1. Start and run the engine at low idle.
2. Turn off the swing park switch.
3. At the display, navigate to the swing diagnostics screen and verify the swing park brake is released.
4. Swing the crane by moving the control handle in both directions and verify the rotating bed swings freely.
5. Move the control handle to the NEUTRAL position and allow the rotating bed to come to a complete stop.
6. Turn on the swing park switch.
7. At the display, verify the swing park brake is applied.

CAUTION

Overheating Hazard!

Do not stall any function for more than 5 seconds. Damage from overheating can occur to the system components.

WARNING

Moving Crane Hazard!

If a disc brake slips when the swing brake test is performed, repair or replace it before placing the crane back into service. The crane could move if the brakes are not operating properly, causing serious injury.

See the corresponding motor or gearbox manufacturer's manual for disc brake repair instructions.

8. Attempt to swing the crane by moving the control handle in both directions and verify the following:
   - Specified system pressure is reached before 50% of the pump command is reached.
   - The swing brake does not slip.

NOTE: If the brake fails to meet these criteria, it must be repaired or replaced and retested before operating with a load.

9. Shut off the engine.

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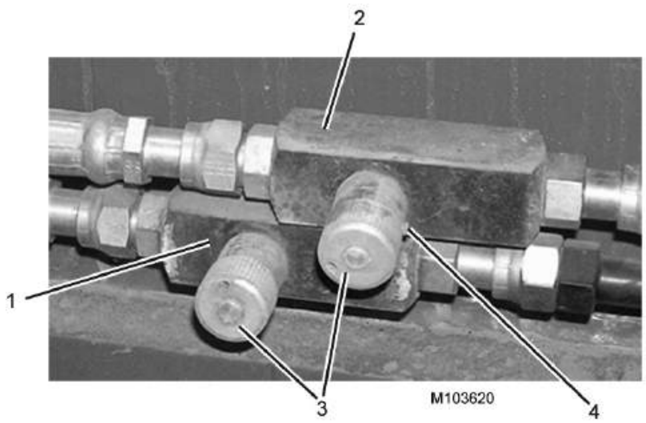

Near Cab On Left Side of Rotating Bed

Item	Description
1	Tilt Down—Flow Control Valve
2	Tilt Up—Flow Control Valve
3	Adjusting Knob (qty 2)
4	Set Screw (qty 2)

FIGURE 2-34

Cab Tilt Adjustment

To adjust the speed at which the cab tilts up and down, proceed as follows.

See Figure 2-34 for the following procedure.

1. Loosen the set screws (4).
2. Turn the adjusting knobs (3) fully clockwise to close the valves.
3. Open both valves slightly.
4. Test the cab tilt operation with the switch on the control console in the cab.
5. Repeat step 2 through step 4 until the cab tilt starts and stops smoothly in both directions.
6. Securely tighten the set screws.

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SECTION 3
ELECTRICAL SYSTEM

TABLE OF CONTENTS

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SECTION 3
ELECTRICAL SYSTEM

ELECTRICAL DRAWINGS AND SCHEMATICS

Electrical schematics are located at the end of this section.

ELECTRICAL POWER SEQUENCE

Battery Power

Power for the crane's electrical system is provided by two 12-volt batteries connected in series to produce 24 volts.

The following devices are connected to the battery positive terminal at all times:

- Alternator (via 150 A alternator fuse or circuit breaker)
    - Alternator fuse (F0)—Tier 4
    - Alternator circuit breaker (CB0)—Tier 3
- Remote battery positive terminal
- Left and right starter solenoids
- Battery disconnect switch
- CraneStar® TCU (via fuse F5)

Battery Power Disconnect

When in the OFF position (contacts open), the battery disconnect switch S1 disconnects the battery positive terminal from the crane's electrical systems. The switch is turned to the OFF position for the following situations:

- Whenever the electrical system is being serviced.
- During extended downtime to help save battery life.
- For security reasons.

The battery disconnect switch must be in the ON (contacts closed) position for machine operation. When the switch is closed, battery power becomes available to the following circuits and devices, via the main circuit breaker CB61:

- Engine run switch S3 (via CB6)
- Relay K3 and external run switch S33 (via CB4)
- Relays K4 and K6 (normally open contacts)
- Relay K5 (via CB8)
- Display modules (via CB4)
- Horn, dome light, and service lights switches (via CB5)
- Radio clock and preset memory (via CB5)
- Boom top warning light switch (via CB6)
- Setup remote battery charger (via CB4)
- Diesel heater (via CB9)
- Tier 4 engine sensors (via CB2)

FOR REFERENCE ONLY

Crane Electrical Power Distribution

When the battery disconnect switch is closed and battery power is available, turning the engine run switch S3 to the RUN position provides power to terminal KL15 on the following control modules:

- SCM-00
- CCM-10
- CCMC11
- IOSA22
- IOLC30
- IOLC31
- IOLC32
- IOLC33
- IOLC34

The engine run switch also provides power directly to the following components:

- Main (ODM) display
- RCL/RCI (RDM) display
- CraneStar TCU

When in the RUN position, the engine run switch provides power from circuit breaker CB4 to relays K3—K6, closing the normally open contacts of the relays and providing power to the engine electrical control module (ECM) and the crane's CAN Bus control modules as follows:

- Relay K3 energizes relay K4, which provides power to the engine ECM through the following circuit breakers:
  - CB15 and CB16 (Tier 3)
  - CB17, CB19, and CB20 (Tier 4)
- Relay K5 provides power from circuit breaker CB8 to terminal +UE on the following control modules:
  - SCM-00
  - CCM-10
  - CCMC11
  - IOSA22
  - IOLC30
  - IOLC31
  - IOLC32
  - IOLC33
  - IOLC34
  - SCMD01
- When energized, relay K6 provides power to terminal +UB on all crane CAN Bus control modules. K6 also provides power to terminals KL15 and +UE on the following control modules:
  - SCMD01—KL15
  - CCMB11—KL15 and +UE
  - IOSC22—KL15 and +UE
  - IOLC35—KL15 and +UE

When energized, relay K6 also provides power to the following components and circuits:

- Jog dial and joysticks (via CB46)
- Climate controls (via CB42)
- Wiper controls (via CB43)
- Work lights and panel lights (via CB44)
- 24 V_{DC}-to-12 V_{DC} converter (powers the radio and seat motor switches) (via CB41)
- Variable position counterweight (VPC™) encoder (via CB39)

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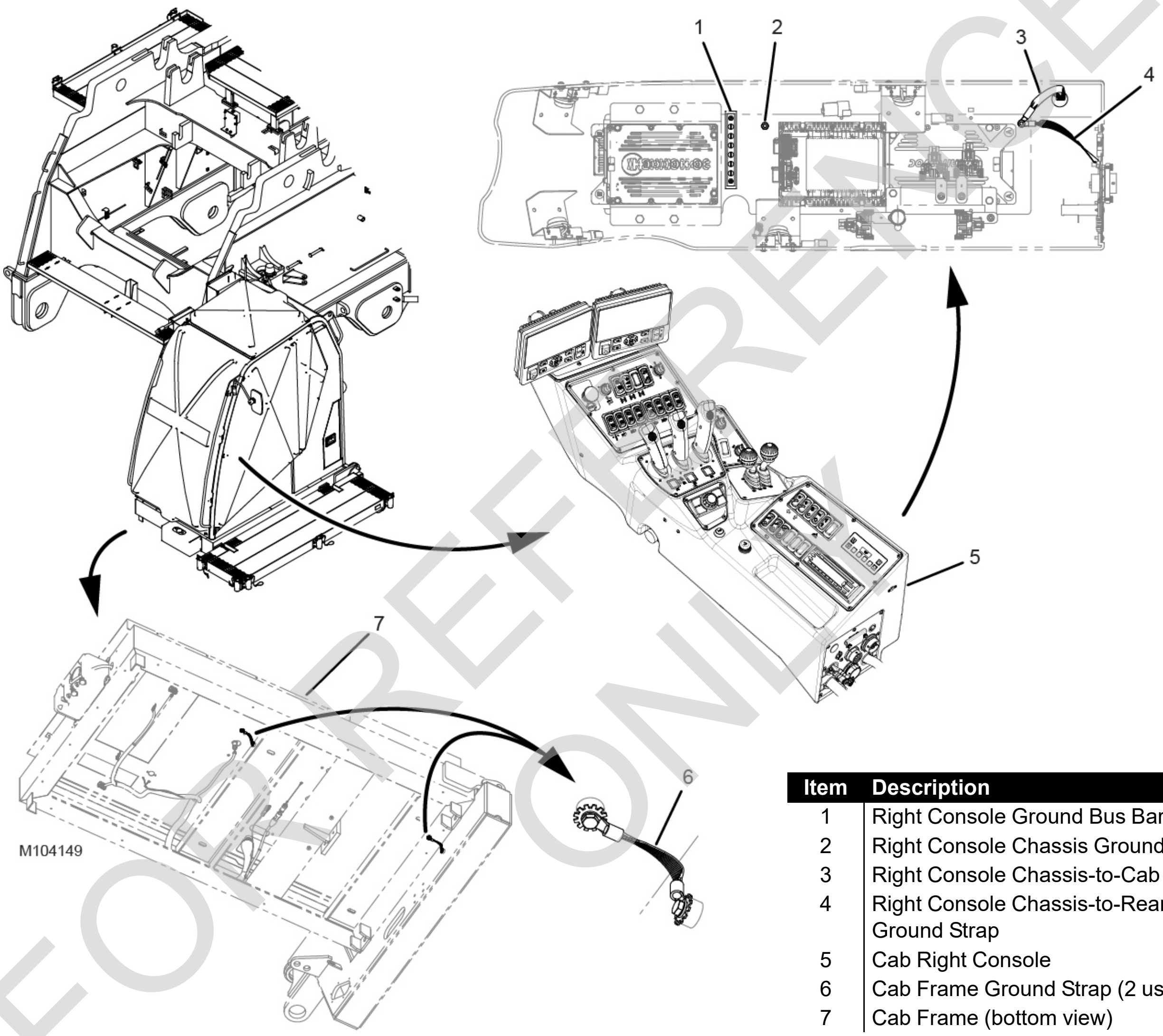
Crane Electrical System Ground Points

Electrical system ground points are located in and under the cab, on the rotating bed, and on the engine block.

Cab Ground Points

The cab electrical ground points are at the following locations (Figure 3-1):

- Cab right console (5):
  - Right console ground bus bar (1)
  - Right console chassis ground stud (2)
  - Right console chassis-to-cab ground strap (3)
  - Right console chassis-to-rear panel ground strap (4)
- Cab frame ground straps (6) under cab frame (7)



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Item	Description
1	Right Console Ground Bus Bar
2	Right Console Chassis Ground Stud
3	Right Console Chassis-to-Cab Ground Strap
4	Right Console Chassis-to-Rear Panel Ground Strap
5	Cab Right Console
6	Cab Frame Ground Strap (2 used)
7	Cab Frame (bottom view)

FIGURE 3-1

Rotating Bed Ground Points

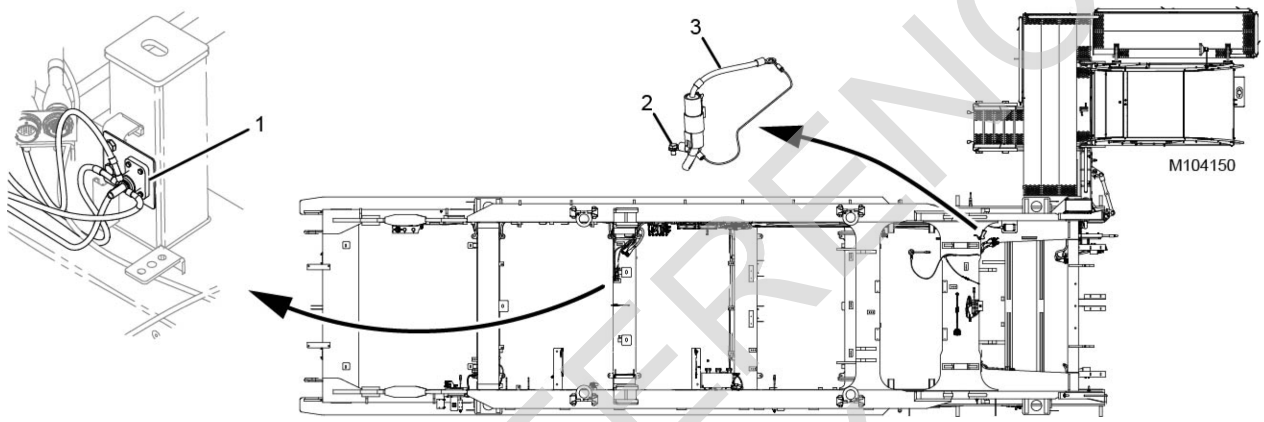
There are two major ground points on the rotating bed:

- Rotating bed ground point (1)
- Live mast-to-rotating bed ground point (2)

The rotating bed ground point (1) is a ground stud located at the left engine mount bracket (Figure 3-2). The ground stud provides a single connection point for the ground circuit of all the electrical devices located on the rotating bed and the carbody. A ground cable connects the battery negative (-) terminal to the ground stud.

The live mast-to-rotating bed ground point (2) provides a path to ground for electrical components on the live mast frame. It electrically connects the left arm of the live mast to the rotating bed frame.

The ground cable cap assembly (3) provides connector protection when the live mast is not attached to the rotating bed.



Item	Description
1	Rotating Bed Ground Point
2	Live Mast-to-Rotating Bed Ground Point
3	Ground Cable Cap Assembly

FIGURE 3-2

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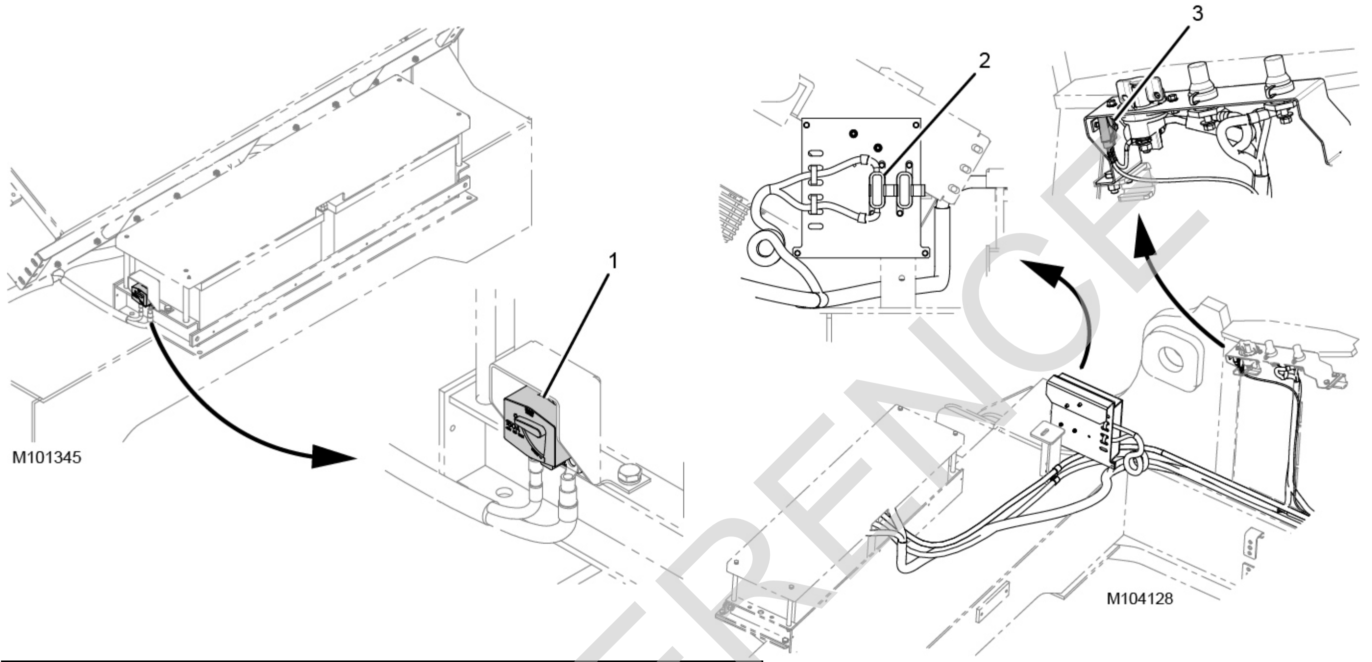
CIRCUIT BREAKERS, FUSES, AND RELAYS



Item	Description
1	CB0—Alternator 150 A Circuit Breaker (Tier 3—Past Production)
2	F0—Alternator 150 A Fuse (Tier 4 and Tier 3—Current Production)
3	F5—TCU CraneStar 5 A Fuse

FIGURE 3-3

For past production Tier 3 cranes, the alternator circuit breaker CB0 (1) is mounted next to the battery box (Figure 3-3).

For Tier 4 cranes and current production Tier 3 cranes, the alternator fuse F0 (2) is mounted on a panel left of the battery box (Figure 3-3).

The TCU CraneStar fuse F5 (3) is mounted on the battery disconnect bracket.

All other circuit breakers and fuses are mounted in the junction box DC load center (Figure 3-5).

All relays are also mounted in the junction box DC load center (Figure 3-5).

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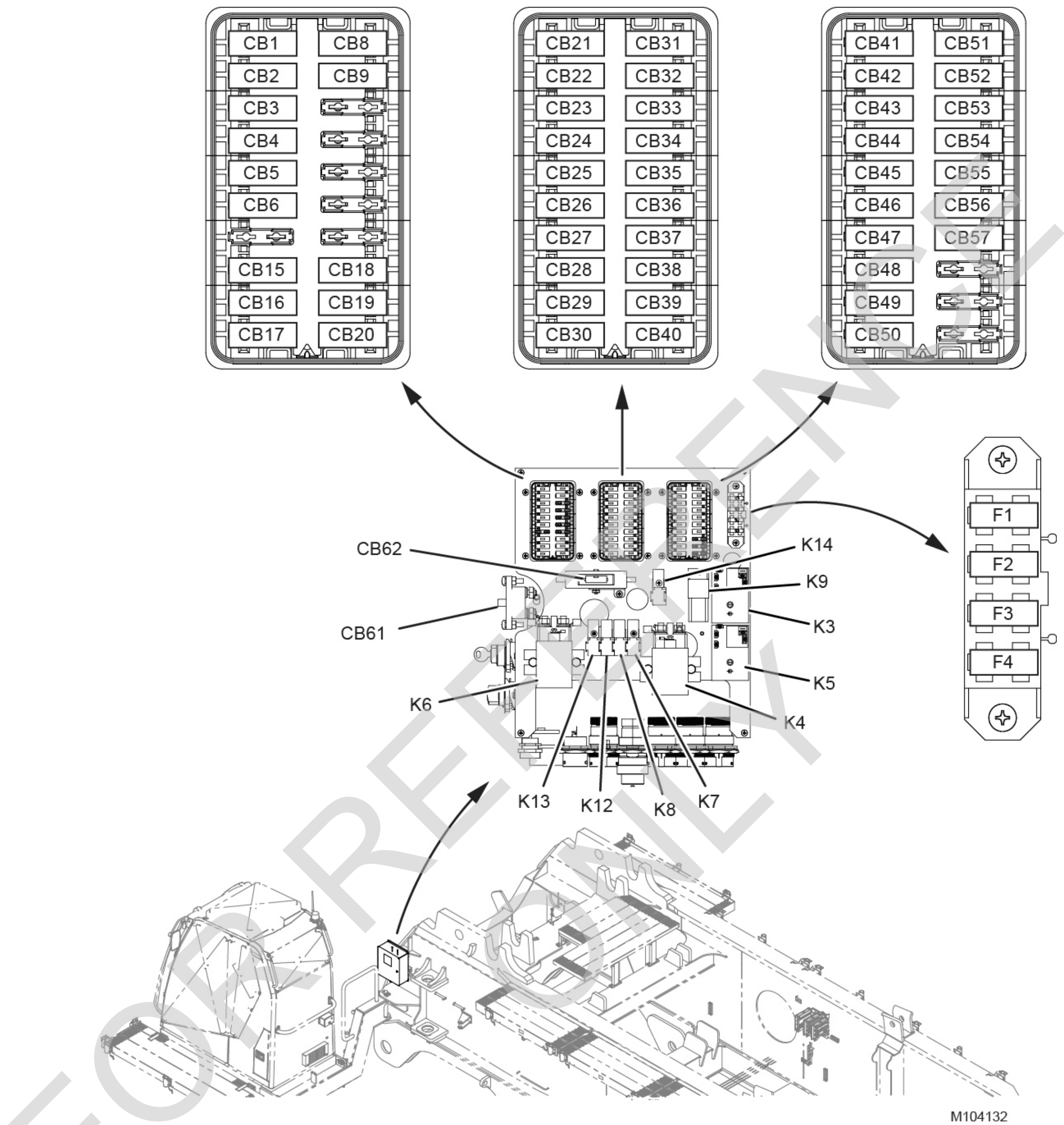

FIGURE 3-4

Relay	Description	Relay	Description
K1	Left Starter Motor Relay (not shown)	K7	ECM Key (start)
K2	Right Starter Motor Relay (not shown)	K8	DEF Pressure Hose Heater
K3	ECM Bus (300 second TDO)	K9	DEF Supply Module
K4	ECM Bus	K12	DEF Return Hose Heater
K5	Ignition Bus (10 second TDO)	K13	DEF Suction Hose Heater
K6	Crane Bus	K14	Not Used

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Circuit Breaker	Amps	Description of Item Protected	Circuit Breaker	Amps	Description of Item Protected
CB1	15	Spare	CB36	15	IOLC33 (+UB input supply)
CB2	10	ECM Start Relay (K7)	CB37	15	IOLC33 (+UB input supply)
CB3	15	Spare	CB38	15	IOLC33 (+UB input supply)
CB4	15	External Key Switch, Setup Remote Receiver, Display Modules, and K3	CB39	15	CCM-10 (+UB), VPC™ Encoder
CB5	15	Dome Light, Horn, Radio, and Bed Service Lights (optional)	CB40	15	CCM-10 (+UB input supply)
CB6	15	Ignition Switch Circuits and Boom Top Warning Light	CB41	25	24 V_{DC}-to-12 V_{DC} Converter
CB8	15	Control Modules +UE Power Supply	CB42	15	Heater/AC, ECU Power Interface
CB9	15	Diesel Heater	CB43	15	Wipers
CB15	10	ECM (Tier 3)	CB44	15	Back Panel Lights, Diagnostic Port, Cameras, and Work Lights
CB16	10	ECM (Tier 3)	CB45	15	SCM-00, IOSA22 (+UB input supply)
CB17	30	ECM (Tier 4)	CB46	15	Joysticks, Jog Dial, Park Switches
CB18	10	Spare	CB47	15	Spare
CB19	15	DEF Heater Relays (K8, K12, K13)—Cummins	CB48	15	Diesel Heater
CB20	15	Spare	CB49	15	CCMC11 (+UB input supply)
CB21	15	IOLC31 (+UB input supply) IOLC35 (+UB, +UE, KL15 supply)	CB50	15	CCMC11 (+UB input supply)
CB22	15	IOLC31 (+UB input supply)	CB51	15	IOLC34 (+UB input supply)
CB23	15	IOLC31 (+UB input supply)	CB52	15	IOLC34 (+UB input supply)
CB24	15	IOLC31 (+UB input supply)	CB53	15	IOLC34 (+UB input supply)
CB25	15	IOLC30 (+UB input supply)	CB54	15	IOLC34 (+UB input supply)
CB26	15	IOLC30 (+UB input supply)	CB55	15	Spare
CB27	15	IOLC30 (+UB input supply)	CB56	15	Spare
CB28	15	IOLC30 (+UB input supply)	CB57	15	CCMB11 and IOSB22 (+UB, +UE, KL15 input supply)
CB29	15	SCMD01 (+UB, KL15)	CB61	120	Main Circuit Breaker
CB30	15	Spare	CB62	40	Spare
CB31	15	IOLC32 (+UB input supply)	F1	10	Power Point (right 12 V outlet)
CB32	15	IOLC32 (+UB input supply)	F2	10	Power Point (left 12 V outlet)
CB33	15	IOLC32 (+UB input supply)	F3	10	Radio
CB34	15	IOLC32 (+UB input supply)	F4	10	Spare
CB35	15	IOLC33 (+UB input supply)			

NOTE: Sockets for circuit breakers CB7, CB10—CB14, and CB58—CB60 are not used.

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INSPECT ELECTRICAL COMPONENTS

DANGER

Electric Shock Hazard

Ensure that the battery cables are disconnected from the batteries before loosing any electrical connections.

Every Month or 200 Hours

1. Visually inspect all electrical harnesses and cables for the following:
   - Damaged, cut, or deteriorated harness loom covering
   - Damaged, cut, or abraded individual wires or cable insulation
   - Exposed bare copper conductors
   - Kinked, crushed, or flattened harnesses and cables
   - Blistered, soft, or degraded wires and cables.
   - Cracked, damaged, or badly corroded battery terminal connections.
   - Damaged terminals or excessive corrosion on machine ground connections.
   - Other signs of significant deterioration

   If any of these conditions exist, evaluate the harness for repair or replacement.

2. Visually inspect all controller area network (CAN) control modules and electrical junction boxes for the following:
   - Damaged or loose connectors.
   - Damaged or missing electrical clamps or tie straps.
   - Excessive corrosion or dirt on the junction boxes.
   - Loose junction box mounting hardware.

   If any of these conditions exist, address them appropriately.

Degradation Due to Severe Environment

Table 3-1.Climate Zone Classification

Zone	Description
A	Tropical Moist: All months average above 18° C. Latitude: 15° to 25° N & S
B	Dry or Arid: Deficient precipitation most of the year. Latitude: 20° to 35° N & S
C	Moist Mid-Latitude: Temperate with mild winters. Latitude: 30° to 50° N & S
D	Moist Mid-Latitude: Cold winters. Latitude 50° to 70° N & S
E	Polar: Extremely cold winters and summers. Latitude: 60° to 75° N & S

Zones A and B

Replace harnesses and battery cables operating in this climate zone after 8,000 hours of service life. Their electrical service life is reduced by 25% to 40%.

Zone C

Replace harnesses and battery cables operating in this climate zone after 10,000 hours of service life.

Zones D and E

Cold temperatures will negatively impact service life. Regularly inspect electrical harnesses and cable assemblies per step 1.

Salt Environment

Harness and cable assemblies operating in salt water climates could see a significant reduction in service life. Regularly inspect electrical harnesses and cable assemblies per step 1.

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CAN BUS CONTROL SYSTEM

CAN Bus System Overview

The CAN Bus control system consists of the following components:

- CAN Bus
- Control modules
- CAN Bus devices
- CAN Bus terminator plugs

CAN Bus—The CAN Bus is the crane's serial communication network consisting of a shielded twisted pair of wires—one wire is designated CAN High (+), and the other wire is CAN Low (-). The twisted pair and shielding helps prevent spurious signals and noise from being introduced into the CAN Bus.

The crane contains six separate CAN Buses (Figure 3-5):

- CAN Bus A (cab)
- CAN Bus B (carbody)
- CAN Bus C (rotating bed)
- CAN Bus D (RCL/boom)
- CAN Bus J (engine)
- CAN Bus H (CraneStar)

Control Modules—The CAN Bus control system contains control modules that use the CAN Bus to communicate with each other and with other CAN Bus devices. (For more information, see Control Modules, on page 3-11.)

The control modules receive inputs from components such as switches, sensors, and transducers.

The control modules drive outputs to components such as motors, relays, and solenoids. The control module components are hardwired separately to the control modules. (For more information, see Control Module Devices, on page 3-17.)

CAN Bus Devices—Besides control modules, the CAN Bus also contains the following devices:

- Main (ODM) display
- RCL/RCI (RDM) display
- Jog dial
- Joysticks
- Travel handles
- Swing encoder
- *VPC™ encoder
- *VPC-MAX™ encoder
- Setup remote receiver
- CAN Bus program port

*VPC = Variable Position Counterweight

CAN Bus Terminator Plugs—Terminator plugs reduce electrical noise pickup. The terminator plugs are added to each end of the CAN bus to match the impedance of the CAN line, which prevents line reflection.

The terminator plugs may also provide a load for the control module drivers.

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CAN Bus System Chart

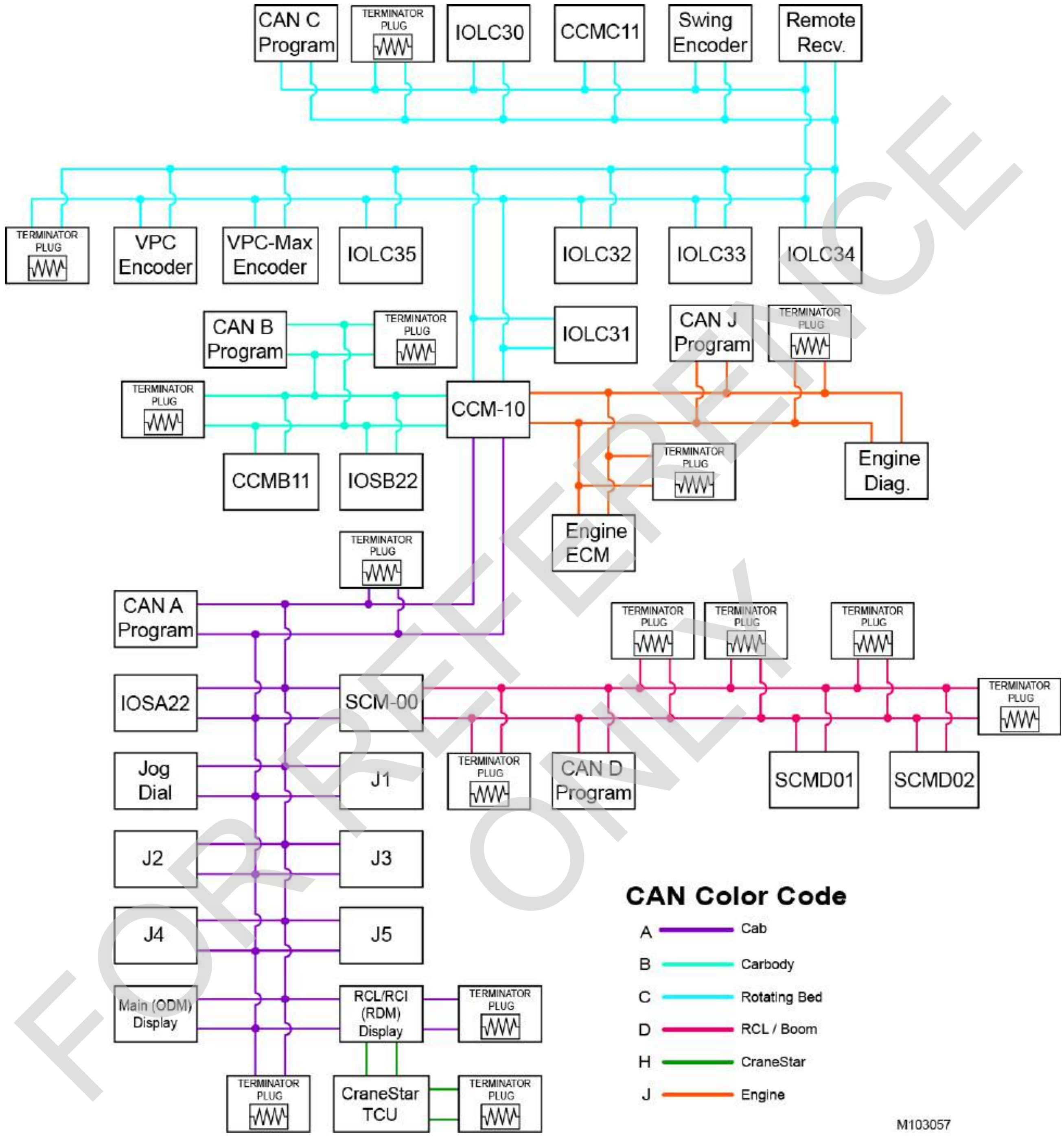

FIGURE 3-5

Control Modules

Control modules perform several functions:

- Run the software control programs
- Communicate with each other over the CAN Bus
- Read input devices
- Command output devices

Control Module Naming Conventions

There are three types of control modules in the CAN Bus system:

- Safety Control Module (SCM)
- Crane Control Module (CCM)
- Input/Output—Large (IOL)
- Input/Output—Small (IOS)

Control modules are named in the format MWXXXABC. Table 3-2 defines the variables used to build the name.

Table 3-2. Control Module Naming Definitions

Identifier	Definition
XXX	Module Type: SCM CCM IOL IOS
A	CAN Bus ID: - = Multiple Buses A = CAN Bus A B = CAN Bus B C = CAN Bus C D = CAN Bus D J = CAN Bus J H = CAN Bus H
B	Module Hardware ID: 0 = SCM 1 = CCM 2 = IOS 3 = IOL
C	Module Index

Control Module Input/Output (I/O) Types

Table 3-3 defines the terms used in the schematics for the I/O types used by the control modules.

Table 3-3. Control Module I/O Types

Schematic Term	Definition
IAC	Analog Current Input
IACV	Analog Current/Voltage Input
$IBRTC_n$	Real-Time Clock Battery Negative Input
$IBRTC_p$	Real-Time Clock Battery Positive Input
ID	Digital Input
IDF	Digital Frequency Input
IMID1	Module Identifier Input
KL15	Control Module Ignition Power Input
ODHxA	Digital Output, where “x” is the current in Amps
OPHxA	PWM Output High Side, where “x” is the current in Amps
OPLxA	PWM Output Low Side, where “x” is the current in Amps
OS85H	8.5 V_{DC} Supply Power
OS85L	8.5 V_{DC} Supply Ground
+UB	Battery Supply for Control Module Outputs
+UE	Control Module Battery Power Input

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Safety Control Module (SCM)

SCMs are controllers that run the software programs to interface with the cab controls and to govern boom and jib load safety. The software running in each SCM controls the I/O devices connected directly to the SCM and any I/O modules connected on its bus.

There are three SCMs on the crane (Figure 3-6):

- MWSCMD01 (boom)
- MWSCM-00 (cab)
- MWSCMD02 (jib CSM)

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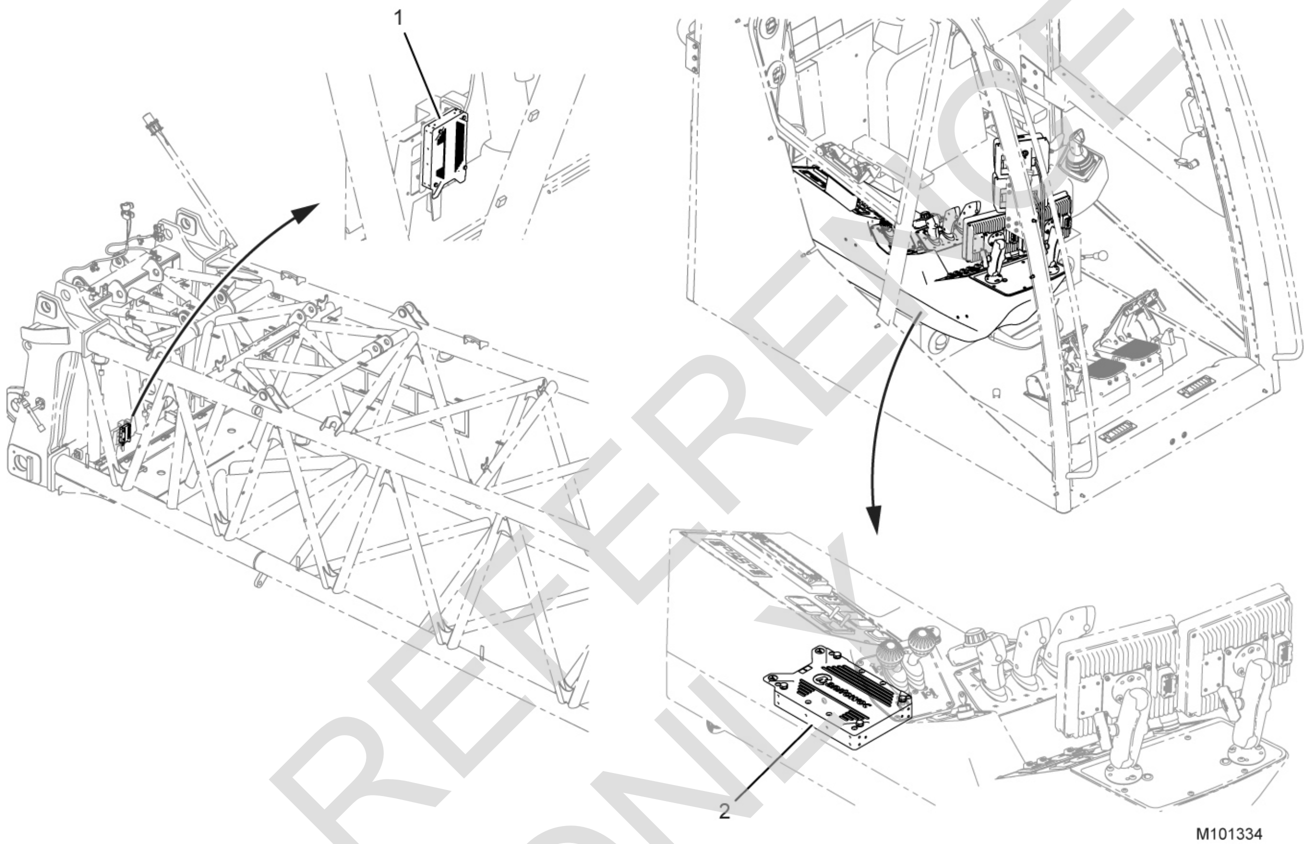


Item	Description
1	MWSCMD01
2	MWSCM-00
3	MWSCMD02

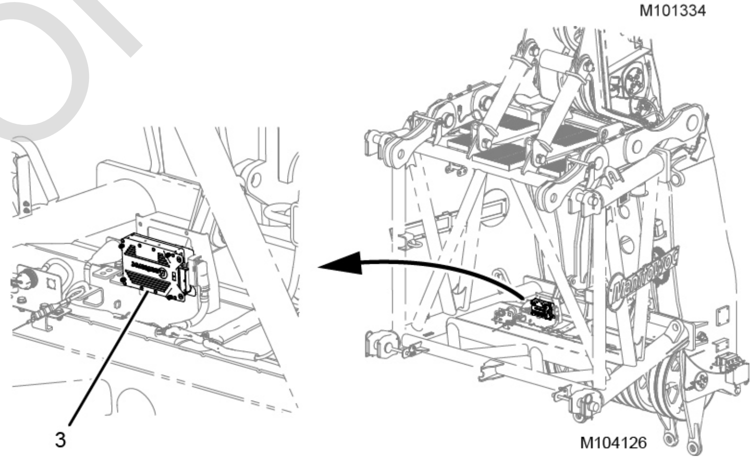


FIGURE 3-6

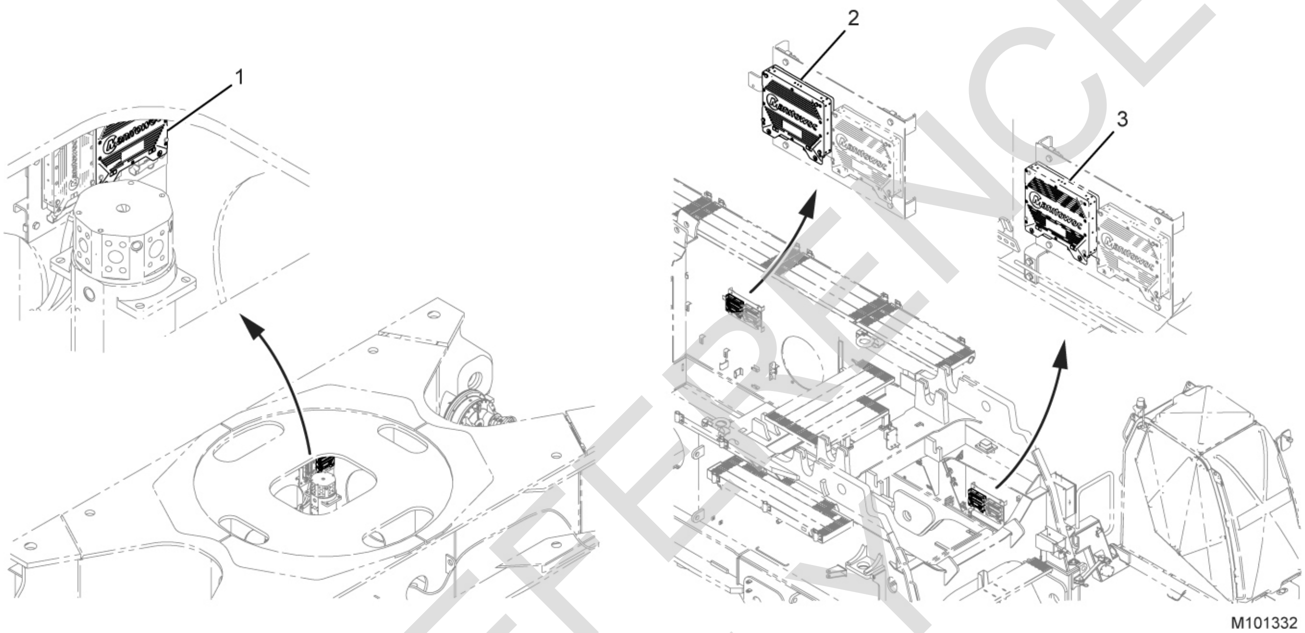
FOR REFERENCE ONLY

Crane Control Module (CCM)

CCMs are controllers that run the software programs governing crane operations in the rotating bed and carbody. The software running in each CCM controls the I/O devices connected directly to the CCM and any I/O modules connected to its bus.

There are three CCMs mounted on the crane (Figure 3-7):

- MWCCMB11 (carbody)
- MWCCM-10 (rotating bed—master)
- MWCCMC11 (rotating bed—slave)



Item	Description
1	MWCCMB11
2	MWCCM-10
3	MWCCMC11

FIGURE 3-7

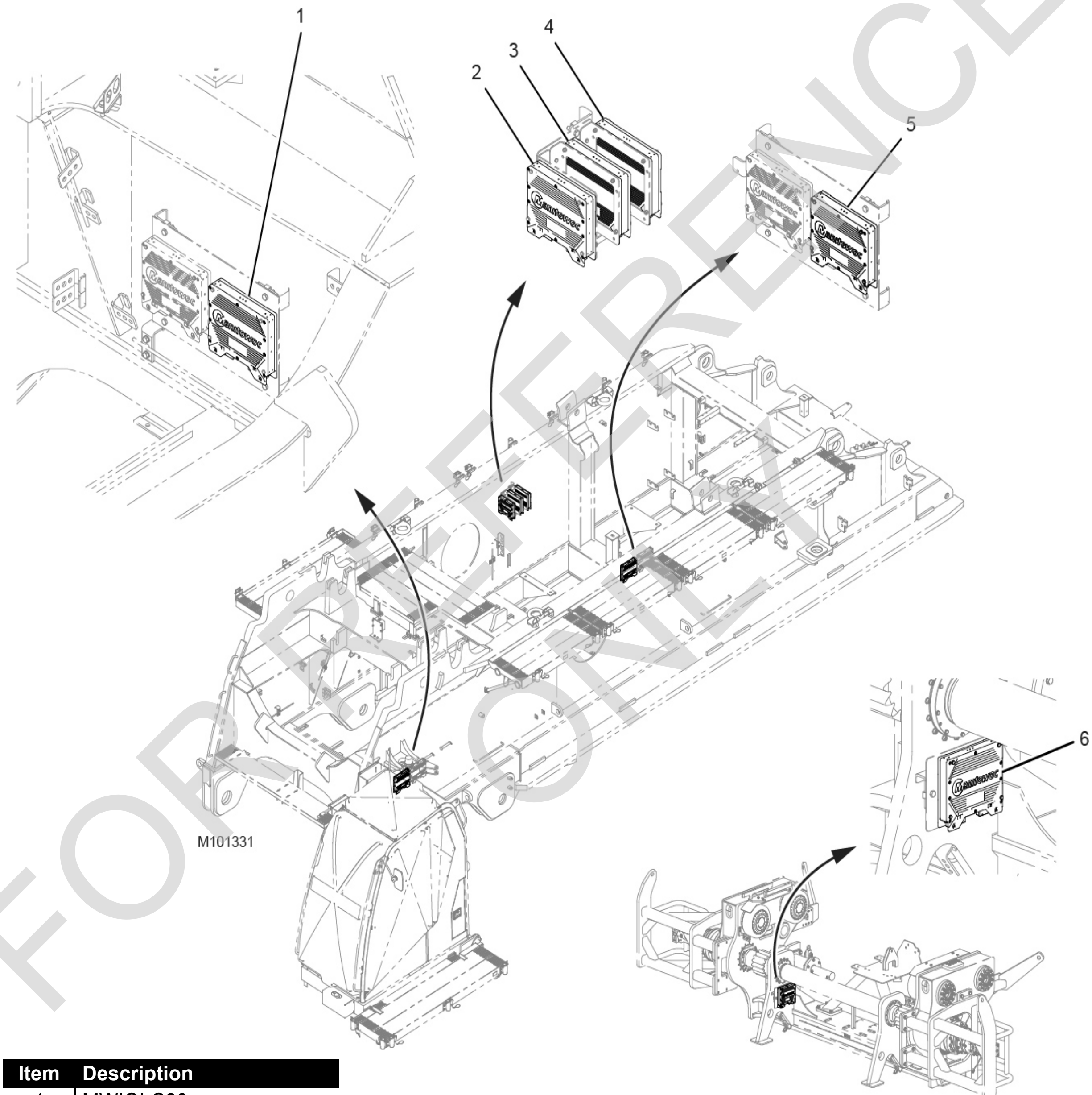
FOR REFERENCE ONLY

Input/Output—Large (IOL) Module

IOLs control the devices connected to them and communicate with CSMs or CCMs connected to their bus. IOLs have twice the device capacity as input/output—small (IOS) modules.

There are six IOL modules mounted on the rotating bed (Figure 3-8):

- MWIOLC30
- MWIOLC32
- MWIOLC33
- MWIOLC34
- MWIOLC31
- MWIOLC35 (VPC-MAX)



Item	Description
1	MWIOLC30
2	MWIOLC32
3	MWIOLC33
4	MWIOLC34
5	MWIOLC31
6	MWIOLC35 (VPC-MAX)

FIGURE 3-8

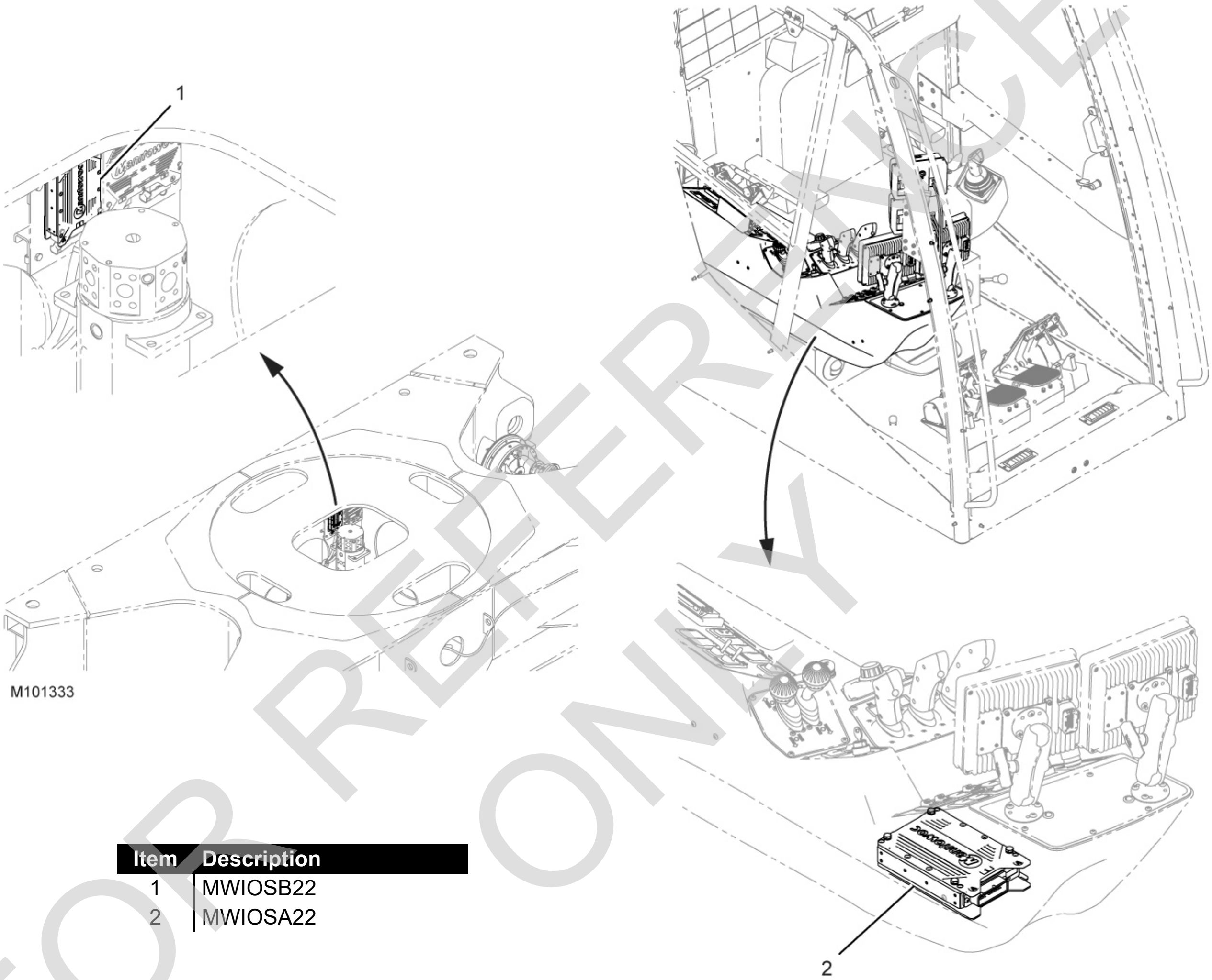
FOR REFERENCE ONLY

Input/Output—Small (IOS) Module

IOSs control the devices connected to them and communicate with CSMs or CCMs connected to their bus. IOSs have half the device capacity as input/output—large (IOL) modules.

There are two IOS modules on the crane (Figure 3-9):

- MWIOSB22 (carbody)
- MWIOSA22 (cab)



Item	Description
1	MWIOSB22
2	MWIOSA22

FIGURE 3-9

FOR REFERENCE ONLY

Control Module Devices

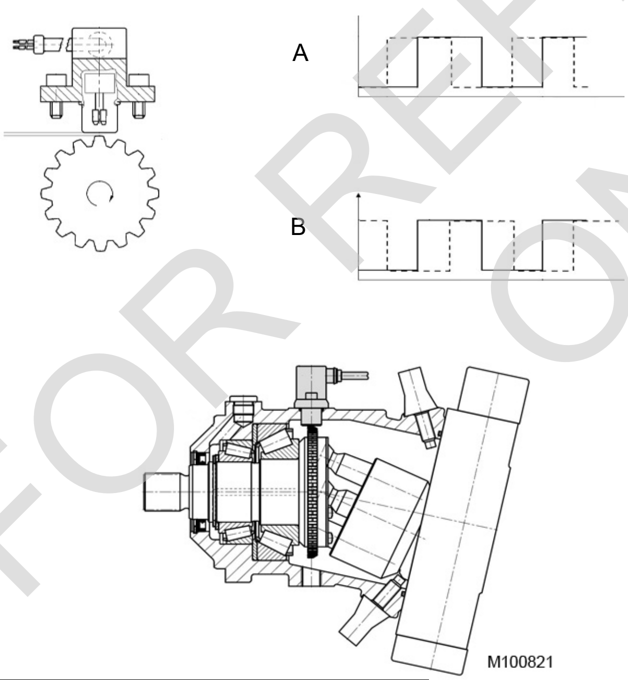
The control modules communicate with output devices to control crane movement and with input devices to read crane status. The following sections detail the operation of these devices.

Pressure Transducers

A controller provides power to the pressure transducer. The pressure transducers send an analog input signal to the controller that is proportional to the hydraulic pressure at the transducer connection. The controllers monitor hydraulic pressures to use as feedback in control algorithms and to provide status information to the operator. Pressure transducers are used to monitor the following:

- Drum system pressures
- Swing system pressure
- Accessory system pressure
- Track pressure
- Variable position counterweight (VPC) actuator pressure
- Cooler fan pressure

Motor Speed Sensors



Item	Description
A	Clockwise Rotation Signals
B	Counterclockwise Rotation Signals

FIGURE 3-10

A controller provides power to Hall-effect speed sensors located within the hydraulic motors that drive the drums rotating bed, VPC, and crawlers. A gear wheel within the motor has teeth that move past the speed sensor as a motor shaft spins, causing the sensor to produce two square-wave signals that are offset with a 90° phase delay (Figure 3-10). These signals are read at the frequency inputs of the controller.

The frequency of the square waves is determined by the number of teeth on the circumference of the gear wheel and shaft speed. The rotational direction is determined by which signals phase leads the other. Software uses the square-wave frequency and phase information to calculate the rotational speed and direction of the motor.

Limit Switches—Dual Contact

In the non-tripped state, a controller provides power to the normally closed contact and grounds the normally open contact. A controller digital input reads the applied power through the normally closed contact back through the common center terminal as a logic high. When the switch is tripped, the normally closed contact opens, breaking the current path through the common terminal. At the same time, the normally open contact closes, grounding the common terminal and sending a controller digital input a logic low signal.

Dual contact limit switches are used to sense the travel limits of the following crane functions:

- Drums 1, 2, 3, 5, and 6 minimum bail limit
- Drums 4, 5, and 6 pawl limit
- Maximum boom angle limit
- Mast position limit
- VPC beam in and out maximums
- VPC tray in and out maximums
- VPC-MAX™ beam in and out maximums
- VPC-MAX tray in and out maximums
- VPC-MAX beam up left and right
- VPC-MAX beam on hook left and right
- Gantry limit

Limit Switches—Single Contact

In the non-tripped state, a controller provides power to the normally closed contact. A controller digital input reads the applied power back through the normally closed contact as a logic high. When the switch is tripped, the normally closed contact opens, breaking the current path through the common terminal. The controller digital input reads this as a logic low.

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Single contact limit switches are used for the following crane functions:

- Lower boom point block-up limit
- Lower boom point block-up slow down
- Upper boom point block-up limit
- Upper boom point block-up slow down
- Luffing jib minimum angle
- Luffing jib maximum angle
- Left luffing jib cylinder stop position
- Right luffing jib cylinder stop position
- EUBP block-up limit 1 and 2

Solenoids

Solenoids are driven by controller digital outputs. The solenoids activate and control the following cylinders, valves, and pumps:

- Brake release cylinders
- Drum pawl cylinders
- Mast cylinders
- Cab tilt cylinders
- Self-assembly cylinder
- Cylinder stowage
- Rigging winch (drum 0)
- Diverter valves
- Jack cylinders
- Pin pusher cylinders
- Cooler fan pump

Angle Sensors

A controller provides power to the angle sensor. The sensor produces an analog signal that is proportional to the sensor angle. A controller analog input reads this signal, and the controller software determines the mast angle based upon the signal level.

Angle sensors are used to measure the following items:

- Live mast angle
- Fixed mast angle
- Boom angle
- Boom top angle
- Rotating bed pitch and roll
- VPC-MAX beam level

Alarms

A controller digital output drives the applicable alarm during various operational states:

- Swing motion
- VPC motion
- Travel motion
- Load approaching or exceeding capacity

Load Pin Sensors

A controller digital output provides power to the load pin sensors. A strain gauge within the load pin produces an analog output current that is proportional to the load. A controller analog input reads this output current, and the controller software determines the value of the load based upon the current level.

Load pin sensors monitor the following loads:

- Mast strap
- Right and left strap links
- Upper boom point/light fixed jib

Temperature Sensors

A controller digital output provides power to the temperature sensor.

The sensor produces an analog voltage signal that is proportional to temperature. A controller analog input reads this voltage signal, and the controller software determines the value of the load based upon the signal level.

Fuel Level Sensor

A controller digital output provides power to the fuel level sensor. The fuel level sensor produces an ultrasonic pulse that reflects off the fuel surface and bottom of the fuel tank.

A micro-controller in the fuel level sensor uses the echo-return time to calculate the distance from the fuel surface to the bottom of the tank. It then converts this information to an analog voltage signal that is proportional to the fuel level and sends the voltage signal to a controller analog input.

Hydraulic Fluid Level Sensor

A controller digital output provides power to the hydraulic level sensor. The sensor has a capacitive probe that is immersed in the hydraulic fluid. The level of hydraulic fluid determines the capacitance of the probe.

A micro-controller in the probe converts the detected capacitance to an analog voltage signal that is proportional to the fluid level. The sensor then sends the voltage signal to a controller analog input.

FOR REFERENCE ONLY

Pressure and Vacuum Switches

The pressure and vacuum switches are normally closed. The switches open when the vacuum or pressure level exceeds the setting of the switch.

A controller digital output provides power to the switch.

In the non-tripped state, the normally closed contact allows power to be sent through the center terminal of the switch, then back to a controller digital input to be read as a logic high.

When the switch is tripped, the normally closed contact opens, breaking the path of power through the center terminal, and the controller reads this as a logic low.

Relays

A controller digital output drives the relay coil. The coil energizes, creating a magnetic field that closes the relay contacts. Relays use a small control signal to control the flow of a large current.

Warning Lights

A controller digital output powers the warning lights.There are warning lights for the following crane systems:

- VPC
- Boom top

Camera Lights

A controller digital output powers the camera lights.There are camera lights for the following:

- Drums 1 to 6
- VPC-MAX rear camera

Hand Throttle

A controller provides an 8.5 V_{DC} supply to a potentiometer that is connected to the hand throttle. Power is applied across the potentiometer windings to ground. Moving the hand throttle moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the hand throttle position and is sent to a controller analog input.

Foot Throttle

A controller provides a digital output to a potentiometer that is connected to the foot throttle. Power is applied across the potentiometer windings to ground. Moving the foot throttle moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the foot throttle position and is sent to a controller analog input.

Travel and Free-Fall Brake Pedals

A controller digital output provides power to a potentiometer that is connected to the pedal. Power is applied across the potentiometer windings to ground. Moving the pedal moves a wiper across the potentiometer windings. The voltage provided at the wiper when referenced to ground is proportional to the pedal position and is sent to a controller analog input.

Pump Displacement Controls

Pump flow is both directional and variable, determined by position and stroke of a proportional solenoid valve.

A controller sends two pulse-width modulated (PWM) output signals to two coils that actuate the solenoid valve in opposite directions. As a PWM duty cycle increases at one coil, more fluid is ported to the swashplate servo pistons through the solenoid valve, increasing the swashplate angle in the direction commanded. As the swashplate angle increases, so does the piston stroke within the pump, increasing the pump output volume.

RCL Beacon

A controller provides a digital output to each indicator in the RCL beacon (red, amber, and green).

Wind Speed Indicators

A controller digital output provides power to the wind speed sensor. The sensor produces an analog signal that is proportional to the wind speed. A controller analog input reads this signal, and the controller software determines the wind speed based upon the signal level.

Proximity Sensors

A controller digital output provides power to the proximity sensor.

Proximity sensors sense metal objects by generating magnetic fields. When no metal object is close to the sensor, the solid state switch within the sensor is open and there is no output signal. When a metal object is close to the sensor, the switch within the sensor closes and outputs a signal which is 1.8 V_{DC} less than the sensor supply voltage.

A yellow LED on the sensor indicates the switch state.

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Control Module Test Voltages

Pump and Motor Voltages and Currents

Table 3-4 shows the voltages and currents of the pumps, hoists, and travel motors.

Table 3-4. Pump and Motor Voltages and Currents

Accessory Pump 9	4 to 15 V nominal 200 to 600 mA[1,2]
Pumps 1 to 8	1 to 25 V nominal 5 to 105 mA[1,2]
Fan Pump	1 to 15 V nominal 50 to 650 mA[1,2]
Travel Motors	3 to 10 V nominal 250 to 700 mA[1,2]
Hoist Motors	3 to 10 V nominal 250 to 700 mA[1,2]

Note 1: Resistance increases as the temperature rises on the pump or motor solenoid coil, resulting in decreased current values when measured with a meter. The listing in the table is the current range for a 21°C (68.9°F) coil.

Note 2: The node regulates displacement of the pump or motor with a PWM output. The values represent the beginning and end of the control range.

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Alphabetical Index of Controller Devices

Find the device of interest and the associated controller in Table 3-5, then refer to the applicable test voltage table for that controller.

Table 3-5. Controller Components

Device	Controller
Alarms	IOLC30, IOLC31, IOLC32
Air Conditioning Clutch	IOLC32
Ambient Air Temperature Sensor	CCMC11
Auto Lube Components—Crawler	CCMB11
Auto Lube Components—Swing	IOLC30
Block-Up Limit & Slow Down Switches	SCMD01, SCMD02
Boom Angle Limit Switch	IOLC30
Boom Butt and Insert Components	CCMC11
Boom Top Components	SCMD01
BRS Components (optional)	CCMC11, IOLC30
Cab Switches and Controls	SCM-00, IOSA22
Cab Tilt	CCM-10
Camera Lights	CCMC11, IOLC30, IOLC32
Cylinder Stowage	IOLC31
Drum Diverter Valves	CCM-10
Drum 0 Components	IOLC31
Drum 1 Components	CCMC11
Drum 2 Components	CCMC11
Drum 3 Components	CCMC11, IOLC30
Drum 4 Components	IOLC32, IOLC33, IOLC34
Drum 5 Components	CCMC11, IOLC30
Drum 6 Components	CCMC11, IOLC30
ECM Start Relay	IOLC32
Engine Components	IOLC32, IOLC34
Ether Start	IOLC32
Fixed Jib Confirm	SCMD01
Fuel Level Sensor	CCMC11
Hydraulic-Charge Filter Alarm Switch	IOLC32
Hydraulic Fluid Level and Temperature Sensor	IOLC32
Hydraulic Vacuum Switch	IOLC32
Jacks—Rotating Bed	CCM-10, IOLC31
Jacks—Carbody	CCMB11, IOSB22
Jib Components	SCM-00, SCMD01, SCMD02
Level Sensor—Rotating Bed	CCMC11
Live Mast Components	CCMC11, IOLC30
Load Pins	SCMD01, CCMC11
Luffing Jib Limit Switches	SCMD01
Mast Butt Components	CCMC11, IOLC30
Pin Pullers	CCMB11
Pin Pushers	CCM-10, IOLC30
Pressure Transducers	CCM-10, IOLC31, IOLC32
Proximity Sensors	SCMD01
Pumps 1 to 4	IOLC32
Pumps 5 to 8	IOLC33
Pump 9	IOLC34
RCL Beacon	SCM-00
Self Assembly Cylinder	IOLC30
Starter Motor Relays	IOLC34
Swing Components	IOLC30, IOLC33
Throttle (hand and foot)	SCM-00
Travel Components	CCMB11, IOSB22, IOLC30
Upper Boom Point Confirm	SCMD01
VPC and VPC-MAX Components	CCM-10, IOLC30, IOLC31, IOLC32, IOLC33, IOLC34, IOLC35
Wind Speed Indicators—Boom and Upper Boom Point	SCMD01
Wind Speed Indicator (luffing jib)	SCMD02

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Test Voltage Tables

Table 3-6. SCM-00 Test Voltages

Pin	I/O Network	Function	Voltages
P1-1	+UB	Control Module Battery Power	24 V_{DC}
P0-2	ODH1A7	RCL Beacon—Amber	0 V_{DC} Off, 24 V_{DC} On
P0-3	ODH1A6	RCL Beacon—Green	0 V_{DC} Off, 24V $_{DC}$ On
P1-4	ODH1A5	Power to RCL Override Switch	24 V_{DC}
P1-5	ODH1A4	Power Bus: • Travel Speed • Seat Safety • VPC Shutdown • Drum 7 Park • Mast Cylinder Switches	24 V_{DC}
P0-6	ODH1A3	RCL Beacon—Red	0 V_{DC} Off, 24 V_{DC} On
P1-7	No Connection		
P0-8	ODH1A1	Power to Foot Throttle	24 V_{DC}
P1-9	IDF1	VPC Shutdown Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-10	IDF2	Drum 7 Park Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-11	IDF3	Mast Cylinder Extend Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-12	IDF4	Mast Cylinder Retract Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-13	ID5	A/C Heater Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-14	$+U_E$	Battery Power for Control Module Outputs	24 V_{DC}
P1-15	No Connection		
P1-16	CAN2_L	CAN Bus D—Low	Not Applicable
P1-17	CAN2_H	CAN Bus D—High	Not Applicable
P1-18	No Connection		
P1-19	No Connection		
P1-20	IMID1	Module Identifier Input (from cab ground bus bar)	0 V_{DC}
P1-21	ID6	Engine Start Switch	0 V_{DC} Open, 24 V_{DC} Closed
P0-22	IACV11	Hand Throttle	0.5 V_{DC} Low Idle 4.5 V_{DC} High Idle
P0-23	IACV12	Foot Throttle	2.9 V_{DC} to 3.0 V_{DC} Low Idle 0.9 V_{DC} to 1.0 V_{DC} High Idle
P1-24	No Connection		
P1-25	IB RTCn	Real-Time Clock Battery Ground	0 V_{DC}
P0-26	OS85L	Ground for Hand Throttle and Travel Pedals 8.5 V_{DC} Circuit	0 V_{DC}
P1-27	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed

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Pin	I/O Network	Function	Voltages
P1-28	ID9	Seat Safety Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-29	GND	Ground (from cab ground bus bar)	0 V_{DC}
P1-30	CAN1_L	CAN Bus A Low	Not Applicable
P1-31	CAN1_H	CAN Bus A High	Not Applicable
P1-32	No Connection		
P1-33	No Connection		
P1-34	IMID2	Module Identifier Input (from cab ground bus bar)	0 V_{DC}
P1-35	ID7	Engine Run Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-36	ID8	Travel Speed Switch	0 V_{DC} Open, 24 V_{DC} Closed
P1-37	No Connection		
P0-38	IACV15	Left Travel Pedal (option)	1.4 to 5 V_{DC} Rev 5 to 8.6 V_{DC} FWD
P0-39	IACV16	Right Travel Pedal (option)	1.4 to 5 V_{DC} Rev 5 to 8.6 V_{DC} FWD
P1-40	IB RTCp	Real-Time Clock Power Supply	3.6 V_{DC}
P0-41	OS85H	8.5 V_{DC} Power Bus: • Hand Throttle • Travel Pedals	8.5 V_{DC}
P0-42	ID10	RCL Override Switch	0 V_{DC} Open, 24 V_{DC} Closed

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Table 3-7. SCMD01 (WBT1, Boom Top) Test Voltages

Pin	I/O Network	Function	Voltages
PD-1	+UB	Control Module Battery Power	24 V_{DC}
PD-2	ODH1A7	Power to Main Right Strut Collapse Solenoid	24 V_{DC}
PD-3	ODH1A6	Power Bus: • Jib Butt Angle Sensor • Luffing Jib Maximum Angle Limit Switch • Luffing Jib Minimum Angle Limit Switch • Jib Stop Left Cylinder Position Limit Switch • Jib Stop Right Cylinder Position Limit Switch	24 V_{DC}
PD-4	ODH1A5	Power Bus: • Boom-Top Angle Sensor • Wind Speed Sensor	24 V_{DC}
PD-5	ODH1A4	Power Bus: • Drum 1 Proximity Sensor A • Drum 1 Proximity Sensor B • Drum 2 Proximity Sensor A • Drum 2 Proximity Sensor B	24 V_{DC}
PD-6	ODH1A3	Power Bus: • Lower Boom Point Block-Up Limit Switch • Lower Boom Point Block-Up Slow Down Switch	24 V_{DC}
PD-7	ODH1A2	Power to Main Left Strut Collapse Solenoid	24 V_{DC}
PD-8	ODH1A1	Power Bus: • Left Strap Load Link • Right Strap Load Link	24 V_{DC}
PD-9	IDF1	Drum 2 Proximity Sensor A	0 V_{DC} Open, 22 V_{DC} Closed
PD-10	IDF2	Drum 2 Proximity Sensor B	0 V_{DC} Open, 22 V_{DC} Closed
PD-11	IDF3	Drum 1 Proximity Sensor A	0 V_{DC} Open, 22 V_{DC} Closed
PD-12	IDF4	Drum 1 Proximity Sensor B	0 V_{DC} Open, 22 V_{DC} Closed
PD-13	ID5	Lower and Upper Boom Point Block-Up Limit Switches	0 V_{DC} Open, 22 V_{DC} Closed
PD-14	$+U_E$	Battery Power for Control Module Outputs	24 V_{DC}
PD-15	ODH2A8	Power Bus: • Jib Stop Left Cylinder Collapse Solenoid • Jib Stop Right Cylinder Collapse Solenoid	24 V_{DC}
PD-16	No Connection		
PD-17	No Connection		
PD-18	No Connection		
PD-19	No Connection		
PD-20	No Connection		

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Pin	I/O Network	Function	Voltages
PD-21	ID6	Lower Boom Point Block-Up Slow Down Switch and Upper Boom Point Block-Up Slow Down Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PD-22	IACV11	Right Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-23	IACV12	Left Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-24	IACV13	Boom-Top Angle Sensor	2 to 20 mA (90 µA/°)
PD-25	No Connection		
PD-26	No Connection		
PD-27	KL15	Control Module Ignition Power (from relay K6)	0 V_{DC} Open, 24 V_{DC} Closed
PD-28	ID9	Upper Boom Point Confirm	0 V_{DC} Not Installed, 24 V_{DC} Installed
PD-29	GND	Ground (from load center)	0 V_{DC}
PD-30	CAN1_L	CAN Bus D—Low	Not Applicable
PD-31	CAN1_H	CAN Bus D—High	Not Applicable
PD-32	No Connection		
PD-33	No Connection		
PD-34	IMID2	Module Identifier Input (ground from load center)	0 V_{DC}
PD-35	ID7	Luffing Jib Maximum Angle Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PD-36	ID8	Luffing Jib Minimum Angle Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PD-37	IACV14	Wind Speed Sensor	0 to 20 mA
PD-38	IACV15	Upper Boom Point/ Light Fixed Jib Left Load Pin Sensor	0 V_{DC} Open, 24 V_{DC} Closed
PD-39	IACV16	Jib Butt Angle/Light Fixed Jib Right Load Pin Sensor	0 V_{DC} Open, 24 V_{DC} Closed
PD-40	No Connection		
PD-41	No Connection		
PD-42	ID10	Luffing Jib Stop Cylinder Position	0 V_{DC} Not Installed, 24 V_{DC} Installed

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Table 3-8. SCMD01 (WWC1, Wind Cap) Test Voltages

Pin	I/O Network	Function	Voltages
PD-1	+UB	Battery Power for Control Module Outputs	24 V_{DC}
PD-2	No Connection		
PD-3	ODH1A6	Power Bus: • Left Strap Load Link • Right Strap Load Link	24 V_{DC}
PD-4	ODH1A5	Power Bus: • Boom-Top Angle Sensor • EUBP Wind Speed Sensor	24 V_{DC}
PD-5	ODH1A4	Power to Lower Boom Point Load Link	24 V_{DC}
PD-6	ODH1A3	Power Bus: • EUBP Block-Up Limit Switch 1 • EUBP Block-Up Limit Switch 2	24 V_{DC}
PD-7	No Connection		
PD-8	ODH1A1	Power to Lower Boom Point Block-Up Limit Switch 1	24 V_{DC}
PD-9	IDF1	Not Used—For Possible Future Expansion	0 V_{DC}
PD-10	IDF2	Not Used—For Possible Future Expansion	0 V_{DC}
PD-11	IDF3	Not Used—For Possible Future Expansion	0 V_{DC}
PD-12	IDF4	Not Used—For Possible Future Expansion	0 V_{DC}
PD-13	ID5	Lower Boom Point Block-Up Limit Switch 1	0 V_{DC} Open, 22 V_{DC} Closed
PD-14	$+U_E$	Control Module Battery Power	24 V_{DC}
PD-15	No Connection		
PD-16	No Connection		
PD-17	No Connection		
PD-18	No Connection		
PD-19	No Connection		
PD-20	No Connection		
PD-21	ID6	Not Used—For Possible Future Expansion	0 V_{DC}
PD-22	IACV11	Right Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-23	IACV12	Left Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-24	IACV13	Boom-Top Angle Sensor	2 to 20 mA (90 µA/°)
PD-25	No Connection		
PD-26	No Connection		
PD-27	KL15	Control Module Ignition Power (from relay K6)	0 V_{DC} Open, 24 V_{DC} Closed
PD-28	ID9	Wind Cap Confirm	0 V_{DC} Not Installed, 24 V_{DC} Installed

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Pin	I/O Network	Function	Voltages
PD-29	GND	Ground (from load center)	0 V_{DC}
PD-30	CAN1_L	CAN Bus D—Low	Not Applicable
PD-31	CAN1_H	CAN Bus D—High	Not Applicable
PD-32	No Connection		
PD-33	No Connection		
PD-34	IMID2	Module Identifier Input (ground from load center)	0 V_{DC}
PD-35	ID7	EUBP Block-Up Limit Switch 1	0 V_{DC} Open, 24 V_{DC} Closed
PD-36	ID8	EUBP Block-Up Limit Switch 2	0 V_{DC} Open, 24 V_{DC} Closed
PD-37	IACV14	EUBP Wind Speed Sensor	0 to 20 mA
PD-38	IACV15	Lower Boom Point Load Link	0 V_{DC} Open, 24 V_{DC} Closed
PD-39	IACV16	Not Used—For Possible Future Expansion	0 V_{DC}
PD-40	No Connection		
PD-41	No Connection		
PD-42	ID10	Not Used—For Possible Future Expansion	0 V_{DC}

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Table 3-9. SCMD02 (WJT1, Jib CSM) Test Voltages

Pin	I/O Network	Function	Voltages
PD-1	+UB	Battery Power for Control Module Outputs	24 V_{DC}
PD-2	No Connection		
PD-3	ODH1A6	Power to Upper Boom Point Load Pin	24 V_{DC}
PD-4	ODH1A5	Power Bus: • Drum 2 Proximity Sensor A • Drum 2 Proximity Sensor B	24 V_{DC}
PD-5	ODH1A4	Power Bus: • Drum 1 Proximity Sensor A • Drum 1 Proximity Sensor B	24 V_{DC}
PD-6	ODH1A3	Power to Upper and Lower Boom Point Block-Up Slow Down Limit Switches	24 V_{DC}
PD-7	ODH1A2	Lower Boom Point Block-Up Limit Switch	24 V_{DC}
PD-8	ODH1A1	Power Bus: • Left Strap Load Link • Right Strap Load Link	24 V_{DC}
PD-9	IDF1	Drum 2 Proximity Sensor A	0 V_{DC} Open, 22 V_{DC} Closed
PD-10	IDF2	Drum 2 Proximity Sensor B	0 V_{DC} Open, 22 V_{DC} Closed
PD-11	IDF3	Drum 1 Proximity Sensor A	0 V_{DC} Open, 22 V_{DC} Closed
PD-12	IDF4	Drum 1 Proximity Sensor B	0 V_{DC} Open, 22 V_{DC} Closed
PD-13	ID5	Upper and Lower Boom Point Block-Up Limit Switches	0 V_{DC} Open, 22 V_{DC} Closed
PD-14	$+U_E$	Control Module Battery Power	24 V_{DC}
PD-15	ODH2A8	Power Bus: • Wind Speed Sensor • Boom-Top Angle Sensor	24 V_{DC}
PD-16	No Connection		
PD-17	No Connection		
PD-18	No Connection		
PD-19	No Connection		
PD-20	IMID1	Module Identifier Input (ground from load center)	0 V_{DC}
PD-21	ID6	Upper and Lower Boom Point Block-Up Slow Down Limit Switches	0 V_{DC} Open, 22 V_{DC} Closed
PD-22	IACV11	Right Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-23	IACV12	Left Strap Load Link	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PD-24	IACV13	Boom-Top Angle Sensor	2 to 20 mA (90 µA/°)
PD-25	No Connection		

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Pin	I/O Network	Function	Voltages
PD-26	No Connection		
PD-27	KL15	Control Module Ignition Power (from relay K5)	0 V_{DC} Open, 24 V_{DC} Closed
PD-28	ID9	Upper Boom Point Confirm	0 V_{DC} Not Installed, 24 V_{DC} Installed
PD-29	GND	Ground (from load center)	0 V_{DC}
PD-30	CAN1_L	CAN Bus D—Low	Not Applicable
PD-31	CAN1_H	CAN Bus D—High	Not Applicable
PD-32	No Connection		
PD-33	No Connection		
PD-34	No Connection		
PD-35	No Connection		
PD-36	No Connection		
PD-37	IACV14	Wind Speed Sensor	0 to 20 mA
PD-38	IACV15	Upper Boom Point Load Pin	0 V_{DC} Open, 24 V_{DC} Closed
PD-39	IACV16	Not Used—For Possible Future Expansion	0 V_{DC}
PD-40	No Connection		
PD-41	No Connection		
PD-42	No Connection		

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Table 3-10. CCM-10 Test Voltages

Pin	I/O Network	Signal	Voltages
PC1-1	OPH3A23	Left Front Jack Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-2	OPH3A28	Left Rear Jack Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-3	ID21	Mast Arm Limit	0 V_{DC} Open, 24 V_{DC} Closed
PC1-4	IDF09	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-5	IDF10	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-6	ID22	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-7	IDF01	VPC Actuator Left Motor Speed Sensor	Not Applicable
PC1-8	IDF04	VPC Left Motor Speed Sensor	Not Applicable
PC1-9	IDF06	VPC Actuator Right Motor Speed Sensor	Not Applicable
PC1-10	IACV20	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-11	IACV16	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-12	IACV18	VPC Actuator Extend Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-13	IACV14	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-14	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-15	OPH3A25	Right Front Jack Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-16	CAN2_L	CAN Bus C—Low	Not Applicable
PC1-17	CAN2_H	CAN Bus C—High	Not Applicable
PC1-18	CAN4_L	CAN Bus J—Low	Not Applicable
PC1-19	CAN4-H	CAN Bus J—High	Not Applicable
PC1-20	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-21	IDF03	VPC Left Motor Speed Sensor	Not Applicable
PC1-22	IDF05	VPC Actuator Right Motor Speed Sensor	Not Applicable
PC1-23	IACV19	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-24	IACV17	Accessory Systems Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-25	IACV11	Swing Right Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-26	OS85L	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-27	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-28	OPH3A27	Left Rear Jack Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-29	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-30	CAN1_L	CAN Bus A—Low	Not Applicable
PC1-31	CAN1_H	CAN Bus A—High	Not Applicable
PC1-32	CAN3_L	CAN Bus B—Low	Not Applicable
PC1-33	CAN3_H	CAN Bus B—High	Not Applicable

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Pin	I/O Network	Signal	Voltages
PC1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-35	IDF02	VPC Actuator Left Motor Speed Sensor	Not Applicable
PC1-36	IDF07	VPC Right Motor Speed Sensor	Input Voltage—0.5 V_{DC} Over Tooth 0 to 0.5 V_{DC} Over Gap
PC1-37	IDF08	VPC Right Motor Speed Sensor	Input Voltage—0.5 V_{DC} Over Tooth 0 to 0.5 V_{DC} Over Gap
PC1-38	IACV15	Left Track Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-39	IACV13	Right Track Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-40	IACV12	Swing Left Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-41	OS85H	Not Used—For Possible Future Expansion	8.5 V_{DC}
PC1-42	OPH3A26	Right Front Jack Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-1	PGND1	Ground (from ground stud on rotating bed)	0 V_{DC}
PC2-2	ODH3A03	Rear Frame Pusher Pin Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-3	No Connection		
PC2-4	ODH3A08	Power Bus: • Mast Arm NC Limit Switch • VPC Actuator Extend Pressure Transducer • Accessory Systems Pressure Transducer	24 V_{DC}
PC2-5	ODH3A05	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-6	ODH3A13	Left Track Drum 1 Diverter Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-7	ODH3A15	Drum 1 Drum 6 Diverter Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-8	No Connection		
PC2-9	No Connection		
PC2-10	PGND2	Ground (from ground stud on rotating bed)	0 V_{DC}
PC2-11	$+U_BSW1$	Battery Power for Control Module Outputs	24 V_{DC}
PC2-12	OPH3A24	Left Front Jack Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-13	ODH3A01	Power Bus: • Swing Right Pressure Transducer • Swing Left Pressure Transducer • Right Track Pressure Transducer • Left Track Pressure Transducer	24 V_{DC}
PC2-14	ODH3A07	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-15	ODH3A06	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Signal	Voltages
PC2-16	ODH3A14	Right Track Drum 2 Diverter Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-17	No Connection		
PC2-18	$+U_B SW2$	Battery Power for Control Module Outputs	24 V_{DC}
PC2-19	No Connection		
PC2-20	$+U_B SW1$	Battery Power for Control Module Outputs	24 V_{DC}
PC2-21	ODH3A02	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-22	ODH3A04	Rear Frame Pin Pusher Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-23	No Connection		
PC2-24	ODH3A11	Cab Tilt Up Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-25	ODH3A12	Cab Tilt Down Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-26	ODH3A16	Drum 3 Drum 2 Diverter Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-27	No Connection		
PC2-28	No Connection		
PC2-29	$+U_B SW2$	Battery Power for Control Module Outputs	24 V_{DC}

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Table 3-11. CCMC11 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	OPH3A23	Drum 1 Left Motor Control	0 V_{DC} Open, 24 V_{DC} Closed
PC1-2	OPH3A28	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-3	ID21	Drum 1 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-4	IDF09	Drum 3 Right Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-5	IDF10	Drum 3 Right Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-6	ID22	Drum 2 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-7	IDF01	Drum 1 Left Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-8	IDF04	Drum 2 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to10% of Input Voltage Over Gap
PC1-9	IDF06	Drum 6 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-10	IACV20	Ambient Air Temperature Sensor (optional)	0 to 10 V_{DC}
PC1-11	IACV16	Boom Angle Sensor	2 to 20 mA (90 µA/°)
PC1-12	IACV18	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-13	IACV14	Live Mast Angle Sensor	2 to 20 mA (90 µA/°)
PC1-14	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-15	OPH3A25	Drum 2 Left Motor Control	0 V_{DC} Open, 24 V_{DC} Closed
PC1-16	No Connection		
PC1-17	No Connection		
PC1-18	No Connection		
PC1-19	No Connection		
PC1-20	No Connection		
PC1-21	IDF03	Drum 2 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-22	IDF05	Drum 6 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-23	IACV19	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-24	IACV17	Mast Strap Load Pin	2 mA @ No Load 20 mA @ 238,140 kg (525,009 lb)
PC1-25	IACV11	Fuel Level Sensor	1 V_{DC} Full, 9 V_{DC} Empty
PC1-26	OS85L	Ground for Drums 3 and 5 Motor Speed Sensors 8.5 V_{DC} Circuit	0 V_{DC}
PC1-27	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-28	OPH3A27	Drum 6 Motor Control	0 V_{DC} Open, 24 V_{DC} Closed

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Pin	I/O Network	Function	Voltages
PC1-29	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-30	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-31	CAN1_H	CAN Bus C—High	Not Applicable
PC1-32	No Connection		
PC1-33	No Connection		
PC1-34	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-35	IDF02	Drum 1 Left Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-36	IDF07	Drum 5 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-37	IDF08	Drum 5 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-38	IACV15	Fixed Mast Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC1-39	IACV13	Rotating Bed Level Sensor	5.025 V_{DC} @ 0° ±1.005 V_{DC} Offset/°
PC1-40	IACV12	Rotating Bed Level Sensor	5.025V_{DC} @ 0° ±1.005V_{DC} Offset/°
PC1-41	OS85H	8.5 V_{DC} Power to Drums 3 and 5 Motor Speed Sensors	8.5 V_{DC}
PC1-42	OPH3A26	Drum 2 Right Motor Control	0 V_{DC} Open, 24 V_{DC} Closed
PC2-1	PGND1	Ground (from rotating bed ground stud)	0 V_{DC}
PC2-2	ODH3A03	Drums 1 and 2 / 6 Camera Lights	0 V_{DC} Off, 24 V_{DC} On
PC2-3	ODH3A09	Drum 6 Right Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-4	ODH3A08	Drum 6 Pawls Out Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-5	ODH3A05	Power Bus: • Drum 6 Minimum Bail Normally Closed Limit Switch • Drum 6 Pawl Normally Open Limit Switch	24 V_{DC}
PC2-6	ODH3A13	Drum 5 Pawls Out Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-7	ODH3A15	Power Bus: • Ambient Air Temperature Sensor • Engine Fuel Level Sensor • Maximum Boom Angle Limit Switch • Mast Strap Load Pin • Live Mast Angle Sensor	24 V_{DC}
PC2-8	No Connection		
PC2-9	No Connection		
PC2-10	PGND2	Ground (from ground stud on rotating bed)	0 V_{DC}
PC2-11	$+U_BSW1$	Battery Power for Control Module Outputs	24 V_{DC}

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Pin	I/O Network	Function	Voltages
PC2-12	OPH3A24	Drum 1 Right Motor Control	0 V_{DC} Open, 24 V_{DC} Closed
PC2-13	ODH3A01	Power Bus: • Drums 1 and 2 Minimum Bail Normally Closed Limit Switches • Boom Angle Sensor	24 V_{DC}
PC2-14	ODH3A07	Drum 6 Pawls In Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-15	ODH3A06	Drum 2 Left Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-16	ODH3A14	Drum 5 Right Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-17	No Connection		
PC2-18	$+U_B$SW2	Battery Power for Control Module Outputs	24 V_{DC}
PC2-19	No Connection		
PC2-20	$+U_B$SW1	Battery Power for Control Module Outputs	24 V_{DC}
PC2-21	ODH3A02	Drum 1 Left Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-22	ODH3A04	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-23	ODH3A10	Power Bus: • Drum 5 Minimum Bail Normally Closed Limit Switch • Mast Position Limit Switch • Fixed Mast Cylinder System Pressure Transducer • Drum 5 Pawl Normally Open Limit Switch	24 V_{DC}
PC2-24	ODH3A11	Diesel Heater	0 V_{DC} Off, 24 V_{DC} On
PC2-25	ODH3A12	Drum 5 Pawls In Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-26	ODH3A16	Power Bus: • Rotating Bed Level Sensor • Drum 3 Minimum Bail Normally Closed Limit Switch	24 V_{DC}
PC2-27	No Connection		
PC2-28	No Connection		
PC2-29	$+U_B$SW2	Battery Power for Control Module Outputs	24 V_{DC}

Table 3-12. CCMB11 Test Voltages

Pin	I/O Network	Function	Voltages
PB1-1	OPH3A23	Left Front Carbody Jack Raise Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-2	OPH3A28	Left Rear Carbody Jack Lower Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-3	ID21	Left Crawler Grease Pressure Switch (2200 PSI)	0 V_{DC} Open, 24 V_{DC} Closed
PB1-4	IDF09	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-5	IDF10	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-6	ID22	Right Crawler Grease Pressure Switch (2200 PSI)	0 V_{DC} Open, 24 V_{DC} Closed

FOR REFERENCE ONLY

Pin	I/O Network	Function	Voltages
PB1-7	IDF01	Left Travel Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PB1-8	IDF04	Right Travel Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PB1-9	IDF06	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-10	No Connection		
PB1-11	No Connection		
PB1-12	No Connection		
PB1-13	IACV14	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-14	$+U_E$	Control Module Battery Power	24 V_{DC}
PB1-15	OPH3A25	Right Front Carbody Jack Raise Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-16	No Connection		
PB1-17	No Connection		
PB1-18	No Connection		
PB1-19	No Connection		
PB1-20	No Connection		
PB1-21	IDF03	Right Travel Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PB1-22	No Connection		
PB1-23	No Connection		
PB1-24	No Connection		
PB1-25	IACV11	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-26	OS85L	Left and Right Travel Motor Speed Sensors Ground	0 V_{DC}
PB1-27	KL15	Control Module Ignition Power (from relay K6)	0 V_{DC} Open, 24 V_{DC} Closed
PB1-28	OPH3A27	Left Rear Carbody Jack Raise Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-29	GND	Ground	0 V_{DC}
PB1-30	CAN1_L	CAN Bus B—Low	Not Applicable
PB1-31	CAN1_H	CAN Bus B—High	Not Applicable
PB1-32	No Connection		
PB1-33	No Connection		
PB1-34	IMID2	Ground (from load center)	0 V_{DC}
PB1-35	IDF02	Left Travel Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PB1-36	IDF07	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-37	IDF08	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-38	IACV15	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-39	IACV13	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Function	Voltages
PB1-40	IACV12	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-41	OS85H	8.5 V_{DC} Power Bus: • Left Travel Motor Speed Sensor • Right Travel Motor Speed Sensor	8.5 V_{DC}
PB1-42	OPH3A26	Right Front Carbody Jack Lower Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-1	PGND1	Ground	0 V_{DC}
PB2-2	ODH3A03	Right Crawler Tracks Auto-Lube	0 V_{DC} Off, 24 V_{DC} On
PB2-3	ODH3A09	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-4	ODH3A08	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-5	ODH3A05	Left Crawler Carbody Pin Puller Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-6	ODH3A13	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-7	ODH3A15	Jacking Selector Lever	0 V_{DC} Off, 24 V_{DC} On
PB2-8	No Connection		
PB2-9	No Connection		
PB2-10	PGND2	Ground	0 V_{DC}
PB2-11	$+U_B$SW1	Supply Power for Control Module Outputs	24 V_{DC}
PB2-12	OPH3A24	Left Front Carbody Jack Lower Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-13	ODH3A01	Power Bus: • Right Crawler Grease Pressure Switch • Left Crawler Grease Pressure Switch	24 V_{DC}
PB2-14	ODH3A07	Right Crawler Carbody Pin Puller Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-15	ODH3A06	Right Crawler Carbody Pin Puller Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-16	ODH3A14	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-17	No Connection		
PB2-18	$+U_B$SW2	Supply Power for Control Module Outputs	24 V_{DC}
PB2-19	No Connection		
PB2-20	$+U_B$SW1	Supply Power for Control Module Outputs	24 V_{DC}
PB2-21	ODH3A02	Left Crawler Tracks Auto Lube	0 V_{DC} Off, 24 V_{DC} On
PB2-22	ODH3A04	Left Crawler Carbody Pin Puller Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB2-23	ODH3A10	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-24	ODH3A11	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-25	ODH3A12	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-26	ODH3A16	Not Used—For Possible Future Expansion	0 V_{DC}
PB2-27	No Connection		
PB2-28	No Connection		
PB2-29	$+U_B$SW2	Supply Power for Control Module Outputs	24 V_{DC}

FOR REFERENCE ONLY

Table 3-13. IOSA22 Test Voltages

Pin	I/O Network	Function	Voltages
PA1-1	GND	Ground from Cab Ground Bus Bar	0 V_{DC}
PA1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PA1-3	ID01	DPF Regeneration Initiate Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-4	ID02	DPF Regeneration Disable Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-5	OPH6A01	Power Bus: • Cab Tilt • Boom Raise • Limit Bypass • APU Run/Start • DPF Regeneration • Camera Light Switches	24 V_{DC}
PA1-6	OPH6A02	Switched Horn Power	24 V_{DC}
PA1-7	No Connection		
PA1-8	No Connection		
PA1-9	IMID1	Module Identifier Input (ground from cab ground bus)	0 V_{DC}
PA1-10	CAN1-H	CAN Bus A—High	Not Applicable
PA1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PA1-12	$+U_E$	Control Module Battery Power	24 V_{DC}
PA1-13	ID03	Limit Bypass Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-14	ID04	Cab Tilt Up Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-15	ID05	Cab Tilt Down Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-16	ID06	Camera Light Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-17	No Connection		
PA1-18	No Connection		
PA1-19	CAN1_L	CAN Bus A—Low	Not Applicable
PA1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PA1-21	ID07	Boom Raise Extend Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-22	ID08	Boom Raise Retract Switch	0 V_{DC} Open, 24 V_{DC} Closed
PA1-23	ID09	APU Switch—Run	0 V_{DC} Open, 24 V_{DC} Closed
PA1-24	ID10	APU Switch—Start	0 V_{DC} Open, 24 V_{DC} Closed
PA1-25	ID11	Heater Command	0 V_{DC} Open, 24 V_{DC} Closed
PA1-26	No Connection		
PA1-27	No Connection		
PA1-28	No Connection		
PA1-29	IMID3	Module Identifier Input (ground from cab ground bus)	0 V_{DC}

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Table 3-14. IOSB22 Test Voltages

Pin	I/O Network	Function	Voltages
PB1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PB1-2	KL15	Control Module Ignition Power (from relay K6)	0 V_{DC} Open, 24 V_{DC} Closed
PB1-3	ID01	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-4	ID02	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-5	OPH6A01	Right Rear Carbody Jack Raise Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-6	OPH6A02	Right Rear Carbody Jack Lower Solenoid	0 V_{DC} Off, 24 V_{DC} On
PB1-7	OPH6A03	Left Front and Rear Travel Motors Control	0 V_{DC} Off, 24 V_{DC} On
PB1-8	OPH6A04	Right Front and Rear Travel Motors Control	0 V_{DC} Off, 24 V_{DC} On
PB1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PB1-10	CAN1-H	CAN Bus B—High	No Connection
PB1-11	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PB1-12	+U_E	Control Module Battery Power	24 V_{DC}
PB1-13	ID03	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-14	ID04	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-15	ID05	Not Used—For Possible Future Expansion	0 V_{DC}
PB1-16	No Connection		
PB1-17	No Connection		
PB1-18	No Connection		
PB1-19	CAN1_L	CAN Bus B—Low	Not Applicable
PB1-20	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PB1-21	No Connection		
PB1-22	No Connection		
PB1-23	No Connection		
PB1-24	No Connection		
PB1-25	No Connection		
PB1-26	No Connection		
PB1-27	No Connection		
PB1-28	No Connection		
PB1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}

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Table 3-15. IOLC30 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3	ID01	Boom Connected	24 V_{DC}
PC1-4	ID02	Drum 5 Minimum Bail Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-5	OPH6A18	Self-Assembly Cylinder Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-6	OPH6A19	Self-Assembly Cylinder Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-7	OPH6A20	Live Mast Raise Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-8	OPH6A21	Live Mast Lower Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-13	ID03	Mast Position Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-14	ID04	Drum 6 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-15	ID05	APU Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC1-16	ID06	Swing Grease Pressure Switch (2200 PSI)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-17	IDF15	Swing Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21	ID07	Maximum Boom Angle Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-22	ID08	Drum 6 Pawl Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-23	ID09	Drum 5 Pawl Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-24	ID10	Drum 3 Minimum Bail Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-25	ID11	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-26	IDF16	Swing Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-27	IACV17	Fixed Mast Cylinder System Pressure Transducer	0 to 20 mA
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC2-1	ID12	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Function	Voltages
PC2-2	ID13	Ambient Air Temperature Sensor Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC2-3	ID14	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-4	IACV18	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-5	ODH3A02	Drums 3 and 5 Camera Lights	0 V_{DC} Off, 24 V_{DC} On
PC2-6	ODH3A04	Power Bus: • Swing Motor Speed Sensor • Swing Grease Pressure Switch • Swing Encoder	24 V_{DC}
PC2-7	ODH3A07	Travel Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-8	ODH3A10	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-9	ODH3A12	Front Frame Pin Pusher Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-10	OPH3A15	Drum 5 Right Side Motor Control 2	0 V_{DC} Off, 24 V_{DC} On
PC2-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	OS85H	8.5 V_{DC} Power Bus: • Drum 1 Left Side Motor Speed Sensor • Drum 2 Motor Speed Sensor	8.5 V_{DC}
PC2-13	IACV19	A Frame Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC2-14	IACV20	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-15	ODH3A01	Front Swing/Travel/LMI Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-16	ODH3A06	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-17	ODH3A09	Swing Bearing Auto Lube	0 V_{DC} Off, 24 V_{DC} On
PC2-18	OPH3A14	Drum 3 Right Side Motor Control	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC2-19	OPH3A17	Right Mast Cylinder Pressure Reducing Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	OS85L	8.5 V_{DC} Circuit Ground for: • Drum 1 Left Side Motor Speed Sensor • Drum 2 Motor Speed Sensor	0 V_{DC}
PC2-22	IACV21	Left Mast Cylinder Pressure Transducer	0 to 20 mA
PC2-23	IACV22	Right Mast Cylinder Pressure Transducer	0 to 20 mA
PC2-24	ODH3A03	Drum 3 Right Side Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-25	ODH3A05	Swing Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-26	ODH3A08	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-27	ODH3A11	Front Frame Pin Pusher Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-28	ODH3A13	Front Swing/Travel/LMI Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-29	OPH3A16	Left Mast Cylinder Pressure Reducing Solenoid	0 V_{DC} Off, 24 V_{DC} On

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Table 3-16. IOLC31 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3	ID01	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-4	ID02	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-5	OPH6A18	Drum 0 Spool In Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-6	OPH6A19	Drum 0 Spool Out Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC1-7	OPH6A20	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-8	OPH6A21	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-9	No connection		
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	+U_E	Control Module Battery Power	24 V_{DC}
PC1-13	ID03	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-14	ID04	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-15	ID05	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-16	ID06	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-17	IDF15	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21	ID07	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-22	ID08	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-23	ID09	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-24	ID10	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-25	ID11	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-26	IDF16	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-27	IACV17	Drum 5 Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC2-1	ID12	VPC-MAX Shorting Wire	24 V_{DC}
PC2-2	ID13	VPC Tray Shorting Plug	24 V_{DC}
PC2-3	No Connection		
PC2-4	IACV18	Drum 3 Pressure Transducer	0 V_{DC} Off, 24 V_{DC} On

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Pin	I/O Network	Function	Voltages
PC2-5	ODH3A02	Power to Right and Left VPC Actuator Motor Speed Sensors	24 V_{DC}
PC2-6	ODH3A04	VPC Tray Diverter Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-7	ODH3A07	VPC Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-8	ODH3A10	Left Stowage Cylinder Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-9	ODH3A12	Right Stowage Cylinder Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-10	OPH3A15	Right Rear Jack Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-11	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	OS85H	Not Used—For Possible Future Expansion	8.5 V_{DC}
PC2-13	IACV19	Drum 4 Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC2-14	IACV20	Drum 1 Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC2-15	ODH3A01	Power Bus: • Drums 1, 3, 4, and 5 Pressure Transducers • VPC Actuator Retract Pressure Transducer	24 V_{DC}
PC2-16	ODH3A06	VPC Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-17	ODH3A09	VPC Rear Warning Lights	0 V_{DC} Off, 24 V_{DC} On
PC2-18	OPH3A14	Right Rear Jack Extend Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-19	OPH3A17	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-20	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	OS85L	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-22	IACV21	VPC Actuator Retract Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC2-23	No Connection		
PC2-24	ODH3A03	VPC Actuator Brake	0 V_{DC} Off, 24 V_{DC} On
PC2-25	ODH3A05	VPC Tray Brake	0 V_{DC} Off, 24 V_{DC} On
PC2-26	ODH3A08	VPC Front Warning Lights	0 V_{DC} Off, 24 V_{DC} On
PC2-27	ODH3A11	Left Stowage Cylinder Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-28	ODH3A13	Right Stowage Cylinder Retract Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-29	OPH3A16	ACC System Prop Relief	0 V_{DC} Off, 24 V_{DC} On

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Table 3-17. IOLC32 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3	ID01	Hydraulic Charge Filter Alarm Pressure Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-4	No Connection		
PC1-5	OPH6A18	Drum 3/2 Pump 2	0 V_{DC} Open, 24 V_{DC} Closed
PC1-6	OPH6A19	Drum 3/2 Pump 2	0 V_{DC} Open, 24 V_{DC} Closed
PC1-7	OPH6A20	Right Travel/Drum 2 Pump 4	0 V_{DC} Open, 24 V_{DC} Closed
PC1-8	OPH6A21	Right Travel/Drum 2 Pump 4	0 V_{DC} Open, 24 V_{DC} Closed
PC1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-13	No Connection		
PC1-14	No Connection		
PC1-15	No Connection		
PC1-16	ID06	VPC Tray Max In Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-17	IDF15	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-18	No Connection		
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21	ID07	Hydraulic Vacuum Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-22	ID08	Drum 4 Pawl Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-23	ID09	Active Fixed Mast Stop System Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC1-24	ID10	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-25	ID11	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-26	IDF16	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-27	IACV17	Hydraulic Fluid Temperature Sensor	0.5 to 4.5 V_{DC}
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC2-1	ID12	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-2	ID13	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-3	No Connection		
PC2-4	IACV18	Hydraulic Fluid Level Sensor	1 V_{DC} Full, 9 V_{DC} Empty
PC2-5	ODH3A02	Drum 4 Pawls Out Solenoid	0 V_{DC} Off, 24 V_{DC} On

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Pin	I/O Network	Function	Voltages
PC2-6	ODH3A04	Drum 4 Brake Release Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-7	ODH3A07	Ether Start	0 V_{DC} Off, 24 V_{DC} On
PC2-8	ODH3A10	Air Conditioning Clutch	0 V_{DC} Off, 24 V_{DC} On
PC2-9	ODH3A12	Not Used	0 V_{DC}
PC2-10	OPH3A15	Drum 1/6 Pump 1	0 V_{DC} Off, 24 V_{DC} On
PC2-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	OS85H	8.5 V_{DC} Power to Hydraulic Fluid Temperature Resistors	8.5 V_{DC}
PC2-13	IACV19	Cooler Fan Pressure Transducer	4 mA @ 0 psi 20 mA @ 7,500 psi
PC2-14	No Connection		
PC2-15	ODH3A01	Power Bus: • Drum 4 Pawl Limit Switch • Hydraulic Charge Filter Alarm Switch • Hydraulic Fluid Level Sensor • VPC Tray Max In Limit Switch • VPC Tray Max Out Limit Switch • Gantry Limit Switch	24 V_{DC}
PC2-16	ODH3A06	Power Bus: • Hydraulic Vacuum Switch • Cooler Fan Pressure Transducer	24 V_{DC}
PC2-17	ODH3A09	Front Swing/Travel/LMI Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-18	OPH3A14	Drum 1/6 Pump 1	0 V_{DC} Off, 24 V_{DC} On
PC2-19	OPH3A17	Left Travel/Drum 1 Pump 3	0 V_{DC} Off, 24 V_{DC} On
PC2-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	No Connection		
PC2-22	No Connection		
PC2-23	No Connection		
PC2-24	ODH3A03	Drum 4 Pawls In Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-25	ODH3A05	Drum 4 Camera Lights	0 V_{DC} Off, 24 V_{DC} On
PC2-26	ODH3A08	Rear Swing/Travel/LMI Alarm	0 V_{DC} Off, 24 V_{DC} On
PC2-27	ODH3A11	Not Used	0 V_{DC}
PC2-28	ODH3A13	ECM Start Relay	0 V_{DC} Off, 24 V_{DC} On
PC2-29	OPH3A16	Left Travel/Drum 1 Pump 3	0 V_{DC} Off, 24 V_{DC} On

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Table 3-18. IOLC33 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3		No Connection	
PC1-4		No Connection	
PC1-5	OPH6A18	VPC1/VPC2 Pump 7	0 V_{DC} Off, 24 V_{DC} On
PC1-6	OPH6A19	VPC1/VPC2 Pump 7	0 V_{DC} Off, 24 V_{DC} On
PC1-7	OPH6A20	Swing Pump 8	0 V_{DC} Off, 24 V_{DC} On
PC1-8	OPH6A21	Swing Pump 8	0 V_{DC} Off, 24 V_{DC} On
PC1-9		No Connection	
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	$+U_E$	Control Module Batter Power	24 V_{DC}
PC1-13		No Connection	
PC1-14	ID04	Gantry Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-15	ID05	VPC Tray Max Out Limit Switch	0 V_{DC} Open, 24 V_{DC} Closed
PC1-16		No Connection	
PC1-17	IDF15	Drum 4 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-18		No Connection	
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21		No Connection	
PC1-22		No Connection	
PC1-23		No Connection	
PC1-24		No Connection	
PC1-25		No Connection	
PC1-26	IDF16	Drum 4 Motor Speed Sensor	55 to 85% of Input Voltage Over Tooth 2 to 10% of Input Voltage Over Gap
PC1-27		No Connection	
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	IMID3	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC2-1		No Connection	
PC2-2		No Connection	

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Pin	I/O Network	Function	Voltages
PC2-3	No Connection		
PC2-4	No Connection		
PC2-5	ODH3A02	Power Bus: • VPC Max Beam Maximum In Limit Switch • VPC Max Beam Maximum Out Limit Switch • VPC Max Right Beam Up Limit Switch • VPC Max Left Beam Up Limit Switch • VPC Max Right Beam On Hook Limit Switch • VPC Max Left Beam On Hook Limit Switch	24 V_{DC}
PC2-6	ODH3A04	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-7	ODH3A07	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-8	ODH3A10	APU Run Command	0 V_{DC} Off, 24 V_{DC} On
PC2-9	ODH3A12	Right Fixed Mast Cylinder Directional Control Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-10	OPH3A15	Drum 4 Pump 5	0 V_{DC}
PC2-11	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	OS85H	8.5 V_{DC} Power to Drum 4 Motor Speed Sensor	8.5 V_{DC}
PC2-13	No Connection		
PC2-14	No Connection		
PC2-15	ODH3A01	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-16	ODH3A06	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-17	ODH3A09	Engine AC Heat Relay	0 V_{DC} Off, 24 V_{DC} On
PC2-18	OPH3A14	Drum 4 Pump 5	0 V_{DC} Off, 24 V_{DC} On
PC2-19	OPH3A17	Drum 5 Pump 6	0 V_{DC} Off, 24 V_{DC} On
PC2-20	+U_B	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	OS85L	Ground for Drum 4 Motor Speed Sensor 8.5 V_{DC} Circuit	0 V_{DC}
PC2-22	No Connection		
PC2-23	No Connection		
PC2-24	ODH3A03	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-25	ODH3A05	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-26	ODH3A08	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-27	ODH3A11	Left Fixed Mast Cylinder Directional Control Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-28	ODH3A13	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-29	OPH3A16	Drum 5 Pump 6	0 V_{DC} Off, 24 V_{DC} On

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Table 3-19. IOLC34 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from engine run switch)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3	ID01	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-4	ID02	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-5	OPH6A18	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-6	OPH6A19	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-7	OPH6A20	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-8	OPH6A21	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-9	IMID1	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-13	ID03	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-14	ID04	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-15	ID05	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-16	No Connection		
PC1-17	IDF15	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21	ID07	VPC-MAX Beam Maximum In	0 V_{DC} Open, 24 V_{DC} Closed
PC1-22	ID08	VPC-MAX Right Beam Up	0 V_{DC} Open, 24 V_{DC} Closed
PC1-23	ID09	VPC-MAX Left Beam Up	0 V_{DC} Open, 24 V_{DC} Closed
PC1-24	ID10	VPC-MAX Right Beam On Hook	0 V_{DC} Open, 24 V_{DC} Closed
PC1-25	ID11	VPC-MAX Left Beam On Hook	0 V_{DC} Open, 24 V_{DC} Closed
PC1-26	IDF16	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-27	IACV17	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	No Connection		
PC2-1	No Connection		
PC2-2	No Connection		
PC2-3	ID14	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-4	IACV18	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-5	ODH3A02	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Function	Voltages
PC2-6	ODH3A04	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-7	ODH3A07	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-8	ODH3A10	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-9	ODH3A12	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-10	OPH3A15	Drum 4 Left Motor Control	0 V_{DC} Open, 24 V_{DC} Closed
PC2-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	OS85H	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-13	IACV19	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-14	IACV20	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-15	ODH3A01	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-16	ODH3A06	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-17	ODH3A09	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-18	OPH3A14	Pump 9 Variable Displacement	0 V_{DC} Off, 24 V_{DC} On
PC2-19	OPH3A17	Cooler Fan Pump Solenoid	0 V_{DC} Off, 24 V_{DC} On
PC2-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	OS85L	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-22	IACV21	VPC-MAX Beam Max Out	24 V_{DC}
PC2-23	IACV22	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-24	ODH3A03	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-25	ODH3A05	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-26	ODH3A08	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-27	ODH3A11	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-28	ODH3A13	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-29	ODH3A16	Drum 4 Right Side Motor Control	0 V_{DC} Off, 24 V_{DC} On

Table 3-20. IOLC35 Test Voltages

Pin	I/O Network	Function	Voltages
PC1-1	GND	Ground (from ground stud on rotating bed)	0 V_{DC}
PC1-2	KL15	Control Module Ignition Power (from relay K6)	0 V_{DC} Open, 24 V_{DC} Closed
PC1-3	ID01	VPC-MAX Tray Max Out	0 V_{DC} Open, 24 V_{DC} Closed
PC1-4	ID02	VPC-MAX Tray Max In	0 V_{DC} Open, 24 V_{DC} Closed
PC1-5	OPH6A18	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-6	OPH6A19	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-7	OPH6A20	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-8	OPH6A21	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Function	Voltages
PC1-9	No Connection		
PC1-10	CAN1_H	CAN Bus C—High	Not Applicable
PC1-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-12	$+U_E$	Control Module Battery Power	24 V_{DC}
PC1-13	ID03	VPC-MAX Tray Beam Connected	0 V_{DC} Not Installed, 24 V_{DC} Installed
PC1-14	ID04	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-15	ID05	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-16	No Connection		
PC1-17	No Connection		
PC1-18	IMID2	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-19	CAN1_L	CAN Bus C—Low	Not Applicable
PC1-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC1-21	ID07	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-22	ID08	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-23	ID09	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-24	ID10	Not Used—For Possible Future Expansion	0 V_{DC}
PC1-25	No Connection		
PC1-26	No Connection		
PC1-27	No Connection		
PC1-28	IMID4	Module Identifier Input (from ground stud on rotating bed)	0 V_{DC}
PC1-29	No Connection		
PC2-1	ID12	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-2	ID13	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-3	ID14	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-4	No Connection		
PC2-5	ODH3A02	VPC Actuator Pin Extend	0 V_{DC} Off, 24 V_{DC} On
PC2-6	ODH3A04	VPC Beam Left Warning Light, VPC Beam Right Warning Light	0 V_{DC} Off, 24 V_{DC} On
PC2-7	No Connection		
PC2-8	ODH3A10	Beam/Foot Upper Pin Retract	0 V_{DC} Off, 24 V_{DC} On
PC2-9	ODH3A12	Beam/Foot Lower Pin Retract	0 V_{DC} Off, 24 V_{DC} On
PC2-10	No Connection		
PC2-11	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-12	No Connection		
PC2-13	IACV19	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-14	IACV20	Not Used—For Possible Future Expansion	0 V_{DC}

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Pin	I/O Network	Function	Voltages
PC2-15	ODH31A01	Power Bus: • VPC-MAX Tray Maximum In • VPC-MAX Tray Maximum Out • VPC-MAX Beam Level Sensor	0 V_{DC} Open, 24 V_{DC} Closed
PC2-16	No Connection		
PC2-17	ODH3A09	Beam/Foot Upper Pin Extend	0 V_{DC} Off, 24 V_{DC} On
PC2-18	OPH3A14	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-19	OPH3A17	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-20	$+U_B$	Supply Power for Control Module Outputs	24 V_{DC}
PC2-21	No Connection		
PC2-22	IACV21	VPC-MAX Beam Level Sensor (pitch)	5.025 V_{DC} @ 0° ±1.005 V_{DC} Offset/°
PC2-23	IACV22	VPC-MAX Beam Level Sensor (roll)	5.025 V_{DC} @ 0° ±1.005 V_{DC} Offset/°
PC2-24	ODH3A03	VPC Actuator Pin Retract	0 V_{DC} Off, 24 V_{DC} On
PC2-25	No Connection		
PC2-26	ODH3A08	VPC-MAX Actuator Encoder	0 V_{DC} Off, 24 V_{DC} On
PC2-27	ODH3A11	Beam/Foot Lower Pin Extend	0 V_{DC} Off, 24 V_{DC} On
PC2-28	ODH3A13	Not Used—For Possible Future Expansion	0 V_{DC}
PC2-29	ODH3A16	Not Used—For Possible Future Expansion	0 V_{DC}

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SECTION 4
BOOM

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SECTION 4
BOOM

GENERAL MAINTENANCE

This section contains maintenance and adjustment instructions for the limit devices used with the boom and luffing jib attachment.

It also contains maintenance and inspection of the following components:

- Straps
- Fleeting Sheaves

BOOM AND LUFFING JIB ANGLE INDICATOR CALIBRATION

An angle sensor (Figure 4-1) is located inside the boom and luffing jib tops. The sensors are calibrated on the Range Capacity Limiter/ Range Capacity Indicator (RCL/RCI) display and do not require adjustment.

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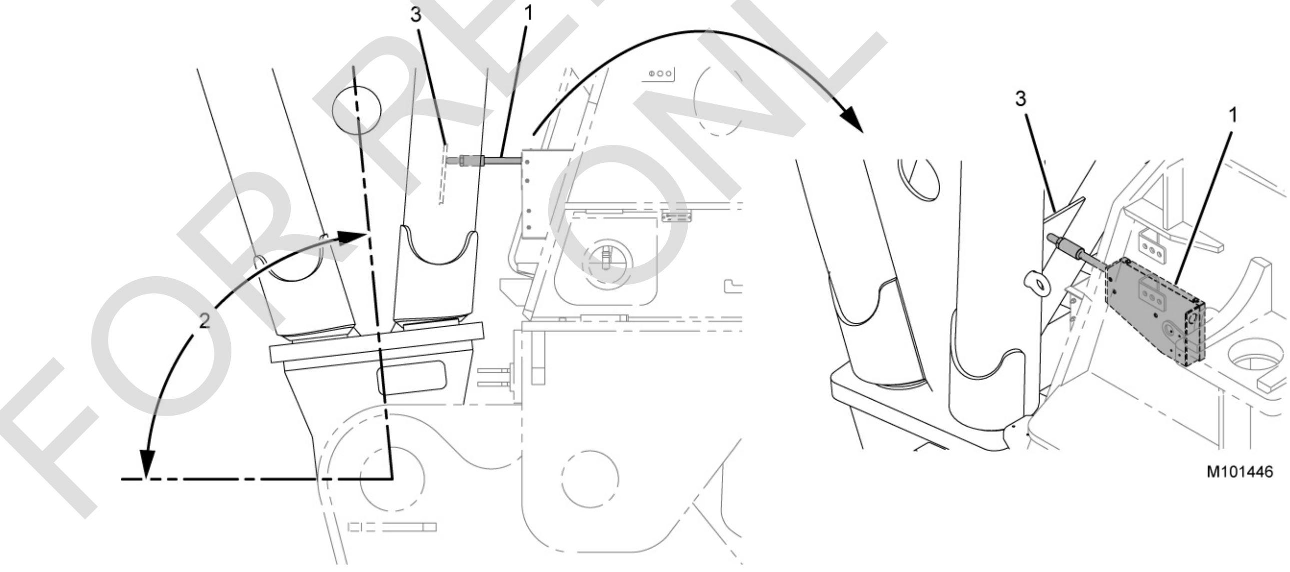
FIGURE 4-1

BOOM STOP LIMIT SWITCH

When the boom is at a position other than the maximum allowable angle, the limit switch in the boom stop switch unit (1, Figure 4-2) is closed, providing a continuous 24 V_{DC} signal to the ID07 input on the IOLC30 control module.

If the boom reaches the maximum allowable angle for your boom/jib configuration, the limit switch will open (voltage at the ID07 input drops to 0 V_{DC}), signaling the control system to stop the boom hoist and apply the hoist brake.



Item	Description
1	Boom Stop Switch Unit
2	Maximum Switch Boom Angle: 84.5° Boom only with VPC-MAX 86.4° Boom with Luffing Jib and without VPC-MAX 86.4° Boom with Luffing Jib and VPC-MAX 86.4° Boom only with VPC
3	Boom Stop Plate

FIGURE 4-2

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Automatic Boom Stop Overview

See Figure 4-2 for the following procedure.

The boom stop switch unit (1) automatically stops the boom and applies the boom hoist brake if the boom is raised to the maximum switch boom angle (2).

NOTE: The maximum switch boom angle is greater than the maximum boom angle to allow the operator to boom up past the maximum capacity chart angle to get to the minimum chart radius with a load on the hook and the boom deflected.

⚠ WARNING

Falling Attachment Hazard!

Do not operate the crane unless the automatic boom stop is properly adjusted and operational. Do not adjust the maximum operating angle higher than specified. The boom could be pulled over backward or collapse, causing death or serious injury.

When the maximum switch boom angle is reached, the fault alarm is activated and the boom maximum up icon appears in the information screen of the main display.

To correct the fault once it is activated, lower the boom. The fault cannot be bypassed.

Maintenance

At least once weekly, verify that the automatic boom stop stops the boom at the specified maximum switch boom angle. If it does not, replace any worn or damaged parts and/or adjust the automatic boom stop. See Adjusting Automatic Boom Stop, page 4-4.

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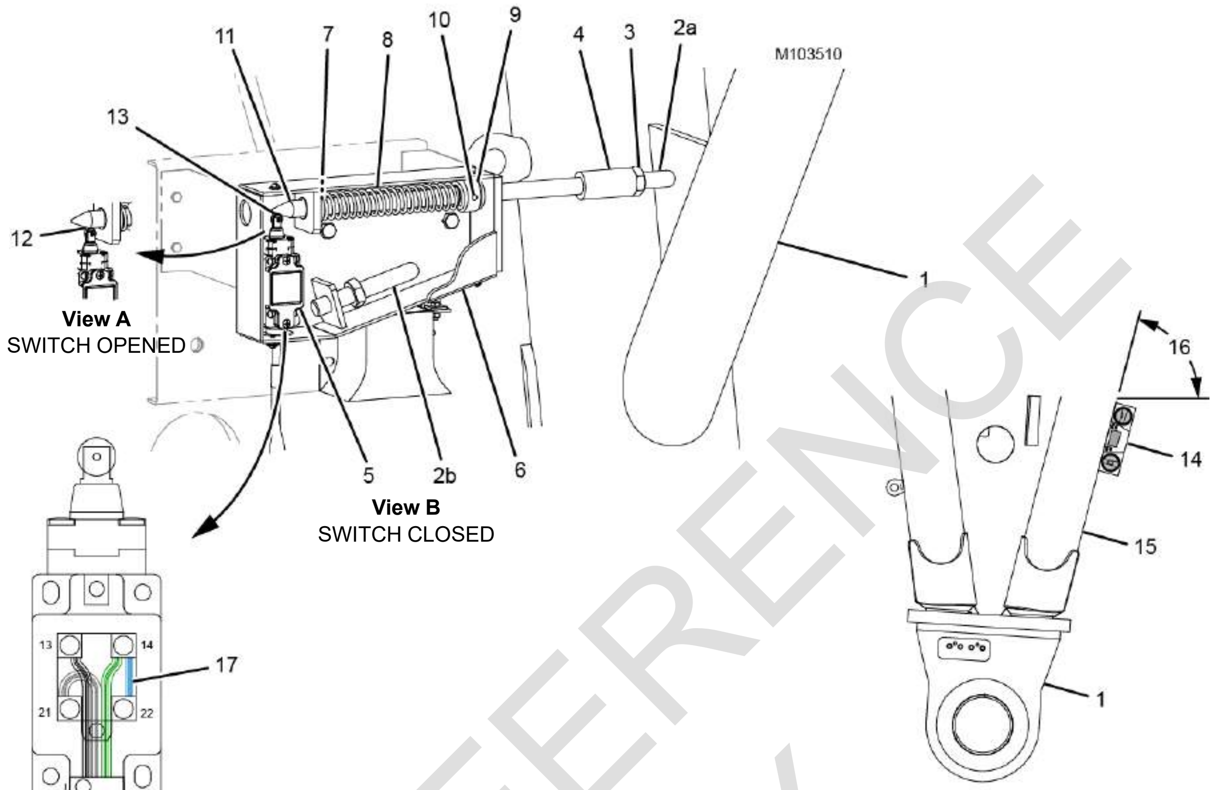

View C
RIGHT SIDE OF BOOM BUTT

View D
LIMIT SWITCH WIRING

Receptacle	Switch Terminals		Function
Black	13		Ground
Green	14		Maximum Angle
White	21		24 VDC Supply
Blue	14	22	Jumper

Maximum Switch Boom Angle	Digital Level Angle (16)
84.5° —Boom only with VPC-MAX	73.57°
86.4° —Boom with Luffing Jib and without VPC-MAX	75.47°
86.4° —Boom with Luffing Jib and VPC-MAX	75.47°
86.4° —Boom only with VPC	75.47°

Maximum Boom Angle
83° —Boom only with VPC-MAX
85° —Boom with Luffing Jib and without VPC-MAX
85° —Boom with Luffing Jib and VPC-MAX
85° —Boom only with VPC

Item	Description	Item	Description
1	Boom Butt	9	Spring Washer
2a	Adjusting Rod for 83° Boom Angle—133 mm (5.25 in)	10	Spring Pin
2b	Adjusting Rod for 85° Boom Angle—105 mm (4.125 in)	11	Actuator Rod
3	Jam Nut	12	Over-Travel
4	Coupling (part of actuator rod)	13	Switch Closed
5	Limit Switch	14	Digital Protractor-Level
6	Boom Stop Switch Unit	15	Boom Butt Bottom Chord
7	Spring Washer	16	Digital Level Angle
8	Spring	17	Blue Jumper Wire

FIGURE 4-3

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Adjusting Automatic Boom Stop

WARNING

Falling Attachment Hazard!

Do not operate the crane unless the boom stop limit switch is properly adjusted and operational. Do not adjust the maximum operating angle higher than specified. The boom could be pulled over backward or collapse, causing death or serious injury.

See Figure 4-3 for the following procedure.

The limit switch for the automatic boom stop was set at the factory and should not require periodic adjustment. Adjustment is necessary when:

- Parts are replaced
- The boom/luffing jib configuration is changed

The following instructions assume that the RCL/RCI is installed and properly calibrated.

During the following procedure, the boom angle is monitored on the working screen of the RCL/RCI and on a digital protractor-level (14) (see View C).

1. Park the crane on a firm level surface or level the crane by blocking under the crawlers.

2. Make sure the correct adjusting rod (2a or 2b) is installed:

   - Adjusting rod (2a) for 83° boom angle
   - Adjusting rod (2b) for 85° boom angle

3. Boom up slowly while monitoring the boom angle on the RCL/RCI working screen.

4. Stop boom up when the boom reaches the specified maximum switch boom angle. (See Maximum Switch Boom Angle table in View C.)

NOTE: The maximum switch boom angle is greater than the maximum boom angle to allow for boom deflection.

5. Verify the boom angle with an accurate digital protractor-level (14) placed on the boom butt bottom chord (15) (see View C). The corresponding digital level angle (16) should appear on the protractor-level.

   - If the boom stops at the specified angle, further adjustment is not needed.
   - If the boom stops before reaching the specified angle, go to step 6.
   - If the boom reaches the specified angle before it stops, go to step 7.

6. If the boom stops before reaching the specified angle, perform the following:

   a. Loosen the jam nut (3).

   b. Turn the adjusting rod (2a or 2b) all the way into the coupling (4).

   c. Boom up slowly until the boom reaches the specified angle.

   d. Turn the adjusting rod out against the stop plate on the boom butt (1) until the limit switch (5) clicks open.

   e. Tighten the jam nut.

7. If the boom reaches the specified angle before it stops, perform the following:

   a. Loosen the jam nut (3) (see View B).

   b. Turn the adjusting rod (2a or 2b) out against the boom butt (1) until the limit switch (5) clicks open.

   c. Tighten the jam nut.

8. Verify the position of the actuator rod (11) relative to the limit switch roller to ensure there is over-travel (12) (see View A).

9. Boom down and then boom back up. The boom must stop at the specified maximum switch boom angle.

10. If the boom does not stop at the specified angle, repeat step 3 through step 9.

Replacing Boom Stop Limit Switch Actuator Rod

See Figure 4-3 for the following procedure.

1. Disassemble the boom stop switch unit (6).

2. Assemble the boom stop switch unit using the following instructions:

   a. Position the actuator rod (11) so the tapered end just touches the limit switch roller (see View B). The actuator rod must not depress the limit switch shaft.

   b. Drill a 6,35 mm (1/4 in) hole through the spring washer (9) and actuator rod.

   c. Install the spring pin (10).

   d. Push the actuator rod in until the limit switch clicks open. Check position of the limit switch roller to ensure there is over-travel (12) (see View A).

FOR REFERENCE ONLY

PHYSICAL BOOM STOP

WARNING

Falling Attachment Hazard!

The physical boom stops must be installed for all crane operations.

Physical boom stops do not automatically stop the boom at maximum operating angle. The automatic boom stop must be installed and properly adjusted.

See Figure 4-4 for the following procedure.

Physical boom stops (1) serve the following purposes:

- Assist in stopping the boom smoothly at any angle above 78°
- Assists in preventing boom rigging from pulling the boom back when traveling or setting loads with boom at any angle above 78°
- Assists in moving the boom forward when lowering the boom from any angle above 78°
- Provides a physical stop at 88°

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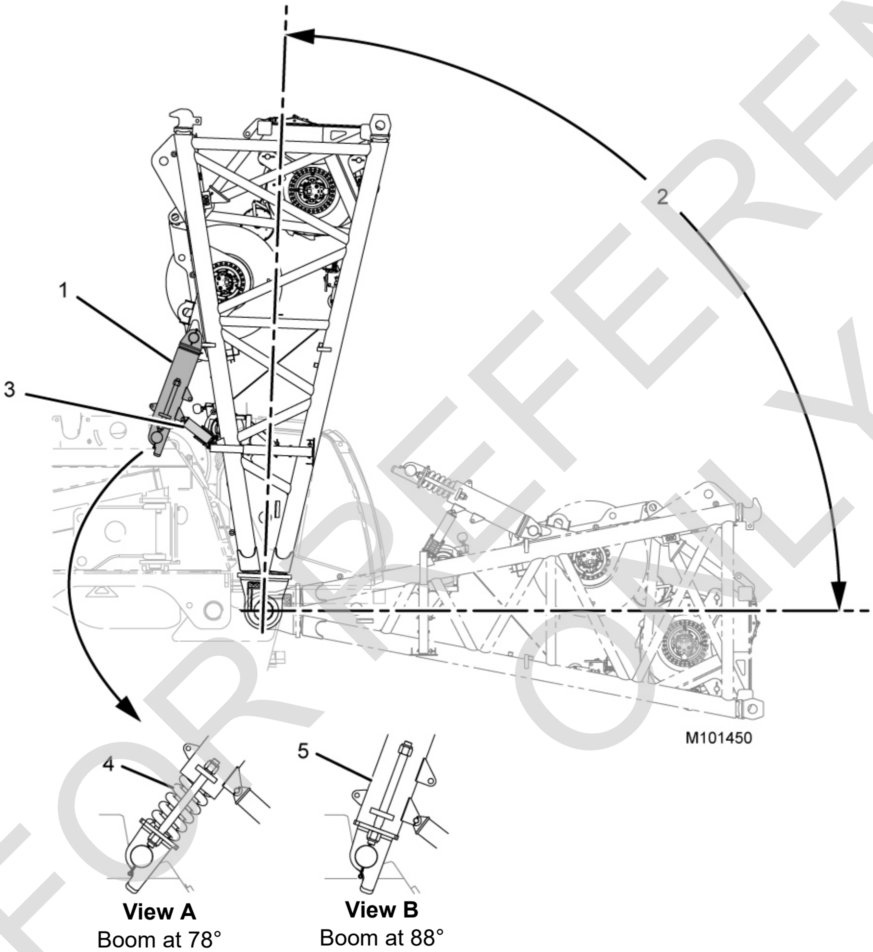


Item	Description
1	Physical Boom Stop
2	Boom Angle
3	Strut
4	Boom Stop Spring
5	Boom Stop Tube

FIGURE 4-4

Physical Boom Stop Operation

1. When the boom is raised to 78°, the boom stop spring (4) in the boom stop tube (5) begins to compress (see View A).
2. As the boom is raised higher, spring compression increases to exert greater force against the boom.
3. If the boom is raised to 88°, the boom stop spring becomes fully compressed and the boom stop tube provides a physical stop (see View B).

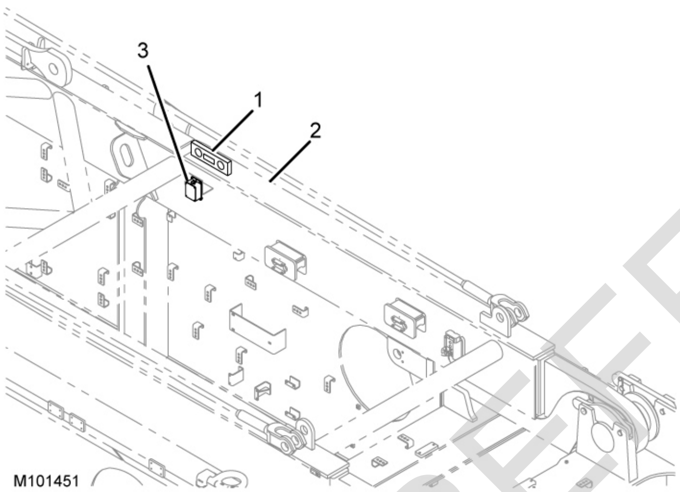
NOTE: Struts (3) do not require adjustment.

BOOM AND LUFFING JIB ANGLE INDICATORS

Angle indicators are mounted on the boom top and the luffing jib top. Boom and luffing jib angles are calibrated automatically by the crane's safety control module (SCM) as part of the load indicator calibration procedure (see Rated Capacity Indicator/Limiter Operation Manual for instructions).

MAST ANGLE SENDING UNIT

The mast angle sending unit was set at the factory and should not require periodic adjustment. Adjustment is required if parts are replaced.



Item	Description
1	Digital Protractor-Level
2	Left Mast Leg
3	Angle Sensor

FIGURE 4-5

Adjusting the Mast Angle

See Figure 4-5 for the following procedure.

1. Lower the mast to the transport position.
2. Place a digital protractor-level (1) on the left mast leg (2) and note the mast angle.
3. Note the mast angle on the main display Information screen.
4. Verify the angles noted in step 2 and step 3 are within 1° of each other.
5. If necessary, loosen the mounting screws and rotate the angle sensor (3) in the mounting slots until the reading on the Information screen matches the angle displayed on the level.
6. Securely tighten the mounting screws.

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FLEETING SHEAVE MAINTENANCE

See Figure 4-6 for the following.

General

Each fleeting sheave assembly (1), located on the 6M insert wire rope guides of the #680 boom assembly, has three automatic grease guns (2) that provide lubrication automatically.

Specifications

- Pressure: maximum 5 bar (75 psi)
- Temperature: -20 to 60°C (-4 to 140°F)
- Lifespan: maximum of 1 year
- Grease: Mobil XHP 222
- Mount: 6,35 mm (0.25 in) NPT

Inspection

Inspect the automatic grease guns weekly for the following:

- Damage to the grease gun canister
- Level of grease inside the grease gun

Replacement

The automatic grease gun should be replaced as soon as the gun is verified to be damaged or empty.

The grease gun can be removed by hand. Turn the grease gun counterclockwise to remove from the fitting on the fleeting sheave assembly. Carefully thread the new grease gun clockwise onto the fleeting sheave fitting by hand. Do not overtighten the grease gun. Damage to the grease gun can occur when excessive tightening force is applied to the plastic canister.

Activation

To activate the grease gun, turn the dial on the grease gun canister head to a minimum of 1 and to a maximum of 12.

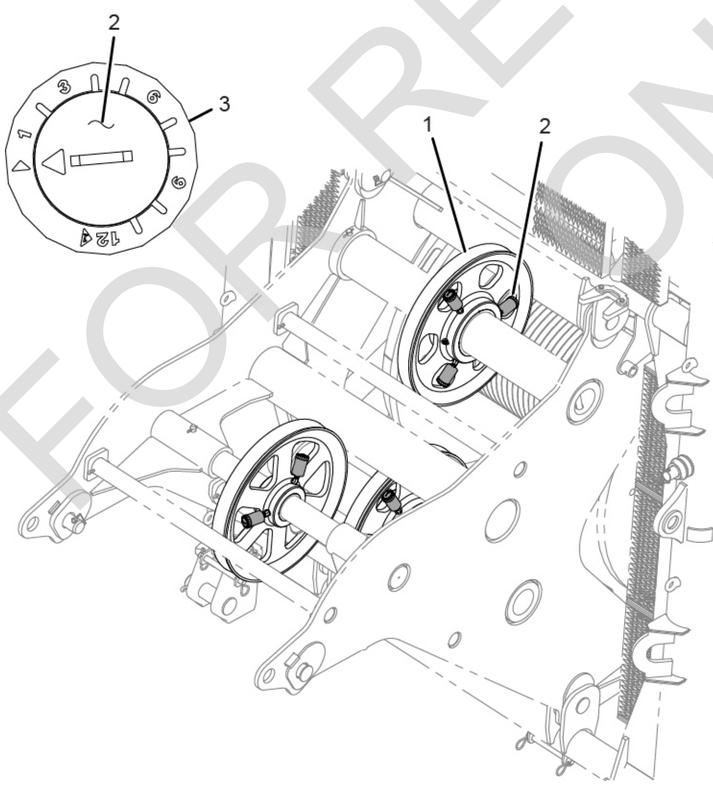
Adjustment

The dial indicator on the top of the grease gun can be set to empty in monthly increments. Set the dial as necessary to provide adequate grease based on the level of crane operation. For example, when the dial indicator is set to 1, the grease gun will empty in approximately one month.

Operation

Operation of the fleeting sheave grease gun is self-sustaining once activated.

When the crane is not in use for extended periods of time or is placed into storage, it is recommended that the grease gun be set to the OFF position. This deactivates the grease gun, preventing grease from being pumped to the sheave bearing. The dial indicator (3) in Figure 4-6 is shown in the OFF position.



Item	Description
1	Fleeting Sheave Assembly
2	Automatic Grease Gun
3	Dial Indicator—OFF Position

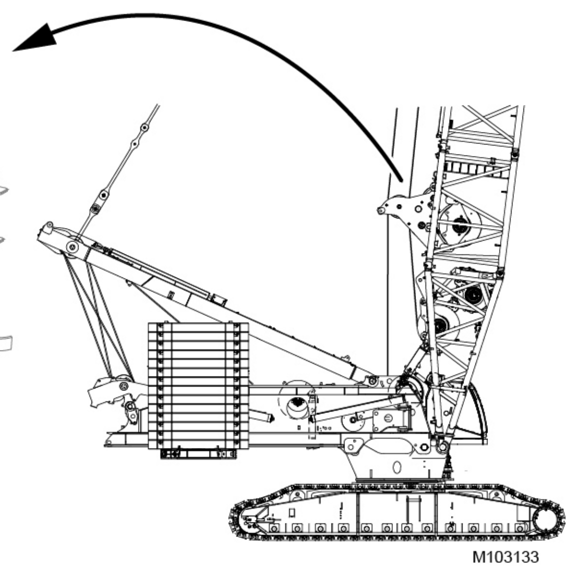


FIGURE 4-6

FOR REFERENCE ONLY

BOOM TOP ELECTRICAL SCHEMATIC

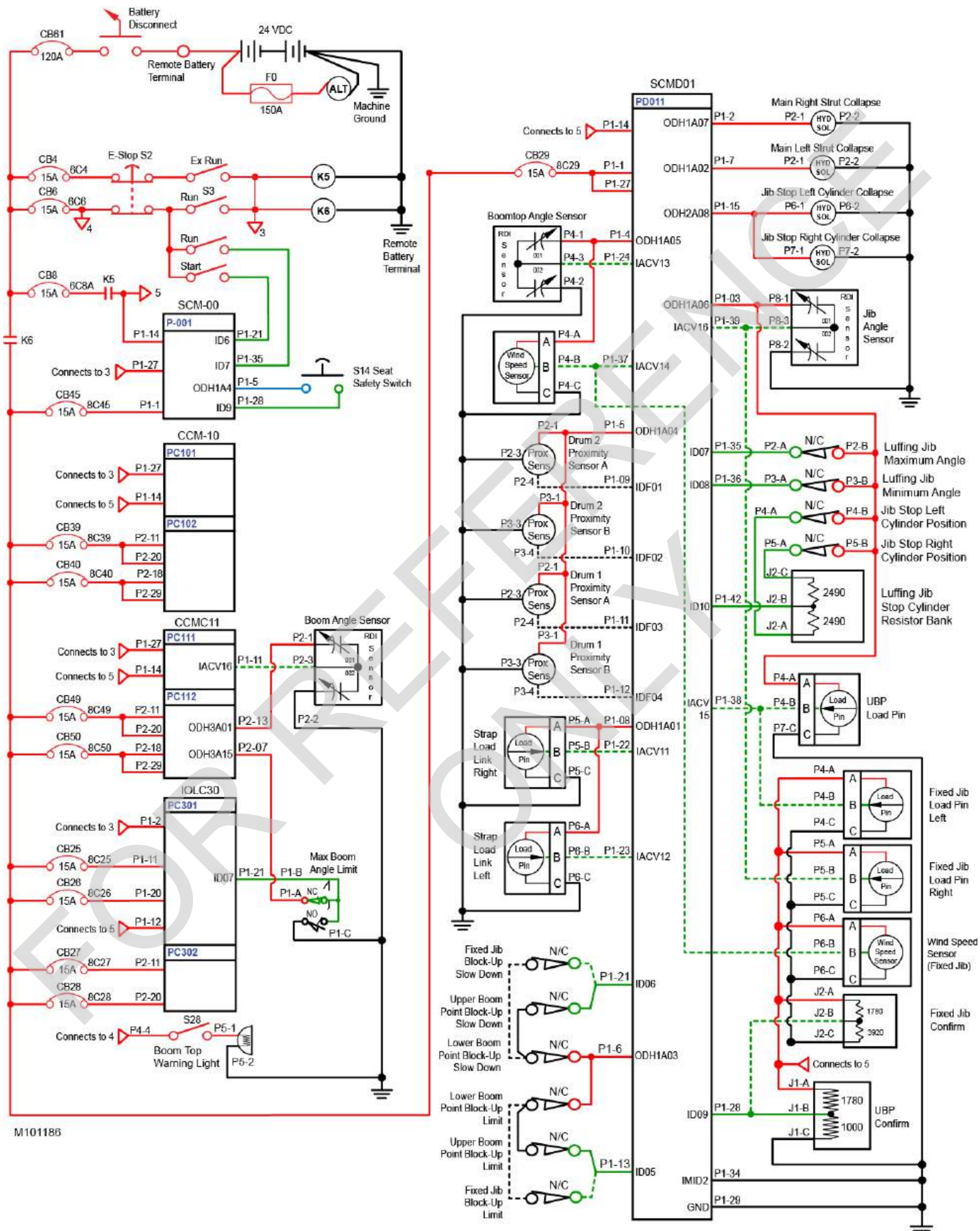


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FIGURE 4-7

LUFFING JIB TOP ELECTRICAL SCHEMATIC

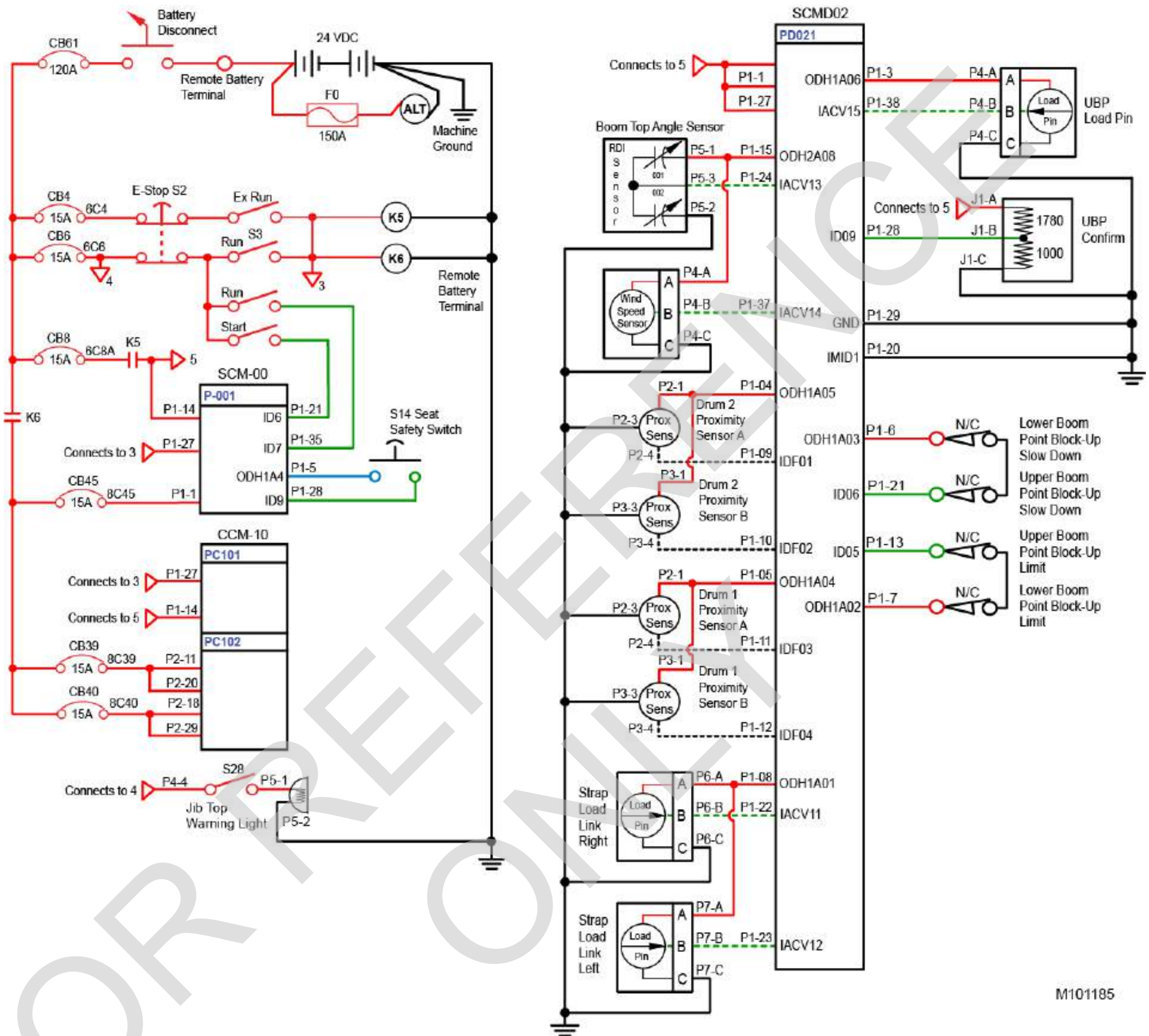

FIGURE 4-8

FOR REFERENCE ONLY

BOOM WIND CAP ELECTRICAL SCHEMATIC

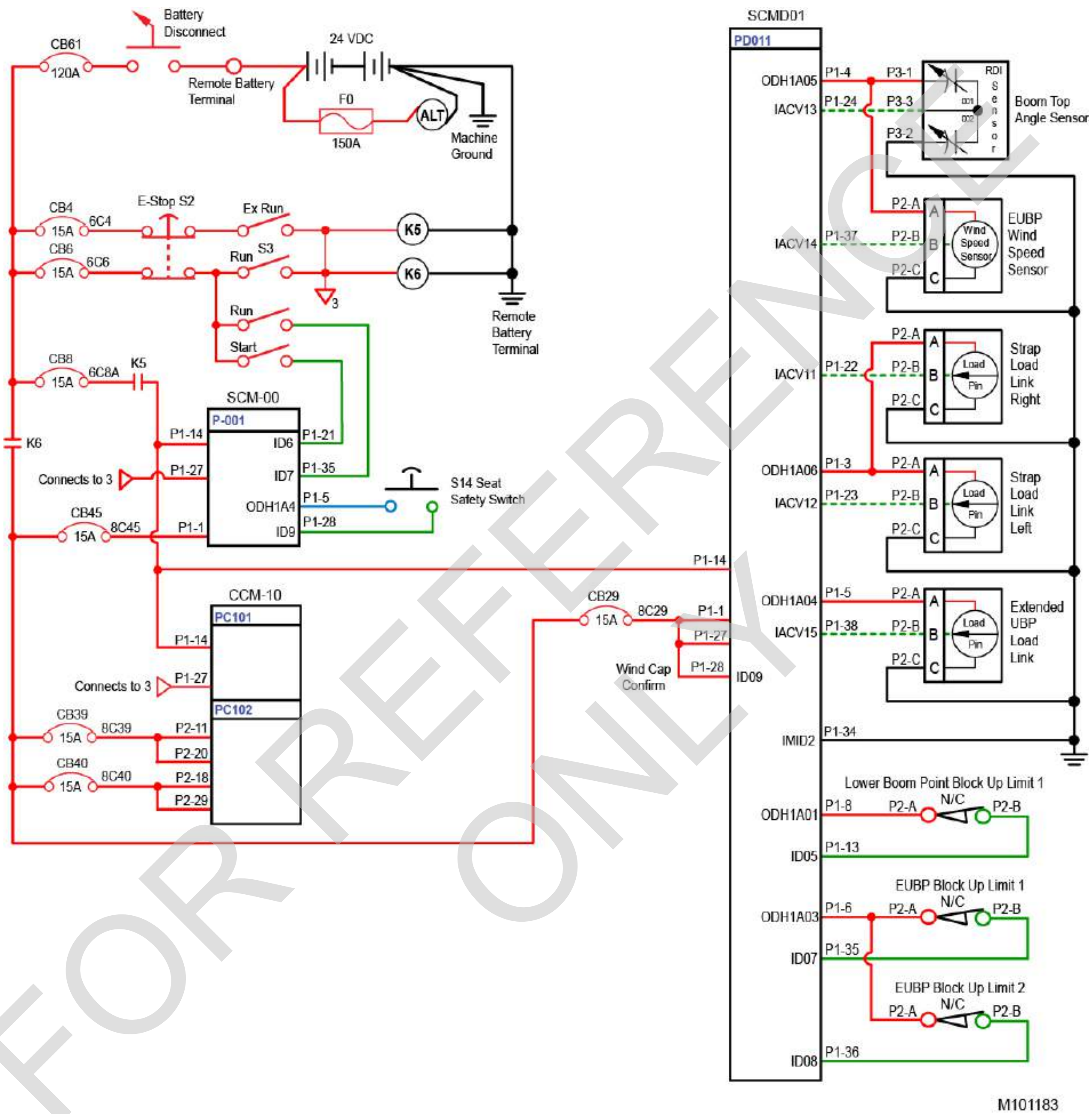

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FIGURE 4-9

STRAP INSPECTION AND MAINTENANCE

This section is a guide to crane owners for properly inspecting and maintaining straps in the field. It is impossible to predict whether or when a strap may fail. Frequent and periodic inspections can help reveal potential for failure. Straps are to be inspected regularly by a qualified person as part of the crane's preventive maintenance program. Dated records should also be kept.

Strap repairs are prohibited. Perform only the maintenance indicated in this section. For inspection procedures not covered in this manual, contact your dealer or the Manitowoc Crane Care Lattice Team.

NOTE: If strap damage was caused by overload or shock load or if there is damage to other major structural components, Manitowoc Cranes recommends that a thorough inspection be made by a qualified person. A nondestructive test of all critically stressed members must be made.

Strap connecting links are subject to the same inspection procedures and replacement specifications as those for straps. In this section, "strap" means straps and connecting links.

Inspection

Regular inspection of all straps is necessary to ensure that the crane can lift its rated load. If a strap fails, the boom or other attachment can collapse. All inspections must be performed by a qualified inspector at the following intervals:

- Routinely on a daily (frequent inspection) or monthly (periodic inspection) basis
- Before initial use
- After transport
- After an overload or shock loading has occurred
- If the boom and/or jib has come into contact with another object (for example, power lines, building, another crane)
- If the boom or jib has been struck by lightning

Frequent Inspection

Visually inspect all straps once each work shift for obvious damage that poses an immediate hazard. Pay particular attention to areas where wear and other damage is likely to occur. Look for straps that are disconnected, loose, or sagging excessively and for distortion such as kinking or twisting. If any strap looks like it is damaged, the strap must be checked to make sure it is within the specifications given in this section.

Periodic Inspection

Periodic inspection must be performed at least monthly. During this inspection, the entire length of strap must be inspected to ensure that it is within specifications. Any damage found must be recorded and a determination must be made as to whether continued use of the strap is safe.

NOTE: The strap must be within all specifications identified in this section.

Before beginning an inspection, thoroughly clean the strap of all dirt, grease, oil, etc., so a thorough inspection can be made. Closely examine those areas where paint is chipped, wrinkled, or missing and where faint rust lines or marks appear.

A qualified inspector may modify an interval for periodic inspection depending on the following factors:

- Severity of environment in which crane is operated
- Size, nature, and frequency of lifts
- Exposure to shock loading or other abuse

Cranes Not in Regular Use

A qualified inspector should determine the type of inspection required for cranes that have been idle. A frequent inspection (visual observation) should be adequate for a crane that has been idle for less than six months. A periodic inspection is required for cranes that have been idle for more than six months.

4

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Identifying Straps

To aid in identification, the part number is stamped into both ends of each strap (Figure 4-10).

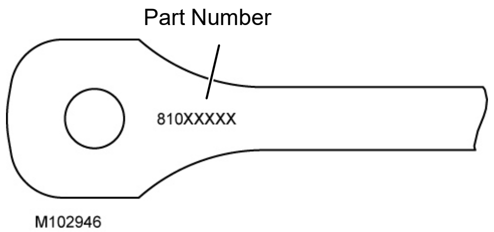

FIGURE 4-10

Replacement Specifications

Any strap not within the specifications listed in Table 4-1 must be replaced.

⚠ WARNING

Falling Attachment Hazard!

If damage to the strap exceeds that allowed within specification, do not operate the crane until the strap has been replaced.

Operating the crane with a damaged strap can cause structural failure or collapse of the boom, jib, mast, or other crane components.

Table 4-1. Strap Specifications

Condition	Reference	Allowable Tolerance or Deviation	Corrective Action
Dent	Figure 4-11 View A	$<$ 3% of strap thickness	Monitor condition.
		$\geq$ 3% of strap thickness	Remove strap from service.
Crack or Break	Figure 4-11 View B	None	Remove strap from service.
Kink	Figure 4-11 View C	None	Remove strap from service.
Corrosion or Abrasion	Figure 4-12	$<$3% of strap cross-sectional area	Sandblast and paint to maintain continuous protective coating.
		$\geq$3% of strap cross-sectional area	Remove strap from service.
Straightness (gradual or sweeping bend)	Figure 4-13	Table 4-2	Remove strap from service if deviation exceeds maximum allowed.
Flatness (includes twisted straps)	Figure 4-14	Table 4-3	Remove strap from service if deviation exceeds maximum allowed.
Elongated Holes	Figure 4-15	None	Remove strap from service.
Length	Figure 4-16	None	Remove strap from service.

$<$ = less than
$\geq$ = equal to or greater than

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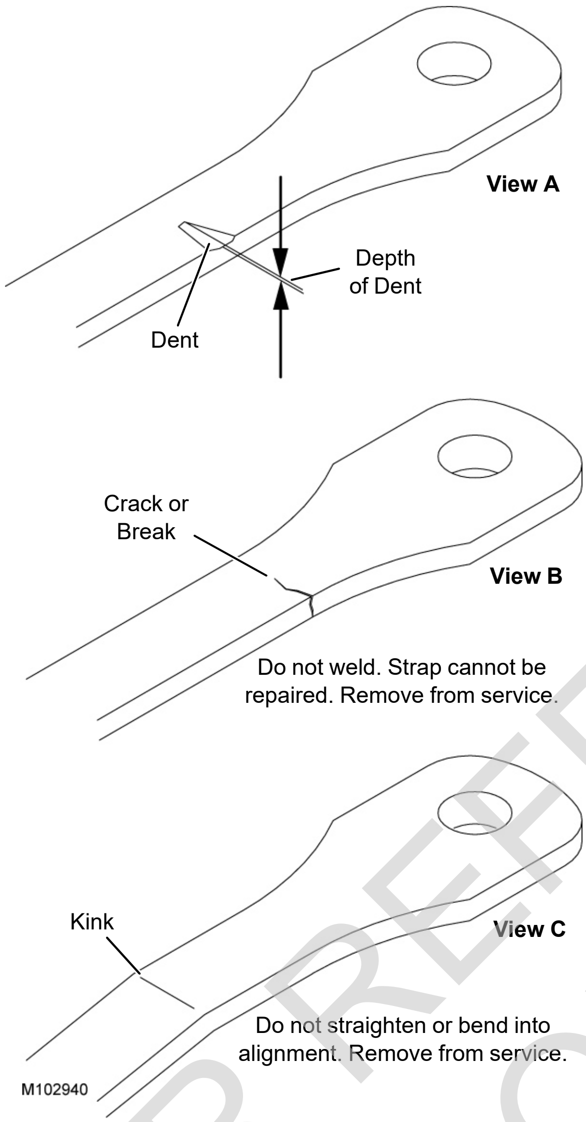

FIGURE 4-11

Corrosion or Abrasion

See Figure 4-12 for the following procedure.

For quick identification by repair workers, clearly mark damaged areas with brightly colored tape.

Sandblast to remove corrosion. Do not grind!

Determine the reduction in the cross-sectional area.

If the reduction is less than 3% of the strap's cross-sectional area, paint the strap to maintain a continuous protective coating.

If the reduction is 3% or more of the strap's cross-sectional area, remove the strap from service.

Corrosion or Abrasion

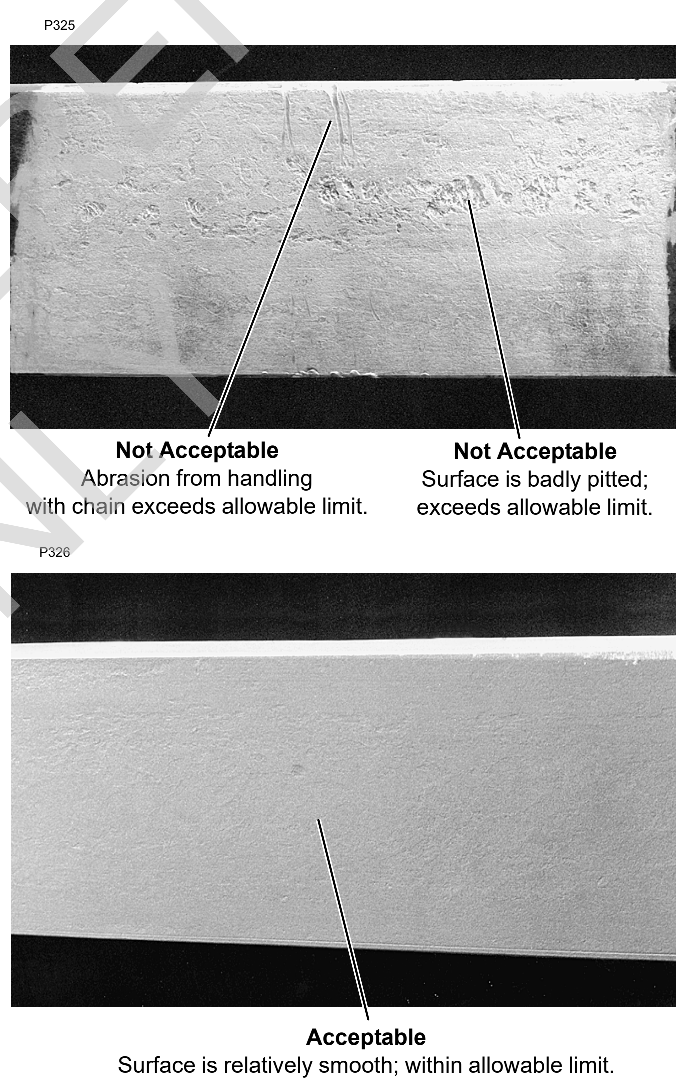

FIGURE 4-12

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Straightness

See Figure 4-13 for the following procedure.

1. Stretch a line (string or wire) from the pin storage hole at one end of the strap.
2. Stretch the line as tight as possible and tie it off at the other end.
3. Mark the strap's centerline. Do not use a center punch!
4. If the string does not align with the centerline, measure the distance from the centerline to the line.

If the deviation from straight is greater than the maximum allowed in Table 4-2, remove the strap from service.

Table 4-2. Strap Straightness

Strap Length (L)	Maximum Deviation Allowed
1,5 to <3,0 m (5 to <10 ft)	1,5 mm (0.060 in)
3,0 to <6,1 m (10 to <20 ft)	3,2 mm (0.125 in)
6,1 to <9,1 m (20 to <30 ft)	6,4 mm (0.250 in)
9,1 to <12,2 m (30 to <40 ft)	9,5 mm (0.375 in)
12,2 to <15,2 m (40 to <50 ft)	12,7 mm (0.50 in)
< = less than	

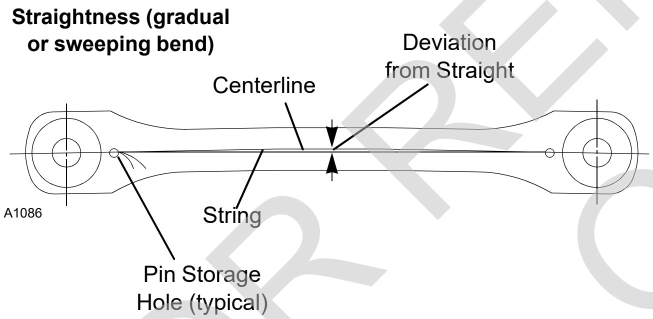

FIGURE 4-13

Flatness

See Figure 4-14 for the following procedure.

1. Lay the strap on a flat surface. Do not put the strap on blocks. This may cause the strap to sag.
2. Stretch a line (string or wire) across the top surface of the strap from the pin storage hole at one end of the strap.
3. Stretch the line as tight as possible and tie it off at the other end.
4. Verify that the line touches the top surface of the strap at all points along its length.
5. If the string does not touch the strap, measure the distance from the line to the strap.

   If the deviation from flat is greater than the maximum allowed in Table 4-3, remove the strap from service.
6. Remove the line. Turn the strap over.
7. Repeat step 1 through step 5 above.

Flatness (includes twisted straps)

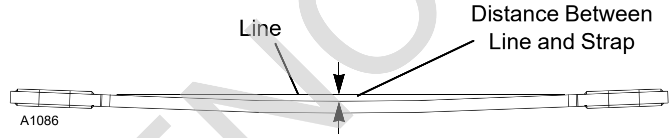

FIGURE 4-14

Table 4-3.Strap Flatness

Strap Length (L) m (ft)	Maximum Deviation Allowed	
	25,4 to <50,8 mm (1 to <2 in) Thick	50,8 to <101,6 mm (2 to <4 in) Thick
<0,9 (<3)	4,3 mm (0.17 in)	12,7 mm (0.50 in)
0,9 to <1,2 (3 to <4)	15,9 mm (0.63 in)	14,3 mm (0.56 in)
1,2 to <1,5 (4 to <5)	19,1 mm (0.75 in)	17,8 mm (0.70 in)
1,5 to <1,8 (5 to <6)	20,6 mm (0.80 in)	19,1 mm (0.75 in)
1,8 to <2,1 (6 to <7)	22,2 mm (0.88 in)	19,1 mm (0.75 in)
2,1 to <2,4 (7 to <8)	23,8 mm (0.94 in)	19,1 mm (0.75 in)
2,4 to <2,7 (8 to <9)	25,4 mm (1.0 in)	19,1 mm (0.75 in)
2,7 to <3,0 (9 to <10	25,4 mm (1.0 in)	22,2 mm (0.88 in)
3,0 to <3,7 (10 to <12)	25,4 mm (1.0 in)	25,4 mm (1.0 in)
≥3,7 (≥12)	Deviation not to exceed 25,4 mm (1 in) in any 3,7 m (12 ft) length of strap	
< = less than		
≥ = equal to or greater than		

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Elongated Hole

See Figure 4-15 for the following procedure.

1. Insert the pin into the hole.
2. Push the pin tight against the edge of the hole along the horizontal centerline. Measure the dimension between the pin and the hole (see View A).
3. Push the pin tight against the edge of the hole along the vertical centerline. Measure the dimension between the pin and the hole (see View B).

   If dimension B is not half of A, the hole is elongated. Remove the strap from service.

If dimension A is greater than 0,8 mm (0.030 in), contact the Manitowoc Crane Care Lattice Team.

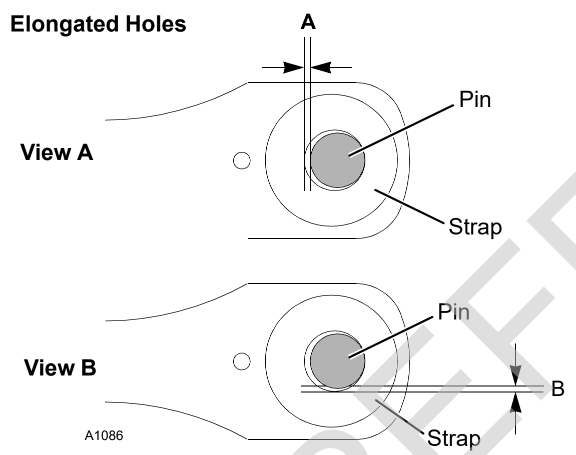

FIGURE 4-15

Strap Length

Check the strap length (Figure 4-16) by measuring pin hole to pin hole. See the appropriate Rigging Drawing in the Operator Manual for the original length. Strap length includes the connecting link. If a change in length is detected, remove the strap from service.

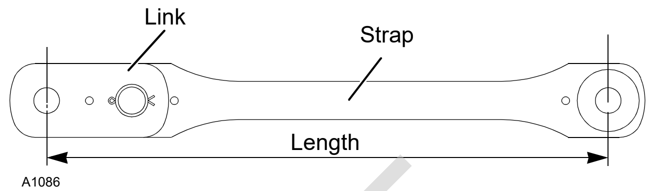

FIGURE 4-16

Storing Straps

Straps should be stored in a protected area. If stored in the open, a protective covering is recommended, especially in a corrosive environment (chemicals, salt water spray, etc.).

Inspect straps in storage for corrosion monthly. If necessary, sandblast to remove corrosion and repaint to maintain a continuous protective surface. If corrosion is not removed, the strap will need to be removed from service because the reduction in thickness will exceed the maximum allowed.

A full periodic inspection is required for straps returned to service from storage.

Removing Straps from Service

Straps removed from service should be clearly marked to prevent accidental future use. Rendering the strap useless in some way, such as cutting off an end, is recommended.

Inspection Checklist

A Strap Inspection Checklist is provided at the end of this section. The checklist can be reproduced as needed.

Signed and dated copies of the Strap Inspection Checklist must be kept on file at all times for each strap, since the checklists may be required to verify warranty or product liability claims.

If no damage is found or the damage is within specification, check the box (☑) next to the item to indicate that its specific condition was evaluated and found acceptable. If damage is not within specification, indicate so in the box next to the item (for example: “D” to indicate damage).

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STRAP INSPECTION CHECKLIST

Inspector's Name ______________ **Signature** ______________ **Date** __________

Length ______________ mm (ft) Part Number ______________

- [ ] Dents
- [ ] Kinks
- [ ] Cracks
- [ ] Breaks
- [ ] Corrosion
- [ ] Abrasion
- [ ] Length
- [ ] Straightness
- [ ] Flatness
- [ ] Elongated Holes
- [ ] Other ______________________________

Length ______________ mm (ft) Part Number ______________

- [ ] Dents
- [ ] Kinks
- [ ] Cracks
- [ ] Breaks
- [ ] Corrosion
- [ ] Abrasion
- [ ] Length
- [ ] Straightness
- [ ] Flatness
- [ ] Elongated Holes
- [ ] Other ______________________________

Length ______________ mm (ft) Part Number ______________

- [ ] Dents
- [ ] Kinks
- [ ] Cracks
- [ ] Breaks
- [ ] Corrosion
- [ ] Abrasion
- [ ] Length
- [ ] Straightness
- [ ] Flatness
- [ ] Elongated Holes
- [ ] Other ______________________________

Length ______________ mm (ft) Part Number ______________

- [ ] Dents
- [ ] Kinks
- [ ] Cracks
- [ ] Breaks
- [ ] Corrosion
- [ ] Abrasion
- [ ] Length
- [ ] Straightness
- [ ] Flatness
- [ ] Elongated Holes
- [ ] Other ______________________________

Length ______________ mm (ft) Part Number ______________

- [ ] Dents
- [ ] Kinks
- [ ] Cracks
- [ ] Breaks
- [ ] Corrosion
- [ ] Abrasion
- [ ] Length
- [ ] Straightness
- [ ] Flatness
- [ ] Elongated Holes
- [ ] Other ______________________________

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NOTES

SKETCHES AND PHOTOGRAPHS

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LATTICE SECTION INSPECTION AND LACING REPLACEMENT

Refer to Folio 2279 at the end of this section for lattice section inspection and lacing replacement instructions.

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SECTION 5
HOISTS

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SECTION 5
HOISTS

GENERAL

This section provides the electrical and hydraulic crane hoist information. Electrical and hydraulic circuit schematics are provided for each drum system.

Details of individual components are covered later in this section. Component information can also be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

DRUM 1 MAIN HOIST

Drum 1 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch. The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10,5 bar (153 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

During lowering operation, the main hydraulic flow from pumps 1 and/or 3 is supplied to the drum 1 brake release solenoid valve.

During hoisting operation, the charge pump flow from pumps 1 and/or 3 is supplied to the drum 1 brake release solenoid valve.

Drum 1 Brake Operation

See Figure 5-2 and Figure 5-4.

The J2 joystick sends a 24 V_{DC} output to the drum 1 park switch. The park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the CCMC11 control module via the controller area network bus (CAN Bus).

In the default state, the left travel/drum 1 selector solenoid valve (2) and the drum 1/drum 6 selector solenoid valve (3), located in the accessory valve manifold (1), are de-energized. The drum 6 park switch must be in the ON position for this to occur.

With the selector solenoid valves (2 and 3) de-energized, the pumps 1 and 3 charge pressure diverter valves (4 and 8) are in the default position, allowing charge pressure from pumps 1 and 3 to be present at the drum brake release solenoid valve (18).

During drum 1 operation, the CCM-10 control module energizes the left travel/drum 1 selector solenoid valve. The left travel park switch must be in the ON position for this to occur.

When energized, the left travel/drum 1 selector solenoid valve routes hydraulic fluid to the pilot control of the left travel/drum 1 diverter valve (9) and the pump 3 charge pressure diverter valve (4). The diverter valves shift position, allowing the pump 3 main hydraulic pressure to be present at the brake release solenoid valve. Charge pressure from pump 3 is blocked at this time. Only pump 1 charge pressure is available to the charge pressure check valve (13).

If the main pump pressure drops to less than 1,7 bar (25 psi) of the charge pressure, the check valve opens, allowing the pump 1 charge pressure fluid to flow to the brake release solenoid valve.

When the CCMC11 control module receives the un-park command from the J2 joystick, the CCMC11 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake cylinder, releasing the brake.

When the brake switch is moved to the ON-PARK position, the park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the CCMC11 control module via the CAN Bus.

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When the CCMC11 control module receives the on-park command from the J2 joystick, the CCMC11 control module sends a 0 V_{DC} output voltage to the drum brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the fluid in the brake cylinder to flow through the drum brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

Drum 1 Motor Loop Flushing

See Figure 5-2 and Figure 5-3 for the following.

Loop flushing of the right and left hydraulic motors (14 and 16) occurs whenever pressure on the lowering side of the circuit is above 13,8 bar (200 psi). The charge pressure check valve (13) only allows flow from the charge pump(s) to the lowering side of the circuit if the charge pressure is 1,7 bar (25 psi) or higher than the lowering side of the circuit.

Drum 1 Hoisting Operation

See Figure 5-2 and Figure 5-4 for the following.

To enable the drum 1 pumps and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 1 park switch in the OFF position

NOTE: For the following operation, the drum 6 park switch and/or left travel park switch are in the ON position.

In the default state, the CCM-10 control module de-energizes the drum 1/drum 6 selector solenoid valve (3), located in the accessory valve manifold (1). The de-energized solenoid valve routes hydraulic fluid to the pilot control of drum 1/drum 6 diverter valve (10). The diverter valve shifts to the default position, allowing main hydraulic fluid from pump 1 to flow to the double manifold (11), then to the left and right hydraulic motors (14 and 16).

During the drum 1 hoisting operation when the drum 6 park switch and/or left travel park switch are in the ON position, the CCM-10 control module energizes the left travel/drum 1 selector solenoid valve (2), located in the accessory valve manifold. The energized solenoid valve routes hydraulic fluid to the pilot control of the left travel/drum 1 diverter valve (9). The diverter valve shifts position, allowing the main hydraulic fluid from pump 3 to flow to the double manifold where it combines with the fluid from pump 1. The combined fluid then flows to the left and right hydraulic motors.

Hydraulic fluid from the left travel/drum 1 selector solenoid valve also flows to the pilot control of the pump 3 charge pressure diverter valve (4), causing the valve to shift. When in this position, charge pressure from pump 3 is blocked. Only pump 1 charge pressure is available to the charge pressure check valve (13). If the main pump pressure drops below a predetermined level, the check valve opens, allowing the pump 1 charge pressure hydraulic fluid to flow into the main pressure circuit as makeup oil.

During the drum 1 hoisting operation, the CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoids of pumps 1 and/or 3 electronic displacement controls (EDCs). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump(s). From the pump(s), the flow is routed through the diverter valves (9 and 10), the double manifold (11), and then into the B-side of the right hydraulic motor (16) and the A-side of the left hydraulic motor (14).

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 1 motor speed sensor, pump 1 pressure transducer (drum 1 psi) (7), and pump 3 pressure transducer (L-travel psi) (5) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows, while maintaining the speeds commanded by the joystick input.

FOR REFERENCE ONLY

Drum 1 Lowering Operation

See Figure 5-3 and Figure 5-4 for the following.

To enable the drum 1 pumps and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 1 park switch in the OFF position

NOTE: For the following operation, the drum 6 park switch and/or left travel park switch are in the ON position.

In the default state, the CCM-10 control module de-energizes the drum 1/drum 6 selector solenoid valve (3), located in the accessory valve manifold (1). The de-energized solenoid valve routes hydraulic fluid to the pilot control of drum 1/drum 6 diverter valve (10). The diverter valve shifts to the default position, allowing main hydraulic fluid from the pump 1 to flow to the double manifold (11), then to the left and right hydraulic motors (14 and 16).

During the drum 1 lowering operation when the drum 6 park switch and/or left travel park switch are in the ON position, the CCM-10 control module energizes the left travel/drum 1 selector solenoid valve (2), located in the accessory valve manifold. The energized solenoid valve routes hydraulic fluid to the pilot control of the left travel/drum 1 diverter valve (9). The diverter valve shifts position, allowing the main hydraulic fluid from pump 3 to flow to the double manifold where it can combine with the fluid from the pump 1. The combined fluid then flows to the left and right hydraulic motors.

Hydraulic fluid from the left travel/drum 1 selector solenoid valve also flows to the pilot control of the pump 3 charge pressure diverter valve (4), causing the valve to shift. When in this position, charge pressure from pump 3 is blocked. Only pump 1 charge pressure is available to the charge pressure check valve (13). If the main pump pressure drops below a predetermined level, the check valve opens, allowing the pump 1 charge pressure hydraulic fluid into the main pressure circuit as makeup oil.

During the drum 1 lowering operation, the CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoids of pumps 1 and/or 3 EDCs. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump(s). From the pump(s), the flow is routed through the diverter valves (9 and 10), the double manifold (11), and then into the A-side of the right hydraulic motor (16) and the B-side of the left hydraulic motor (14).

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 1 motor speed sensor, pump 1 pressure transducer (drum 1 psi) (7), and pump 3 pressure transducer (L-travel psi) (5) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows, while maintaining the speeds commanded by the joystick input.

Drum 1 Minimum Bail Limit

The optional minimum bail limit assembly on drum 1 is a protective device that limits how much wire rope can be spooled off the drum.

The minimum bail limit automatically stops the drum when there are three to four wraps of wire rope remaining on the first layer.

When the limit is reached, the operating limit fault is activated and the fault icon appears in the fault bar of the main display working screen.

NOTE: The drum can be operated in the hoist direction when the minimum bail limit switch is contacted.

Field adjustment should not be necessary unless a new limit switch is installed.

⚠ WARNING

Falling Load Hazard!

Avoid possible injury. Do not operate the drum with less than three or four full wraps of wire rope remaining on the drum. Doing so can cause the wire rope to be pulled out of the drum and the load to fall.

See Figure 5-1 for the following instructions.

Limit Switch Replacement

Removal

1. Land the load from the drum being adjusted.
2. Lockout-tagout the crane.
3. Remove the screws (7) and the limit switch (8).
4. Remove the limit switch cover (9).
5. Disconnect the electrical wires, including the jumper wire, inside the limit switch (see View C).
6. Remove the cable restraint connector (10) and carefully pull the electrical cable and wires from the limit switch.

FOR REFERENCE ONLY

Installation

1. Connect the electrical wires to the new limit switch as follows.
   - a. Remove the limit switch cover (9).
   - b. Insert the wires of the electrical cable into the limit switch. Connect the cable wires and the jumper wire to the correct terminals in the limit switch (see View C).
   - c. Install and tighten the cable restraint connector (10) to the limit switch.
   - d. Install the limit switch cover.
2. Using the screws (7), install the limit switch.

Adjustment

NOTE: The limit switch (8) must stop the drum (4) when a minimum of three to four wraps of rope remain on the first layer.

1. Adjust the limit switch as follows.
   - a. Make sure the rollers (2) contact the drum (see Views A and D).
   - b. Turn the adjusting screw (6) until the 44 mm (1.7 in) dimension (see View B) is obtained.
   - c. Tighten the jam nut (5) against the mounting tab (11) to lock the adjusting screw.
   - d. Spool several wraps of wire rope onto the drum, then pay out the wire rope. The drum must stop with three to four wraps of wire rope remaining on the first layer.
   - e. Repeat the adjustment procedure if necessary.
2. Make sure the return springs (12) have sufficient tension to hold the rollers firmly against the drum.

   If necessary, adjust spring tension as follows.
   - a. Adjust the eyebolt (13) of each spring to the 35 mm (1.4 in) dimension (see View D).
   - b. Tighten the two eyebolt jam nuts (14) to lock adjustment.
3. Adjust the lever kickstand as follows.

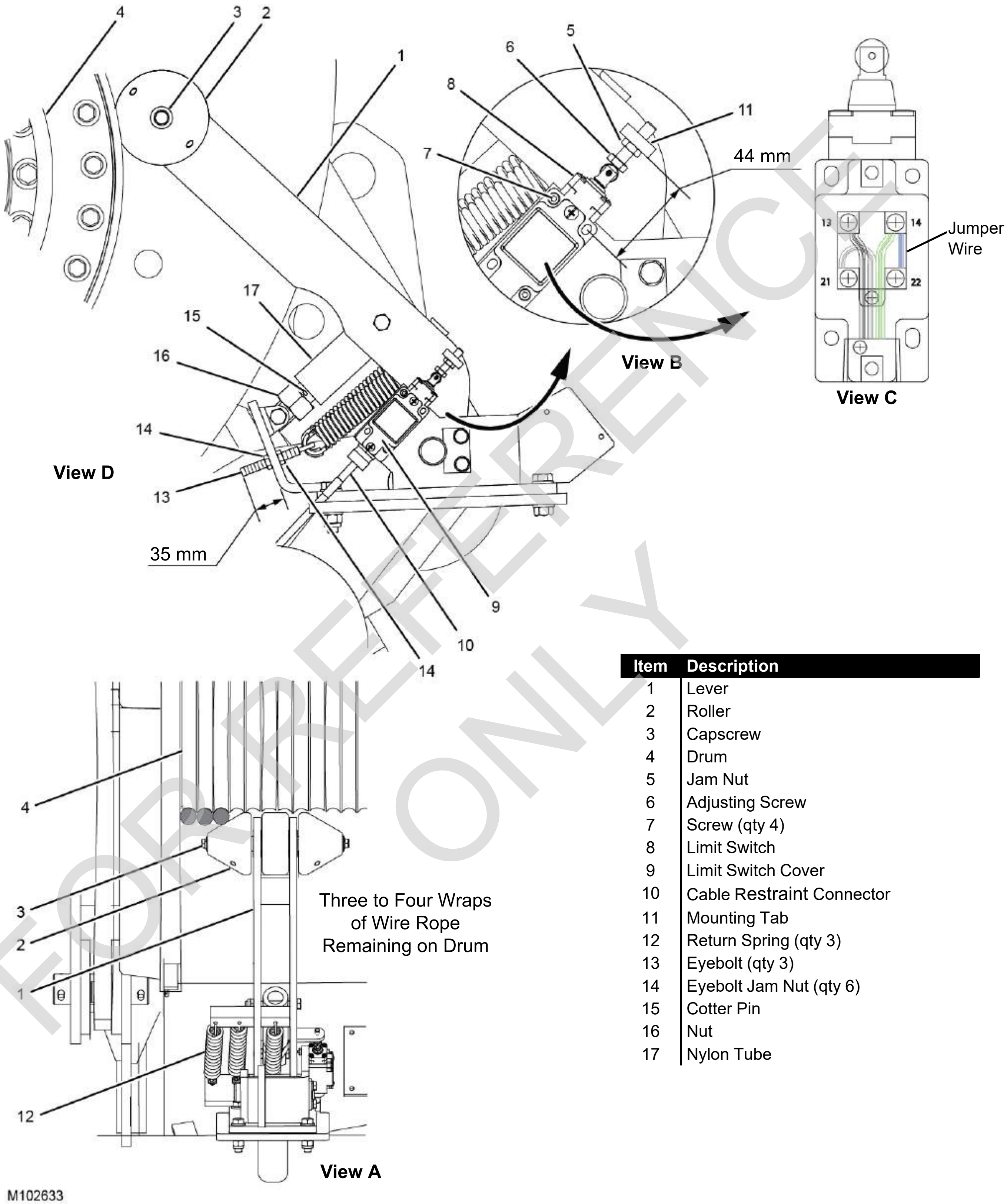
NOTE: Use the following steps when removing and installing the lever assembly.

   - a. To overcome the spring pressure when removing the lever assembly, remove the cotter pin (15) and tighten the nut (16) against the nylon tube (17) until the lever is locked in a secure position.
   - b. When the lever assembly is installed, make sure that the cotter pin is installed with the nut in the locked position (see View D).

Weekly Maintenance

1. Check the limit switch (8) for correct operation. Pay out the wire rope from the drum. The drum must stop with approximately three to four wraps of wire rope remaining on the first layer.
2. Make sure the capscrews (3) holding rollers on the lever shaft are tight.
3. Make sure the return springs (12) have sufficient tension to hold the bail limit rollers against the bare drum. To increase the spring tension, adjust the eyebolt (13) of each spring as needed.

FOR REFERENCE ONLY



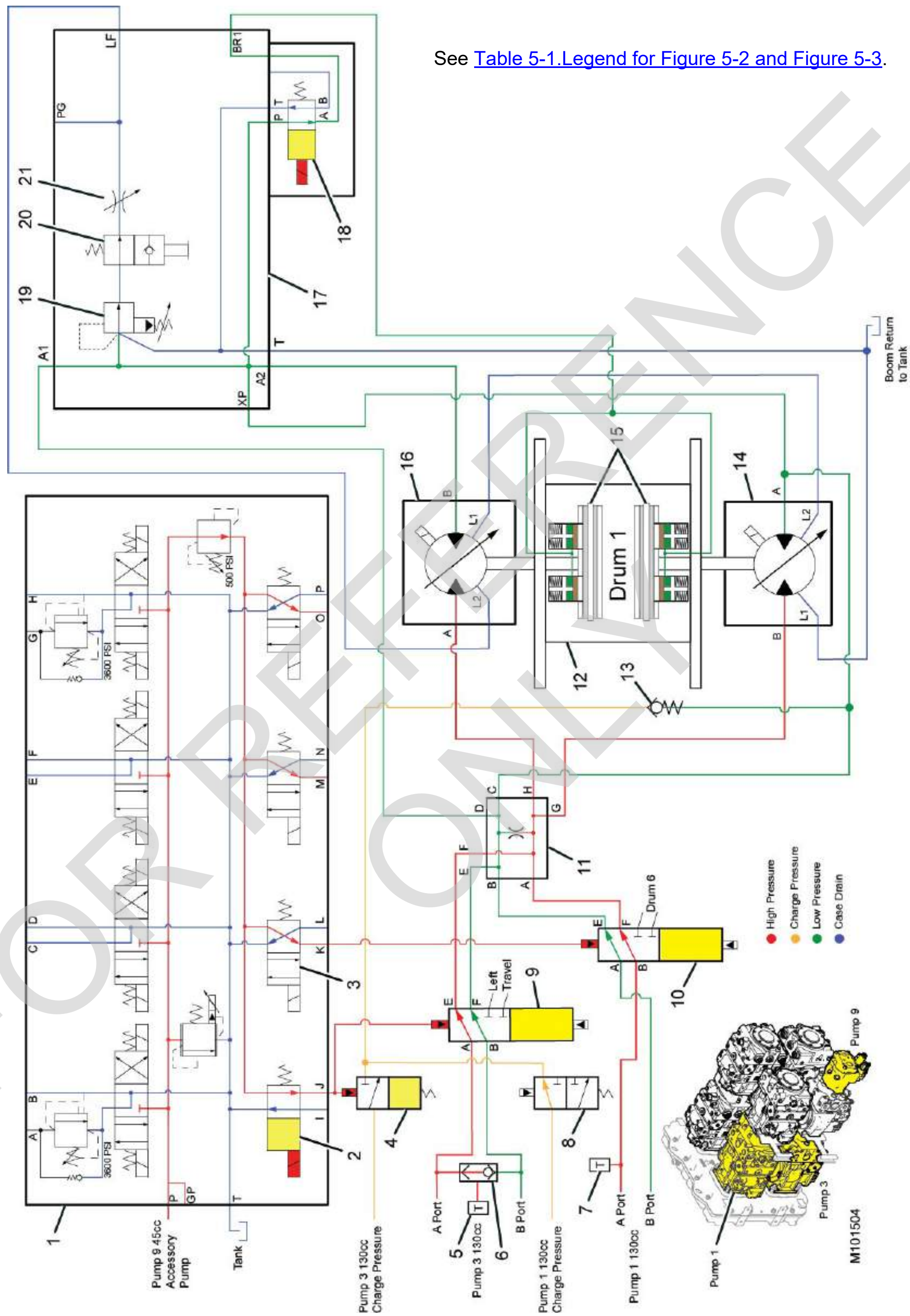
Item	Description
1	Lever
2	Roller
3	Capscrew
4	Drum
5	Jam Nut
6	Adjusting Screw
7	Screw (qty 4)
8	Limit Switch
9	Limit Switch Cover
10	Cable Restraint Connector
11	Mounting Tab
12	Return Spring (qty 3)
13	Eyebolt (qty 3)
14	Eyebolt Jam Nut (qty 6)
15	Cotter Pin
16	Nut
17	Nylon Tube

FIGURE 5-1

FOR REFERENCE ONLY

Drum 1 Hoisting Hydraulic Schematic

See Table 5-1.Legend for Figure 5-2 and Figure 5-3.

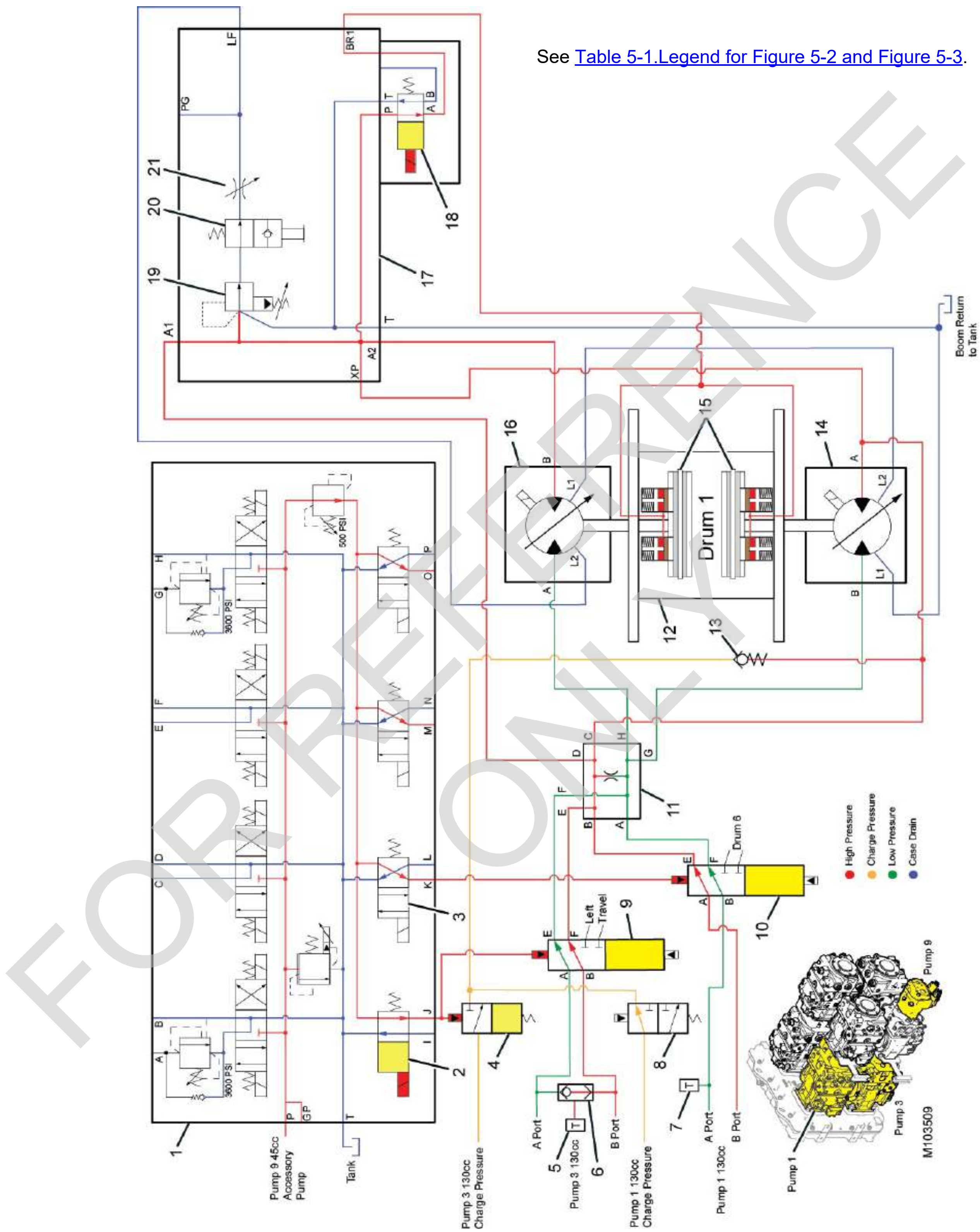


FOR REFERENCE ONLY

FIGURE 5-2

Drum 1 Lowering Hydraulic Schematic

See Table 5-1.Legend for Figure 5-2 and Figure 5-3.



FOR REFERENCE ONLY

FIGURE 5-3

5

Table 5-1. Legend for Figure 5-2 and Figure 5-3

Item	Description
1	Accessory Valve Manifold
2	Left Travel/Drum 1 Selector Solenoid Valve
3	Drum 1/Drum 6 Selector Solenoid Valve
4	Pump 3 Charge Pressure Diverter Valve (directional control)
5	Pump 3 Pressure Transducer (left track psi)
6	Shuttle Valve
7	Pump 1 Pressure Transducer (drum 1 psi)
8	Pump 1 Charge Pressure Diverter Valve (directional control)
9	Left Travel/Drum 1 Diverter Valve (directional control)
10	Drum 1/Drum 6 Diverter Valve (directional control)
11	Double Manifold (for diverter control)
12	Drum Hoist Gearbox and Brake Assembly
13	Charge Pressure Check Valve (1,7 bar [25 psi])
14	Drum 1 Left Hydraulic Motor (variable 160 cc)
15	Drum 1 Brake Pressurized (disengaged)
16	Drum 1 Right Hydraulic Motor (variable 160 cc)
17	Loop Flushing Valve (6 GPM @ 200 psi)
18	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
19	Pilot-Operated Sequence Valve (balanced piston)
20	Manually Operated Service Valve (2-position 2-way poppet control)
21	Flow Control Valve (6 GPM @ 200 psi)

FOR REFERENCE ONLY

Drum 1 Electrical Schematic

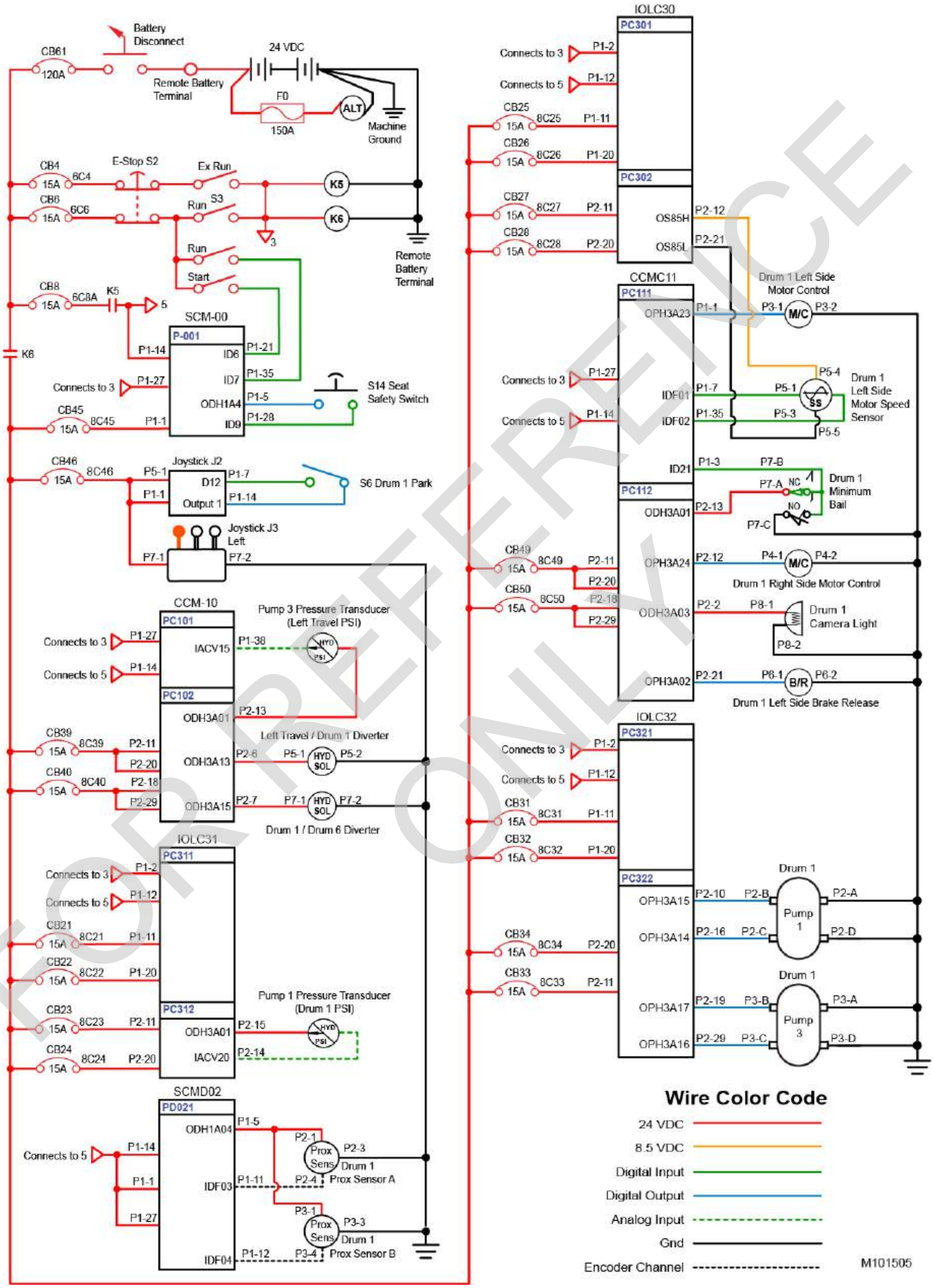


FIGURE 5-4

5

DRUM 2 MAIN HOIST

Drum 2 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch. The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10,5 bar (153 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

During lowering operation, the main hydraulic flow from pumps 2 and/or 4 is supplied to the drum 2 brake release solenoid valve.

During hoisting operation, the charge pump flow from pumps 2 and/or 4 is supplied to the drum 2 brake release solenoid valve.

Drum 2 Brake Operation

See Figure 5-6 and Figure 5-8 for the following.

The J2 joystick sends a 24 V_{DC} output to the drum 2 park switch. The park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the CCMC11 control module via the controller area network bus (CAN Bus).

In the default state, the right travel/drum 2 selector solenoid valve (11) and the drum 2/drum 3 selector solenoid valve (12), located in the accessory valve manifold (1), are de-energized. The drum 3 park switch must be in the ON position for this to occur.

With the selector solenoid valves (11 and 12) de-energized, the pumps 2 and 4 charge pressure diverter valves (2 and 6) are in the default position, allowing charge pressure from pumps 2 and 4 to be present at the drum brake release solenoid valve (18).

During drum 1 operation, the CCM-10 control module energizes the right travel/drum 2 selector solenoid valve. The right travel park switch must be in the ON position for this to occur.

When energized, the solenoid valve routes hydraulic fluid to the pilot control of the right travel/drum 2 diverter valve (5) and the pump 4 charge pressure diverter valve (2). The diverter valves shift position, allowing the pump 4 main hydraulic pressure to be present at the brake release solenoid valve and the pump 4 charge pressure present at the charge pressure check valve (10).

If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing charge pressure fluid from pumps 2 and 4 to flow to the brake release solenoid valve.

When the CCMC11 control module receives the un-park command from the J2 joystick, the CCMC11 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake cylinder, releasing the brake.

When the brake switch is moved to the ON-PARK position, the park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the CCMC11 control module via the CAN Bus.

When the CCMC11 control module receives the on-park command from the J2 joystick, the CCMC11 control module sends a 0 V_{DC} output voltage to the drum brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the fluid in the brake cylinder to flow through the drum brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

FOR REFERENCE ONLY

Drum 2 Motor Loop Flushing

See Figure 5-6 and Figure 5-7 for the following.

Loop flushing of the right and left hydraulic motors (14 and 16) occurs whenever pressure on the lowering side of the circuit is above 13,8 bar (200 psi). The charge pressure check valve (10) only allows flow from the charge pump(s) to the lowering side of the circuit if the charge pressure is 1,7 bar (25 psi) or higher than the lowering side of the circuit.

Drum 2 Hoisting Operation

See Figure 5-6 and Figure 5-8 for the following.

To enable the drum 2 pumps and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 2 park switch in the OFF position

NOTE: For the following operation, the drum 3 park switch and/or right travel park switch are in the ON position.

In the default state, the CCM-10 control module de-energizes the drum 2/drum 3 selector solenoid valve (12), located in the accessory valve manifold (1). The de-energized solenoid valve routes hydraulic fluid to the pilot control of drum 2/drum 3 diverter valve (8). The diverter valve shifts to the default position, allowing main hydraulic fluid from the pump 2 to flow to the double manifold (9), then to the left and right hydraulic motors (14 and 16).

During the drum 2 hoisting operation when the drum 3 park switch and/or right travel park switch are in the ON position, the CCM-10 control module energizes the right travel/drum 2 selector solenoid valve (11), located in the accessory valve manifold.

The energized solenoid valve routes hydraulic fluid to the pilot control of the right travel/drum 2 diverter valve (5). The diverter valve shifts position, allowing the main hydraulic fluid from pump 4 to flow to the double manifold where it combines with the fluid from pump 2. The combined fluid then flows to the left and right hydraulic motors.

Hydraulic fluid from the right travel/drum 2 selector solenoid valve also flows to the pilot control of the pump 4 charge pressure diverter valve (2), causing the valve to shift. When in this position, charge pressure from pump 4 is present at the charge pressure check valve (10). If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing the pumps 2 and 4 charge pressure hydraulic fluid to flow into the main pressure circuit as makeup oil.

During the drum 2 hoisting operation, the CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoids of pumps 2 and/or 4 electronic displacement controls (EDCs). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump(s). From the pump(s), the flow is routed through the diverter valves (5 and 8), the double manifold (9), and then into the B-side of the right hydraulic motor (16) and the A-side of the left hydraulic motor (14).

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 2 motor speed sensor, pump 2 pressure transducer (drum 3 psi) (7), and pump 4 pressure transducer (R-travel psi) (3) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows, while maintaining the speeds commanded by the joystick input.

FOR REFERENCE ONLY

Drum 2 Lowering Operation

See Figure 5-7 and Figure 5-8 for the following.

To enable the drum 2 pumps and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 2 park switch in the OFF position

NOTE: For the following operation, the drum 3 park switch and/or right travel park switch are in the ON position.

In the default state, the CCM-10 control module de-energizes the drum 2/drum 3 selector solenoid valve (12), located in the accessory valve manifold (1). The de-energized solenoid valve routes hydraulic fluid to the pilot control of drum 2/drum 3 diverter valve (8). The diverter valve shifts to the default position, allowing main hydraulic fluid from the pump 2 to flow to the double manifold (9), then to the left and right hydraulic motors (14 and 16).

During the drum 2 lowering operation when the drum 3 park switch and/or right travel park switch are in the ON position, the CCM-10 control module energizes the right travel/drum 2 selector solenoid valve (11), located in the accessory valve manifold. The energized solenoid valve routes hydraulic fluid to the pilot control of the right travel/drum 2 diverter valve (5). The diverter valve shifts position, allowing the main hydraulic fluid from pump 4 to flow to the double manifold where it combines with the fluid from pump 2. The combined fluid then flows to the left and right hydraulic motors.

Hydraulic fluid from the right travel/drum 2 selector solenoid valve also flows to the pilot control of the pump 4 charge pressure diverter valve (2), causing the valve to shift. When in this position, charge pressure from pump 4 is present at the charge pressure check valve (10). If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing the pumps 2 and 4 charge pressure hydraulic fluid to flow into the main pressure circuit as makeup oil.

During the drum 2 lowering operation, the CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoids of pumps 2 and/or 4 EDCs. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump(s). From the pump(s), the flow is routed through the diverter valves (5 and 8), the double manifold (9), and then into the A-side of the right hydraulic motor (16) and the B-side of the left hydraulic motor (14).

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor flow until the rotational speed is maximized based on the pump flow.

The drum 2 motor speed sensor, pump 2 pressure transducer (drum 3 psi) (7), and pump 4 pressure transducer (R-travel psi) (3) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows, while maintaining the speeds commanded by the joystick input.

FOR REFERENCE ONLY

Drum 2 Minimum Bail Limit

The optional minimum bail limit assembly on drum 2 is a protective device which limits how much wire rope can be spooled off the drum.

The minimum bail limit automatically stops the drum when there are three to four wraps of wire rope remaining on the first layer.

When the limit is reached, the operating limit fault is activated and the fault icon appears in the fault bar of the main display working screen.

NOTE: The drum can be operated in the hoist direction when the minimum bail limit switch is contacted.

Field adjustment should not be necessary unless a new limit switch is installed.

⚠ WARNING

Falling Load Hazard!

Avoid possible injury. Do not operate the drum with less than three or four full wraps of wire rope remaining on the drum. Doing so can cause the wire rope to be pulled out of the drum and the load to fall.

See Figure 5-5 for the following instructions.

Limit Switch Replacement

Removal

1. Land the load from the drum being adjusted.
2. Lockout-tagout the crane.
3. Remove the screws (7) and the limit switch (8).
4. Remove the limit switch cover (9).
5. Disconnect the electrical wires, including the jumper wire, inside the limit switch (see View C).
6. Remove the cable restraint connector (10) and carefully pull the electrical cable and wires from the limit switch.

Installation

1. Connect the electrical wires to the new limit switch as follows.
   - a. Remove the limit switch cover (9).
   - b. Insert the wires of the electrical cable into the limit switch. Connect the cable wires and the jumper wire to the correct terminals in the limit switch (see View C).
   - c. Install and tighten the cable restraint connector (10) to the limit switch.
   - d. Install the limit switch cover.
2. Using the screws (7), install the limit switch.

Adjustment

NOTE: The limit switch (8) must stop the drum (4) when a minimum of three to four wraps of rope remain on the first layer.

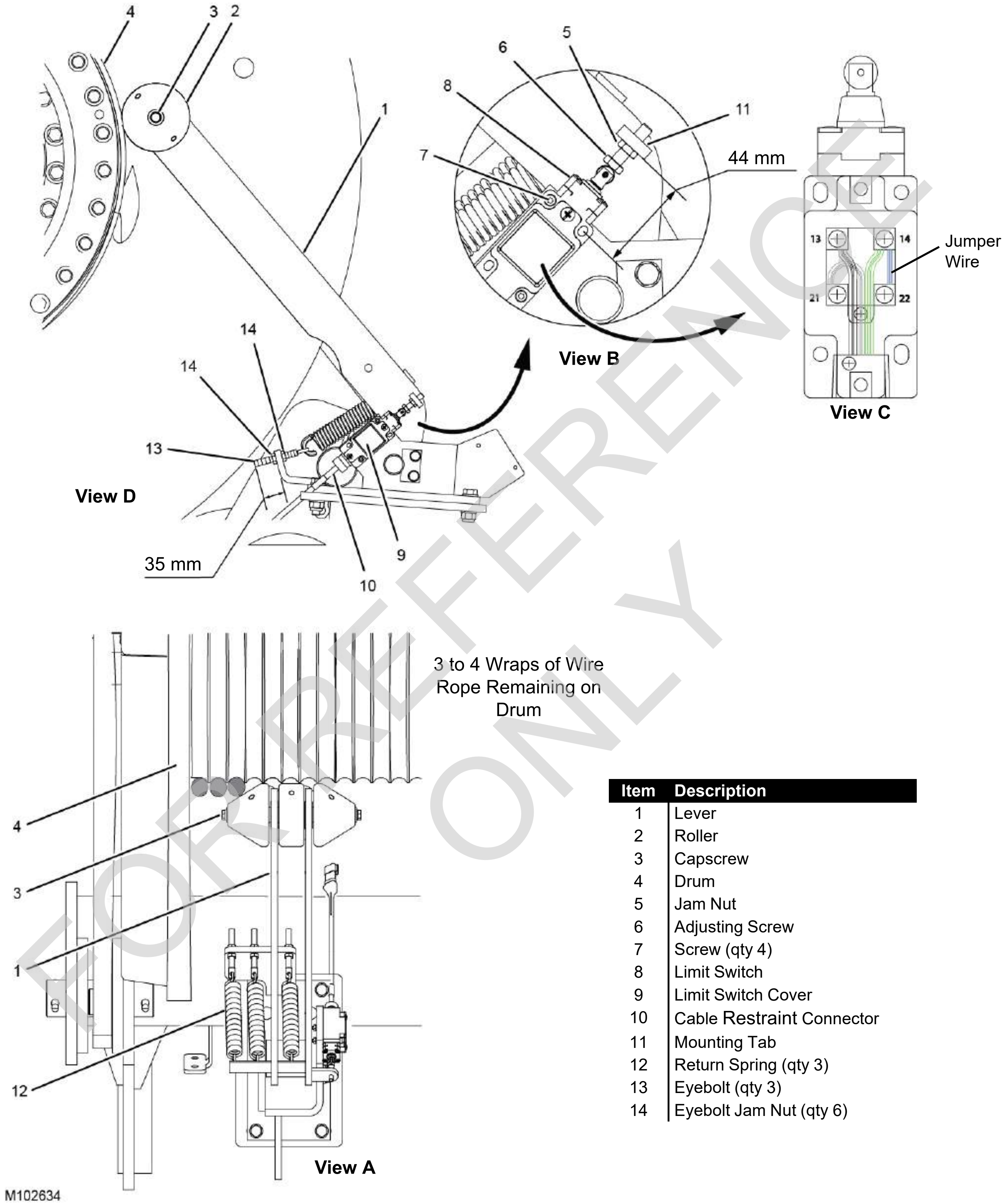
1. Adjust the limit switch as follows.
   - a. Make sure the rollers (2) contact the drum (see Views A and D).
   - b. Turn the adjusting screw (6) until the 44 mm (1.7 in) dimension (see View B) is obtained.
   - c. Tighten the jam nut (5) against the mounting tab (11) to lock the adjusting screw.
   - d. Spool several wraps of wire rope onto the drum, then pay out the wire rope. The drum must stop with three to four wraps of wire rope remaining on the first layer.
   - e. Repeat the adjustment procedure if necessary.
2. Make sure the return springs (12) have sufficient tension to hold the rollers firmly against the drum.

   If necessary, adjust spring tension as follows.
   - a. Adjust the eyebolt (13) of each spring to the 35 mm (1.4 in) dimension (see View D).
   - b. Tighten the two eyebolt jam nuts (14) to lock adjustment.

Weekly Maintenance

1. Check the limit switch (8) for correct operation. Pay out the wire rope from the drum. The drum must stop with approximately three to four wraps of wire rope remaining on the first layer.
2. Make sure the capscrews (3) holding rollers on the lever shaft are tight.
3. Make sure the return springs (12) have sufficient tension to hold the bail limit rollers against the bare drum. To increase the spring tension, adjust the eyebolt (13) of each spring as needed.

FOR REFERENCE ONLY



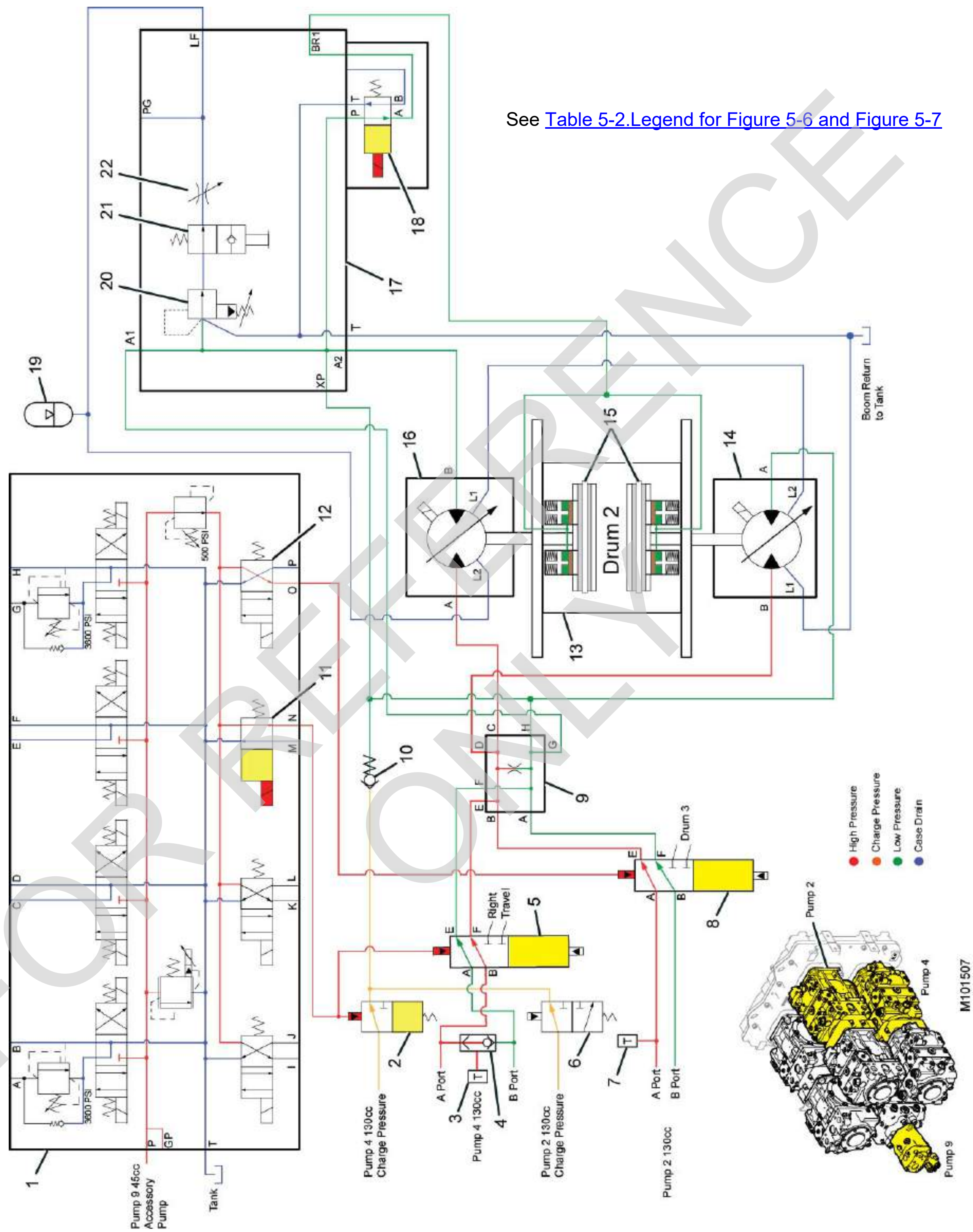
Item	Description
1	Lever
2	Roller
3	Capscrew
4	Drum
5	Jam Nut
6	Adjusting Screw
7	Screw (qty 4)
8	Limit Switch
9	Limit Switch Cover
10	Cable Restraint Connector
11	Mounting Tab
12	Return Spring (qty 3)
13	Eyebolt (qty 3)
14	Eyebolt Jam Nut (qty 6)

FIGURE 5-5

FOR REFERENCE ONLY

Drum 2 Hoisting Hydraulic Schematic

See Table 5-2.Legend for Figure 5-6 and Figure 5-7

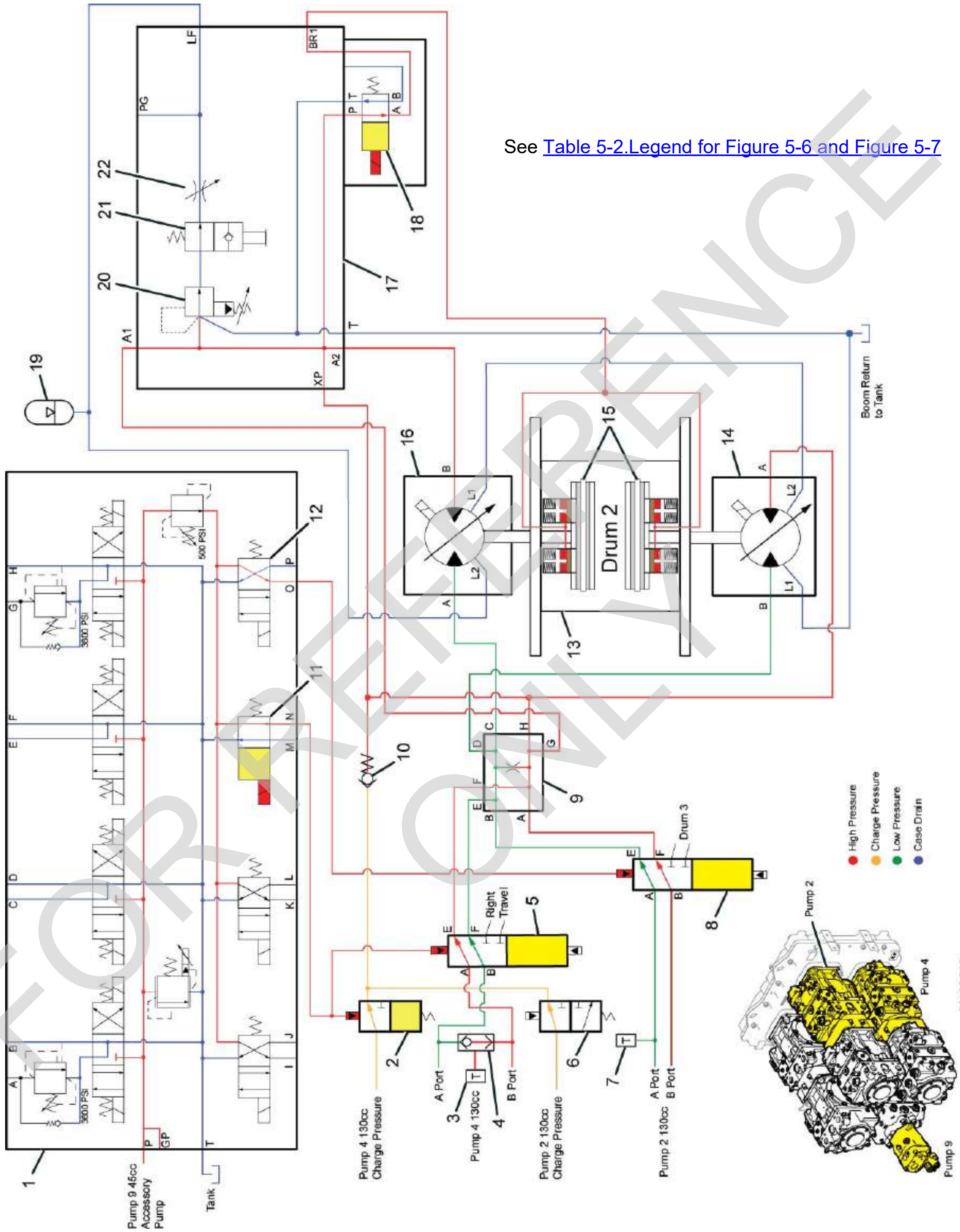


FOR REFERENCE ONLY

FIGURE 5-6

Drum 2 Lowering Hydraulic Schematic

See Table 5-2.Legend for Figure 5-6 and Figure 5-7



FOR REFERENCE ONLY

FIGURE 5-7

Table 5-2. Legend for Figure 5-6 and Figure 5-7

Item	Description
1	Accessory Valve Manifold
2	Pump 4 Charge Pressure Diverter Valve (directional control)
3	Pump 4 Pressure Transducer (right travel psi)
4	Shuttle Valve
5	Right Travel/Drum 2 Diverter Valve (directional control)
6	Pump 2 Charge Pressure Diverter Valve (directional control)
7	Pump 2 Pressure Transducer (drum 3 psi)
8	Drum 2/Drum 3 Diverter Valve (directional control)
9	Double Manifold for Diverter Control
10	Charge Pressure Check Valve (1,7 bar [25 psi])
11	Right Travel/Drum 2 Selector Solenoid Valve
12	Drum 2/Drum 3 Selector Solenoid Valve
13	Drum Hoist Gearbox and Brake Assembly
14	Drum 2 Left Hydraulic Motor (variable 160 cc)
15	Drum 2 Brake Pressurized (disengaged)
16	Drum 2 Right Hydraulic Motor (variable 160 cc)
17	Loop Flushing Valve (6 GPM @ 200 psi)
18	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
19	Accumulator
20	Pilot-Operated Sequence Valve (balanced piston)
21	Manually Operated Service Valve (2-position 2-way poppet control)
22	Flow Control Valve (6 GPM @ 200 psi)

FOR REFERENCE ONLY

Drum 2 Electrical Schematic

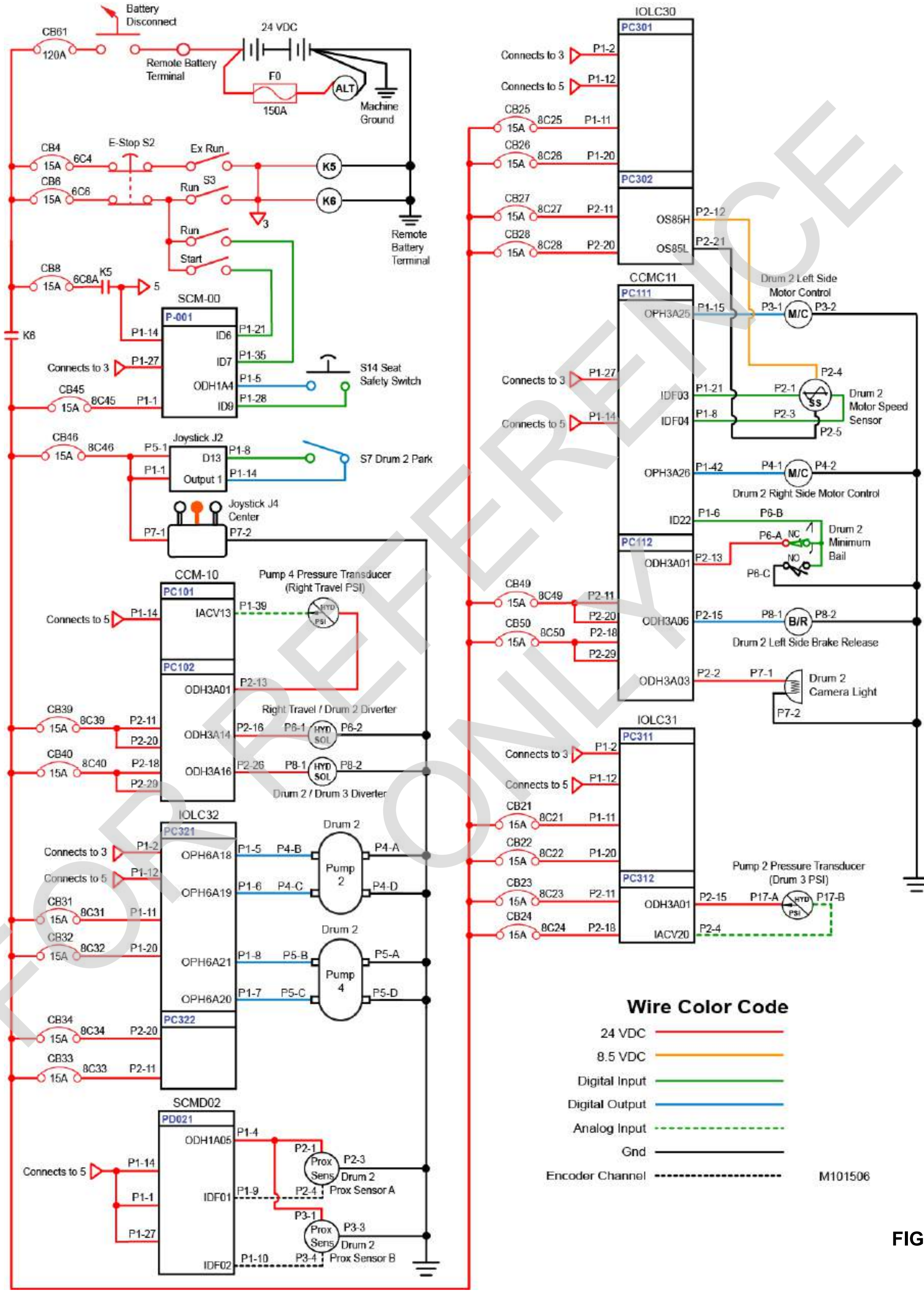


FIGURE 5-8

FOR REFERENCE ONLY

DRUM 3 WHIP HOIST

Drum 3 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch. The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10,5 bar (153 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

Hydraulic flow to the drum 3 brake release solenoid valve is provided by the main and charge pressure hydraulic flow from pump 2.

Drum 3 Brake Operation

See Figure 5-10 for the following.

The J2 joystick sends a 24 V_{DC} output to the drum 3 park switch. The park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the IOLC30 control module via the controller area network bus (CAN Bus).

During drum 3 operation, the CCM-10 control module energizes the drum 2/drum 3 selector solenoid valve (14), located in the accessory valve manifold (1).

When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the drum 2/drum 3 diverter valve (4) and the pump 2 charge pressure diverter valve (2). The diverter valves shift position, allowing the pump 2 main hydraulic pressure to be present at the brake release solenoid valve (12) and the pump 2 charge pressure present at the charge pressure check valve (5).

If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing the pump 2 charge pressure fluid to flow to the brake release solenoid valve.

When the IOLC30 control module receives the un-park command from the J2 joystick, the IOLC30 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the drum brake piston, releasing the brake.

When the drum brake switch is moved to the ON-PARK position, the drum park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the IOLC30 control module via the CAN Bus.

When the IOLC30 control module receives the on-park command from the J2 joystick, the IOLC30 control module sends a 0 V_{DC} output voltage to the drum brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the fluid in the brake piston to flow through the drum brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

Drum 3 Motor Loop Flushing

See Figure 5-10 and Figure 5-11 for the following.

Loop flushing of the drum 3 hydraulic motor (7) occurs whenever the drum 2/drum 3 diverter valve (4) is energized. The loop flush circuit receives flow from two sources:

- Main pump flow when the motor is being driven
- Charge pump flow when the main pump pressure is reduced

The charge pressure check valve (5) only allows flow from the charge pump when the main pump pressure is more than 0,35 bar (5 psi) lower than the charge pressure.

FOR REFERENCE ONLY

Drum 3 Hoisting Operation

See Figure 5-10 and Figure 5-12 for the following.

To enable the control system to drive the drum 3 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 3 park switch in the OFF position

NOTE: For the following operation, the drum 2 park switch and/or right travel park switch are in the ON position.

During the drum 3 operation, the CCM-10 energizes the drum 2/drum 3 selector solenoid valve (14), located in the accessory valve manifold (1). When energized, the solenoid valve routes hydraulic fluid to the pilot control of the drum 2/drum 3 diverter valve (4). The diverter valve shifts position, allowing main hydraulic fluid from pump 2 to flow to the drum 3 hydraulic motor (7).

Hydraulic fluid from the drum 2/drum 3 selector solenoid valve also flows to the pilot control of the pump 2 charge pressure diverter valve (2), causing the valve to shift. When in this position, charge pressure from pump 2 is present at the charge pressure check valve (5).

If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing charge pressure fluid from pump 2 to flow to the drum 3 hydraulic motor.

When the designated drum 3 joystick is moved to the hoisting position, the CCM-10 control module sends a signal to the IOLC32 control module via the controller area network bus (CAN Bus) to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoid of pump 2 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, the hydraulic flow is routed through the drum 2/drum 3 diverter valve (4), and then into the A-side of the drum 3 hydraulic motor (7).

The CCM-10 control module sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 3 motor control solenoid. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor speed until the rotational speed is maximized based on the pump flow

The drum 3 motor speed sensor and pump 2 pressure transducer (drum 3 psi) (3) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speed commanded by the joystick input.

Drum 3 Lowering Operation

See Figure 5-11 and Figure 5-12 for the following.

To enable the control system to drive the drum 3 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 3 park switch in the OFF position

NOTE: For the following operation, the drum 2 park switch and/or right travel park switch are in the ON position.

During the drum 3 operation, the CCM-10 energizes the drum 2/drum 3 selector solenoid valve (14), located in the accessory valve manifold (1). When energized, the solenoid valve routes hydraulic fluid to the pilot control of the drum 2/drum 3 diverter valve (4). The diverter valve shifts position, allowing main hydraulic fluid from pump 2 to flow to the drum 3 hydraulic motor (7).

Hydraulic fluid from the drum 2/drum 3 selector solenoid valve also flows to the pilot control of the pump 2 charge pressure diverter valve (2), causing the valve to shift. When in this position, charge pressure from pump 2 is present at the charge pressure check valve (5).

If the main pump pressure drops to less than 0,35 bar (5 psi) of the charge pressure, the check valve opens, allowing charge pressure fluid from pump 2 to flow to the drum 3 hydraulic motor.

When the designated drum 3 joystick is moved to the lowering position, the CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoid of pump 2 EDC. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, the hydraulic flow is routed through the drum 2/drum 3 diverter valve (4), and then into the B-side of the drum 3 hydraulic motor (7).

The CCM-10 control module sends a signal to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 3 motor control solenoid. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 3 motor speed sensor and pump 2 pressure transducer (drum 3 psi) (3) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speed commanded by the joystick input.

FOR REFERENCE ONLY

Drum 3 Minimum Bail Limit

See Figure 5-9 for the following instructions.

The optional minimum bail limit assembly on drum 3 is a protective device that limits how much wire rope can be spooled off the drum.

The minimum bail limit automatically stops the drum when there are three to four wraps of wire rope remaining on the first layer.

When the limit is reached, the operating limit fault is activated and the fault icon appears in the fault bar of the main display working screen.

NOTE: The drum can be operated in the hoist direction when the minimum bail limit switch is contacted.

Field adjustment should not be necessary unless a new limit switch is installed.

WARNING

Falling Load Hazard!

Avoid possible injury. Do not operate the drum with less than three or four full wraps of wire rope remaining on the drum. Doing so can cause the wire rope to be pulled out of the drum and the load to fall.

Lowering Limit Switch Replacement

Removal

1. Land the load from the drum being adjusted.
2. Lockout-tagout the crane.
3. Remove the fasteners (3) and remove the switch cover (2).
4. Remove the cable restraint connector (4) and carefully pull the electrical wires from the limit switch assembly (1).
5. Remove capscrews (5), washers (6), and the limit switch assembly.

Installation

1. Connect the electrical wires to the new switch as follows.
   a. Remove the switch cover (2).
   b. Connect the electrical wires and tighten the cable restraint connector (4) onto the switch cover.
   c. Install the switch cover.
2. Using capscrews (5) and washers (6), install the limit switch assembly (1).

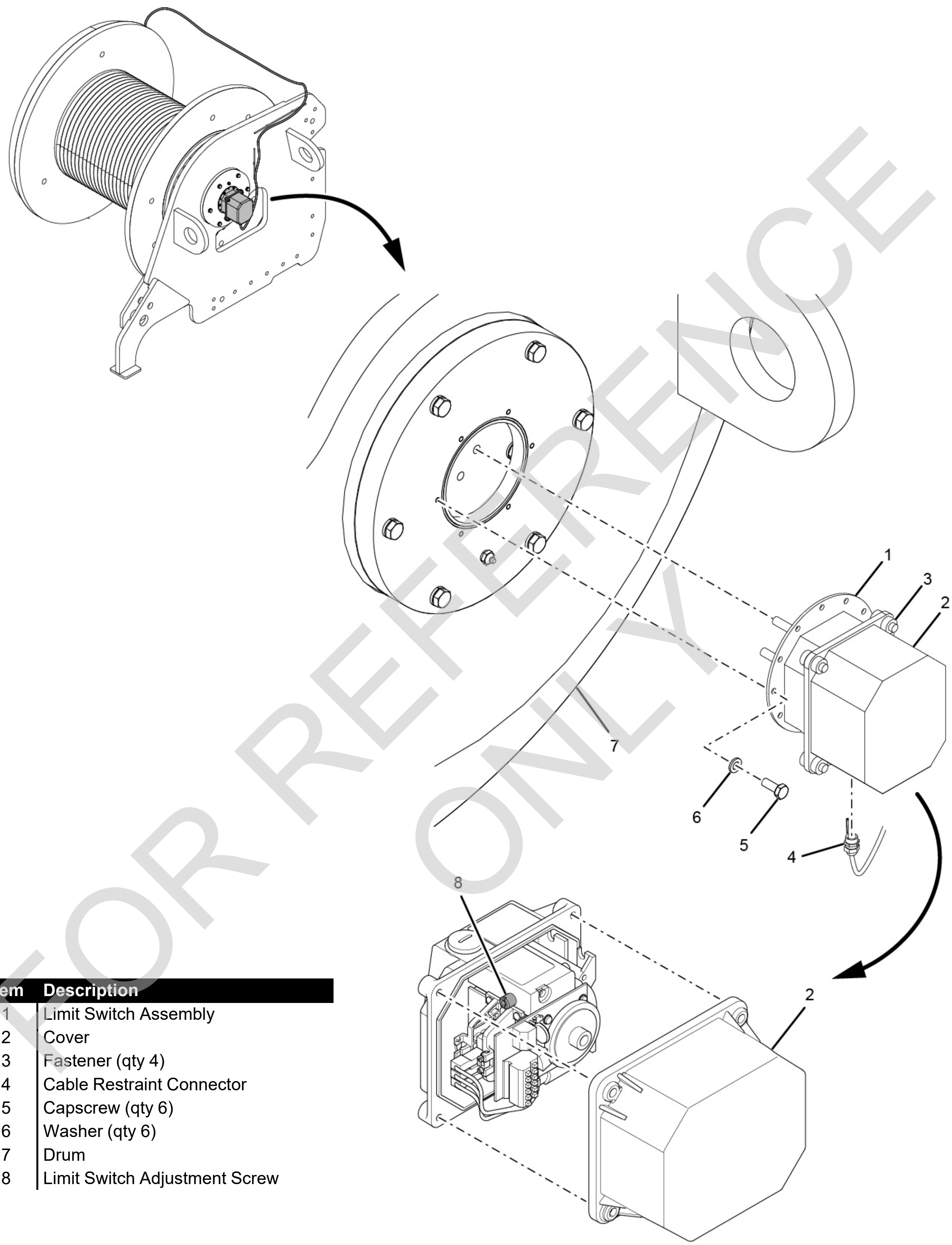
Adjustment

1. Adjust the rope so that there are three wraps on the first layer of the drum (7).
2. Remove the cover (2) from the limit switch assembly.
3. Turn the limit switch adjustment screw (8) until the switch activates.
4. Confirm the indication on the appropriate cab display.
5. Spool the rope on the drum (7) until there are ten wraps on the first layer.
6. Spool the rope off the drum to verify the lowering limit switch activates with three to four wraps on the first layer. Adjust the switch, if necessary. Install the cover.

Weekly Maintenance

1. Check the lowering limit switch for proper operation. Pay out wire rope from the drum. The drum must stop with approximately three to four wraps of wire rope remaining on the first layer.
2. Make sure that all electrical cable connections are secure and undamaged.
3. Make sure that the capscrews holding the limit switch assembly are tight.

FOR REFERENCE ONLY

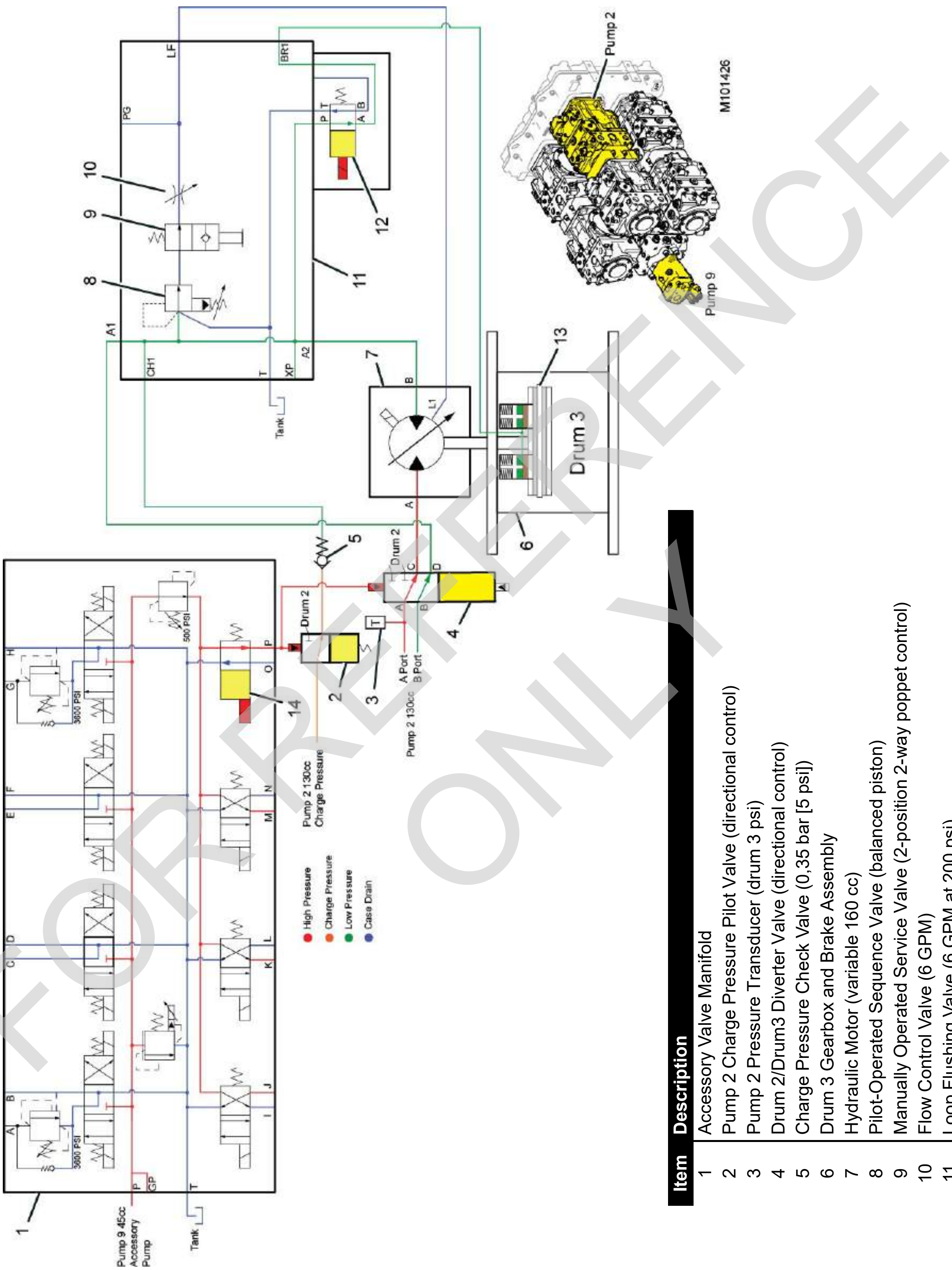


Item	Description
1	Limit Switch Assembly
2	Cover
3	Fastener (qty 4)
4	Cable Restraint Connector
5	Capscrew (qty 6)
6	Washer (qty 6)
7	Drum
8	Limit Switch Adjustment Screw

FIGURE 5-9

FOR REFERENCE ONLY

Drum 3 Hoisting Hydraulic Schematic

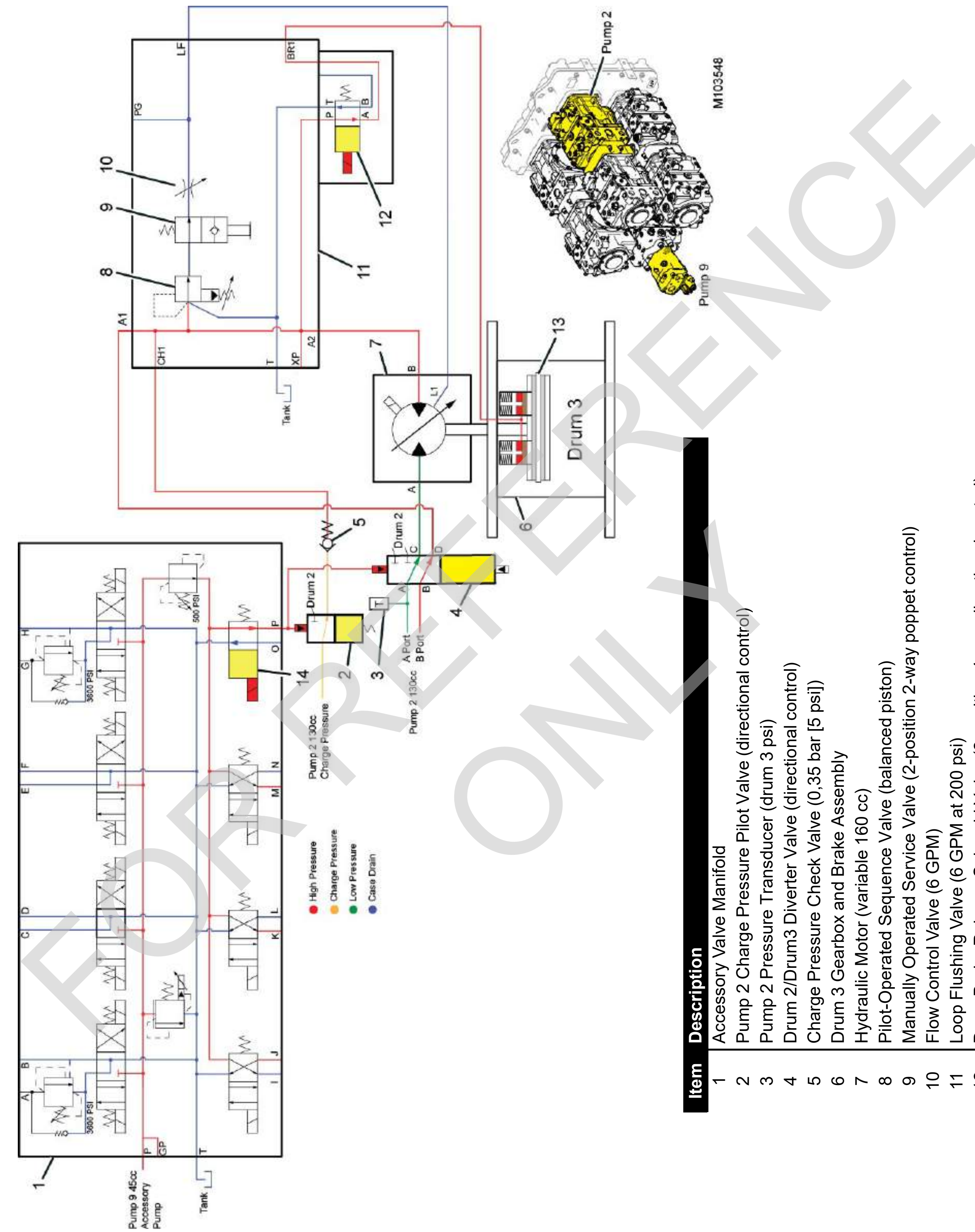


Item	Description
1	Accessory Valve Manifold
2	Pump 2 Charge Pressure Pilot Valve (directional control)
3	Pump 2 Pressure Transducer (drum 3 psi)
4	Drum 2/Drum3 Diverter Valve (directional control)
5	Charge Pressure Check Valve (0,35 bar [5 psi])
6	Drum 3 Gearbox and Brake Assembly
7	Hydraulic Motor (variable 160 cc)
8	Pilot-Operated Sequence Valve (balanced piston)
9	Manually Operated Service Valve (2-position 2-way poppet control)
10	Flow Control Valve (6 GPM)
11	Loop Flushing Valve (6 GPM at 200 psi)
12	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
13	Drum Brake Pressurized (disengaged)
14	Drum 2/Drum 3 Selector Solenoid Valve

FOR REFERENCE ONLY

FIGURE 5-10

Drum 3 Lowering Hydraulic Schematic

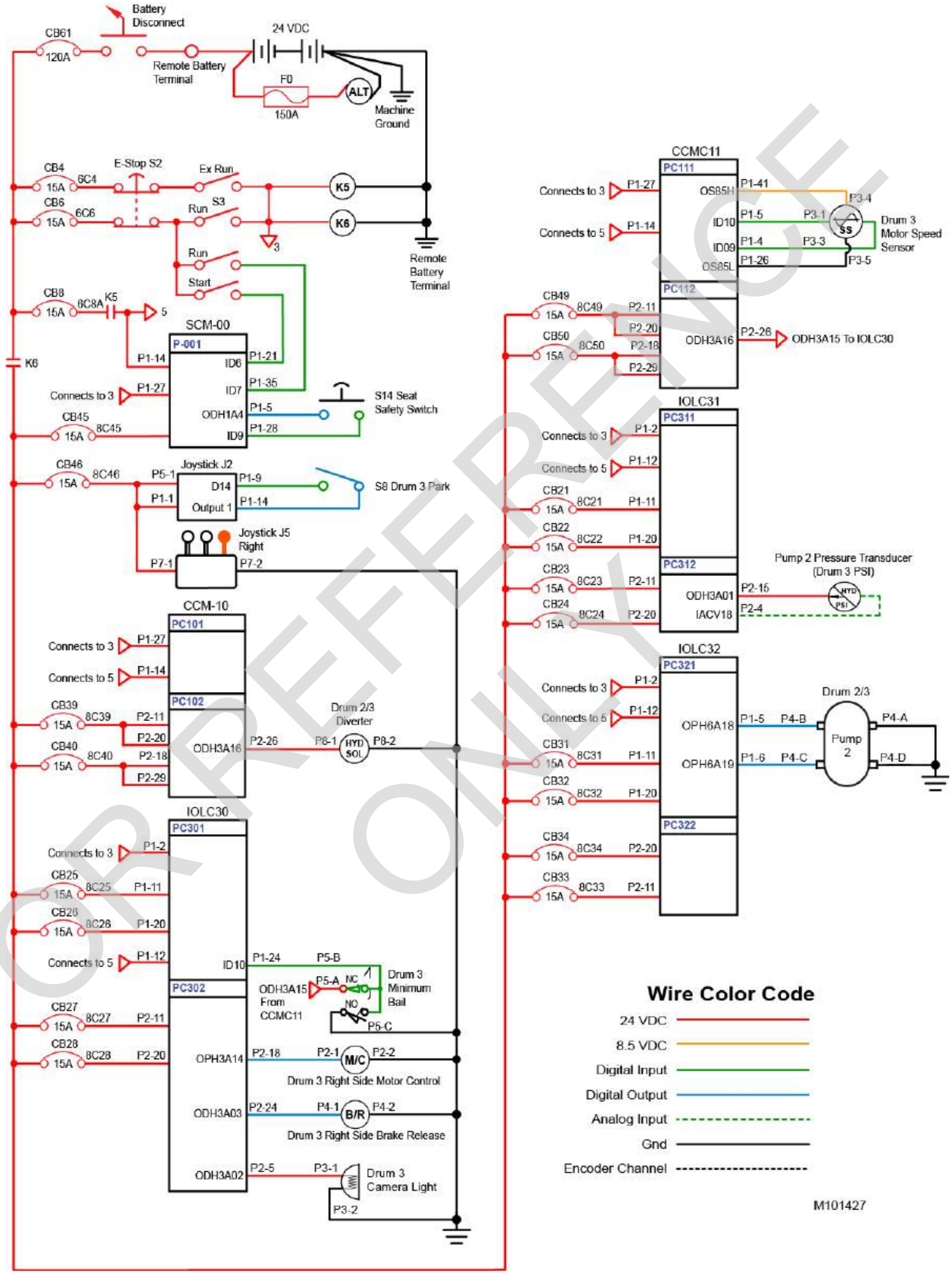


Item	Description
1	Accessory Valve Manifold
2	Pump 2 Charge Pressure Pilot Valve (directional control)
3	Pump 2 Pressure Transducer (drum 3 psi)
4	Drum 2/Drum3 Diverter Valve (directional control)
5	Charge Pressure Check Valve (0,35 bar [5 psi])
6	Drum 3 Gearbox and Brake Assembly
7	Hydraulic Motor (variable 160 cc)
8	Pilot-Operated Sequence Valve (balanced piston)
9	Manually Operated Service Valve (2-position 2-way poppet control)
10	Flow Control Valve (6 GPM)
11	Loop Flushing Valve (6 GPM at 200 psi)
12	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
13	Drum Brake Pressurized (disengaged)
14	Drum 2/Drum 3 Selector Solenoid Valve

FOR REFERENCE ONLY

FIGURE 5-11

Drum 3 Electrical Schematic



FOR REFERENCE ONLY

FIGURE 5-12

5

DRUM 4 BOOM HOIST OR MAST HOIST (VPC-MAX™)

Drum 4 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch.The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering. To accomplish this, the brake pressure must be above 12 bar (175 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

Hydraulic flow to the drum 4 brake release solenoid valve is provided by the main and charge pressure hydraulic flow from pump 5.

Drum 4 Brake Operation

See Figure 5-14 and Figure 5-16.

The J2 joystick sends a 24 V_{DC} output to the drum 4 park switch. The drum park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the IOLC32 control module via the controller area network bus (CAN Bus).

When the IOLC32 control module receives the un-park command from the J2 joystick, IOLC32 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid from the pump 5 to the drum brake piston, releasing the brake.

When the drum brake switch is moved to the ON-PARK position, the drum park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the IOLC32 control module via the CAN Bus.

When the IOLC32 control module receives the on-park command from the J2 joystick, the IOLC32 control module sends a 0 V_{DC} output voltage to the drum brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the fluid in the brake piston to flow through the drum brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

Drum 4 Motor Loop Flushing

See Figure 5-14 and Figure 5-16.

Loop flushing of the drum 4 right and left hydraulic motors (6 and 15) occurs whenever pressure on the lowering side of the circuit is above 13,8 bar (200 psi). The charge pressure check valve (8) only allows flow from the charge pump to the lowering side of the circuit if the charge pressure is 0,35 bar (5 psi) or higher than the lowering side of the circuit.

FOR REFERENCE ONLY

Drum 4 Hoisting Operation

See Figure 5-14 and Figure 5-16.

To enable the control system to drive the drum 4 pump and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 4 park switch in the OFF position

When the drum 4 joystick is moved in the hoist up direction, a signal is sent to the IOLC33 control module via the controller area network bus (CAN Bus) to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoid of the pump 5 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, the flow is routed to the B-side of the right drum motor and the A-side of the left drum motor.

A signal is sent to the IOLC34 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 4 motor speed sensor and pump 5 pressure transducer (drum 4 psi) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speeds commanded by the joystick Input.

Drum 4 Lowering Operation

See Figure 5-15 and Figure 5-16.

To enable the control system to drive the drum 4 pump and motors, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 4 park switch in the OFF position

When the drum 4 joystick is moved in the hoist down direction, a signal is sent to the IOLC33 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoid of the pump 5 EDC. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, the flow is routed to the A-side of the right drum motor and the B-side of the left drum motor.

A signal is sent to the IOLC34 control module via the CAN Bus to ramp up the PWM duty cycle to the left motor and right motor controllers. Increasing the PWM duty cycle decreases the swashplate angle in each motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 4 motor speed sensor and pump 5 pressure transducer (drum 4 psi) provide closed loop feedback to the control modules. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speeds commanded by the joystick input.

FOR REFERENCE ONLY

Drum 4 Pawl Operation

WARNING

Falling Boom Hazard!

Avoid possible injury. Before performing the steps in this section, land the loads and lower the boom onto blocking at ground level. There is no positive means of holding the boom up when the pawl is being serviced.

See Figure 5-14 and Figure 5-16.

The pawl is controlled by the park switch.

When the drum park is turned on to engage the drum pawl, the IOLC32 control module sends a 24 V_{DC} output to the drum 4 pawl-in solenoid valve, energizing the solenoid. The solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the rod end of the pawl cylinder. The cylinder rod retracts, moving the drum pawl to the engaged position.

When the drum park is turned off to disengage the drum pawl, the IOLC32 control module sends a 24 V_{DC} output to the drum 4 pawl-out solenoid valve, energizing the solenoid. The solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the tube end of the pawl cylinder. The cylinder rod extends, moving the drum pawl to the disengaged position.

When the control system is not powered, the drum pawl solenoid valve moves to the center position, allowing hydraulic fluid at both ends of the pawl cylinder to return to the tank. Spring force holds the pawl in the engaged position.

Drum 4 Pawl Limit Switch

WARNING

Falling Boom Hazard!

Avoid possible injury. Before performing the steps in this section, land the loads and lower the boom onto blocking at ground level. There is no positive means of holding the boom up when the pawl is being serviced.

See Figure 5-13 for the following procedures.

Limit Switch Replacement

Field adjustment should not be necessary unless a new limit switch is installed.

Removal

1. Land the load from the drum being adjusted.
2. Lockout-tagout the crane.
3. Remove the screws (5) and the limit switch (1).
4. Remove the limit switch cover (7).
5. Disconnect the electrical wires, including the jumper wire, inside the limit switch (see View C).
6. Remove the cable restraint connector (6) and carefully pull the electrical cable and wires from the limit switch.
7. Loosen the screws (10) and remove the limit switch arm (2) from the limit switch shaft (11).

Installation

1. Connect the electrical wires to the new limit switch as follows.
   a. Remove the limit switch cover (7).
   b. Connect the wires, including the jumper wire, to the correct terminals in the limit switch (see View C).
   c. Install and tighten the cable restraint connector (6) to the limit switch (1).
   d. Install the limit switch cover.
2. If needed, reposition the limit switch head as follows.
   a. Remove the screws (8).
   b. Rotate the limit switch head (9), as necessary.
   c. Install the screws (8).
3. Install the limit switch arm (2) onto the limit switch shaft (11). Do not tighten the screw (10) at this time (see View B).
4. Using the screws (5), install the limit switch (1).

Adjustment

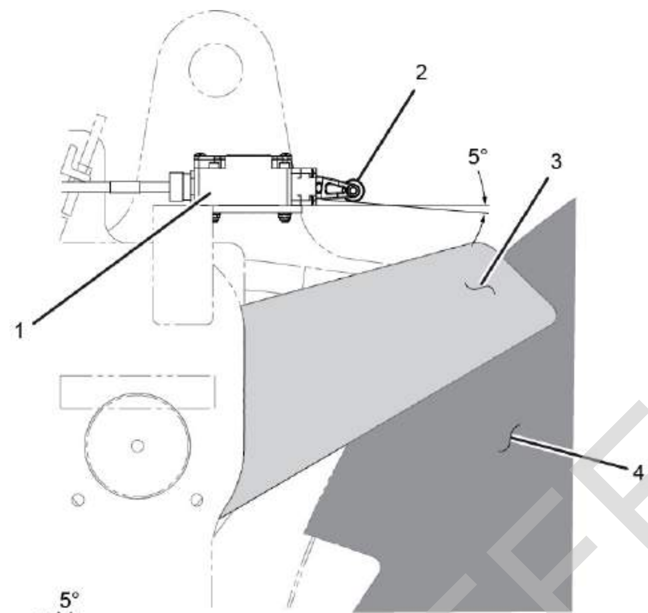
1. Slowly turn the limit switch shaft (11) clockwise (as viewed from shaft end) until the limit switch clicks open, then hold the shaft.
2. Adjust the limit switch arm (2) 5° from horizontal position (see View A).
3. Adjust the limit switch position so that it trips when the pawl is fully disengaged from the drum.
4. Tighten the screw (10) to secure the limit switch arm (2) to the limit switch shaft (11) and lock adjustment.

FOR REFERENCE ONLY

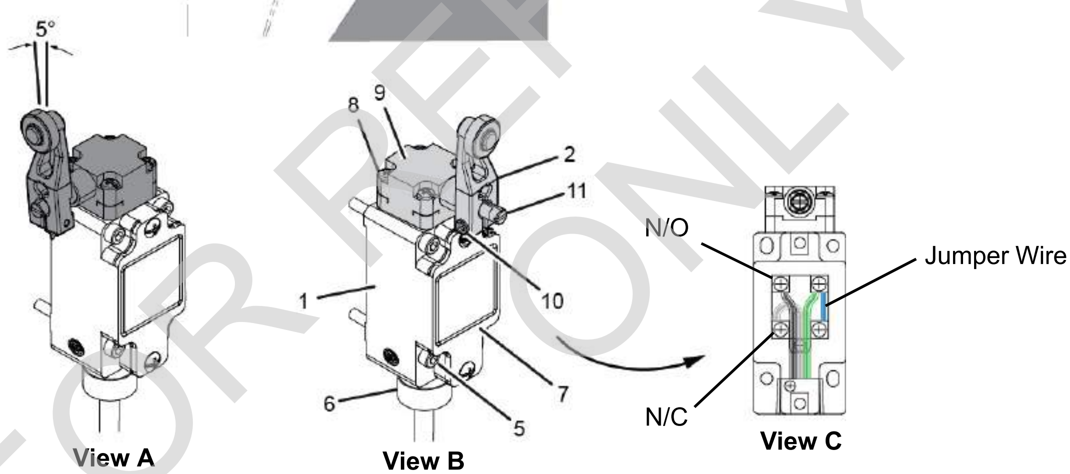
Weekly Maintenance

Inspect and test the limit switch device weekly or every 40 hours of operation as follows.

1. Inspect each limit switch arm for freedom of movement.
2. Inspect the entire length of each electrical cable for damage.
3. Make sure the electrical cables are clear of all moving parts and that cables are securely fastened with nylon straps.
4. Make sure that all plugs are securely fastened.



Item	Description
1	Limit Switch
2	Limit Switch Arm
3	Drum Pawl
4	Drum
5	Screw (qty 4)
6	Cable Restraint Connector
7	Limit Switch Cover
8	Screw (qty 4)
9	Limit Switch Head
10	Screw
11	Limit Switch Shaft



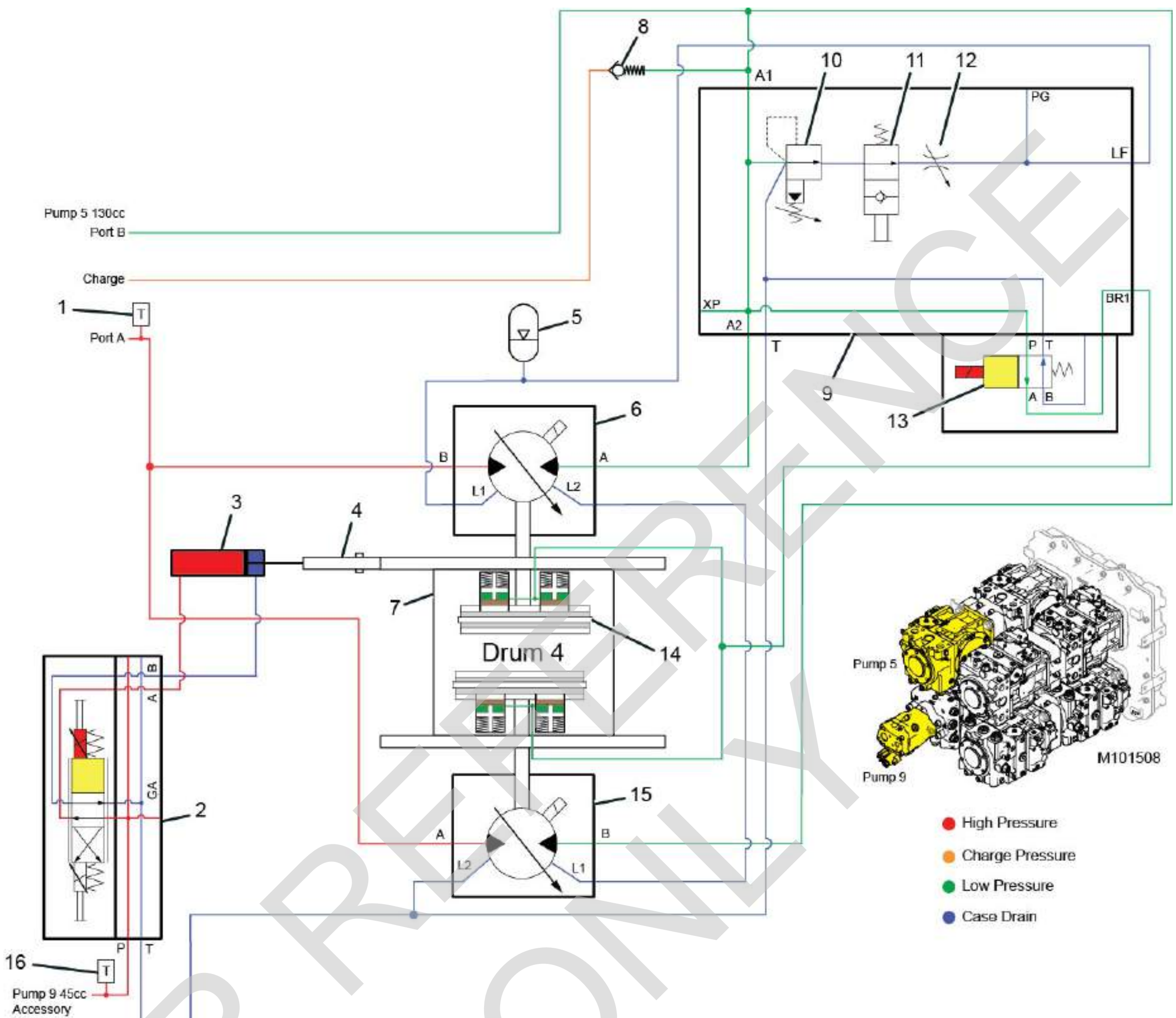
CABLE NAME	FROM PLUG	TO TERMINAL	WIRE COLOR	SYSTEM I.D.
W1	J1-21	J2-A	WHITE	N/C
W1	J1-13	J2-C	BLACK	N/O
W1	J1-14	J2-B	GREEN	INPUT

M102599

FIGURE 5-13

FOR REFERENCE ONLY

Drum 4 Hoisting Hydraulic Schematic

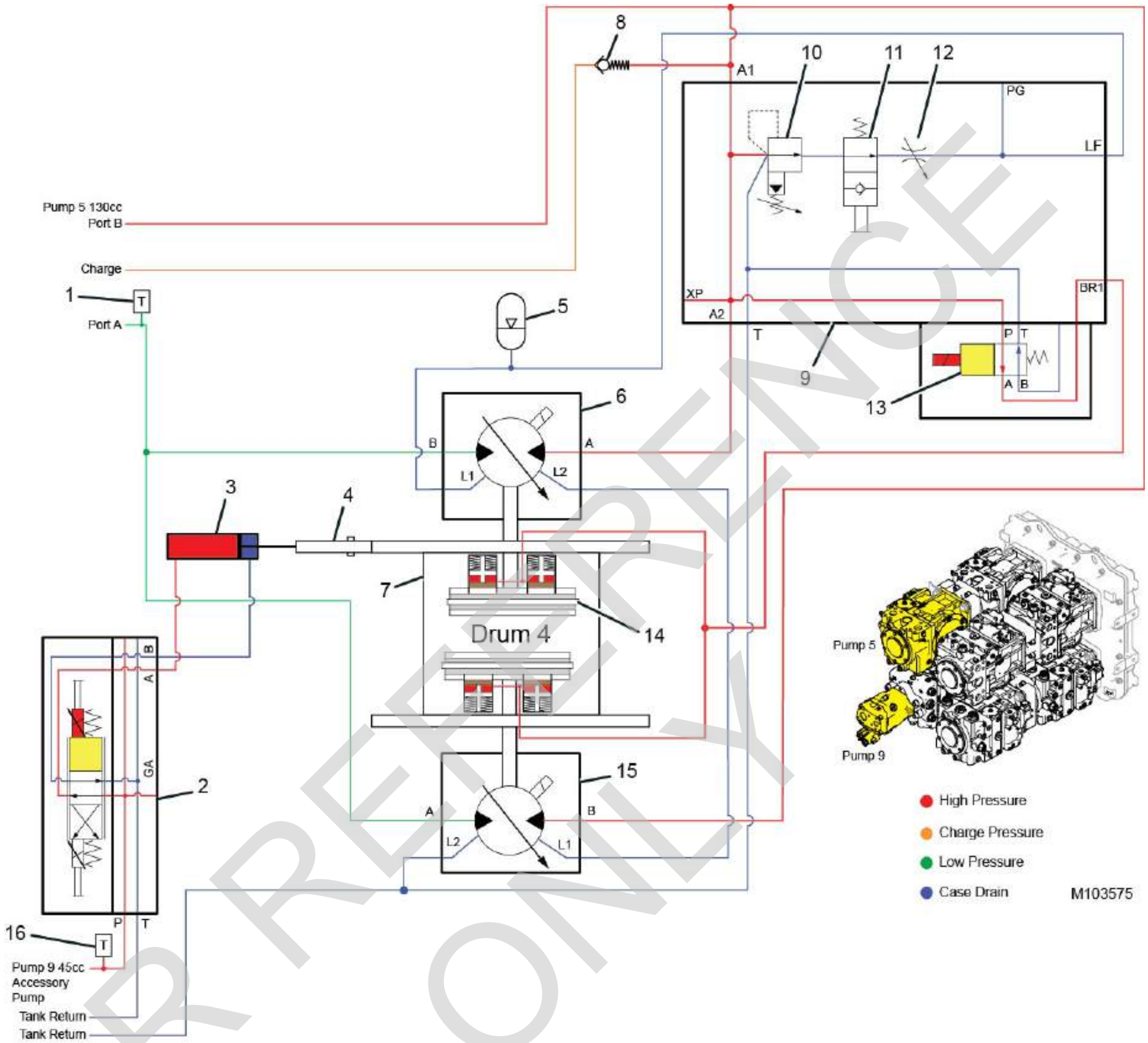


Item	Description
1	Pump 5 Pressure Transducer (drum 4 psi)
2	Pawl Solenoid Valve Control Manifold
3	Drum Pawl Actuator
4	Drum Pawl Assembly
5	Accumulator
6	Drum 4 Right Hydraulic Motor (variable 160 cc)
7	Drum Hoist Gearbox and Brake Assembly
8	Check Valve (0,35 bar [5 psi])
9	Loop Flushing Valve (6 GPM at 200 psi)
10	Pilot-Operated Sequence Valve (balanced piston)
11	Manually Operated Service Valve (2-position 2-way poppet control)
12	Flow Control Valve (6 GPM)
13	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
14	Drum Brake Pressurized (disengaged)
15	Drum 4 Left Hydraulic Motor (variable 160 cc)
16	Pump 9 Pressure Transducer (acc systems psi)

FIGURE 5-14

FOR REFERENCE ONLY

Drum 4 Lowering Hydraulic Schematic



Item	Description
1	Pump 5 Pressure Transducer (drum 4 psi)
2	Pawl Solenoid Valve Control Manifold
3	Drum Pawl Actuator
4	Drum Pawl Assembly
5	Accumulator
6	Drum 4 Right Hydraulic Motor (variable 160 cc)
7	Drum Hoist Gearbox and Brake Assembly
8	Check Valve (0,35 bar [5 psi])
9	Loop Flushing Valve (6 GPM at 200 psi)
10	Pilot-Operated Sequence Valve (balanced piston)
11	Manually Operated Service Valve (2-position 2-way poppet control)
12	Flow Control Valve (6 GPM)
13	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
14	Drum Brake Pressurized (disengaged)
15	Drum 4 Left Hydraulic Motor (variable 160 cc)
16	Pump 9 Pressure Transducer (acc systems psi)

FIGURE 5-15

FOR REFERENCE ONLY

Drum 4 Electrical Schematic

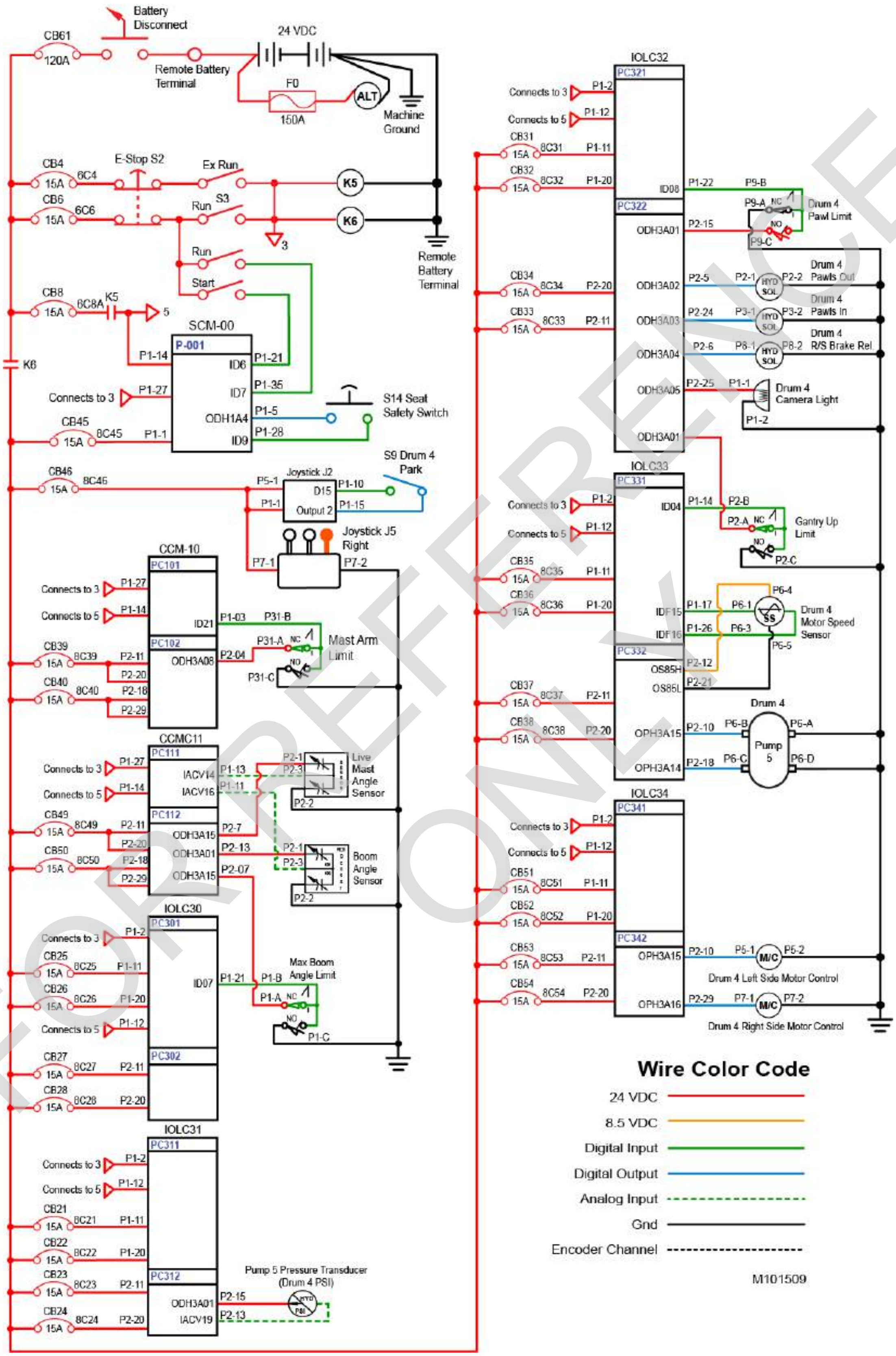


FIGURE 5-16

FOR REFERENCE ONLY

Manitowoc®

DRUM 5 BOOM HOIST (VPC-MAX)

Drum 5 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch.The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10,5 bar (153 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

Hydraulic flow to the drum 5 brake release solenoid valve is provided by the main and charge pressure hydraulic flow from pump 6.

Drum 5 Brake Operation

See Figure 5-18 and Figure 5-20.

The J2 joystick sends a 24 V_{DC} output to the drum 5 park switch. The drum park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the CCMC11 control module via the controller area network bus (CAN Bus).

When the CCMC11 control module receives the un-park command from the J2 joystick, the CCMC11 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. The brake release solenoid valve shifts position, routing hydraulic fluid from the pump 6 to the drum brake piston, releasing the brake.

When the drum brake switch is moved to the ON-PARK position, the drum park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the CCMC11 control module via the CAN Bus.

When the CCMC11 control module receives the on-park command from the J2 joystick, the CCMC11 control module sends a 0 V_{DC} output voltage to the drum brake solenoid valve, de-energizing the solenoid. This causes the brake release valve to return to the default position, allowing the fluid in the brake piston to flow through the brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

Drum 5 Hoisting Operation

See Figure 5-18 and Figure 5-20.

To enable the control system to drive the drum 5 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 5 park switch in the OFF position

When the drum 5 joystick is moved in the hoist up direction, a signal is sent to the IOLC33 control module via the controller area network bus (CAN Bus) to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoid of the pump 6 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, the flow is routed to the B-side of the drum motor.

A signal is sent to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 5 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 5 motor speed sensor and pump 6 pressure transducer (drum 5 psi) provide closed loop feedback to the control units. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speeds commanded by the joystick.

FOR REFERENCE ONLY

Drum 5 Lowering Operation

See Figure 5-19 and Figure 5-20.

To enable the control system to drive the drum 5 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 5 park switch in the OFF position

When the drum 5 joystick is moved in the hoist down direction, a signal is sent to the IOLC33 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoid of the pump 6 EDC. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, the flow is routed to the A-side of the drum motor.

A signal is sent to the IOLC30 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 5 motor controller. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 5 motor speed sensor and pump 6 pressure transducer (drum 5 psi) provide closed loop feedback to the control units. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speeds commanded by the joystick.

Drum 5 Pawl Operation

See Figure 5-18 and Figure 5-20.

The pawl is controlled by the park switch.

When the drum park is turned on to engage the drum pawl, the CCMC11 control unit sends a 24 V_{DC} output to the drum 5 pawl-in solenoid valve, energizing the solenoid. The drum pawl solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the rod end of the pawl cylinder. The cylinder rod retracts, engaging the drum pawl.

When the drum park is turned off to disengage the drum pawl, the CCMC11 control module sends a 24 V_{DC} output to the drum 5 pawl-out solenoid valve, energizing the solenoid. The drum pawl solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the tube end of the pawl cylinder. The cylinder rod extends, disengaging the drum pawl.

When the control system is not powered, the drum pawl solenoid valve moves to the center position, allowing hydraulic fluid at both ends of the pawl cylinder to return to tank. Spring force holds the pawl in the engaged position.

FOR REFERENCE ONLY

Drum 5 Pawl Limit Switch

WARNING

Falling Boom Hazard!

Avoid possible injury. Before performing the steps in this section, land the loads and lower the boom onto blocking at ground level. There is no positive means of holding the boom up when the pawl is being serviced.

See Figure 5-17 for the following procedures.

Limit Switch Replacement

Removal

1. Land the load from the drum.
2. Lockout-tagout the crane.
3. Remove the screws (5) and the limit switch (1).
4. Remove the limit switch cover (7).
5. Disconnect the electrical wires, including the jumper wire, inside the limit switch (see View C).
6. Remove the cable restraint connector (6) and carefully pull the electrical cable and wires from the limit switch.
7. Loosen the screw (10) and remove the limit switch arm (2) from the limit switch.

Installation

1. Connect the electrical wires to the limit switch as follows.
   a. Remove the limit switch cover (7).
   b. Connect the wires, including the jumper wire, to the correct terminals in the limit switch (see View C).
   c. Install and tighten the cable restraint connector (6) to the limit switch (1).
   d. Install the limit switch cover.
2. If necessary, reposition the limit switch head as follows.
   a. Remove the screws (8).
   b. Rotate the limit switch head (9) to the position shown (see View B).
   c. Install the screws (8).
3. Install the limit switch arm (2) onto the limit switch shaft (11). Do not tighten the screw (10) at this time (see View A).
4. Using the screws (5), install the limit switch (1).

Adjustment

1. Slowly turn the limit switch shaft (11) clockwise (as viewed from shaft end) until the limit switch clicks open, then hold the shaft.
2. Adjust the limit switch arm (2) 54° from the horizontal position (see View B).
3. Adjust the limit switch position so that it will trip when the pawl is fully disengaged from the drum.
4. Tighten the screw (10) to secure the limit switch arm (2) to the limit switch shaft (11) and lock adjustment.

Weekly Maintenance

Inspect and test the limit switch device weekly or every 40 hours of operation as follows.

1. Inspect each limit switch arm for freedom of movement.
2. Inspect the entire length of each electrical cable for damage.
3. Make sure the electrical cables are clear of all moving parts and that cables are securely fastened with nylon straps.
4. Make sure that all plugs are securely fastened.

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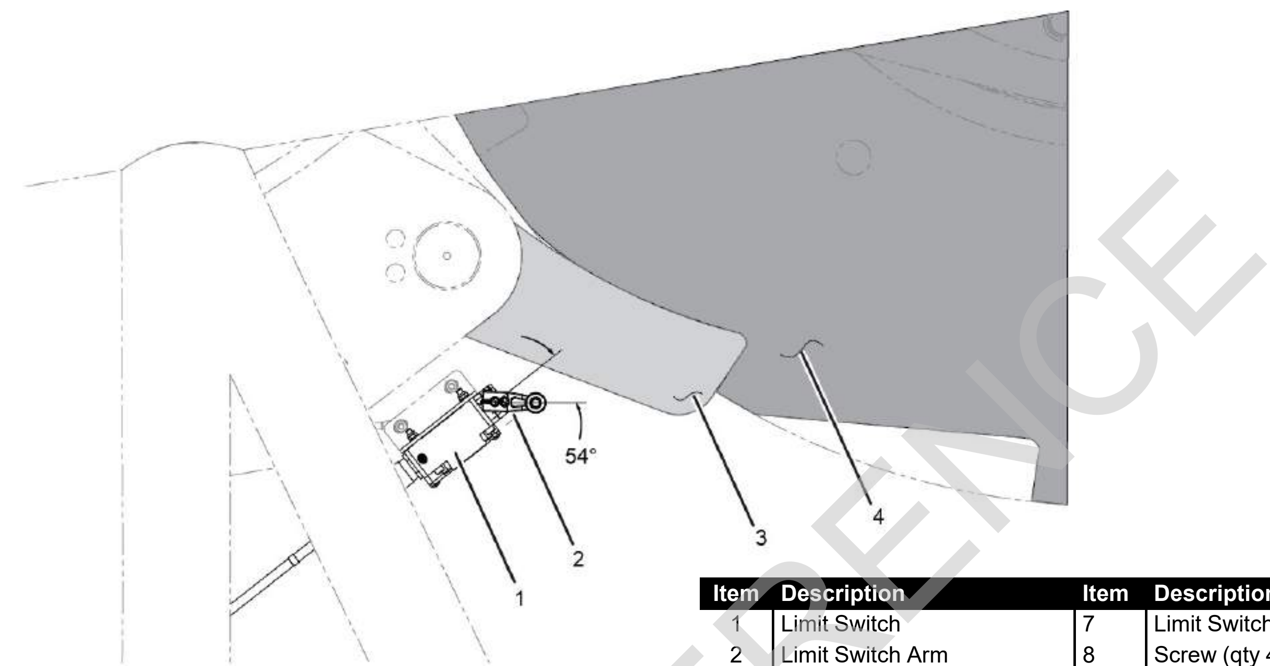
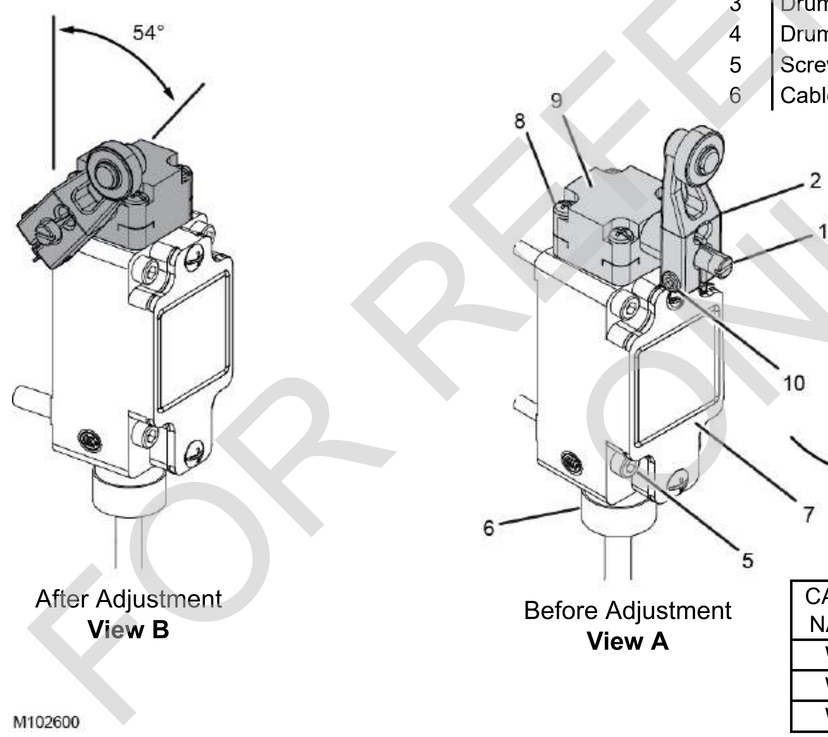
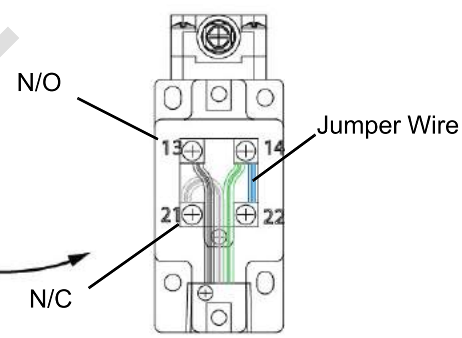


Item	Description	Item	Description
1	Limit Switch	7	Limit Switch Cover
2	Limit Switch Arm	8	Screw (qty 4)
3	Drum Pawl	9	Limit Switch Head
4	Drum	10	Screw
5	Screw (qty 4)	11	Limit Switch Shaft
6	Cable Restraint Connector		



View C



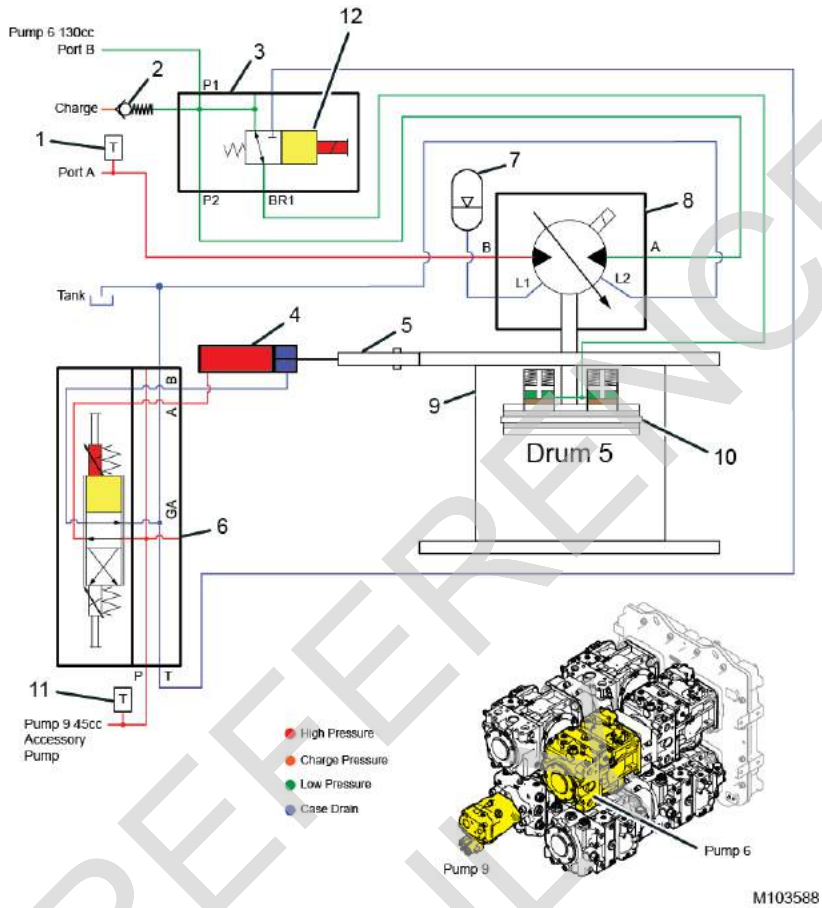
CABLE NAME	FROM PLUG	TO TERMINAL	WIRE COLOR	SYSTEM I.D.
W1	J1-21	J2-A	WHITE	N/C
W1	J1-13	J2-C	BLACK	N/O
W1	J1-14	J2-B	GREEN	INPUT

FIGURE 5-17

FOR REFERENCE ONLY

Published 03-13-20, Control # 229-11

Drum 5 Hoisting Hydraulic Schematic

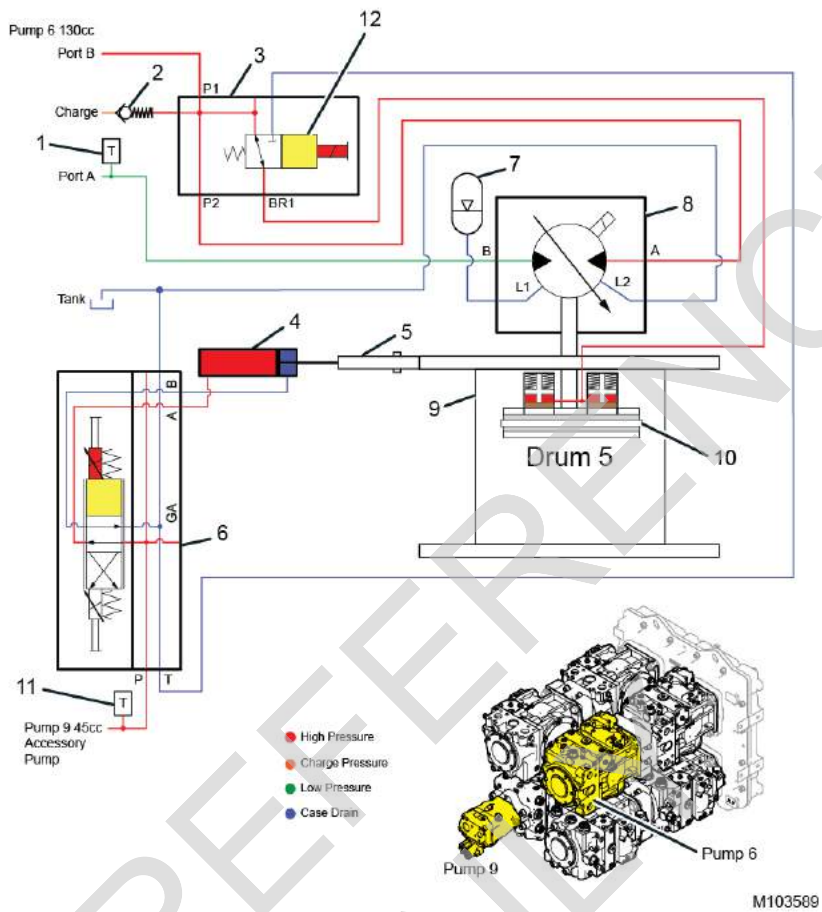


Item	Description
1	Pump 6 Pressure Transducer (drum 5 psi)
2	Charge Pressure Check Valve (0,35 bar [5 psi])
3	Charge and Brake Manifold Assembly
4	Drum Pawl Actuator
5	Drum Pawl Assembly
6	Pawl Control Manifold
7	Accumulator
8	Hydraulic Motor (variable 160 cc)
9	Drum Hoist Gearbox and Brake Assembly
10	Drum Brake Pressurized (disengaged)
11	Pump 9 Pressure Transducer (acc systems psi)
12	Drum Brake Release Solenoid Valve

FIGURE 5-18

FOR REFERENCE ONLY

Drum 5 Lowering Hydraulic Schematic



Item	Description
1	Pump 6 Pressure Transducer (drum 5 psi)
2	Charge Pressure Check Valve (0,35 bar [5 psi])
3	Charge and Brake Manifold Assembly
4	Drum Pawl Actuator
5	Drum Pawl Assembly
6	Pawl Control Manifold
7	Accumulator
8	Hydraulic Motor (variable 160 cc)
9	Drum Hoist Gearbox and Brake Assembly
10	Drum Brake Pressurized (disengaged)
11	Pump 9 Pressure Transducer (acc systems psi)
12	Drum Brake Release Solenoid Valve

FIGURE 5-19

FOR REFERENCE ONLY

Drum 5 Electrical Schematic

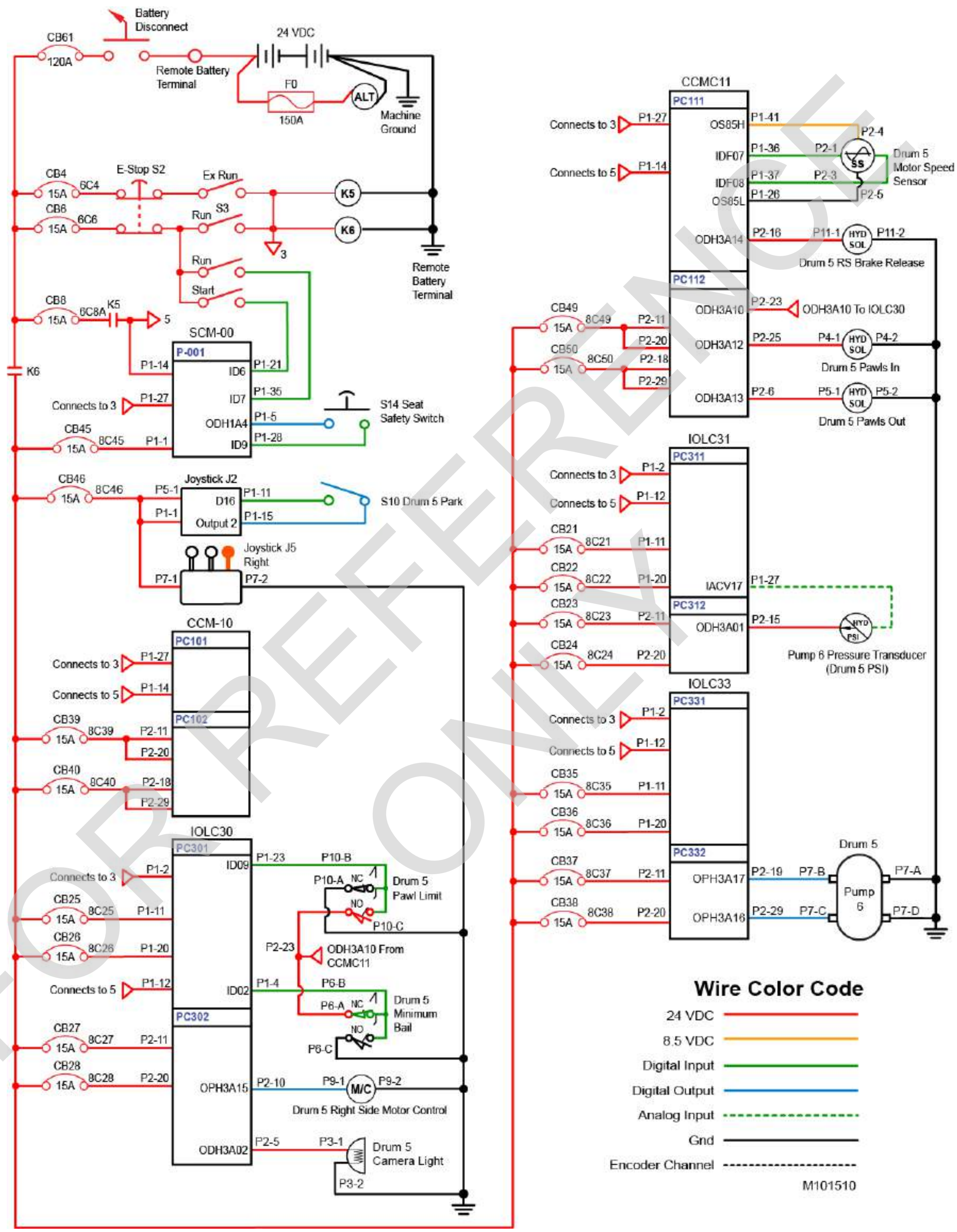


FIGURE 5-20

FOR REFERENCE ONLY

DRUM 6 LUFFING HOIST

Drum 6 Brake Overview

A brake is attached to the drum motors, with the brake discs attached to the drum shaft. The brakes are controlled by joystick movement and the drum park brake switch.The brakes are applied by spring force and released by hydraulic pressure.

CAUTION

Possible Machine Damage!

When raising or lowering a load, do not use the drum park switch to stop the load movement, since this could cause damage to the boom. Use the joystick for a controlled smooth stop.

The brakes must be fully released to allow the drum to rotate for hoisting and lowering operations. To accomplish this, the brake pressure must be above 10,5 bar (153 psi). Any pressure below this could cause the brakes to remain partially applied, which could damage the drum brake system.

If brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

Hydraulic flow to the drum 6 brake release solenoid valve is provided by the main and charge pressure hydraulic flow from pump 1.

Drum 6 Brake Operation

See Figure 5-22 and Figure 5-24.

The J2 joystick sends a 24 V_{DC} output to the drum 6 park switch. The drum park switch is closed in the UN-PARK position, causing the switch to send a 24 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the un-park brake command to the CCMC11 control module via the controller area network bus (CAN Bus).

The CCM-10 control module energizes the drum 1 / drum 6 selector solenoid valve, located in the accessory valve manifold. When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the pump 1 charge pressure pilot valve and drum 1/ drum 6 diverter pilot valve. The charge pressure and diverter pilot valves shift position, allowing pump 1 main and charge hydraulic pressures to be present at the drum brake release solenoid valve.

The charge pressure check valve only allows flow from the charge pump when main pump pressure is not present.

When the CCMC11 control module receives the un-park command from the J2 joystick, the CCMC11 control module sends a 24 V_{DC} output to the drum brake release solenoid valve, energizing the solenoid. This causes the solenoid valve to shift position, routing hydraulic fluid to the drum brake piston, releasing the brake.

When the brake switch is moved to the ON-PARK position, the park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. The J2 joystick communicates the on-park brake command to the CCMC11 control module via the CAN Bus.

When the CCMC11 control module receives the un-park command from the J2 joystick, the CCMC11 control module sends a 0 V_{DC} output voltage to the drum brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the fluid in the brake piston to flow through the drum brake release solenoid valve, and back to the tank. The reduced hydraulic pressure allows spring force to apply the drum brake.

Drum 6 Motor Loop Flushing

See Figure 5-22 and Figure 5-24.

Loop flushing of the drum 6 motor occurs whenever the drum 1/drum 6 selector solenoid valve is energized. The loop flush circuit receives flow in two sources:

- Main pump flow when the motor is being driven
- Charge pump flow when the motor is not being driven, or if main pump pressure is too low

The charge pressure check valve (3) only allows flow from the charge pump when the main pump pressure is more than 0,35 bar (5 psi) lower than the charge pressure.

FOR REFERENCE ONLY

Drum 6 Hoisting Operation

See Figure 5-22 and Figure 5-24.

To enable the control system to drive the drum 6 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 6 park switch in the OFF position

NOTE: For the following operation, the drum 1 park switch and/or left travel park switch are in the ON position.

When the drum 6 joystick is moved in the hoist up direction, the CCM-10 control module energizes the drum 1 /drum 6 diverter solenoid valve, located in the accessory valve manifold. When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the drum 1 / drum 6 diverter valve and the pump 1 charge pressure pilot valve. The charge pressure and diverter pilot valves shift position, allowing hydraulic fluid from pump 1 to flow to the drum 6 motor circuit.

The CCM-10 control module sends a signal to the IOLC32 control module via the controller area network bus (CAN Bus) to ramp up the pulse-width modulation (PWM) duty cycle to the A-side solenoid of pump 1 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump. From the pump, the flow is routed through the diverter pilot valve and then into the A-side of the drum motor.

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 6 motor control solenoid. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 6 motor speed sensor and pump 1 pressure transducer (drum 1 psi) provide closed loop feedback. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speed commanded by the joystick.

Drum 6 Lowering Operation

See Figure 5-23 and Figure 5-24.

To enable the control system to drive the drum 6 pump and motor, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Drum 6 park switch in the OFF position

NOTE: For the following operation, the drum 1 park switch and/or left travel park switch are in the ON position.

When the drum 6 joystick is moved in the hoist down direction, the CCM-10 control module energizes the drum 1 / drum 6 diverter solenoid valve, located in the accessory valve manifold. When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the drum 1 / drum 6 diverter valve and the pump 1 charge pressure pilot valve. The charge pressure and diverter pilot valves shift position, allowing hydraulic fluid from pump 1 to flow to the drum 6 motor circuit.

The CCM-10 control module sends a signal to the IOLC32 control module via the CAN Bus to ramp up the PWM duty cycle to the B-side solenoid of pump 1 EDC. The PWM signal is in proportion to the speed commanded by the joystick. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump. From the pump, the flow is routed through the diverter pilot valve and then into the B-side of the drum motor.

The CCM-10 control module sends a signal to the CCMC11 control module via the CAN Bus to ramp up the PWM duty cycle to the drum 6 motor control solenoid. Increasing the PWM duty cycle decreases the swashplate angle in the motor, which increases the motor speed until the rotational speed is maximized based on the pump flow.

The drum 6 motor speed sensor and pump 1 pressure transducer (drum 1 psi) provide closed loop feedback. The control algorithm uses this feedback to adjust the pump and motor flows while ramping up to, and maintaining, the speed commanded by the joystick.

FOR REFERENCE ONLY

Drum 6 Pawl Operation

See Figure 5-22 and Figure 5-24.

The pawl is controlled by the park switch.

When the drum park is turned on to engage the drum pawl, the CCMC11 control module sends a 24 V_{DC} output to the drum 6 pawl-in solenoid valve, energizing the solenoid. The solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the tube end of the cylinder. The cylinder rod extends, moving the drum pawl to the engaged position.

When the drum park is turned off to disengage the drum pawl, the CCMC11 control module sends a 24 V_{DC} output to the drum 6 pawl-out solenoid valve, energizing the solenoid. The solenoid valve shifts position to route hydraulic fluid from the accessory pump 9 to the rod end of the cylinder. The cylinder rod retracts, moving the drum pawl to the disengaged position.

When the control system is not powered, the drum pawl solenoid valve moves to the center position, allowing hydraulic fluid at both ends of the pawl cylinder to return to the tank. Spring force holds the pawl in the engaged position.

Drum 6 Pawl Limit Switch

WARNING

Falling Boom Hazard!

Avoid possible injury. Before performing the steps in this section, land the loads and lower the boom onto blocking at ground level. There is no positive means of holding the boom up when the pawl is being serviced.

See Figure 5-21 for the following procedures.

Limit Switch Replacement

Removal

1. Land the load from the drum.
2. Lockout-tagout the crane.
3. Remove the screws (5) and the limit switch (1).
4. Remove the limit switch cover (7).
5. Disconnect the electrical wires, including the jumper wire, inside the limit switch (see View C).
6. Remove the cable restraint connector (6) and carefully pull the electrical cable and wires from the limit switch.
7. Loosen the screw (10) and remove the limit switch arm (2) from the limit switch.

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Installation

1. Connect the electrical wires to the new limit switch (1).
   a. Remove the limit switch cover (7).
   b. Connect the electrical wires, including the jumper wire, to the correct terminals in the limit switch (see View C).
   c. Install and tighten the cable restraint connector (6) to the limit switch (1).
   d. Install the limit switch cover.
2. If necessary, reposition the limit switch head as follows.
   a. Remove the screws (8).
   b. Rotate limit switch head (9) to the position shown (see View B).
   c. Install the screws (8).
3. Install the limit switch arm (2) onto the limit switch shaft (11). Do not tighten the screw (10) at this time (see View A).
4. Using the screws (5), install the limit switch (1).

Adjustment

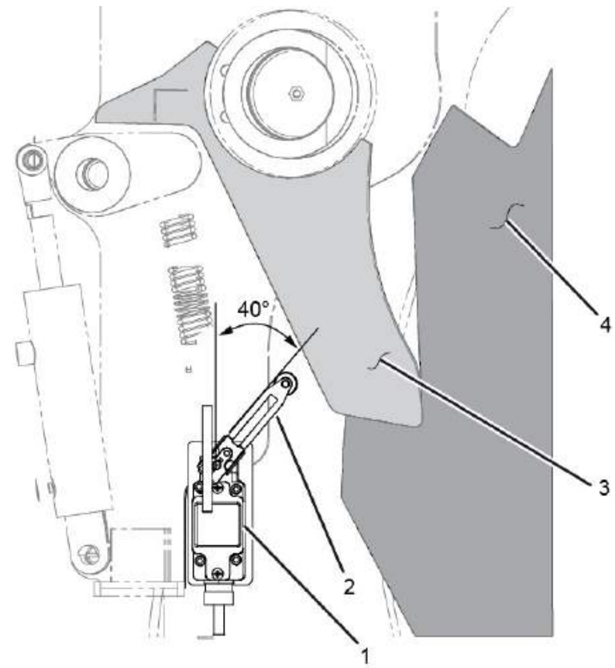
1. Slowly turn the limit switch shaft (11) clockwise (as viewed from shaft end) until the limit switch clicks open, then hold the shaft.
2. Adjust the limit switch arm (2) 40° from the horizontal position (see View B).
3. Adjust the limit switch position so that it will trip when the pawl is fully disengaged from the drum.
4. Tighten the screw (10) to secure the limit switch arm (2) to the limit switch shaft (11) and lock adjustment.

Weekly Maintenance

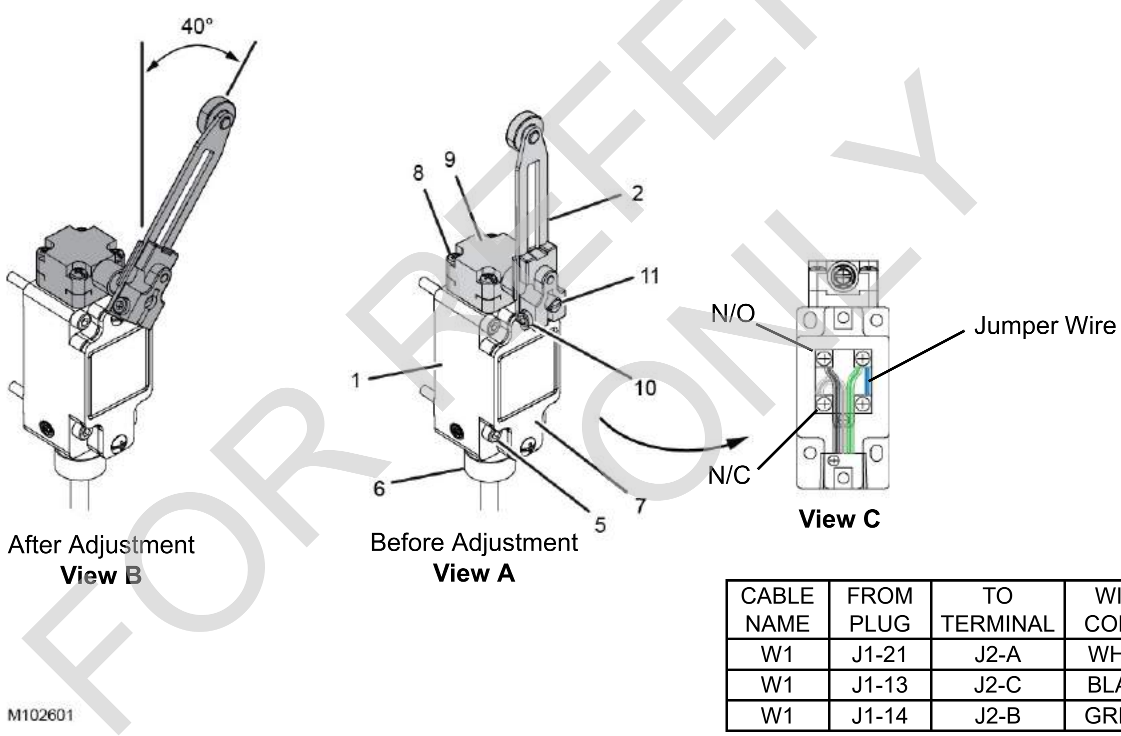
Inspect and test the limit switch device weekly or every 40 hours of operation as follows.

1. Inspect each limit switch arm for freedom of movement.
2. Inspect the entire length of each electrical cable for damage.
3. Make sure the electrical cables are clear of all moving parts and that cables are securely fastened with nylon straps.
4. Make sure that all plugs are securely fastened.

FOR REFERENCE ONLY



Item	Description
1	Limit Switch
2	Limit Switch Arm
3	Drum Pawl
4	Drum
5	Screw (qty 4)
6	Cable Restraint Connector
7	Limit Switch Cover
8	Screw (qty 4)
9	Limit Switch Head
10	Screw
11	Limit Switch Shaft

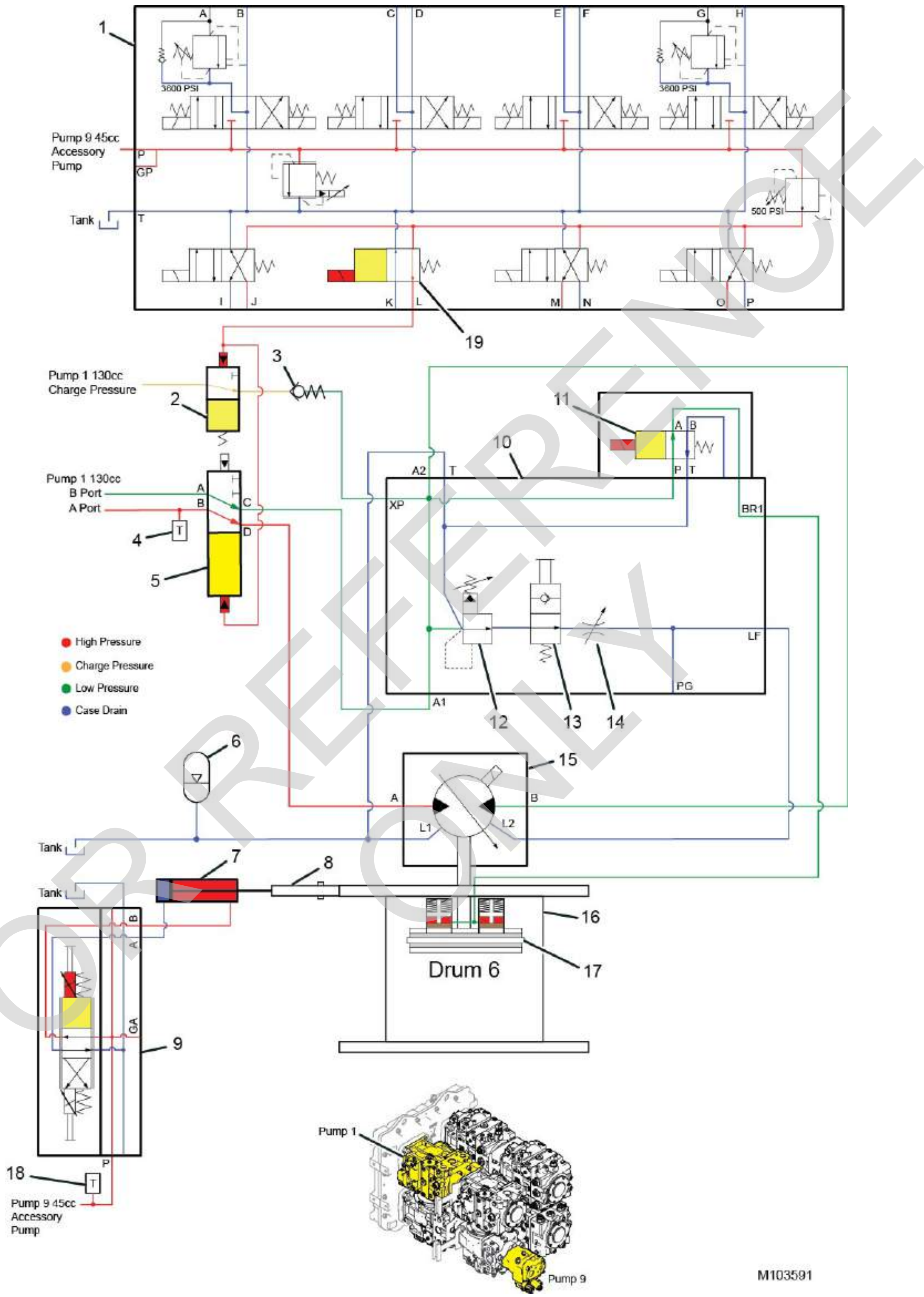


CABLE NAME	FROM PLUG	TO TERMINAL	WIRE COLOR	SYSTEM I.D.
W1	J1-21	J2-A	WHITE	N/C
W1	J1-13	J2-C	BLACK	N/O
W1	J1-14	J2-B	GREEN	INPUT

FIGURE 5-21

FOR REFERENCE ONLY

Drum 6 Hoisting Hydraulic Schematic



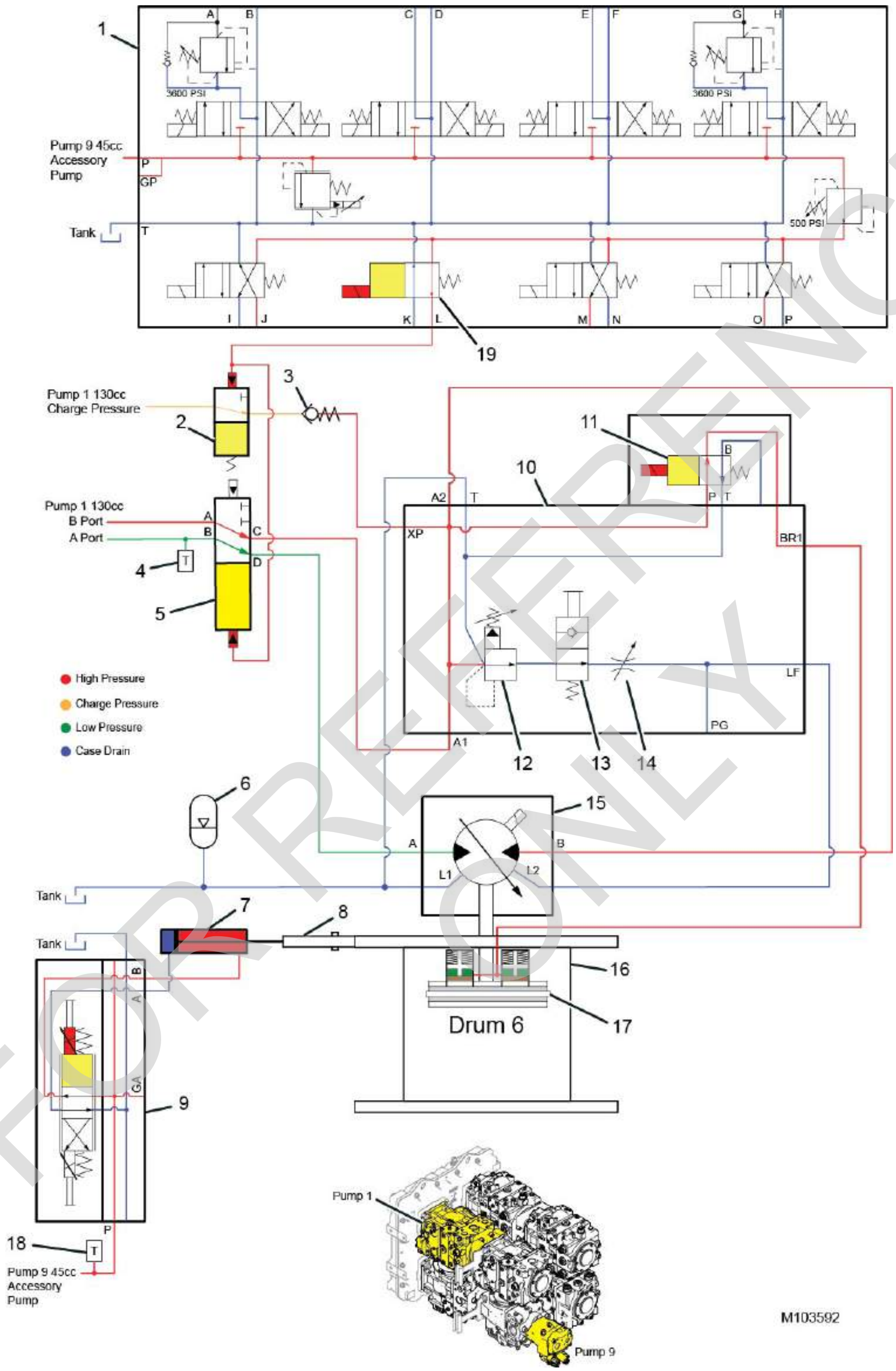
See Table 5-3.Legend for Figure 5-22 and Figure 5-23.

FIGURE 5-22

FOR REFERENCE ONLY

5

Drum 6 Lowering Hydraulic Schematic



See Table 5-3.Legend for Figure 5-22 and Figure 5-23.

FIGURE 5-23

Table 5-3. Legend for Figure 5-22 and Figure 5-23

Item	Description
1	Accessory Valve Manifold
2	Pump 1 Charge Pressure Diverter Valve (directional control)
3	Charge Pressure Check Valve (1,7 bar [25 psi])
4	Pump 1 Pressure Transducer (drum 1 psi)
5	Drum 1/Drum 6 Diverter Valve (directional control)
6	Accumulator
7	Drum Pawl Actuator
8	Drum Pawl Assembly
9	Drum Pawl Control Manifold
10	Loop Flushing Valve (6 GPM at 200 psi)
11	Drum Brake Release Solenoid Valve (2-position 4-way directional control)
12	Pilot-Operated Sequence Valve (balanced piston)
13	Manually Operated Service Valve (2-position 2-way poppet control)
14	Flow Control Valve (6 GPM)
15	Hydraulic Pump (variable 130 cc)
16	Drum Hoist Gearbox and Brake Assembly
17	Drum 6 Brake Pressurized (disengaged)
18	Pump 9 Pressure Transducer (acc systems psi)
19	Drum 1/Drum 6 Selector Solenoid Valve

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Drum 6 Electrical Schematic

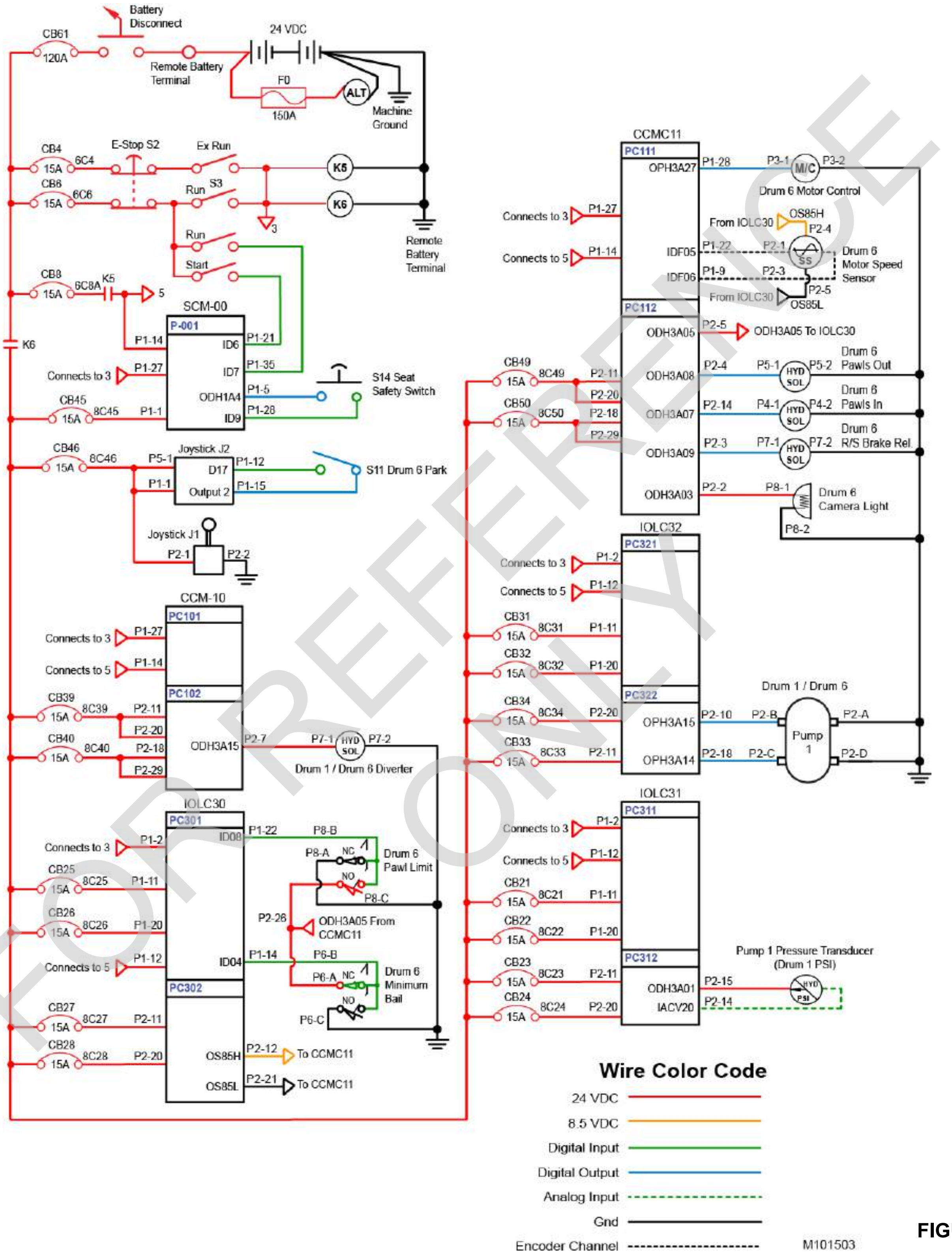

FIGURE 5-24

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GEARBOXES

The drum gearboxes are filled with gear oil and are open to the inside of the drum. Maintenance consists of periodically checking the level and changing the oil.

Gear Oil Specifications

For gear oil specifications, see the Lubrication Guide supplied with the crane.

Oil Analysis

An oil analysis program is the best way to determine the optimal oil change interval and the condition of the drum gearboxes.

Periodic Maintenance

Weekly

Check the gearbox oil level.

All drums have a level plug or level sight tube. For details, refer to the Lubrication Guide supplied with the crane.

Monthly or 200 Hours

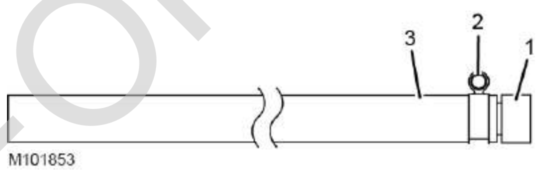
Check the oil level in the drum gearboxes every 200 hours of operation or monthly, whichever occurs first. For details, see the Lubrication Guide supplied with the crane.

Every 6 Months or 1,000 Hours

Drain and refill the gearboxes every 1,000 hours of operation or every 6 months, whichever occurs first.

Quick-Drain Valve

Each drum gearbox is equipped with a quick-drain valve that requires use of the quick-drain drainer assembly (see Figure 5-25). The quick-drain drainer assembly is stored in the parts box supplied with the crane.



Item	Description
1	Quick-Drain Drainer
2	Hose Clamp
3	Hose: 19 mm (3/4 in) ID x 3,0 m (10 ft) length

FIGURE 5-25

Changing the Gearbox Oil

Drum 1 and Drum 2

See Figure 5-26 for the following procedures.

The gearboxes should be drained and refilled after every 200 hours of drum operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

Only fill after the drum assembly is installed into the boom butt.

The oil level sight glass on drum 1 will read the correct oil level with the boom butt and 4M insert installed and resting on the ground (approximately -11° boom angle). The oil level can be checked at any boom angle by removing the radial drain plug from the gearbox when the boom is nearly horizontal.

The oil level sight glass on the drum 2 will read the correct oil level at 0° boom angle. The oil level can be checked at any boom angle by removing the radial drain plug from the gearbox when the boom is nearly horizontal.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the drum guard assembly (7) to access the radial quick-drain valve (4b).
4. Remove the dust caps (3) from the quick-drain valves (4a and 4b).
5. Place the non-fitting end of the quick-drain drainer assembly hose (6) into an appropriate container for collecting the drained oil.
6. Connect the quick-drain drainer assembly hose to the quick-drain valve (4a, see View B).
7. When the draining is finished, disconnect the quick-drain drainer assembly hose.
8. Connect the quick-drain hose to the radial quick-drain valve (4b) to drain the remaining oil.
9. When the draining is finished, remove the quick-drain hose.
10. Fasten the dust caps to the quick-drain valves.

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11. Fill the gearbox with specific oil as follows.

Manual Fill Procedure (very slow process)

- **a.** If not already done, remove the breather plug (1).
- **b.** Add oil through the fill port (2) using an appropriate funnel until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
- **c.** Install the breather plug.

Power Fill Procedure (recommended)

- **a.** If not already done, remove the breather plug (1).
- **b.** Remove the dust cap (3) from the quick-drain valve (4a).
- **c.** Thoroughly clean the inside of the quick-drain drainer assembly hose (6).
- **d.** Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
- **e.** Connect the quick-drain drainer assembly hose to a portable pump, either hydraulically powered or hand powered.
- **f.** Slowly pump oil into the gearbox until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
- **g.** When the gearbox is filled, remove the quick-drain drainer assembly hose.
- **h.** Fasten the dust cap to the quick-drain valve.
- **i.** Install the breather plug.

12. Check the oil level after operating the hoist. If necessary, add oil through the fill port (2).

13. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.

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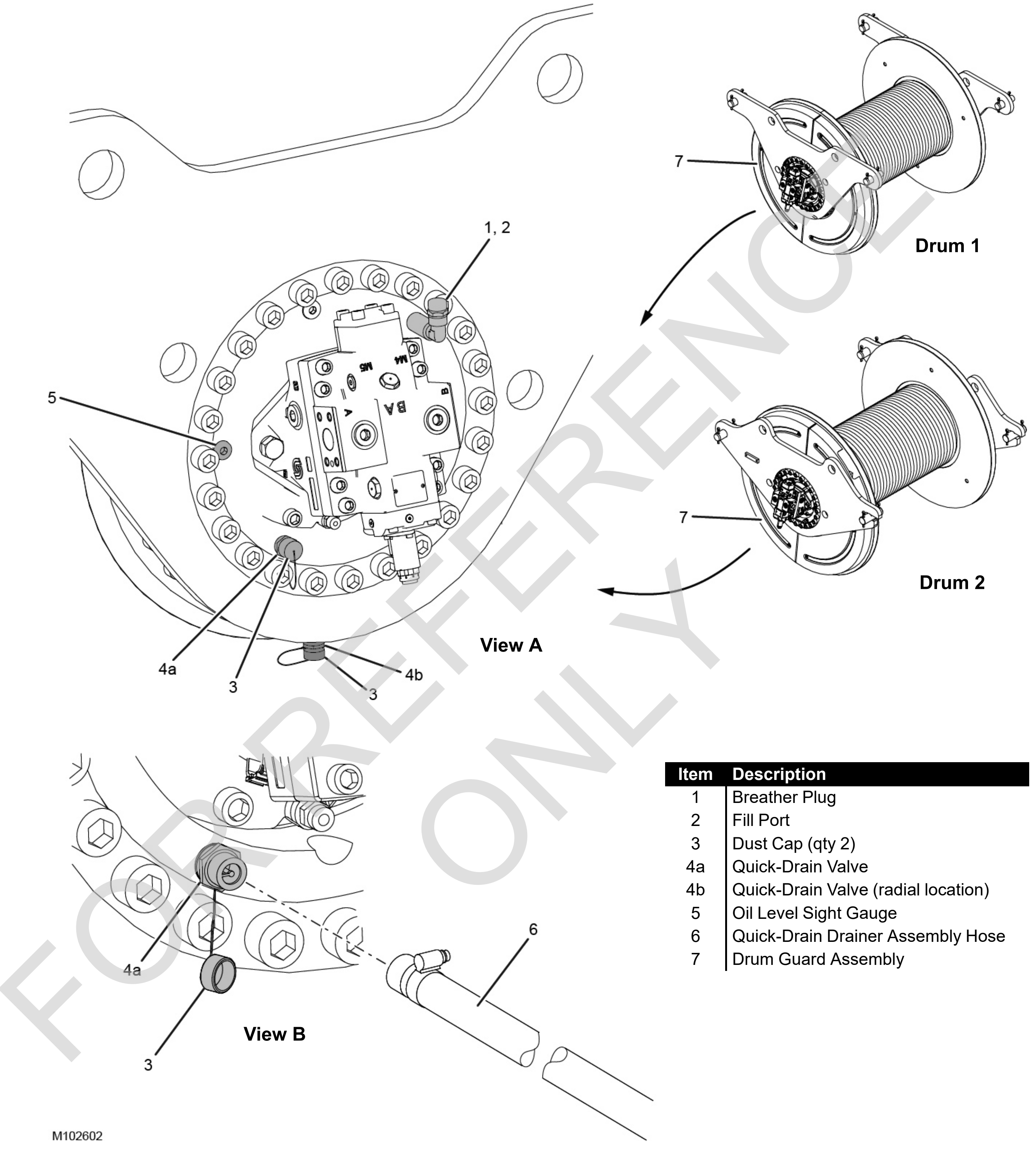


Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap (qty 2)
4a	Quick-Drain Valve
4b	Quick-Drain Valve (radial location)
5	Oil Level Sight Gauge
6	Quick-Drain Drainer Assembly Hose
7	Drum Guard Assembly

FIGURE 5-26

FOR REFERENCE ONLY

Drum 3

See Figure 5-27 for the following procedures.

The gearboxes should be drained and refilled after every 200 hours of drum operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

Only fill after the drum assembly is installed into the rotating bed.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the dust cap (3) from the quick-drain valve (4).
4. Place the non-fitting end of the quick-drain drainer assembly hose (6) into an appropriate container for collecting the drained oil.
5. Connect the quick-drain drainer assembly hose to the quick-drain valve (see View C).
6. When the gearbox has finished draining, remove the quick-drain drainer assembly hose.
7. Fasten the dust cap to the quick-drain valve.
8. Fill the gearbox with specific oil as follows.

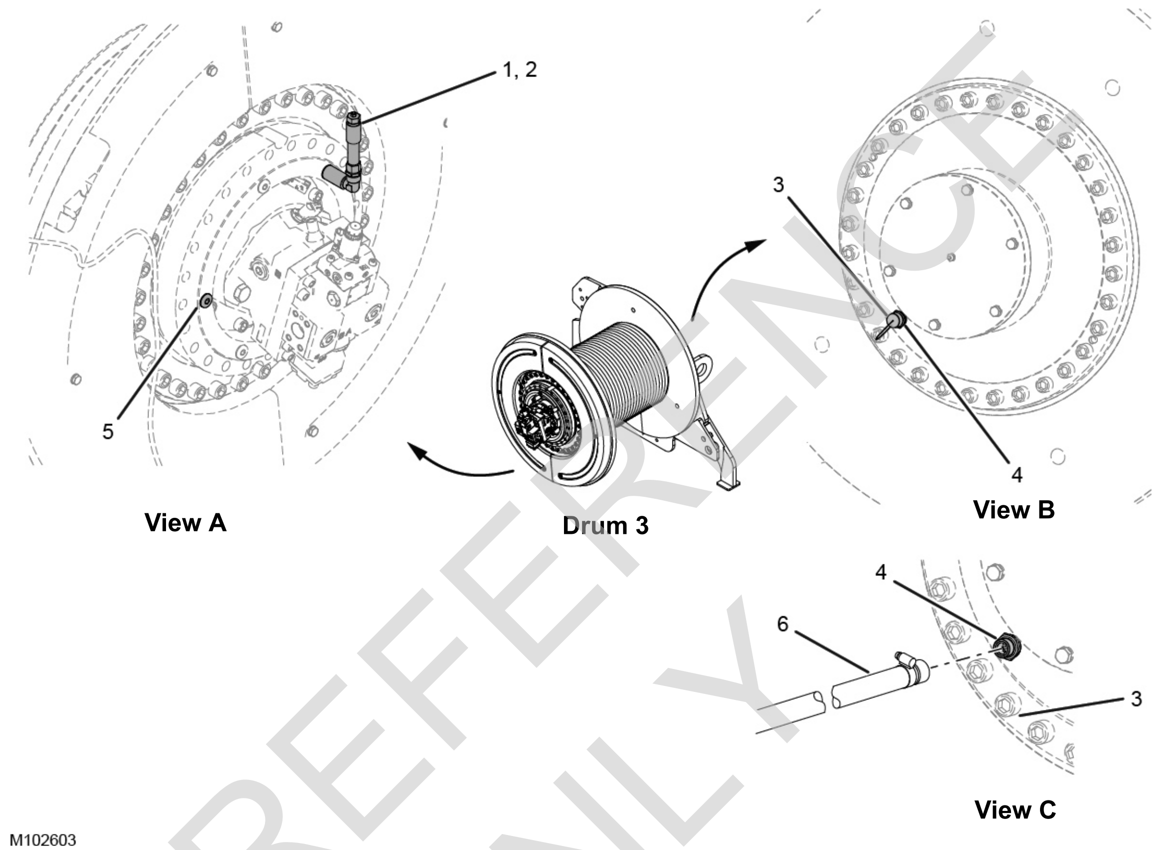
   Manual Fill Procedure (very slow process)

   a. If not already done, remove the breather plug (1).
   b. Add oil through the fill port (2) using an appropriate funnel until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
   c. Install the breather plug.

   Power Fill Procedure (recommended)

   a. If not already done, remove the breather plug (1).
   b. Remove the dust cap (3) from the quick-drain valve (4).
   c. Thoroughly clean the inside of the quick-drain drainer assembly hose (6).
   d. Connect the quick-drain drainer assembly hose to quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
   e. Connect the quick-drain drainer assembly hose to a portable pump, either hydraulically powered or hand powered.
   f. Slowly pump oil into the gearbox until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
   g. When the gearbox is filled, remove the quick-drain drainer assembly.
   h. Fasten the dust cap to the quick-drain valve.
   i. Install the breather plug.
9. Check the oil level after operating the hoist. If necessary, add oil through the fill port (2).
10. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.

FOR REFERENCE ONLY



Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap
4	Quick-Drain Valve
5	Oil Level Sight Gauge
6	Quick-Drain Drainer Assembly Hose

FIGURE 5-27

FOR REFERENCE ONLY

Drum 4

See Figure 5-28 for the following procedures.

The gearboxes should be drained and refilled after every 200 hours of drum operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

Only fill after the drum assembly is installed into the rotating bed.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the drum guard assembly (7) to access the radial quick-drain valve (4b).
4. Remove the dust caps (3) from the quick-drain valves (4a and 4b).
5. Place the non-fitting end of the quick-drain drainer assembly hose (6) into an appropriate container for collecting the drained oil.
6. Connect the quick-drain drainer assembly hose to the quick-drain valve (4a, see View B).
7. When the draining is finished, disconnect the quick-drain drainer assembly hose.
8. Connect the quick-drain drainer assembly hose to the radial quick-drain valve (4b) to drain the remaining oil.
9. When the draining is finished, remove the quick-drain drainer assembly hose.
10. Fasten the dust caps to the quick-drain valves.
11. Fill the gearbox with specific oil as follows.

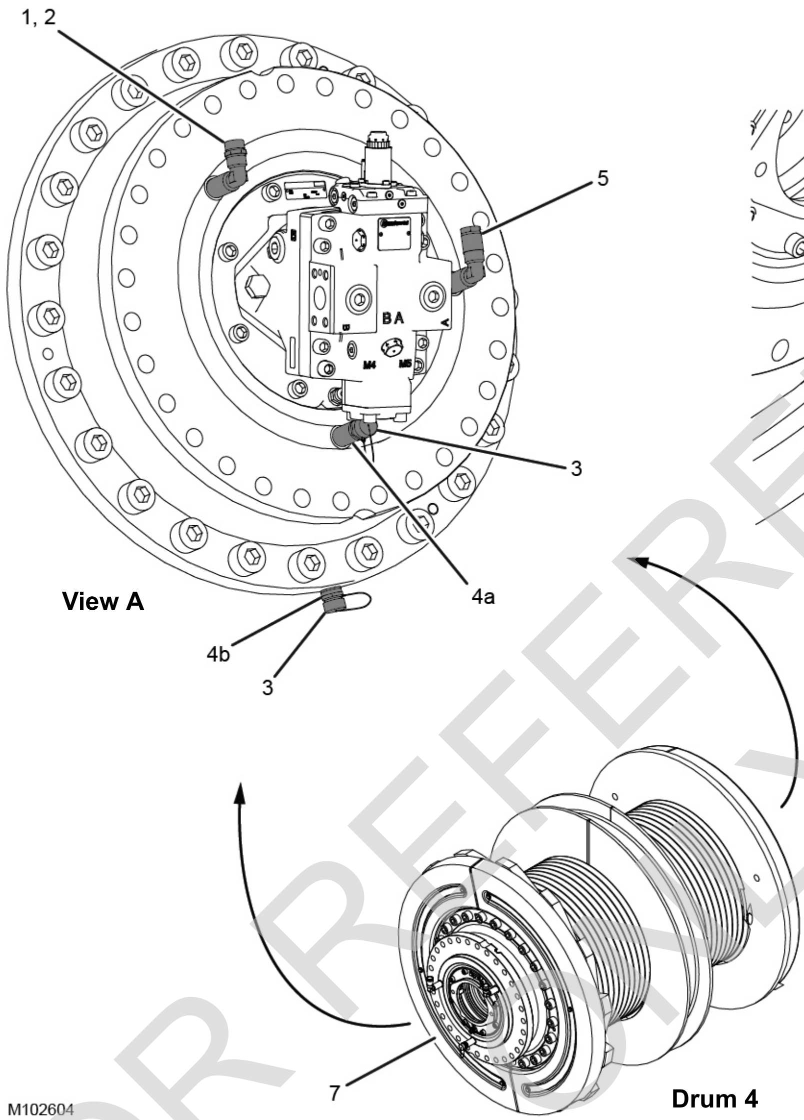
    Manual Fill Procedure (very slow process)

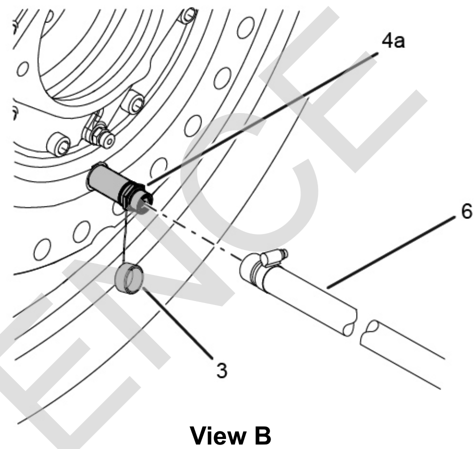
    a. If not already done, remove the breather plug (1).
    b. Add oil through the fill port (2) using an appropriate funnel until the oil level is halfway up the transparent oil level plug (5). Do not overfill.
    c. Install the breather plug.

    Power Fill Procedure (recommended)

    a. If not already done, remove the breather plug (1).
    b. Remove the dust cap (3) from quick-drain valve (4a).
    c. Thoroughly clean the inside of the quick-drain drainer assembly hose (6).
    d. Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
    e. Connect the hose from the quick-drain drainer assembly (6) to a portable pump, either hydraulically powered or hand powered.
    f. Slowly pump oil into the gearbox until the oil level is halfway up the transparent oil level plug (5). Do not overfill.
    g. When the gearbox is filled, remove the quick-drain drainer assembly hose.
    h. Fasten the dust cap to the quick-drain valve.
    i. Install the breather plug.
12. Check the oil level after operating the hoist. If necessary, add oil through the fill port.
13. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.

FOR REFERENCE ONLY





Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap (qty 2)
4a	Quick-Drain Valve
4b	Quick-Drain Valve (radial location)
5	Oil Level Plug
6	Quick-Drain Drainer Assembly Hose
7	Drum Guard Assembly

FIGURE 5-28

FOR REFERENCE ONLY

Drum 5

See Figure 5-29 for the following procedures.

The gearboxes should be drained and refilled after every 200 hours of drum operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

The oil level sight glass on front of the gearbox is located to show the correct level reading with the mast assembled to the machine and the mast top on the ground (approximately -7° angle). The oil level can be checked at any boom angle by removing the radial drain plug from the gearbox when boom is nearly horizontal.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the dust caps (3) from the quick-drain valves (4a and 4b).
4. Place the non-fitting end of the quick-drain drainer assembly hose (6) into an appropriate container for collecting the drained oil.
5. Connect the quick-drain drainer assembly hose to the quick-drain valve (4a, see View B).
6. When the draining is finished, remove the quick-drain drainer assembly (6).
7. Connect the quick-drain drainer assembly (6) to the radial quick-drain valve (4b) to drain the remaining oil.
8. When the draining is finished, disconnect the quick-drain drainer assembly hose.
9. Fasten the dust caps to the quick-drain valves.
10. Fill the gearbox with specific oil as follows.

    Manual Fill Procedure (very slow process)

    a. If not already done, remove the breather plug (1).
    b. Add oil through the fill port (2) using an appropriate funnel until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
    c. Install the breather plug.

    Power Fill Procedure (recommended)

    a. If not already done, remove the breather plug (1).
    b. Remove the dust cap (3) from the quick-drain valve (4a).
    c. Thoroughly clean the inside of the quick-drain drainer assembly hose (6).
    d. Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
    e. Connect the quick-drain drainer assembly hose to a portable pump, either hydraulically powered or hand powered.
    f. Slowly pump the oil into the gearbox until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
    g. When the gearbox is filled, remove the quick-drain drainer assembly hose.
    h. Fasten the dust cap to the quick-drain valve.
    i. Install the breather plug.
11. Check the oil level after operating the hoist. If necessary, add oil through the fill port (2).
12. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.

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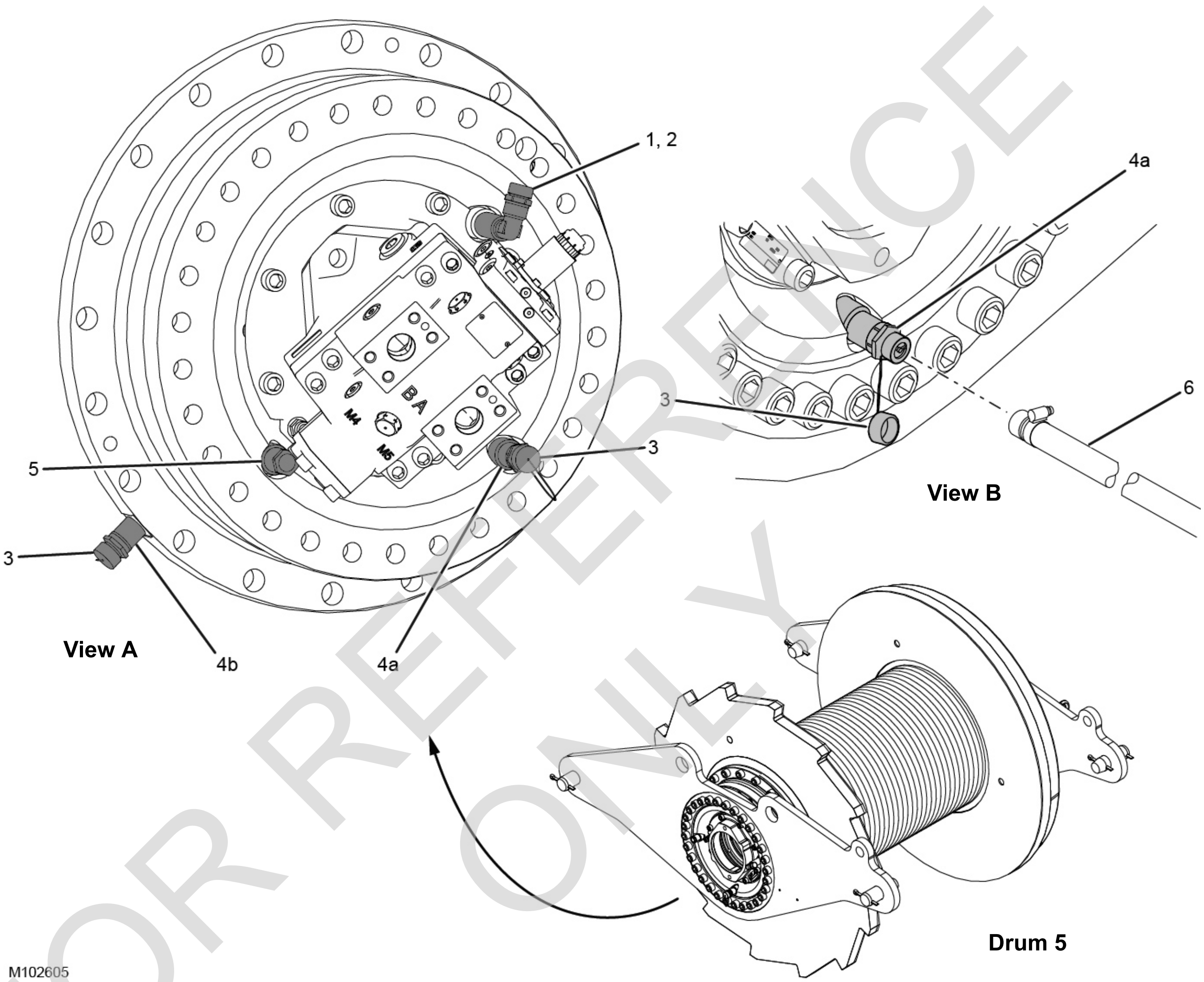

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Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap (qty 2)
4a	Quick-Drain Valve
4b	Quick-Drain Valve (radial location)
5	Oil Level Sight Gauge
6	Quick-Drain Drainer Assembly Hose

FIGURE 5-29

Drum 6

See Figure 5-30 for the following procedures.

The gearboxes should be drained and refilled after every 200 hours of drum operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

The oil level sight glass on front of the gearbox is located to show the correct level reading with the drum in the shipping position (approximately -18° angle). The oil level can be checked at any boom angle by removing the radial drain plug from the gearbox when the boom is nearly horizontal.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the drum guard assembly (7) to access the radial quick-drain valve (4b).
4. Remove the dust caps (3) from the quick-drain valves (4a and 4b).
5. Place the non-fitting end of the quick-drain drainer assembly hose (6) into an appropriate container for collecting the drained oil.
6. Connect the quick-drain drainer assembly hose to the quick-drain valve (4a, see View B).
7. When the draining is finished, disconnect the quick-drain drainer assembly hose.
8. Connect the quick-drain drainer assembly hose to the radial quick-drain valve (4b) to drain the remaining oil.
9. When the draining is finished, remove the quick-drain drainer assembly hose.
10. Fasten the dust caps to the quick-drain valves.
11. Fill the gearbox with specific oil as follows.

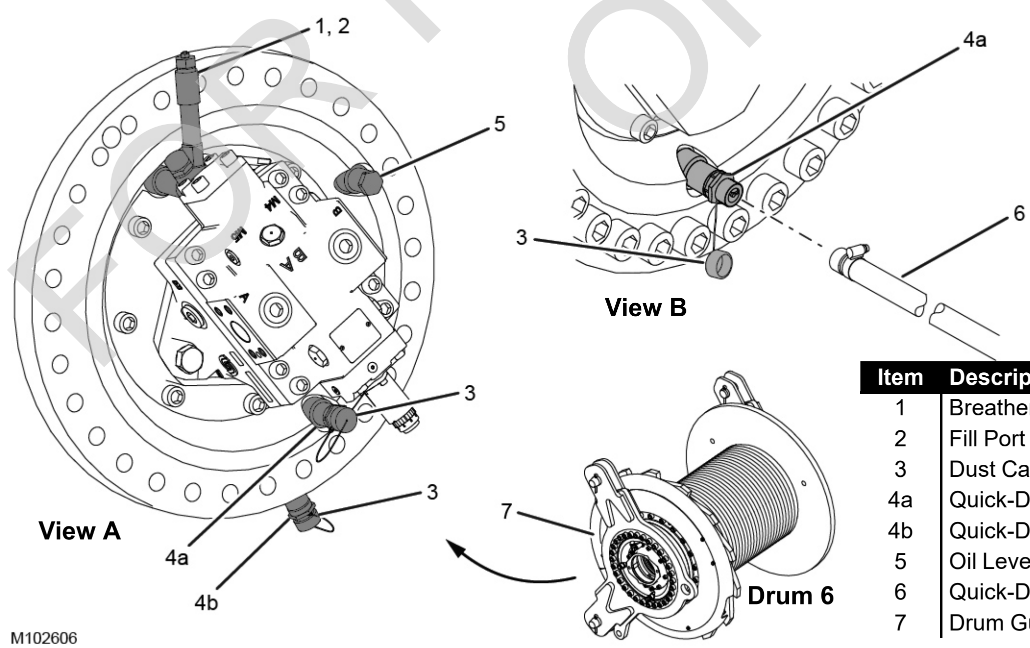
Manual Fill Procedure (very slow process)

a. If not already done, remove the breather plug (1).
b. Add oil through the fill port (2) using an appropriate funnel until the oil level is halfway up the oil level sight gauge (5). Do not overfill.
c. Install the breather plug.

Power Fill Procedure (recommended)

a. If not already done, remove the breather plug (1).
b. Remove the dust cap (3) from the quick-drain valve (4a).
c. Thoroughly clean the inside of the quick-drain drainer assembly hose (6).
d. Connect the quick-drain drainer assembly hose to the quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.
e. Connect the quick-drain drainer assembly hose to a portable pump, either hydraulically powered or hand powered.

FOR REFERENCE ONLY



Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap (qty 2)
4a	Quick-Drain Valve
4b	Quick-Drain Valve (radial location)
5	Oil Level Sight Gauge
6	Quick-Drain Drainer Assembly Hose
7	Drum Guard Assembly

FIGURE 5-30

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f. Slowly pump oil into the gearbox until the oil level is halfway up the oil level sight gauge (5). Do not overfill.

g. When the gearbox is filled, remove the quick-drain drainer assembly hose.

h. Fasten the dust cap to the quick-drain valve.

i. Install the breather plug.

12. Check the oil level after operating the hoist. If necessary, add oil through the fill port (2).

13. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.

FOR REFERENCE ONLY

DRUM MOTOR SPEED SENSOR

A speed sensor is installed in each motor. The sensor sends rotational speed and direction information to the corresponding control module to be used by the crane control functions.

Speed Sensor Replacement

See Figure 5-31 for the following procedure.

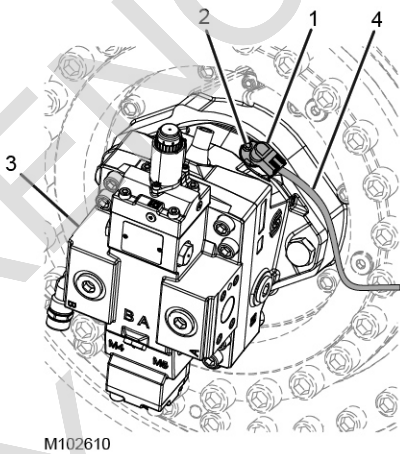
WARNING

Burn Hazard!

Oil will drain from the port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

1. Lockout-tagout the crane.
2. Disconnect the sensor cable (4) from the wire harness.
3. Thoroughly clean all around the sensor to prevent dirt from entering the hydraulic system.
4. On motors positioned so that the sensor is located on the underside of the motor, place an appropriate container under the drain plug and remove the drain plug.
5. Remove the sensor mounting screws (2).
6. Remove the speed sensor (1) and the O-ring. Be careful to contain any hydraulic fluid that might drain from the motor.
7. Clean the mating surfaces, then install a new sensor and O-ring.
8. Install the sensor mounting screws and tighten to the correct torque value for the size screw.
9. Connect the sensor cable to the wire harness.
10. On motors positioned so that the sensor is located on the underside of the motor, perform the following:
    a. Make sure that the drain plug is clean, then install the drain plug.
    b. Thoroughly clean all around the fill plug, then remove the fill plug.
    c. Fill the motor with filtered hydraulic oil of the correct type.
    d. Make sure that the fill plug is clean, then install the fill plug.
11. Operate the hoist and check for a steady drum speed (rpm) and direction signal on the corresponding drum's information display in the cab.
12. Check to make sure there is no oil leakage.

NOTE: The drum (hoist) motor speed sensors are set at the factory and should not need adjustment.



Item	Description
1	Speed Sensor
2	Sensor Mounting Screw
3	Drum Motor
4	Sensor Cable

FIGURE 5-31

Weekly Speed Sensor Periodic Maintenance

1. Make sure all the speed sensor assembly parts, wiring, and connections are secure and undamaged.
2. Operate the hoists to verify that there is a reliable speed readout on the main display. If there is intermittent or no readout, troubleshoot the speed sensor assembly.
3. Thoroughly clean the speed sensor of any accumulated dust and debris.

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BLOCK LEVEL

Operation

The block level sensors ensure that the load block remains level when two load lines—drums 1 and 2—are routed to the load block. Located on the #680 boom top, the sensors monitor sheave rotation speed. The crane's control modules use signals from the sensors to equalize the rotation speed of the drums so the load block remains level.

The sensors are adjusted at the factory and need to be adjusted only when a new sensor is installed or the position of a sensor is reconfigured.

Sensor Replacement

See Figure 5-32 for the following procedure.

Drum 1 and Drum 2

1. Lower the boom onto the blocking at the ground level.
2. Lockout-tagout the crane.
3. Remove the bolts (9) and washers (8). Remove the cover (7).
4. Disconnect the electrical cable from the proximity sensor (1).
5. Remove the jam nut (5) securing the proximity sensor from behind the bracket (6).
6. Remove the old proximity sensor from the bracket and install the new proximity sensor with a distance of 71 to 77 mm between sensors. Secure the new proximity sensor with the jam nut.
7. Connect the electrical cable to the proximity sensor.
8. Insert the bracket into the rectangular slot of the guide wire rope assembly (4).
9. Install the cover with the bolts and washers on the bracket.

Adjustment

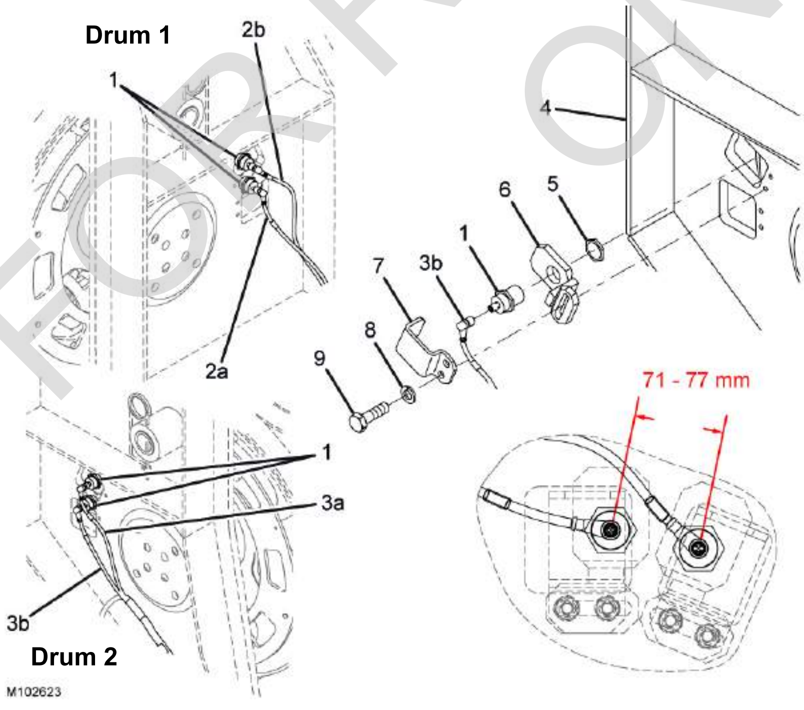
1. Loosen the jam nut (5) securing the proximity sensor (1) to the bracket (6).
2. Turn the proximity sensor in or out as needed until the gap between the end of the proximity sensor and the proximity sensor target plate is 6 to 9 mm (1/4 to 23/64 in).

NOTE: The LED on the proximity sensor illuminates when the sensor detects the passing target plate.

3. Tighten the jam nut.
4. Check for proper operation without load. Drums must operate at the same speed and the load block must remain level.
5. Readjust the proximity sensor as required.

Weekly Maintenance

1. Thoroughly clean the accumulated air dust on the proximity sensor.
2. Make sure all proximity sensor assembly parts, wiring, and connections are secure and undamaged.



Item	Description
1	Proximity Sensor
2a	Drum 1 Proximity A Cable
2b	Drum 1 Proximity B Cable
3a	Drum 2 Proximity A Cable
3b	Drum 2 Proximity B Cable
4	Guide Wire Rope Assembly
5	Jam Nut
6	Bracket
7	Cover
8	Washer
9	Bolt

FIGURE 5-32

FOR REFERENCE ONLY

BLOCK-UP LIMIT SWITCH

A block-up limit (also called anti-two-block device) is a two-blocking prevention device that stops the load drum from hoisting and the boom from lowering when a block or hook is too close to the sheave.

Details of the block-up limit system are found on the boom ESI assembly drawings.

WARNING

Two-Blocking Hazard!

Two-blocking is the condition in which the load block or the weight ball runs into the boom sheaves.

Two-blocking can result in failure of the sheaves and wire rope, possibly causing the load to fall.

The operator shall determine the fastest line speed that allows the block-up limit to function properly and thereafter not exceed that line speed.

If the block or weight ball approaches the boom sheaves too fast, the block-up limit may not prevent two-blocking.

NOTE: The block-up limit is a protective device designed only to assist the operator in preventing a two-blocking condition. Any other use is neither intended nor approved.

See Figure 5-33 for the following information.

The block-up limit system consists of the following components:

- A limit switch, wired for normally closed operation, fastened at the following locations:
  - Lower boom point
  - Upper boom point
- A weight freely suspended by a chain from each limit switch actuating lever (weight encircles load line as shown)
- A lift block fastened to the load line, or a lift plate fastened to the load block

For service of the block-up limit components in the luffing jib, see the MLC650 Luffing Jib Operator Manual supplied with the luffing jib.

Switch Activation Overview

For a complete wiring diagram of the system, see the ESI Boom Wiring Assembly Drawing for each block-up limit assembly.

Normal conditions (block-up limit control deactivated)— During normal operation, the weight overcomes spring force and rotates the actuating lever away from the limit switch lever. This allows the limit switch to close the hoist control handle electrical circuits.

Block-up limit control activated—When the weight is lifted by the lift block or the lift plates, spring force rotates the actuating lever against the limit switch lever. This causes the corresponding limit switch to open the hoist control handle electrical circuits.

The load drum and the boom/mast hoist pumps will stroke to off. At the same time, the load drum and the boom park brakes apply to stop the load drum from hoisting and the boom from lowering.

Weekly Maintenance

CAUTION

Avoid Machinery Damage!

If inspection reveals a problem with the block-up limit components, do not operate the crane until the block-up limit has been repaired to proper working order.

Inspect and test the block-up limits weekly or every 40 hours of operation, as follows.

1. Lower the boom (and the jib, if equipped) onto blocking at the ground level.
2. Lockout-tagout the crane.
3. Carefully inspect the following items.
   a. Inspect each weight for freedom of movement on the load line.
   b. Inspect each weight, chain, shackle and connecting pin for excessive or abnormal wear. Make sure the cotter pins for the shackles are installed and spread.
   c. Inspect the entire length of each electrical cable for damage.
   d. Make sure the electrical cables are clear of all moving parts on the boom (and the jib, if equipped).
   e. Make sure the cables are securely fastened to the boom (and the jib, if equipped) with nylon straps.
   f. Make sure all electrical cable connections are securely fastened.

FOR REFERENCE ONLY

4. Test the block-up limit devices for proper operation using either of the following two methods:

   - **Boom Lowered Method**

     While the boom is lowered and with the engine running:

     Manually lift one of the weights. Try to operate the corresponding hoist control. The drum must not turn in the raise direction and the boom/mast drum must not operate in the down direction.

     Test each block-up limit device this way.

CAUTION

Avoid Sheave Damage!

Use extreme care when testing the block-up limits when the boom is raised. If a block-up limit fails to stop the load, immediately stop the hoist.

   - **Boom Raised Method**

     Slowly hoist one of the load blocks and the weight ball against the weight. When the chain goes slack, the corresponding load drum must stop and the boom/mast hoist must not operate in the down direction.

     Test each block-up limit device this way.

CAUTION

Avoid Sheave Damage!

Do not lengthen or shorten the chains that hold the block limit weights. Proper chain length and weight is necessary for proper switch activation.

If replacement is needed, replace with the same length, size, and material as specified on the engineering drawing.

Switch Adjustment and Replacement

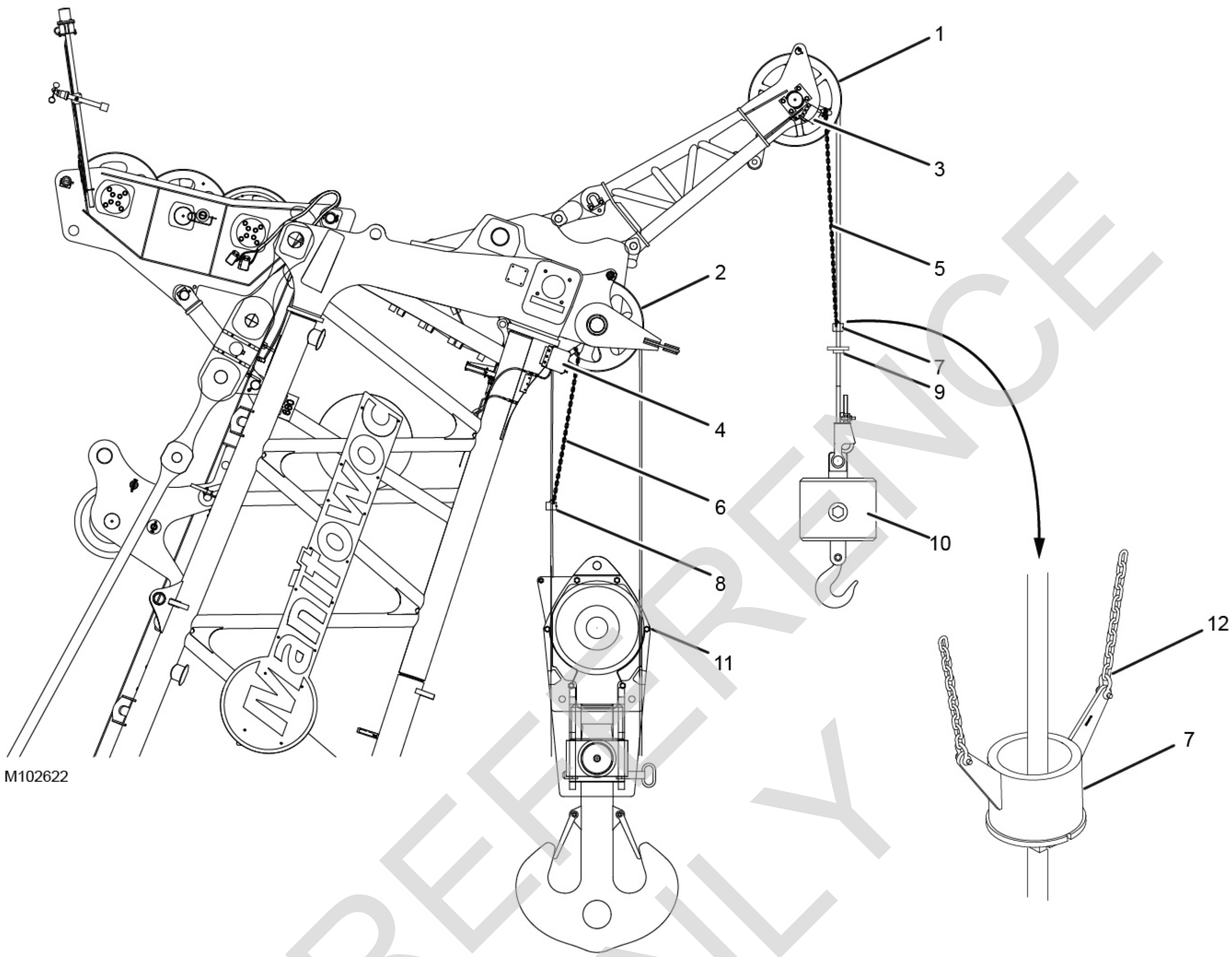
Overview

The spring should have sufficient strength and stiffness to lift the weight of the chain to force the actuator lever to rotate against the limit switch arm, activating the limit switch. The switch then sends a signal to a control module, which sends a corresponding signal to the appropriate cab display.

NOTE: The spring eyebolt distance and the limit switch arm are preset at the factory and are adjustable in service or at replacement.

Always bring the corresponding function to a complete stop before adjusting or replacing the limit switch.

FOR REFERENCE ONLY



Location of components at boom top is shown
Location of components at boom cap, EUBP, and luffing jib top is similar

Item	Description	Item	Description
1	Upper Boom Point	7	Weight
2	Lower Boom Point	8	Weight
3	Block-Up Limit Switch Enclosure	9	Lift Plate
4	Block-Up Limit Switch Enclosure	10	Weight Ball
5	Chain	11	Load Block
6	Chain	12	Chain, Shackle, and Pin

FIGURE 5-33

FOR REFERENCE ONLY

Main Boom Lower Point Block-Up Limit Switch

Adjustment

See Figure 5-34 for the following procedure.

Lower the boom onto blocking at ground level and adjust each limit switch as follows.

1. Remove the block-up limit assembly cover (7) to access internal components.
2. Remove the spring (1a).
3. Adjust the spring (1b) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (6) when the weight is lifted.
4. Manually lift the weight to allow the actuating lever to rotate upward.
5. Hold the actuating lever at Dimension A from the spring return position.
6. Loosen the setscrew (3) on the limit switch actuator arm (5).
7. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 8.
8. Turn the limit switch shaft (4) clockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
9. Attach the spring (1a).
10. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
11. Repeat the adjustment steps until the limit switch operates properly.
12. Install the block-up limit assembly cover when testing is complete.

Replacement

See Figure 5-34 for the following procedure.

1. Remove the block-up limit assembly cover (7).
2. Remove four mounting screws on the limit switch (8).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (3) and remove the limit switch actuator arm (5).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install the limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the main boom lower point block-up limit switch adjustment procedure.
13. Adjust the tension of the spring (1a) by adjusting the corresponding eyebolt (2) to Dimension C.

    Adjust the tension of the spring (1b) by adjusting the corresponding eyebolt to Dimension B.
14. Install the block-up limit assembly cover.

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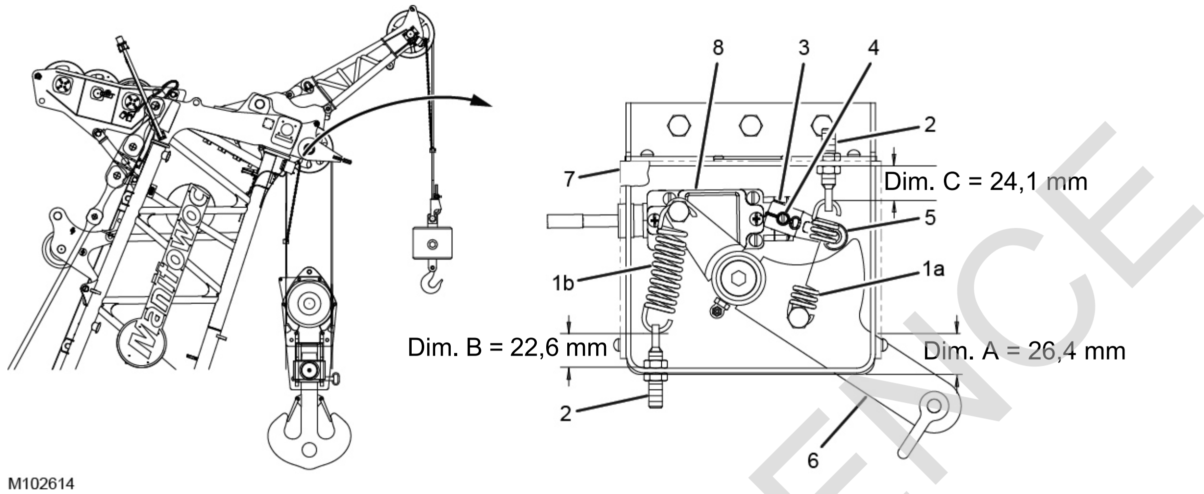


Item	Description
1a	Spring
1b	Spring
2	Eyebolt (qty 2)
3	Setscrew
4	Limit Switch Shaft
5	Limit Switch Actuator Arm
6	Actuating Lever
7	Block-Up Limit Assembly Cover
8	Limit Switch

FIGURE 5-34

FOR REFERENCE ONLY

Main Boom Upper Point Block-Up Limit Switch

Adjustment

See Figure 5-35 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch as follows.

1. Remove the block-up limit assembly cover (6) to access the internal components.
2. Adjust the spring (1) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (5) when the weight is lifted.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold the actuating lever at Dimension A from the spring return position.
5. Loosen the setscrew (2) on the limit switch actuator arm (4).
6. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 7.
7. Turn the limit switch shaft (3) clockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
8. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
9. Repeat the adjustment steps until the limit switch operates properly.
10. Install the block-up limit assembly cover when testing is complete.

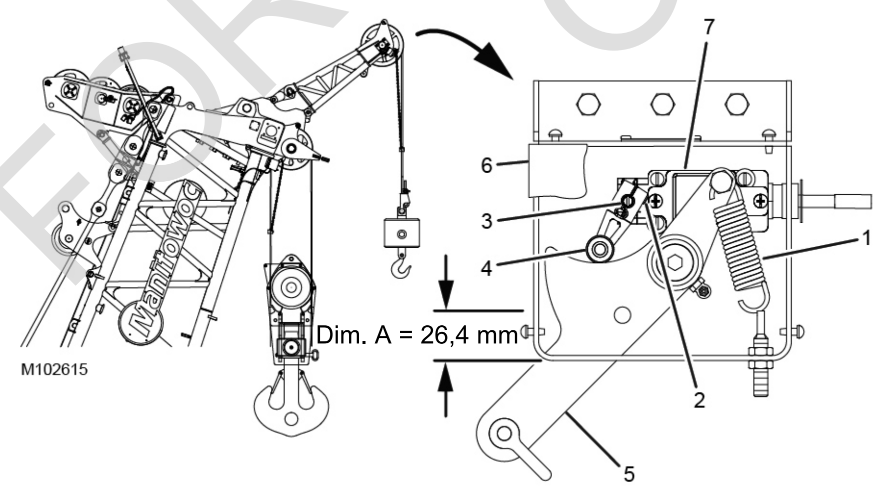
Replacement

See Figure 5-35 for the following procedure.

1. Remove the block-up limit assembly cover (6).
2. Remove four mounting screws on the limit switch (7).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (2) and remove the limit switch actuator arm (4).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install the limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the main boom upper point block-up limit switch adjustment procedure.
13. Install the block-up limit assembly cover.

FOR REFERENCE ONLY



Item	Description
1	Spring
2	Setscrew
3	Limit Switch Shaft
4	Limit Switch Actuator Arm
5	Actuating Lever
6	Block-Up Limit Assembly Cover
7	Limit Switch

FIGURE 5-35

Main Boom Lower Point 1M Boom Cap Block-Up Limit Switch

Adjustment

See Figure 5-36 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch as follows.

1. Remove the block-up limit assembly cover (8) to access the internal components.
2. Remove the spring (1).
3. Adjust the spring (2) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (7) when the weight is lifted.
4. Manually lift the weight to allow the actuating lever to rotate upward.
5. Hold the actuating lever at Dimension A from the spring return position.
6. Loosen the setscrew (4) on the limit switch actuator arm (6).
7. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 8.
8. Turn the limit switch shaft (5) clockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
9. Attach the spring.
10. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
11. Repeat the adjustment steps until the limit switch operates properly.
12. Install the block-up limit assembly cover when testing is complete.

Replacement

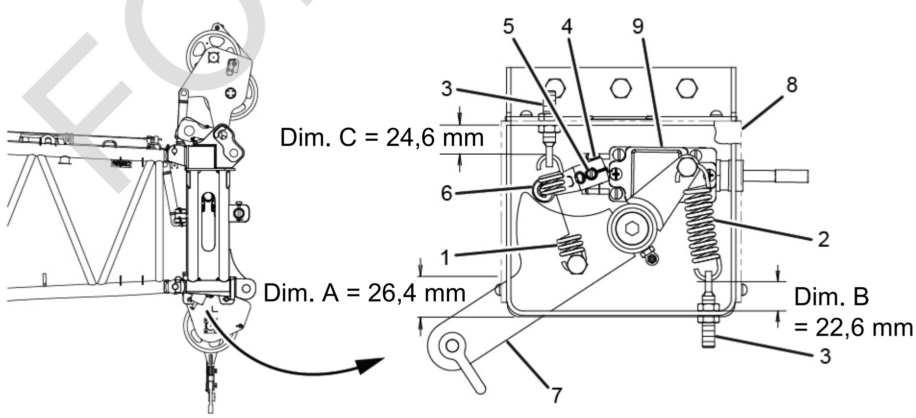
See Figure 5-36 for the following procedure.

1. Remove the block-up limit assembly cover (8).
2. Remove four mounting screws on the limit switch (9).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (4) and remove the limit switch actuator arm (6).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install the limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the main boom lower point 1M boom cap block-up limit adjustment procedure.
13. Adjust the tension of the spring (1) by adjusting the corresponding eyebolt (3) to Dimension C.

    Adjust the tension of the spring (2) by adjusting the corresponding eyebolt to Dimension B.
14. Install the block-up limit assembly cover.

FOR REFERENCE ONLY



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Item	Description
1	Spring
2	Spring
3	Eyebolt
4	Setscrew
5	Limit Switch Shaft
6	Limit Switch Actuator Arm
7	Actuating Lever
8	Block-Up Limit Assembly Cover
9	Limit Switch

FIGURE 5-36

EUBP Limit 1 Block-Up Limit Switch

Adjustment

See Figure 5-37 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch as follows.

1. Remove the block-up limit assembly cover (6) to access the internal components.
2. Adjust the spring (1) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (5) when the weight is lifted.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold the actuating lever at Dimension A from the spring return position.
5. Loosen the setscrew (2) on the limit switch actuator arm (4).
6. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 7.
7. Turn the limit switch shaft (3) clockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
8. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
9. Repeat the adjustment steps until the limit switch operates properly.
10. Install the block-up limit assembly cover when testing is complete.

Replacement

See Figure 5-37 for the following procedure.

1. Remove the block-up limit assembly cover (6).
2. Remove four mounting screws on the limit switch (7).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (2) and remove the limit switch actuator arm (4).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install the limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the EUBP limit 1 block-up limit switch adjustment procedure.
13. Install the block-up limit assembly cover.

FOR REFERENCE ONLY

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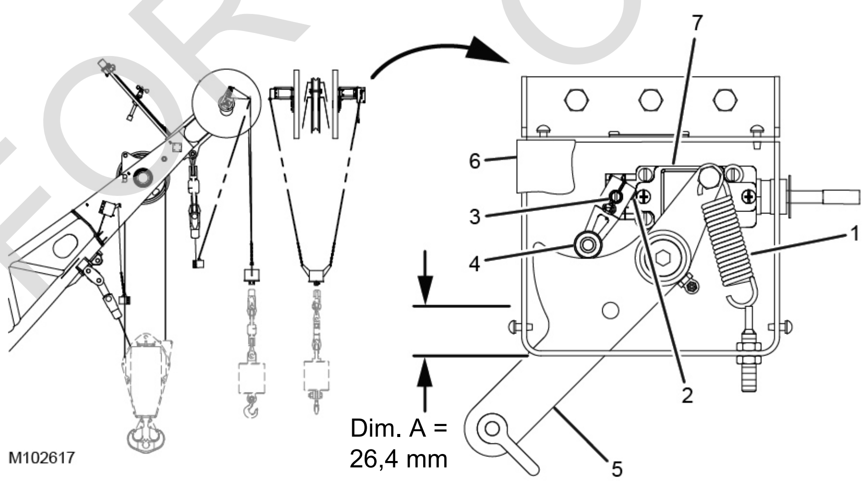


Item	Description
1	Spring
2	Setscrew
3	Limit Switch Shaft
4	Limit Switch Actuator Arm
5	Actuating Lever
6	Block-Up Limit Assembly Cover
7	Limit Switch

FIGURE 5-37

EUBP Limit 2 Block-Up Limit Switch

Adjustment

See Figure 5-38 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch as follows:

1. Remove the block-up limit assembly cover (6) to access the internal components.
2. Adjust the spring (1) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (5) when the weight is lifted.
3. Manually lift the weight to allow the actuating lever to rotate upward.
4. Hold the actuating lever at Dimension A from the spring return position.
5. Loosen the setscrew (2) on the limit switch actuator arm (4).
6. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 7.
7. Turn the limit switch shaft (3) counterclockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
8. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
9. Repeat the adjustment steps until the limit switch operates properly.
10. Install the block-up limit assembly cover when testing is complete.

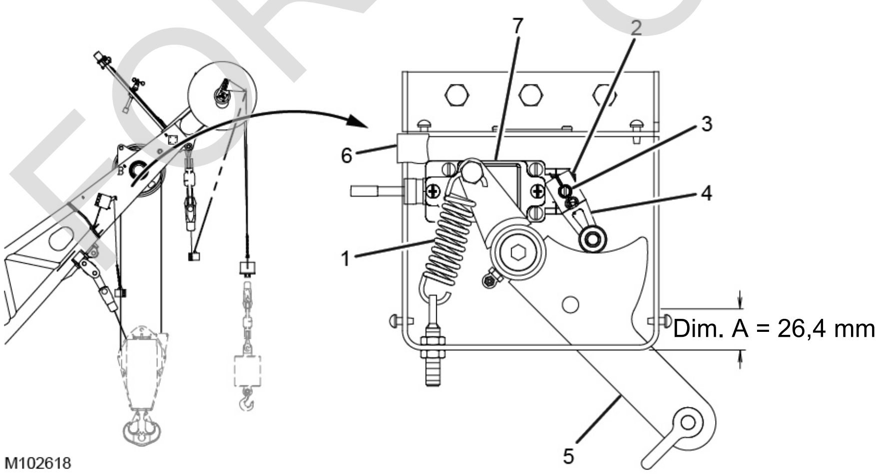
Replacement

See Figure 5-38 for the following procedure.

1. Remove the block-up limit assembly cover (6).
2. Remove four mounting screws on the limit switch (7).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (2) and remove the limit switch actuator arm (4).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the EUBP limit 2 block-up limit switch adjustment procedure.
13. Install the block-up limit assembly cover.

FOR REFERENCE ONLY



Item	Description
1	Spring
2	Setscrew
3	Limit Switch Shaft
4	Limit Switch Actuator Arm
5	Actuating Lever
6	Block-Up Limit Assembly Cover
7	Limit Switch

FIGURE 5-38

Luffing Jib Lower Boom Point #682 Top Block-Up Limit Switch

Adjustment

See Figure 5-39 for the following procedure.

Lower the boom onto blocking at the ground level and adjust each limit switch as follows.

1. Remove the block-up limit assembly cover (8) to access the internal components.
2. Remove the spring (1).
3. Adjust the spring (2) tension so there is enough force to lift the weight of the chain and rotate the actuating lever (7) when the weight is lifted.
4. Manually lift the weight to allow the actuating lever to rotate upward.
5. Hold the actuating lever at Dimension A from the spring return position.
6. Loosen the setscrew (4) on the limit switch actuator arm (6).
7. Using a screwdriver, hold the roller on the limit switch actuator arm against the actuating lever while performing step 8.
8. Turn the limit switch shaft (5) counterclockwise until the switch just actuates, then tighten the setscrew on the limit switch actuator arm.
9. Attach the spring.
10. Test the limit switch for proper operation (see Weekly Maintenance on page 5-62).
11. Repeat the adjustment steps until the limit switch operates properly.
12. Install the block-up limit assembly cover when testing is complete.

Replacement

See Figure 5-39 for the following procedure.

1. Remove the block-up limit assembly cover (8).
2. Remove four mounting screws on the limit switch (9).
3. Remove the limit switch cover to expose the internal wiring connections.
4. Disconnect the electrical wires inside the limit switch.
5. Remove the cable restraint nut and carefully pull the electrical cable and wires from the limit switch.
6. Loosen the setscrew (4) and remove the limit switch actuator arm (6).
7. Insert the electrical cable into the new limit switch and connect the wiring.

   The jumper wires and the receptacle lead wires must be stripped to 6,35 mm (0.25 in) to properly fit the U-clamp screw termination.
8. Install and tighten the cable restraint nut to the limit switch.
9. Install the limit switch cover.
10. Install the limit switch actuator arm.
11. Install the limit switch onto the block-up limit assembly using four mounting screws.
12. Perform the luffing jib lower boom point #682 top block-up limit adjustment procedure.
13. Adjust the tension of the spring (1) by adjusting the corresponding eyebolt (3) to Dimension C.

    Adjust the tension of the spring (2) by adjusting the corresponding eyebolt to Dimension B.
14. Install the block-up limit assembly cover.

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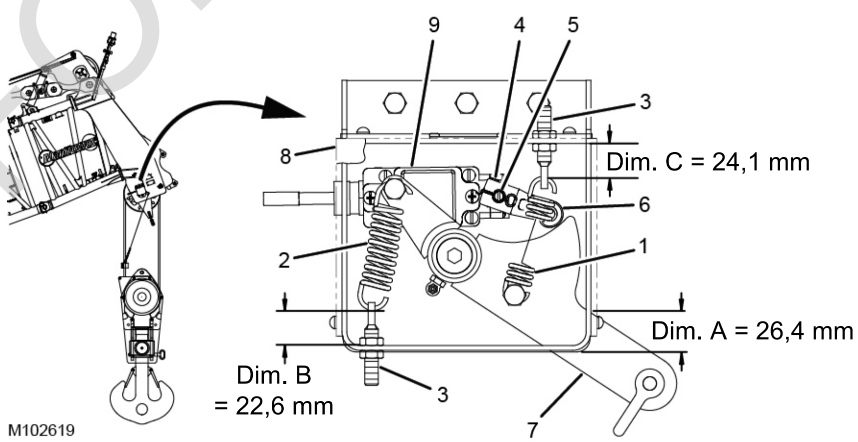

Item	Description
1	Spring
2	Spring
3	Eyebolt (qty 2)
4	Setscrew
5	Limit Switch Shaft
6	Limit Switch Actuator Arm
7	Actuating Lever
8	Block-Up Limit Assembly Cover
9	Limit Switch

FIGURE 5-39

PRESSURE ROLLER

Overview

The pressure roller is a protective device that prevents the wire rope from jumping wraps on the corresponding drum or from jumping off the corresponding drum.

CAUTION

Prevent Wire Rope Damage!

If equipped, make sure the pressure roller springs are tight enough to hold the rollers snugly against all layers of wire rope on the drum—from the first layer to the last layer.

Drum 3

See Figure 5-40 for the following procedures.

Weekly Maintenance

1. Watch the pressure rollers (2) while paying out and hauling in the wire rope on the drum (1). The springs (3) must hold the pressure rollers snugly against all layers of wire rope on the drum—from the first layer to the last layer.
2. If necessary, increase the tension of the springs by tightening the lock nut (7a).

Spring Replacement

1. Attach lifting slings from a hoist to the pressure roller assembly. The pressure roller assembly weighs 123,7 kg (272.73 lb).
2. Remove the spring load from the pressure roller by tightening the lock nuts (7b) against the plates (11).
3. Remove the cotter pins (5 and 9). Remove the pins (6 and 10) and the washers (8).
4. Remove the pressure roller assembly from the drum assembly.
5. Unload the springs by loosening and removing the lock nuts (7b).
6. Remove the spring retainer bars (4).
7. Remove the old springs (3) and replace with new springs.
8. Install the spring retainer bars.

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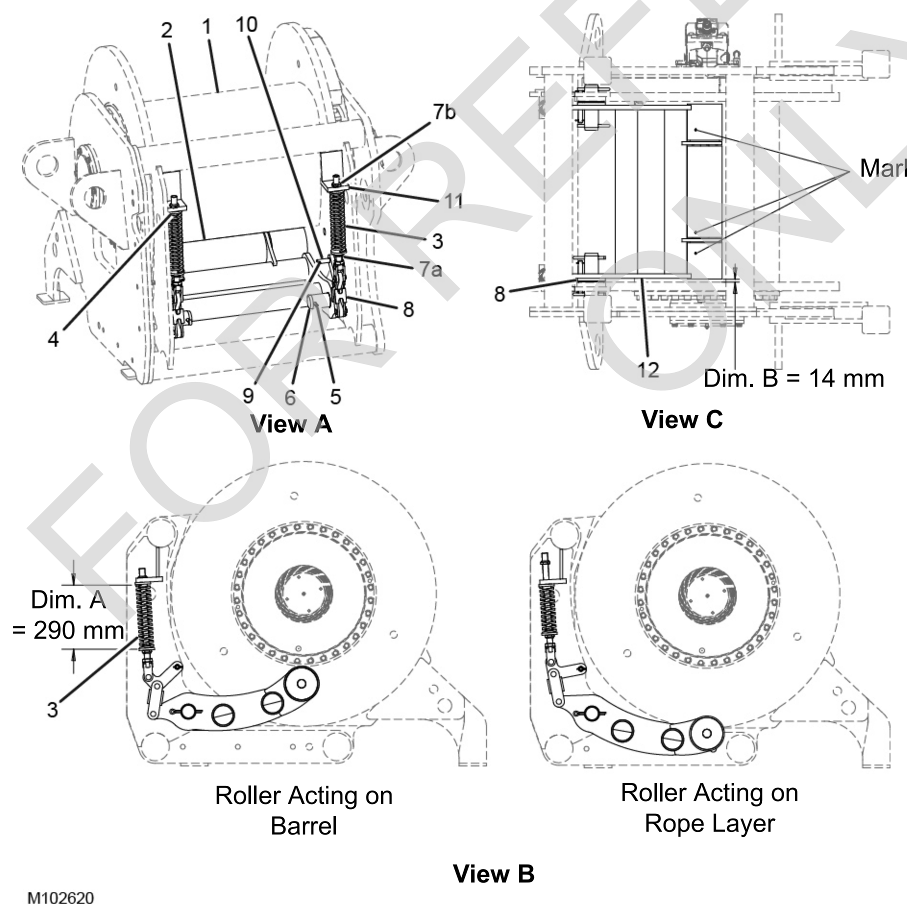

Item	Description
1	Drum
2	Pressure Roller
3	Spring
4	Spring Retainer Bar
5	Cotter Pin
6	Pin
7a	Lock Nut
7b	Lock Nut
8	Washer
9	Cotter Pin
10	Pin
11	Plate
12	Pressure Roller Arm

FIGURE 5-40

9. Tighten the lock nuts (7b) against the plates until components can be assembled.
10. Attach lifting slings from a hoist to the pressure roller assembly. The pressure roller assembly weighs 123,7 kg (272.73 lb).
11. Lift the pressure roller assembly into position at the plates on the drum assembly.
12. Install the pins (6 and 10) and the washers. Install the cotter pins (5 and 9).
13. Loosen the lock nuts (7b) to their original position on the spring retainer bars.

Adjustment

1. Pre-load the spring (3) to Dimension A with the pressure roller (2) against the drum barrel (see View B).
2. Use washers (8) to center support the pressure roller arms (12) from inside the drum flange to Dimension B (see View C).
3. To aid in lining up the spring pin holes, align scribed marks on the rollers and the shaft (see View C).

Drum 5

See Figure 5-41 for the following procedures.

Weekly Maintenance

1. Watch the pressure rollers (2) while paying out and hauling in the wire rope on the drum (1). The springs (3) must hold the pressure rollers firmly against all layers of wire rope on the drum—from the first layer to the last layer.
2. If necessary, increase the tension of the springs by tightening the lock nut (7a).

Spring Replacement

1. Attach lifting slings from a hoist to the pressure roller assembly. The pressure roller assembly weighs 185,7 kg (409.4 lb).
2. Remove the spring load from the pressure roller by tightening the lock nuts (7b) against the plates (11).
3. Remove the cotter pins (5 and 9). Remove the pins (6 and 10) and the washers (8).
4. Remove the pressure roller assembly from the drum assembly.
5. Unload the springs by loosening and removing the lock nuts (7b).
6. Remove the spring retainer bars (4).
7. Remove the old springs (3) and replace with new springs.
8. Install the spring retainer bars.
9. Tighten the lock nuts (7b) against the plates until the components can be assembled.
10. Attach lifting slings from a hoist to the pressure roller assembly. The pressure roller assembly weighs 185,7 kg (409.4 lb).
11. Lift the pressure roller assembly into position at the plates on the drum assembly.
12. Install the pins (6 and 10) and the washers (8). Install the cotter pins (5 and 9).
13. Loosen the lock nuts (7b) to their original position on the spring retainer bars.

Adjustment

1. Pre-load the spring (3) to Dimension A with the pressure roller (2) against the drum barrel (see View B).
2. Use the washers (8) to center support the pressure roller arm (12) from inside the drum flange to Dimension B (see View C).
3. To aid in lining up the spring pin holes, align scribed marks on the rollers and the shaft (see View C).

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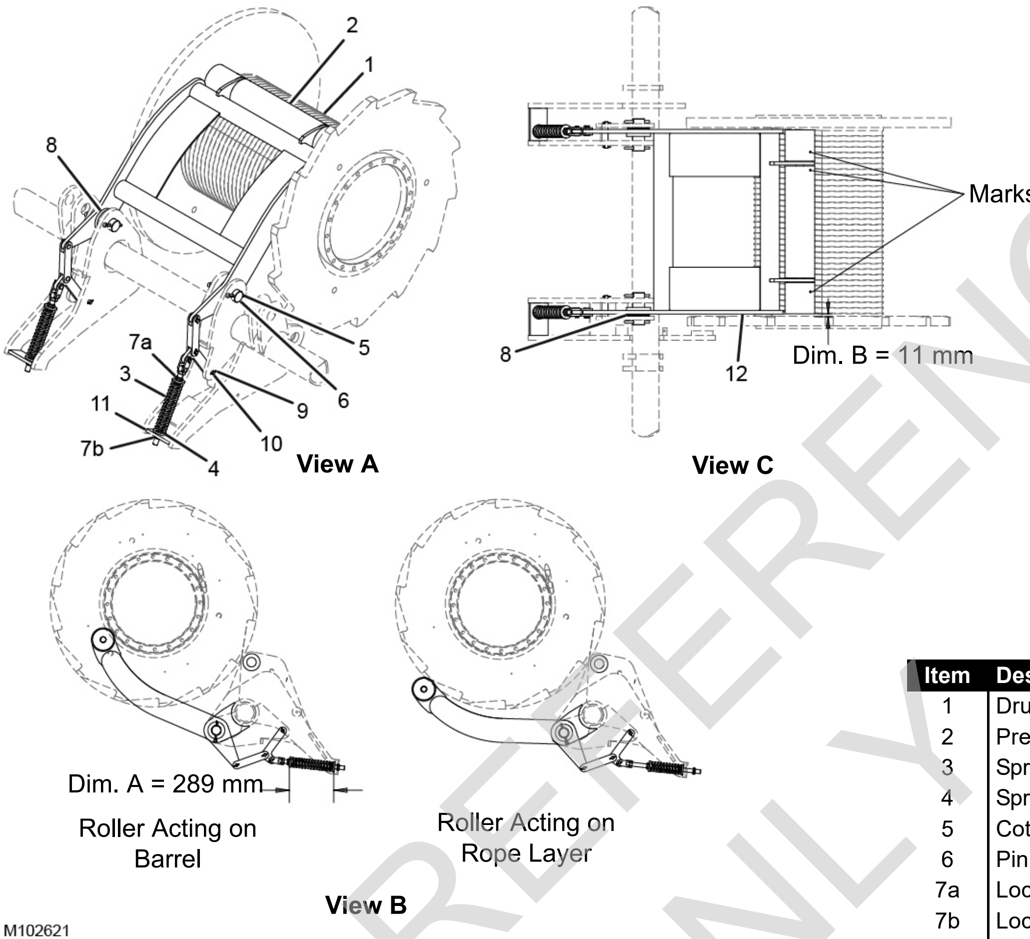

Item	Description
1	Drum
2	Pressure Roller
3	Spring
4	Spring Retainer Bar
5	Cotter Pin
6	Pin
7a	Lock Nut
7b	Lock Nut
8	Washer
9	Cotter Pin
10	Pin
11	Plate
12	Pressure Roller Arm

FIGURE 5-41

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WIRE ROPE INSPECTION AND REPLACEMENT

The following information is from various wire rope manufacturers and includes inspection, replacement, and maintenance guidelines for wire rope as established by ANSI/ASME B30.5, federal regulations, and Manitowoc Cranes.

Wire Rope Lubrication

Refer to the lube folio for lubrication techniques.

CAUTION

Prevent Wire Rope Damage!

Do not use grease to lubricate the wire rope. Grease will not penetrate the rope properly and will build up in the valleys between the wires and strands. This buildup will inhibit rope inspection and could trap moisture in the rope's interior.

A high-quality wire rope lubricant is available from the Manitowoc Crane Care Lattice Team. Otherwise, consult your wire rope supplier.

Maintain a Wire Rope Condition Report

Always keep on file a signed and dated periodic inspection report of the wire rope's condition. The report must cover all inspection points discussed in this section. The information in the reports can then be used to determine when a wire rope should be replaced.

After initial loading of a new rope, measure and record its diameter for comparison with future inspections. Measure the rope's diameter across the crowns of the strands so the true diameter is measured (Figure 5-43).

Wire rope removed from service should be examined and a corresponding report should be kept. This information can be used to establish a relationship between visual inspection and the rope's actual internal condition at the time of its removal from service. See Replacement Criteria on page 5-77 for inspection guidelines.

Required Inspection Intervals

The frequency of wire rope inspection must be:

- Daily (see Daily Inspection on page 5-75) and
- Yearly (at minimum) (see Periodic Comprehensive Inspection on page 5-77)

Wire Rope Care and Replacement Guidelines

- When replacing fixed-length wire rope assemblies (such as pendants) having permanently attached end fittings, use only pre-assembled lengths of wire rope as supplied from Manitowoc Cranes. Do not build lengths from individual components.
- Replace an entire wire rope assembly. Do not attempt to rework damaged wire rope or wire rope ends.
- Never electroplate a wire rope assembly.
- Do not weld any wire rope assembly or component unless welding is recommended by the wire rope manufacturer.
- Welding spatter must never be allowed to come in contact with the wire rope or wire rope ends. In addition, make sure that the wire rope is not an electrical path during other welding operations.
- Wire ropes are manufactured from special steels. If heating a wire rope assembly is absolutely necessary for removal, the entire wire rope assembly must be discarded.
- On systems equipped with two or more wire rope assemblies operating as a matched set, they must be replaced as an entire set.
- Do not paint or coat wire ropes with any substance except approved lubricants.

Daily Inspection

Wire rope should be inspected in accordance with ANSI/ASME B30.5 and OSHA 29 CFR 1926.1413. A running record of the condition of each wire rope should be noted in the equipment inspection log.

WARNING

Personal Injury Hazard!

Prior to conducting an inspection of wire rope:

- Lock out the equipment power when removing or installing the wire rope assemblies.
- Use safety glasses for eye protection.
- Wear protective clothing, gloves, and safety shoes as appropriate.
- Use supports and clamps to prevent uncontrolled movement of the wire rope, parts, and equipment.

- Each work day, prior to crane work, visually inspect all rope that can reasonably be expected to be used that day. Check for obvious damage, including the following:
    - Rope defects such as shown in Figure 5-42

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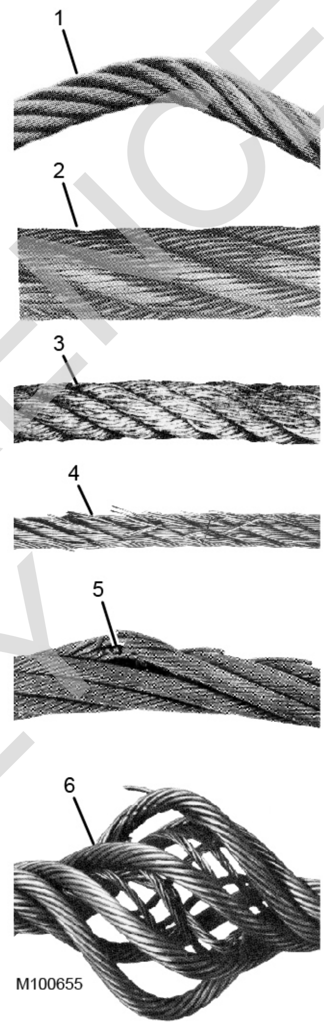
- Distortion to the uniform structure of the rope
- Loss of rope diameter (see Reduction in the Rope Diameter on page 5-77)
- Broken wires—Record the number, distribution and type of broken wires (see Broken Rope Wires on page 5-78).
- Internal wear or broken wires for ropes operating on synthetic sheaves. Common indicators of internal deterioration include localized reduction in the rope diameter, corrosion between the strands, localized lengthening of lay, wire displacement, or wire distortion.
- Gross damage, deterioration, or corrosion to the end connections
- Evidence of heat, electrical, or lightning damage
- Localized change in lubrication condition
- Minor or general corrosion
- Areas that deteriorate more rapidly, such as the flange points, the crossover points, and the repetitive pickup points on the drums
- Take special care to observe the boom hoist ropes and rotation-resistant ropes for evidence of core failure or other deterioration (remove from service)
- Internal deterioration of rotation-resistant ropes may not be readily observable

• Throughout the day, observe the wire rope during operation, particularly at the following locations:

a. Repetitive wear points, such as the following:
   - Flange step-up, crossover, repetitive pickup points on drums
   - Reverse bends in the reeving systems
   - Equalizer sheaves
   - End connections
   - Sheave or drum groove wear or corrugation

b. Known wear areas based on previous experience or inspections

c. Locations where rope vibrations are reduced, such as the following:
   - Sections is contact with equalizer or other sheaves where rope travel is limited
   - Sections of the rope at or near end connections where corroded or broken wires may protrude
   - Rope at the reverse bends in the boom hoist or luffing hoist reeving
   - Repetitive pickup points, crossovers, and change of layers at flanges on the drums
   - Fleeting or deflector sheaves



Item	Description
1	Dog-Leg or Kink
2	Drum Abrasion
3	Drum Crushing
4	Sheaves Too Small
5	Corrosion
6	Bird Cage (sudden release of load)

FIGURE 5-42

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Periodic Comprehensive Inspection

The comprehensive inspection must be done by a qualified person. The inspection must include pulling all the rope off the drum and carefully inspecting the entire length.

The inspection must include the following:

- All points listed under Daily Inspection on page 5-75
- Inspection of the rope diameter (see Reduction in the Rope Diameter on page 5-77)
- Comprehensive examination for broken wires (see Broken Rope Wires on page 5-78)
- End connections—Check for broken wires and severely corroded, cracked, bent, worn, or improperly applied end connections.
- Areas subjected to rapid deterioration, such as the following:
  - Sections in contact with saddles, equalizer sheaves, or other sheaves where the wire rope travel is limited
  - Sections of the wire rope at or near the terminal ends where corroded or broken wires may protrude
- Inspection of the boom sheaves, hook block sheaves, gantry/mast sheaves, boom extension/jib sheaves, jib strut sheaves, and hoist drums for wear

NOTE: Damaged sheaves or hoist drums can accelerate wear and cause rapid deterioration of the wire rope.

Any damage of the wire rope found must be recorded and a determination made as to whether continued use of the rope is safe (see Replacement Criteria on page 5-77).

WARNING

Falling Load Hazard!

- As a wire rope approaches the end of its useful life, perform inspections more frequently.
- All wire rope will eventually deteriorate to a point where it is no longer usable.
- A comprehensive inspection of each wire rope must be performed at least once a year.

Determining the Frequency of Inspection

Intervals for comprehensive inspections may vary from machine to machine. The inspection interval must be determined by a qualified person and be based on such factors as the following:

- Expected rope life as determined by experience on the particular installation or similar installations
- Size, nature, and frequency of lifts
- Rope maintenance practices
- Severity of the environment, such as:
  - Variation in the temperature
  - Continuous excessive moisture levels
  - Exposure to corrosive chemicals or vapors
  - Subjecting the wire rope to abrasive material
  - Power line contact
- Exposure to abuse and shock loads, such as:
  - High-velocity movement, such as hoisting or swinging a load followed by abrupt stops
  - Suspending loads while traveling over irregular surfaces such as railroad tracks, potholes, and rough terrain
  - Moving a load that is beyond the rated capacity of the lifting mechanism (overloading)

NOTE: Inspection intervals may also be predetermined by state and local regulatory agencies.

5

Replacement Criteria

The decision as to when a wire rope should be replaced is the responsibility of the qualified person who is appointed to review rope inspection records and evaluate rope condition.

The following are indications that the rope needs to be replaced:

- Reduction in the rope diameter and excessive broken wires (see Reduction in the Rope Diameter on page 5-77 and Broken Rope Wires on page 5-78)
- Wear of one-third of the original diameter of outside individual wires
- Kinking, crushing, birdcaging, or any other damage resulting in distortion of the rope structure
- Evidence of any heat damage from any cause
- Severe corrosion as evidenced by pitting
- Independent wire rope core (IWRC) or strand core protrusion between outer strands
- Obvious damage existing from any heat source including—but not limited to—welding, power line strike, or lightning

Reduction in the Rope Diameter

A reduction in rope diameter is often the first outward sign that the rope core is damaged. Reduction in the rope

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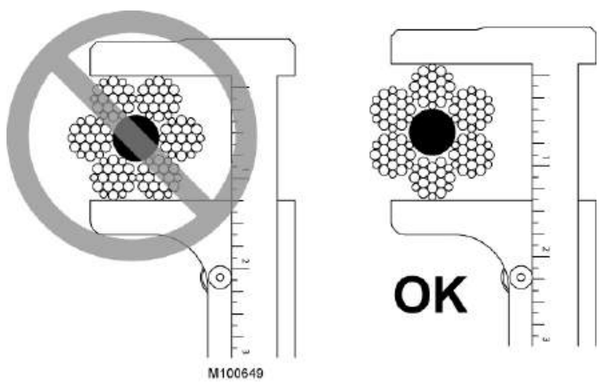
diameter can be caused by loss of core support, internal or external corrosion, or wear of the outside wires.

After initial loading, measure and record the diameter of any new wire rope for comparison to future inspections (see Maintain a Wire Rope Condition Report on page 5-75).

The wire rope must be taken out of service when the reduction from its nominal diameter is more than 5 percent.



Incorrect Correct

Measuring Technique

FIGURE 5-43

Broken Rope Wires

WARNING

Falling Load Hazard!

A broken wire indicates a weakened wire rope. Replace wire rope when more than one broken wire appears.

When conducting the periodic comprehensive inspection, thoroughly clean the wire rope so breaks can be seen. Relax the rope, move it off “pick-up points,” and flex it as much as possible to uncover damage. Use a sharp awl to lift any wire which appears loose. ***Do not attempt to open the rope***.

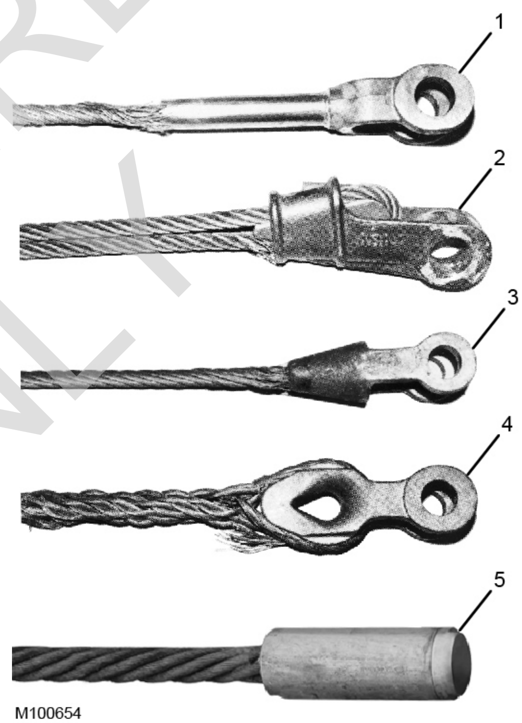
Wire breaks are typically at the crown of the strands—the area that contacts the sheave or drum when a load is picked up. Breaks at the crown will appear as small gaps in a wire. In comparison, when wires in the valley of a strand break, the broken ends will rise up and are easier to notice.

NOTE: The daily inspection does not require that the rope be cleaned or probed.

The wire rope must be taken out of service when it has the following number of broken wires:

See Figure 5-45 for an explanation of lay length.

- Running ropes—six randomly broken wires in one lay length or three broken wires in one strand in one lay length
- Standing ropes (pendants)—more than two broken wires in one lay length in sections beyond the end attachment, or more than one broken wire at the end attachment (Figure 5-44)
- Rotation-resistant rope—two randomly distributed broken wires in six-rope diameters or four randomly distributed broken wires in 30-rope diameters
- All ropes—one outer wire broken at the point of contact with the core and protrudes or loops out of the rope structure—additional inspection is required
- End attachments (Figure 5-44)—when more than one broken wire appears at the attachment, replace the rope or cut off the affected area and reattach the fitting



Item	Description
1	Swagged Socket
2	Wedge Socket
3	Poured Zinc Socket
4	Hand-Spliced Socket
5	Button Socket

FIGURE 5-44

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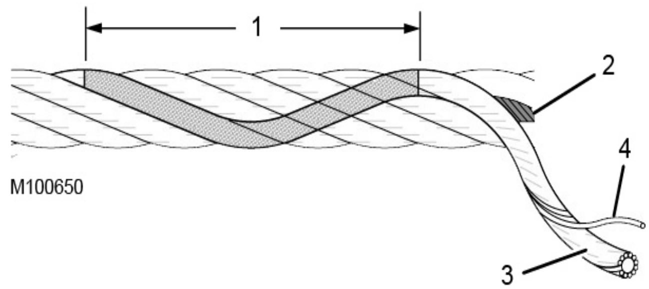

Item	Description
1	Lay Length (distance in which one strand makes one complete revolution around core)
2	Core
3	Strand
4	Wire

FIGURE 5-45

Rope That Has Been Idle a Month or More

Wire rope must be given a complete inspection if it has been idle for a month or more. The inspection must be performed by a qualified inspector looking for the damage identified under both Daily and Periodic Comprehensive Inspection.

NOTE: Wire rope may be purchased through the Manitowoc Crane Care Lattice Team.

WARNING

Falling Load Hazard!

Replacement wire rope can break if it does not meet Manitowoc Cranes specifications given in the following publications supplied with your crane:

- Wire Rope Specifications Chart located in the Capacity Chart Manual (for load lines)
- Boom or Jib Assembly drawings located in the Operator Manual (for boom or luffing hoist)
- Mast Assembly drawing located in the Parts Manual

Distributing Wire Rope Wear

Wire rope wear at the "critical wear points" can be reduced and the life of the wire rope extended by moving the rope at regular intervals so, different sections of the rope are subjected to the wear points. This practice can also help correct spooling problems and rope vibration.

To move the wire rope, cut off a piece of the rope at the worn end and refasten. The piece should be long enough to move the wire rope at least one full drum wrap.

If the wire rope is too short to allow cutting off a piece, reverse the rope end for end and refasten it.

SHEAVE, ROLLER, AND DRUM INSPECTION

Perform the following inspections weekly:

- Check the drum clutches and the brakes for proper adjustment.
- Check all sheaves, rollers, and drums for the following conditions:
  - Unusual noises
  - Freedom of movement—must turn freely by hand. Wire rope may need to be loosened to perform this inspection.
  - Wobble—must turn true with very little side-to-side or up-and-down play.
  - Signs of rust (indicating that water may have entered bearing)
  - Grease leaks (indicating a faulty seal or water in grease)

  The above problems indicate bearing damage. If found, the corresponding sheave, roller, or drum should be disassembled for further inspection. New bearings should be installed.

  For sheaves not equipped with grease fittings, be sure to pack the new bearings with grease at assembly.
- For steel sheaves, check the depth, width, and contour of each sheave using a groove gauge (Figure 5-46). Replace the sheaves that have oversized or undersized grooves.
- Replace any grooved drums that allow one wrap of the wire rope to contact the next wrap as the rope spools onto the drum.
- Inspect the sheaves to verify they do not contact another sheave or structural plate work. There should be uniform clearance between sheaves in a cluster. Repair or replace worn or damaged sheaves.
- Remachine or replace steel sheaves, drums, or rollers that have been corrugated by the wire rope's print (Figure 5-47.)
- Measure the nylon sheaves for excessive tread wear (Figure 5-49). To check for uneven wear, measure at three places.

  Wear must not exceed the limit given. Replace worn or damaged sheaves.

FOR REFERENCE ONLY

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Observe the groove to see if the contour of the gauge matches the contour at the bottom of the sheave groove.

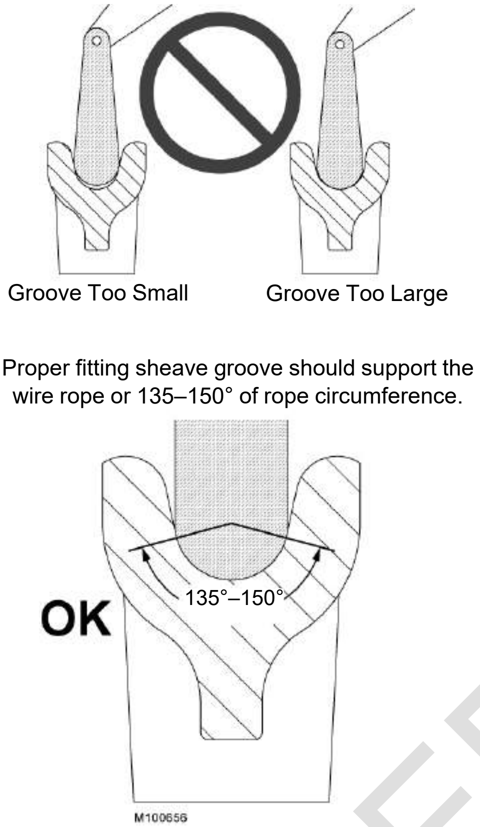

FIGURE 5-46

"Corrugated" steel sheave, roller, or drum will cause the wire rope to wear rapidly.

FIGURE 5-47

- Inspect the nylon sheaves to verify they have not separated and "walked off" the steel inserts or the bearings (Figure 5-48).

  Maximum sideways displacement is 3 mm (1/8 in). Replace worn or damaged sheaves.

NOTE: Nylon sheaves have the following characteristics:

- Depending on the type of wire rope used, it is normal for nylon sheaves to show the wire rope print. Do not machine the nylon sheaves.
- Nylon sheaves cannot be accurately inspected using conventional methods, such as sheave gauges.
- Due to the characteristics of nylon sheaves, the nylon material will actually move to better support the wire rope as the sheave wears normally.
- Nylon sheave properties will be degraded in temperatures above 60°C (140°F).

NOTE: Many current production sheaves are not equipped with grease fittings, but are packed with grease at assembly. Repack the bearings of these sheaves with CraneLUBE EP #2 grease when the sheaves are overhauled.

Due to application and design variations, it is not possible to give specific grease repacking intervals or the life expectancy of the components.

- Make sure the sheaves, drums, and rollers are properly lubricated according to the instructions in the lubrication guide provided with this manual.

NOTE: For some sheaves, the seals are an integral part of the bearing. Therefore, if a seal is damaged during repacking, the complete bearing may need to be replaced.

Item	Description
1	Nylon Sheave
2	Improper Snap Ring Engagement
3	Steel Insert of Bearing
4	1/8 in (3 mm) Maximum Sideways Displacement

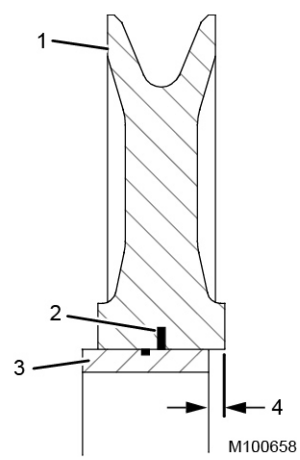

FIGURE 5-48

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B = tread diameter, new sheave
E = tread diameter, used sheave
B minus E = total wear
If total wear is 5 mm (3/16 in) or more, the sheave should be replaced.
If a tread print exists in the root of the sheave groove, measure to the maximum tread diameter.

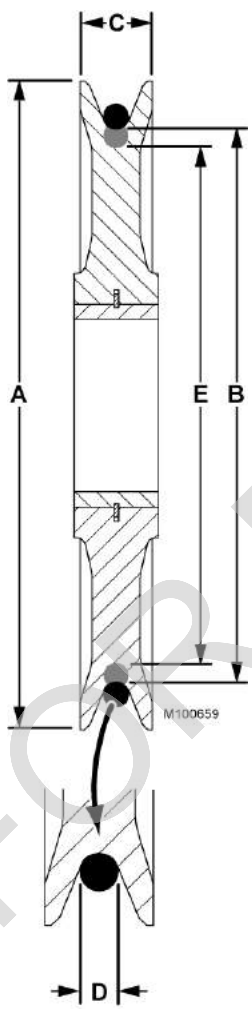

FIGURE 5-49

PLASTIC SHEAVE DATA

Sheave Part	Outside Diameter		Tread Diameter		C Width		D Rope Diameter	
	mm	inch	mm	inch	mm	inch	mm	inch
912738	335	13.19	290,1	11.42	45	1.77	16	5/8
631056								
631054	335	13.19	290,1	11.42	45	1.77	22	7/8
631065	406,4	16	339,6	13.37	55,1	2.17	14	9/16
631071	406,4	16	352,6	13.88	55,1	2.17	16	5/8
631526	489	19.25	422,4	16.63	50,8	1.94	22	7/8
631527	489	19.25	422,4	16.63	50,8	1.94	16	5/8
631055	500,1	19.69	447	17.60	47	1.85	22	7/8
631067	500,1	19.69	450,9	17.75	50	1.97	19	3/4
631529	508	20	431,8	17.00	76,2	3	25	1
631519	584,2	23	511	20.13	57,2	2.25	22	7/8
631520								
631084	584,2	23	511	20.13	63,5	2.50	22	7/8
A00083								
631102	584,2	23	511	20.13	63,5	2.50	25	1
631082	27.00	685.8	23.00	584.2	3.00	76.2	1	25
631103								
A00051								
631096	27.00	685.8	23.00	584.2	3.00	76.2	1.18	28
A00050								
631100	30.00	762.0	27.00	685.8	3.00	76.2	1-1/8	29

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LOAD BLOCK AND HOOK-AND-WEIGHT BALL INSPECTION

WARNING

Falling Load Hazard!

To prevent the load from dropping due to structural failure of load block or hook-and-weight ball:

- Only use a load block or a hook-and-weight ball that has a capacity equal to or greater than the load to be handled.
- Do not remove or deface the nameplate (Figure 5-50) that is attached to the load blocks and hook-and-weight balls.
- See Section 4 of the Operator Manual for recommended sling angles and capacity restrictions when the load block has a duplex or a quadruplex hook.

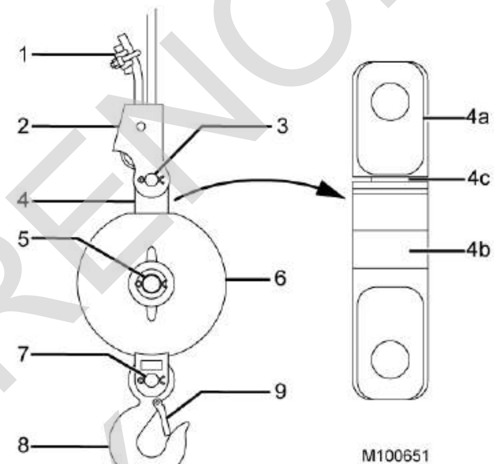
Item	Description
1	Working Load Limit (ton [US and metric])
2	Wire Rope Diameter (mm and inch)
3	Block Weight (kg and lb)
4	Block Serial Number
5	Block Part Number (OEM and Manitowoc)
6	Design Factor

FIGURE 5-50

Daily Inspection

The operating condition of the load block and the hook-and-weight ball can change daily with use, and therefore must be inspected daily (at the start of each shift). During operation, look for any defects that could affect their safe operation. Correct all defects before using the load block or the hook-and-weight ball.

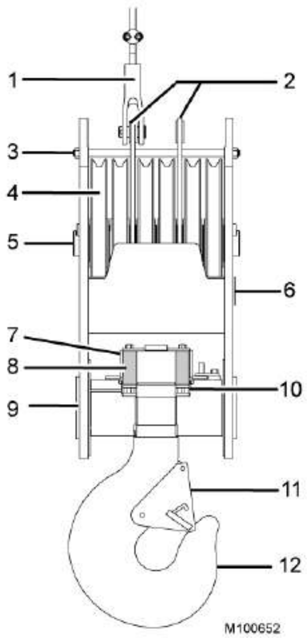
Daily inspection and maintenance will include the following checks (Figure 5-51 and Figure 5-52):



Item	Description	Item	Description
1	Dead-End Clip	4c	Check Gap Here
2	Socket and Wedge	5	Bolt or Pin
3	Bolt or Pin	6	Weight Ball
4	Swivel	7	Bolt or Pin
4a	Swivel Shank	8	Hook
4b	Swivel Barrel	9	Latch

FIGURE 5-51

FOR REFERENCE ONLY



Item	Description
1	Socket and Wedge
2	Center Plates
3	Tie-Bolt
4	Sheaves
5	Sheave Shaft
6	Name Plate
7	Locking Cap
8	Hook Nut
9	Trunnion
10	Thrust Bearing
11	Latch
12	Hook

FIGURE 5-52

- Clean the load block or the hook-and-weight ball.
- Lubricate the sheaves (if fittings provided), the hook trunnion, the hook swivel, and any other part equipped with a grease fitting at the intervals specified in the Lubrication Guide.
- Tighten any loose tie-bolts, cap screws, and setscrews. Check that all the cotter pins are installed with the legs opened and trimmed.
- Check the sheaves for uneven wear in the grooves and on the flanges. Check for loose or wobbly sheaves. These conditions indicate faulty bearings or bushings.
- Check the fit of the wire rope in the groove of each sheave.
  - An oversized wire rope can crack the lip of the sheave flange, causing rapid wear of the wire rope and sheave.
  - The groove must be larger than the wire rope, and the groove must be free of rough edges and burrs.
- Make sure the hook, the trunnion, and the swivel rotate freely without excessive play. Incorrect operation indicates faulty bushings or bearings, or inadequate lubrication.
- Check the swivel of the hook-and-weight ball for the following conditions:
  - Overloading—Spin the swivel by hand. If the motion is rough or has a ratchet-like effect, the swivel bearings are damaged.
  - Side loading—This can cause the swivel to turn freely in one spot and to lockup in another.

    This condition can also be checked by checking the gap (4c, Figure 5-51) between the barrel and shank (To check, the swivel must be removed from the weight ball).

    If the gap is wide on one side and closed on the other side, damage is present.

NOTE: The gap between the barrel and the shank is normally 0,5 mm (0.02 in) to 1,3 mm (0.05 in). If the gap increases, swivel-bearing failure is indicated.

- Check the load block for signs of overloading:
  - Spread side plates
  - Elongated holes
  - Bent or elongated tie-bolts
  - Cracks
- Check all of the welds for defects and cracks.
- Check the wire rope for wear and broken wires at the point where the wire rope enters the dead-end socket. Check the socket for cracks. Tighten the wire-rope clips located at the dead end of the wire rope.
- Make sure each hook has a latch and that the hook latch operates properly.

WARNING

Falling Load Hazard!

To prevent the load from dropping due to a hook or shackle failure, do not attempt to repair any cracks in hooks and shackles by welding.

Do not weld on any load-bearing component unless proper welding methods are used (contact the Manitowoc Crane Care Lattice Team for material and welding specifications).

FOR REFERENCE ONLY

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⚠ WARNING

Falling Load Hazard!

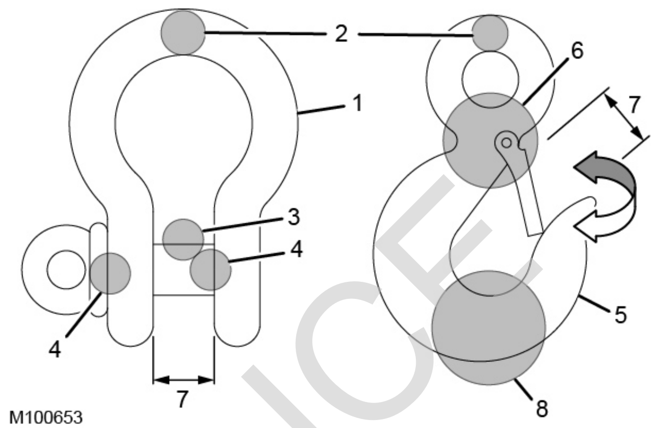
To prevent the load from dropping, make sure that, under slack conditions, the hook latch retains the slings or other rigging in the hook.

The hook latch is not intended as an anti-fouling device. Make sure that the hook latch does not support any part of the load.

Make sure that any slings or other rigging are seated in the hook. Rigging must never be in a position to foul the hook latch.

Never disable the hook latch. The hook latch must be allowed to function as intended.

- Inspect each hook and shackle for damage (Figure 5-53).
- See the ASME B30-10 Standard for specific hook replacement guidelines. The standards are available as follows:
  - **Mail**—ASME, 22 Law Drive, Fairfield, New Jersey, 0700-2900
  - **Toll-free phone**—US & Canada 800-843-2763, Mexico 95-800-843-2763, Universal 973-882-1167
  - **Fax**—973-882-1717 or 973-882-515
  - **E-mail**— infocentral@asme.org.
- Contact the supplier of your hooks, shackles, blocks, and other rigging for repair instructions.



Item	Description
1	Shackle
2	Check for Wear and Deformation
3	Check for Wear and Straightness
4	Check That Pin Is Always Seated
5	Hook
6	Check That Hook Is Not Twisted
7	Check for Cracks and Twisting
8	Check for Wear and Cracks

FIGURE 5-53

Yearly Inspection

Check each hook and shackle at least yearly for cracks using one or more of the following methods:

- Dye penetrant test
- MAG particle test
- Ultrasonic test
- X-ray

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SECTION 6
SWING SYSTEM

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SECTION 6
SWING SYSTEM

GENERAL

This section provides the hydraulic and electrical information for the crane's swing system. Hydraulic and electrical circuit schematics are provided (Figure 6-1 and Figure 6-2).

Details of individual components are covered later in this section. Component information can also be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

SWING SYSTEM OVERVIEW

The swing system is a closed-looped system consisting of an engine-driven hydraulic pump and two hydraulic motors or three hydraulic motors, if the crane is equipped with the VPC-MAX™ option.

The swing pump is an electronically controlled, bi-directional, variable-displacement pump that provides hydraulic flow to the swing motors.

The swing motors are bi-directional fixed-displacement type of motors mounted on the planetary swing drives. The planetary swing drives are mounted onto the adapter frame.

To swing the crane, each swing motor rotates a pinion gear located on the corresponding planetary swing drive. The pinion gear meshes with a ring gear that is attached to the carbody, causing the adapter frame (and rotating bed) to rotate relative to the carbody.

The speed of the swing motors is proportional to the output flow volume of the swing pump that is controlled by the position of the J1 joystick.

The J1 joystick left-right position determines the crane's swing direction and speed. The J1 joystick also has a momentary contact switch to control the swing brake.

The J1 joystick communicates with the crane's control system using the controller area network bus (CAN Bus).

NOTE: The J1 joystick has no external locations where voltages can be checked.

Swing speed and swing torque can be selected for the type of work being performed from the speed and torque limits screen on the main display (see the MLC650 Main Display Operation F2267).

SWING BRAKE OPERATION

The swing brake is a spring-applied, hydraulically released brake system located between each swing motor and its corresponding planetary drive. If the brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

The swing brake release system uses charge pressure from the swing pump, supplied to the swing brake solenoid valve. The brake release pressure must be at least 18 bar (261 psi) to fully release the brakes. If the pressure is less than 18 bar (261 psi), the brakes could remain partially applied, which could damage the swing brake system.

Swing Park Switch Control

The J2 joystick sends a 24 V_{DC} output to the swing park switch. When the swing brake switch is at the UN-PARK position, the swing park switch is closed, sending a 24 V_{DC} signal back to the J2 joystick.

The J2 joystick communicates the un-park brake command to the IOLC30 control module via the CAN Bus. The IOLC30 control module then sends a 24 V_{DC} output to the swing brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the swing brake cylinders, releasing the brakes.

When the swing brake switch is moved to the ON-PARK position, the swing park switch is open, sending a 0 V_{DC} signal back to the J2 joystick.

The J2 joystick communicates the on-park brake command to the IOLC30 control module via the CAN Bus. The IOLC30 control module then sends a 0 V_{DC} output voltage to the swing brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow back to the tank. The reduced hydraulic pressure allows spring force to apply the brake.

Momentary Swing Brake Control

When the momentary swing brake button is pressed on the J1 joystick, the joystick communicates the brake command to the IOLC30 control module via the CAN Bus. The IOLC30 control module then sends a 0 V_{DC} output voltage to the swing brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow back to the tank. The reduced hydraulic pressure allows spring force to apply the brake.

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FOR REFERENCE ONLY

SWING OPERATION

Swing Pump Control

The swing pump is controlled by an electronic displacement control (EDC). The EDC is a proportional solenoid valve that determines the swing pump's output volume and flow direction.

When a swing command is communicated to the IOLC33 control module via the CAN Bus, the IOLC33 control module sends a pulse-width modulation (PWM) output signal to the EDC. The PWM signal is proportional to the speed commanded by the J1 joystick position. Increasing the PWM duty cycle increases the pump swashplate angle. As the swashplate angle increases, so does the piston stroke within the pump, increasing the pump output volume.

Swing Left

When the J1 joystick is moved to the left, the joystick sends a swing left command to the IOLC33 control module via the CAN Bus.

The IOLC33 control module then ramps up the PWM duty cycle to the proportional solenoid A in the swing pump EDC to move the pump swashplate to a position that meets the direction and speed commanded by the joystick position.

The swing pump sends hydraulic fluid out port A on the pump to port B on the motors via the triple swing manifold. The triple swing manifold evenly splits the flow from the pump to the swing motors.

Hydraulic fluid then flows from port A on the motors to port B on the pump via the triple swing manifold to complete the closed-loop circuit. The triple swing manifold combines the return flow from the motors into one stream before flowing back to the pump.

The swing motor speed sensor and pump 8 port A pressure transducer (swing left psi) provide closed loop feedback to the control modules CCM-10 and IOLC30.

Swing Right

When the J1 joystick is moved to the right, the joystick sends a swing right command to the IOLC33 control module via the CAN Bus.

The IOLC33 control module then ramps up the PWM duty cycle to the proportional solenoid B in the swing pump EDC to move the pump swashplate to a position that meets the direction and speed commanded by the joystick position.

The swing pump sends hydraulic fluid out port B on the pump to port A on the motors via the triple swing manifold. The triple swing manifold evenly splits the flow from the pump to the swing motors.

Hydraulic fluid then flows from port B on the motors to port A on the pump via the triple swing manifold to complete the closed-loop circuit. The triple swing manifold combines the return flow from the motors into one stream before flowing back to the pump.

The swing motor speed sensor and pump 8 port B pressure transducer (swing right psi) provide closed loop feedback to the control modules CCM-10 and IOLC30.

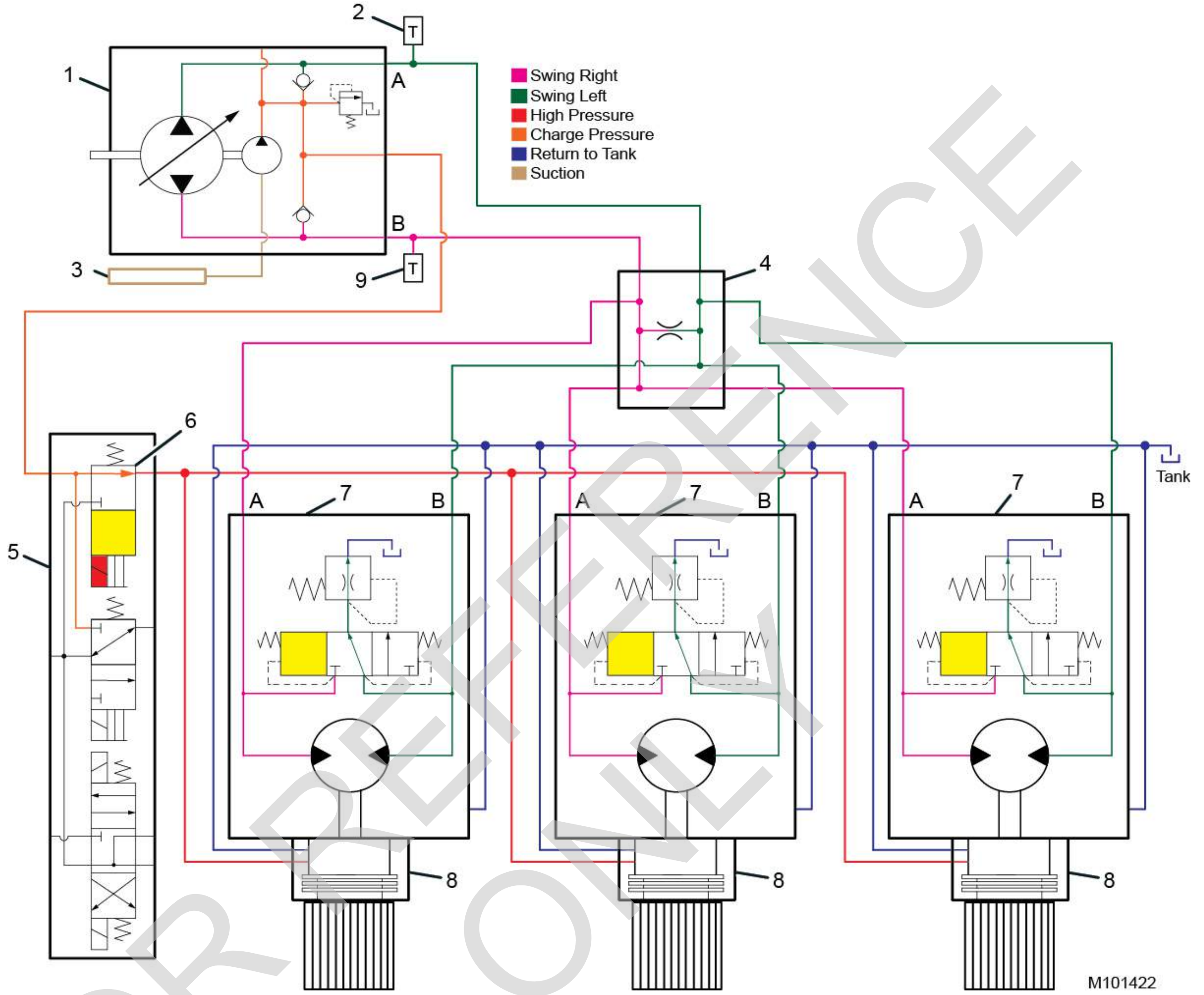
Coasting

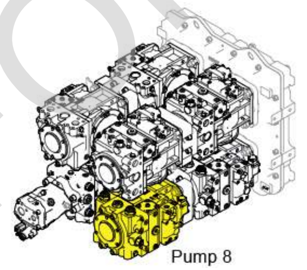
When the J1 joystick is moved back to the neutral position, the IOLC33 control module ramps down the PWM signal to the energized A or B solenoid in the EDC. This allows the springs to center the spool inside the proportional solenoid valve, causing the pump swashplate to destroke (moves to the center position), stopping hydraulic flow to the motors.

With the J1 joystick in the neutral position and the swing brake not applied, the crane is allowed to coast because of an orifice located in the triple swing manifold. The orifice is connected in parallel with ports A and B of the swing motors, allowing a restricted amount of hydraulic fluid to flow from one side of the motors to the other side without having to go through the pump.

FOR REFERENCE ONLY

Swing Hydraulic Schematic





Item	Description
1	Variable-Displacement Hydraulic Pump 100 cc
2	Pump 8 Port A Pressure Transducer (swing left psi)
3	Suction Manifold
4	Triple Swing Manifold
5	Adapter Frame Valve Assembly
6	Swing Brake Solenoid Valve
7	Fixed-Displacement Hydraulic Motor 75 cc
8	Gearbox and Brake Assembly
9	Pump 8 Port B Pressure Transducer (swing right psi)

FIGURE 6-1

FOR REFERENCE ONLY

Swing Electrical Schematic

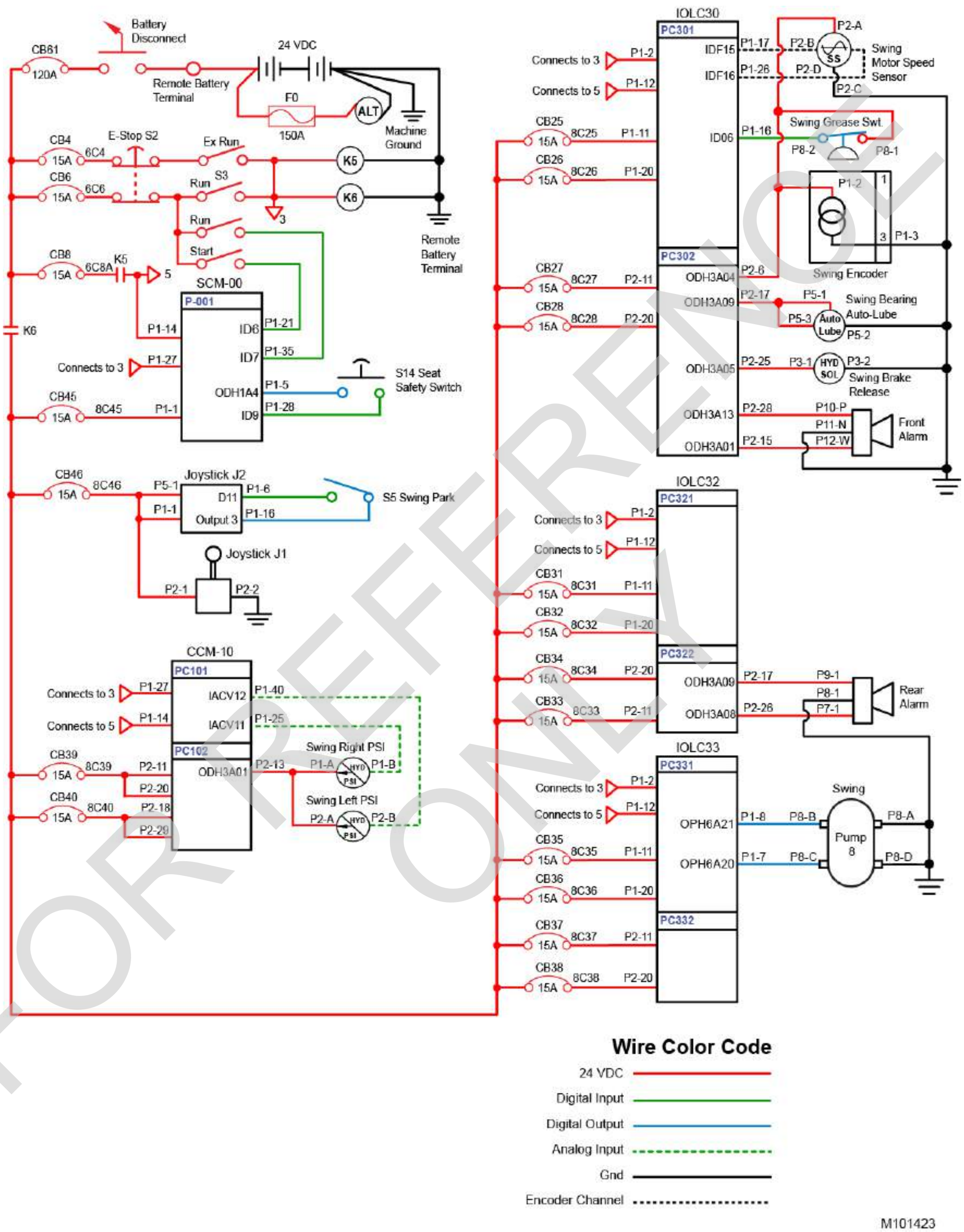
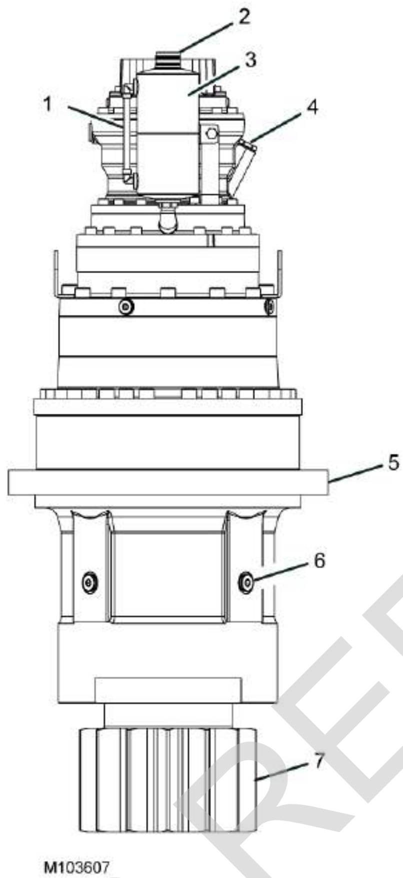


FIGURE 6-2

FOR REFERENCE ONLY

SWING DRIVE SYSTEM

Planetary Swing Drive



Item	Description
1	Oil Level Sight Gauge
2	Breather/Filler Cap
3	Oil Expansion Tank
4	Oil Filler Plug
5	Mounting Flange
6	Oil Drain Plug
7	Pinion Gear

FIGURE 6-3

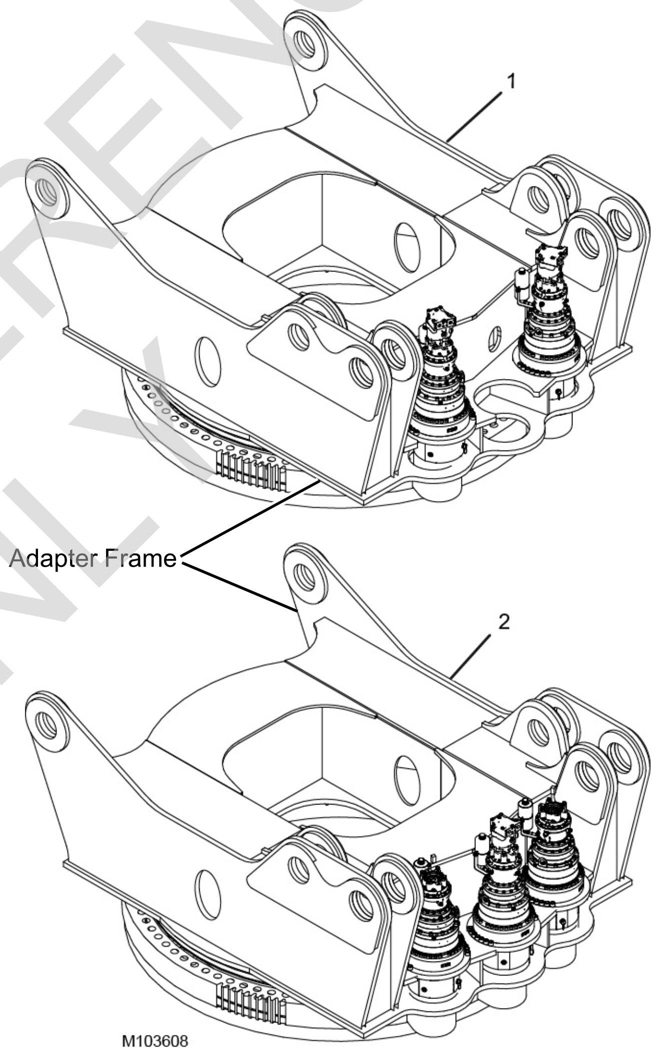
Swing Adapter Frame

The planetary swing drives are mounted to the adapter frame. The ring gear is mounted to the carbody. The planetary swing drive pinion gear drives the ring gear, causing the adapter frame assembly to rotate relative to the carbody.

See Figure 6-4 for the following.

Cranes without VPC-MAX option (1) have two planetary swing drives mounted to the adapter frame.

Cranes with VPC-MAX option (2) have three planetary swing drives mounted to the adapter frame.



Item	Description
1	Without VPC-MAX Option
2	With VPC-MAX Option

FIGURE 6-4

FOR REFERENCE ONLY

PLANETARY SWING DRIVE GEAR OIL

The planetary swing drive gearbox is filled with gear oil. Maintenance consists of periodically checking the level and changing the oil.

Gear Oil Specifications

For gear oil specifications, see the Lubrication Guide supplied with the crane.

Oil Analysis

An oil analysis program is the best way to determine the optimal oil change interval and the condition of the planetary drive.

Periodic Maintenance

The planetary swing drives should be drained and refilled after the first 200 hours of operation and thereafter every 1000 hours. This interval may be adjusted according to the results of oil analysis.

Weekly

Check the planetary swing drive oil level.

All planetary swing drives have a level sight gauge. For details, refer to the Lubrication Guide supplied with the crane.

Monthly or 200 Hours

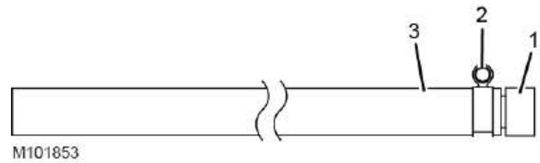
Check the oil level of the planetary swing drives every 200 hours of operation or monthly, whichever occurs first. For details, see the Lubrication Guide supplied with the crane.

Every 6 Months or 1,000 Hours

Drain and refill the planetary swing drives every 1,000 hours of operation or every 6 months, whichever occurs first.

Quick-Drain Valve

Each planetary swing drive gearbox is equipped with a quick-drain valve that requires use of the quick-drain drainer assembly (see Figure 6-5). The quick-drain drainer assembly is stored in the parts box supplied with the crane.



Item	Description
1	Quick-Drain Drainer
2	Hose Clamp
3	Hose: 19 mm (3/4 in) ID x 3,0 m (10 ft) length

FIGURE 6-5

Changing the Planetary Swing Drive Oil

Non-VPC and Non-VPC-Max Planetary Swing Drives

See Figure 6-5 and Figure 6-6 for the following procedure.

NOTE: It is better to change the oil when the planetary drive is warm (not hot).

To prevent harmful contaminants from entering the planetary drive, thoroughly clean components before disconnecting or connecting them.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the planetary drive.
3. Remove the dust cap (3) from the quick-drain valve (4).
4. Place the non-fitting end of the quick-drain drainer assembly hose into an appropriate container for collecting the drained oil.
5. Connect the quick-drain drainer assembly hose to the quick-drain valve.
6. When the planetary drive has finished draining, remove the quick-drain drainer assembly.
7. Fasten the dust cap to the quick-drain valve.
8. Fill the planetary drive with specific oil as follows.

   Manual Fill Procedure (very slow process)

   a. If not already done, remove the breather plug (1).

   b. Using an appropriate funnel, add oil through the fill port (2) until oil is at the level indicated on the decal next to the sight gauge (5). Do not overfill.

   c. Install the breather plug.

FOR REFERENCE ONLY

Power Fill Procedure (recommended)

a. If not already done, remove the breather plug (1).

b. Remove the dust cap (3) from the quick-drain valve (4).

c. Thoroughly clean the inside of the quick-drain drainer assembly.

d. Connect the quick-drain drainer assembly to quick-drain valve. Make sure the fitting is all the way on, so that the poppet inside the valve opens.

e. Connect the quick-drain drainer assembly hose to a portable pump, either hydraulically powered or hand powered.

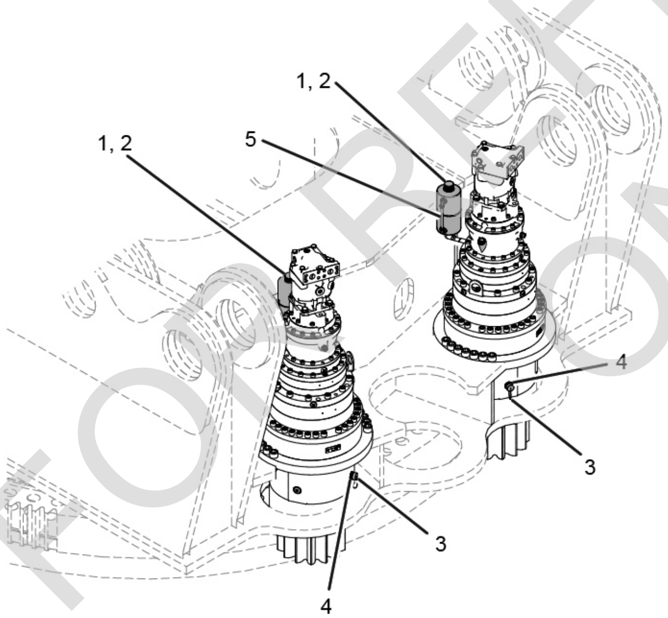
f. Slowly pump oil into the planetary drive gearbox until the oil is at the level indicated on the decal next to the sight gauge (5). Do not overfill.

g. When the planetary drive is filled, remove the quick-drain drainer assembly.

h. Fasten the dust cap to the quick-drain valve.

i. Install the breather plug.

9. Thoroughly clean the quick-drain drainer assembly hose and store it in the parts box.



Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap
4	Quick-Drain Valve
5	Oil Level Sight Gauge

FIGURE 6-(

VPC Planetary Swing Drives

See Figure 6-7 for the following procedure.

NOTE: It is better to change the oil when the planetary drive is warm (not hot).

To prevent harmful contaminants from entering the planetary drive, thoroughly clean components before disconnecting or connecting them.Lock out / tag out the crane.

1. Lockout-tagout the crane.

2. Remove the dust cap (2) from the quick-drain valve (3).

3. Place the non-fitting end of the quick-drain drainer assembly hose into an appropriate container for collecting the drained oil.

4. Connect the quick-drain drainer assembly hose to the quick-drain valve.

5. When the planetary drive has finished draining, remove the quick-drain drainer assembly.

6. Fasten the dust cap to the quick-drain valve.

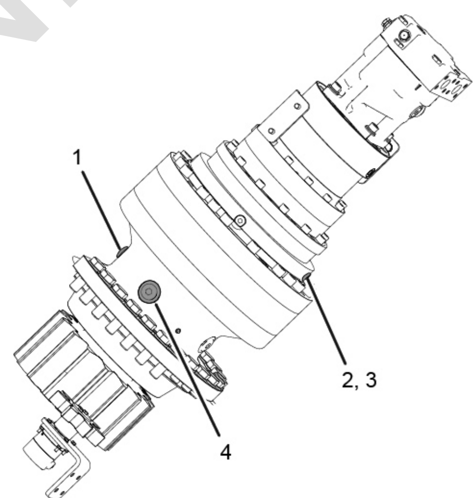
7. Fill the gearbox with specific oil.

8. Fill the planetary drive with specific oil as follows.

a. Remove the plug from the fill port (1).

b. Add oil through the fill port using an appropriate funnel until oil level is halfway up the oil level sight gauge (4). Do not overfill.

c. Install the fill port plug.



Item	Description
1	Fill Port
2	Dust Cap
3	Quick-drain Valve
4	Oil Level Sight Gauge

FIGURE 6-7

6

FOR REFERENCE ONLY

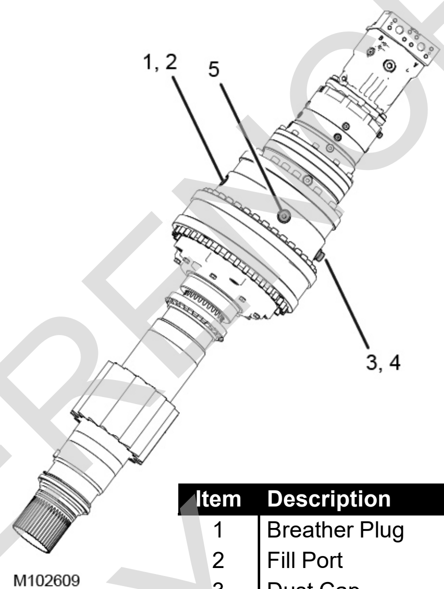
VPC-MAX Planetary Swing Drives

See Figure 6-8 for the following procedures.

NOTE: It is better to change the oil when the gearbox is warm (not hot).

To prevent harmful contaminants from entering the gearbox, thoroughly clean components before disconnecting or connecting them.

1. Lockout-tagout the crane.
2. Remove the breather plug (1) to vent the gearbox.
3. Remove the dust cap (3) from quick-drain valve (4).
4. Place the non-fitting end of the quick-drain drainer assembly hose into an appropriate container for collecting the drained oil.
5. Connect the quick-drain drainer assembly hose to the quick-drain valve.
6. When the planetary drive has finished draining, remove the quick-drain drainer assembly.
7. Fasten the dust cap to quick-drain valve.
8. Fill the planetary drive with specific oil as follows.
   - **a.** Remove the plug from the fill port (2).
   - **b.** Add oil through the fill port using an appropriate funnel until oil level is halfway up the oil level sight gauge (5). Do not overfill.
   - **c.** Install the fill port plug.



Item	Description
1	Breather Plug
2	Fill Port
3	Dust Cap
4	Quick-drain Valve
5	Oil Level Sight Gauge

FIGURE 6-8

FOR REFERENCE ONLY

MANUAL RELEASE OF SWING BRAKE

See Figure 6-9 for the following procedure.

When removing or installing a planetary drive, the swing brake must be released to allow alignment of the planetary drive pinion gear with the carbody ring gear.

WARNING

Unexpected Crane Movement!

Avoid possible injury. When the swing brake is released, the crane can suddenly swing. Before releasing the swing brake, secure the crane by lowering the boom onto blocking at ground level to prevent sudden uncontrolled swinging.

The swing brake manual release procedure is for servicing purposes only. Do not operate the crane unless the swing brake is fully operational.

NOTE: A hydraulic hand pump with a pressure gauge is needed to manually release the swing brake.

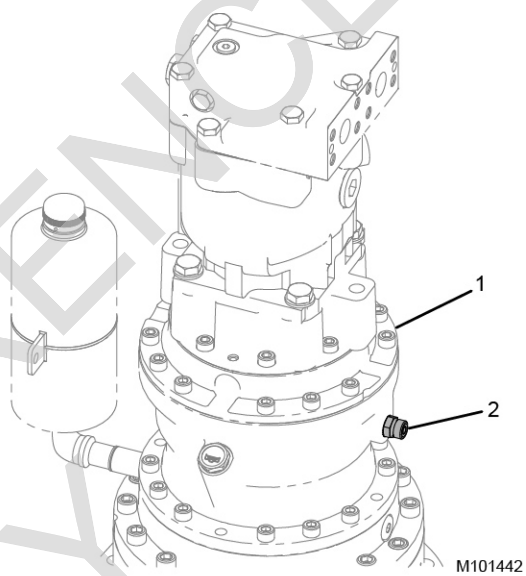
1. At the planetary swing drive (1), disconnect the swing brake hose from the brake release port fitting (2).
2. Connect the hand pump hose to the brake release port fitting.

CAUTION

Avoid Damage to Parts!

Do not exceed 18 bar (261 psi) pressure when using a hand pump to release the swing brake.

3. Using the hand pump, pressurize the brake to 18 bar (261 psi).
4. To apply the swing brake, relieve hydraulic pressure to the brake.
5. Disconnect the hand pump hose from the brake release port fitting.
6. Connect the swing brake hose to the brake release port fitting.



Item	Description
1	Planetary Swing Drive
2	Brake Release Port Fitting

FIGURE 6-9

6

FOR REFERENCE ONLY

SWING MOTOR SPEED SENSOR

A speed sensor is installed in each swing motor. The sensor sends rotational speed and direction information to the corresponding control module to be used by the crane control functions.

See Figure 6-10 for the following procedures.

Speed Sensor Replacement

WARNING

Burn Hazard!

Avoid possible injury. Oil will drain from the port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

NOTE: When removing the motor speed sensor (1) from the swing motor (2), be careful to contain the hydraulic fluid that will drain from the motor.

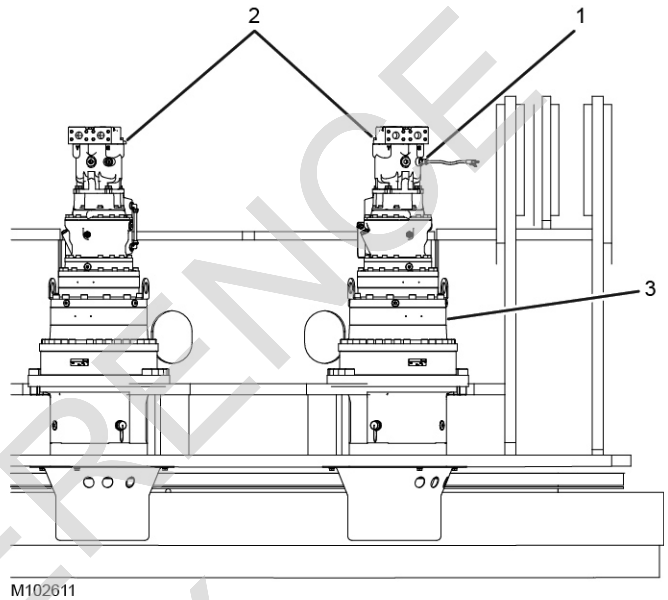
1. Loosen the sensor lock nut with an 1-1/16 in hex wrench and remove the sensor.
2. Install and adjust the new sensor. See Speed Sensor Adjustment, page 6-10.
3. Before starting the engine, add clean hydraulic oil of the correct type to the motor's top case drain port.

Speed Sensor Adjustment

The speed sensors are set at the factory and should not need adjustment, unless replaced. When installing or adjusting the speed sensor on the motor, it must be set at a specific distance from the speed ring on the unit's cylinder.

Adjust the speed sensor as follows.

1. Loosen the sensor lock nut with an 1-1/16 in hex wrench.
2. Turn the sensor clockwise by hand until it contacts the speed ring.
3. Turn the sensor counterclockwise 1/2 turn (180°) to establish the nominal gap of 0.71 mm (0.028 in).
4. Turn the sensor clockwise until the wrench flats on the sensor body are positioned at a 22° angle to the pump shaft centerline.
5. The final sensor position should be between 1/2 turn (180°) and 1/4 turn (90°) counterclockwise from the point where the sensor contacts the speed ring.
6. Hold the sensor in the position with a 1/2 in hex wrench while tightening the lock nut to 13 Nm (10 ft-lb).



Planetary Swing Drive Assembly—Front

Item	Description
1	Motor Speed Sensor
2	Swing Motor
3	Planetary Swing Drive Assembly

FIGURE 6-10

Weekly Periodic Maintenance

1. Check that all the speed sensor assembly parts, wiring, and connections are secure and undamaged.
2. Operate the swing drives to verify that there is a reliable speed readout on the main display. If there is intermittent or no readout, troubleshoot the speed sensor assembly.
3. Thoroughly clean the sensor of any accumulated dust and debris.

FOR REFERENCE ONLY

SECTION 7
POWER TRAIN

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FOR REFERENCE ONLY

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SECTION 7
POWER TRAIN

BATTERIES

Battery Safety

WARNING

Explosion Hazard!

Batteries can explode with great violence and spraying of acid if a spark or flame is brought too close. The room or compartment in which batteries are stored must be ventilated and away from flames or sparks.

Chemical Burn Hazard!

Battery electrolyte can cause severe burns. If electrolyte comes in contact with eyes, skin, or clothing, the area must be immediately flushed with large amounts of water.

Seek medical attention in event of an electrolyte burn.

Always wear eye protection when servicing batteries.

Battery Gases Are Explosive

Avoid sparks while charging batteries. Do not disturb the connection between the batteries until the charger is turned off.

Another source of explosion lies in the reverse connection of the charging equipment. This hazard is present with all types of chargers, but particularly in the case of high-rate equipment. Carefully check the connections before turning on the charger.

Jump-Starting a Battery

Improper use of a booster battery to start a crane also presents an explosion hazard. To minimize this hazard, the following procedure is suggested.

1. Connect one end of each jumper cable to the proper battery terminals on the crane to be started. Do not allow the cable ends to touch.
2. Connect the positive cable to the positive terminal of the booster battery.
3. Connect the remaining cable to the frame or block of the starting vehicle. Never connect it to the grounded terminal of the starting vehicle.

Causes of Battery Failure

A battery should never be left in a discharged state. When discharged, it rapidly sulfates and, unless recharged within hours, will permanently lose capacity.

Overcharging

Overcharging is one cause of battery failure, and is most often caused by a malfunctioning voltage regulator.

Excessive heat is a result of overcharging. Overheating causes the plates to warp, which can damage the separators and cause a short circuit within a cell. This bubbling and gassing of the electrolyte can wash the active material from the plates, reducing the battery's capacity or causing an internal short.

Undercharging or Discharged

Undercharging can cause a type of sulfate to develop on the plates. The sulfate reduces the battery capacity and causes strains in the positive plates, which cause plate buckling. Buckled plates can pinch the separators and cause a short circuit. An undercharged battery is not only unable to deliver power, but may freeze (see Table 7-1).

Table 7-1. Battery Freeze Points

State of Charge	Specific Gravity	Freeze Point °C (°F)
100%	1.26	-57 (-70)
75%	1.23	-38 (-36)
50%	1.20	-26 (-15)
25%	1.17	-19 (-2)
0%	1.11	-8 (18)

Lack of Water

The plates must be completely covered with electrolyte. If the plates are exposed, the high acid concentration will char and disintegrate the separators. The plates cannot take a full charge if they are not completely covered by the electrolyte.

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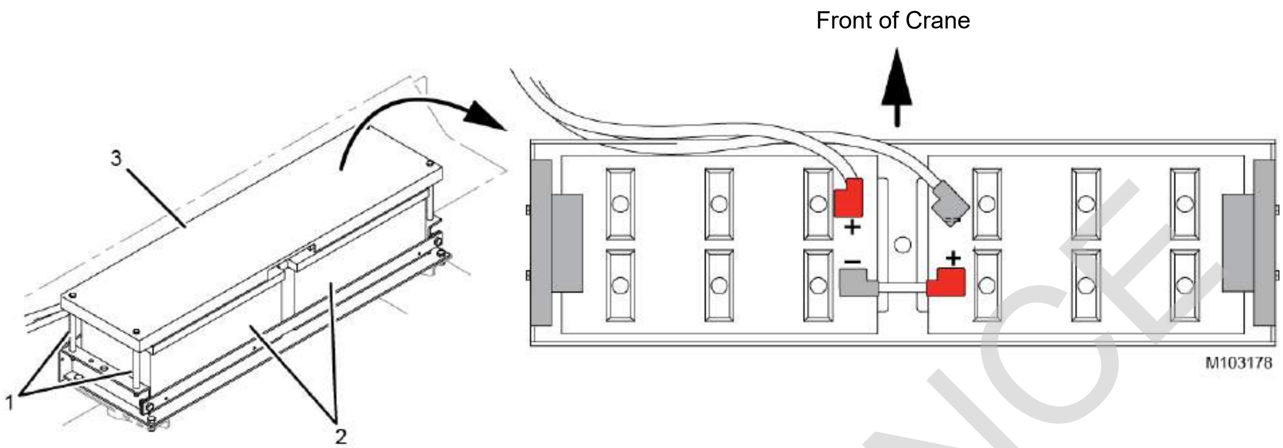

Item	Description
1	Cover Hold-Down Bolt (qty 4)
2	12 V_{DC} Battery (qty 2)
3	Battery Cover with Latches

FIGURE 7-1

FOR REFERENCE ONLY

Loose Hold-Downs

Loose hold-downs will allow the battery to vibrate in the holder. This can cause cracks or wear in the container and cause the acid to leak. Leaking acid corrodes terminals and cables, causing high resistance at the battery connections, which weakens the battery. Hold-downs can also distort or crack the container.

Overloads

Avoid prolonged cranking or the addition of extra electric devices. These can drain the battery and may cause excessive heat.

Multiple Battery System

The crane's 24 V_{DC} system is powered by two 12 V_{DC} batteries connected in series (see Figure 7-1).

Always refer to the wiring diagram for the correct connections. Be careful not to reverse the battery connections.

Installing the batteries with electrical connections that are reversed will not only damage batteries but also the crane's electrical system, voltage regulator, and/or alternator.

Battery Maintenance

CAUTION

Potential Electronic Control Module Malfunction!

Before disconnecting the batteries or opening the battery disconnect, make sure that the engine ignition switch has been off for 5 minutes. This will avoid engine fault codes and undesirable operation.

⚠ WARNING

Personal Injury Hazard!

Each battery weighs approximately 58 kg (130 lb). Use proper lifting procedures.

Checking Battery State of Charge

Special equipment is required to properly determine the condition of a battery that has been in service. However, a voltmeter can be used to determine a battery's state of charge by checking the voltage between the battery terminals (see Figure 7-2 and Table 7-2).

This open-circuit test is the simplest test, but not as accurate in determining a battery's condition as a hydrometer test. The advantage is that the cell covers do not need to be opened, eliminating the possibility of cell contamination and electrolyte spill.

NOTE: Do not use this test method if the battery has been recently charged by a charger or alternator. Recent charging places a high surface charge voltage, which is not a true indication of actual battery voltage.

Item	Description
1	Test Leads on Battery Terminals
2	Voltmeter

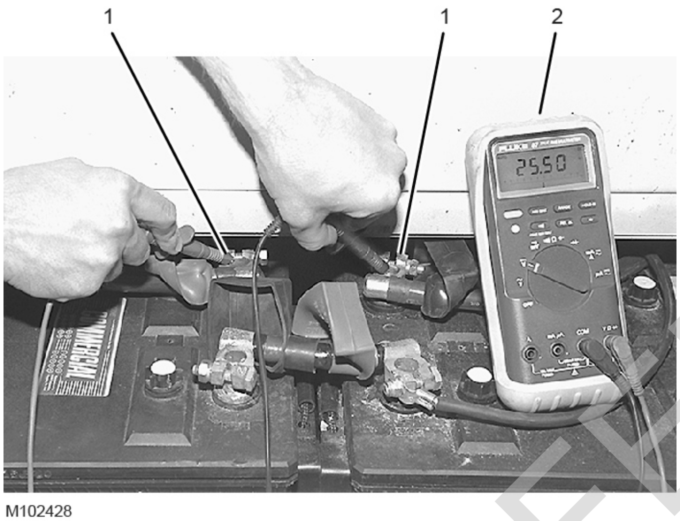

FIGURE 7-2

Table 7-2. Open Circuit Voltage

State of Charge	Specific Gravity	Approximate Open-Circuit Voltage (24V System)
100%	1.260	25.2
75%	1.230	24.8
50%	1.200	24.4
25%	1.170	24.0
0%	1.110	23.6

Consult the manual provided with the test meter for detailed test information.

Troubleshooting—Slow Cranking

If the starter cranks too slowly and the battery is charged and in good condition, do a voltage-drop test to make sure that the starter connections are good.

When cranking, a voltage drop of more than 0.2 volts between the starting motor cable and ground can cause hard starting regardless of a battery's condition. The voltage drop can be caused by a poor contact between the cable terminal and ground or between the clamp terminal and the battery post. Also, poor start-switch contacts and frayed, broken, or corroded cables can be the cause.

Quarterly Battery System Maintenance

- Thoroughly clean the batteries and the holder with a baking soda/water solution.
- If provided, make sure the drain holes are open in the holder. If water collects in the holder, drill some drain holes.
- Clean the posts and terminals. The posts can be lightly coated with petroleum jelly to prevent corrosion.
- Make sure that the hold-downs are in good condition. Replace faulty parts.
- Replace frayed, broken, or corroded cables.
- Replace the batteries if their containers are cracked or worn to the point that they leak.
- Ensure a good tight contact between the clamp terminals and the battery posts.
- Make sure the hold-downs are tight enough to prevent battery movement but not so tight to cause distortion.

Charging

NOTE: If the crane is equipped with the optional charger, see APU Operation Manual.

1. Remove the batteries or disconnect all the crane wiring from the batteries.
2. Read and follow the charger manufacturer's instructions.

   Always wear eye protection when servicing batteries.

NOTE: The battery should be at room temperature when recharging. Never attempt to recharge a frozen battery.

3. Clean the top of the battery to help prevent dirt entering the cells.
4. Verify the plates are covered with electrolyte. If the level is low, add distilled water to bring the level just to the top of the plates. Use a clean funnel. Re-check after charging.
   - The maximum charge rate in amperes should be no more than 1/3 of the battery's reserve capacity minute rating.

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NOTE: The Deka 908D battery originally supplied with the crane has a reserve capacity rating of 430 minutes.

- Do not exceed 16 volts while charging (or 32 volts when charging two batteries in series).
- Charge until a 2-hour period results in no increase in voltage or decrease in current.

NOTE: Overcharging will shorten a battery's life.

- If battery becomes hot to the touch or if it gasses violently, temporarily halt charging or reduce the charging current.

Storage

When the crane is left idle for prolonged periods, the batteries should be periodically charged.

When storing a battery, make sure it is fully charged to prevent sulfation and the possibility of freezing.

Follow your battery dealer's recommendations.

BATTERY DISCONNECT SWITCH

CAUTION

Avoid Electronic Control Module Malfunction!

Before opening the battery disconnect, make sure that the engine ignition switch has been off for 5 minutes. This will avoid engine fault codes and undesirable operation.

The battery disconnect switch (see Figure 7-3) disconnects the positive side of the battery.

To operate the battery disconnect switch:

- Turn the knob clockwise to connect the battery circuit.
- Turn the knob counterclockwise to disconnect the battery circuit for the following reasons:
  - When servicing the crane's electrical control system
  - To prevent batteries from discharging when the crane is stored for extended periods of time
  - To prevent the crane from being started by unauthorized personnel

The handle of the battery disconnect switch can be padlocked to prevent unauthorized use

.

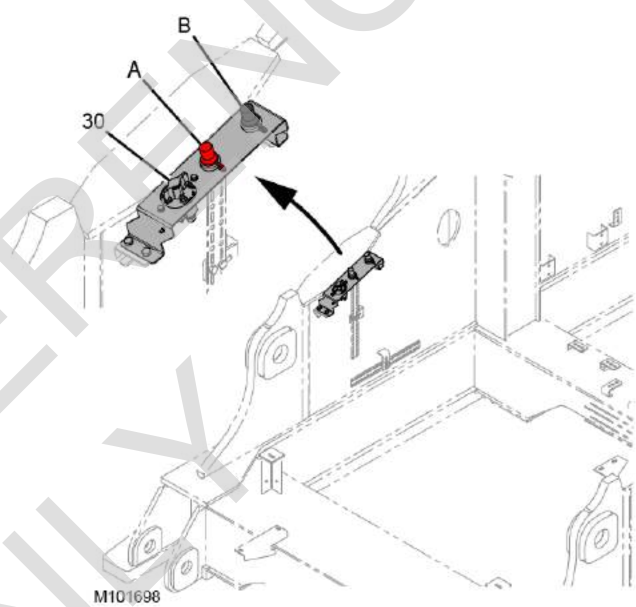
CAUTION

Avoid Control System Damage!

Before welding:

- Disconnect the battery cables at batteries.
- Disconnect the cabling from any control module enclosures that are in the vicinity of the welding.

Do not rely on the disconnect switch to protect the crane's electronic systems when welding.



Item	Description
30	Battery Disconnect Switch
A	Positive—Remote Battery Terminal
B	Negative—Remote Battery Terminal

FIGURE 7-3

ENGINE CONTROLS

See the engine start procedure in Section 3 of the MLC650 Operator Manual for engine startup. See the Cummins engine manual for detailed engine instructions.

The engine is started and stopped with the engine key switch.

The speed of the crane motors and actuating cylinders depends on engine speed and equipment control handle movement. Engine speed is controlled with the hand or foot throttle, and is monitored by a speed sensor.

The emergency stop button (when pushed) stops the engine and applies all brakes. Any operating functions will stop abruptly.

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AIR CLEANER—TIER 4

See Figure 7-4 for location of components.

The air filter requires periodic maintenance. Use the service indicator to determine when to change the filter element. This occurs when the yellow cylinder enters the red change zone. Never open the air cleaner to check the condition of the filter element, as this could allow unfiltered air to enter the engine.

The following air filter conditions can cause engine damage:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Inspection

To maintain engine protection and filter service life, inspect the filters at daily and monthly intervals as described:

Daily

Check the service indicator (located under the front middle enclosure access panel near the clutch lever) with the engine running. The indicator gives a visual indication when it is time to replace the filters.

A yellow flag in the indicator window extends as the filters become plugged. Replace filters when the yellow indicator reaches the red zone at the end of the indicator.

The yellow flag remains locked in place after the engine is stopped. The indicator reset button on the top of the indicator can be pressed at any time. When the engine is running, the indicator will return to the proper reading.

Monthly

Complete the following checks monthly:

- Inspect the rubber reducer and the elbows between the air cleaner and the engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace the worn or damaged parts.
- Check the housing for dents or other damage that may allow unfiltered air to enter the engine. Replace the housing if damaged.
- Check for loose clamps and bands. Tighten loose parts.
- Inspect the pre-cleaner inlet for obstructions. Clean as required.

CAUTION

Avoid Engine Damage!

- Stop the engine before servicing the air cleaner. Otherwise, unfiltered air will be drawn directly into the engine. Never operate the engine without a filter installed in the air cleaner.
- Before servicing, clean the fittings, mounting hardware, and the area around the component(s) to be removed.
- Replace the secondary filter as quickly as possible to avoid engine ingestion of contaminants.
- Do not attempt to clean and reuse the old filters. Discard old filters and install new filters. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the filter media, leading to engine damage.

FOR REFERENCE ONLY

Changing the Filters

See Figure 7-4 for the following procedure.

The air cleaner has two primary filters (1c) and two secondary filters (1d).

1. Ensure you have the correct air filter elements for replacement.
2. Thoroughly clean the air cleaner housing (1) and components.
3. Unfasten the eight clamps (1b) that hold the service cover (1a) to the air cleaner housing.
4. Remove the used primary and secondary air filter elements. Avoid dislodging dust from the filters as they are being removed.

CAUTION

Avoid Engine Damage!

Dust on the sealing surfaces could render the seal ineffective and cause leakage. Ensure all contamination is removed before installing the new filters.

Dirt accidentally transferred to the inside of the outlet tube will reach the engine and cause wear. It takes only a few grams of dirt to destroy an engine.

---

5. Clean the sealing surfaces in the housing.

   Use a clean cloth to wipe clean the sealing surfaces and the inside of the housing.

6. Clean the inside of the outlet tube.

   Carefully wipe the inside of the outlet tube using a clean cloth, while being careful not to damage the sealing area of the tube.

7. Visually inspect old filters for leaks. A streak of dust on the clean side of a filter is a telltale sign. Remove any cause of leaks before installing a new filter.
8. Inspect the new filters, especially the sealing area. Never install damaged filters.
9. Install the new filters in a timely manner to shorten the amount of time the opened air cleaner is exposed to the environment.
10. Carefully install each new secondary filter by gently pushing the filter element into the housing. Apply pressure to all four corners to make sure the filter is completely seated in the housing.
11. Repeat step 10 for the primary filters.

CAUTION

Avoid Air Filter Damage!

Never use the clamps on the service cover to force the filters into the air cleaner housing. Using the clamps to push the filters in could damage the housing and will void the warranty.

---

12. Install the service cover and fasten it with the eight clamps.
13. Inspect all system duct work. Ensure that all clamps and connections are tight, and all piping is free of cracks and holes.
14. Push the reset button (8b) on the service indicator (8).

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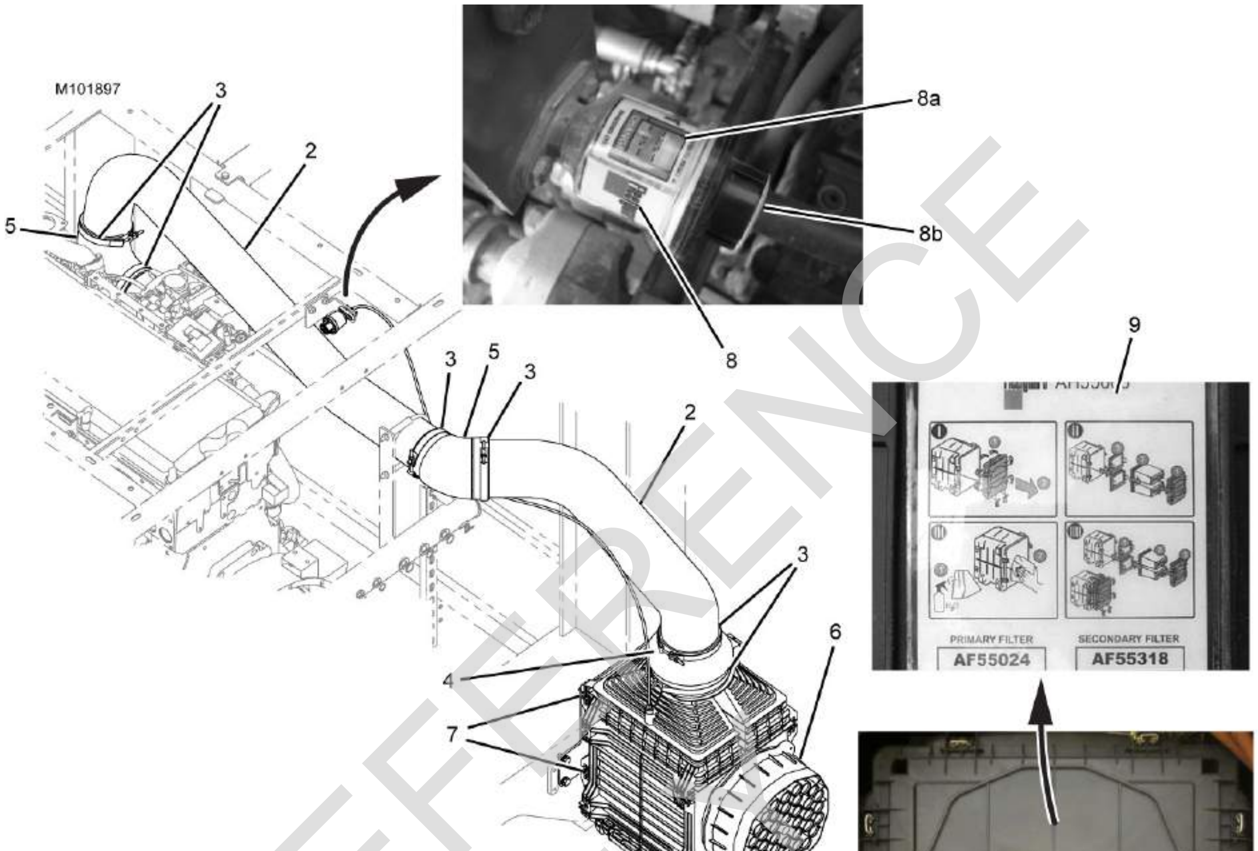
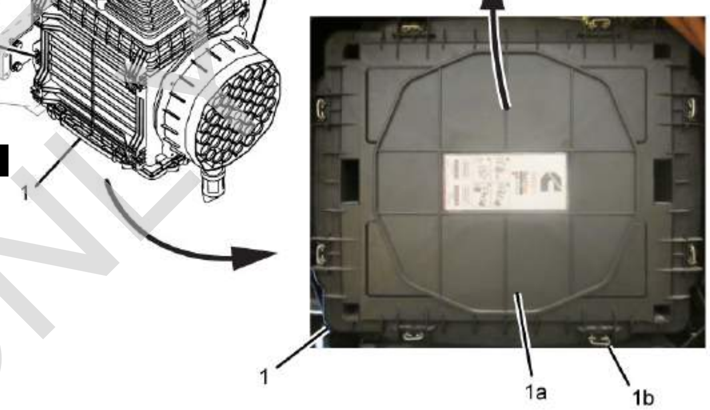




Item	Description	Item	Description
1	Air Cleaner Housing	4	Straight Adapter
1a	Service Cover	5	Rubber Elbow (qty 2)
1b	Clamp (qty 8)	6	Air Intake
1c	Primary Filter (qty 2)	7	Mounting Lugs
1d	Secondary Filter (qty 2)	8	Service Indicator
1e	Inner Housing	8a	Service Window
1f	Removal Tab	8b	Reset Button
2	Steel Tube (qty 2)	9	Service Instruction
3	Clamp (qty 6)		

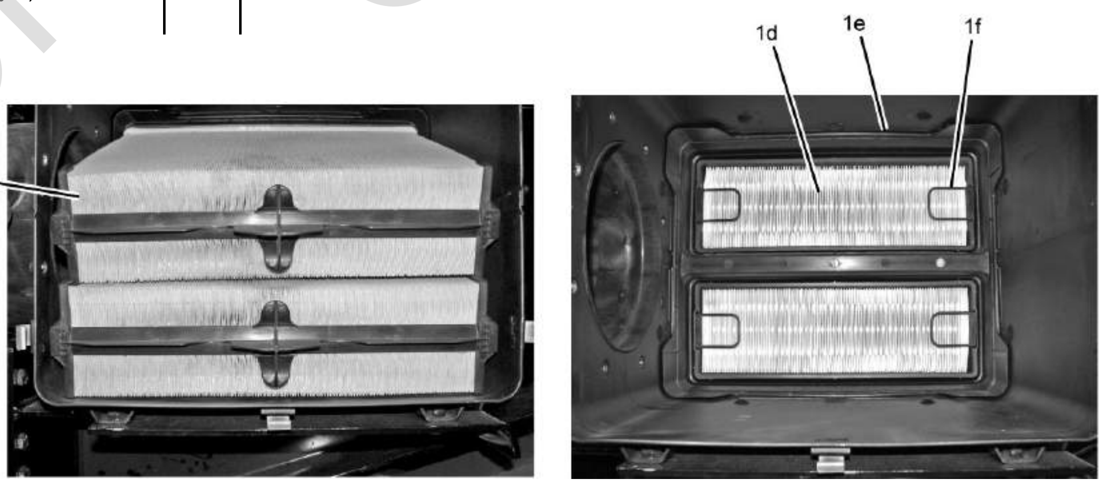


FIGURE 7-4

FOR REFERENCE ONLY

AIR CLEANER—TIER 3

See Figure 7-5 for location of components.

The air filter requires periodic maintenance. Use the service indicator to determine when to change the filter element. This occurs when the yellow cylinder enters the red change zone. Never open the air cleaner to check the condition of the filter element, as this could allow unfiltered air to enter the engine.

The following air filter conditions may cause engine damage:

- Clogged air cleaner filters will prevent adequate air flow to the engine, causing poor starting and increased exhaust emissions.
- An improperly installed or damaged air cleaner can allow dirty air to be drawn directly into the engine.

Inspection

To maintain engine protection and filter service life, inspect the filters at daily and monthly intervals as described.

Daily

Check the service indicator with the engine running. The indicator gives a visual indication when it is time to replace the filters.

A yellow flag in the indicator window extends as the filters become plugged. Replace filters when the yellow indicator reaches the red zone at the end of the indicator.

The yellow flag remains locked in place after the engine is stopped. The indicator reset button on the top of the indicator can be pressed at any time. When the engine is running, the indicator will return to the proper reading.

Monthly

Complete the following actions monthly:

- Inspect the rubber reducer and the elbow between the air cleaner and the engine for cracks or other damage that might allow unfiltered air to enter the engine. Replace the worn or damaged parts.
- Check the housing for dents or other damage that may allow unfiltered air to enter the engine. Replace the housing if damaged.
- Check for loose clamps and bands. Tighten any loose parts.
- Inspect the inlet cap for obstructions. Clean as required.
- Inspect the pre-cleaner dust spout for obstructions.

CAUTION

Avoid Engine Damage!

- Stop the engine before servicing the air cleaner. Otherwise, unfiltered air will be drawn directly into the engine. Never operate the engine without an air filter installed in the air cleaner.
- Before servicing, clean the fittings, mounting hardware, and the area around the component(s) to be removed.
- Replace the secondary filter as quickly as possible to avoid engine ingestion of contaminants.
- Do not attempt to clean and reuse the old filters. Discard old filters and install new filters. Cleaning filter elements by impact or compressed air voids the warranty and can degrade or damage the air filter, leading to engine damage.

FOR REFERENCE ONLY

Changing the Filters

See Figure 7-5 for the following procedure.

The air cleaner has one primary filter (1d) and one secondary filter (1e).

1. Unfasten the clamps (1b) and carefully remove the service cover (1a).
2. Carefully remove the primary filter. There will be some initial resistance, similar to breaking the seal on a jar.

   Gently move the end of the filter back and forth to break the seal, while trying to avoid dislodging any dust from the filter.

NOTE: The secondary filter should be replaced every third time the primary filter is replaced. Inspect the secondary filter and replace as necessary.

3. Remove the secondary filter by pulling on the plastic ring tabs. Avoid dislodging any dust from the filter.

CAUTION

Avoid Engine Damage!

Dust on the sealing surfaces could render the seal ineffective and cause leakage. Ensure all contamination is removed before installing the new air filters.

Dirt accidentally transferred to the inside of the outlet tube will reach the engine and cause wear. It takes only a few grams of dirt to destroy an engine.

---

4. Clean the sealing surfaces in the housing.

   Use a clean cloth to wipe clean the sealing surfaces and the inside of the housing.

5. Clean the inside of the outlet tube.

   Carefully wipe the inside of the outlet tube using a clean cloth, while being careful not to damage the sealing area of the tube.

6. Visually inspect old filters for leaks. A streak of dust on the clean side of a filter is a telltale sign. Remove any cause of leaks before installing a new filter.
7. Inspect the new filters, especially the sealing area. Never install damaged filters.
8. Install the new filters in a timely manner to shorten the amount of time the opened air cleaner is exposed to the environment.
9. Carefully install the new secondary filter (if required) and gently push it into the back of the housing. Evenly apply pressure to make sure the filter is completely seated in the housing.
10. Repeat step 9 for the primary filter.
11. Install the service cover, making sure that the O-ring is in place and that the filter lines up with its support feature on the cover.

CAUTION

Avoid Air Filter Damage!

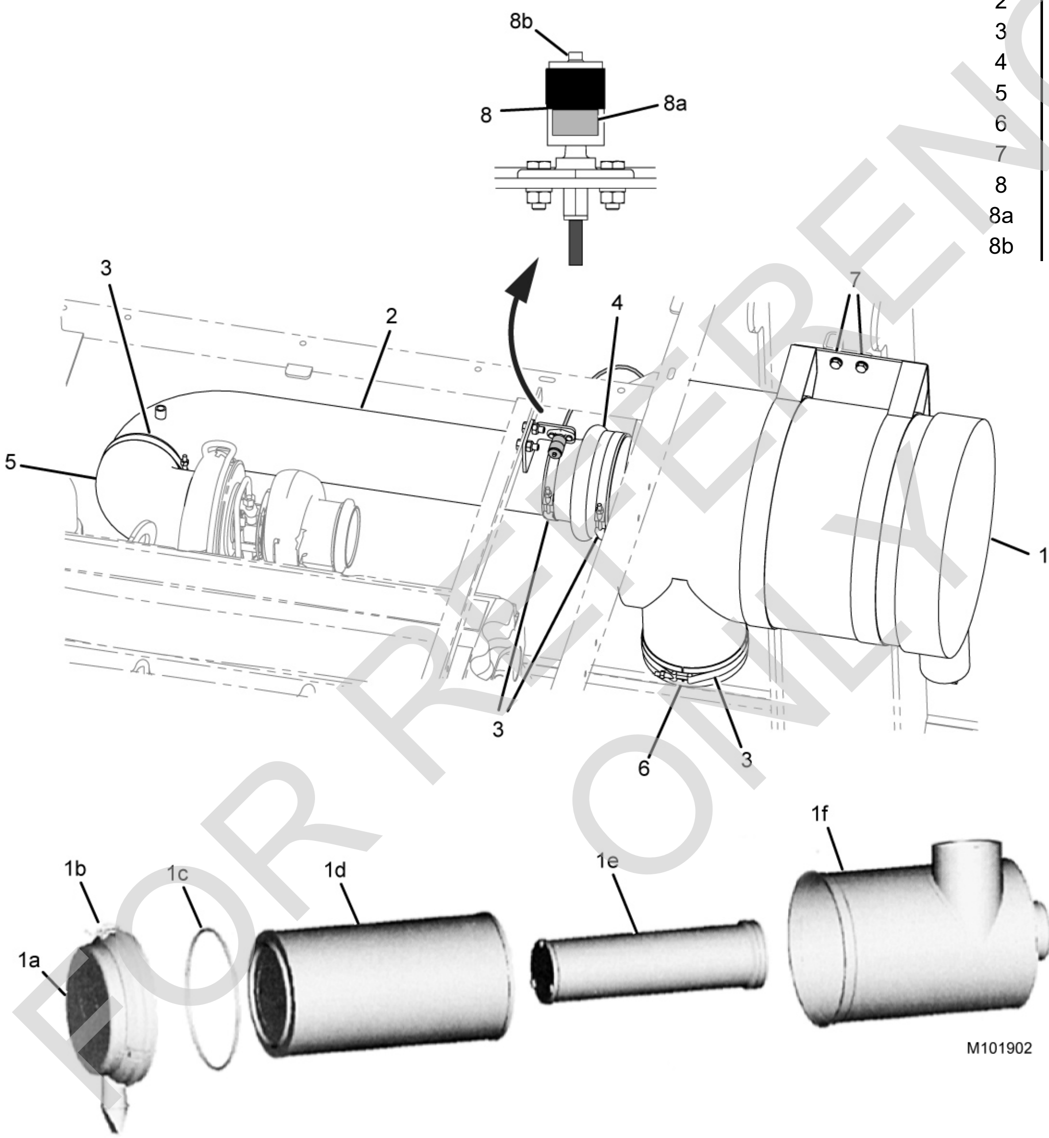
Never use the clamps on the service cover to force the filters into the air cleaner housing. Using the clamps to push the filters in could damage the housing and will void the warranty.

---

12. Fasten the service cover using the clamps. The cover should seat without extra force.
13. Push the reset button (8b) on the service indicator (8).

FOR REFERENCE ONLY

Item	Description
1	Air Cleaner Assembly
1a	Service Cover
1b	Clamp (qty 3)
1c	Cover Seal
1d	Primary Filter
1e	Secondary Filter
1f	Air Cleaner Housing
2	Steel Tube
3	Clamp (qty 5)
4	Straight Adapter Fitting
5	Rubber Elbow
6	Air Intake
7	Mounting Bracket Capscrews
8	Service Indicator
8a	Service Window
8b	Reset Button



FOR REFERENCE ONLY

FIGURE 7-5

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ENGINE THROTTLE ADJUSTMENT

The engine throttle assembly consists of an electronic hand throttle control in the left console and an electronic foot throttle control on the cab floor. There is no mechanical linkage between the throttle controls.

The hand and foot throttle controls send an analog signal to the SCM-00 control module. The SCM-00 control module transmits the throttle command to CCM-10 control module, via the controller area network bus (CAN Bus). The CCM-10 control module transmits the throttle command to the engine control module (ECM) via the CAN Bus. The ECM then increases or decreases the engine speed as commanded by the throttle controls.

Hand Throttle Control

The hand throttle control does not require adjustment and is not repairable.

Foot Throttle Control

If there is a problem with the foot throttle, it is best to either replace it or send the unit to Manitowoc Cranes for repair.

However, if field disassembly was done, use the following procedure to re-assemble and calibrate the throttle control.

NOTE: The foot throttle control was properly assembled and calibrated at the initial installation and should not require further attention.

Foot Throttle Control Assembly and Calibration

See Figure 7-6 for the following procedure.

Steps 1 through 7 must be done on a clean work bench.

1. To assemble the right foot pedal shaft (3) and the torsion spring (5) into the foot pedal housing (1), first assemble the spring onto the shaft by inserting the lug on one end of the spring into the hole in the head of the shaft.
2. Insert the shaft into the cavity in the bottom of the housing, through the roller bearing (8), and into the foot pedal (2).

   The lug on the outboard end of the torsion spring must engage the hole in the housing (see A-A).
3. Insert the left foot pedal shaft (4) into the cavity in the bottom of the foot pedal housing, through the roller bearing, and into the foot pedal.
4. Rotate the foot pedal as needed and install the roll pins (10) through the holes in the foot pedal and the foot pedal shafts (see Pedal Position A).
5. Install the setscrew (17) only partway into the threaded hole. Do not allow the setscrew to contact the right foot pedal shaft at this time.
6. Rotate the foot pedal approximately 40° to Pedal Position B (low idle). The flat on the head of the right foot pedal shaft should be parallel with the surface X on the foot pedal housing.
7. Turn in the setscrew until it just contacts the flat on the head of the right foot pedal shaft (see A-A).
8. Install the potentiometer (6) and calibrate the foot throttle as follows.
   a. Solder the control wires to the potentiometer leads as follows (see B-B):
      - Black wire (12) to the outer lead
      - Green wire (13) to the middle lead
      - White wire (14) to the fixed resistor lead
   b. Turn the potentiometer shaft fully counterclockwise as viewed from the shaft end.

      With a supply voltage of 25 V_{DC} to 26 V_{DC} available at the white wire, 0 V_{DC} should be present at the potentiometer output (green wire) lead.
   c. With the pedal at Pedal Position B, insert the potentiometer into the cavity in the bottom of the housing (see B-B). Insert the potentiometer shaft into the end of the left foot pedal shaft (4) and tighten the setscrew (18).
   d. Rotate the foot pedal to the high idle position and adjust the setscrew (17) to hold the foot pedal at this position.
   e. Rotate the potentiometer housing to obtain an output of 0.9 V_{DC} to 1.0 V_{DC}.
   f. Apply silicone sealant RTV-162 between the housing and potentiometer. Do not get sealant on the shaft. Allow sealant to cure before proceeding to the next step.
   g. After the sealant has cured, check the potentiometer output for 0.9 V_{DC} to 1.0 V_{DC} with the foot pedal at the high idle position.
   h. Remove the setscrew (17) and apply Loctite #242 to the threads. Install and adjust the setscrew to obtain a low idle pedal position output of 2.9 V_{DC} to 3.0 V_{DC}.
9. Install the assembly onto the crane.

FOR REFERENCE ONLY

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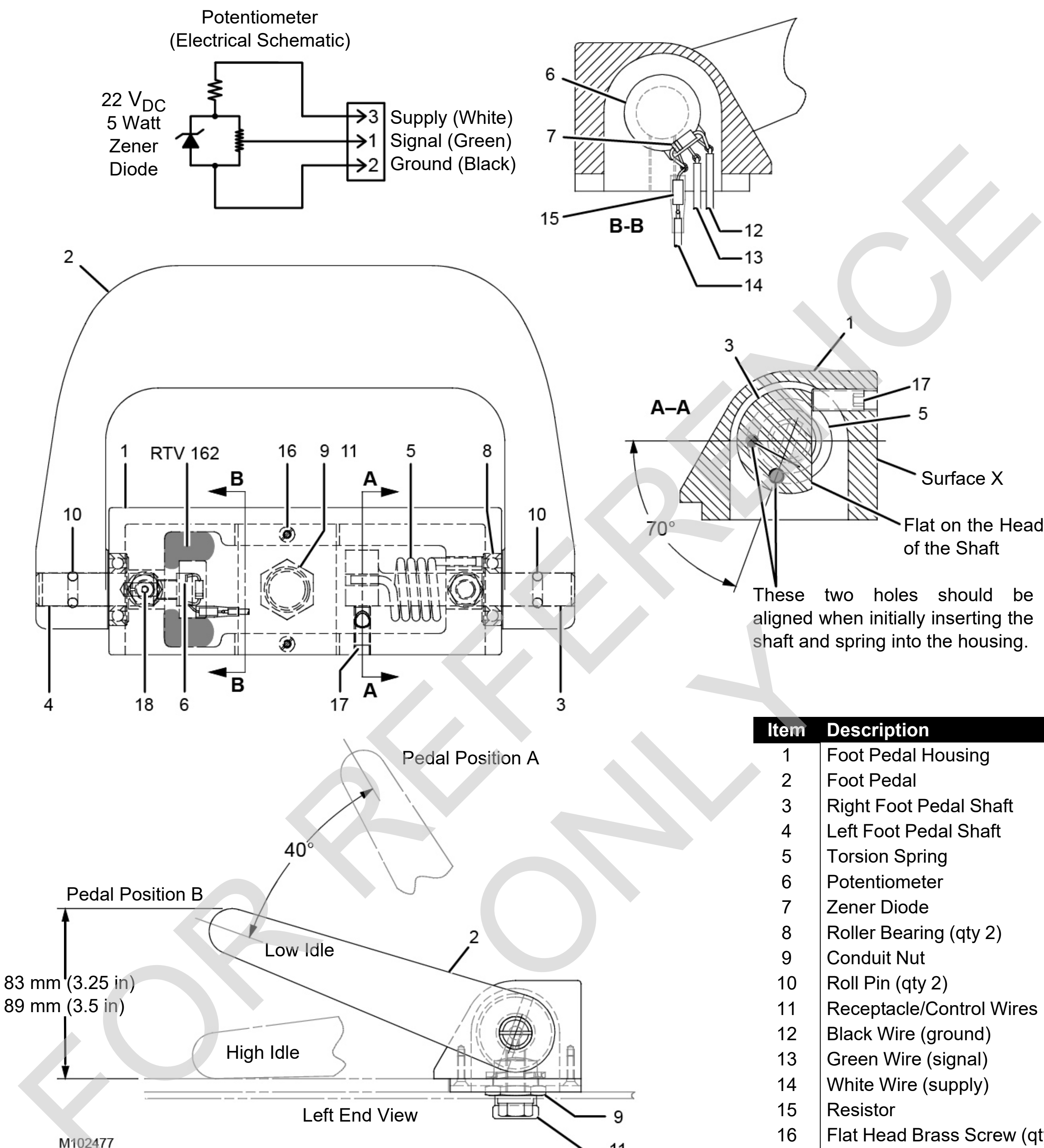


Item	Description
1	Foot Pedal Housing
2	Foot Pedal
3	Right Foot Pedal Shaft
4	Left Foot Pedal Shaft
5	Torsion Spring
6	Potentiometer
7	Zener Diode
8	Roller Bearing (qty 2)
9	Conduit Nut
10	Roll Pin (qty 2)
11	Receptacle/Control Wires
12	Black Wire (ground)
13	Green Wire (signal)
14	White Wire (supply)
15	Resistor
16	Flat Head Brass Screw (qty 2)
17	Setscrew (3/4 in)
18	Setscrew (3/16 in)

FIGURE 7-6

FOR REFERENCE ONLY

ENGINE ELECTRICAL SCHEMATIC

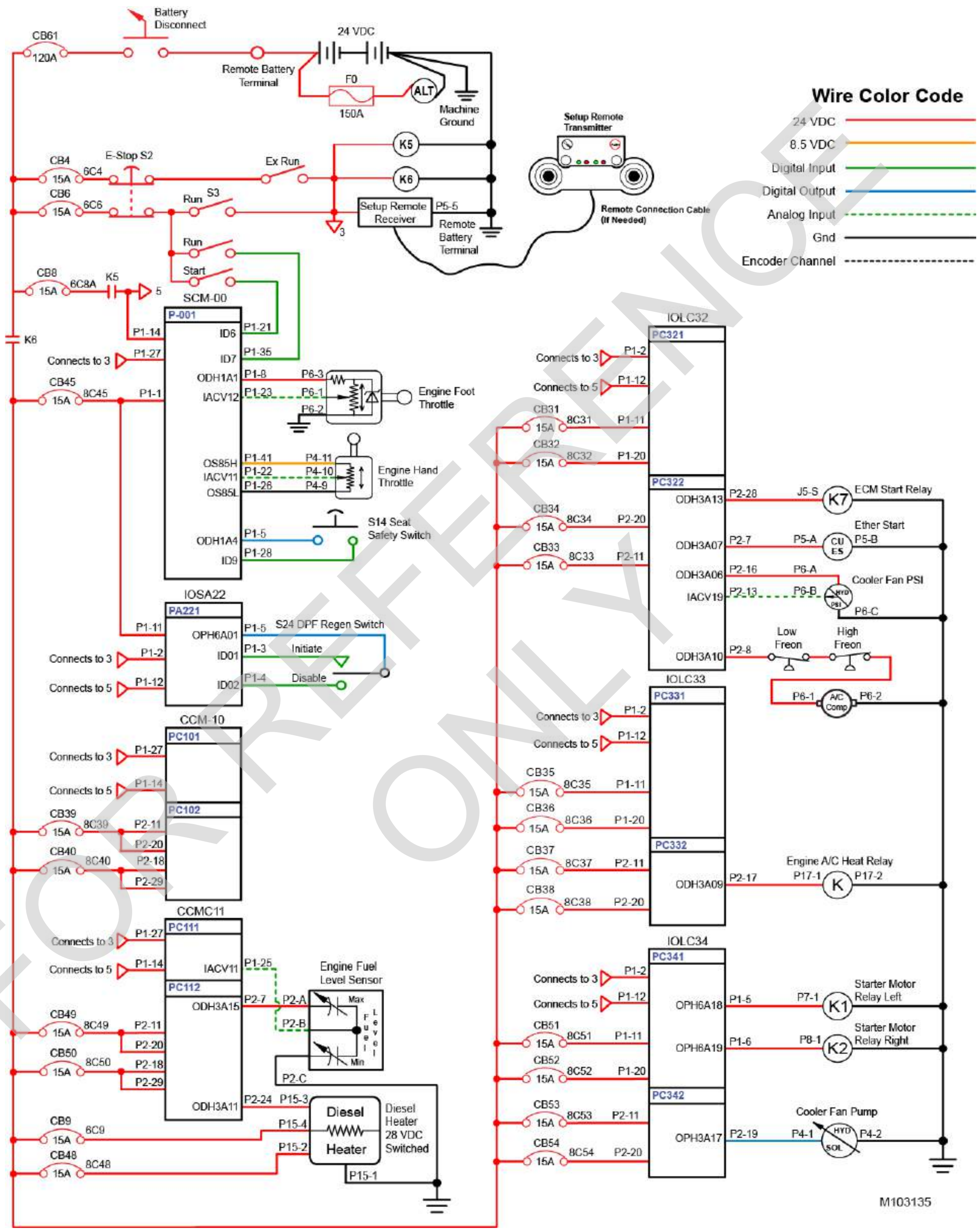
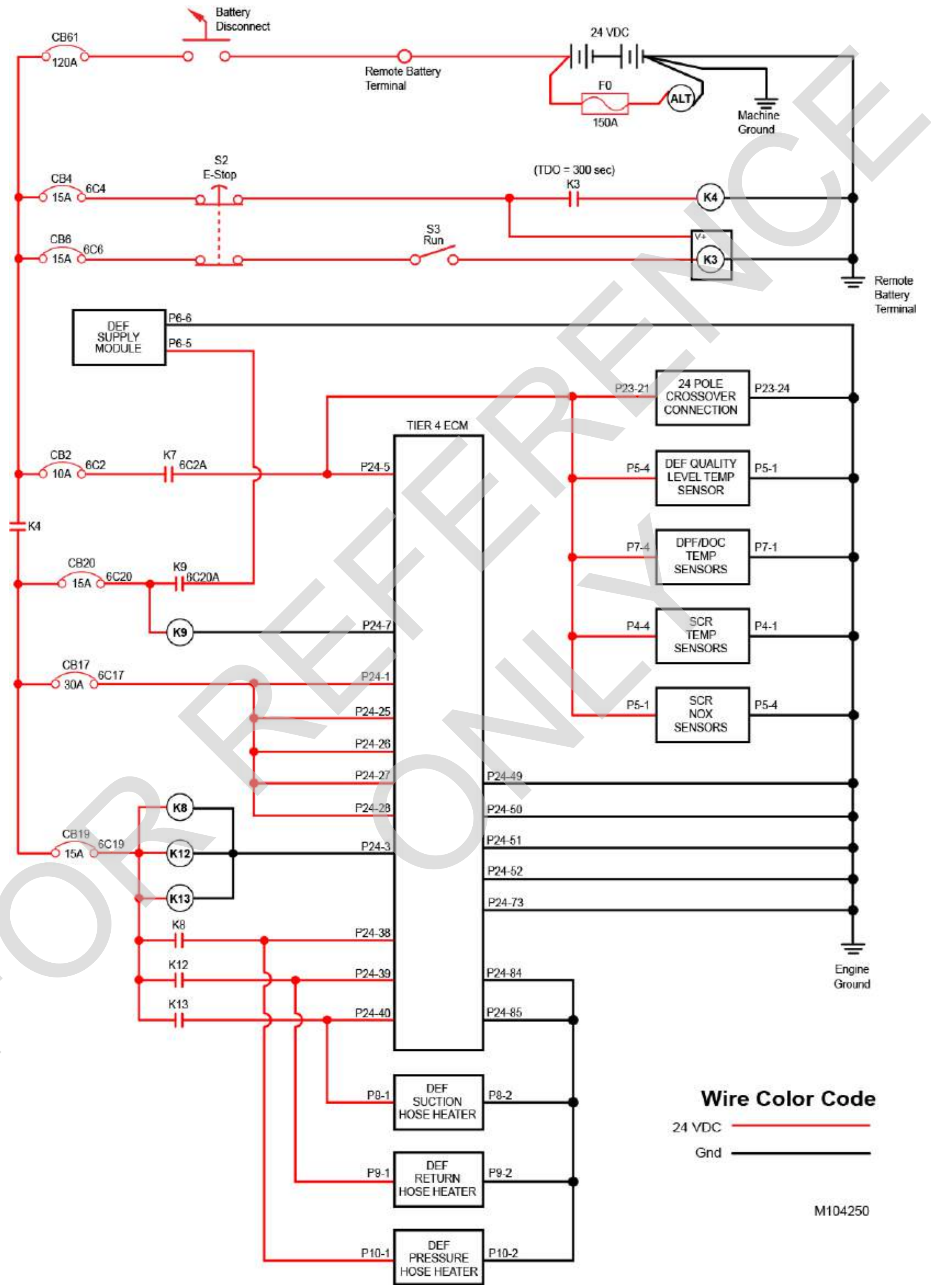


FIGURE 7-7

FOR REFERENCE ONLY

TIER 4 ECM ELECTRICAL SCHEMATIC— POWER AND GROUND CIRCUITS



FOR REFERENCE ONLY

FIGURE 7-8

Manitowoc®

TIER 3 ECM ELECTRICAL SCHEMATIC— POWER AND GROUND CIRCUITS

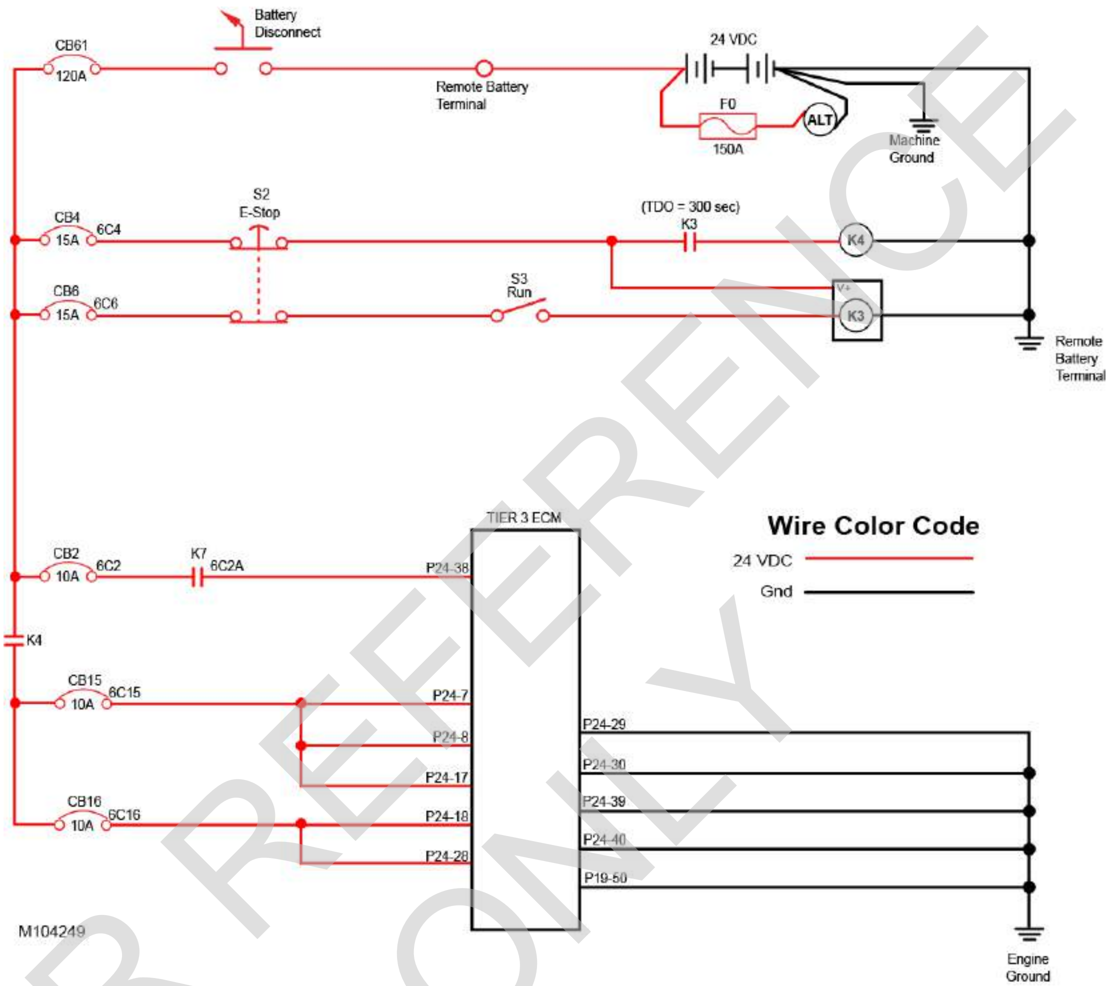


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FIGURE 7-9

ENGINE ENCLOSURE

See Figure 7-10 for location of components.

The engine enclosure consists of seven cover panels that can be removed to allow access for engine service.

Do not operate the crane without the cover panels in place and properly fastened.

See the engine enclosure assembly drawing for the location of enclosure components.

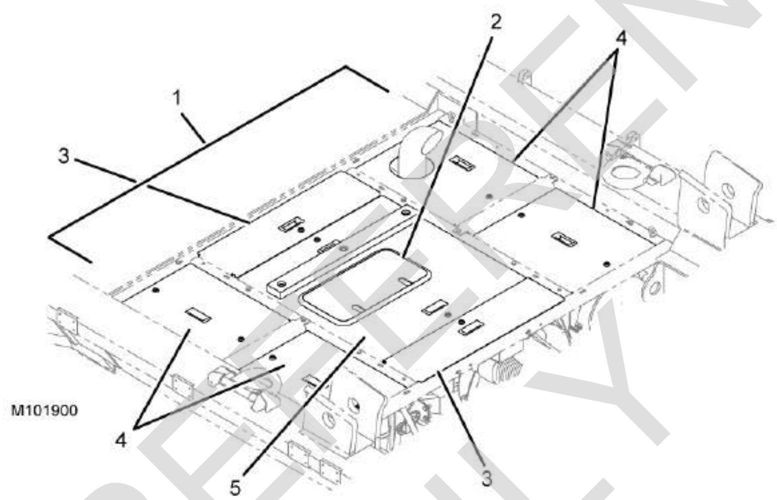
WARNING

Personal Injury Hazard—Heavy Objects!

The panels over each DPF weigh approximately 9 kg (20 lb).

The panel over the engine weighs approximately 25 kg (55 lb).

To prevent serious injury, use the appropriate lifting equipment when lifting or removing these objects.



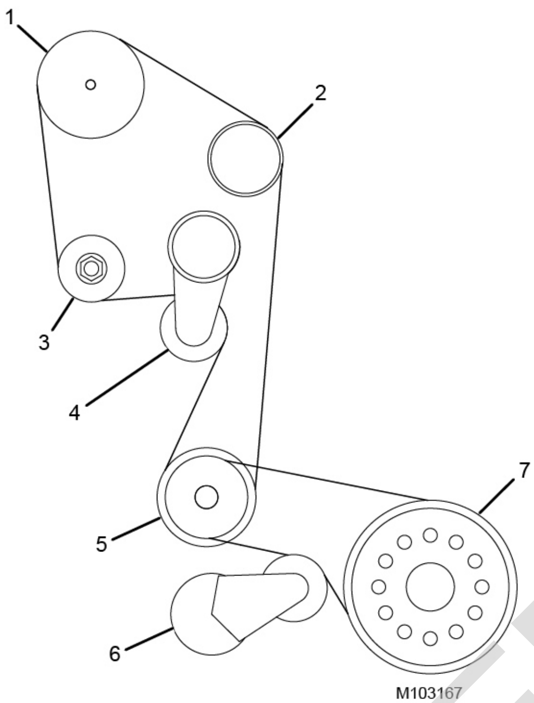
Item	Description
1	Engine Enclosure
2	Hatch in Enclosure Panel
3	Enclosure Panel, 5 kg (11 lb)
4	Enclosure Panel, 9 kg (20 lb)
5	Enclosure Panel, 25 kg (55 lb)

FIGURE 7-10

FOR REFERENCE ONLY

ENGINE BELT ROUTING

See Figure 7-11 for engine belt routing.



Item	Description
1	A/C Compressor
2	Idler
3	Alternator
4	Tensioner
5	Water Pump
6	Tensioner
7	Harmonic Balancer

FIGURE 7-11

ENGINE RADIATOR

WARNING

Burn Hazard!

Do not remove the radiator fill cap from a hot engine. Allow the engine to cool below 50°C (120°F) before adding the coolant.

Material Hazard!

Coolant is toxic. Do not ingest. If not reused, dispose in accordance with all local and other applicable environmental regulations.

CAUTION

Avoid Engine Damage!

The required coolant level must be maintained to prevent engine damage.

FOR REFERENCE ONLY

Checking Coolant Level

For any service other than this periodic checking of the coolant level, refer to the Cummins engine manual for instructions.

When the engine is cold, check the coolant level by using the sight glass (4) located on the top of the radiator. The coolant must be visible in the glass. Add the correct type of coolant, if needed, by performing the following procedure (see Figure 7-12).

1. Open the access hatch (2) in the engine enclosure (1).
2. Place a heavy cloth over the radiator reservoir cap (3), then turn (do not depress) the cap counterclockwise until the cap stops at the safety detent.
3. Wait for all pressure to escape.
4. When the hissing stops, depress the radiator reservoir cap, and turn it counterclockwise to remove.
5. Add coolant to the radiator reservoir, stopping at times to prevent overflow and to allow the coolant to flow into the engine and all portions of the radiator.
6. When the coolant is visible in the sight glass, install the radiator reservoir cap.
7. Run the engine until normal operating temperature is reached.
8. When the engine is cool again, re-check the coolant level as previously described. If needed, add coolant until it is visible in the sight glass.

Item	Description
1	Engine Enclosure
2	Access Hatch
3	Radiator Reservoir Cap
4	Sight Glass

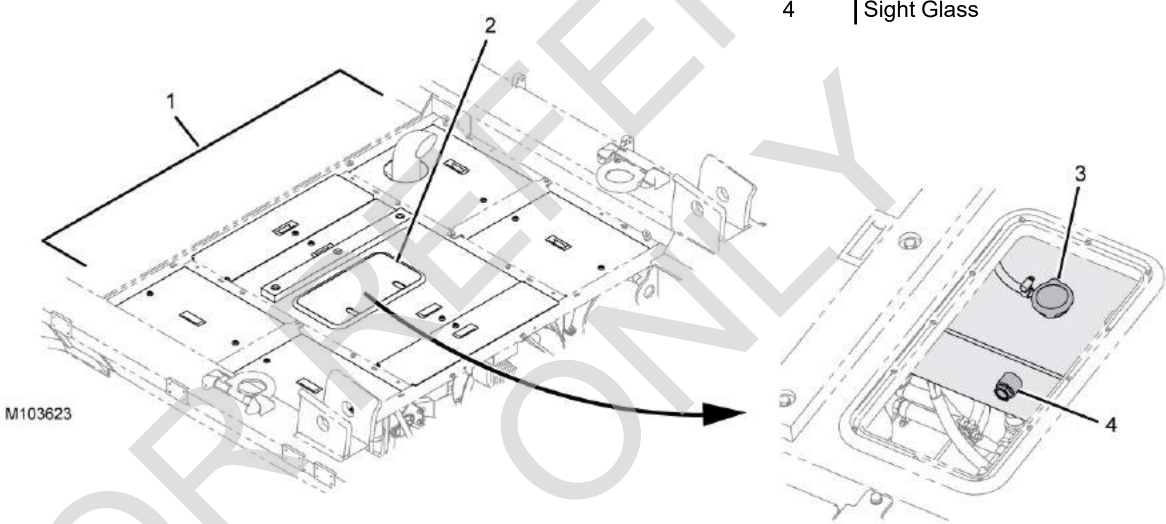


FIGURE 7-12

FOR REFERENCE ONLY

Fill a Drained Cooling System

CAUTION

Maintain Coolant Additive!

The required supplemental coolant additive (SCA) concentration must be maintained to prevent engine damage.

Supplemental coolant additive must be added to the cooling system to prevent liner pitting and for scaling protection.

Check the SCA concentration according to the schedule in the engine manufacturer's operator manual and per the manufacturer's warnings, cautions, and instructions.

See Figure 7-12, unless otherwise noted.

1. Check that the cab heater valves (lower right side of the engine) are open. In the cab, place the heat control to maximum.

NOTE: It is not necessary to turn on the heater fan.

2. Make sure the drain valve (3, Figure 7-13) is closed.
3. Open the access hatch (2) in the engine enclosure (1) and remove the radiator reservoir cap (3).
4. Open the petcock vents (2, Figure 7-13) on the top side of the radiator end tanks.
5. Add the supplemental coolant additive to the radiator.

NOTE: The capacity of the Tier 4 cooling system is approximately 106 liters (28 gallons).

The capacity of the Tier 3 cooling system is approximately 91 liters (24 gallons).

6. Add a 50-50 mix of water and ethylene glycol to the radiator.

NOTE: The maximum fill rate is 19 liters/min (5 GPM).

7. Close the petcock vents once coolant begins to flow out.
8. When coolant is visible in the sight glass (4), wait 1 to 2 minutes, then add coolant again as needed.

WARNING

Chemical and Burn Hazard!

Coolant could spray from an open radiator cap while the engine is running. Do not stand near the radiator while operating the engine with the radiator reservoir cap removed.

Coolant is toxic. Do not ingest. If not reused, dispose of in accordance with all local and other applicable environmental regulations.

9. Start the engine and run until the thermostat opens.
10. Reduce engine speed to low idle for two minutes to cool down engine components, then stop the engine.
11. When the engine has cooled, add coolant until it is visible in the sight glass. Install the radiator reservoir cap and close the access hatch.

Item	Description
1	Radiator
2	Petcock Vent (qty 2)
3	Drain Valve

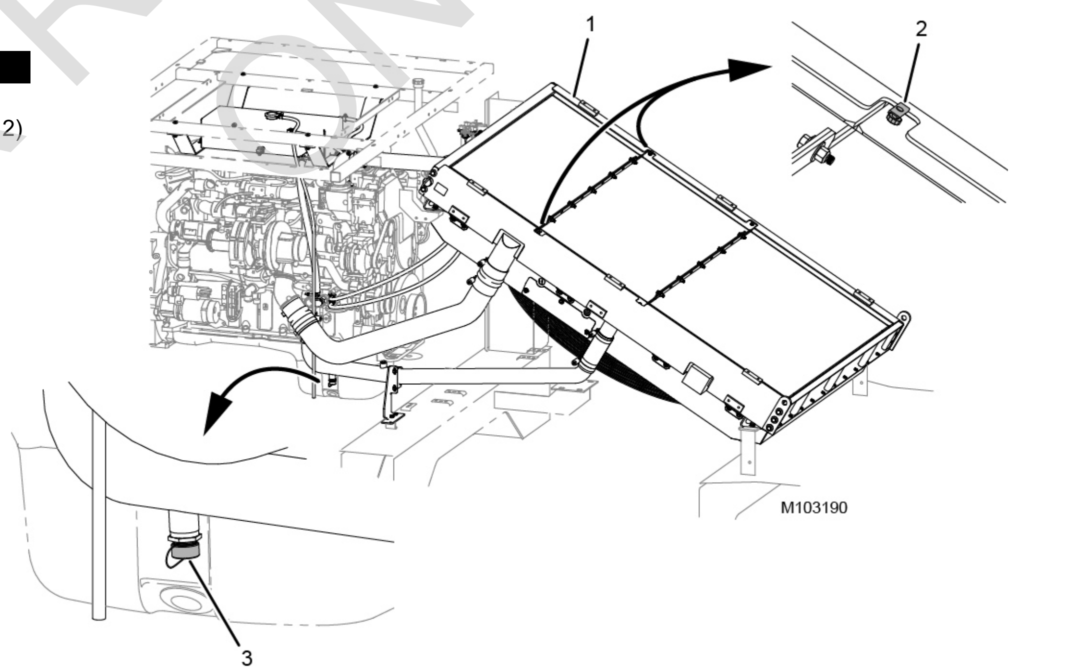


FIGURE 7-13

FOR REFERENCE ONLY

DIESEL PARTICULATE FILTER

The diesel particulate filter (DPF), located left of the engine, captures soot and ash from the engine exhaust.

- Soot is partially burned fuel particles that occur during normal operation (black smoke).

  Soot is automatically removed by a process called regeneration.

- Ash is partially burned engine oil particles that occur during normal operation.

  Ash removal—The DPF must be periodically removed and replaced (see DPF Replacement on page 7-21).

Regeneration

Regeneration is the process of converting soot collected in the DPF into carbon dioxide. Regeneration requires heat.

Two types of regeneration are used:

- Passive
- Active

For information on the related switches and faults, see Section 3 of the Operator Manual.

Passive Regeneration

Passive regeneration occurs when the exhaust temperatures are naturally high enough to oxidize the soot faster than it is collected in the DPF.

The process typically occurs during normal crane operation. The operator will not know when passive regeneration is occurring.

Active Regeneration

Active regeneration occurs when the exhaust temperatures are not naturally high enough to oxidize the soot faster than it is collected in the DPF. If this happens, the engine control module (ECM) will initiate the process (see engine manufacturer's manual for detailed instructions).

The process occurs more frequently in cranes operated at light or no load.

Active regeneration will be transparent to the operator, except there may be an increase in turbocharger noise and exhaust temperature. The High Exhaust Temperature icon should be on during regeneration and remain on until regeneration cycle is completed and the exhaust temperatures return to normal.

Manual Regeneration

Manual regeneration is active regeneration that is initiated by the operator. The DPF icon will come on if manual regeneration is required.

Regeneration Inhibit

Do not use the inhibit switch unless specifically instructed to do so by the Manitowoc Crane Care Lattice Team.

NOTE: The inhibit switch is only for special circumstances in which it is desirable to disable active regeneration.

Prolonged engine operation with inhibit on will cause the DPF to fill with soot. Too much soot could cause the engine to stop. If that occurs, it will be necessary to clean the DPF before the engine can be restarted.

Maintenance

If ash buildup is not removed, the DPF can be damaged or its life reduced.

At a minimum service interval of 4,500 operating hours (roughly every two years of one-shift operation), the DPF should be sent to the manufacturer for cleaning or exchanged for a clean one.

DPF cleaning requires special tools and equipment and should not be attempted by field service personnel.

For inspection and/or cleaning, the DPF must be removed. It may be reusable.

NOTE: If engine Fault Code 1981 or 1922 has been noted and the DPF is contaminated with coolant, the DPF must be removed and replaced.

See the aftertreatment assembly drawing for removal, installation, and orientation of the diesel particulate filter.

FOR REFERENCE ONLY

DPF Replacement

WARNING

Hot Exhaust Surfaces and Inhalation Hazards!

Extremely hot surfaces and exhaust gasses can cause death or serious injury.

When the HEST icon is illuminated, make sure that people stay at least 1,5 m (5 ft) away from the exhaust pipe and that the pipe is not directed at anything that can melt, burn, or explode.

Allow the engine and the exhaust system to cool before servicing.

WARNING

Personal Injury Hazard—Heavy Objects!

Each panel over the DPF weighs approximately 9 kg (20 lb).

The panel over the engine weighs approximately 25 kg (55 lb).

The DPF assembly weighs approximately 74 kg (163 lb).

To prevent serious injury, use appropriate lifting equipment when lifting or removing these objects.

WARNING

Electrical Shock Hazard!

A dangerous shock is possible from a 24 V_{DC} source. Ensure that the battery cables are disconnected from the batteries before loosening any electrical connections.

CAUTION

Avoid Electronic Control Module Malfunction!

Before disconnecting the batteries, make sure the engine ignition switch has been off for 5 minutes. This will avoid engine fault codes and undesirable operation.

CAUTION

Avoid Damage to the DPF!

The oxidation catalyst elements of the diesel particulate filter are made of brittle material. Do not drop or strike the side of the DPF. Otherwise, damage to these elements can result.

Removal

See Figure 7-14 for the following procedure.

1. Move the live mast to a position that allows the removal of the engine enclosure assembly.
2. Using the appropriate lifting equipment, remove engine enclosure components as needed for service.
3. Disconnect the crane's batteries (negative cable first and positive cable last).
4. Disconnect wire connectors (4) from the DPF assembly (2).
5. Remove the bolt from the P-clamp that holds the wire connectors to the DPF assembly. Remove the P-clamp and move wiring out of the way.
6. Loosen the exhaust clamp (1) and remove.
7. Loosen the exhaust clamp (6) and remove.
8. Attach the appropriate lifting equipment to the lifting tabs (5) on the DPF assembly and remove any slack. The assembly total weight is 74 kg (163 lb).
9. Loosen and remove the exhaust mounting bracket bolts (7). Remove the DPF exhaust mounting brackets (3).

NOTE: Do not remove the exhaust mounting brackets underneath the DPF assembly.

10. Lift the DPF assembly out of the engine compartment. Use the appropriate procedures when moving the DPF assembly to the transport equipment.

Installation

1. Install the DPF assembly (2) by completing the removal procedure in reverse.
2. Install the engine enclosure components and connect the batteries (positive cable first and negative cable last).

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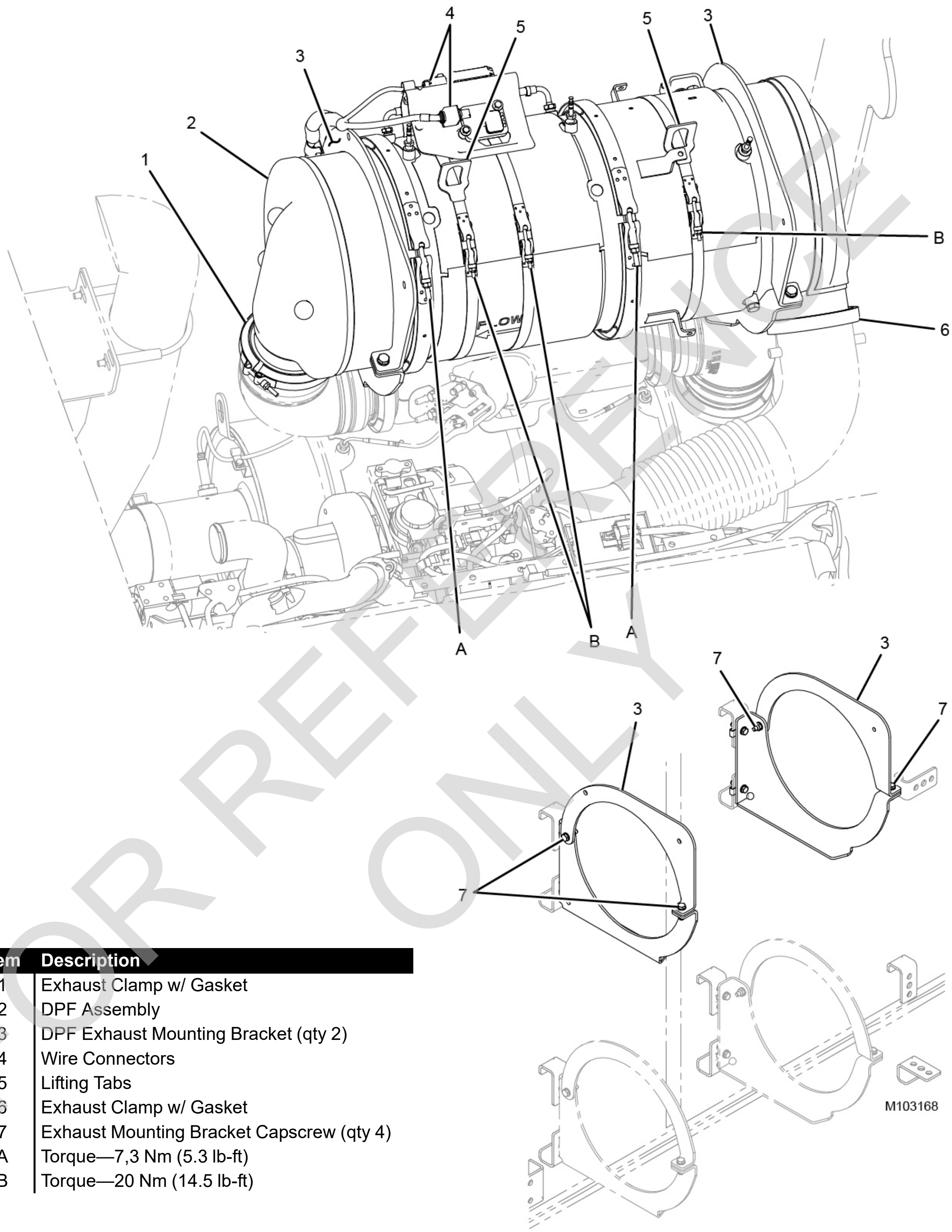

Item	Description
1	Exhaust Clamp w/ Gasket
2	DPF Assembly
3	DPF Exhaust Mounting Bracket (qty 2)
4	Wire Connectors
5	Lifting Tabs
6	Exhaust Clamp w/ Gasket
7	Exhaust Mounting Bracket Capscrew (qty 4)
A	Torque—7,3 Nm (5.3 lb-ft)
B	Torque—20 Nm (14.5 lb-ft)

FIGURE 7-14

FOR REFERENCE ONLY

SECTION 8
UNDERCARRIAGE

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Published 03-13-20, Control # 229-11

SECTION 8
UNDERCARRIAGE

GENERAL

This section provides operational information and electrical and hydraulic schematics for the following systems:

- Travel System
- Carbody Jack Cylinders
- Crawler/Carbody Pin Pullers

Additional component information for these systems can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

This section also provides repair, maintenance, and adjustment procedures for the crawler and turntable.

HYDRAULIC TRAVEL SYSTEM

Travel System Overview

The travel system consists of two closed-looped systems, each consisting of an engine-driven hydraulic pump and two hydraulic motors.

The travel pumps are electronically controlled, bi-directional, variable-displacement type of pumps that provide hydraulic flow to the travel motors.

The travel motors are electronically controlled, bi-directional variable-displacement type of motors that provide power to planetary drives.

The speed and direction of the travel motors are dependent on the output flow volume of the travel pump and the position of the travel motor servo. The pumps and motors are electronically controlled by the position of the corresponding travel control handle (J2 joystick) and the travel speed switch located on the right console.

The left travel control handle controls pump 3 and the left travel motors. The right travel control handle controls pump 4 and the right travel motors.

Each travel motor is equipped with a park brake that must be hydraulically released before travel can occur.

Travel Brake Operation

See Figure 8-1 and Figure 8-3 for the following information.

The travel brakes are a spring-applied, hydraulically released brake system located between each travel motor and its corresponding planetary drive. If the brake hydraulic pressure or electrical control is lost, the brake is applied by spring force.

The travel brake release system uses charge pressure from the swing pump, supplied to the travel brake cylinders via the travel brake release solenoid valve. The brake release pressure must be at least 16 bar (232 psi) to fully release the brakes. If the pressure is less than 16 bar (232 psi), the brakes could remain partially applied, which could damage the brake system.

Travel Park Brake Disengage

The J2 joystick sends a 24 VDC output to the travel park switch. The travel park switch is closed in the UN-PARK position, causing the switch to send a 24 VDC signal back to the J2 joystick. When 24 VDC is detected, the J2 joystick activates the travel control handles, but does not allow the travel park brake to disengage until a travel control handle is moved.

When a travel control handle is moved, either forward or rearward, the J2 joystick sends the disengage park brake command to the IOLC30 control module via the controller area network bus (CAN Bus). The IOLC30 control module then sends a 24 V_{DC} output to the travel brake release solenoid valve, energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the travel brake pistons, releasing the brakes.

Travel Park Brake Engage

When the travel park switch is moved to the ON-PARK position, the travel park switch is open, sending a 0 V_{DC} signal back to the J2 joystick. When 0 V_{DC} is detected, the J2 joystick deactivates the travel control handles and sends the engage park brake command to the IOLC30 control module via the CAN Bus.

The IOLC30 control module then sends a 0 V_{DC} output voltage to the travel brake release solenoid valve, de-energizing the solenoid. This causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the travel brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the travel brakes.

FOR REFERENCE ONLY

Travel Speed Selection

The travel speed switch, located on the right console, provides low-speed and high-speed travel selections. Travel speed is dependent on the position of the travel speed switch and the position of the crawler control handle. The control algorithm determines the pump and motor flows needed to achieve either a high or low travel speed.

Low Travel Speed

See Figure 8-2 and Figure 8-3 for the following information.

The SCM-00 control module sends a 24 VDC output to the travel speed switch. When the switch is in the LOW speed position, the switch is open, sending a 0 VDC signal back to the SCM-00 control module. The SCM-00 control module communicates the low-speed command to the CCM-10 control module via the CAN Bus.

The CCM-10 control module then sends a corresponding signal to the IOSB22 control module via the CAN Bus. The IOSB22 control module then decreases the pulse width modulation (PWM) duty cycle to the travel motor control solenoids. The decreased PWM duty cycle increases the angle of the motor swashplate, causing the motor speed to decrease. Motor displacement goes to maximum.

When in low-speed travel mode, the travel motors are kept at maximum displacement and any variation in travel speed is done by varying the PWM duty cycle to the pump control solenoids.

High Travel Speed

See Figure 8-1 and Figure 8-3 for the following information.

When the travel speed switch is in the HIGH speed position, the switch is closed, sending a 24 VDC signal back to the SCM-00 control module. The SCM-00 control module communicates the high-speed command to the CCM-10 control module via the CAN Bus.

The CCM-10 control module then sends a corresponding signal to the IOLC32 and IOSB22 control modules via the CAN Bus. The control algorithm commands the IOLC32 and IOSB22 control modules to drive the travel pumps and motors at a higher rate of speed relative to the movement of the travel control handles.

When in high-speed travel mode, the IOSB22 control module varies the PWM duty cycle to the travel motor control solenoids as commanded by the control algorithm. Increasing the PWM duty cycle decreases the angle of the motor swashplate, causing the motor speed to increase.

NOTE: When the load on the travel circuit increases, the control algorithm decreases the PWM signal to the motors. This causes the angle of each motor's swashplate to increase, which increases motor displacement. The motors rotate at a slower speed, but with more torque.

Travel Operation

See Figure 8-1 and Figure 8-3 for the following information.

To enable the control system, the switches listed below must be in the stated positions:

- Seat safety switch closed
- Travel park switch in the UN-PARK position

In the default state, the left travel / drum 1 diverter solenoid valve and the right travel / drum 2 diverter solenoid valve, located in the accessory valve manifold, are de-energized.

With the left travel / drum 1 diverter solenoid valve de-energized, the left travel/ drum 1 diverter pilot valve is kept in the default position and hydraulic fluid from pump 3 is routed to the left travel motors.

With the right travel / drum 2 diverter solenoid valve de-energized, the right travel/ drum 2 diverter pilot valve is kept in the default position and hydraulic fluid from pump 4 is routed to the right travel motors.

Left Forward Travel Control

See Figure 8-1 and Figure 8-3 for the following information.

When the left travel control handle (J2 joystick) is moved to the forward position, the J2 joystick communicates the travel command to the CCM-10 control module via the CAN Bus.

If equipped with the optional travel pedals, moving the left pedal to the forward travel position sends a corresponding analog signal to the SCM-00 control module. The SCM-00 control module then communicates the travel command to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives the left forward travel command, it sends a corresponding signal to the IOLC32 and IOSB22 control modules via the CAN Bus.

The IOLC32 then begins to ramp up the PWM duty cycle to the B-side solenoid of the pump 3 electronic displacement control (EDC). The PWM signal is in proportion to the speed commanded by the travel control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump.

From the pump, the flow is routed through the left travel/ drum 1 diverter pilot valve and then into the B-side of the left travel motors. If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the left travel motors control solenoids to increase the motor speed until the commanded travel speed is achieved.

The left motor speed sensor and pump 3 pressure transducer (left track psi) provide the closed loop feedback to the control modules. The control algorithm uses this feedback to adjust pump and motor flows to maintain the commanded travel speed.

FOR REFERENCE ONLY

Left Reverse Travel Control

See Figure 8-2 and Figure 8-3 for the following information.

When the left travel control handle (J2 joystick) is moved to the rearward position, the J2 joystick communicates the travel command to the CCM-10 control module via the CAN Bus.

If equipped with the optional travel pedals, moving the left pedal to the reverse travel position sends a corresponding analog signal to the SCM-00 control module. The SCM-00 control module then communicates the travel command to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives the left reverse travel command, it sends a corresponding signal to the IOLC32 and IOSB22 control modules via the CAN Bus.

The IOLC32 begins to ramp up the PWM duty cycle to the A-side solenoid of the pump 3 EDC. The PWM signal is in proportion to the speed commanded by the travel control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump.

From the pump, the flow is routed through the left travel/drum 1 diverter pilot valve and then into the A-side of the left travel motors. If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the left travel motors control solenoids to increase the motor speed until the commanded travel speed is achieved.

The left motor speed sensor and pump 3 pressure transducer (left track psi) provide the closed loop feedback to the control modules. The control algorithm uses this feedback to adjust pump and motor flows to maintain the commanded travel speed.

Right Forward Travel Control

See Figure 8-1 and Figure 8-3 for the following information.

When the right travel control handle (J2 joystick) is moved to the forward position, the J2 joystick communicates the travel command to the CCM-10 control module via the CAN Bus.

If equipped with the optional travel pedals, moving the right pedal to the forward travel position sends a corresponding analog signal to the SCM-00 control module. The SCM-00 control module then communicates the travel command to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives the right forward travel command, it sends a corresponding signal to the IOLC32 and IOSB22 control modules via the CAN Bus.

The IOLC32 begins to ramp up the PWM duty cycle to the B-side solenoid of the pump 4 EDC. The PWM signal is in proportion to the speed commanded by the travel control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the B-side of the pump.

From the pump, the flow is routed through the right travel/drum 2 diverter pilot valve and then into the A-side of the right travel motors. If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the right travel motors control solenoids to increase the motor speed until the commanded travel speed is achieved.

The right motor speed sensor and pump 4 pressure transducer (right track psi) provide the closed loop feedback to the control modules. The control algorithm uses this feedback to adjust pump and motor flows to maintain the commanded travel speed.

Right Reverse Travel Control

See Figure 8-2 and Figure 8-3 for the following information.

When the right travel control handle (J2 joystick) is moved to the rearward position, the J2 joystick communicates the travel command to the CCM-10 control module via the CAN Bus.

If equipped with the optional travel pedals, moving the right pedal to the reverse travel position sends a corresponding analog signal to the SCM-00 control module. The SCM-00 control module then communicates the travel command to the CCM-10 control module via the CAN Bus.

When the CCM-10 control module receives the right reverse travel command, it sends a corresponding signal to the IOLC32 and IOSB22 control modules via the CAN Bus.

The IOLC32 begins to ramp up the PWM duty cycle to the A-side solenoid of the pump 4 EDC. The PWM signal is in proportion to the speed commanded by the control handle. Increasing the PWM duty cycle increases the pump swashplate angle, which increases the hydraulic flow from the A-side of the pump.

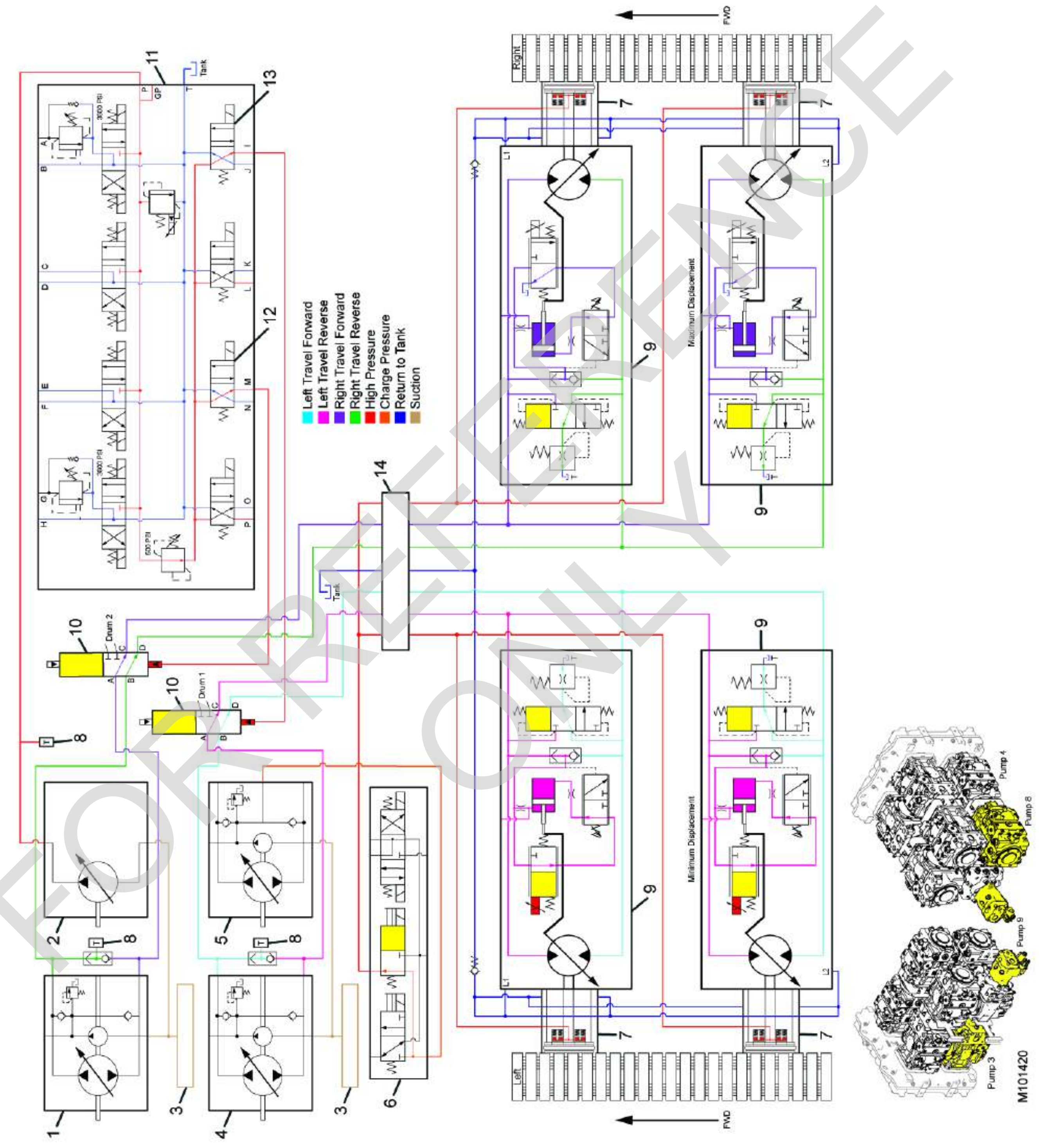
From the pump, the flow is routed through the right travel/drum 2 diverter pilot valve and then into the B-side of the right travel motors. If high-speed travel mode is selected, the IOSB22 control module ramps up the PWM duty cycle to the right travel motors control solenoids to increase the motor speed until the commanded travel speed is achieved.

The right motor speed sensor and pump 4 pressure transducer (right track psi) provide the closed loop feedback to the control modules. The control algorithm uses this feedback to adjust pump and motor flows to maintain the commanded travel speed.

FOR REFERENCE ONLY

Forward Travel (High Speed) Hydraulic Schematic

See Table 8-1.Legend for Figure 8-1 and Figure 8-2

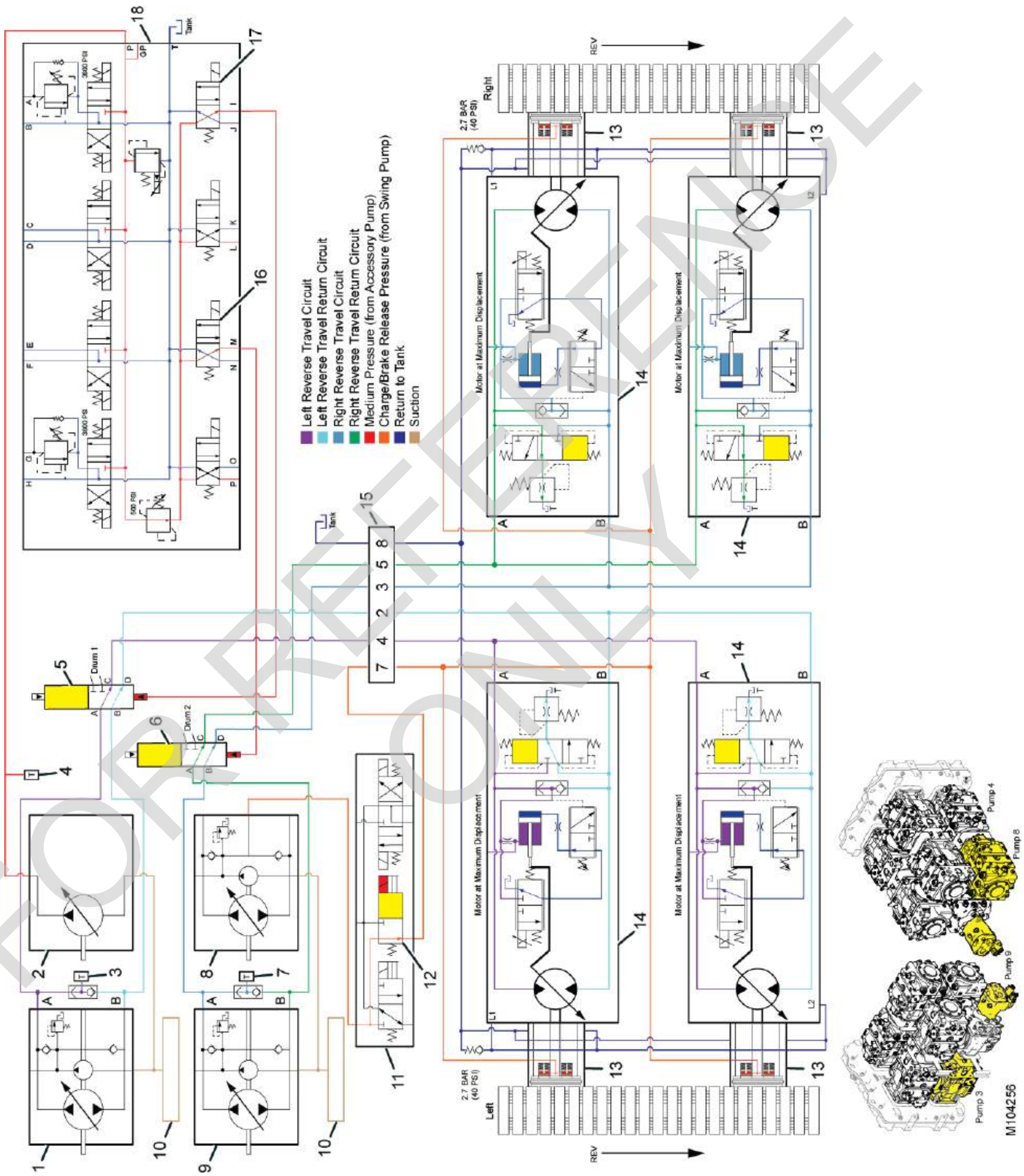


FOR REFERENCE ONLY

FIGURE 8-1

Reverse Travel (Low Speed) Hydraulic Schematic

See Table 8-1.Legend for Figure 8-1 and Figure 8-2



FOR REFERENCE ONLY

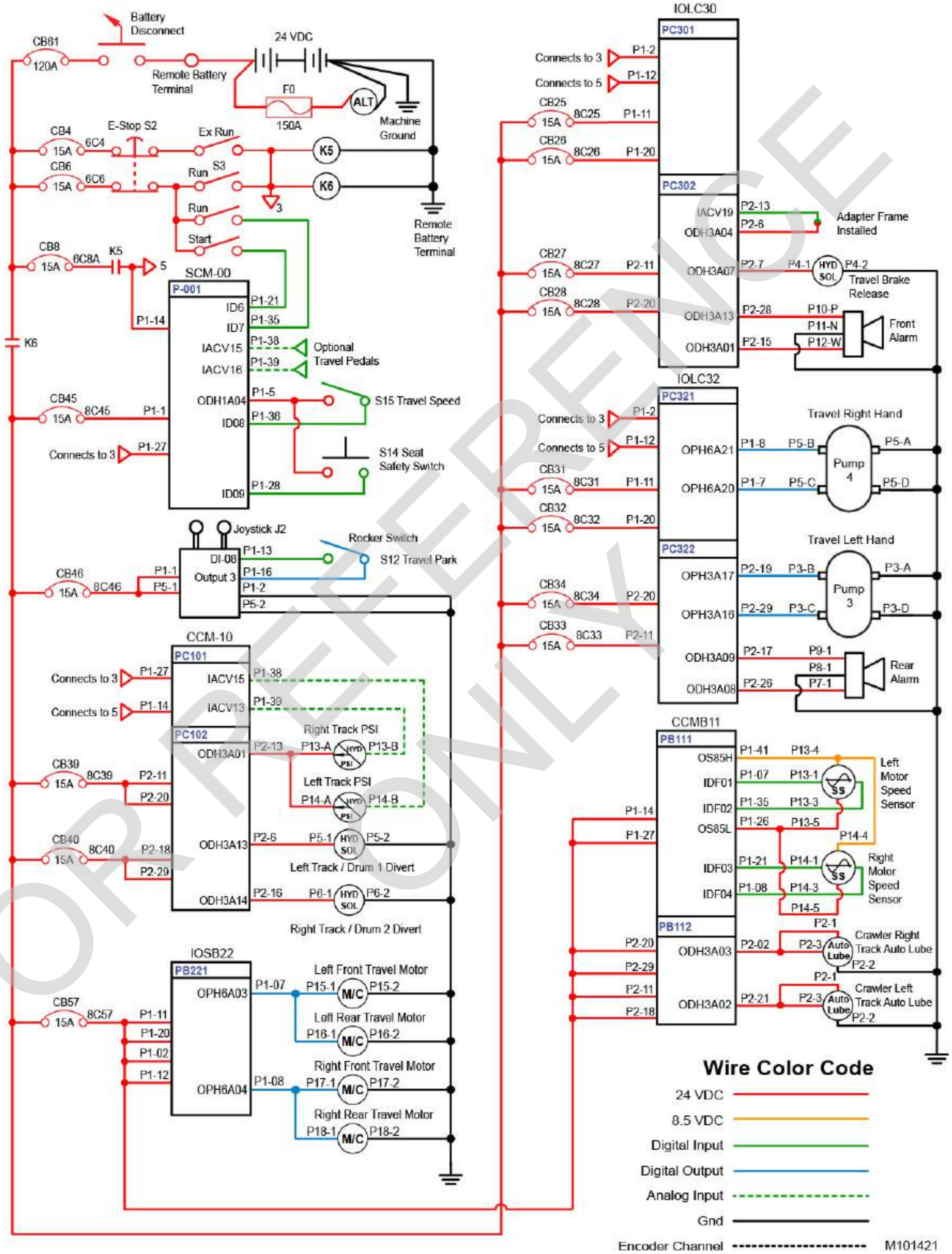
FIGURE 8-2

Table 8-1. Legend for Figure 8-1 and Figure 8-2

Item	Description
1	Pump 3 (left travel / drum 1) (130 cc)
2	Pump 9 (accessory) (45 cc)
3	Pump 3 Pressure Transducer (left track psi)
4	Pump 9 Pressure Transducer (acc systems psi)
5	Left Travel / Drum 1 Diverter Pilot Valve (directional control)
6	Right Travel / Drum 2 Diverter Pilot Valve (directional control)
7	Pump 4 Pressure Transducer (right travel psi)
8	Pump 8 (swing) (100 cc)
9	Pump 4 (right travel / drum 2) (130 cc)
10	Suction Manifold
11	Adapter Frame Valve
12	Travel Brake Release Solenoid Valve
13	Gearbox and Brake Assembly (qty 4)
14	Travel Motor (variable displacement) (160 cc) (qty 4)
15	Swivel
16	Right Travel / Drum 2 Diverter Solenoid Valve
17	Left Travel / Drum 1 Diverter Solenoid Valve
18	Accessory Valve Manifold

FOR REFERENCE ONLY

Travel Electrical Schematic



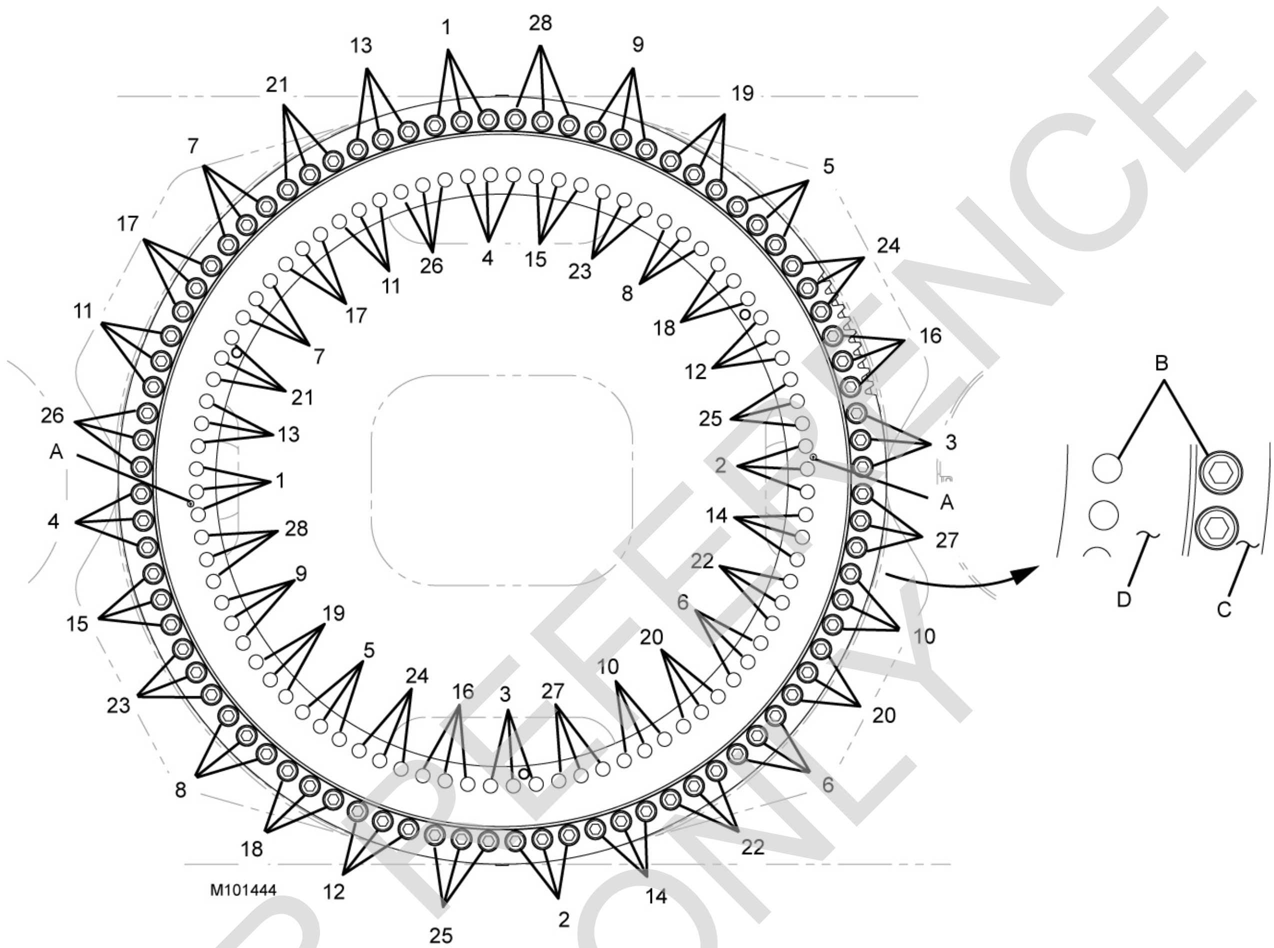
FOR REFERENCE ONLY

FIGURE 8-3

TURNTABLE BEARING ALIGNMENT

The outer ring (C, Figure 8-4) can be installed in any position with relation to the carbody.

Two dowel pins (A) are installed in the inner ring (D) to locate the inner ring on the rotating bed.



FOR REFERENCE ONLY

Item	Description
A	Dowel Pin—Two Places
B	M52 X 5 X 380 LG Special Grade Bolt With Flat Washer 84 Places Outer Ring 84 Places Inner Ring
C	Outer Ring
D	Inner Ring

FIGURE 8-4

TURNTABLE BEARING BOLT PERIODIC TIGHTENING

DANGER

Crushing Injury Hazard!

Two people are required to install the turntable bearing bolts, an operator to operate swing control and a mechanic to tighten the bolts to the correct torque.

It is necessary for the mechanic to go inside the rotating bed to tighten the inner turntable bearing bolts, requiring the following to be complied with:

- Maintain constant communication between the operator and mechanic while the mechanic is inside the rotating bed.
- The operator shall not swing the upperworks until instructed to do so by the mechanic.
- The mechanic shall stay well clear of moving parts while the upperworks are being swung to position the bolts.

WARNING

Bolt Failure!

Loose or improperly tightened bolts can cause bolts or the turntable bearing to fail, possibly allowing the upperworks to break away from the carbody.

After the first 50 hours of initial operation, tighten all bolts, three at a time, in the numbered sequence (see Figure 8-4) to 8700 Nm (6,400 ft-lb).

Annually or every 2,000 hours of operation (whichever comes first), tighten all bolts, three at a time, in the numbered sequence (see Figure 8-4) to 8700 Nm (6,400 ft-lb).

If during annual turntable bearing bolt tightening, one or more bolts are found to be tightened to less than 6960 Nm (5,120 ft-lb), replace each loose bolt and washer as well as the bolts and washers on each side of each loose bolt.

If during annual turntable bearing bolt tightening, 16 or more bolts in either the inner or outer ring are found to be tightened to less than 6960 Nm (5,120 ft-lb), replace all of the bolts and washers for the corresponding ring.

Replace all bolts and washers anytime a new turntable bearing is installed.

REPLACING TURNTABLE BOLTS

1. Apply Never-Seez to the following:
   - Bolt threads
   - Bolt under head
   - Both sides of the washer
2. Position the chamfers of the washers toward the bolt head, then insert the bolts through the washers.
3. Install and tighten the bolts, three at a time, in the numbered sequence (see Figure 8-4) to an initial torque of 2900 Nm (2,100 ft-lb).
4. Tighten the bolts, three at a time, in the numbered sequence (see Figure 8-4) to a final torque of 6960 Nm (5,120 ft-lb).

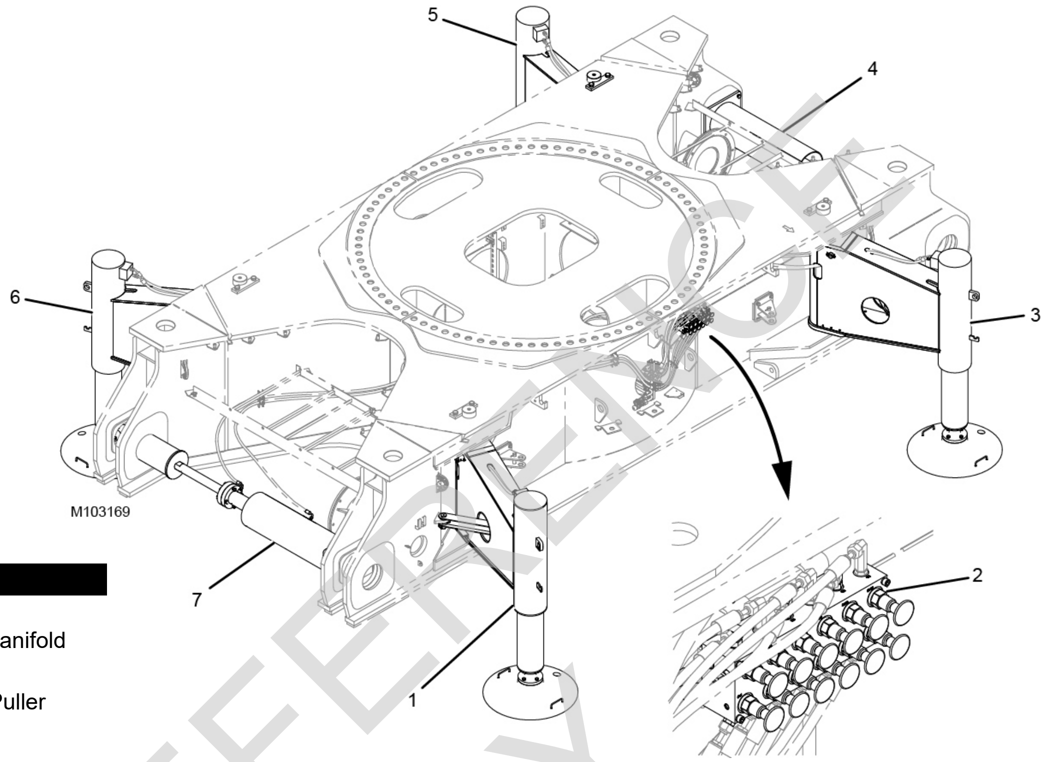
CRAWLER PREVENTIVE MAINTENANCE

Crawler wear cannot be eliminated, but the rate of wear can be reduced through regular preventive maintenance as follows:

- Lubricate the crawlers as instructed in the MLC650 Lubrication Guide.
- Keep the crawlers clean and avoid dirt buildup when cutting.
- Keep all mounting bolts tight (see Parts Manual for applicable torque values).
- Keep the treads properly adjusted.
- Inspect the crawler frames, rollers, and treads on a regular basis.
- Check for oil leaks, excessive wear, cracks, and other damage. Broken or cracked parts can indicate that the treads are adjusted too tightly.
- Repair or replace damaged parts immediately to prevent further damage.

FOR REFERENCE ONLY

CARBODY JACK CYLINDERS AND CARBODY/CRAWLER PIN PULLERS



Item	Description
1	Right Front Jack Cylinder
2	Carbody Manual Control Manifold
3	Left Front Jack Cylinder
4	Left Carbody/Crawler Pin Puller
5	Left Rear Jack Cylinder
6	Right Rear Jack Cylinder
7	Right Carbody/Crawler Pin Puller

FIGURE 8-5

FOR REFERENCE ONLY

CARBODY JACK CYLINDERS CONTROL

See Figure 8-5 for the location of the following components:

- Carbody jack cylinders
- Carbody manual control manifold

See Figure 8-7 for a hydraulic schematic detail of all of the carbody jack circuits when in neutral.

See Figure 8-8 for a hydraulic schematic detail of a single carbody jack circuit when using the setup remote control.

See Figure 8-9 for a hydraulic schematic detail of a single carbody jack circuit when using the carbody manual control.

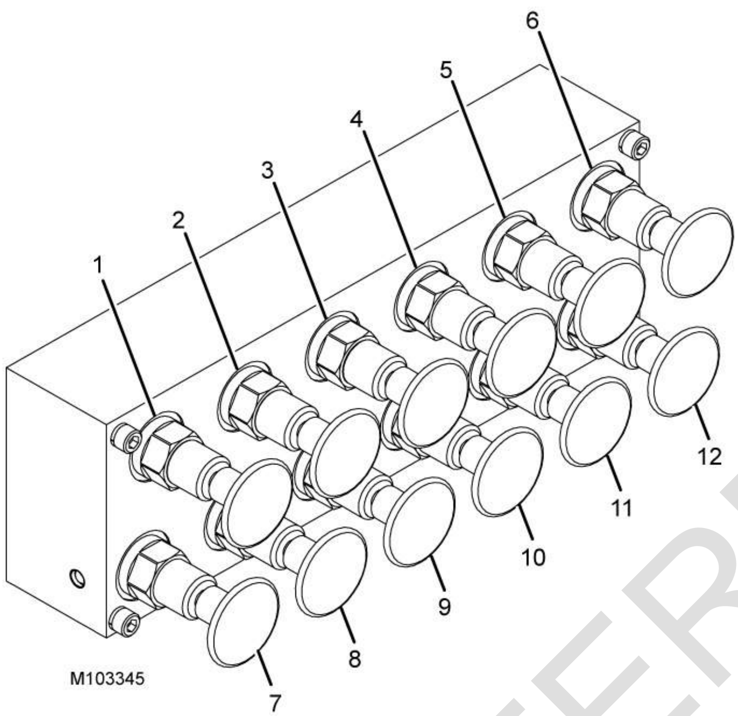
Movement of the carbody jacks is controlled by one of the following methods:

- Setup remote control
- Carbody manual control manifold

Carbody Manual Control

The carbody jacks can be manually controlled using the hydraulic power unit (HPU) and the carbody manual control manifold located on the front of the carbody. From this location, the carbody jack cylinders can be controlled individually.

NOTE: For instructions on operating and connecting the HPU, refer to the folio F2283—MLC650 Hydraulic Power Unit Operation and Maintenance Manual.



Item	Description
1	B1 Right Front Carbody Jack Extend
2	B2 Right Rear Carbody Jack Extend
3	B3 Right Crawler Carbody Pin Puller Extend
4	B4 Left Crawler Carbody Pin Puller Extend
5	B5 Left Rear Carbody Jack Extend
6	B6 Left Front Carbody Jack Extend
7	A1 Right Front Carbody Jack Retract
8	A2 Right Rear Carbody Jack Retract
9	A3 Right Crawler Carbody Pin Puller Retract
10	A4 Left Crawler Carbody Pin Puller Retract
11	A5 Left Rear Carbody Jack Retract
12	A6 Left Front Carbody Jack Retract

FIGURE 8-6

The controls of the carbody manual control manifold (see Figure 8-6) are as follows:

- Valve handles that control carbody jacks extend:
  - B1 right front carbody jack extend (1)
  - B2 right rear carbody jack extend (2)
  - B5 left rear carbody jack extend (5)
  - B6 left front carbody jack extend (6)
- Valve handles that control carbody jacks retract:
  - A1 right front carbody jack retract (7)
  - A2 right rear carbody jack retract (8)
  - A5 left rear carbody jack retract (11)
  - A6 left front carbody jack retract (12)
- Valve handles that control crawler/carbody pins extend:
  - B3 right crawler/carbody pin puller extend (3)
  - B4 left crawler/carbody pin puller extend (4)
- Valve handles that control crawler/carbody pins retract:
  - A3 right crawler/carbody pin puller retract (9)
  - A4 left crawler/carbody pin puller retract (10)

FOR REFERENCE ONLY

8

Extend Carbody Jacks Using Manual Control

See Figure 8-9 for the following.

NOTE: The following describes the operation to extend one carbody jack cylinder. The operation is the same for all carbody jack cylinders.

When the HPU is connected, the selector solenoid valve (1) is de-energized, causing the valve to shift to the default position. When in the default position, the selector valve routes the flow to the carbody manual control manifold (5).

When a valve handle for a jack cylinder extend function is pulled, hydraulic fluid is routed to the corresponding port on the six-section lower accessory valve assembly (2). Inside the valve assembly, fluid flows through a shuttle valve, then to the corresponding valve spool. This causes the spool to move to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (4).

Within the counterbalance valves, flow and control is as follows:

- At the rod side valve, the hydraulic fluid pressure from the rod side of the cylinder and the accessory pump pressure opens the counterbalance valve. As the cylinder extends, the hydraulic fluid from the rod side of the cylinder goes through the now open counterbalance valve, then back to tank.
- At the piston side valve, the hydraulic fluid from the accessory pump flows through the counterbalance bypass check valve (3), then into the piston side of the cylinder.

Retract Carbody Jacks Using Manual Control

See Figure 8-9 for the following.

NOTE: The following describes the operation to retract one carbody jack cylinder. The operation is the same for all carbody jack cylinders.

When the HPU is connected, the selector solenoid valve (1) is de-energized, causing the valve to shift to the default position. When in the default position, the selector valve routes the flow to the carbody manual control manifold (5).

When a valve handle for a jack cylinder retract function is pulled, hydraulic fluid is routed to the corresponding port on the six-section lower accessory valve assembly (2). Inside the valve assembly, hydraulic fluid flows through a shuttle valve, then to the corresponding valve spool. This causes the spool to move to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (4), via the orifice with bypass check valve (3).

NOTE: The orifice decreases the maximum flow during the retract operation.

Within the counterbalance valves, flow and control is as follows:

- At the piston side valve, the hydraulic fluid pressure from the piston side of the cylinder and the accessory pump pressure opens the counterbalance valve. As the cylinder retracts, the hydraulic fluid from the piston side of the cylinder goes through the now open counterbalance valve, then back to tank.
- At the rod side valve, the hydraulic fluid from the accessory pump flows through the counterbalance bypass check valve (3), then into the rod side of the cylinder.

FOR REFERENCE ONLY

Setup Remote Control

Setup Remote Overview

NOTE: The setup remote is covered in section 4 of the Operator Manual.

See Figure 8-7 and Figure 8-10 for the following.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

When the crane control system is on, the selector solenoid valve (1) is energized, overriding the carbody manual control manifold (5). It does this by sending a command to the CCM-10 control module. The CCM-10 control module then sends a signal to the CCMB11 control module to energize the selector solenoid valve. The energized solenoid causes the selector valve to shift position, stopping flow to the carbody manual control manifold. It then routes the flow to the six-section lower accessory valve assembly (2).

When a raise or lower command is initiated on the setup remote transmitter, the transmitter sends the command to the setup remote receiver. The setup remote receiver then sends a signal to the CCM-10 control module, which then sends a signal to the CCMB11 and IOSB22 control modules. The CCMB11 and IOSB22 control modules then energize the corresponding jack cylinder solenoids in the six-section lower accessory valve assembly.

Control of the carbody jack cylinders is as follows:

- IOSB22
  - Right rear cylinder
- CCMB11
  - Right front cylinder
  - Left front cylinder
  - Left rear cylinder

Neutral Position Using Setup Remote

See Figure 8-7 and Figure 8-10 for the following.

When the crane control system is on, the selector solenoid valve (1) is energized. The energized selector valve routes hydraulic fluid to the six-section lower accessory valve assembly (2).

When no signal is sent to any of the jack cylinder solenoids in the six-section lower accessory valve assembly, all the valve spools are held in the neutral position by the return springs. Each jack cylinder is held in position by its corresponding counterbalance valve, which closes and stops the flow to and from the cylinder.

Extend Carbody Jacks Using Setup Remote

See Figure 8-8 and Figure 8-10 for the following.

NOTE: The following describes the operation to extend one carbody jack cylinder. The operation is the same for all carbody jack cylinders.

With the crane control system on, the selector solenoid valve (1) is energized, allowing hydraulic fluid to flow to the six-section lower accessory valve assembly (2).

When a jack extend command is initiated on the setup remote transmitter, the CCMB11 control module or IOSB22 control module (depending on the jack being controlled) energizes the corresponding jack cylinder extend solenoid in the six-section lower accessory valve assembly. The extend solenoid valve routes pilot hydraulic fluid through an internal shuttle valve, then to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (4).

Within the counterbalance valves, flow and control is as follows:

- At the rod side valve, the hydraulic fluid pressure from the rod side of the cylinder and the accessory pump pressure opens the counterbalance valve. As the cylinder extends, the hydraulic fluid from the rod side of the cylinder goes through the now open counterbalance valve, then back to tank.
- At the piston side valve, the hydraulic fluid from the accessory pump flows through the counterbalance bypass check valve (3), then into the piston side of the cylinder.

8

FOR REFERENCE ONLY

Retract Carbody Jacks Using Setup Remote

See Figure 8-8 and Figure 8-10 for the following.

NOTE: The following describes the operation to retract one carbody jack cylinder. The operation is the same for all carbody jack cylinders.

When the crane control system is on, the selector solenoid valve (1) is energized, allowing hydraulic fluid to flow to the six-section lower accessory valve assembly (2).

When a jack retract command is initiated on the setup remote transmitter, the CCMB11 control module or IOSB22 control module (depending on the jack being controlled) energizes the corresponding jack cylinder retract solenoid in the six-section lower accessory valve assembly. The retract solenoid valve routes pilot hydraulic fluid through an internal shuttle valve, then to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (4), via the orifice with bypass check valve (3).

NOTE: The orifice decreases the maximum flow during the retract operation.

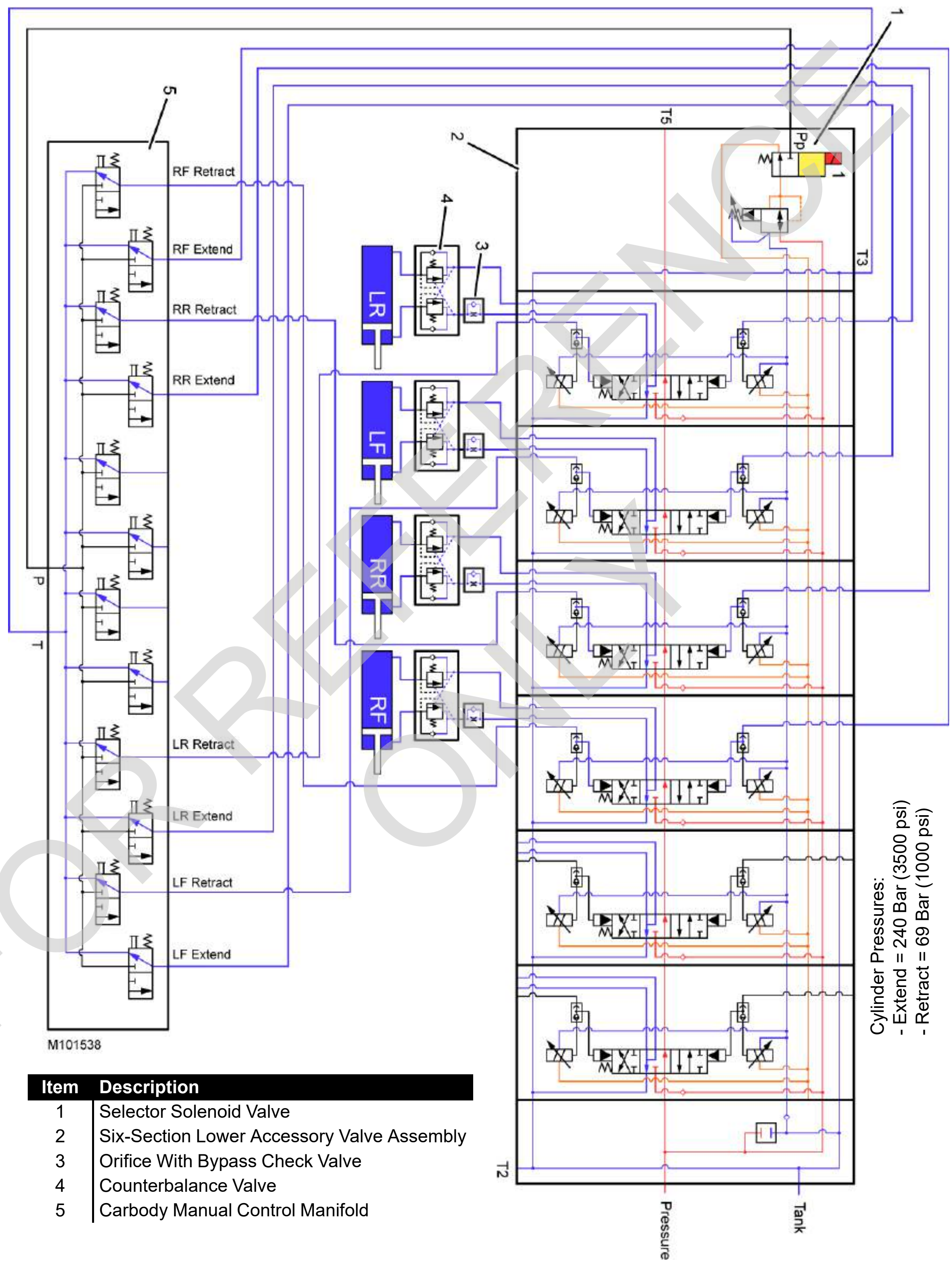
Within the counterbalance valves, flow and control is as follows:

- At the piston side valve, the hydraulic fluid pressure from the piston side of the cylinder and the accessory pump pressure opens the counterbalance valve. As the cylinder retracts, the hydraulic fluid from the piston side of the cylinder goes through the now open counterbalance valve, then back to tank.
- At the rod side valve, the hydraulic fluid from the accessory pump flows through the counterbalance bypass check valve (3), then into the rod side of the cylinder.

FOR REFERENCE ONLY

Carbody Jacks Hydraulic Schematic

The hydraulic schematic is shown with the remote in the neutral state.



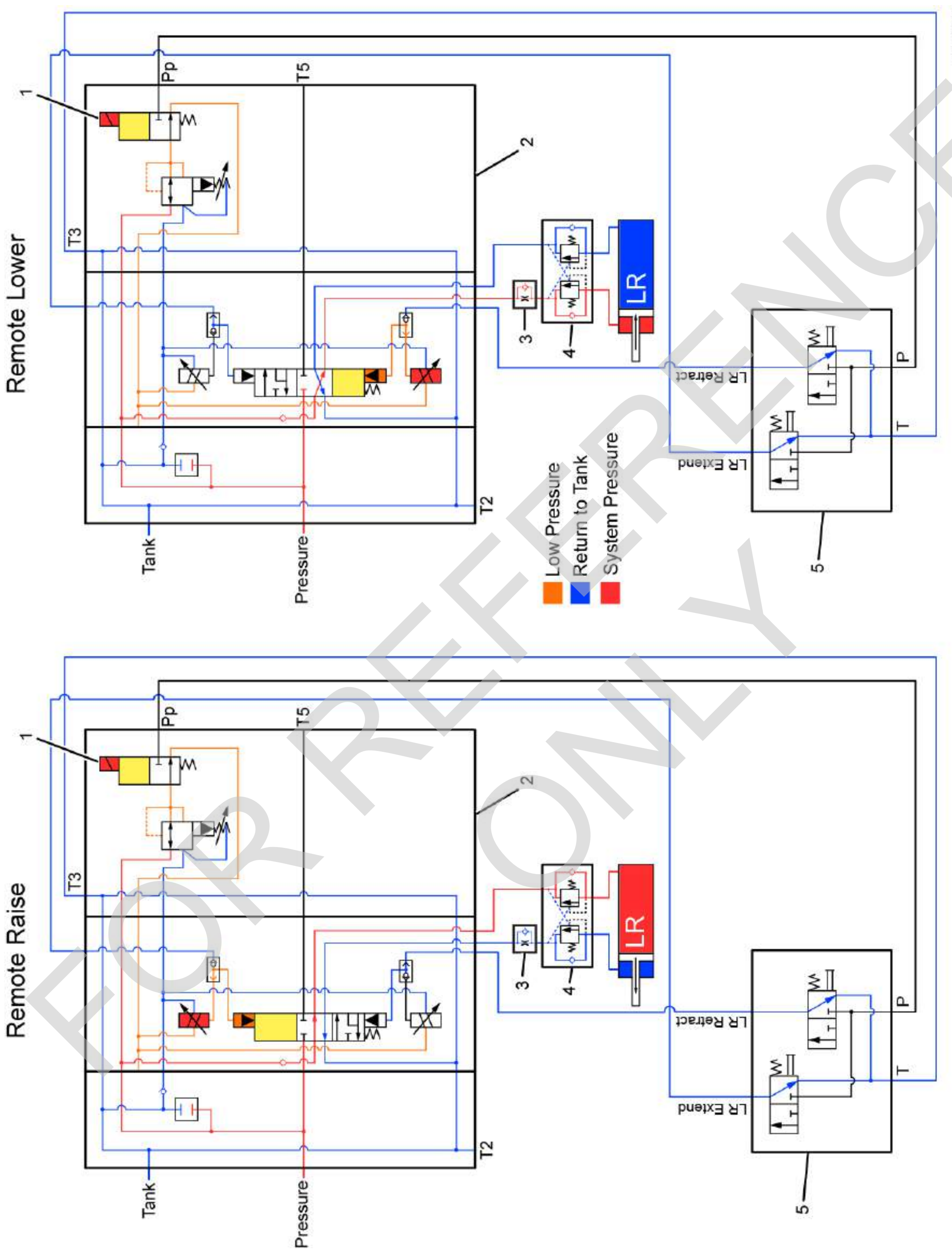
FOR REFERENCE ONLY

Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Orifice With Bypass Check Valve
4	Counterbalance Valve
5	Carbody Manual Control Manifold

FIGURE 8-7

8

Carbody Jacks Hydraulic Schematic (Remote Control)

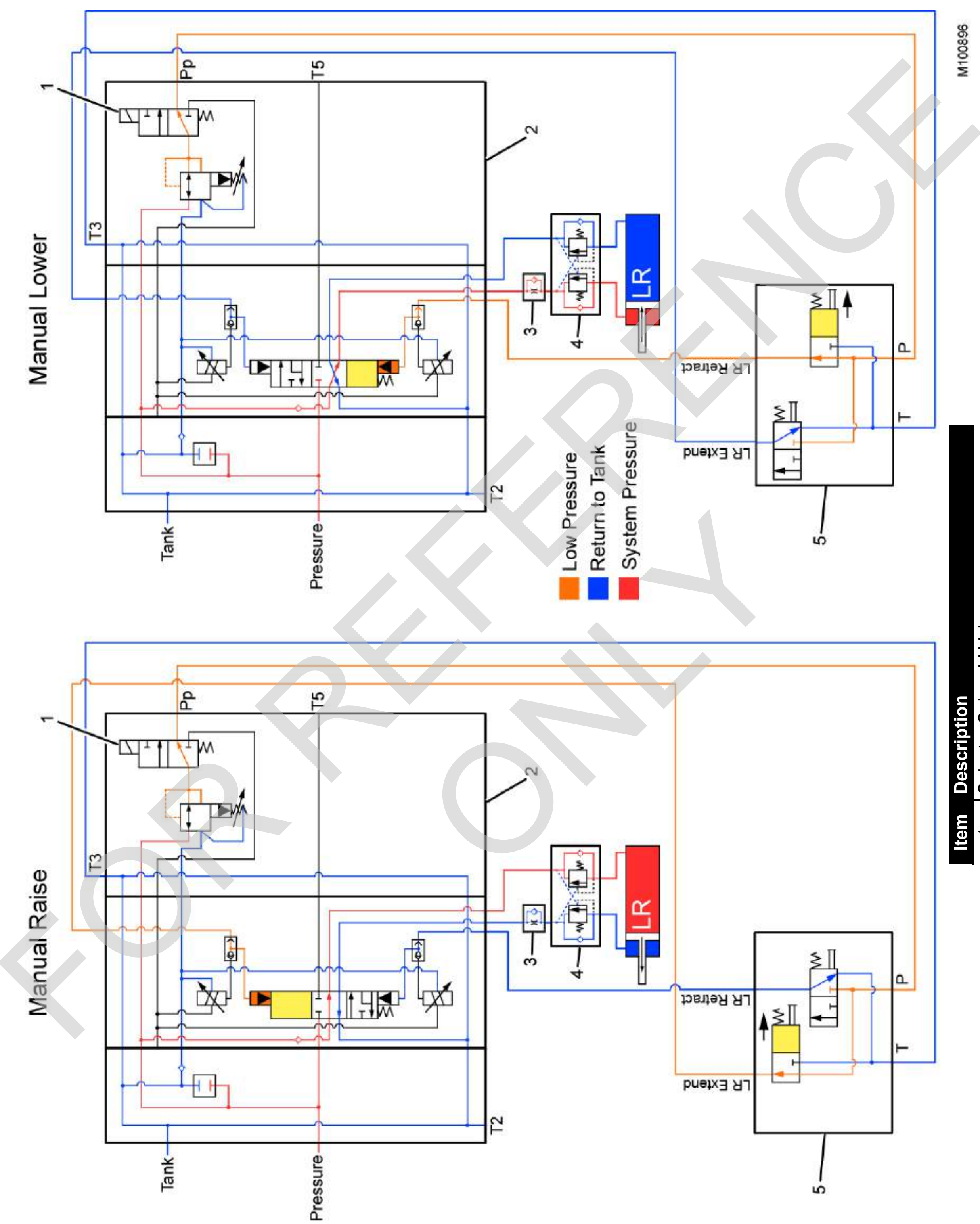


Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Orifice With Bypass Check Valve
4	Counterbalance Valve
5	Carbody Manual Control Manifold

FIGURE 8-8

FOR REFERENCE ONLY

Carbody Jacks Hydraulic Schematic (Manual Control)

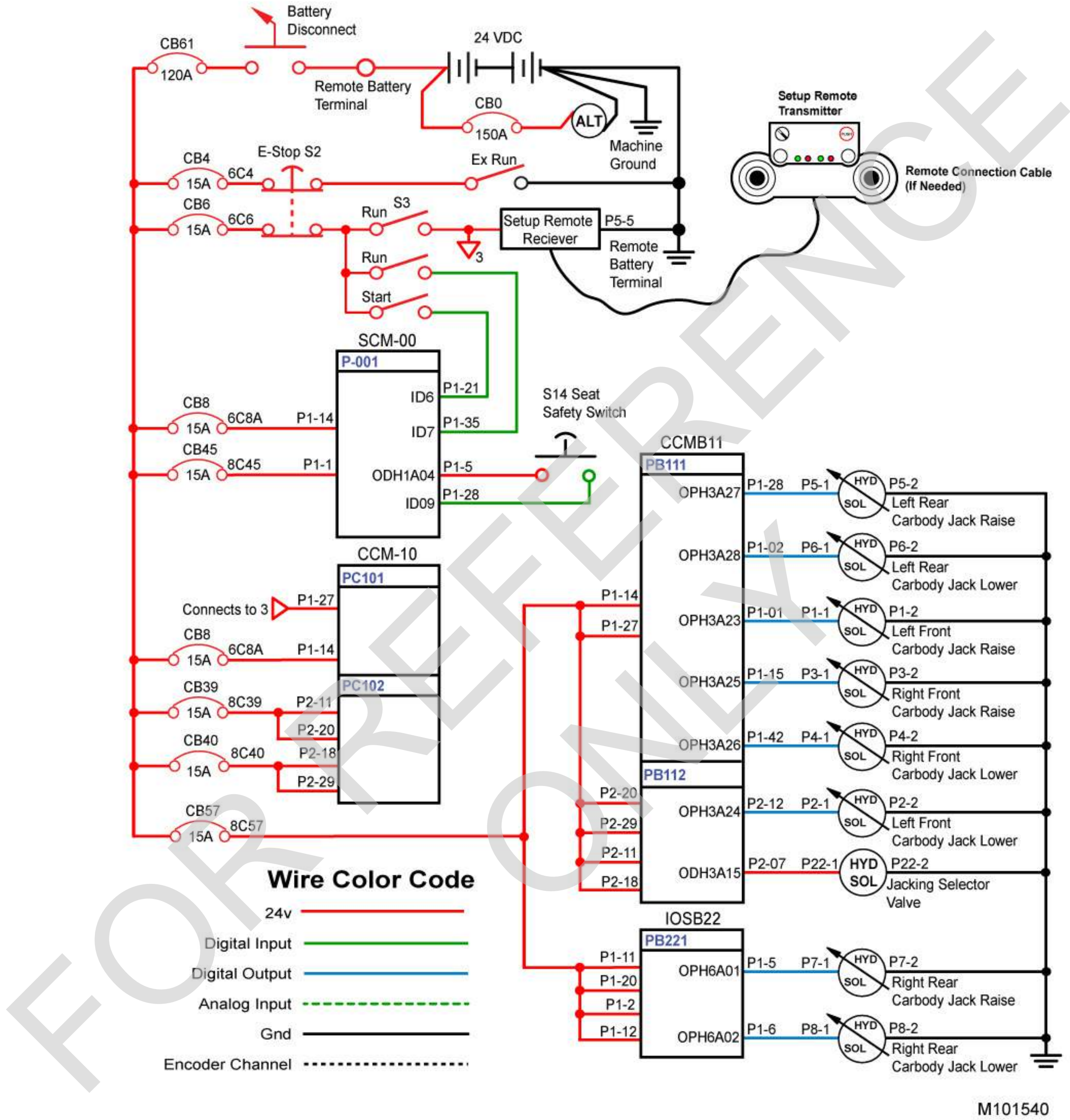


Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Orifice With Bypass Check Valve
4	Counterbalance Valve
5	Carbody Manual Control Manifold

FOR REFERENCE ONLY

FIGURE 8-9

Carbody Jacks Electrical Schematic



FOR REFERENCE ONLY

FIGURE 8-10

CRAWLER/CARBODY PIN PULLERS CONTROL

See Figure 8-5 for the location of the following components:

- Carbody/crawler pin pullers
- Carbody manual control manifold

See Figure 8-6 for details on the carbody manual control manifold.

See Figure 8-11 for a hydraulic schematic detail of all of the pin puller circuits when in neutral.

See Figure 8-12 for a hydraulic schematic detail of a single pin puller circuit when using the setup remote control.

See Figure 8-13 for a hydraulic schematic detail of a single pin puller circuit when using the carbody manual control.

Control of the pin puller cylinders can be performed by one of the following methods:

- Setup remote control
- Carbody manual control manifold

Carbody Manual Control

The crawler/carbody pin pullers can be manually controlled using the hydraulic power unit (HPU) and the carbody manual control manifold located on the front of the carbody (see Figure 8-5). From this location, the pin puller cylinders can be controlled individually.

NOTE: For instructions on operating and connecting the HPU, refer to the folio F2283—MLC650 Hydraulic Power Unit Operation and Maintenance Manual.

Extend Pin Pullers Using Manual Control

See Figure 8-13 for the following.

When the hydraulic power unit (HPU) is connected, the selector solenoid valve (1) is de-energized, causing the valve to shift to the default position. When in the default position, the selector valve routes the flow to the carbody manual control manifold (3).

When a valve handle for a pin puller extend function is pulled, hydraulic fluid is routed to the corresponding port on the six-section lower accessory valve assembly (2). Inside the valve assembly, hydraulic fluid flows through a shuttle valve, then to the corresponding valve spool. This causes the spool to move to a position that allows hydraulic fluid from the accessory pump to flow to the piston end of the pin puller cylinders. At the same time, hydraulic fluid in the rod end of the cylinder is forced out and back to the tank. This causes the rod to extend, engaging the pins.

Retract Pin Pullers Using Manual Control

See Figure 8-13 for the following.

When the HPU is connected, the selector solenoid valve (1) is de-energized, causing the valve to shift to the default position. When in the default position, the selector valve routes the flow to the carbody manual control manifold (3).

When a valve handle for a pin puller retract function is pulled, hydraulic fluid is routed to the corresponding port on the six-section lower accessory valve assembly (2). Inside the valve assembly, hydraulic fluid flows through a shuttle valve, then to the corresponding valve spool. This causes the spool to move to a position that allows hydraulic fluid from the accessory pump to flow to the rod end of the pin puller cylinders. At the same time, hydraulic fluid in the piston end of the cylinder is forced out and back to the tank. This causes the rod to retract, disengaging the pins.

Setup Remote Control

Setup Remote Overview

NOTE: The setup remote is covered in section 4 of the Operator Manual.

See Figure 8-11 and Figure 8-14 for the following.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

When the crane control system is on, it overrides the carbody manual control manifold (3) for controlling movement of the crawler/carbody pin puller cylinders. It does this by sending a command to the CCM-10 control module. The CCM-10 control module then sends a signal to the CCMB11 control module to energize the selector solenoid valve (1). The energized solenoid causes the selector valve to shift position, stopping flow to the carbody manual control manifold. It then routes the flow to the six-section lower accessory valve assembly (2).

When an engage or disengage pins command is initiated on the setup remote transmitter, the transmitter sends the command to the setup remote receiver, which sends a signal to the CCM-10 control module. The CCM-10 control module then sends a signal to the CCMB11 control module to energize the corresponding pin puller solenoids in the six-section lower accessory valve assembly.

FOR REFERENCE ONLY

Neutral Position Using Setup Remote

See Figure 8-11 and Figure 8-14 for the following.

When the crane control system is on, the selector solenoid valve (1) is energized. The energized selector valve routes hydraulic fluid to the six-section lower accessory valve assembly (2).

When no signal is sent to any of the pin puller cylinder solenoids in the six-section lower accessory valve assembly, all the valve spools are held in the neutral position by the return springs. When the spools are in the neutral position, the cylinder is held in place because both sides of the cylinder piston are connected to tank via the valve spool.

When the setup remote transmitter is turned off, the selector solenoid valve shifts to the default position. This causes the hydraulic fluid to flow to the manual control manifold, allowing the pin puller cylinders to be controlled manually.

Extend Pin Pullers Using Setup Remote

See Figure 8-12 and Figure 8-14 for the following.

When the crane control system is on, the selector solenoid valve (1) is energized, allowing hydraulic fluid to flow to the six-section lower accessory valve assembly (2).

When a pin puller extend command is initiated on the setup remote transmitter, the CCMB11 control module energizes the corresponding cylinder extend solenoid in the six-section lower accessory valve assembly. The solenoid valve routes pilot hydraulic fluid through a shuttle valve, then to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the piston end of the pin puller cylinders. At the same time, hydraulic fluid in the rod end of the cylinder is forced out and back to the tank. This causes the rod to extend, engaging the pins.

Retract Pin Pullers Using Setup Remote

See Figure 8-12 and Figure 8-14 for the following.

When the crane control system is on, the selector solenoid valve (1) is energized, allowing hydraulic fluid to flow to the six-section lower accessory valve assembly (2).

When a retract pin puller command is initiated on the setup remote transmitter, the CCMB11 control module energizes the corresponding cylinder retract solenoid in the six-section lower accessory valve assembly. The solenoid valve routes pilot hydraulic fluid through a shuttle valve, then to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the rod end of the pin puller cylinders. At the same time, hydraulic fluid in the piston end of the cylinder is forced out and back to the tank. This causes the rod to retract, disengaging the pins.

FOR REFERENCE ONLY

Crawler/Carbody Pin Pullers Hydraulic Schematic

The schematic is shown with the remote in the neutral state.

Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Carbody Manual Control Manifold

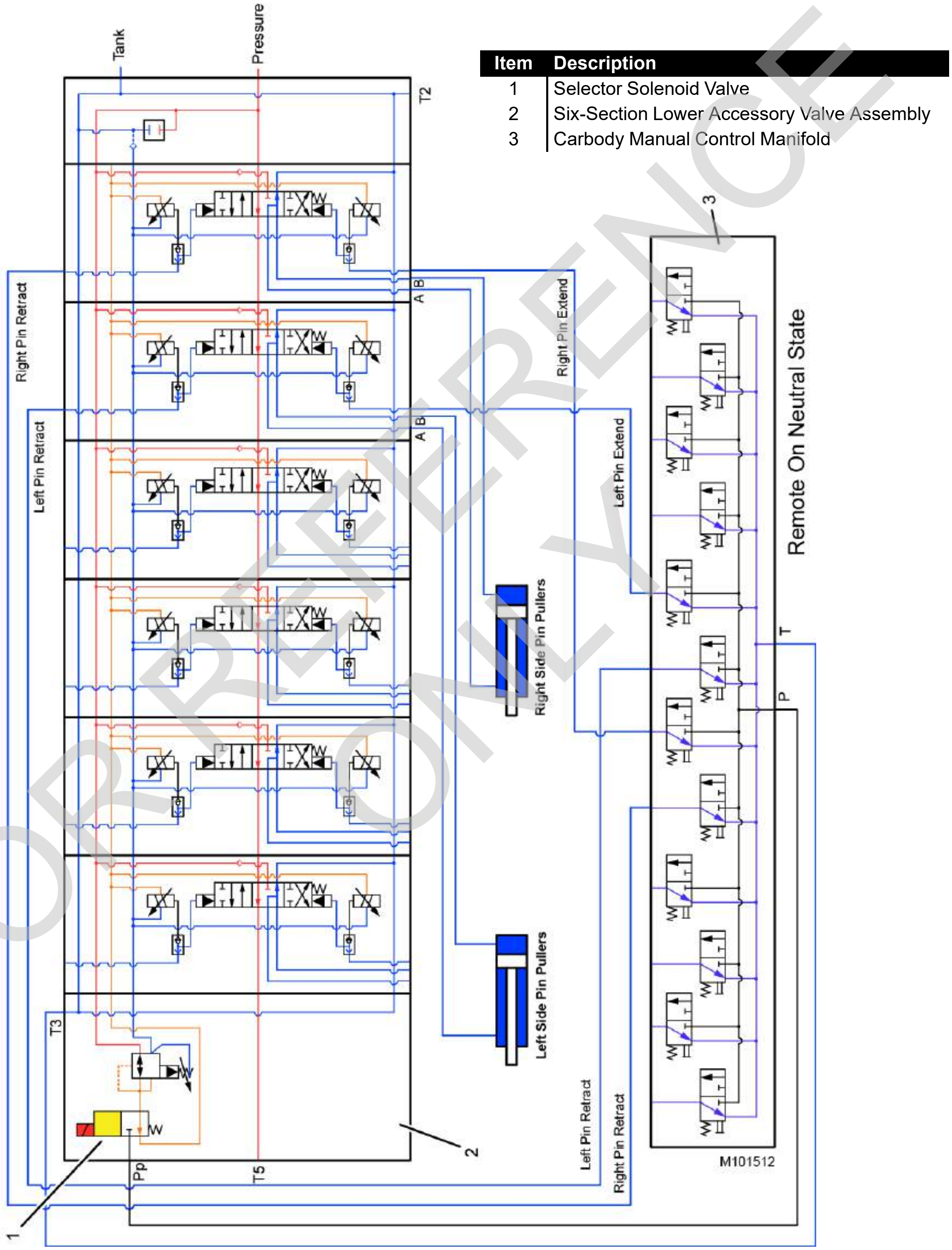
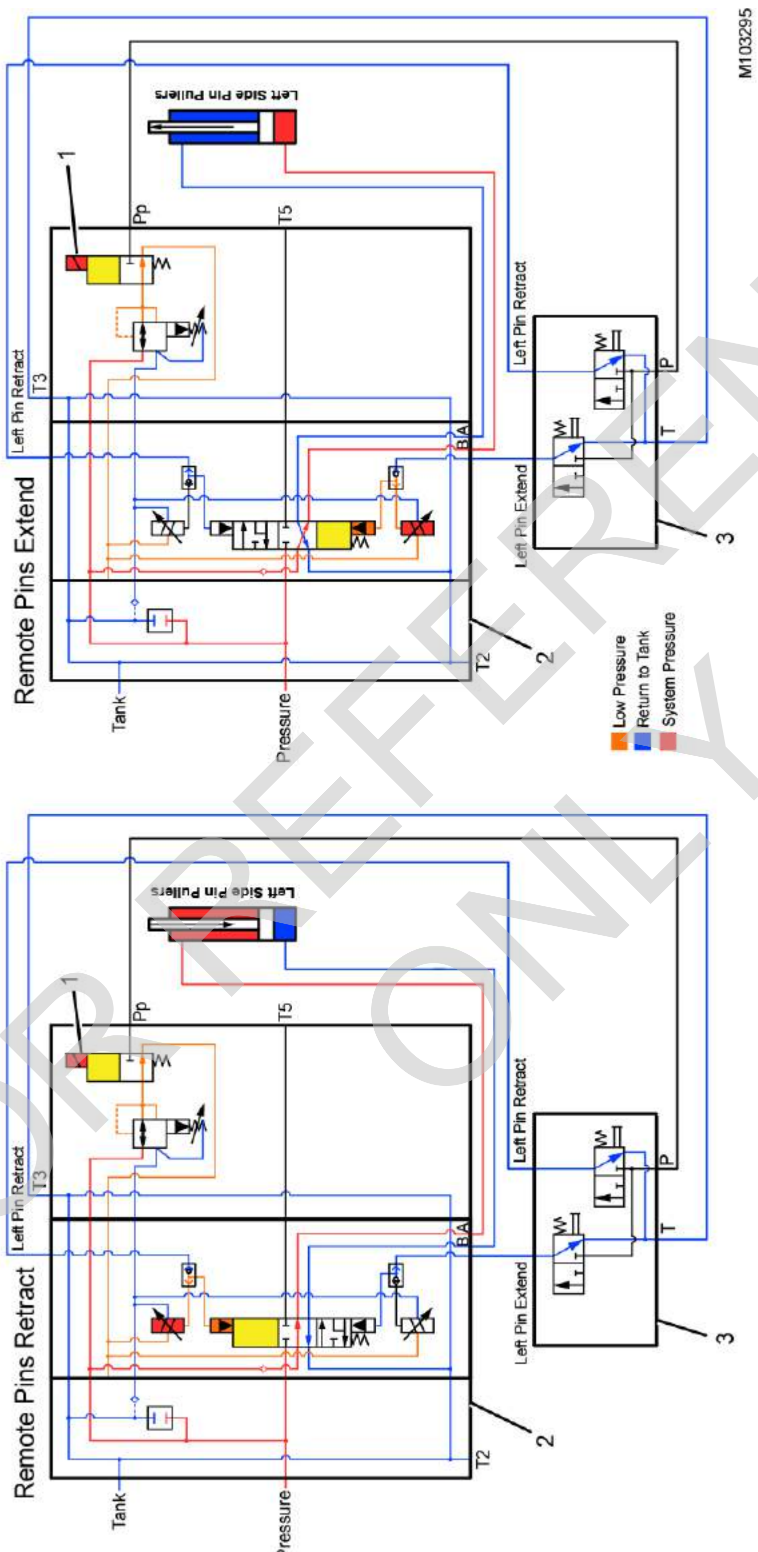


FIGURE 8-11

FOR REFERENCE ONLY

Crawler/Carbody Pin Pullers Hydraulic Schematic (Remote Control)

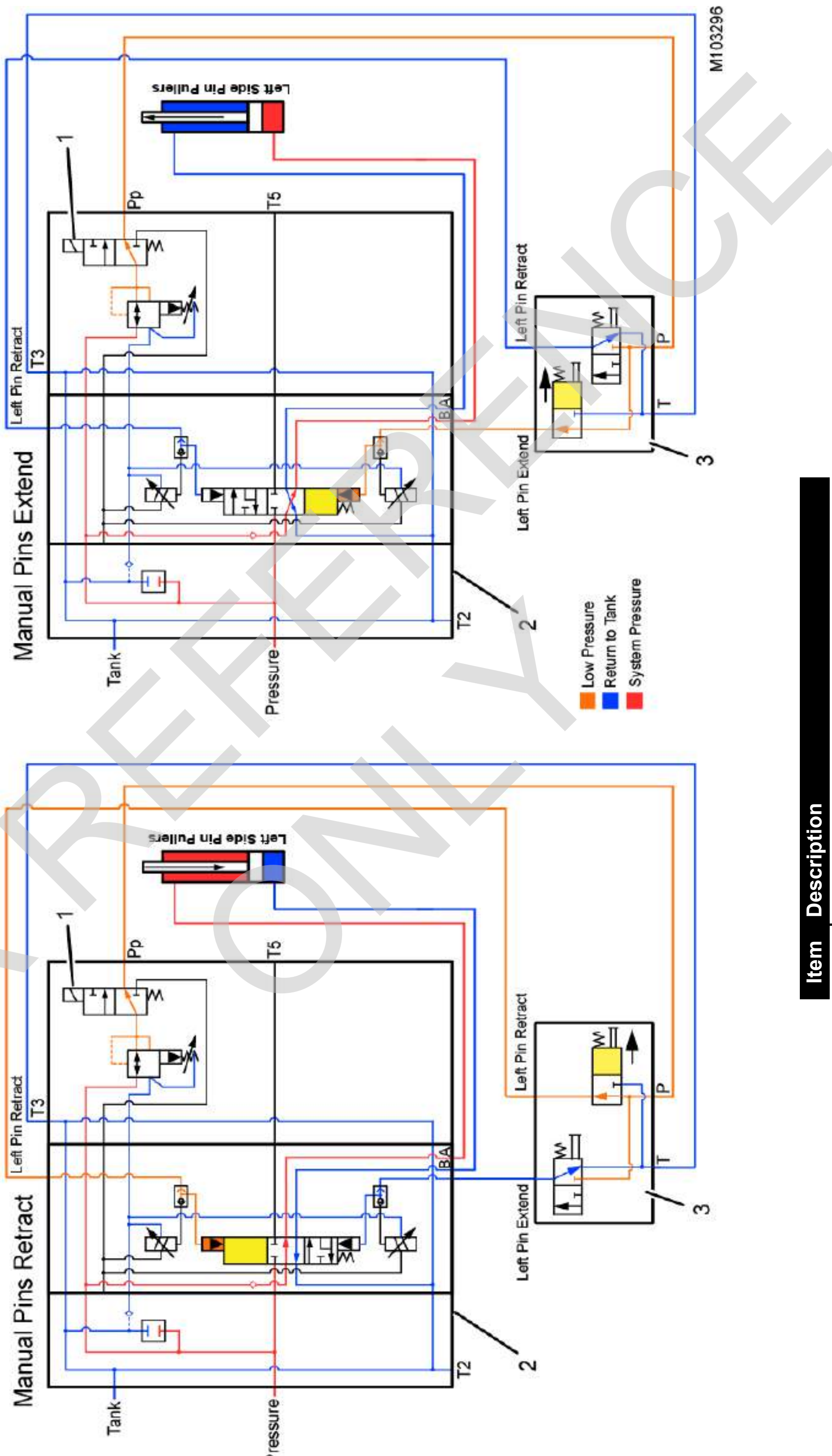


Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Carbody Manual Control Manifold

FIGURE 8-12

FOR REFERENCE ONLY

Crawler/Carbody Pin Pullers Hydraulic Schematic (Manual Control)



Item	Description
1	Selector Solenoid Valve
2	Six-Section Lower Accessory Valve Assembly
3	Carbody Manual Control Manifold

FIGURE 8-13

FOR REFERENCE ONLY

Crawler/Carbody Pin Pullers Electrical Schematic

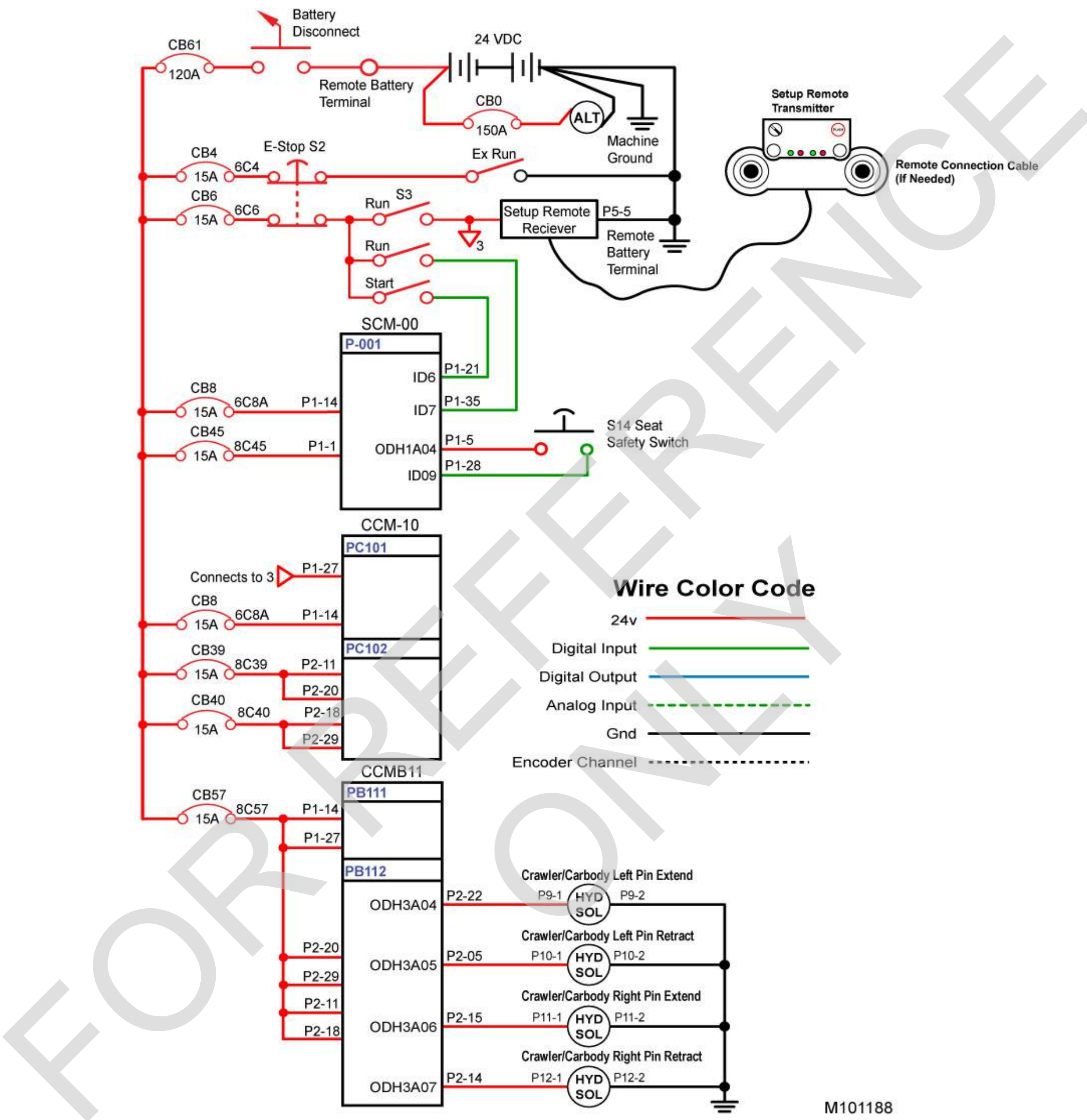
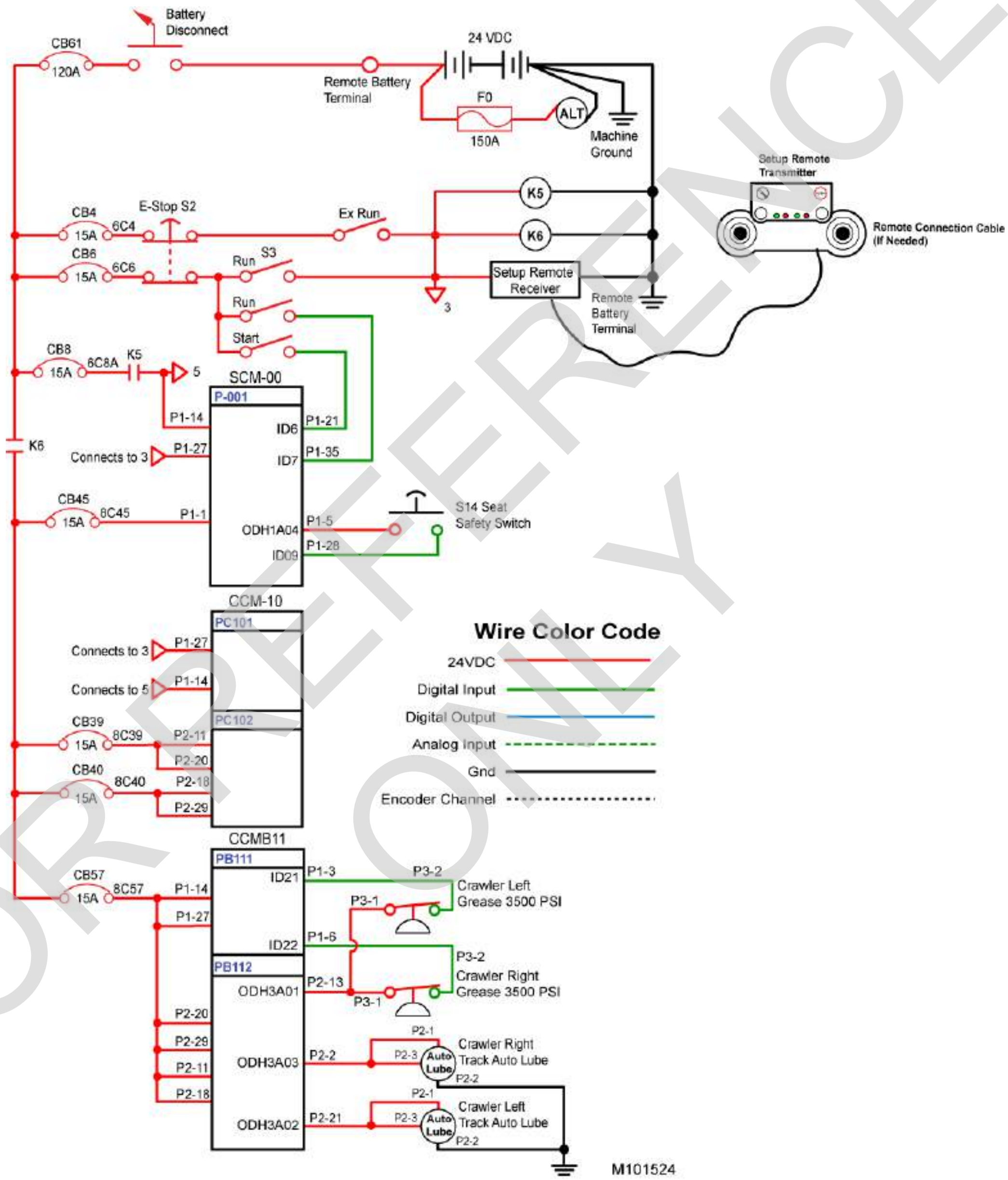


FIGURE 8-14

Crawler Electrical Schematic



FOR REFERENCE ONLY

FIGURE 8-15

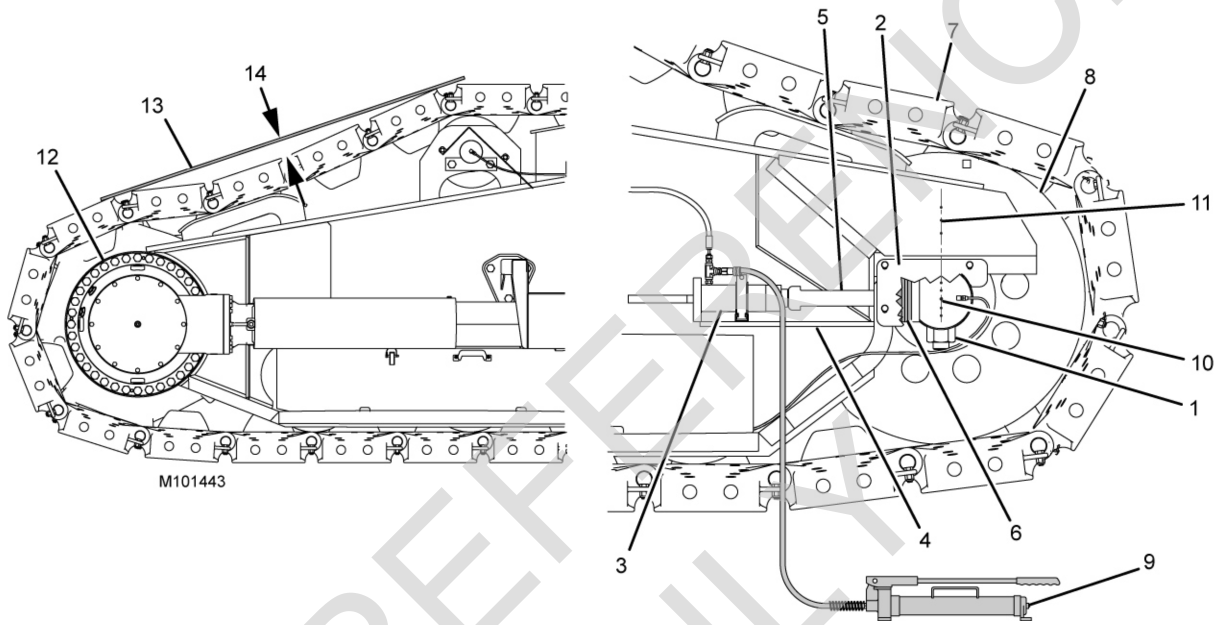
8

CRAWLER TREAD SLACK MEASUREMENT

Check the tread slack at the tumbler end of each crawler. Maintain equal tread slack at both crawlers.

Travel forward or reverse on a firm level surface until all tread slack is in the top of treads at the tumbler end of the crawlers.

1. Place a straightedge (13, Figure 8-16) on top of the tread. Measure the gap (14) between the straightedge and the top of the tread at the lowest point.
   - Tight limit gap—38,1 mm (1.5 in)
   - Loose limit gap—76,2 mm (3 in)
2. If the gap exceeds the tight or loose limits, adjust the crawler tread slack (see Crawler Tread Slack Adjustment on page 8-27).



Item	Description
1	Nut
2	Cover
3	Quick Connect Fitting
4	Crawler Jack Cylinder
5	Rod
6	Shim:
	06 mm (0.24 in)
	12 mm (0.47 in)
	25 mm (0.98 in)
7	Tread
8	Crawler Roller
9	Hand Pump
10	Center Punch Line—Shaft
11	Center Punch Line—Crawler Frame
12	Crawler Tumbler
13	Straightedge
14	Gap

FIGURE 8-16

FOR REFERENCE ONLY

CRAWLER TREAD SLACK ADJUSTMENT

Adjust the treads tighter when operating on firm ground and looser when operating on soft ground (mud or sand).

Adjust tread slack at the roller end of each crawler.

:

CAUTION

Avoid Tread Pin Damage!

Do not adjust the treads too tightly or the tread pins will wear rapidly and may break. Dirt buildup will tighten the treads further, increasing the possibility of damage.

Tight treads require more drive torque, resulting in faster wear and increased fuel consumption.

See Figure 8-16 for the following procedure.

1. Thoroughly clean the crawler to be adjusted.
2. Remove the covers (2) from both sides of the crawler frame.
3. Loosen the nut (1) on each side of the crawler roller (8).
4. Connect the hand pump to the quick connect fitting (3) located on the inside jack cylinder (4) of the crawler tensioning assembly.

NOTE: The crawler tensioning assembly consists of two jack cylinders, one on the outside of the crawler frame and the other on the inside.

5. Using the hand pump, extend the crawler jack cylinder against the rod (5). The jack cylinders should extend equal distance at both sides of the crawler frame. For operating instructions of the hand pump, see Operating the Hand Pump on page 8-28.

NOTE: Erratic operation indicates air in the system. To bleed the jack cylinders, see Remove Air from the Crawler Tensioning Assembly on page 8-29.

For hand pump maintenance, see Maintenance on page 8-29.

6. Add or remove an equal thickness of shims (6) on both sides of the crawler frame. Shim thicknesses are as follows:
   - 06 mm (0.24 in)
   - 12 mm (0.47 in)
   - 25 mm (0.98 in)
7. Relieve the pressure in the crawler tensioning assembly and remove the hand pump.
8. Travel the crane forward or reverse to tighten the shims.

CAUTION

Avoid Parts Wear!

The crawler roller and tumbler must be square with the crawler frame to within 3 mm (0.12 in) or parts will wear rapidly.

9. Check for correct crawler tread slack (see Crawler Tread Slack Measurement on page 8-26). Readjust as required by performing step 4 through step 8.
10. Verify that the inside and outside crawler frame dimensions, measured from the shaft center punch line (10) to the crawler frame center punch line (11), are within 3 mm (0.12 in) of each other.
11. Lubricate the nuts and bolts at the crawler rollers with Never-Seez or an equivalent anti-seizing lubricant.
12. Tighten the nut (1) on the bolt at each side of crawler roller to 2712 Nm (2,000 ft-lb).
13. Install the cover on both sides of the crawler frame.

NOTE: The extreme limit of the tread adjustment occurs when the bolts are tight against the front end of the slots in the crawler frame. One crawler tread can be removed when this limit is reached.

FOR REFERENCE ONLY

CRAWLER TENSIONING ASSEMBLY AND HYDRAULIC HAND PUMP

WARNING

Personal Injury Hazard!

Serious personal injury may occur due to contact with hydraulic oil that is under pressure. Be aware that the following may occur:

- Because the hand pump is not vented, the pump, cylinder, or hose can explode if the maximum pressure rating is exceeded.
- The pump handle can kick back.
- Handle extensions can cause unstable operation.

To avoid injury, observe the following:

- Wear safety glasses and other personal protective gear when operating the hand pump.
- Do not exceed the maximum pressure rating of 700 bar (10,000 psi)
- Do not set the pump relief valve higher than 700 bar (10,000 psi).
- Do not attempt to return more oil to the pump than it is capable of holding.
- Do not overfill the pump.
- Always keep your body to the side of the pump, away from the line of handle force.
- Do not add extensions to the handle.

Operating the Hand Pump

See Figure 8-17 for the following procedure.

1. Before using the hand pump:
   - Check that all fittings are tight and leak free.
   - Check the oil level.

NOTE: The hand pump can be operated in any position from horizontal to vertical as long as the hose end of the pump is down.

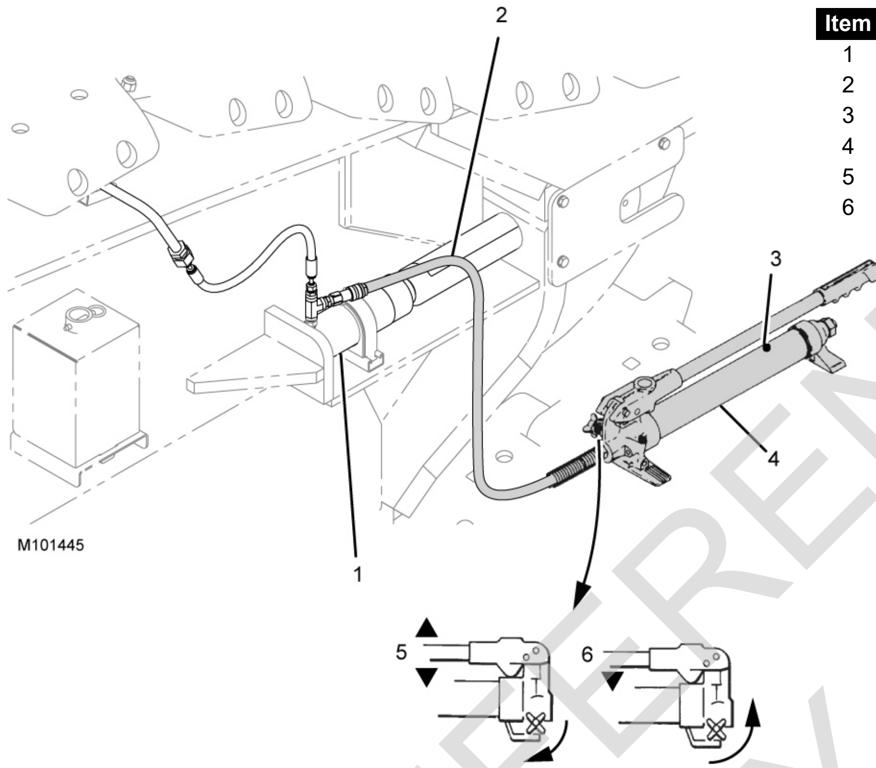
2. To pressurize the crawler tensioning assembly and extend the cylinder rod of the each jack cylinder (1), perform the following.
   a. Close the valve on the hand pump by turning it clockwise (5) until finger tight.
   b. Pump the handle up and down to build pressure. The pressure is maintained until the valve is opened.

      To reduce the handle effort at high pressure, use short strokes. Maximum leverage is obtained in the last five degrees of the stroke.

NOTE: Erratic operation indicates air in the system. To bleed the jack cylinders, see Remove Air from the Crawler Tensioning Assembly on page 8-29.

3. To depressurize the crawler tensioning assembly, push the pump handle down fully, then open the valve by turning it counterclockwise (6).

FOR REFERENCE ONLY



Item	Description
1	Jack Cylinder (qty 2)
2	Hose
3	Fill Cap
4	Hand Pump
5	Clockwise (to pressurize)
6	Counterclockwise (to depressurize)

FIGURE 8-17

Maintenance

See Figure 8-17 for the following procedure.

1. Keep the unit clean and stored in a safe place where it cannot be damaged.
2. Ensure that the hand pump oil level is correct. To check the level:
   a. Turn the pump valve counterclockwise (6) and fully retract the jack cylinder rod to return all oil to the pump. The jack cylinder must be fully retracted, or the system will contain too much oil after filling.
   b. Place the hand pump (4) horizontally on a flat surface.
   c. Using a screw driver, remove the fill cap (3).
   d. Add hydraulic oil to the pump until the reservoir is 2/3 full. Do not overfill.
   e. Reinstall the fill cap.
   f. Test pump operation and remove air from the system, if required. See Remove Air from the Crawler Tensioning Assembly on page 8-29.
   g. Recheck the oil level after removing the air.

Remove Air from the Crawler Tensioning Assembly

See Figure 8-17 for the following procedure.

NOTE: The crawler tensioning assembly consists of two jack cylinders, one on the outside of the crawler frame and the other on the inside.

1. Close the valve on the hand pump (4) by rotating it clockwise (5) until finger tight.
2. Position the hand pump so it is higher than the jack cylinder (1).
3. Operate the pump to fully extend the jack cylinder rod.
4. Open the valve to retract the jack cylinder rod and force oil and trapped air back into the pump.
5. Loosen the fill cap (3) just enough to let any trapped air vent to atmosphere, then tighten the fill cap.
6. Repeat this procedure until the jack cylinders operates smoothly.

NOTE: Erratic operation indicates air in the system.

8

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SECTION 9
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SECTION 9
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SECTION 10
ACCESSORIES

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SECTION 10
ACCESSORIES

ADAPTER FRAME-TO-ROTATING BED PIN PULLERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the following systems:

- Adapter frame-to-rotating bed front pin pullers
- Adapter frame-to-rotating bed rear pin pullers

Additional component information for these systems can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

Adapter Frame-to-Rotating Bed Front Pin Pullers Operation

The adapter frame-to-rotating bed front pin pullers are controlled by the setup remote.

See Figure 10-1 for an illustration of the front pin pullers.

See Figure 10-2 for the hydraulic schematic of the front pin pullers circuit.

See Figure 10-3 for the electrical schematic of the front pin pullers circuit.

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

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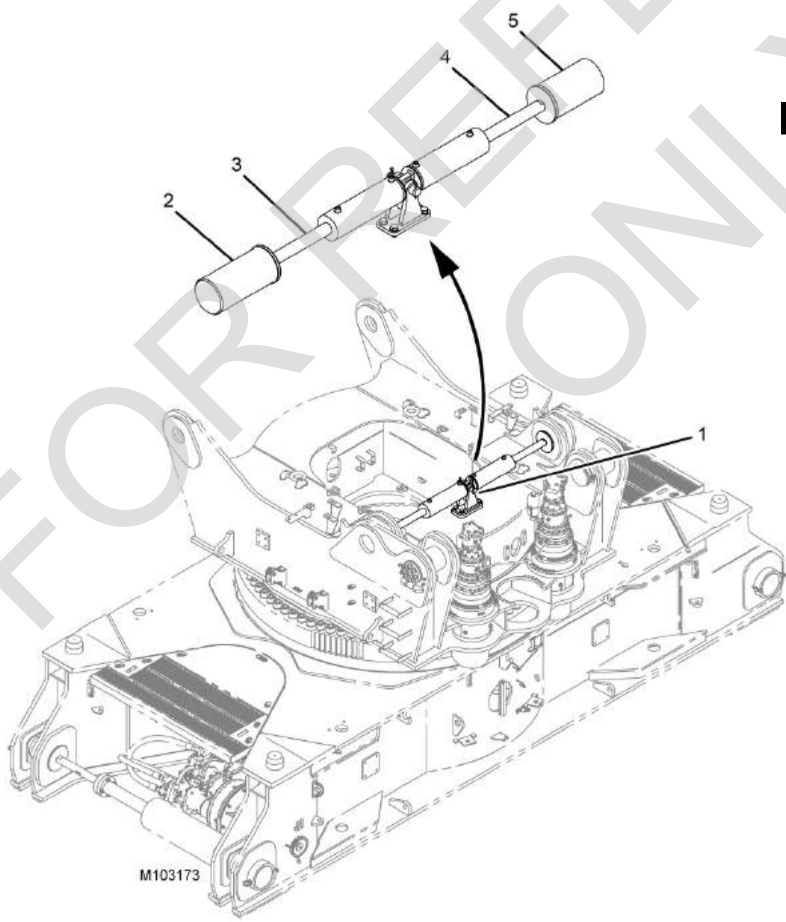


Item	Description
1	Adapter Frame Front Pin Puller Assembly
2	Pin
3	Cylinder Front Pin Puller Female
4	Cylinder Front Pin Puller Male
5	Pin

FIGURE 10-1

FOR REFERENCE ONLY

Neutral Position Using Setup Remote

See Figure 10-2 for the following information.

When the setup remote is not sending a command, the valve spool (2), located in the adapter frame valve assembly (1), is held in the neutral position by the return springs. When in neutral, the pin puller cylinders are held in place because both sides of the cylinders are connected to the tank via the valve spool.

Extend Pin Pullers Using Setup Remote

See Figure 10-2 for the following information.

When the setup remote sends an extend command for the front adapter frame pin puller, the IOLC30 control module energizes the extend solenoid (3). With the extend solenoid energized, the valve spool shifts to a position that allows hydraulic fluid from the accessory pump to flow to the piston end of the cylinders. This causes the cylinder rods to extend, engaging the pins. At the same time, hydraulic fluid in the rod side of the cylinders is pushed out and back to the tank.

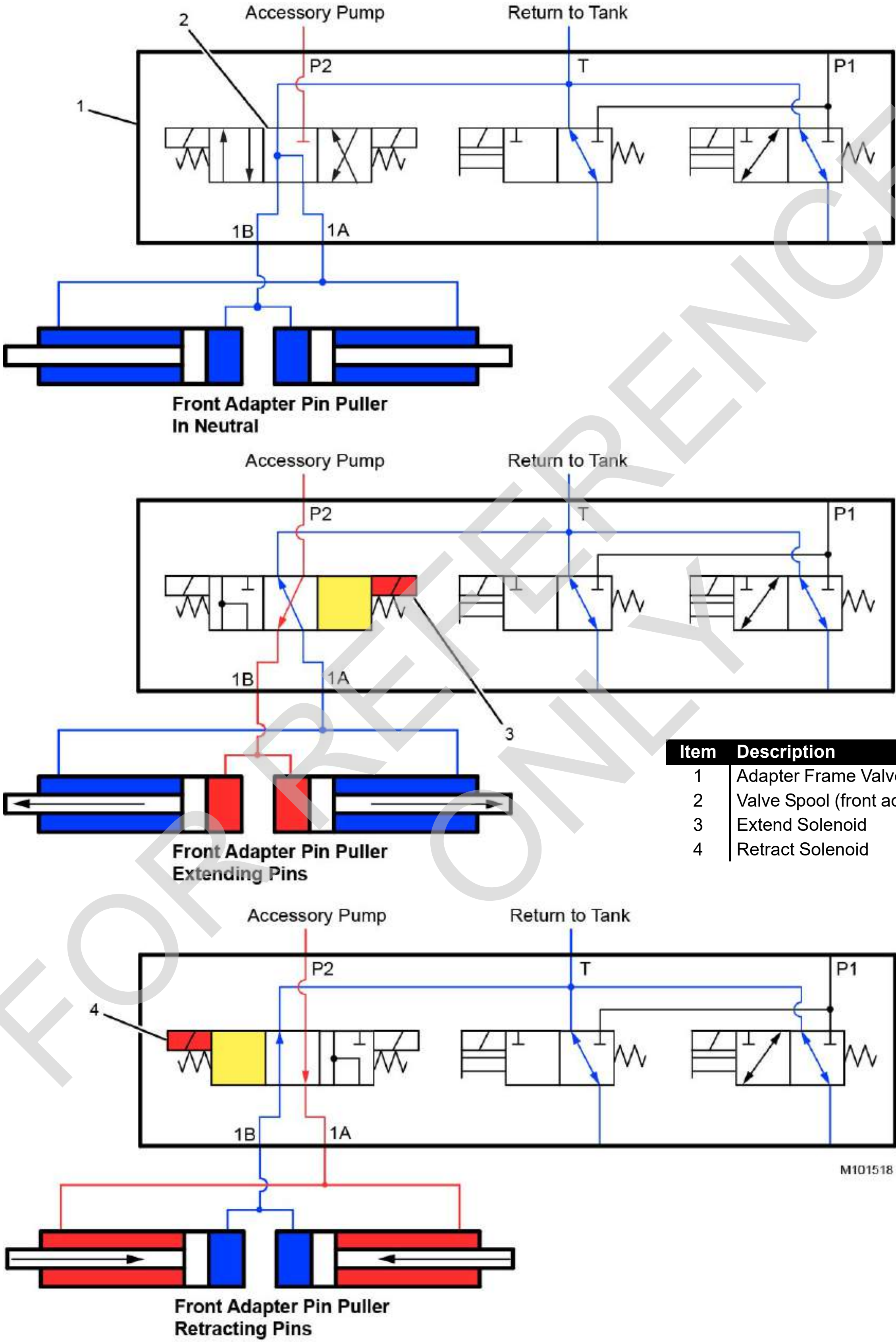
Retract Pin Pullers Using Setup Remote

See Figure 10-2 for the following information.

When the setup remote sends a retract command for the front adapter frame pin puller, the IOLC30 control module energizes the retract solenoid (4). With the retract solenoid energized, the valve spool shifts to a position that allows hydraulic fluid from the accessory pump to flow to the rod end of the cylinders. This causes the cylinder rods to retract, disengaging the pins. At the same time, hydraulic fluid in the piston side of the cylinders is pushed out and back to the tank.

FOR REFERENCE ONLY

Adapter Frame-to-Rotating Bed Front Pin Pullers Hydraulic Schematic

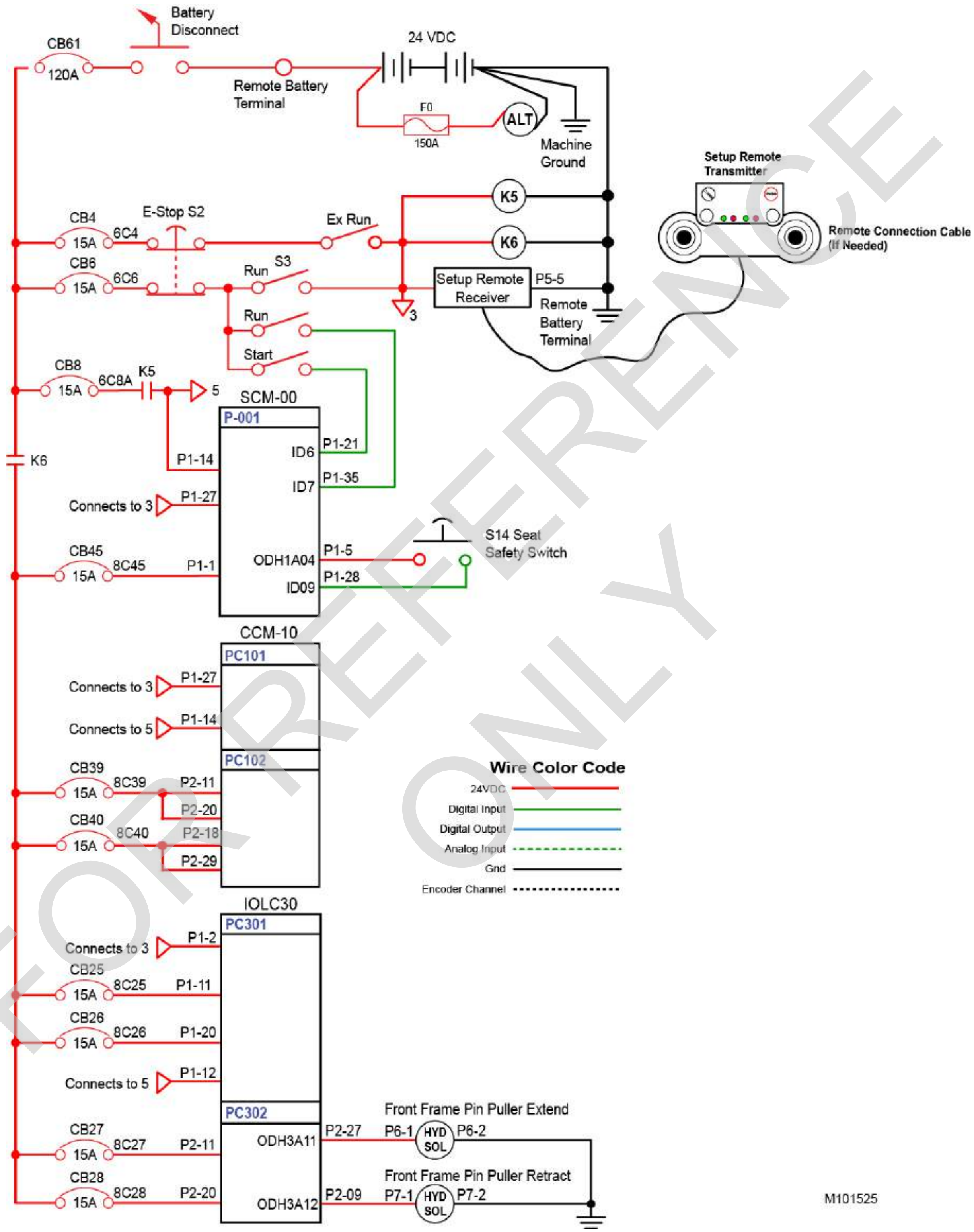


Item	Description
1	Adapter Frame Valve Assembly
2	Valve Spool (front adapter pin puller)
3	Extend Solenoid
4	Retract Solenoid

FIGURE 10-2

FOR REFERENCE ONLY

Adapter Frame-to-Rotating Bed Front Pin Pullers Electrical Schematic



FOR REFERENCE ONLY

FIGURE 10-3

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Adapter Frame-to-Rotating Bed Rear Pin Pullers Operation

The adapter frame-to-rotating bed rear pin pullers are controlled by the setup remote.

See Figure 10-4 for an illustration of the rear pin pullers.

See Figure 10-5 for the hydraulic schematic of the rear pin pullers circuit.

See Figure 10-6 for the electrical schematic of the rear pin pullers circuit.

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote

See Figure 10-5 for the following information.

When the setup remote is not sending a command, the rear adapter frame pin puller valve spool (2), located in the accessory valve manifold (1), is held in the neutral position by the return springs. When in neutral, both sides of the pin puller cylinders are connected to the tank via the valve spool.

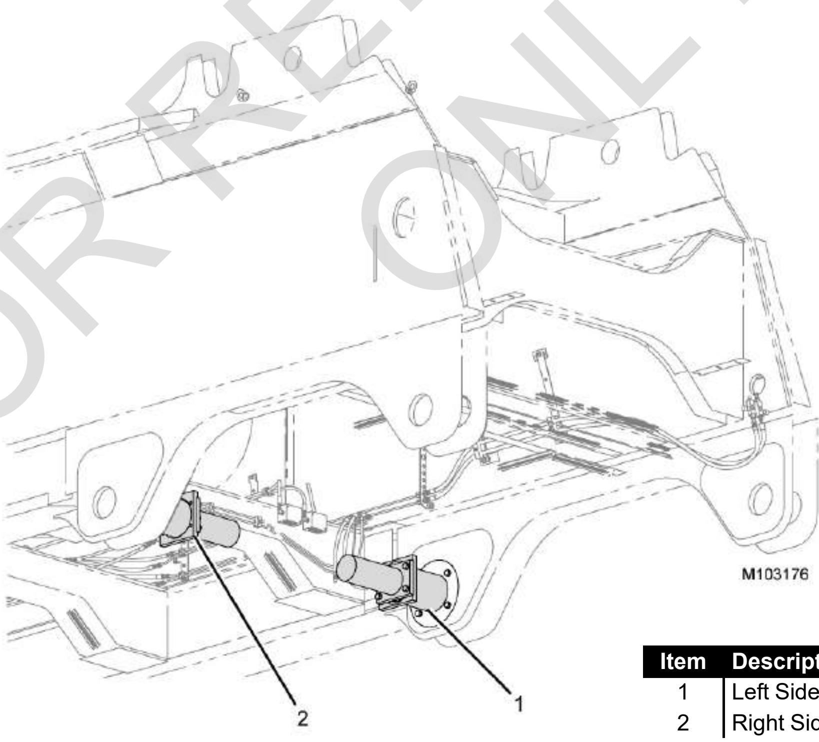
Extend Pin Pullers Using Setup Remote

When the setup remote sends an extend command for the rear adapter frame pin puller, the CCM-10 control module energizes the extend solenoid (4). With the cylinder extend solenoid energized, the valve spool shifts to a position that allows hydraulic fluid from the accessory pump to flow to the piston end of the cylinders. This causes the cylinder rods to extend, engaging the pins. At the same time, hydraulic fluid in the rod side of the cylinders is pushed out and back to the tank.

Retract Pin Pullers Using Setup Remote

When the setup remote sends a retract command for the rear adapter frame pin puller, the CCM-10 control module energizes the retract solenoid (5). With the retract solenoid energized, the valve spool shifts to a position that allows hydraulic fluid from the accessory pump to flow to the rod end of the cylinders. This causes the cylinder rods to retract, disengaging the pins. At the same time, hydraulic fluid in the piston side of the cylinders is pushed out and back to the tank.

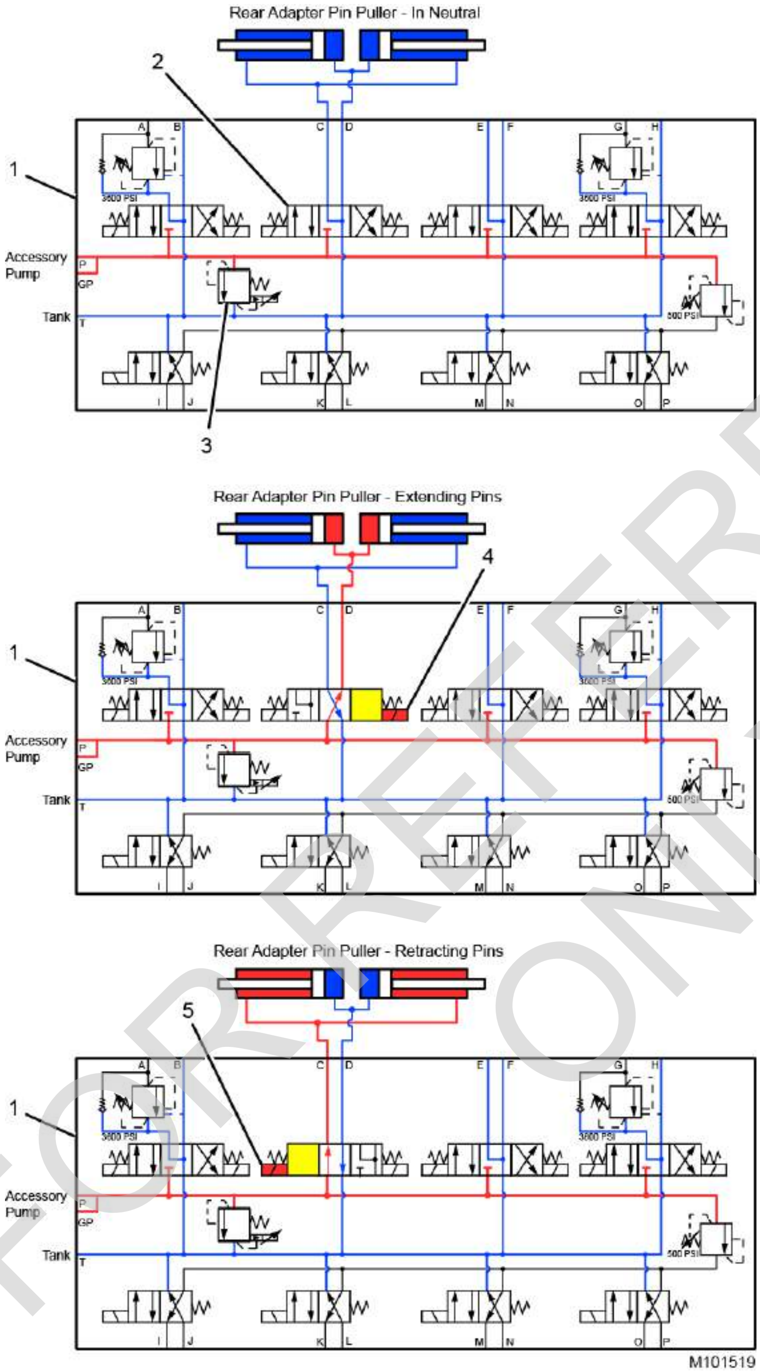
FOR REFERENCE ONLY



Item	Description
1	Left Side Pin Puller Assembly
2	Right Side Pin Puller Assembly

FIGURE 10-4

Adapter Frame-to-Rotating Bed Rear Pin Pullers Hydraulic Schematic



Item	Description
1	Accessory Valve Manifold
2	Valve Spool (rear adapter pin puller)
3	Proportional Pressure Relief Valve (operating pressure = 350 bar [5076 psi])
4	Extend Solenoid
5	Retract Solenoid

FIGURE 10-5

FOR REFERENCE ONLY

Adapter Frame-to-Rotating Bed Rear Pin Pullers Electrical Schematic

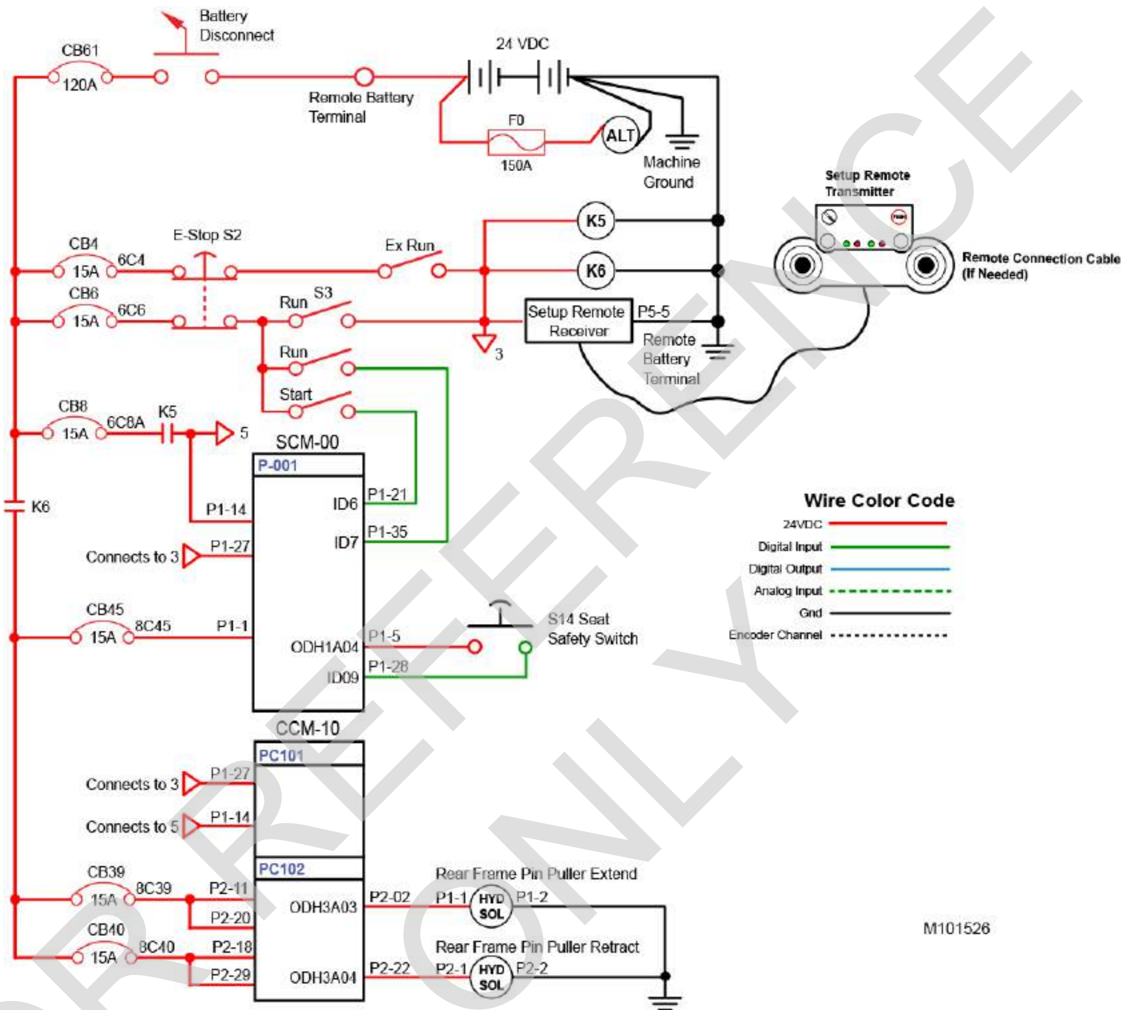


FIGURE 10-6

FOR REFERENCE ONLY

ROTATING BED JACK CYLINDERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the rotating bed jack cylinders when in the working position.

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

The rotating bed jack cylinders are controlled by the following methods:

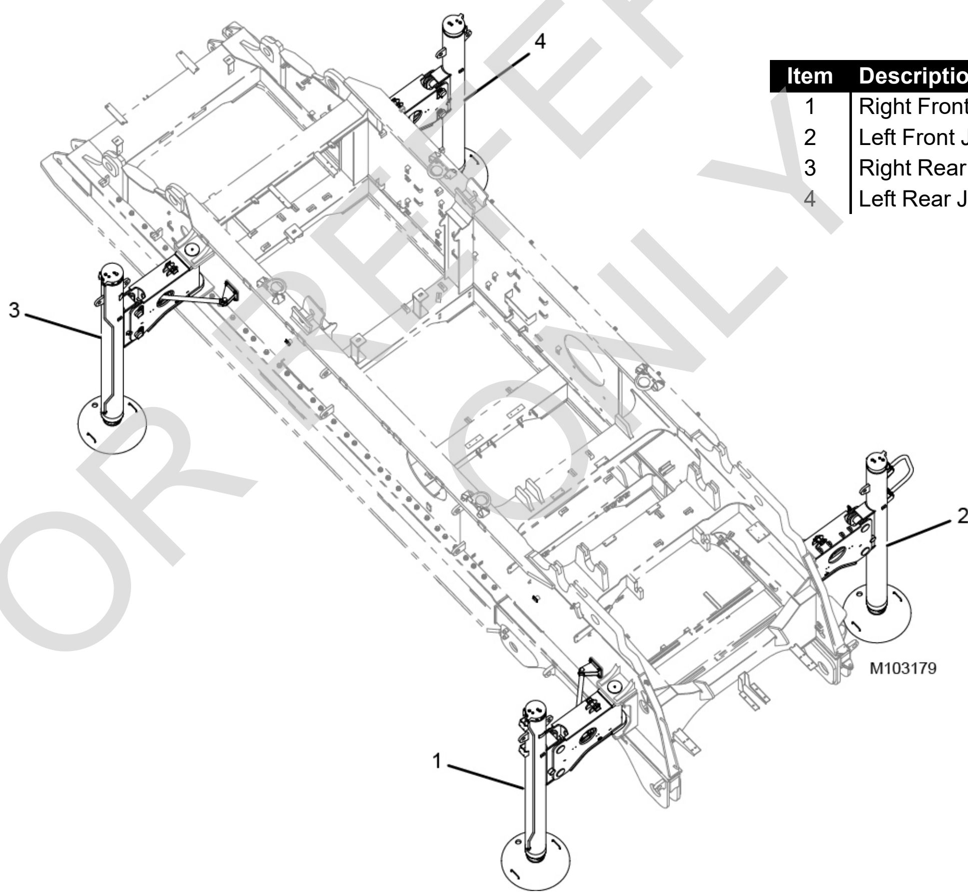
- Setup remote control
- Manual control levers on the upperworks jacking and rigging winch valve assembly (see Figure 10-8)

NOTE: The rotating bed jacks deployment is covered in Section 4: Deploy Rotating Bed Jacking Cylinders of the Operator Manual.

See Figure 10-7 for an illustration of the rotating bed jack cylinders in the working position.

See Figure 10-9 for the hydraulic schematic of the rotating bed jack cylinders circuit.

See Figure 10-12 for the electrical schematic of the rotating bed jack circuit.



Item	Description
1	Right Front Jack Cylinder
2	Left Front Jack Cylinder
3	Right Rear Jack Cylinder
4	Left Rear Jack Cylinder

FIGURE 10-7

FOR REFERENCE ONLY

Setup Remote Control

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote

See Figure 10-9 for the following.

When the setup remote is not sending a command, the rotating bed jack cylinder valve spools, located in the upperworks jacking and rigging winch valve assembly (1), are held in the neutral position by the return springs. Hydraulic fluid from the accessory pump is prevented from flowing to the counterbalance valve (2).

When in neutral, the counterbalance valve provides a load-holding function. The sequence valves within the counterbalance valve are closed, stopping the flow to and from the cylinders. The jack cylinders are held in position by trapped hydraulic fluid.

Extend Jack Cylinder Using Setup Remote

See Figure 10-10 for the following.

NOTE: The following describes the operation to extend one rotating bed jack cylinder. The operation is the same for all rotating bed jack cylinders.

When a raise command is received from the setup remote, the CCM-10 control module or IOLC31 control module (depending on the jack being controlled) energizes the corresponding rotating bed jack extend solenoid. The extend solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valves (2).

Within the counterbalance valves, flow and control is as follows:

- The rod side counterbalance valve is piloted open by the rod side pressure and the accessory pressure from the valve spool on the extend side. Once open, the oil on the rod side is allowed to exit the cylinder and return to tank.
- The piston side counterbalance valve has an integral bypass check valve that allows the accessory pressure to enter the piston side of the cylinder, extending the cylinder.

Retract Jack Cylinder Using Setup Remote

See Figure 10-10 for the following.

NOTE: The following describes the operation to retract one rotating bed jack cylinder. The operation is the same for all rotating bed jack cylinders.

When a lower command is received from the setup remote, the CCM-10 control module or IOLC31 control module (depending on the jack being controlled) energizes the corresponding rotating bed jack retract solenoid. The retract solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (2).

Within the counterbalance valves, flow and control is as follows:

- The piston side counterbalance valve is piloted open by the piston side pressure and the accessory pressure from the valve spool on the retract side. Once open, the oil on the piston side is allowed to exit the cylinder and return to tank.
- The rod side counterbalance valve has an integral bypass check valve that allows the accessory pressure to enter the rod of the cylinder, retracting the cylinder.

FOR REFERENCE ONLY

Manual Control

Extend Jack Cylinder Using Manual Control

NOTE: Manual control is only used for troubleshooting the rotating bed jacks.

When a manual control lever (1, Figure 10-8) on the upperworks jacking and rigging winch valve assembly is moved to the extend position (9, Figure 10-8), the corresponding valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (2, Figure 10-11).

Within the counterbalance valves, flow and control is as follows:

- The rod side counterbalance valve is piloted open by the rod side pressure and the accessory pressure from the valve spool on the extend side. Once open, the oil on the rod side is allowed to exit the cylinder and return to tank.
- The piston side counterbalance valve has an integral bypass check valve that allows the accessory pressure to enter the piston side of the cylinder, extending the cylinder.

Retract Jack Cylinder Using Manual Control

NOTE: Manual control is only used for troubleshooting the rotating bed jacks.

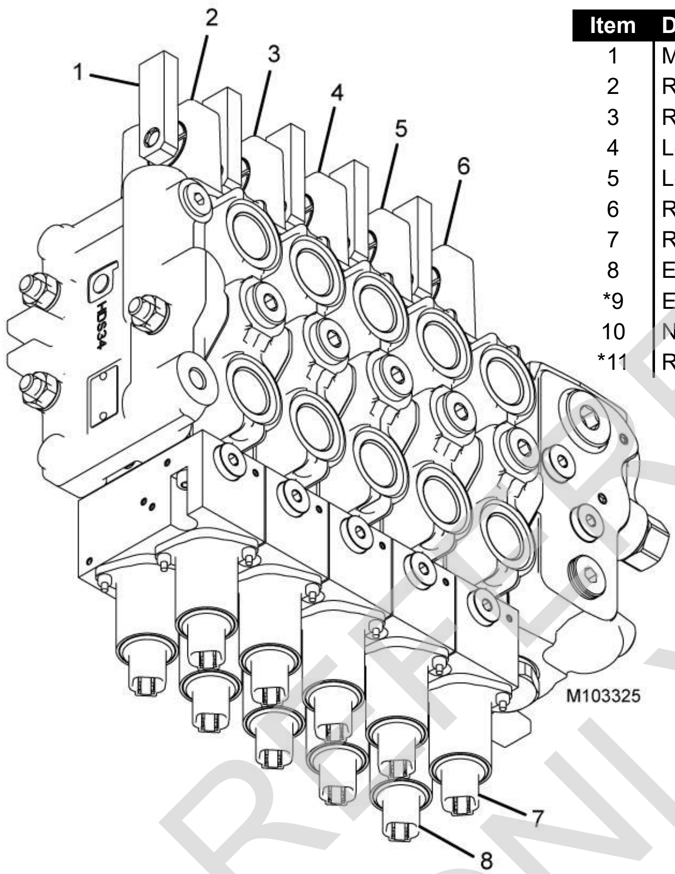
When a manual control lever (1, Figure 10-8) on the upperworks jacking and rigging winch valve assembly is moved to the retract position (11, Figure 10-8), the corresponding valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow to the corresponding jack cylinder counterbalance valve (2, Figure 10-11).

Within the counterbalance valves, flow and control is as follows:

- The piston side counterbalance valve is piloted open by the piston side pressure and the accessory pressure from the valve spool on the retract side. Once open, the oil on the piston side is allowed to exit the cylinder and return to tank.
- The rod side counterbalance valve has an integral bypass check valve that allows the accessory pressure to enter the rod of the cylinder, retracting the cylinder.

FOR REFERENCE ONLY

Upperworks Jacking and Rigging Winch Valve Assembly



Item	Description
1	Manual Control Lever (qty 5)
2	Right Front Rotating Bed Jack Control Valve
3	Right Rear Rotating Bed Jack Control Valve
4	Left Front Rotating Bed Jack Control Valve
5	Left Rear Rotating Bed Jack Control Valve
6	Rigging Winch Control Valve
7	Retract Solenoid (qty 5)
8	Extend Solenoid (qty 5)
*9	Extend Position
10	Neutral Position
*11	Retract Position

* The manual control lever positions for the rigging winch (6) are as follows:
9 = Spool In
11 = Spool Out

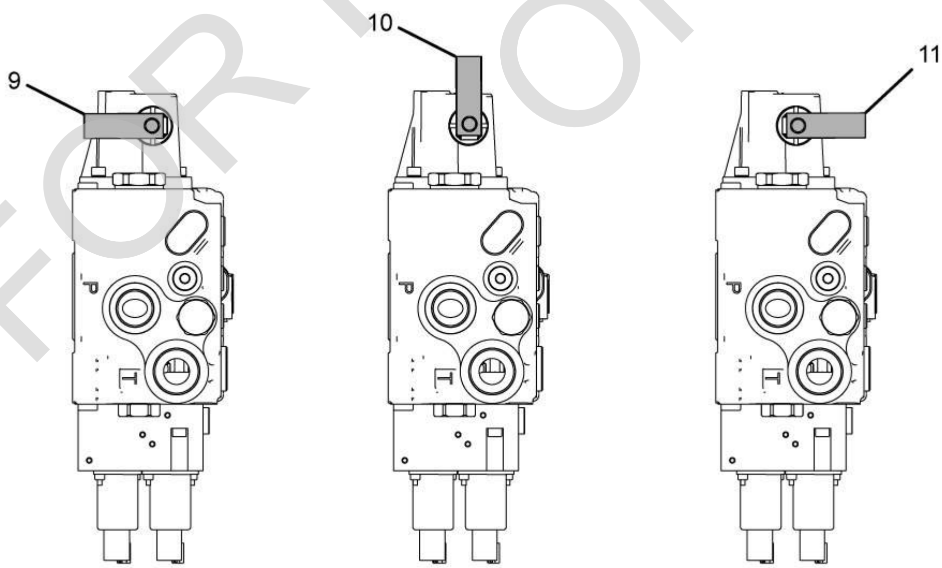
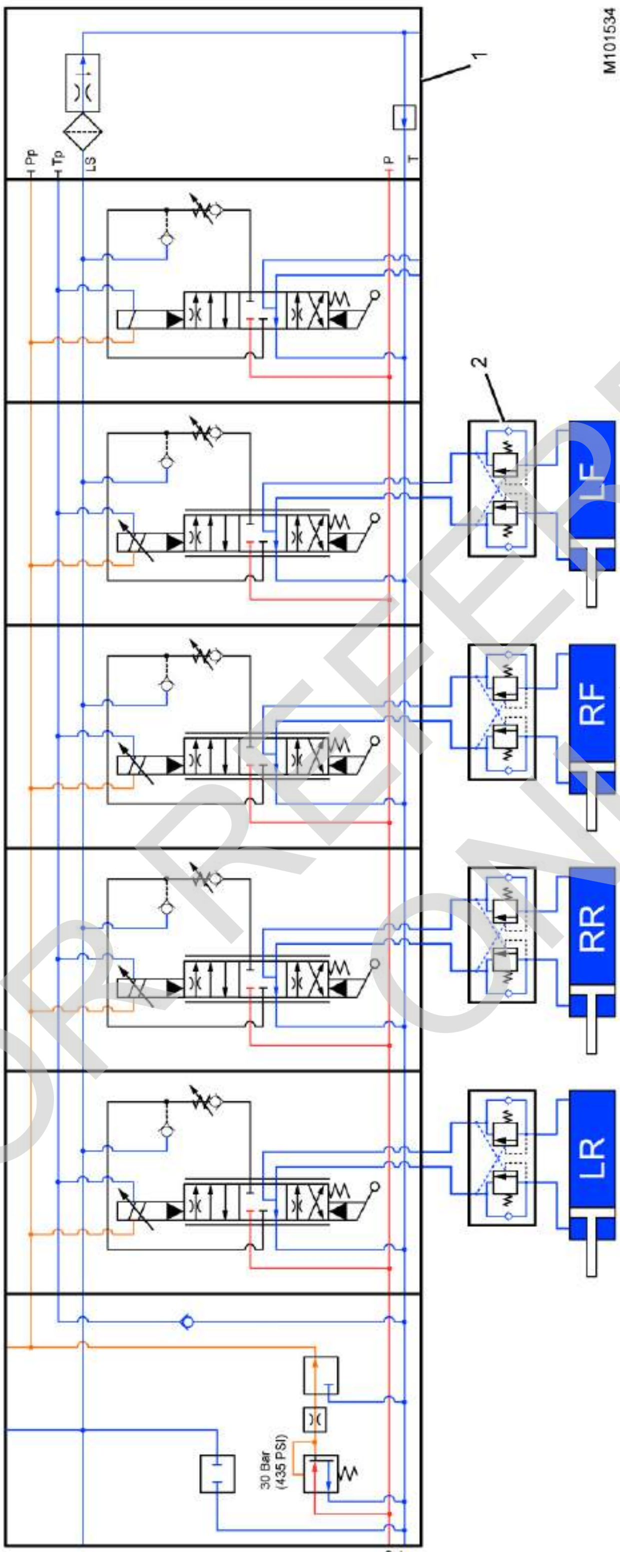


FIGURE 10-8

FOR REFERENCE ONLY

Rotating Bed Jacks Hydraulic Schematic

The hydraulic schematic is shown in the neutral state.

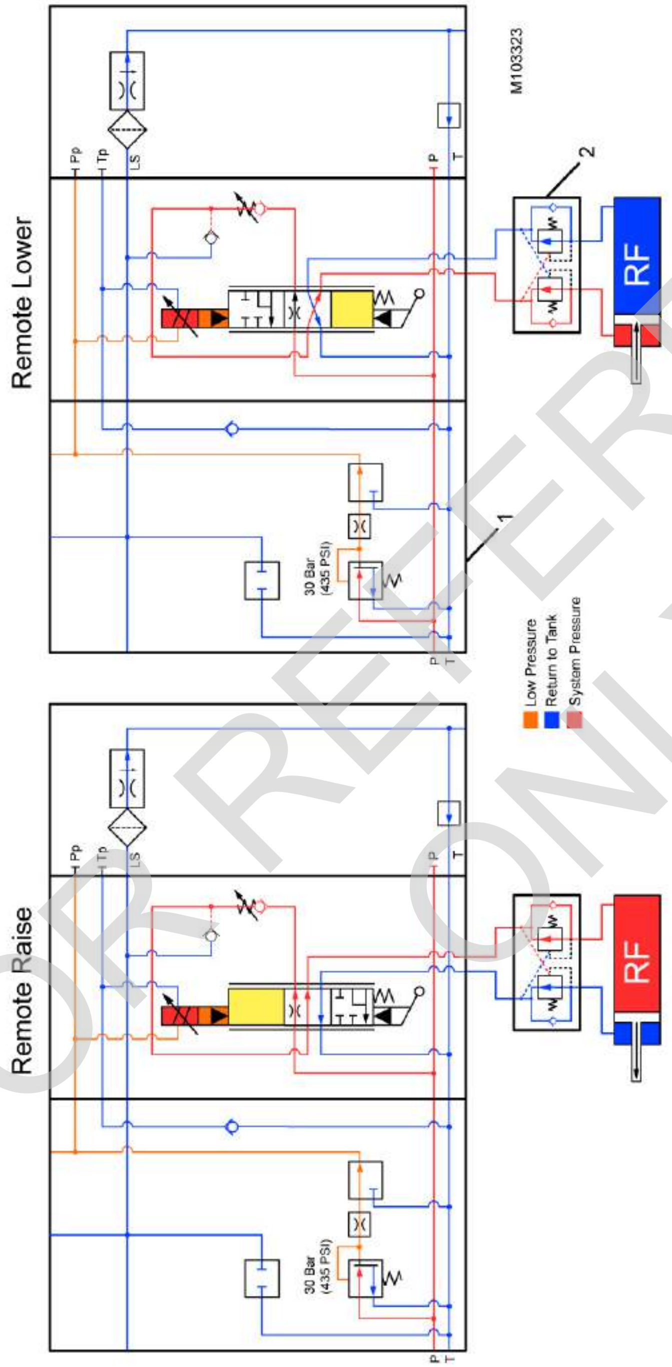


Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Counterbalance Valve (qty 4) (set at 248 bar [3600 psi])

FIGURE 10-9

FOR REFERENCE ONLY

Rotating Bed Jacks Hydraulic Schematic (Remote Control)

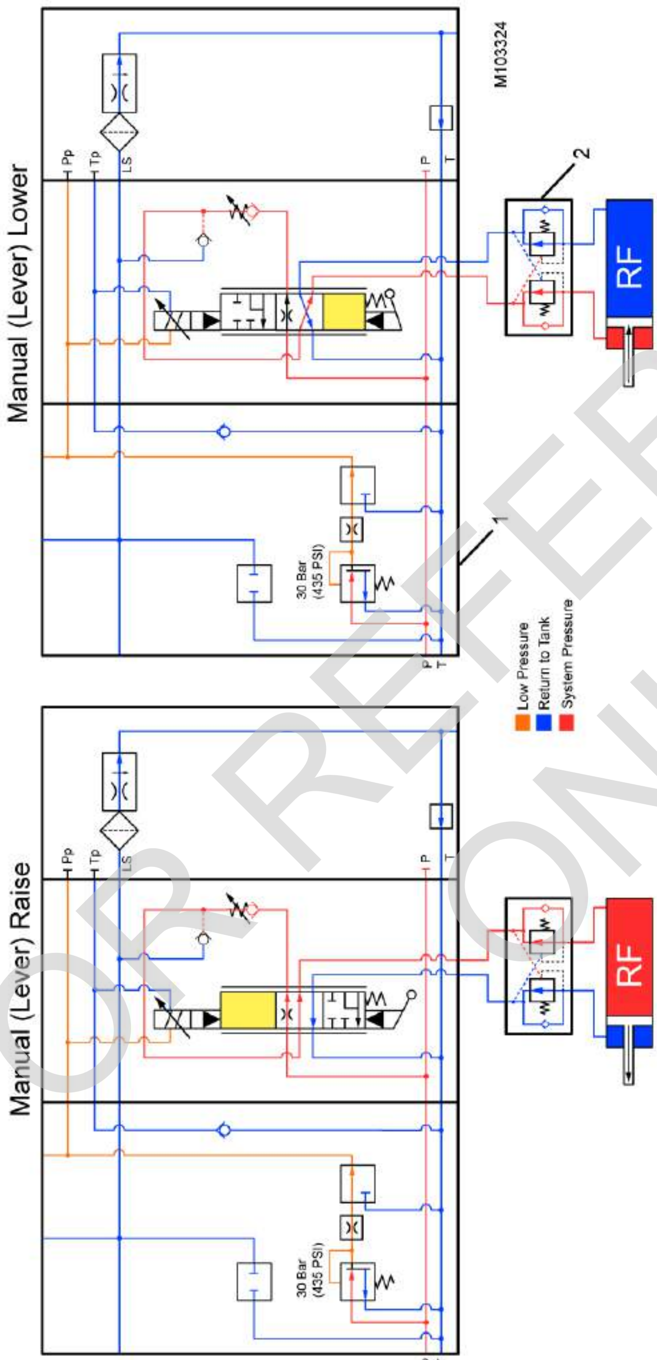


Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Counterbalance Valve (qty 4) (set at 248 bar [3600 psi])

FIGURE 10-10

FOR REFERENCE ONLY

Rotating Bed Jacks Hydraulic Schematic (Manual Control)



Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Counterbalance Valve (qty 4) (set at 248 bar [3600 psi])

FOR REFERENCE ONLY

FIGURE 10-11

Rotating Bed Jacks Electrical Schematic

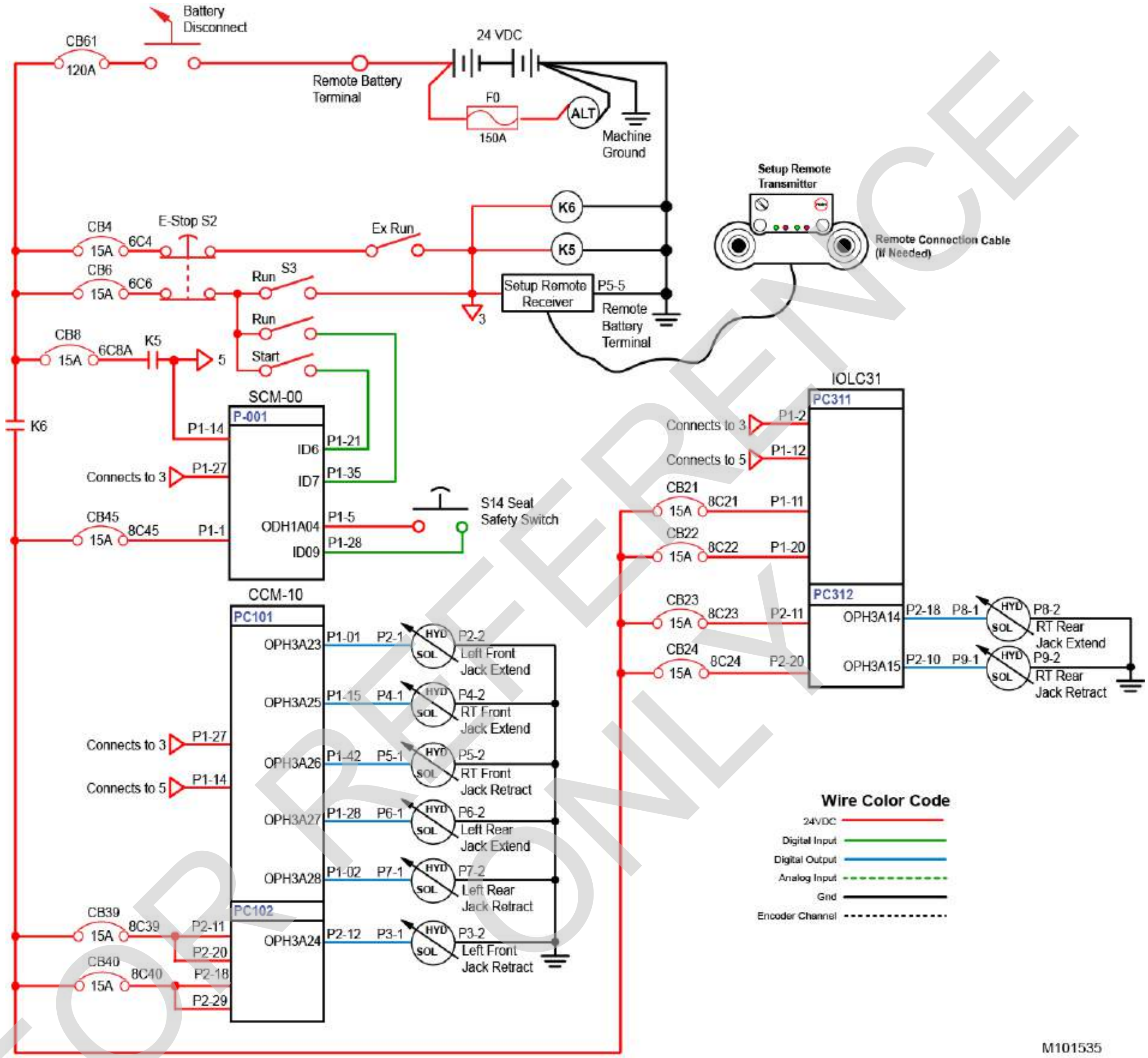


FIGURE 10-12

FOR REFERENCE ONLY

ROTATING BED JACK STOWAGE CYLINDER

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the rotating bed jack stowage cylinder.

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

The rotating bed jack stowage cylinders are controlled by the setup remote.

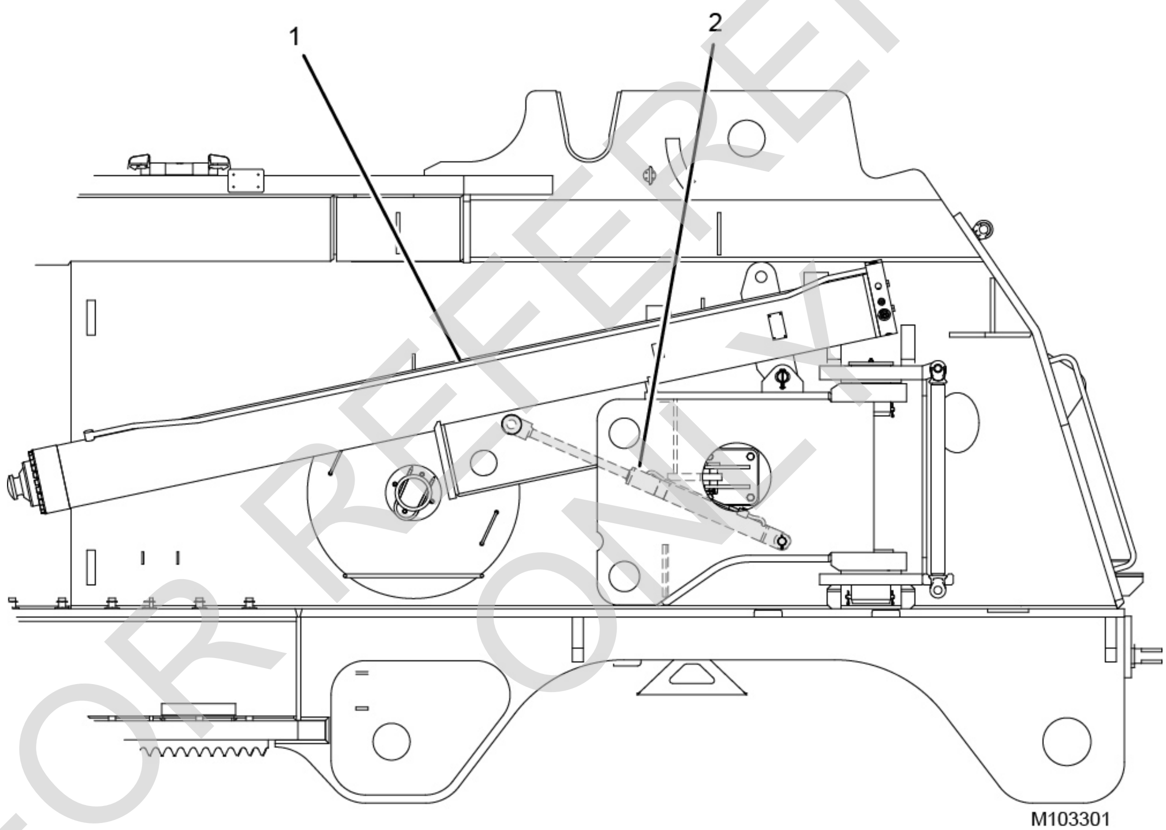
NOTE: The rotating bed jacks stowage is covered in Section 4: Store Rotating Bed Jacking Cylinders of the Operator Manual.

See Figure 10-13 for an illustration of the jack cylinder in the stowed position. The right front jack cylinder is shown.

See Figure 10-14 for the hydraulic schematic of the rotating bed jack stowage cylinder circuit.

See Figure 10-15 for the electrical schematic of the rotating bed jack stowage circuit.

FOR REFERENCE ONLY



Item	Description
1	Rotating Bed Jack Cylinder (stowed position)
2	Rotating Bed Jack Stowage Cylinder

FIGURE 10-13

Rotating Bed Jack Stowage Cylinder Operation

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

The setup remote independently controls the two left side and the two right side stowage cylinders.

NOTE: Before rotating the jack cylinders to the stowage position, all four jack cylinders must be fully retracted.

Neutral Position Using Setup Remote

See Figure 10-14 for the following.

When the setup remote is not sending a command, the valve spools (3 and 5), located in the accessory valve manifold (1), are held in the neutral position by the return springs. When in neutral, the stowage cylinders are held in place by the holding valves (2 and 4), which trap hydraulic fluid in the piston side of the cylinders. The trapped hydraulic fluid prevents the cylinder rod from moving.

Extend Stowage Cylinder Using Setup Remote (Stowage Position)

See Figure 10-14 for the following.

NOTE: The following describes the operation to extend the right side stowage cylinders. The operation to extend the left side stowage cylinders is similar.

When the setup remote sends a stowage cylinder extend command, the IOLC31 control module energizes the extend solenoid (7) in the accessory valve manifold (1). With the extend solenoid energized, the valve spool (3) shifts to a position that allows hydraulic fluid from the accessory pump to flow through a check valve that bypasses the holding valve (2).

This causes the cylinder rods to extend, pivoting the jack cylinders into the stowed position. At the same time, hydraulic fluid in the rod side of the cylinders is pushed out and back to the tank.

After extending the stowage cylinder, a pin is used to secure the cylinder in the stowage position. The cylinder is then manually rotated and locked into the stowage position. (see Figure 10-13).

Retract Stowage Cylinder Using Setup Remote (Working Position)

See Figure 10-14 for the following.

NOTE: The following describes the operation to retract the left side stowage cylinders. The operation to retract the right side stowage cylinders is similar.

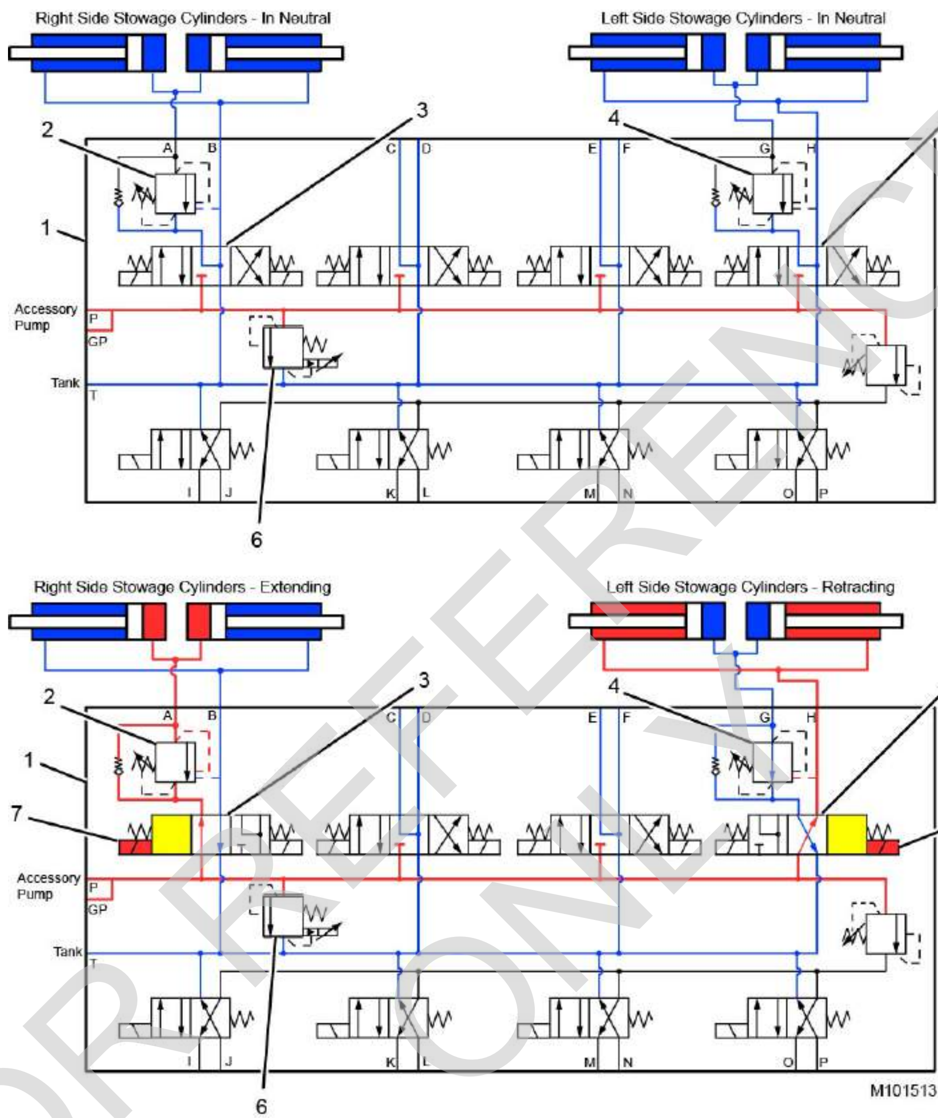
When the setup remote sends a stowage cylinder retract command, the IOLC31 control module energizes the retract solenoid (8) in the accessory valve manifold (1). With the retract solenoid energized, the valve spool (5) shifts to a position that allows hydraulic fluid from the accessory pump to flow to the rod end of the cylinders, causing the cylinder rod of each cylinder to retract. At the same time, the hydraulic fluid flows to the holding valve (4) as pilot pressure, causing the holding valve to open. As the cylinder rod of each cylinder retracts, hydraulic fluid in the piston side of the cylinders is pushed out and back to tank, via the holding valve.

The retracted cylinder rods pivot the jack cylinders into the upright position.

NOTE: Before retracting the stowage cylinders, the jacking cylinders must be manually rotated out and secured in the working position. The stowage cylinders are then used to move the jacking cylinders into the upright working position (see Figure 10-7).

FOR REFERENCE ONLY

Rotating Bed Jack Stowage Cylinders Hydraulic Schematic

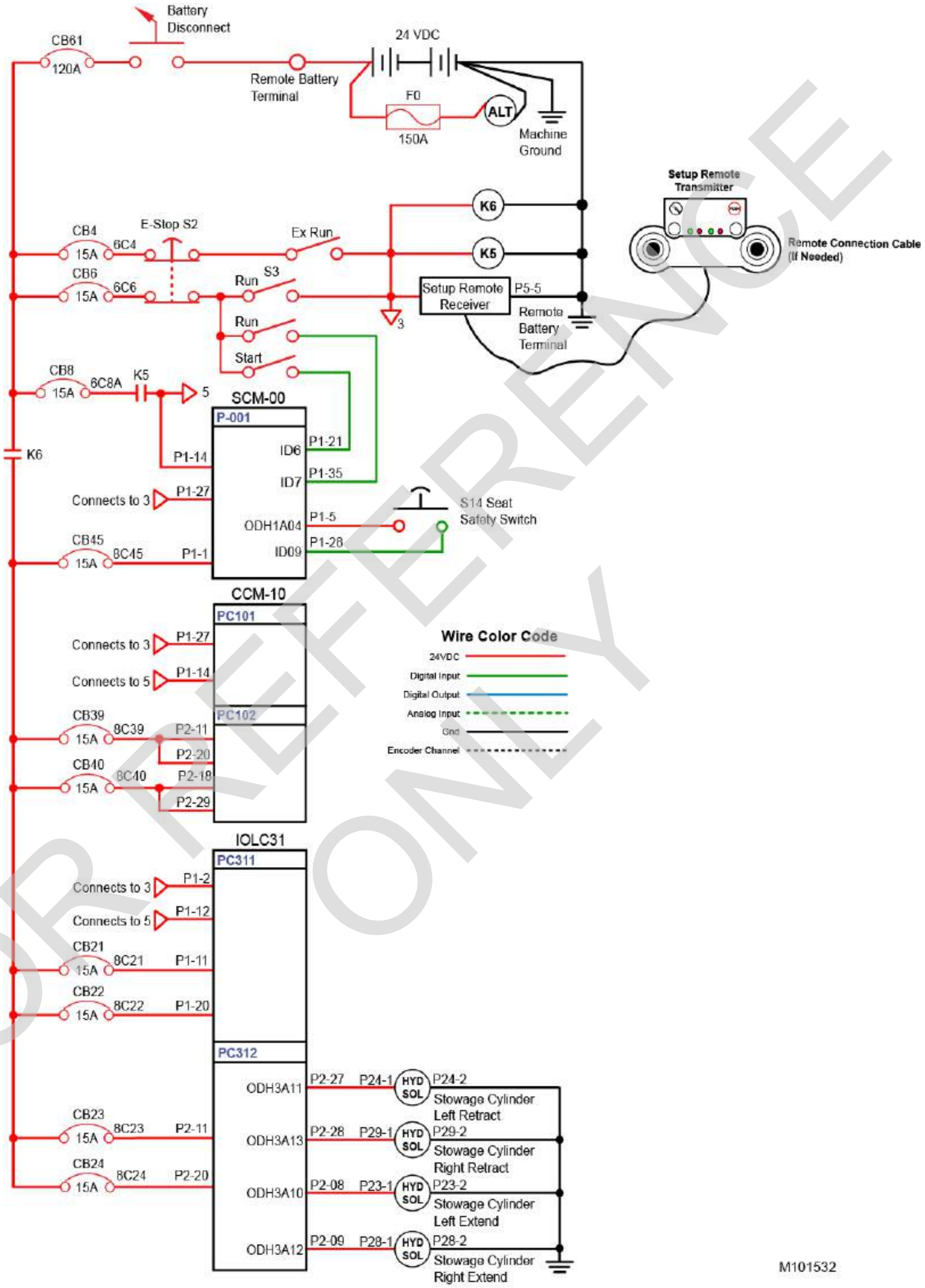


Item	Description
1	Accessory Valve Manifold
2	Right Stowage Cylinders Holding Valve (set at 3600 psi)
3	Valve Spool (right stowage cylinders)
4	Left Stowage Cylinders Holding Valve (set at 3600 psi)
5	Valve Spool (left stowage cylinders)
6	Proportional Pressure Relief Valve (operating pressure = 300 bar [5076 psi])
7	Extend Solenoid (right stowage cylinders)
8	Retract Solenoid (left stowage cylinders)

FIGURE 10-14

FOR REFERENCE ONLY

Rotating Bed Jack Stowage Cylinder Electrical Schematic



FOR REFERENCE ONLY

FIGURE 10-15

RIGGING WINCH (DRUM 0)

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the rigging winch (drum 0).

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

The rigging winch is controlled by the following methods:

- Setup remote
- J1 joystick (located on the left console in the cab)
- Manual control lever on the upperworks jacking and rigging winch valve assembly (see Figure 10-8)

NOTE: Manual control is used only for troubleshooting the rigging winch and is not used for normal operation.

See Figure 10-16 for the hydraulic schematic of the rigging winch circuit.

See Figure 10-19 for the electrical schematic of the rigging winch circuit.

Setup Remote and J1 Joystick Control

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote or J1 Joystick

See Figure 10-16 for the following.

When the setup remote or J1 joystick is not sending a command and the manual control lever is in the neutral position, the rigging winch valve spool, located in the upperworks jacking and rigging winch valve assembly (1), is held in the neutral position by the return springs.

When in the neutral position, the rigging winch valve spool prevents the accessory pump hydraulic fluid from flowing to the drum motor and brake. The counterbalance valve (3) is closed during this time, keeping the motor and drum from spooling out.

The brake shuttle valve (2) provides a return path for hydraulic fluid in the drum brake (4) to flow back to the tank. The drum brake is applied by spring force.

Spool In Using Setup Remote or J1 Joystick

See Figure 10-17 for the following.

When a spool-in command is received from the setup remote or the J1 joystick, the IOLC31 control module energizes the spool-in solenoid, located on the upperworks jacking and rigging winch valve assembly (1).

The spool-in solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow through the function check valve (6) and a check valve in the counterbalance valve (7). The hydraulic fluid then flows to the spool-in/raise side (5) of the motor. At the same time, the hydraulic fluid flows through the brake shuttle valve (2) to the drum brake (4), releasing the brakes. From the opposite side of the motor, the hydraulic fluid returns to the tank.

Spool Out Using Setup Remote or J1 Joystick

See Figure 10-17 for the following.

When a spool-out command is received from the setup remote or the J1 joystick, the IOLC31 control module energizes the spool-out solenoid, located on the upperworks jacking and rigging winch valve assembly (1).

The spool-out solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the spool-out/lower side (3) of the motor. It also provides pilot pressure to the counterbalance valve (7), causing it to shift to a position that forces the return hydraulic fluid from the opposite side of the motor to flow through an orifice passage as it flows back to the tank. The orifice creates some back pressure to prevent uncontrolled motor speed during spool out.

At the same time, the hydraulic fluid from the accessory pump flows through the brake shuttle valve (2) to the drum brake (4), releasing the brakes.

FOR REFERENCE ONLY

Manual Control

NOTE: Manual control is used only for troubleshooting the rigging winch and is not used for normal operation.

Spool In Using Manual Control

See Figure 10-18 for the following.

When the manual control lever for the rigging winch (6, Figure 10-8) on the upperworks jacking and rigging winch valve assembly is moved to the spool-in position (9, Figure 10-8), the corresponding valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow through the function check valve (6) and a check valve in the counterbalance valve (7). The hydraulic fluid then flows to the spool-in/raise side (5) of the motor. At the same time, the hydraulic fluid flows through the brake shuttle valve (2) to the drum brake (4), releasing the brakes. From the opposite side of the motor, the hydraulic fluid returns to the tank.

Spool Out Using Manual Control

See Figure 10-18 for the following.

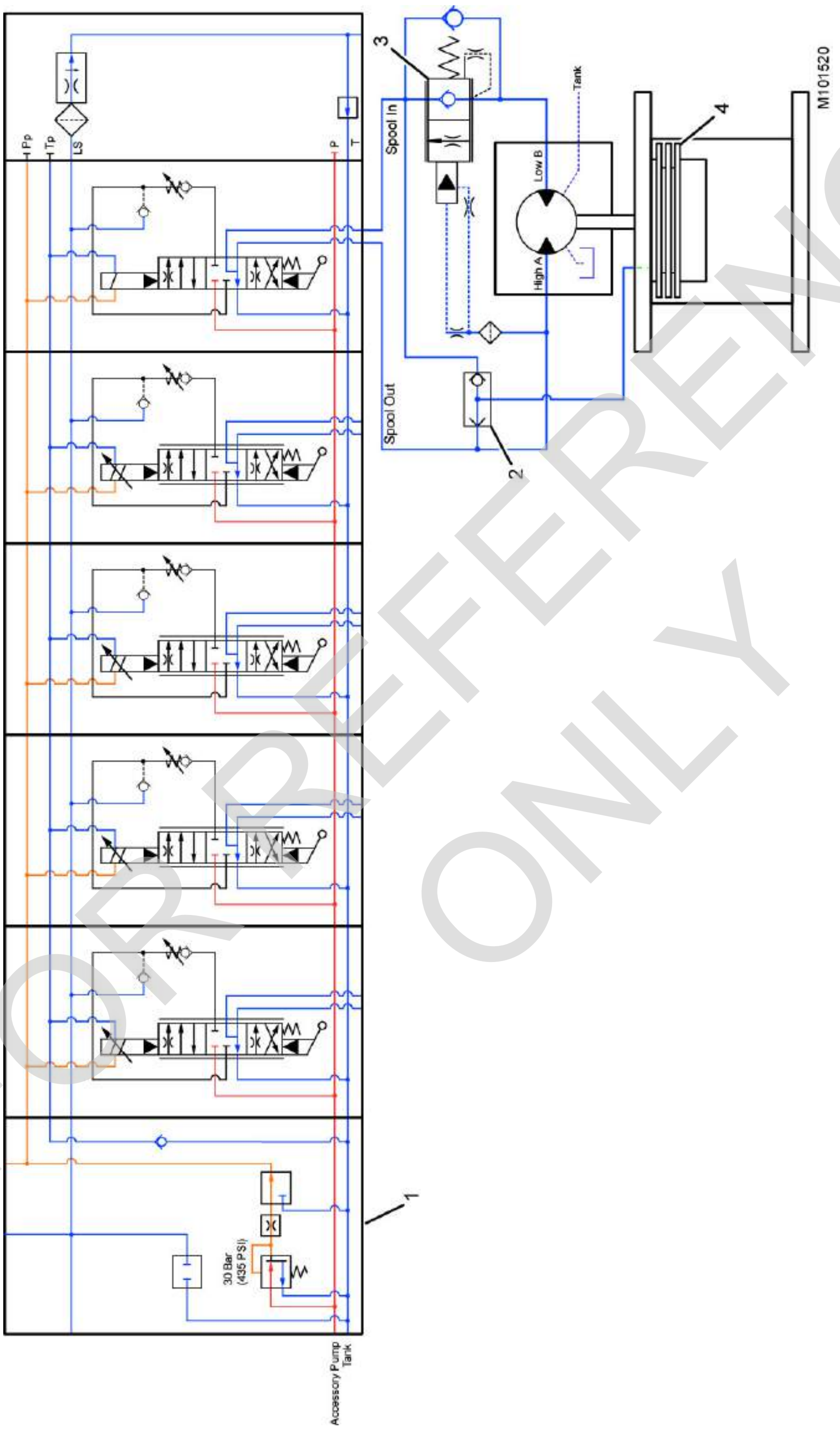
When the manual control lever for the rigging winch (6, Figure 10-8) on the upperworks jacking and rigging winch valve assembly is moved to the spool-out position (11, Figure 10-8), the corresponding valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow to the spool-out/lower side (3) of the motor. It also provides pilot pressure to the counterbalance valve (7), causing it to shift to a position that forces the return hydraulic fluid from the opposite side of the motor to flow through an orifice passage as it flows back to the tank. The orifice creates some back pressure to prevent uncontrolled motor speed during spool out.

At the same time, the hydraulic fluid from the accessory pump flows through the brake shuttle valve (2) to the drum brake (4), releasing the brakes.

FOR REFERENCE ONLY

Rigging Winch (Drum 0) Hydraulic Schematic

The hydraulic schematic is shown in the neutral state.



Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Brake Shuttle Valve
3	Counterbalance Valve
4	Drum Brake

FIGURE 10-16

FOR REFERENCE ONLY

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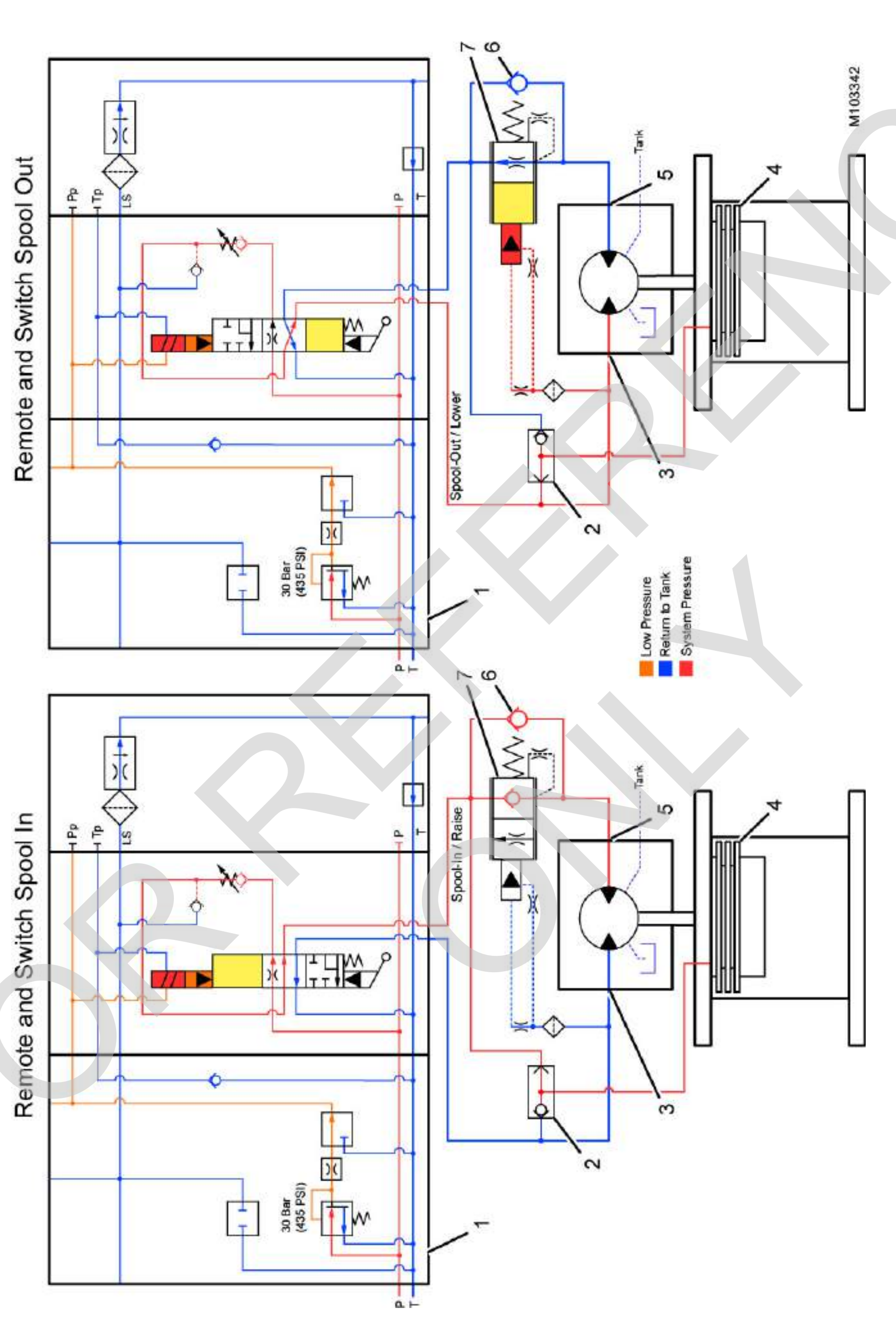
Rigging Winch (Drum 0) Hydraulic Schematic (Remote Control)

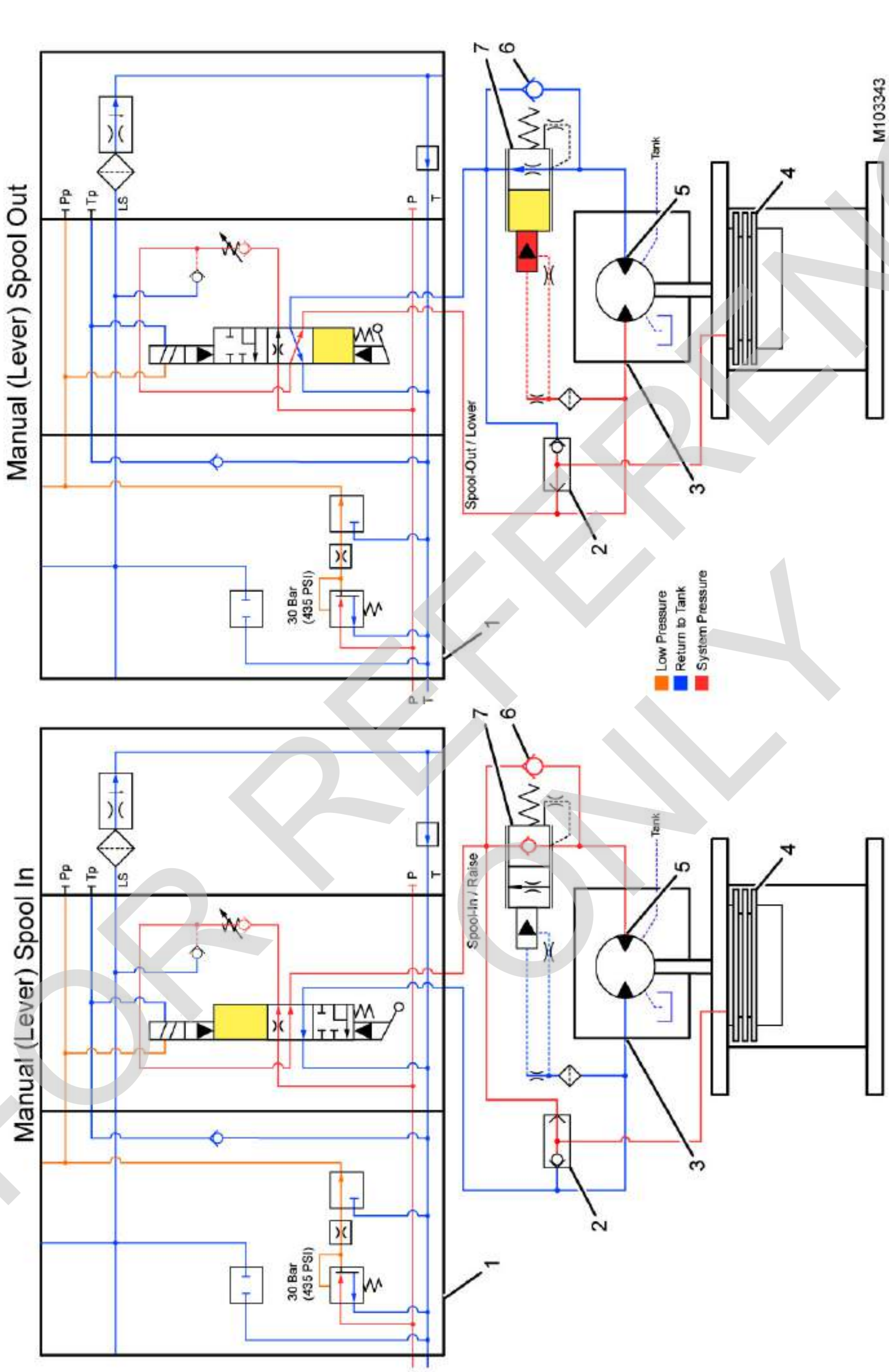


Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Brake Shuttle Valve
3	Spool-Out/Lower Side
4	Drum Brake
5	Spool-In/Raise Side
6	Function Check Valve
7	Counterbalance Valve

FIGURE 10-17

FOR REFERENCE ONLY

Rigging Winch (Drum 0) Hydraulic Schematic (Manual Control)



Item	Description
1	Upperworks Jacking and Rigging Winch Valve Assembly
2	Brake Shuttle Valve
3	Spool-Out/Lower Side
4	Drum Brake
5	Spool-In/Raise Side
6	Function Check Valve
7	Counterbalance Valve

FOR REFERENCE ONLY

FIGURE 10-18

Rigging Winch (Drum 0) Electrical Schematic

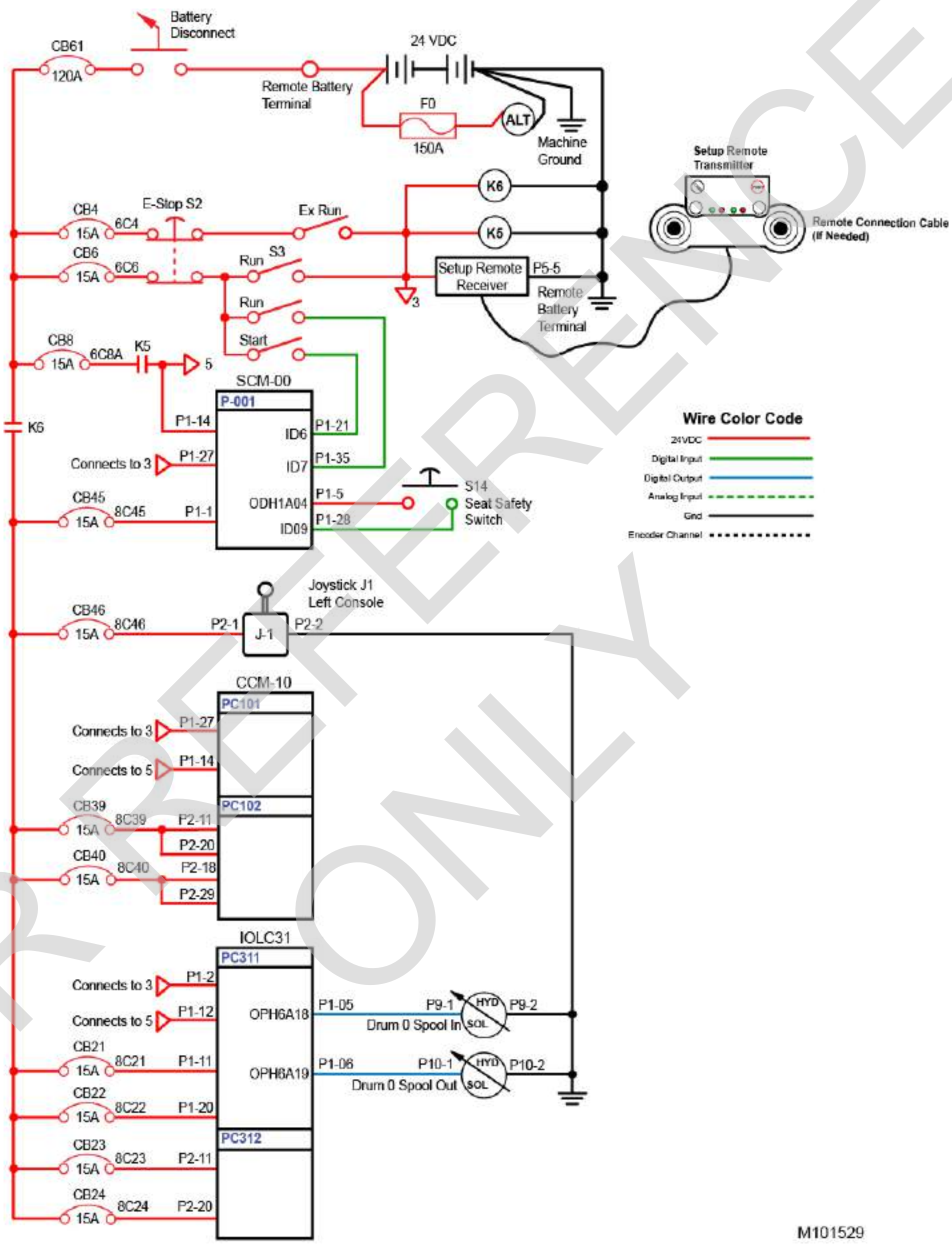


FIGURE 10-19

FOR REFERENCE ONLY

10

MAST ASSIST CYLINDERS

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the live mast assist cylinders.

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

The live mast assist cylinders are controlled by the following methods:

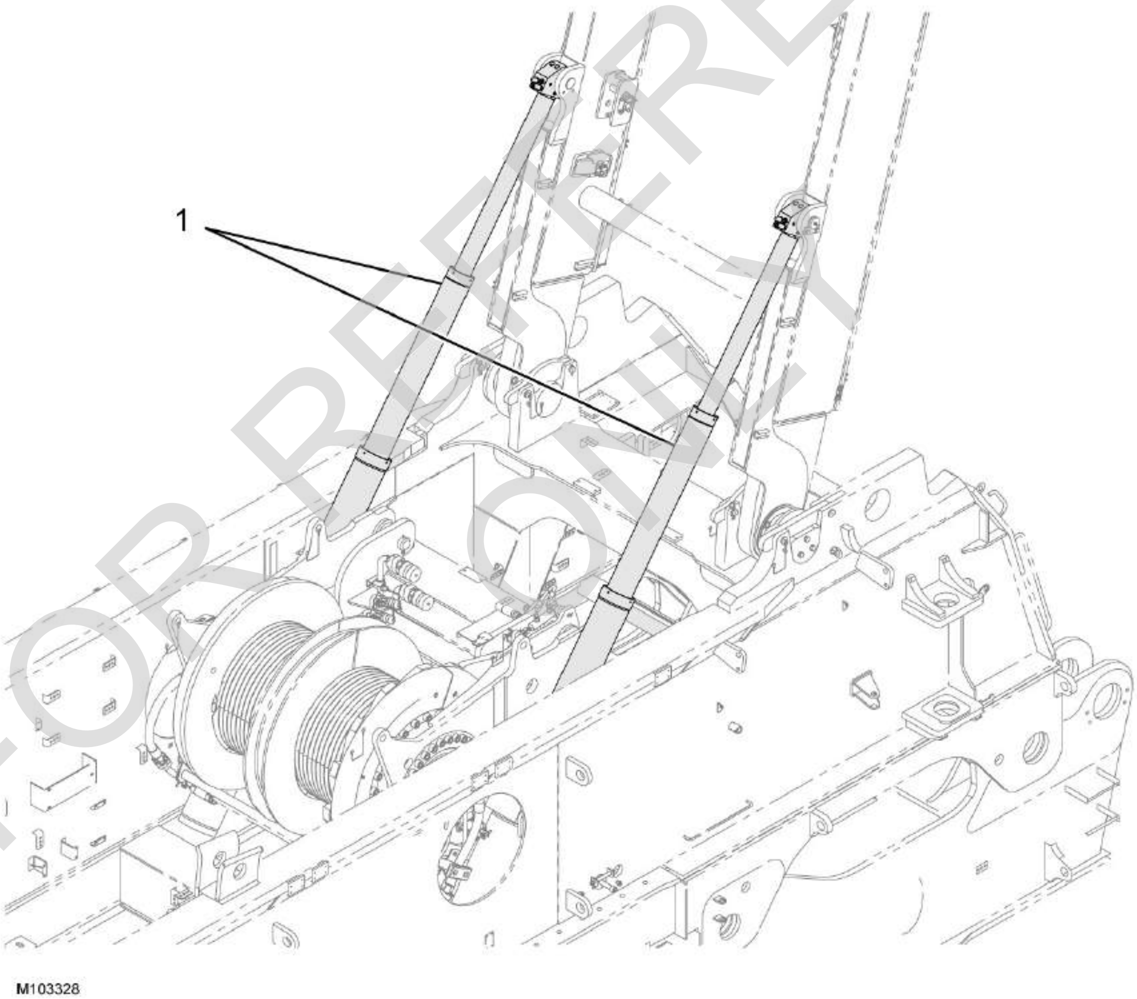
- Setup remote control
- Mast assist arm switch (located on the right console in the cab)
- Manual control lever (located on mast assist and self-assembly cylinders valve assembly) (manual control is only used for troubleshooting) (see Figure 10-21)

See Figure 10-20 for an illustration of the mast assist cylinders.

See Figure 10-22 for the hydraulic schematic of the mast assist cylinders circuit.

See Figure 10-24 for the electrical schematic of the mast assist cylinders circuit.

FOR REFERENCE ONLY



Item	Description
1	Mast Assist Cylinders (qty 2)

FIGURE 10-20

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Setup Remote and Switch Control

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote or Switch

See Figure 10-22 for the following.

When the setup remote or the mast assist switch are not sending a command, the valve spool is held in the neutral position by the return springs. Hydraulic fluid from the accessory pump is prevented from flowing to the load-hold counterbalance valve (2).

When in neutral, the load-hold counterbalance valves provides a cylinder rod holding function. The sequence valves within the load-hold counterbalance valve are closed, stopping the flow to and from the cylinders. The mast assist cylinders are held in position by trapped hydraulic fluid.

Extend Mast Assist Cylinders Using Setup Remote or Switch

See Figure 10-23 for the following.

When the setup remote or the mast assist switch sends a command to raise the mast, the IOLC30 control module energizes the mast assist cylinder extend solenoid. The extend solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the load-hold counterbalance valve (2).

During operation, the load-hold counterbalance valve equalizes the load between the left and right cylinders. Within the load-hold counterbalance valves, flow and control is as follows:

- The rod side counterbalance valve is piloted open by the equalized rod side pressure and the accessory pressure from the valve spool on the extend side.
- The piston side counterbalance valve has an integral bypass check valve that allows the hydraulic fluid to freely flow to the piston side of the cylinders, extending the cylinder.

From the load-hold counterbalance valve, hydraulic fluid flows through the cylinder counterbalance valves to the piston end of the cylinders, causing the rods to extend and raise the mast. At the same time, hydraulic fluid in the rod end of the cylinders is forced out and back to the tank, via the counterbalance valves.

NOTE: During operation, the sequence valves within the cylinder counterbalance valves remain open. The counterbalance valves close only when a sudden loss of hydraulic pressure occurs, such as when a hose bursts. If such an event would occur, the counterbalance valves in the corresponding cylinder will close, stopping the flow to and from the affected cylinder. The cylinder is held in position by trapped hydraulic fluid.

Retract Mast Assist Cylinders Using Setup Remote or Switch

See Figure 10-23 for the following.

When the setup remote or the mast assist switch sends a command to lower the mast, the IOLC30 control module energizes the mast assist cylinder retract solenoid. The retract solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the load-hold counterbalance valve (2).

During operation, the load-hold counterbalance valve equalizes the load between the left and right cylinders. Within the load-hold counterbalance valves, flow and control is as follows:

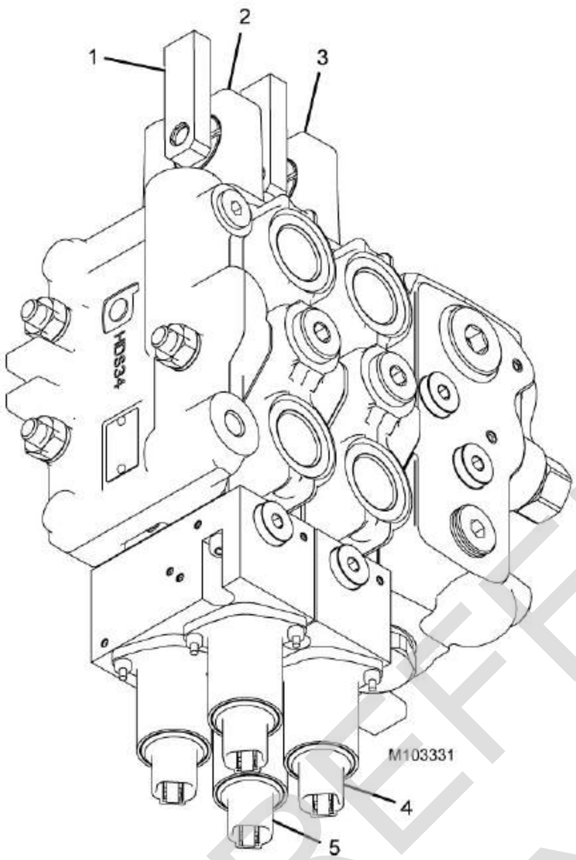
- The piston side counterbalance valve is piloted open by the equalized piston side pressure and the accessory pressure from the valve spool on the retract side.
- The rod side counterbalance valve has an integral bypass check valve that allows the hydraulic fluid to freely flow to the rod side of the cylinders, retracting the cylinder.

From the load-hold counterbalance valve, hydraulic fluid flows though the cylinder counterbalance valves to the rod end of the cylinders, causing the rods to retract and lower the mast. At the same time, hydraulic fluid in the piston end of the cylinders is forced out and back to the tank, via the counterbalance valves.

NOTE: During operation, the sequence valves within the cylinder counterbalance valves remain open. The counterbalance valves close only when a sudden loss of hydraulic pressure occurs, such as when a hose bursts. If such an event would occur, the counterbalance valves in the corresponding cylinder would close, stopping the flow to and from the affected cylinder. The cylinder is held in position by trapped hydraulic fluid.

FOR REFERENCE ONLY

Mast Assist and Self-Assembly Cylinders Valve Assembly



Item	Description
1	Manual Control Lever
2	Self-Assembly Cylinder Control Valve
3	Mast Raise Cylinder Control Valve
4	Retract Solenoid (qty 2)
5	Extend Solenoid (qty 2)
6	Extend Position
7	Neutral Position
8	Retract Position

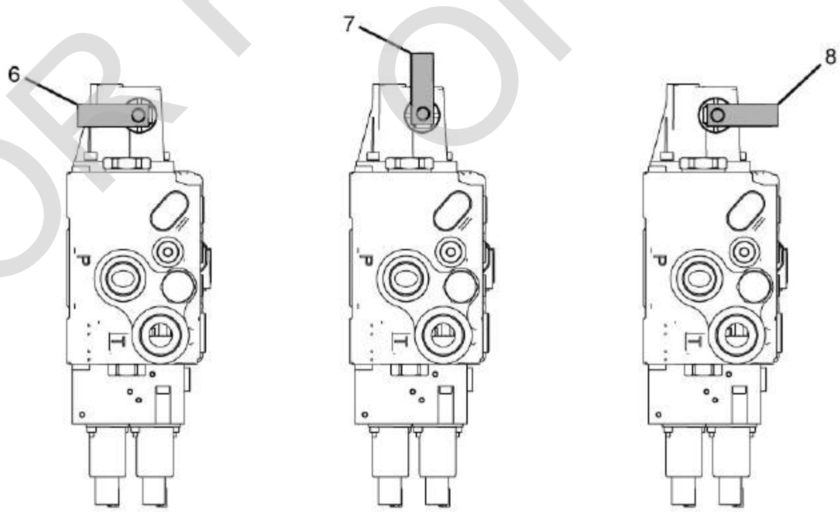


FIGURE 10-21

FOR REFERENCE ONLY

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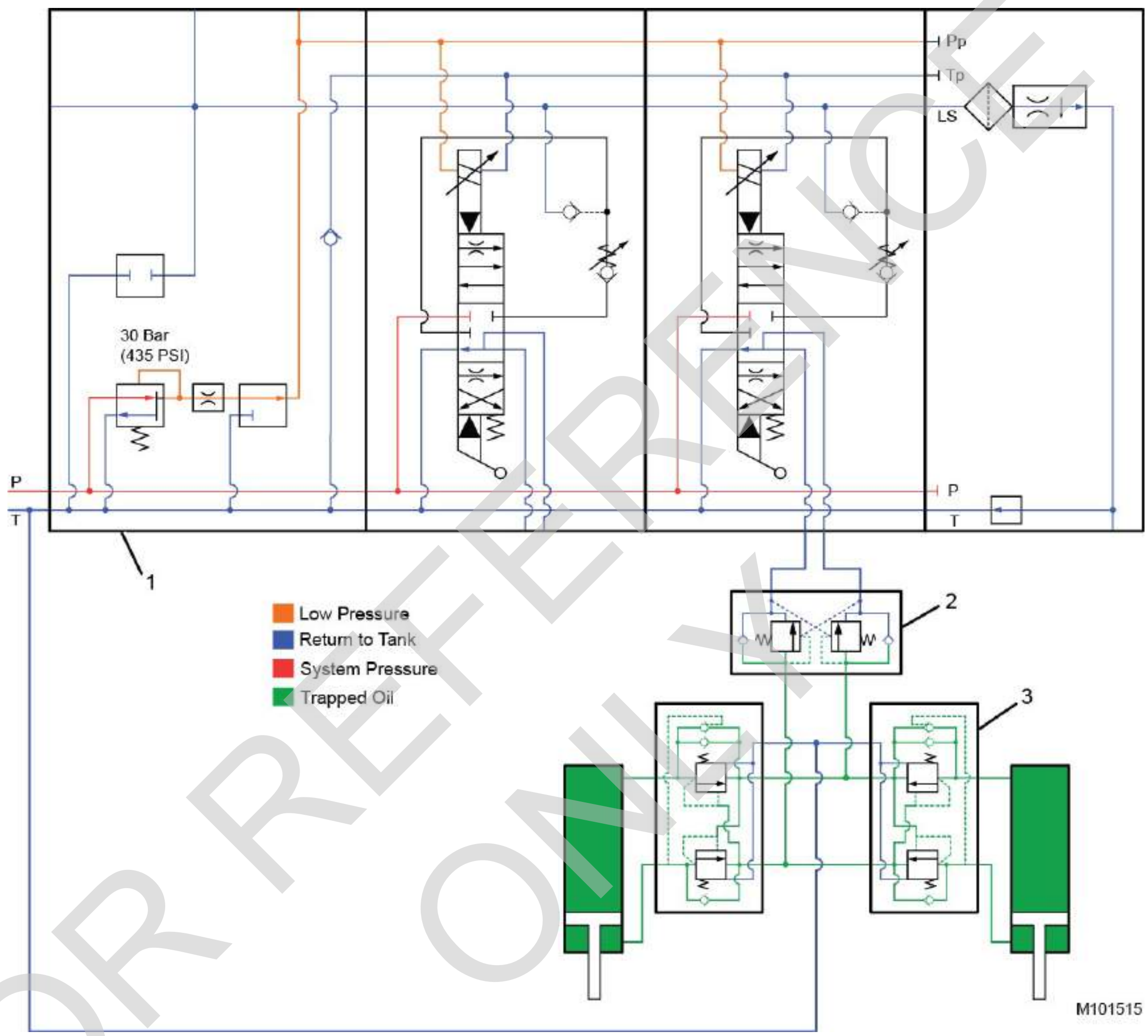
Mast Assist Cylinders Hydraulic Schematic

The hydraulic schematic is shown in the neutral state.

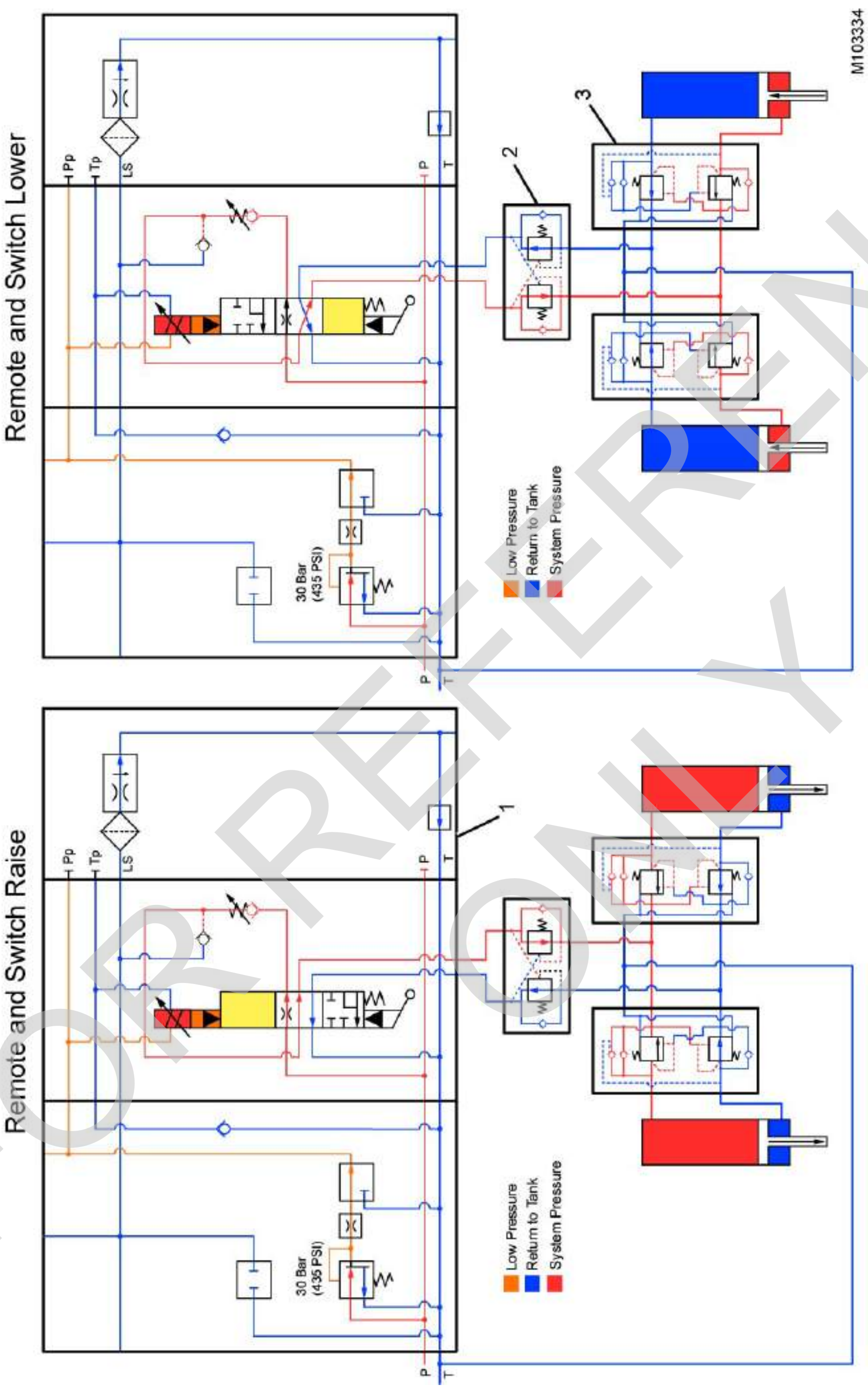


FOR REFERENCE ONLY

Item	Description
1	Mast Assist and Self-Assembly Valve Assembly
2	Load-Hold Counterbalance Valve (set at 275 bar [4000 psi])
3	Cylinder Counterbalance Valve (set at 248 bar [3600 psi]) (qty 4)

FIGURE 10-22

Mast Assist Cylinders Hydraulic Schematic (Setup Remote and Switch Control)



Item	Description
1	Mast Assist and Self-Assembly Valve Assembly
2	Load-Hold Counterbalance Valve (set at 275 bar [4000 psi])
3	Cylinder Counterbalance Valve (set at 248 bar [3600 psi]) (qty 4)

FIGURE 10-23

FOR REFERENCE ONLY

Mast Assist Cylinders Electrical Schematic

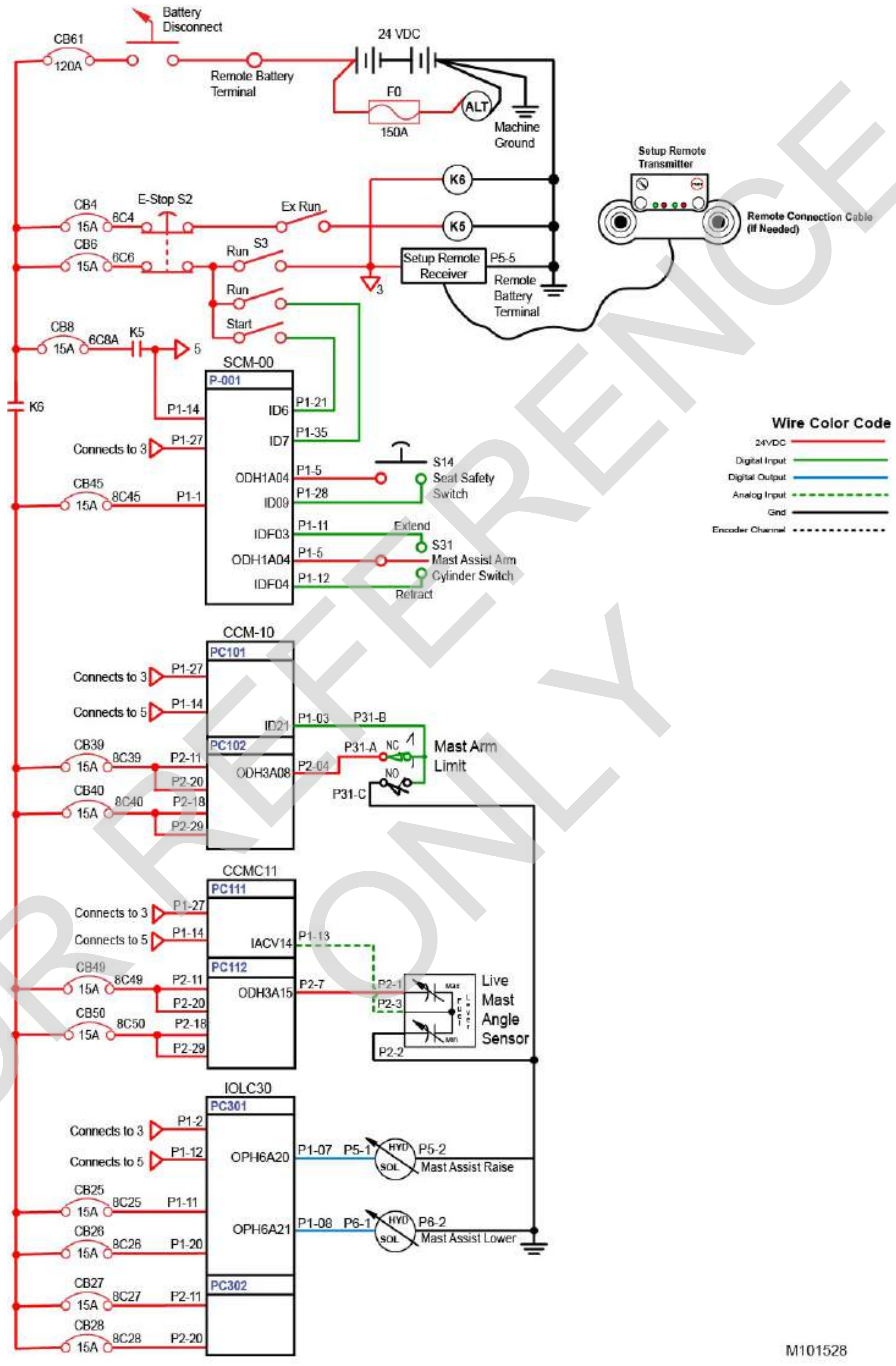


FIGURE 10-24

FOR REFERENCE ONLY

10

SELF-ASSEMBLY CYLINDER (OPTIONAL)

General

This part of Section 10 provides operational information and electrical and hydraulic schematics for the self-assembly cylinder.

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

The self-assembly cylinder is controlled by the following methods:

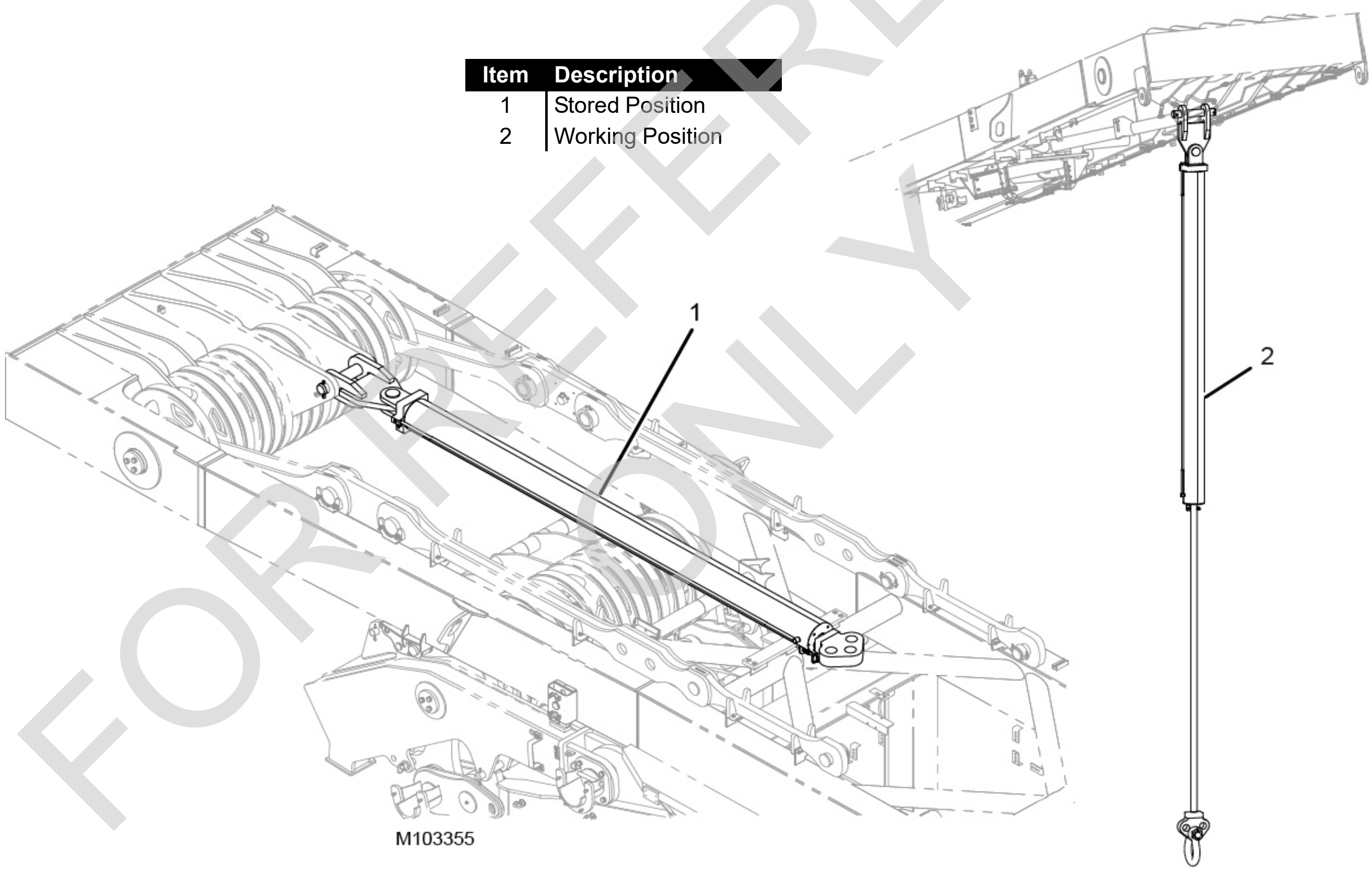
- Setup remote control
- J4 joystick (located on the right console in the cab)
- Manual control lever (located on mast assist and self-assembly cylinders valve assembly) (manual control is only used for troubleshooting) (see Figure 10-21)

See Figure 10-25 for the stored and working positions of the self-assembly cylinder.

See Figure 10-26 for the hydraulic schematic of the self-assembly cylinder circuit.

See Figure 10-28 for the electrical schematic of the self-assembly cylinder circuit.

Item	Description
1	Stored Position
2	Working Position



Self-Assembly Cylinder Working and Stored Positions

FIGURE 10-25

FOR REFERENCE ONLY

Setup Remote and J4 Joystick Control

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote or J4 Joystick

See Figure 10-26 for the following.

When the setup remote or J4 joystick is not sending a command and the manual control lever on the mast assist and self-assembly cylinder valve assembly (1) is in the neutral position, the corresponding valve spool is held in the neutral position by the return springs. Hydraulic fluid from the accessory pump is prevented from flowing to the self-assembly cylinder.

When in neutral, the load-hold valve (2) is closed, stopping the flow to and from the rod end of the self-assembly cylinder. The cylinder is held in position by trapped hydraulic fluid.

Extend Cylinder Using Setup Remote or J4 Joystick

See Figure 10-27 for the following.

When the setup remote or J4 joystick sends an extend command, the IOLC30 control module energizes the self-assembly cylinder extend solenoid on the mast assist and self-assembly cylinder valve assembly (1). The extend solenoid valve routes pilot hydraulic fluid to the corresponding valve spool. This causes the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow to the piston end of the cylinder. It also provides pilot pressure to the load-hold valve (2), causing it to open.

With hydraulic fluid from the accessory pump flowing to the piston end of the cylinder and the load-hold valve being open, the cylinder rod extends, forcing hydraulic fluid in the rod end of the cylinder back to the tank via the load-hold valve.

Retract Cylinder Using Setup Remote or J4 Joystick

See Figure 10-27 for the following.

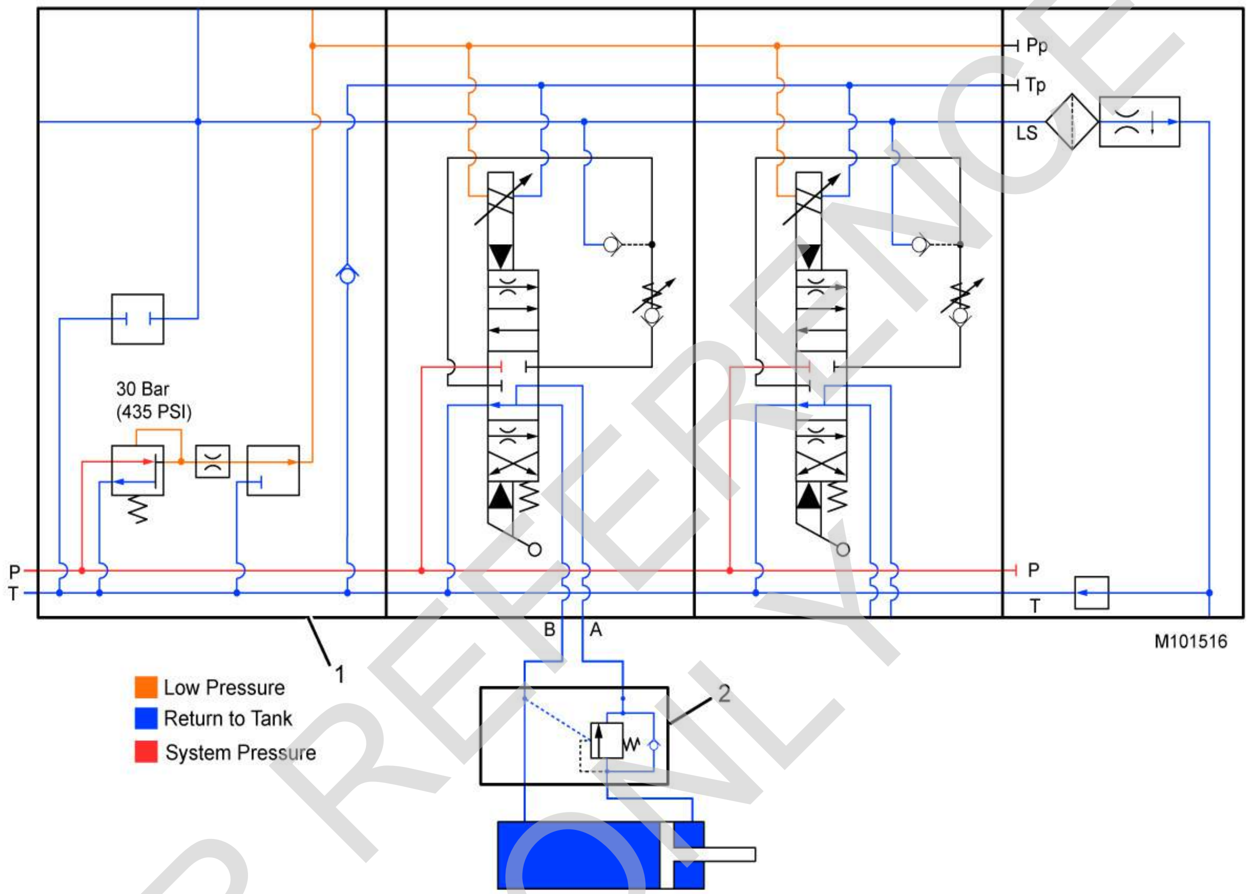
When the setup remote or J4 joystick sends a retract command, the IOLC30 control module energizes the self-assembly cylinder retract solenoid on the mast assist and self-assembly cylinder valve assembly (1).

The retract solenoid valve routes pilot hydraulic fluid to the corresponding valve spool, causing the valve spool to shift to a position that allows hydraulic fluid from the accessory pump to flow through a check valve at the load-hold valve (2). This allows the hydraulic fluid to flow through the load-hold valve to the rod end of the cylinder, causing the cylinder rod to retract. At the same time, hydraulic fluid in the piston end of the cylinder is forced out and back to the tank.

FOR REFERENCE ONLY

Self-Assembly Cylinder Hydraulic Schematic

The hydraulic schematic is shown in the neutral state.

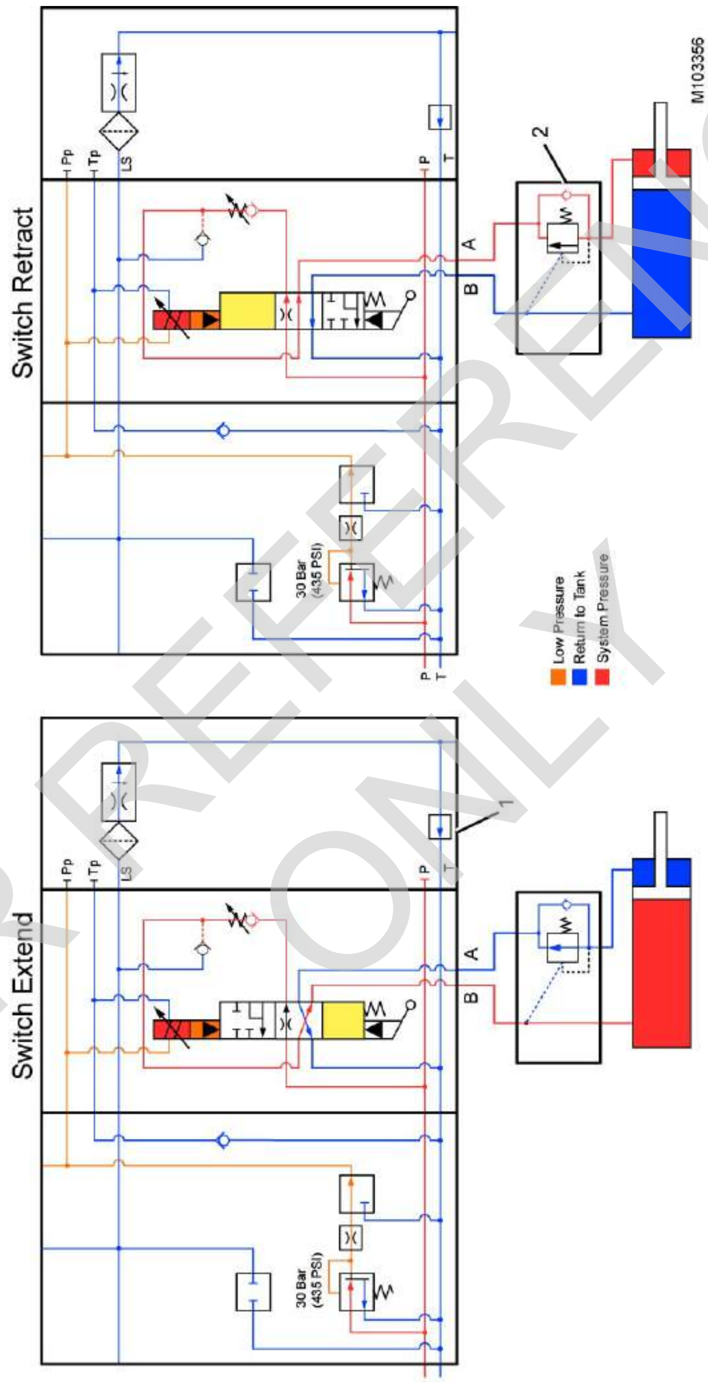


Item	Description
1	Mast Assist and Self-Assembly Cylinder Valve Assembly
2	Load-Hold Valve (set at 269 bar [3900 psi])

FIGURE 10-26

FOR REFERENCE ONLY

Self-Assembly Cylinder Hydraulic Schematic (Setup Remote and J4 Joystick Control)



Item	Description
1	Mast Assist and Self-Assembly Cylinder Valve Assembly
2	Load-Hold Valve (set at 269 bar [3900 psi])

FIGURE 10-27

FOR REFERENCE ONLY

Self-Assembly Cylinder Electrical Schematic

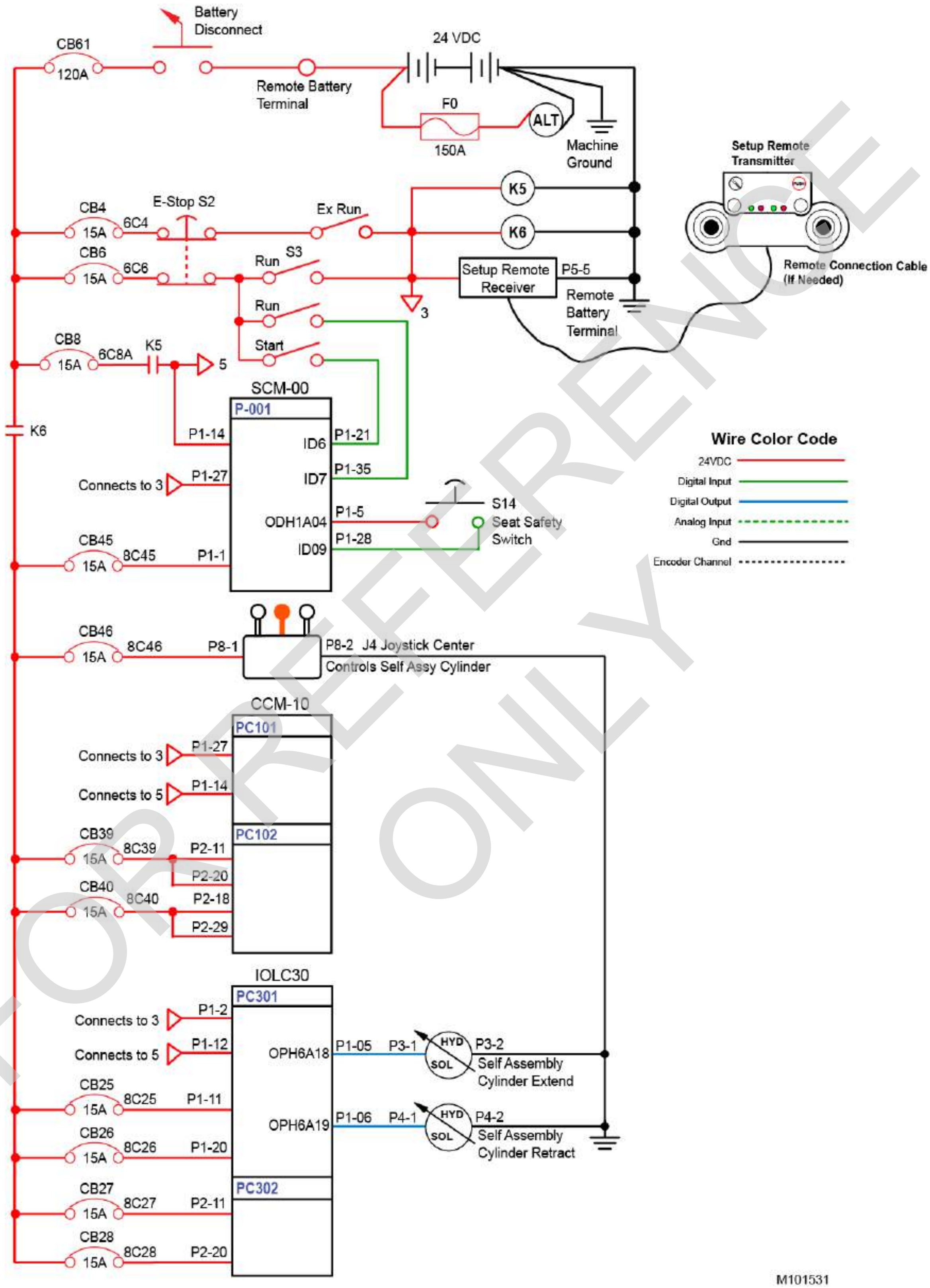


FIGURE 10-28

FOR REFERENCE ONLY

CAB TILT

The cab tilt cylinders are controlled by the cab tilt switch on the right side console in the operator cab.

See Figure 10-29 for the hydraulic schematic of the cab tilt cylinder circuit.

See Figure 10-31 for the electrical schematic of the cab tilt cylinder circuit.

Cab Tilt in Neutral

See Figure 10-29 for the following.

When the cab tilt switch is not sending a command, the cab tilt valve spool (5), located in the accessory valve manifold (1), is held in the neutral position by the return springs.

When in neutral, the counterbalance valve (4) provides a cylinder hold function. The sequence valves within the counterbalance valve are closed, stopping the flow to and from the cylinder. The cab tilt cylinder is held in position by trapped hydraulic fluid.

Cab Tilt Up Using the Cab Tilt Switch

See Figure 10-30 for the following.

When a tilt up command is initiated from the cab tilt switch, the IOSA22 control module sends the tilt up command to the CCM-10 control module, which then energizes the cab tilt up solenoid (5). The valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow to the counterbalance valve (4), via the flow control valves (3).

Within the counterbalance valves, flow and control is as follows:

- The rod side counterbalance valve is piloted open by the rod side pressure and the accessory pressure from the valve spool on the extend side. Once open, the hydraulic fluid on the rod side is allowed to exit the cylinder and return to tank, via the bypass check valve on the flow control valve.
- The piston side counterbalance valve has an integral bypass check that allows the metered flow to the piston side of the cylinder, extending the cylinder.

Cab Tilt Down Using the Cab Tilt Switch

See Figure 10-30 for the following.

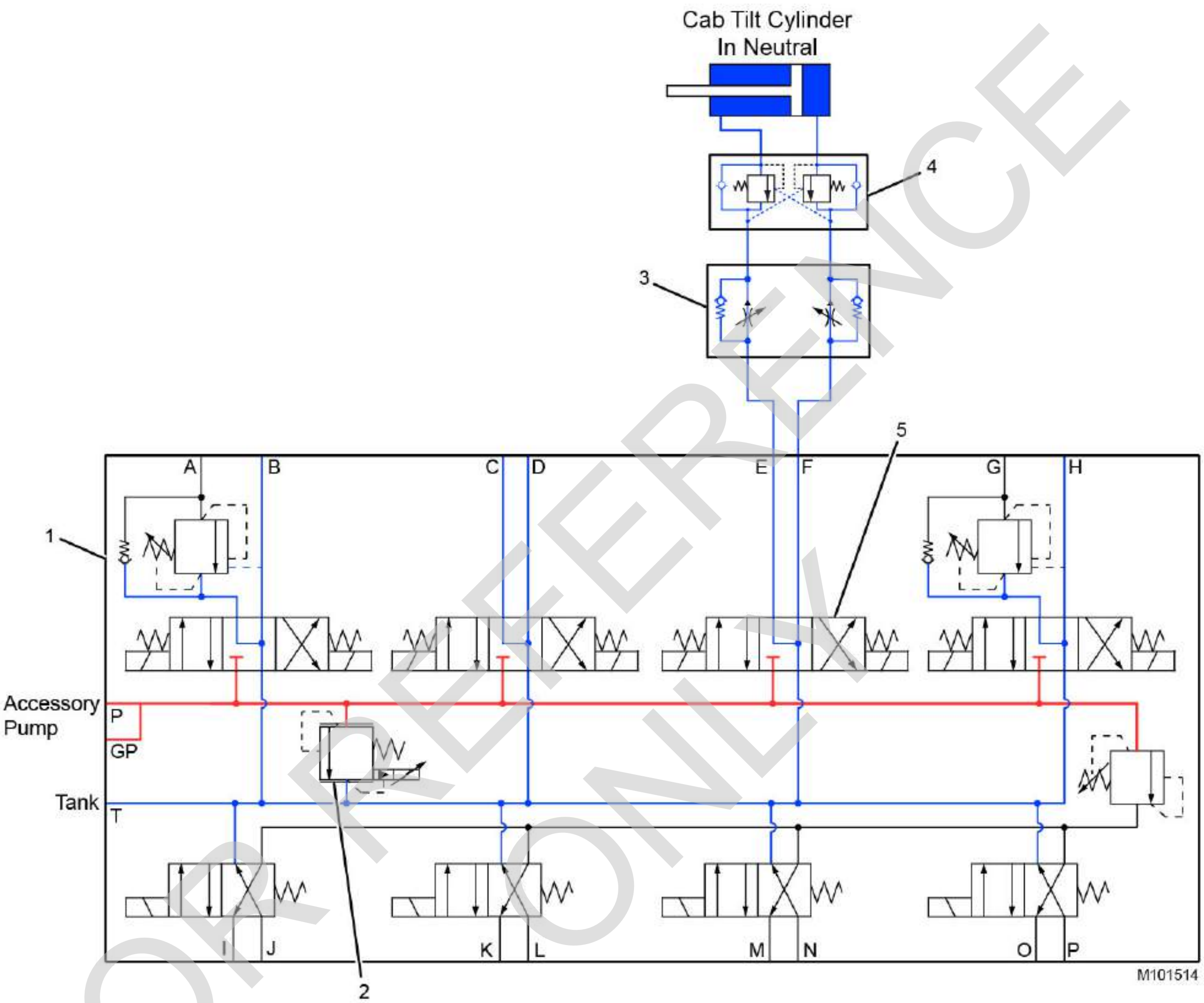
When a tilt down command is initiated from the cab tilt switch, the IOSA22 control module sends the tilt down command to the CCM-10 control module, which then energizes the cab tilt down solenoid (6). The valve spool moves to a position that allows hydraulic fluid from the accessory pump to flow to the counterbalance valve (4), via the flow control valves (3).

Within the counterbalance valves, flow and control is as follows:

- The piston side counterbalance valve is piloted open by the piston side pressure and the accessory pressure from the valve spool on the retract side. Once open, the hydraulic fluid on the piston side is allowed to exit the cylinder and return to tank, via the bypass check valve on the flow control valve.
- The rod side counterbalance valve has an integral bypass check that allows the metered flow to the rod side of the cylinder, retracting the cylinder.

FOR REFERENCE ONLY

Cab Tilt Cylinder Hydraulic Schematic (Neutral)



Item	Description
1	Accessory Valve Manifold
2	Proportional Pressure Relief Valve (operating pressure = 350 bar [5076 psi])
3	Flow Control Valves
4	Counterbalance Valve (set at 275 bar [4000 psi])
5	Cab Tilt Valve Spool

FOR REFERENCE ONLY

FIGURE 10-29

Cab Tilt Cylinder Hydraulic Schematic (Tilt Up and Tilt Down)

Item	Description
1	Accessory Valve Manifold
2	Proportional Pressure Relief Valve (operating pressure = 350 bar [5076 psi])
3	Flow Control Valves
4	Counterbalance Valve (set at 275 bar [4000 psi])
5	Cab Tilt Up Solenoid (cylinder extend)
6	Cab Tilt Down Solenoid (cylinder retract)

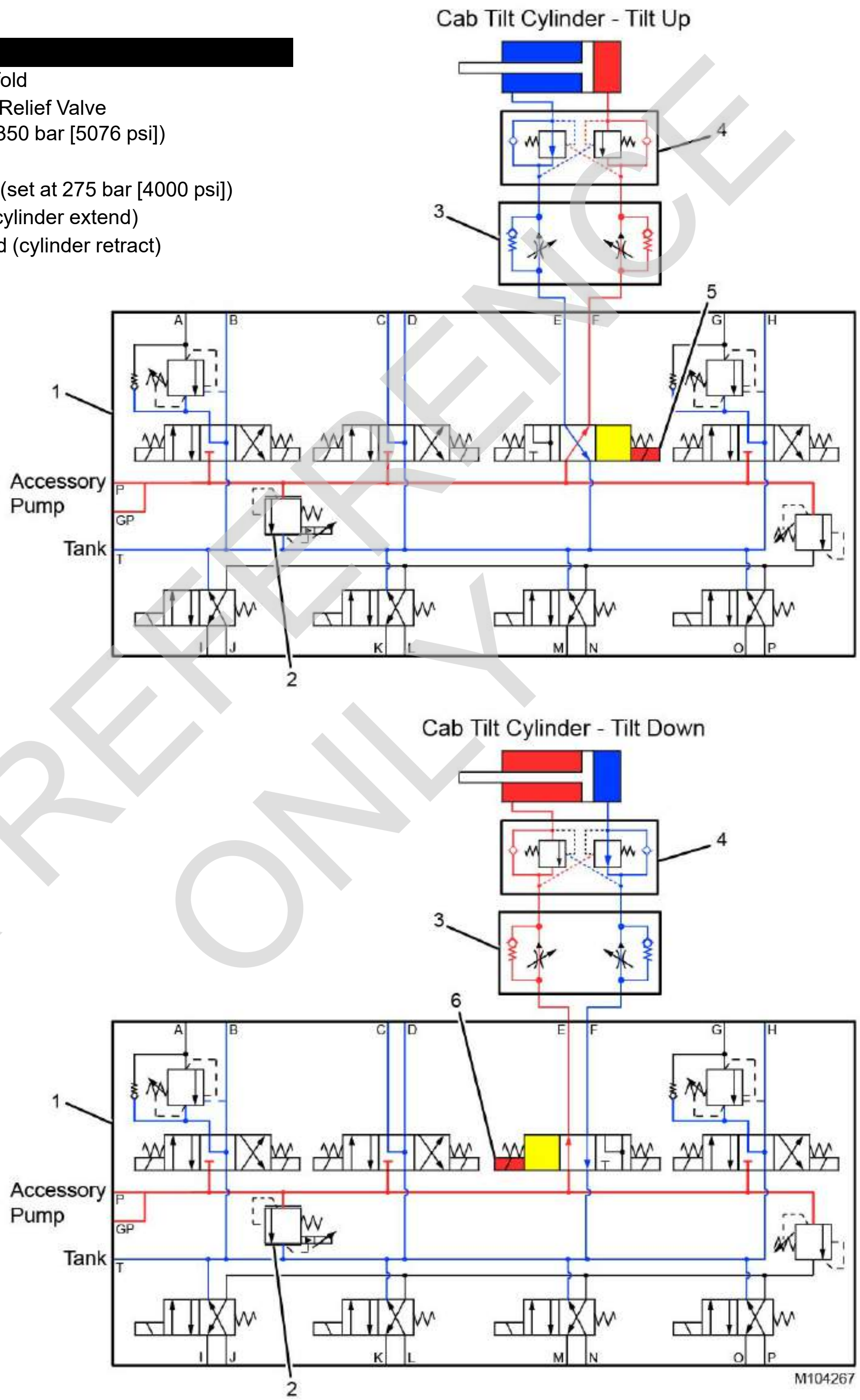


FIGURE 10-30

FOR REFERENCE ONLY

Cab Tilt Electrical Schematic

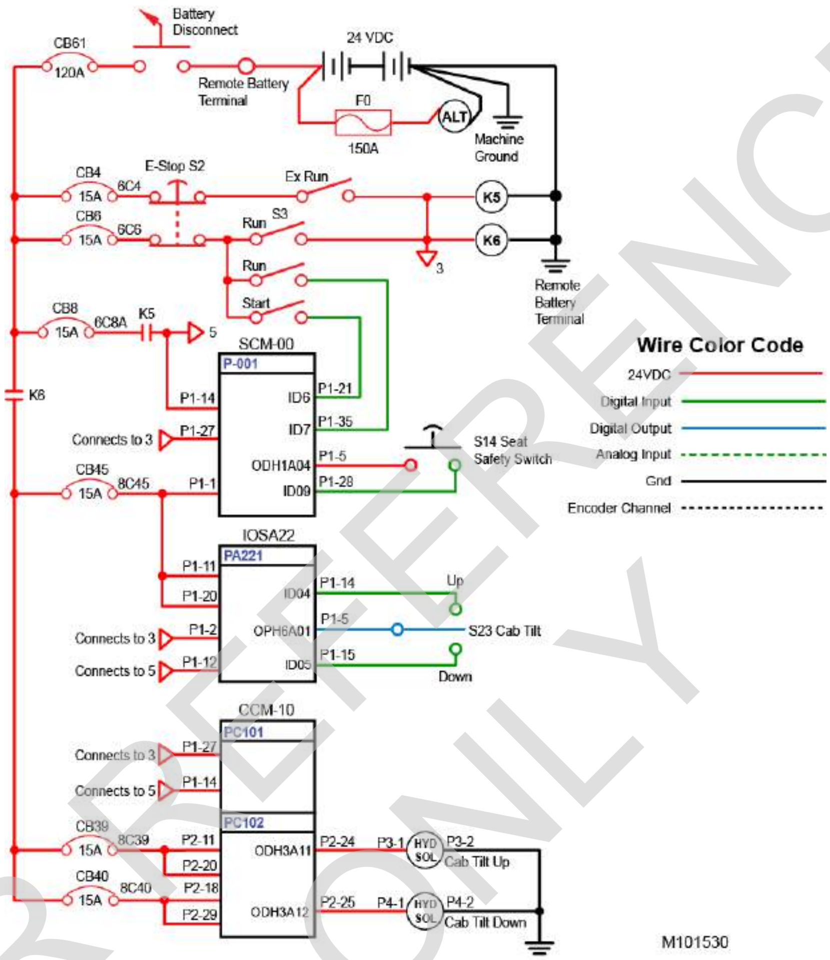


FIGURE 10-31

FOR REFERENCE ONLY

VPC AND VPC-MAX SYSTEMS

General

This part of Section 10 provides the electrical and hydraulic control of the VPC and VPC-MAX counterweight system.

The systems that are covered are as follows:

- VPC Counterweight Tray (see Figure 10-33)
- VPC-MAX Trolley (see Figure 10-41)
- VPC-MAX Beam (see Figure 10-41)

See Figure 10-32 for an illustration of the VPC and VPC-MAX counterweight system.

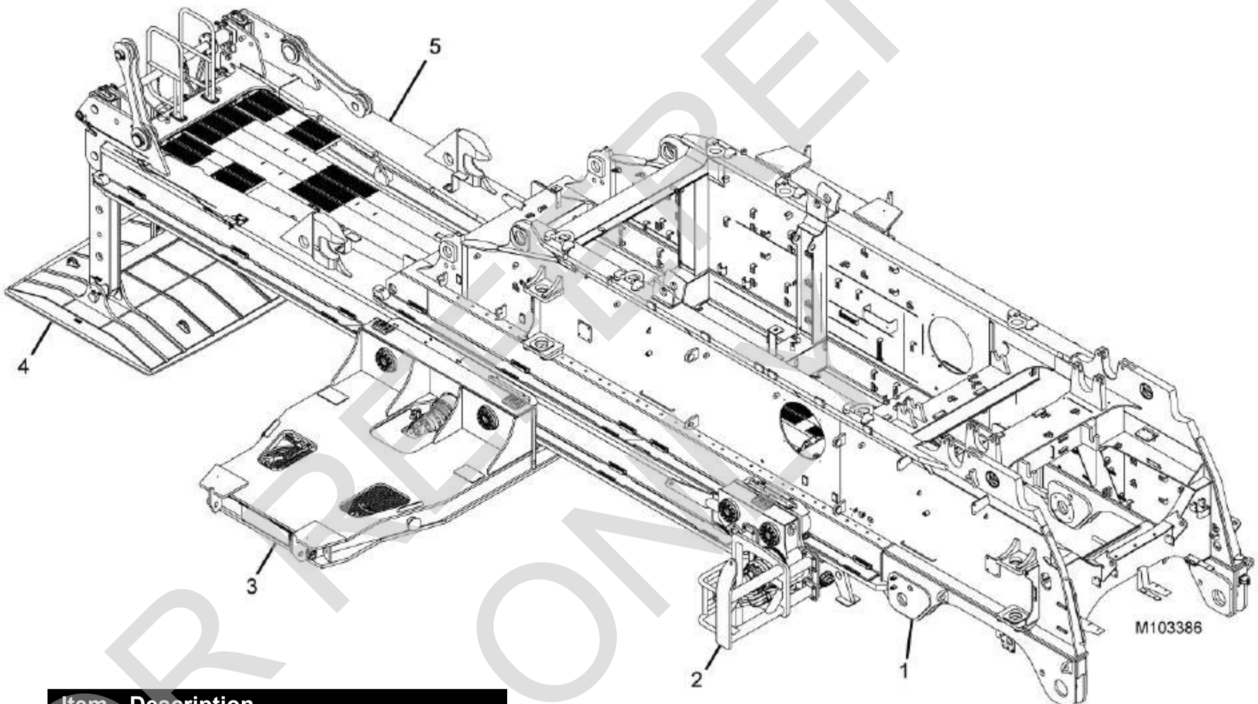
Information and adjustment procedures are provided for the following:

- Speed sensors
- Absolute encoders
- Limit switches
- Roller backlash

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

FOR REFERENCE ONLY



Item	Description
1	Rotating Bed
2	VPC-MAX Trolley
3	VPC Counterweight Tray
4	Frame Assembly Auxiliary Member
5	VPC-MAX Beam

FIGURE 10-32

VPC Counterweight Tray Operation

The VPC counterweight tray movement is controlled by the following methods:

- On-board computer control
- Setup remote

See Figure 10-33 for an illustration of the VPC counterweight tray.

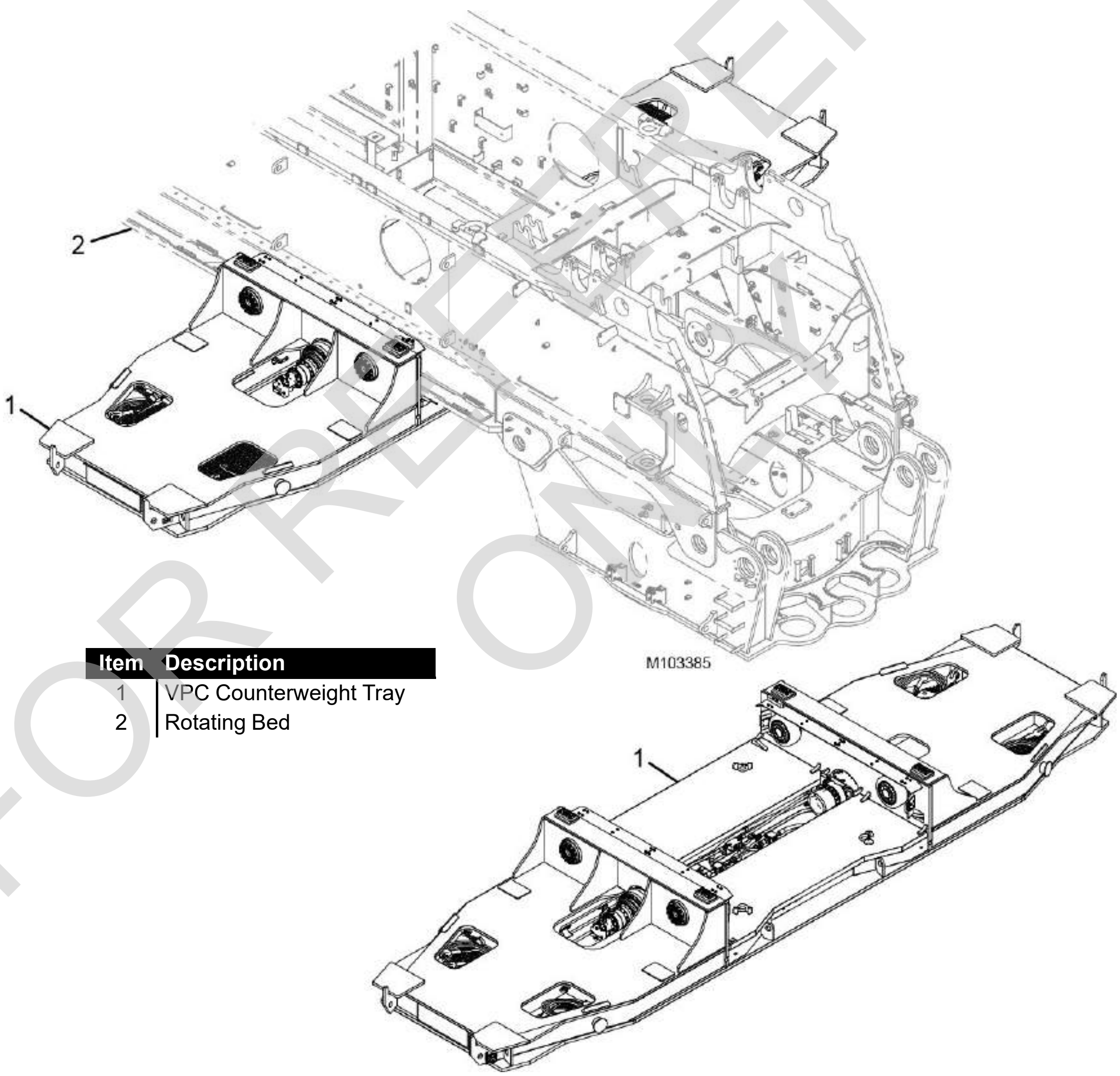
See Figure 10-34 for the hydraulic schematic of the VPC counterweight tray motor circuit.

See Figure 10-35 for the electrical schematic of the VPC counterweight tray motor circuit.

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.



Item	Description
1	VPC Counterweight Tray
2	Rotating Bed

FIGURE 10-33

FOR REFERENCE ONLY

VPC Counterweight Tray Extension

See Figure 10-34 for the following.

When the CCM-10 control module receives an extend tray command (either from the setup remote or from the on-board computer control), the CCM-10 control module sends a command to the IOLC33 control module to begin ramping up the pulse width modulation (PWM) duty cycle to the B-side solenoid of the pump 7 electronic displacement control (EDC).

At the same time, the CCM-10 control module sends a command to the IOLC31 control module to disengage the tray motor brakes. The IOLC31 control module then sends a 24 V_{DC} output voltage to the brake release solenoid valve (7), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the tray motor brakes, releasing the brakes.

When movement of the tray is detected, the VPC warning lights illuminate and the VPC alarm activates.

Increasing the PWM duty cycle increases the pump swashplate angle, which increases the flow from the B-side of the pump to the B-side of the right tray motor and the A-side of the left tray motor. If the crane is equipped with the VPC-MAX option, hydraulic fluid flows from the pump 7, through the hot oil shuttle valve (1) and the VPC 1/VPC 2 diverter valve (2), then to the tray motors. The diverter valve is kept in the VPC 1 (default) position during tray motor operation.

The tray motor speed sensors and pump 7 (port B) pressure transducer (VPC actuator extend psi) provide the closed loop feedback. The control algorithm uses this feedback to adjust the pump flow while ramping up to and maintaining the tray speed.

The VPC tray rear limit (maximum out) switch (2, Figure 10-38) is provided to stop movement of the tray before it reaches the rear physical stop (1, Figure 10-38).

When the CCM-10 receives a stop tray command, the CCM-10 control module sends a command to the IOLC31 control module to engage the brakes. The IOLC31 control module then sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the tray motor brakes.

At the same time, the CCM-10 sends a signal to the IOLC33 control module to ramp down the PWM duty cycle to the pump 7 EDC, stopping all flow to the tray motors. When the tray movement is stopped, the VPC warning lights and alarms are deactivated.

VPC Counterweight Tray Retraction

See Figure 10-34 for the following.

When the CCM-10 control module receives a retract tray command (either from the setup remote or from the on-board computer control), the CCM-10 control module sends a command to the IOLC33 control module to begin ramping up the PWM duty cycle to the A-side solenoid of the pump 7 EDC.

At the same time, the CCM-10 control module sends a command to the IOLC31 control module to disengage the tray motor brakes. The IOLC31 control module then sends a 24 V_{DC} output voltage to the brake release solenoid valve (7), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid to the tray motor brakes, releasing the brakes.

When movement of the tray is detected, the VPC warning lights illuminate and the VPC alarm activates.

Increasing the PWM duty cycle increases the pump swashplate angle, which increases the flow from the A-side of the pump to the A-side of the right tray motor and the B-side of the left tray motor. If the crane is equipped with the VPC-MAX option, hydraulic fluid flows from the pump 7, through the hot oil shuttle valve (1) and the VPC 1/VPC 2 diverter valve (2), then to the tray motors. The diverter valve is kept in the VPC 1 (default) position during tray motor operation.

The tray motor speed sensors and pump 7 (port A) pressure transducer (VPC actuator retract psi) provide the closed loop feedback. The control algorithm uses this feedback to adjust the pump flow while ramping up to and maintaining the tray speed.

The VPC tray forward limit (maximum in) switch (4, Figure 10-38) is provided to stop movement of the tray before it reaches the forward physical stop (5, Figure 10-38).

When the CCM-10 receives a stop tray command, the CCM-10 control module sends a command to the IOLC31 control module to engage the brakes. The IOLC31 control module then sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the tray motor brakes.

At the same time, the CCM-10 sends a signal to the IOLC33 control module to ramp down the PWM duty cycle to the pump 7 EDC, stopping all flow to the tray motors. When the tray movement is stopped, the VPC warning lights and alarms are deactivated.

FOR REFERENCE ONLY

VPC Counterweight Tray Motor Brakes

See Figure 10-34 for the following.

The VPC tray motor brakes are a spring-applied, hydraulically released brake system. Each of the tray motors (4 and 5) has an attached brake assembly (6) that is disengaged when the control system energizes the brake release solenoid valve (7). If the brake hydraulic pressure or electrical control is lost, the brakes are applied by spring force.

The tray motor brake release system uses hydraulic fluid from the accessory pump 9 and charge pressure from pump 7 to release the brakes.

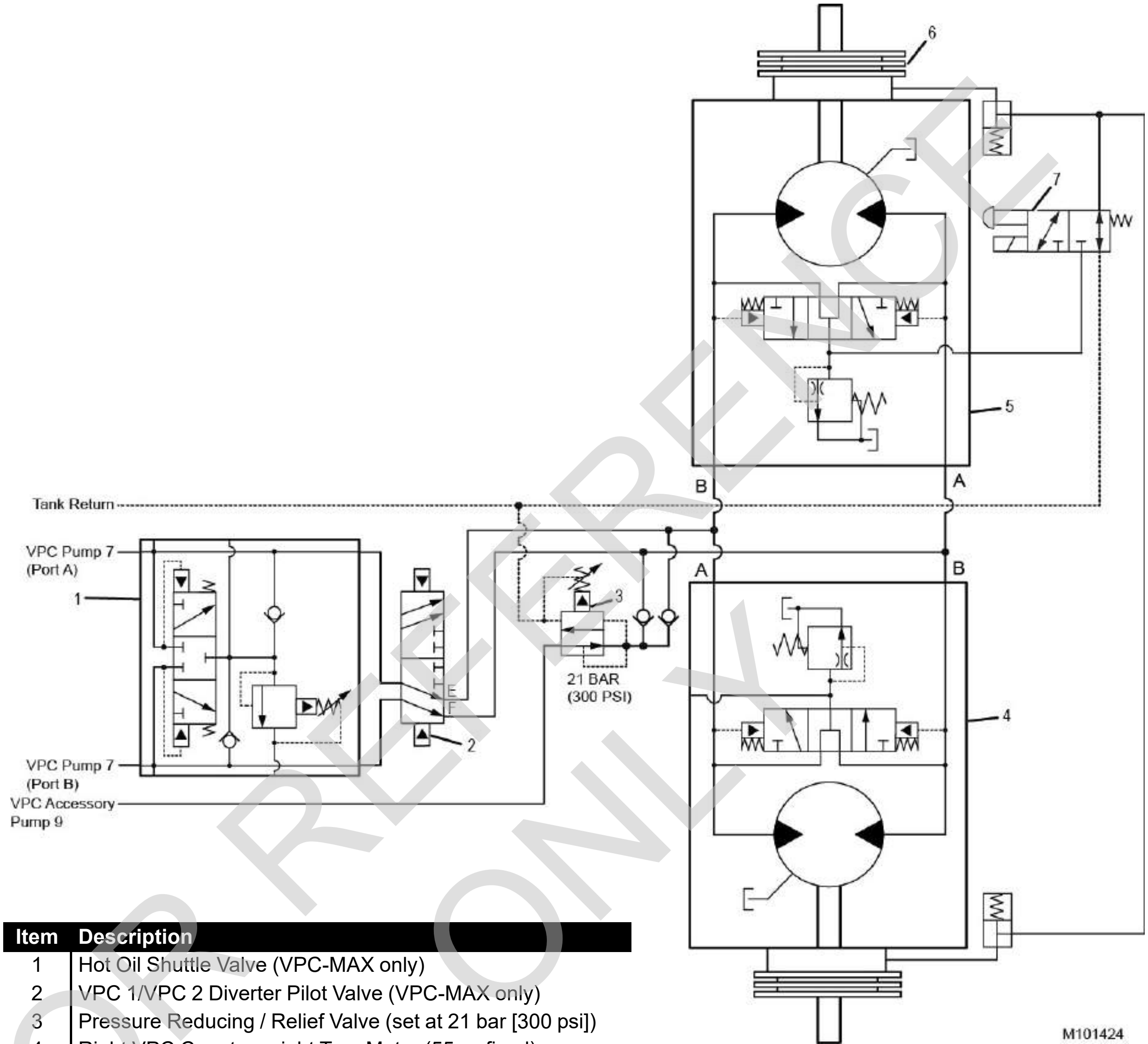
The brake release pressure must be at least 16 bar (232 psi) to fully release the brakes. If the pressure is less than 16 bar (232 psi), the brakes could remain partially applied, which could damage the brake system.

To disengage the tray motor brakes, the IOLC31 control module sends a 24 V_{DC} output voltage to the brake release solenoid valve, energizing the solenoid. The energized solenoid valve routes hydraulic fluid to the brake piston on each tray motor, releasing the brakes.

To engage the tray motor brakes, the IOLC31 control module sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the tray motor brakes.

FOR REFERENCE ONLY

VPC Counterweight Tray Hydraulic Schematic



Item	Description
1	Hot Oil Shuttle Valve (VPC-MAX only)
2	VPC 1/VPC 2 Diverter Pilot Valve (VPC-MAX only)
3	Pressure Reducing / Relief Valve (set at 21 bar [300 psi])
4	Right VPC Counterweight Tray Motor (55 cc fixed)
5	Left VPC Counterweight Tray Motor (55 cc fixed)
6	Brake Assembly
7	Brake Release Solenoid Valve

FIGURE 10-34

FOR REFERENCE ONLY

VPC Electrical Schematic

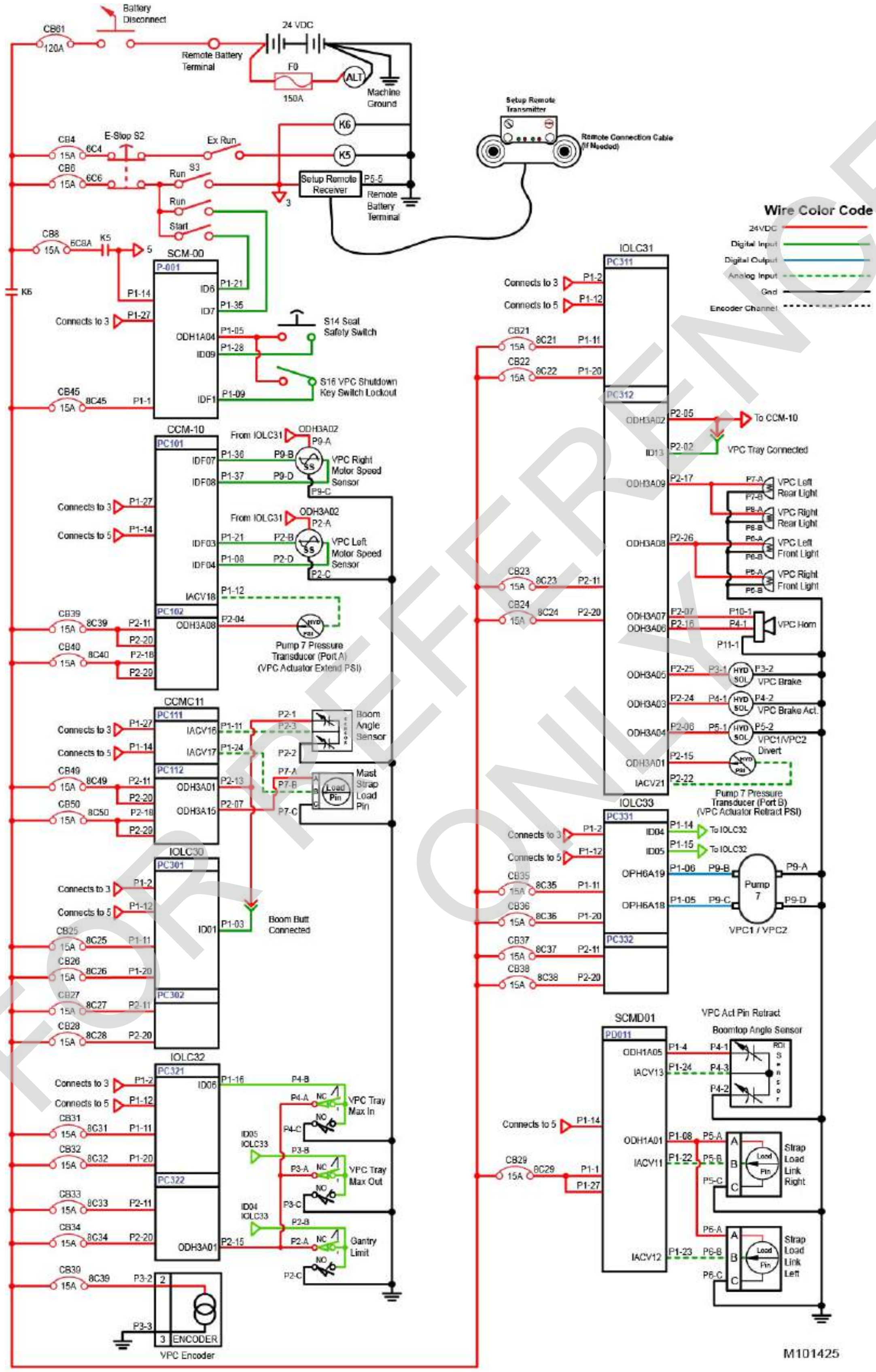


FIGURE 10-35

FOR REFERENCE ONLY

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VPC Counterweight Tray Motor Speed Sensor

Speed Sensor Overview

The VPC counterweight tray is driven by two hydraulic motors. Each motor contains one speed sensor that is mounted in the motor case.

The tray motor speed sensor is a sealed Hall-effect, quad output, high-current, direction and speed sensing sensor with a magnetic pickup.

The sensor senses a target ring that is attached to the rotary group in the motor. The ring's rotation past the sensor generates a measurable voltage that is used to determine the rotational direction and speed of the tray motor.

The sensor sends the rotational speed and direction information to the corresponding control module to be used by the crane control functions.

See Figure 10-36 for the following procedures.

Speed Sensor Weekly Periodic Maintenance

- Check that all the speed sensor assembly parts, wiring, and connections are secure and undamaged.
- Operate the drives to verify that there is a reliable speed readout on the main display. If there is intermittent or no readout, troubleshoot the speed sensor assembly.
- Thoroughly clean the sensor of any accumulated dust and debris.

Speed Sensor Replacement

WARNING

Burn Hazard!

Avoid possible injury. Oil will drain from the port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

NOTE: When removing the speed sensor (1) from a motor, be careful to contain the hydraulic fluid that will drain from the motor.

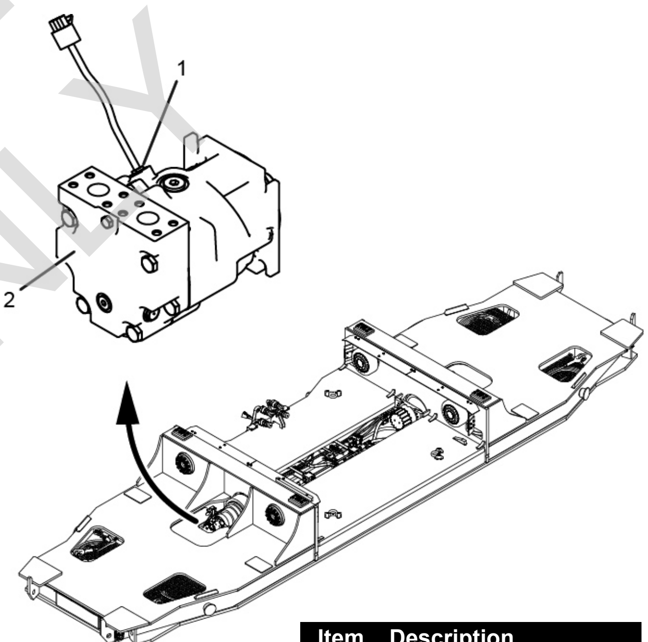
1. Loosen the sensor lock nut with an 1-1/16 inch hex wrench and remove the sensor.
2. Install and adjust the new sensor. See Speed Sensor Adjustment on page 10-47.
3. Before starting the engine, add clean hydraulic oil of the correct type to the motor's top case drain port.

Speed Sensor Adjustment

The speed sensor is set at the factory and should not need adjustment, unless replaced. When installing or adjusting the speed sensor on the motor, it must be set at a specific distance from the target ring on the unit's rotating cylinder.

Adjust the speed sensor as follows.

1. Loosen the sensor lock nut with an 1-1/16 inch hex wrench.
2. Turn the sensor clockwise by hand until the bottom end of the sensor gently touches the motor target ring.
3. Turn the sensor counterclockwise 1/2 turn (180°) to establish the nominal gap of 0,71 mm (0.028 in).
4. Turn the sensor clockwise until the wrench flats on the sensor body are positioned at a 22° angle to the pump shaft centerline.
5. The final sensor position should be between 1/2 turn (180°) and 1/4 turn (90°) counterclockwise from the point where the sensor contacts the target ring.
6. Hold the sensor in position with a 1/2 inch hex wrench while tightening the lock nut to 13 Nm (10 ft-lb).



Item	Description
1	Speed Sensor
2	Tray Motor

FIGURE 10-36

FOR REFERENCE ONLY

VPC Counterweight Tray Absolute Encoder

Absolute Encoder Overview

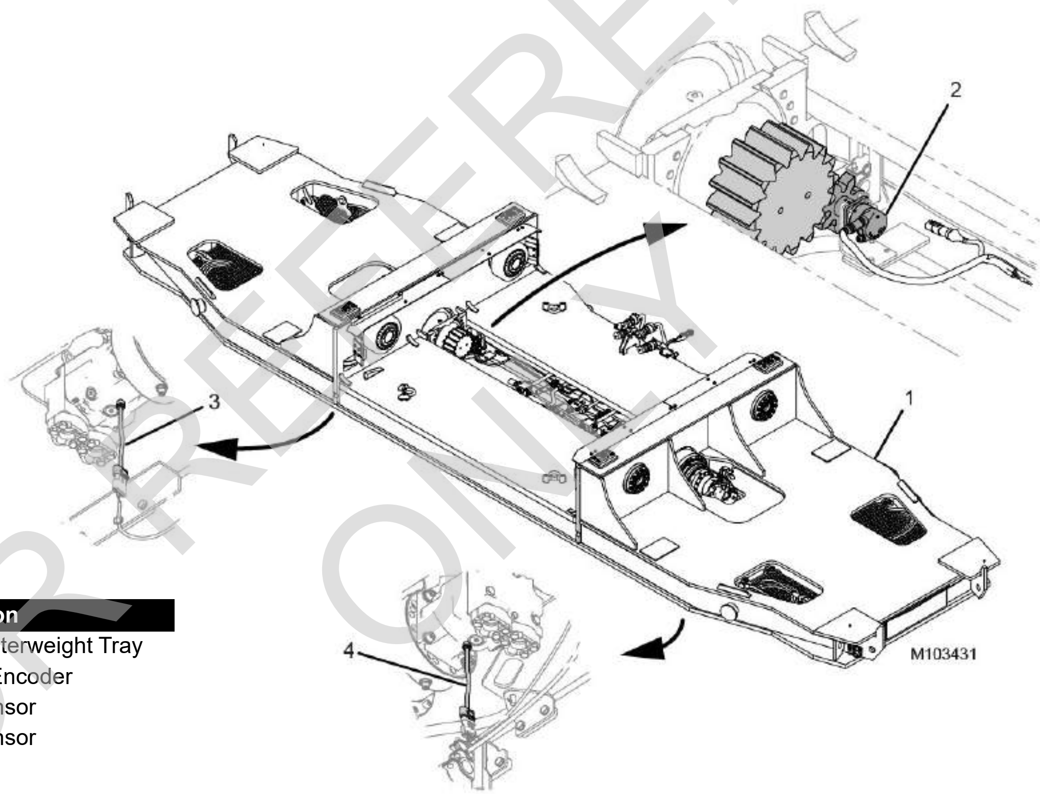
The absolute encoder determines its position using a static reference point. Inside the encoder are two discs, both with concentric rings with offset markers. One of the discs is fixed to the shaft; the other moves freely. As the disc on the shaft turns, the markers along the track of the encoder change position on the fixed disc.

Each configuration along the disc of an absolute encoder represents a unique binary code. When a program looks at the binary code, it determines the absolute position of the tray. The relationship between the encoder value and the physical position of the tray is set at assembly. The system does not need to return to a calibration point to maintain position accuracy.

Absolute Encoder Backlash Adjustment

1. Loosen the encoder mounting capscrews. Position the encoder so that it is tightly meshed with the pinion gear. Do not apply radial load to the encoder shaft.
2. Slide the encoder mounting bracket back approximately 1,5 mm (0.06 in).

   This will create approximately 1,1 mm (0.04 in) of backlash.
3. Tighten the mounting capscrews.



Item	Description
1	VPC Counterweight Tray
2	Absolute Encoder
3	Speed Sensor
4	Speed Sensor

FIGURE 10-37

FOR REFERENCE ONLY

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VPC Counterweight Tray Limit Switches

Forward Limit Switch Adjustment

See Figure 10-38 for the following.

The forward limit switch (4) is used to stop the tray before it reaches the forward physical stop (5).

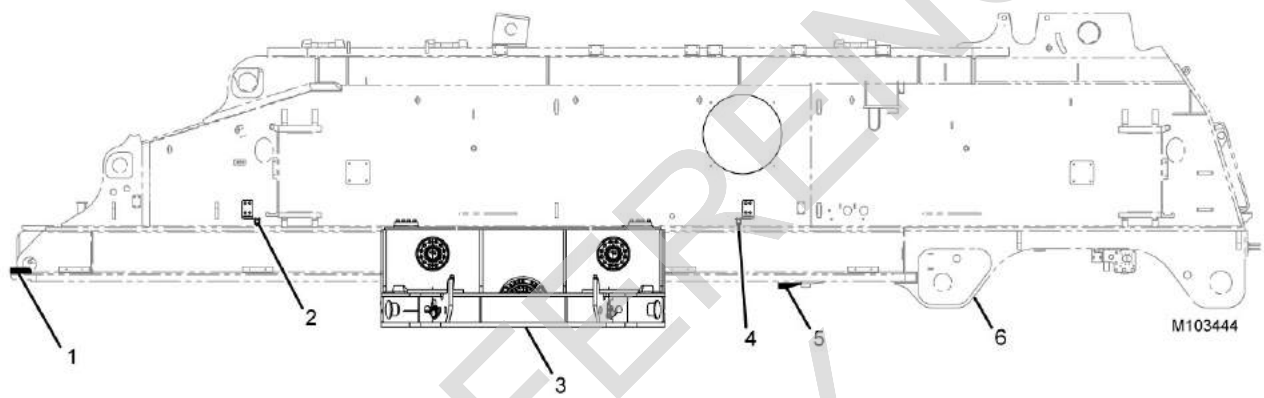
Adjust the forward limit switch position so that it will trip when there is 408 mm (16.1 in) between the physical stop on the VPC counterweight tray (3) and the physical stop on the rotating bed (6).

Rear Limit Switch Adjustment

See Figure 10-38 for the following.

The rear limit switch (2) is used to stop the VPC counterweight tray (3) before it reaches the rear physical stop (1).

With the rear stop installed, adjust the rear limit switch so that it trips when the counterweight tray is 596 mm (23.5 in) away from the rear physical stop.



Item	Description
1	Rear Physical Stop
2	Rear Limit Switch
3	VPC Counterweight Tray
4	Forward Limit Switch
5	Forward Physical Stop
6	Rotating Bed

FIGURE 10-38

FOR REFERENCE ONLY

VPC Counterweight Tray Roller Backlash Adjustment

Check backlash every 2000 hours of operation or annually (whichever comes first) and each time tray components are replaced.

Check backlash when the tray is installed on the crane or on the VPC-MAX beam with ZERO counterweight (all boxes removed).

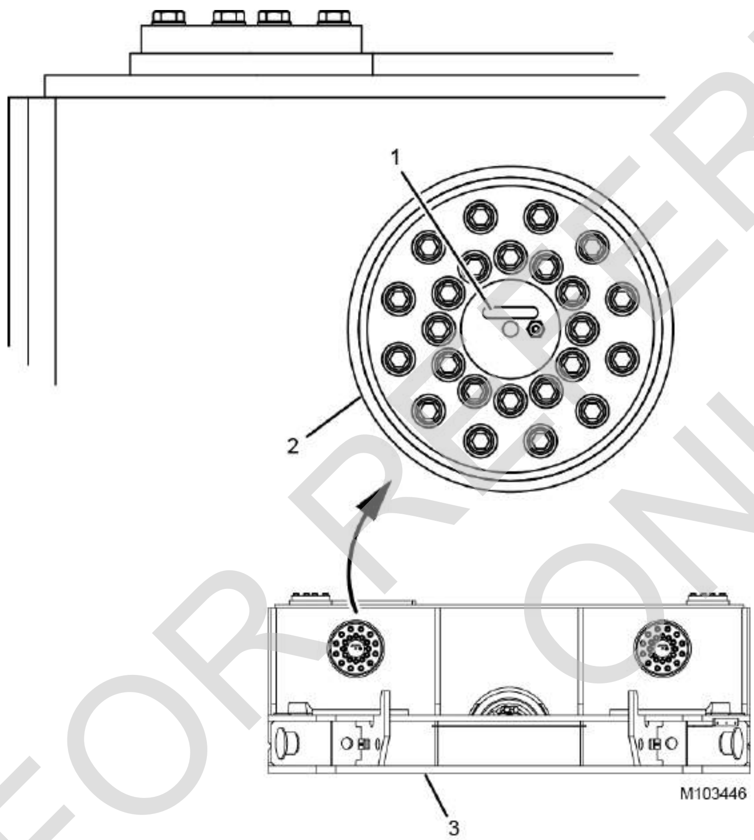
See Figure 10-39 for the following.

Initially position the roller assembly so that the slot (1) is horizontal and above the roller axis .

The shaft of the roller assembly has 2 mm (0.08 in) of eccentricity. It is possible to adjust the rack and pinion backlash by rotating the shaft in the bore.

See Table 10-1 for the permissible front and rear adjustment combinations and resulting change in backlash.

- The desired backlash is 1,0 mm ± 0,4 mm (0.039 in ± 0.016 in)
- To decrease backlash, rotate the shaft counter-clockwise.
- To increase backlash, rotate the shaft clockwise and a corresponding increase in backlash will result.
- Adjust equally side to side.



Item	Description
1	Slot
2	Roller Assembly
3	VPC Counterweight Tray

FIGURE 10-39

FOR REFERENCE ONLY

Table 10-1. Shaft Angle / Decrease in Backlash

Front Shaft Rotation Angle CCW	Rear Shaft Rotation Angle CCW	Resulting Decrease in Backlash
0°	0°	0 Initial Position
0°	30°	0,42 mm (0.02 in)
30°	30°	0,85 mm (0.03 in)
30°	60°	1,15 mm (0.05 in)
60°	60°	1,46 mm (0.057 in)
60°	90°	1,58 mm (0.06 in)
90°	90°	1,69 mm (0.07 in)

Live Mast Limit Switch Adjustment

Adjust the live mast limit switch (2, Figure 10-40) to be tripped when the live mast is down in the shipping position.

Gantry Limit Switch Adjustment

Adjust the gantry limit switch (1, Figure 10-40) to trip as the gantry comes down to the shipping position. When the gantry is in the working position, the limit switch is closed.

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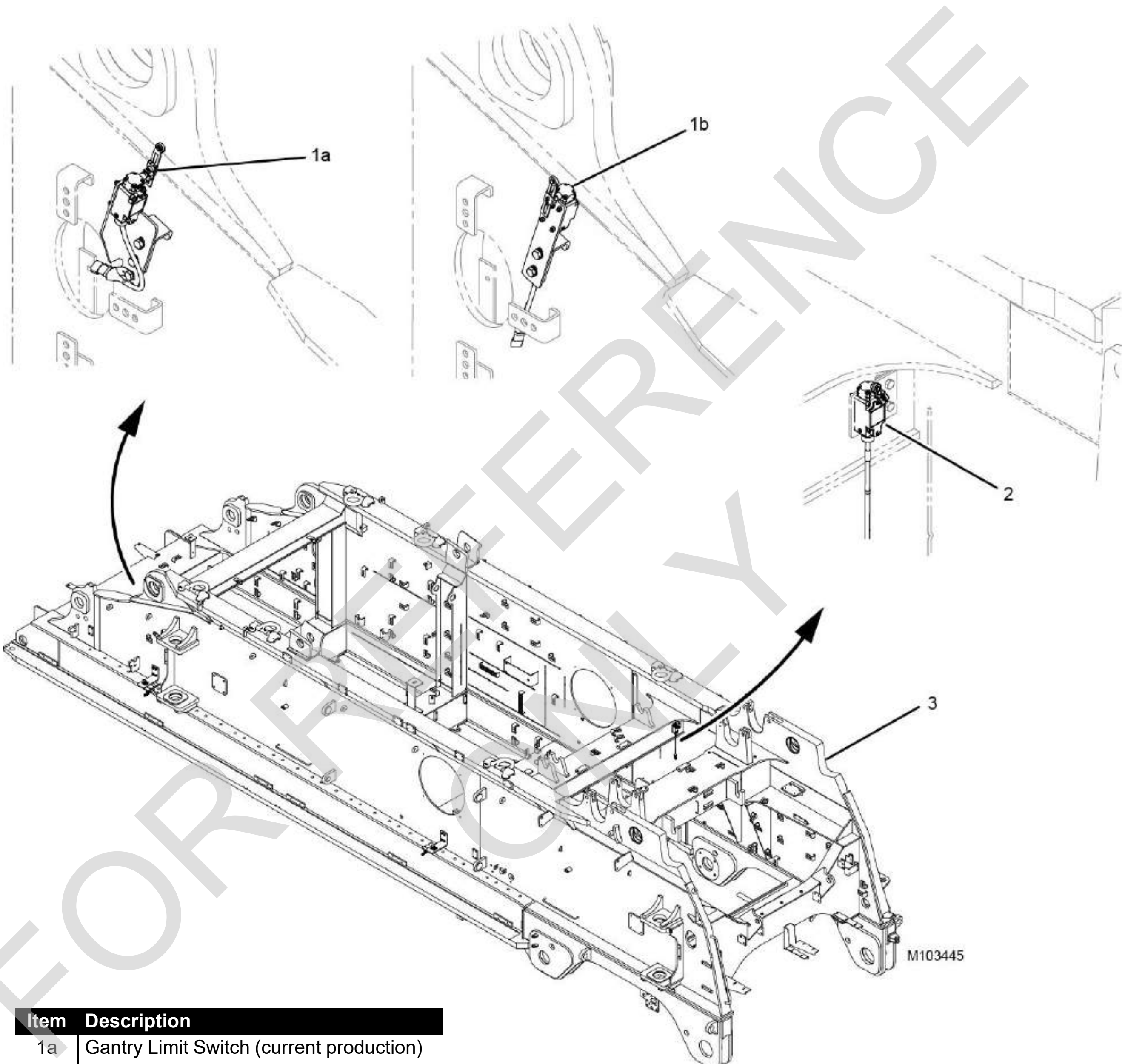

FOR REFERENCE ONLY

Item	Description
1a	Gantry Limit Switch (current production)
1b	Gantry Limit Switch (past production)
2	Live Mast Limit Switch
3	Rotating Bed

FIGURE 10-40

VPC-MAX Trolley Operation

The VPC-MAX trolley is attached to the VPC-MAX beam by two hydraulically actuated pins controlled by the setup remote. When pinned they move as one unit.

The VPC-MAX trolley movement is controlled by the following methods:

- On-board computer control
- Setup remote

See Figure 10-41 for an illustration of the VPC-MAX trolley and beam.

See Figure 10-42 for the hydraulic schematic of the VPC-MAX trolley motor circuit.

See Figure 10-43 for the electrical schematic of the VPC-MAX trolley motor circuit.

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

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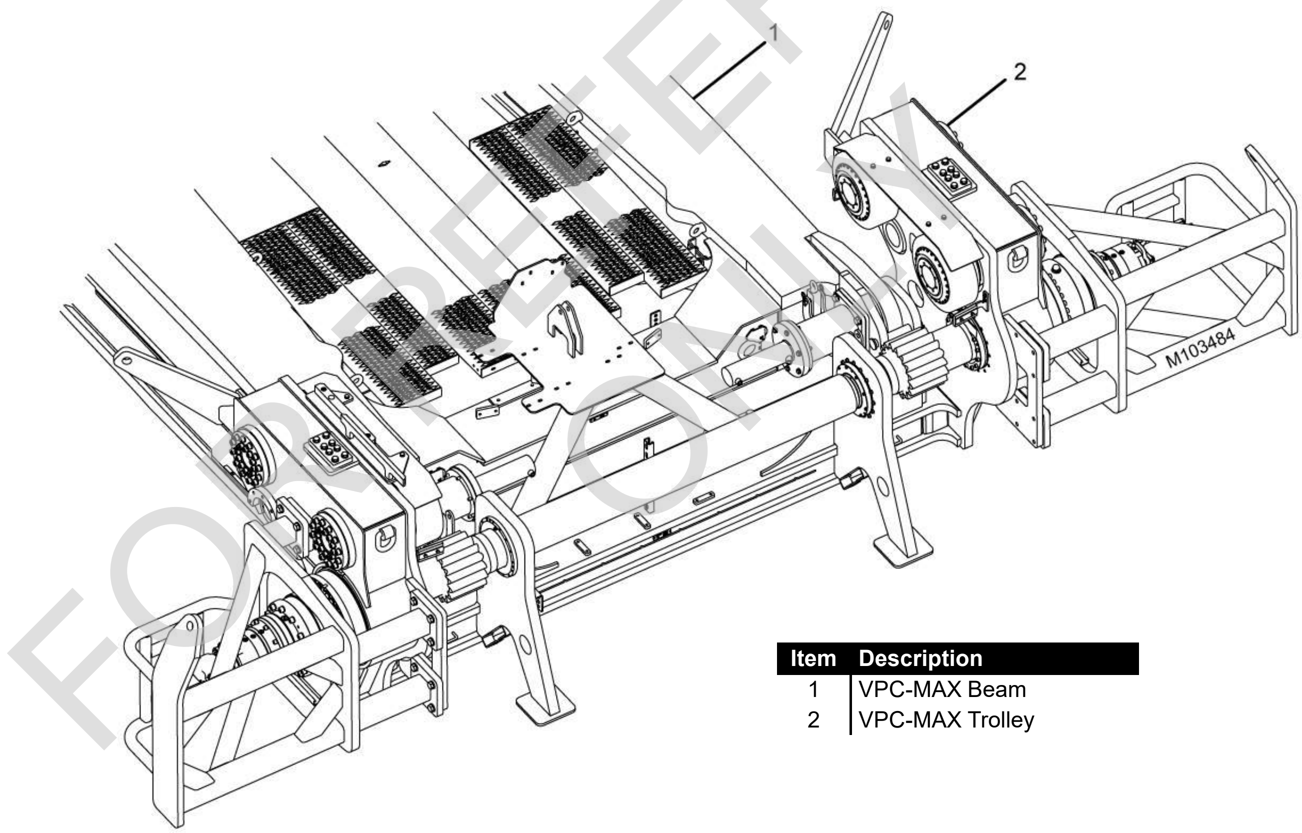


Item	Description
1	VPC-MAX Beam
2	VPC-MAX Trolley

FIGURE 10-41

Trolley Extension

See Figure 10-42 for the following.

When the CCM-10 control module receives an extend trolley command (either from the setup remote or from the on-board computer control), the CCM-10 control module energizes the VPC 1/VPC 2 diverter solenoid valve (6), located in the VPC-MAX actuator valve (5). When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the VPC 1/VPC 2 diverter pilot valve (9). The diverter pilot valve shifts to the VPC 2 position, allowing hydraulic fluid from pump 7 to flow to the left and right VPC-MAX trolley motors (2 and 10).

The CCM-10 control module also sends a command to the IOLC33 control module to begin ramping up the pulse width modulation (PWM) duty cycle to the B-side solenoid of the pump 7 electronic displacement control (EDC).

At the same time, the CCM-10 control module sends a command to the IOLC31 control module to disengage the trolley motor brakes. The IOLC31 control module then sends 24 V_{DC} output voltage to the brake release solenoid valve (7), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid from the accessory pump 9 to the trolley motor brakes, releasing the brakes.

When movement of the trolley is detected, the VPC warning lights illuminate and the VPC alarm activates.

Increasing the PWM duty cycle increases the pump swashplate angle, which increases the flow from the B-side of the pump to the B-side of the right trolley motor and the A-side of the left trolley motor.

The trolley motor speed sensors and pump 7 (port B) pressure transducer (VPC actuator extend psi) provide the closed loop feedback. The control algorithm uses this feedback to adjust the pump flow while ramping up to and maintaining the trolley motor speed, which maintains the extension speed of the VPC-MAX beam.

When the CCM-10 receives a stop trolley command, the CCM-10 control module sends a command to the IOLC31 control module to engage the brakes. The IOLC31 control module then sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the tray motor brakes.

At the same time, the CCM-10 sends a signal to the IOLC33 control module to ramp down the PWM duty cycle to the pump 7 EDC, stopping all flow to the trolley motors. When the trolley movement has stopped, the VPC warning lights and alarms are deactivated.

Trolley Retraction

See Figure 10-42 for the following.

When the CCM-10 control module receives a retract trolley command (either from the setup remote or from the on-board computer control), the CCM-10 control module energizes the VPC 1/VPC 2 diverter solenoid valve (6), located in the VPC-MAX actuator valve (5). When energized, the solenoid valve routes hydraulic fluid to the pilot controls of the VPC 1/VPC 2 diverter pilot valve (9). The diverter pilot valve shifts to the VPC 2 position, allowing hydraulic fluid from pump 7 to flow to the left and right VPC-MAX trolley motors (2 and 10).

The CCM-10 control module also sends a command to the IOLC33 control module to begin ramping up the PWM duty cycle to the A-side solenoid of the pump 7 EDC.

At the same time, the CCM-10 control module sends a command to the IOLC31 control module to disengage the trolley motor brakes. The IOLC31 control module then sends 24 V_{DC} output voltage to the brake release solenoid valve (7), energizing the solenoid. The solenoid valve shifts position, routing hydraulic fluid from the accessory pump 9 to the trolley motor brakes, releasing the brakes.

When movement of the trolley is detected, the VPC warning lights illuminate and the VPC alarm activates.

Increasing the PWM duty cycle increases the pump swashplate angle, which increases the flow from the A-side of the pump to the A-side of the right trolley motor and the B-side of the left trolley motor.

The trolley motor speed sensors and pump 7 (port A) pressure transducer (VPC actuator retract psi) provide the closed loop feedback. The control algorithm uses this feedback to adjust the pump flow while ramping up to and maintaining the trolley motor speed, which maintains the retraction speed of the VPC-MAX beam.

When the CCM-10 receives a stop trolley command, the CCM-10 control module sends a command to the IOLC31 control module to engage the brakes. The IOLC31 control module then sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the tray motor brakes.

At the same time, the CCM-10 sends a signal to the IOLC33 control module to ramp down the PWM duty cycle to the pump 7 EDC, stopping all flow to the trolley motors. When the trolley movement has stopped, the VPC warning lights and alarms are deactivated.

FOR REFERENCE ONLY

Trolley Motor Brakes

See Figure 10-42 for the following.

The VPC trolley motor brakes are a spring-applied, hydraulically released brake system. Each of the trolley motors (2 and 10) have an attached brake assembly (11) that is disengaged when the control system energizes the brake release solenoid valve (7), located in the VPC-MAX actuator valve (5). If the brake hydraulic pressure or electrical control is lost, the brakes are applied by spring force.

The trolley motor brake release system uses hydraulic fluid supplied by the accessory pump 9 and pressure from the VPC pump 7. The brake release pressure must be at least 14.6 bar (212 psi) to fully release the brakes. If the pressure is less than 14.6 bar (212 psi), the brakes could remain partially applied, which could damage the brake system.

To disengage the trolley motor brakes, the IOLC31 control module sends a 24 V_{DC} output voltage to the brake release solenoid valve, energizing the solenoid. The energized solenoid valve routes hydraulic fluid to the brake cylinder on each trolley motor, releasing the brakes.

To engage the trolley motor brakes, the IOLC31 control module sends a 0 V_{DC} output voltage to the brake release solenoid valve, de-energizing the solenoid. The de-energized solenoid causes the solenoid valve to return to the default position, allowing the hydraulic fluid in the brake cylinders to flow through the brake release solenoid valve, then back to the tank. The reduced hydraulic pressure allows spring force to apply the trolley motor brakes.

VPC-MAX Trolley Pin Pullers

Extend Trolley Pin Pullers Using Setup Remote

See Figure 10-42 for the following.

When a command to extend the VPC-MAX trolley pin puller cylinders is initiated on the setup remote, the CCM-10 control module sends the command to the IOLC35 control module. The IOLC35 control module then sends a 24 V_{DC} output voltage to the pin pullers extend solenoid (4), energizing the solenoid. The energized solenoid valve routes hydraulic fluid from the accessory pump to the piston end of the trolley pin puller cylinders (1). At the same time, hydraulic fluid in the rod end of the cylinders is forced out and back to the tank. This causes the rod to extend, engaging the pins.

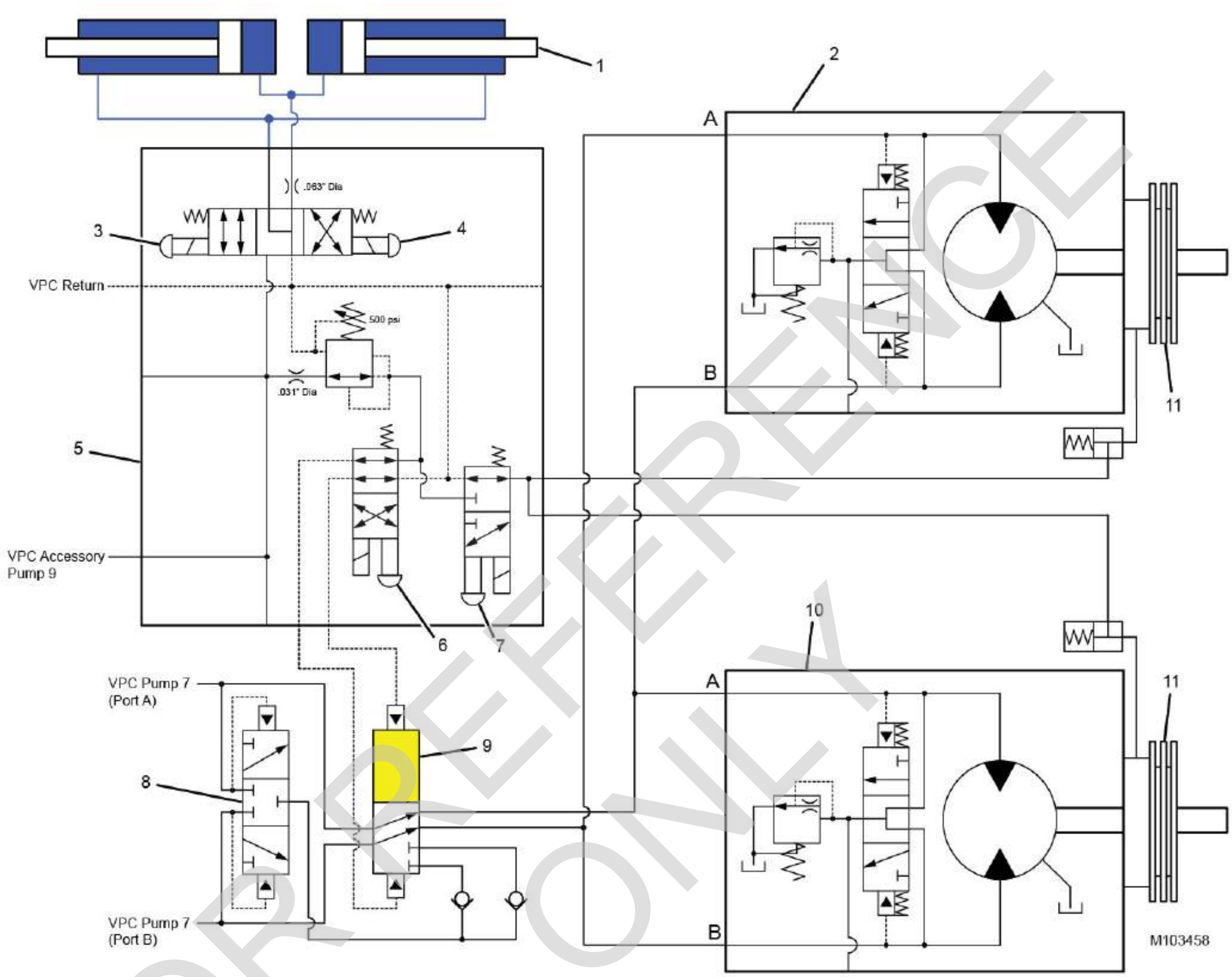
Retract Trolley Pin Pullers Using Setup Remote

See Figure 10-42 for the following.

When a command to retract the VPC-MAX trolley pin puller cylinders is initiated on the setup remote, the CCM-10 control module sends the command to the IOLC35 control module. The IOLC35 control module then sends a 24 V_{DC} output voltage to the pin pullers retract solenoid (3), energizing the solenoid. The energized solenoid valve routes hydraulic fluid from the accessory pump to the rod end of the trolley pin puller cylinders (1). At the same time, hydraulic fluid in the piston end of the cylinders is forced out and back to the tank. This causes the rod to retract, disengaging the pins.

FOR REFERENCE ONLY

VPC-MAX Trolley Hydraulic Schematic



Item	Description
1	Trolley Pin Puller Cylinder (qty 2)
2	Left Trolley Motor (100 cc fixed)
3	Pin Pullers Retract Solenoid
4	Pin Pullers Extend Solenoid
5	VPC-MAX Actuator Valve
6	VPC 1/VPC 2 Diverter Solenoid Valve
7	Brake Release Solenoid Valve
8	Hot Oil Shuttle Valve
9	VPC 1/VPC 2 Diverter Pilot Valve
10	Right Trolley Motor (100 cc fixed)
11	Brake Assembly (qty 2)

FIGURE 10-42

FOR REFERENCE ONLY

VPC-MAX Trolley Electrical Schematic

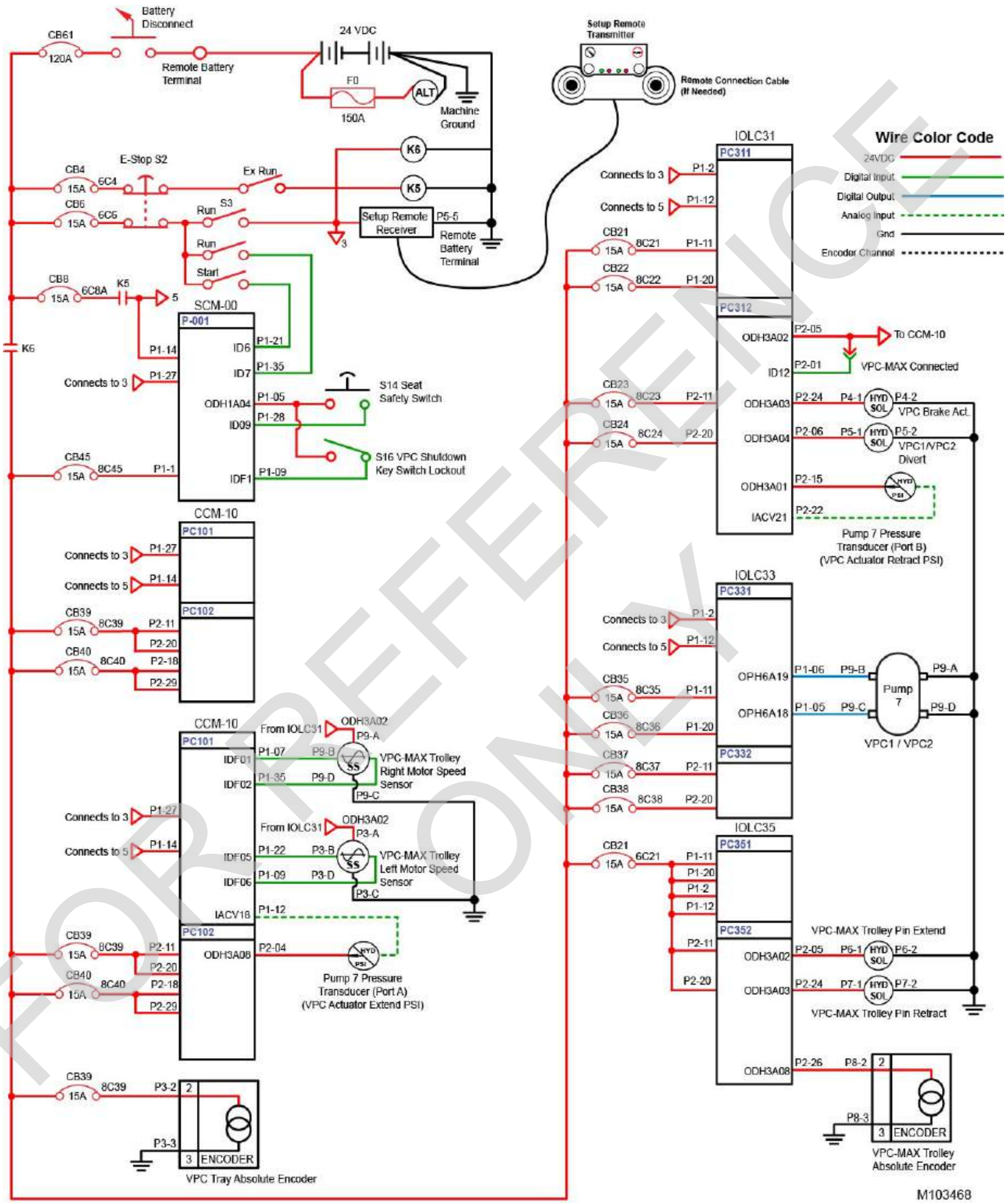


FIGURE 10-43

FOR REFERENCE ONLY

VPC-MAX Trolley Motor Speed Sensor

Speed Sensor Overview

The VPC-MAX trolley is driven by two hydraulic motors. Each motor contains one speed sensor that is mounted in the motor case.

The trolley motor speed sensor is a sealed Hall-effect, quad output, high-current, direction and speed sensing sensor with a magnetic pickup.

The sensor senses a target ring that is attached to the rotating cylinder in the motor. The ring's rotation past the sensor generates a measurable voltage that is used to determine the rotational direction and speed of the trolley motor.

The sensor sends the rotational speed and direction information to the corresponding control module to be used by the crane control functions.

See Figure 10-44 for the following procedures.

Speed Sensor Weekly Periodic Maintenance

- Check that all the speed sensor assembly parts, wiring, and connections are secure and undamaged.
- Operate the drives to verify that there is a reliable speed readout on the main display. If there is intermittent or no readout, troubleshoot the speed sensor assembly.
- Thoroughly clean the sensor of any accumulated dust and debris.

Speed Sensor Replacement

WARNING

Burn Hazard!

Avoid possible injury. Oil will drain from the port when the sensor is removed. Wait for the hydraulic oil to cool before removing the sensor.

NOTE: When removing the speed sensor (1) from a motor, be careful to contain the hydraulic fluid that will drain from the motor.

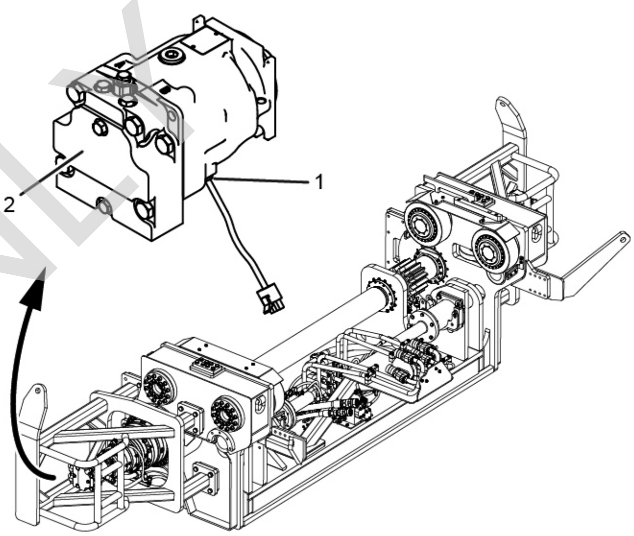
1. Loosen the sensor lock nut with an 1-1/16 inch hex wrench and remove the sensor.
2. Install and adjust the new sensor. See Speed Sensor Adjustment on page 10-57.
3. Before starting the engine, add clean hydraulic oil of the correct type to the motor's top case drain port.

Speed Sensor Adjustment

The speed sensor is set at the factory and should not need adjustment, unless replaced. When installing or adjusting the speed sensor on the motor, it must be set at a specific distance from the target ring on the unit's rotating cylinder.

Adjust the speed sensor as follows.

1. Loosen the sensor lock nut with an 1-1/16 inch hex wrench.
2. Turn the sensor clockwise by hand until it contacts the target ring.
3. Turn the sensor counterclockwise 1/2 turn (180°) to establish the nominal gap of 0,71 mm (0.028 in).
4. Turn the sensor clockwise until the wrench flats on the sensor body are positioned at a 22° angle to the pump shaft centerline.
5. The final sensor position should be between 1/2 turn (180°) and 1/4 turn (90°) counterclockwise from the point where the sensor contacts the target ring.
6. Hold the sensor in position with a 1/2 inch hex wrench while tightening the lock nut to 13 Nm (10 ft-lb).



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Item	Description
1	Speed Sensor
2	Trolley Motor

FIGURE 10-44

FOR REFERENCE ONLY

VPC-MAX Trolley Absolute Encoder

Absolute Encoder Overview

The absolute encoder determines its position using a static reference point. Inside the encoder are two discs, both with concentric rings with offset markers. One of the discs is fixed to the shaft; the other moves freely. As the disc on the shaft turns, the markers along the track of the encoder change position on the fixed disc.

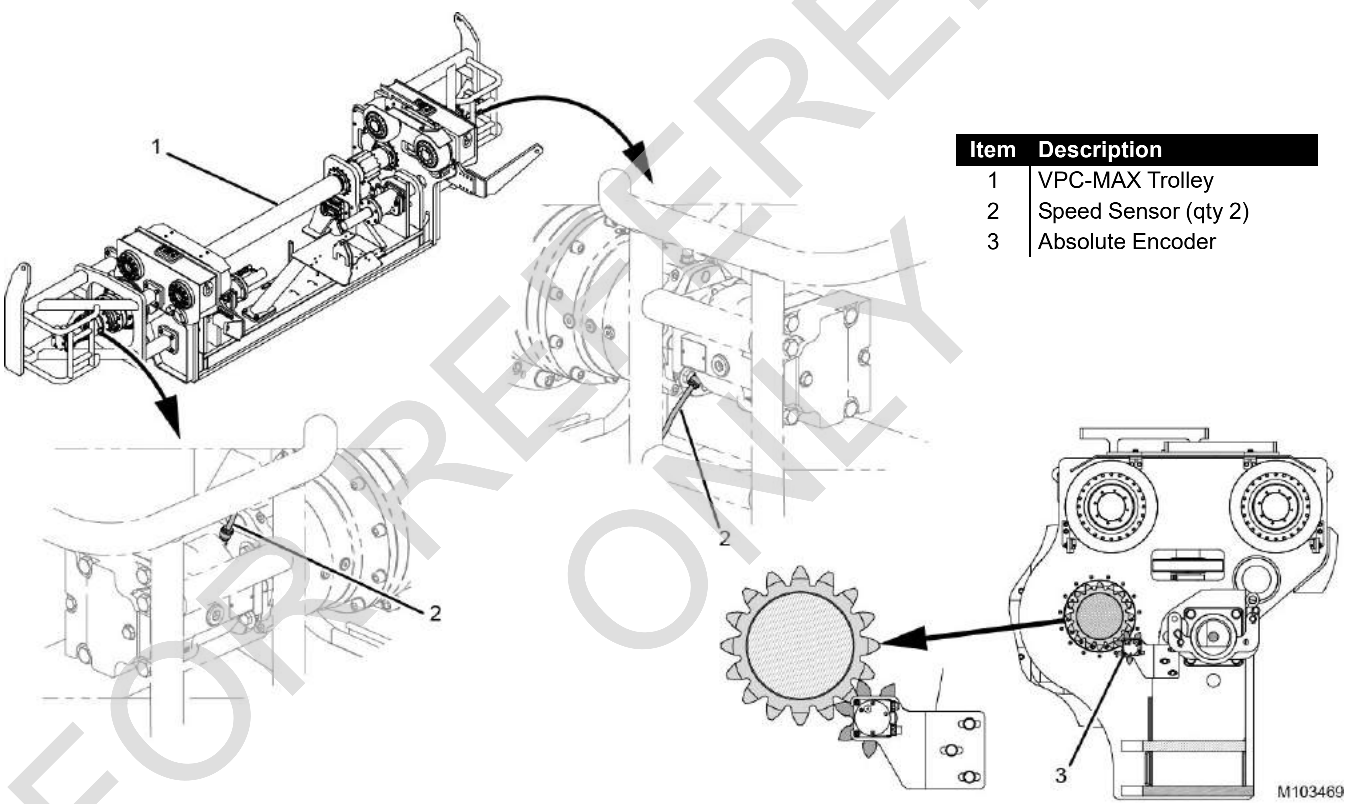
Each configuration along the disc of an absolute encoder represents a unique binary code. When a program looks at the binary code, it determines the absolute position of the VPC-MAX trolley.The relationship between the encoder value and the physical position of the trolley is set at assembly. The system does not need to return to a calibration point to maintain position accuracy.

Absolute Encoder Backlash Adjustment

See Figure 10-45 for the following procedures.

1. Loosen the encoder mounting capscrews. Position the encoder so that it is tightly meshed with the pinion gear. (Do not apply radial load to the encoder shaft).
2. Slide the encoder mounting bracket back approximately 1,5 mm (0.06 in).

   This will create approximately 1,1 mm (0.04 in) of backlash.
3. Tighten the encoder mounting capscrews.



Item	Description
1	VPC-MAX Trolley
2	Speed Sensor (qty 2)
3	Absolute Encoder

FIGURE 10-45

FOR REFERENCE ONLY

VPC-MAX Trolley Roller Backlash Adjustment

Check backlash every 2000 hours of operation or annually (whichever comes first) and each time trolley components are replaced.

Check backlash when the trolley is installed on the crane. The VPC-MAX beam can be either removed or installed with ZERO counterweight (all boxes removed).

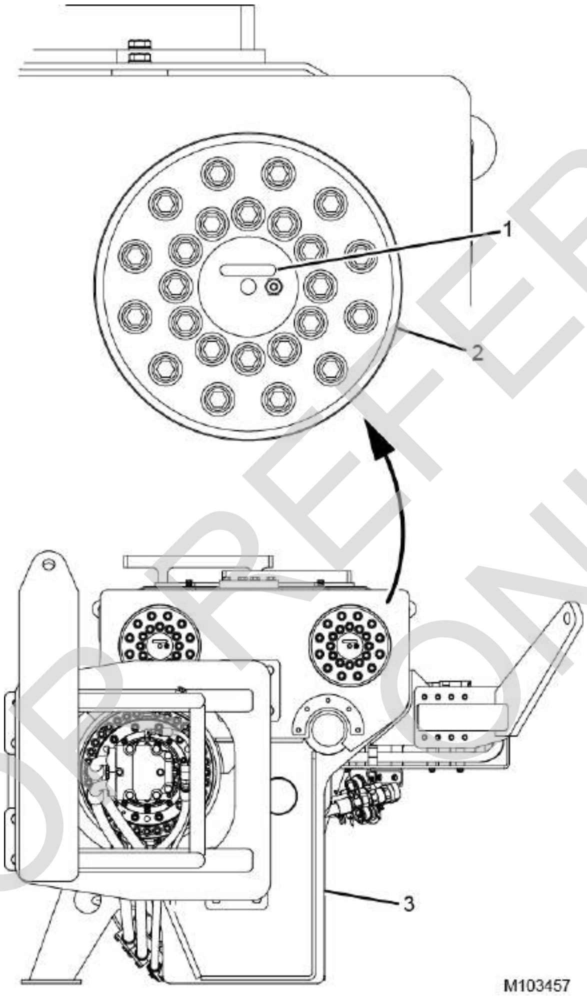
See Figure 10-46 for following.

Initially position the roller assembly so that the slot is horizontal and above the roller axis.

The shaft of the roller assembly has 2 mm (0.08 in) of eccentricity. It is possible to adjust the rack and pinion backlash by rotating the shaft in the bore.

See Table 10-2 for the permissible front and rear adjustment combinations and resulting change in backlash.

- The desired backlash is 0,9 mm ± 0,5 mm (0.035 in ± 0.020 in)
- To decrease backlash, rotate the shaft counter-clockwise.
- To increase backlash, rotate the shaft clockwise.
- Adjust equally side to side.



Item	Description
1	Slot
2	Roller Assembly
3	VPC-MAX Trolley

FIGURE 10-46

FOR REFERENCE ONLY

Table 10-2. Shaft Angle / Decrease in Backlash

Front Shaft Rotation Angle CCW	Rear Shaft Rotation Angle CCW	Resulting Decrease in Backlash
0°	0°	0 Initial Position
30°	30°	0,85 mm (0.03 in)
60°	60°	1,46 mm (0.057 in)
90°	90°	1,69 mm (0.07 in)

VPC-MAX Beam Pin Pullers

The VPC-MAX frame assembly auxiliary member attaches to the VPC-MAX beam assembly using four hydraulically actuated pins. The pin cylinders are controlled by the setup remote.

See Figure 10-47 for an illustration of the VPC-MAX beam pin pullers shown retracted.

See Figure 10-48 for an illustration of the frame assembly auxiliary member connected to the VPC-MAX beam assembly.

See Figure 10-49 for the hydraulic schematic of the VPC-MAX beam pin pullers circuit.

See Figure 10-50 for the electrical schematic of the VPC-MAX beam pin pullers circuit.

Setup Remote Overview

NOTE: The setup remote is covered in Section 4 of the Operator Manual.

The setup remote control communicates with the CCM-10 control module using the controller area network bus (CAN Bus). The crane control modules use the CAN Bus to communicate with each other.

Neutral Position Using Setup Remote

See Figure 10-49 for the following.

When the setup remote is not sending a command, the upper and lower pin puller valve spools (3 and 4) are held in the neutral position by the return springs. When in neutral, the valve spools connect both the piston end and rod end of the upper and lower pin puller cylinders (1 and 2) to the tank.

Extend Pin Puller Cylinders Using Setup Remote

See Figure 10-49 for the following.

When a command to extend the VPC-MAX beam pin puller cylinders is initiated on the setup remote, the CCM-10 control module sends the command to the IOLC35 control module. The IOLC35 control module then sends a 24 V_{DC} output voltage to the upper and lower pin puller extend solenoids (5 and 6), energizing the solenoids.

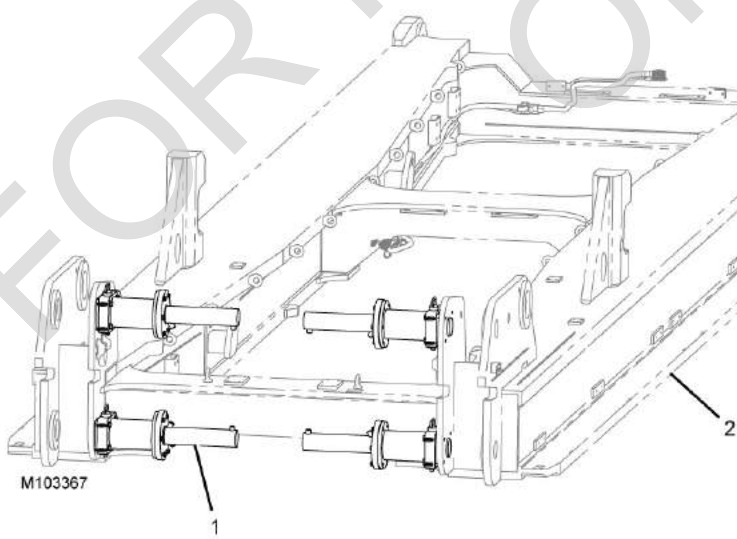
The energized solenoids route hydraulic fluid from the accessory pump to the piston end of the upper and lower pin puller cylinders (1 and 2). At the same time, hydraulic fluid in the rod end of the cylinders is forced out and back to the tank. This causes the rods to extend, engaging the pins.

Retract Pin Puller Cylinders Using Setup Remote

See Figure 10-49 for the following.

When a command to retract the VPC-MAX beam pin puller cylinders is initiated on the setup remote, the CCM-10 control module sends the command to the IOLC35 control module. The IOLC35 control module then sends a 24 V_{DC} output voltage to the upper and lower pin puller retract solenoids (7 and 8), energizing the solenoids.

The energized solenoids route hydraulic fluid from the accessory pump to the rod end of the upper and lower pin puller cylinders (1 and 2). At the same time, hydraulic fluid in the piston end of the cylinders is forced out and back to the tank. This causes the rods to retract, disengaging the pins.

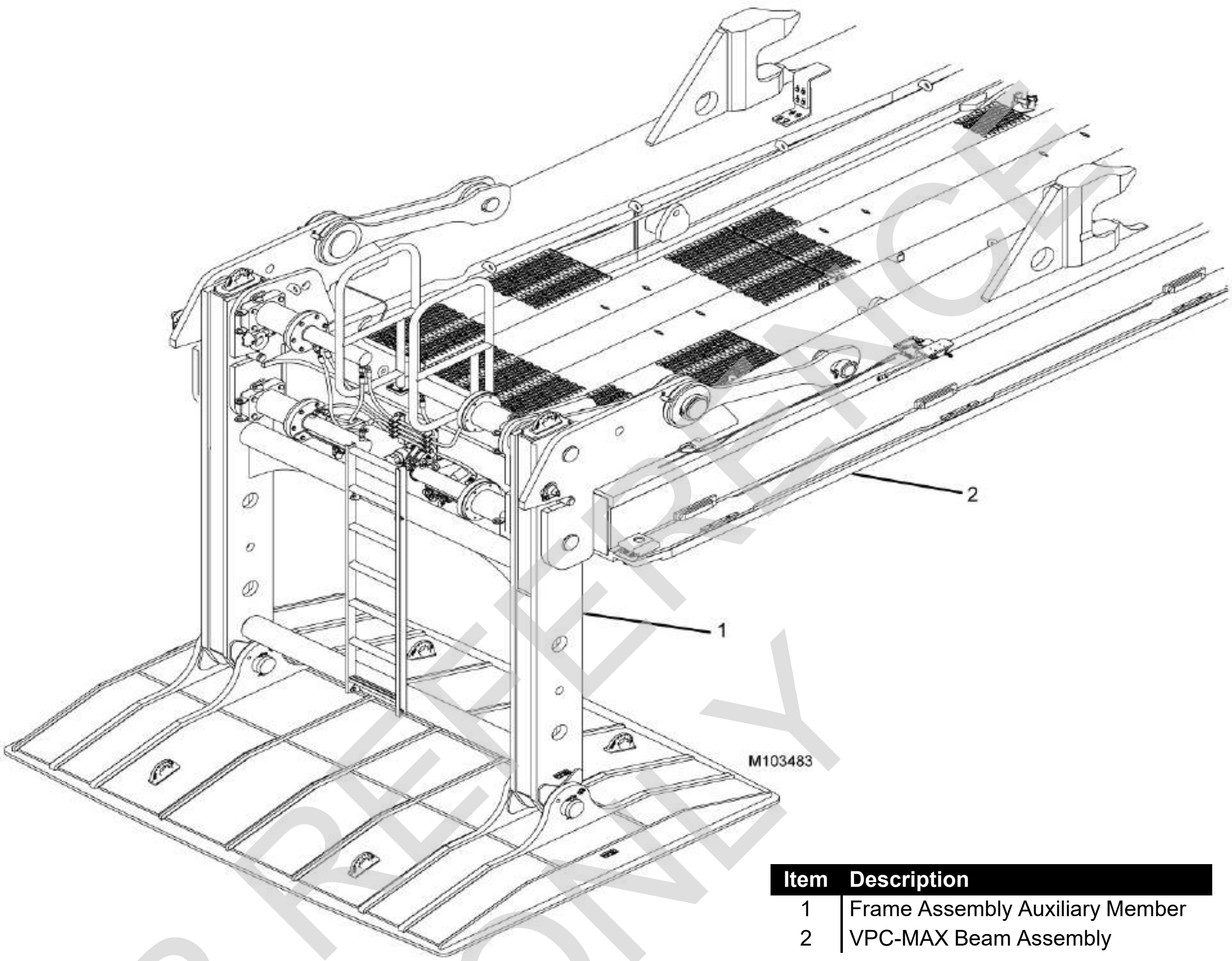


Item	Description
1	VPC-MAX Beam Pin Puller Cylinder (qty 4)
2	VPC-MAX Beam Assembly

FIGURE 10-47

FOR REFERENCE ONLY

VPC-MAX Frame Assembly Auxiliary Member to VPC-MAX Beam Assembly

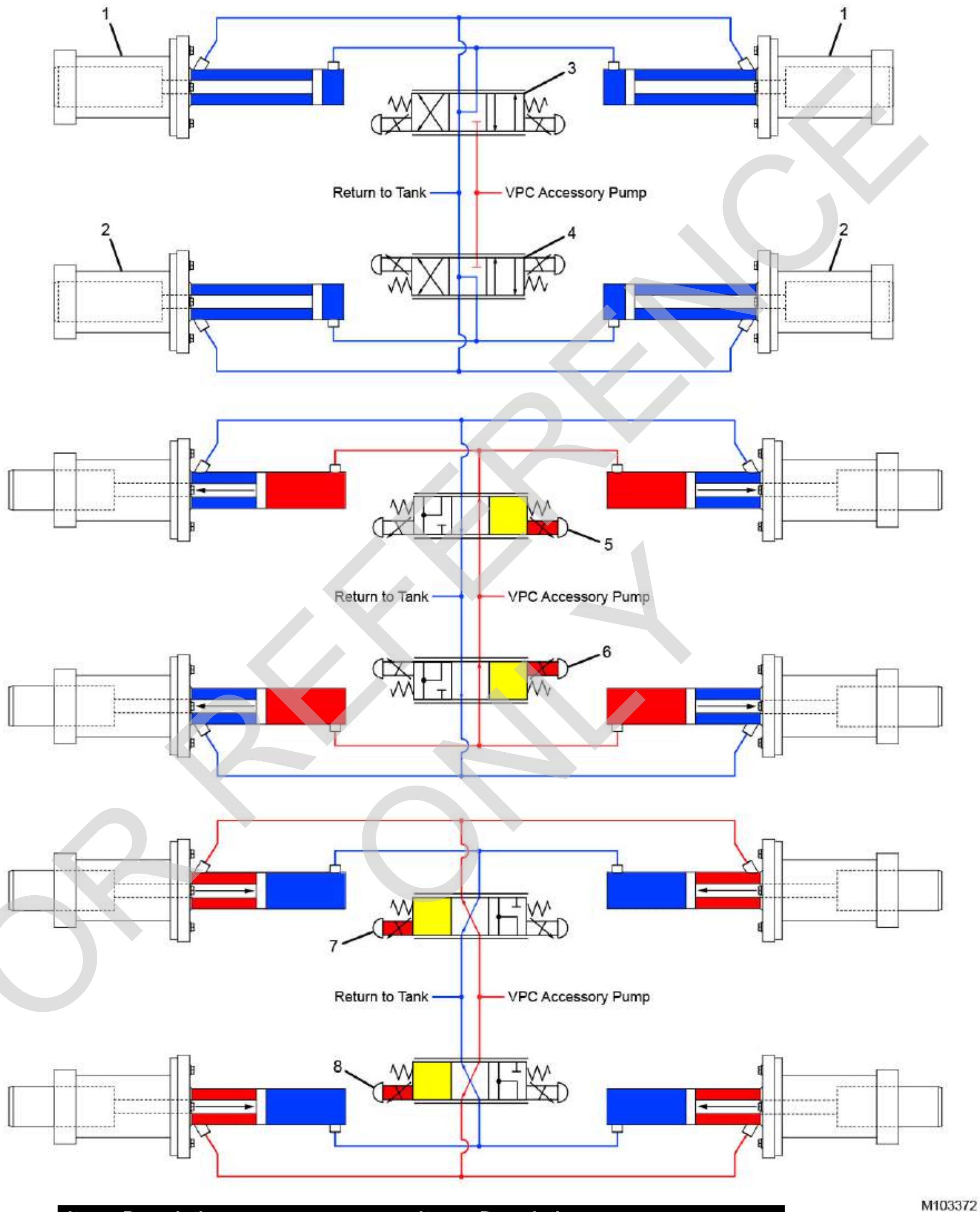


Item	Description
1	Frame Assembly Auxiliary Member
2	VPC-MAX Beam Assembly

FIGURE 10-48

FOR REFERENCE ONLY

VPC-MAX Beam Pin Puller Hydraulic Schematic

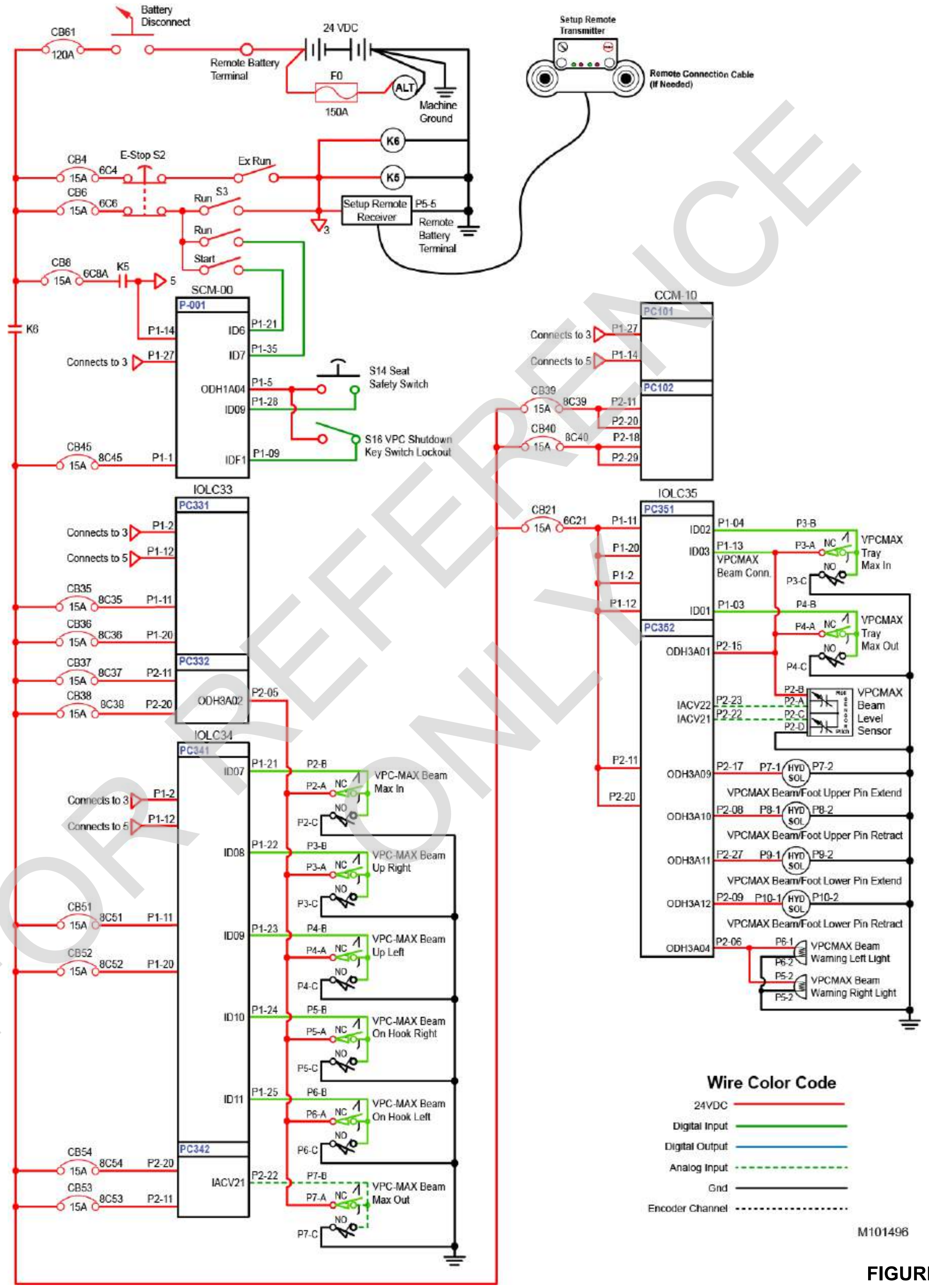


Item	Description	Item	Description
1	Upper Pin Puller Cylinder (qty 2)	5	Upper Pin Puller Extend Solenoid
2	Lower Pin Puller Cylinder (qty 2)	6	Lower Pin Puller Extend Solenoid
3	Upper Pin Puller Valve Spool	7	Upper Pin Puller Retract Solenoid
4	Lower Pin Puller Valve Spool	8	Lower Pin Puller Retract Solenoid

FIGURE 10-49

FOR REFERENCE ONLY

VPC-MAX Beam Electrical Schematic



FOR REFERENCE ONLY

FIGURE 10-50

VPC-MAX Beam Switch Adjustments

The VPC-MAX beam maximum tray in and maximum tray out switches require adjustment.

Maximum Tray In Switch Adjustment

See Figure 10-51 for the following.

Adjust the forward limit switch position so that it will trip the limit switch when the counterweight tray reaches a position that is 409 mm (16.1 in) away from the forward physical stop.

Maximum Tray Out Switch Adjustment

See Figure 10-51 for the following.

Adjust the rear limit switch position so that it will trip the limit switch when the counterweight tray reaches a position that is 466 mm (18.3 in) away from the rear physical stop and 6327 mm (249.1 in) away from the forward physical stop.

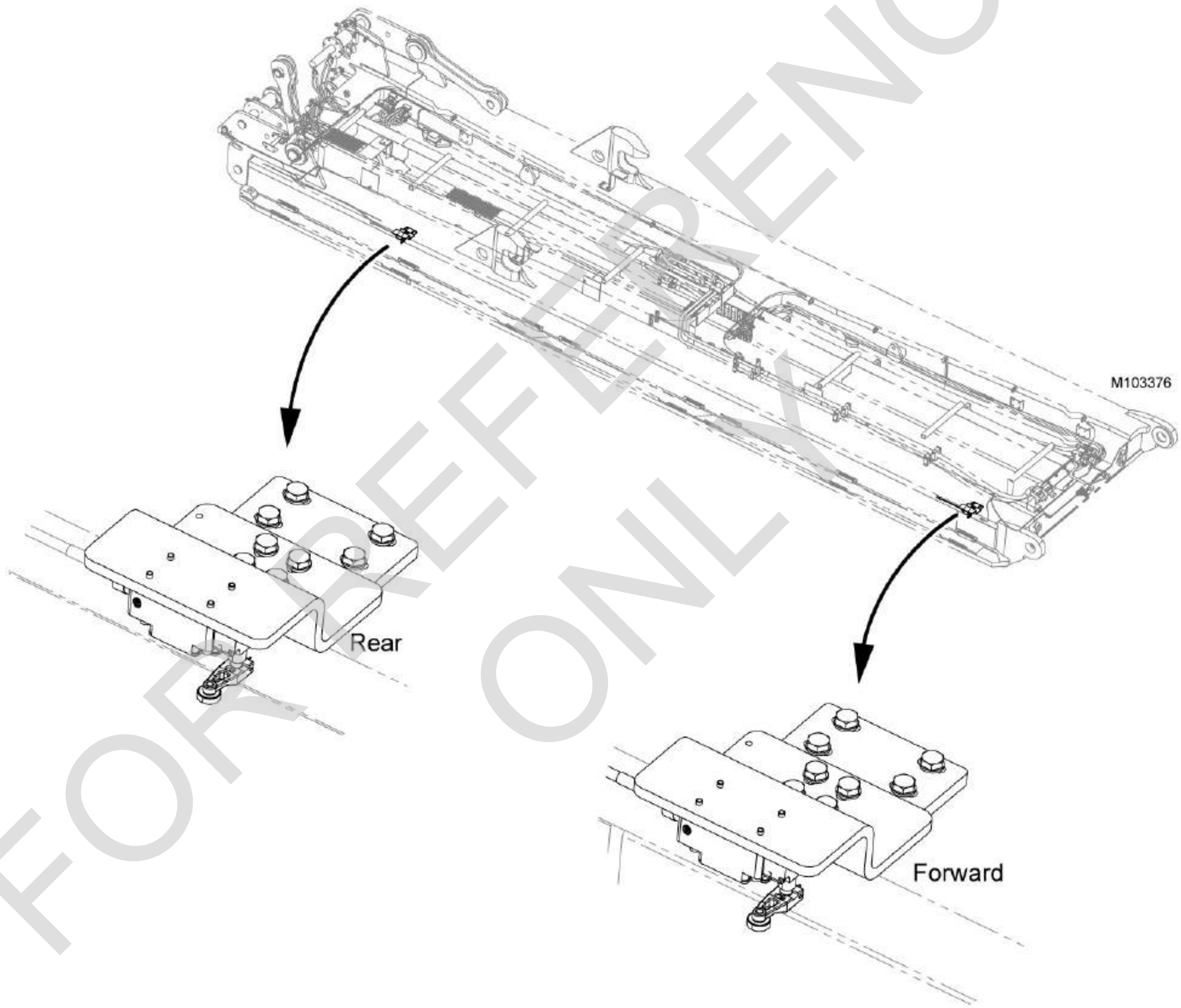


FIGURE 10-51

FOR REFERENCE ONLY

VPC-MAX Beam Up Limit Switch Adjustment

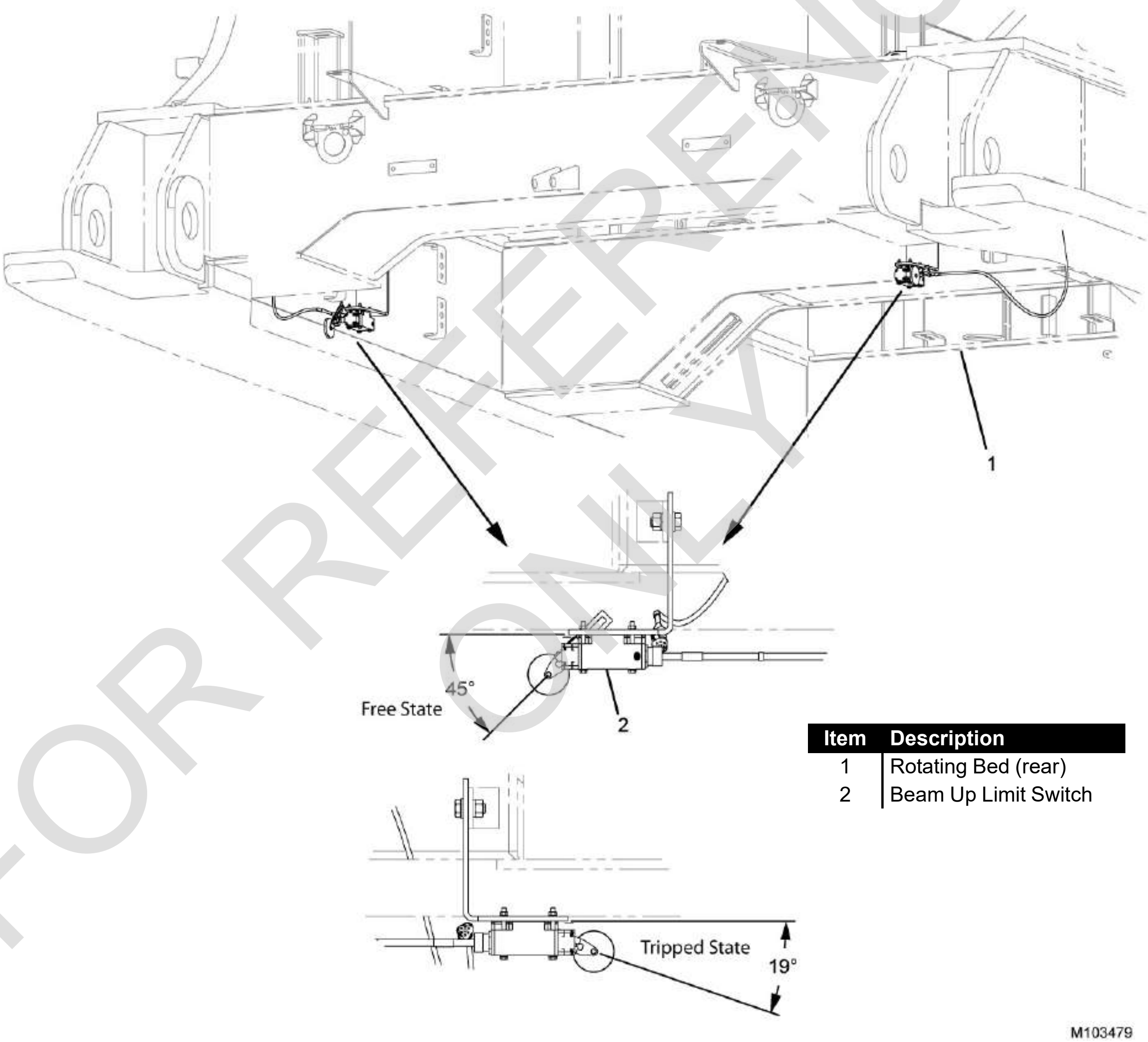
The VPC-MAX beam up limit switches require adjustment.

Beam Up Limit Switch Adjustment

See Figure 10-52 for the following procedure.

1. Set the adjustable limit switch arm to 32 mm (1.26 in).
2. Set the switch to trip when the bottom of the beam hook opening is 10 mm (0.39 in) away from contacting the bottom of the hook pin on the rotating bed.

   At this point the rack teeth at the end of the rotating bed should be approximately 15 mm (0.59 in) from the top of the beam.



Item	Description
1	Rotating Bed (rear)
2	Beam Up Limit Switch

FIGURE 10-52

FOR REFERENCE ONLY

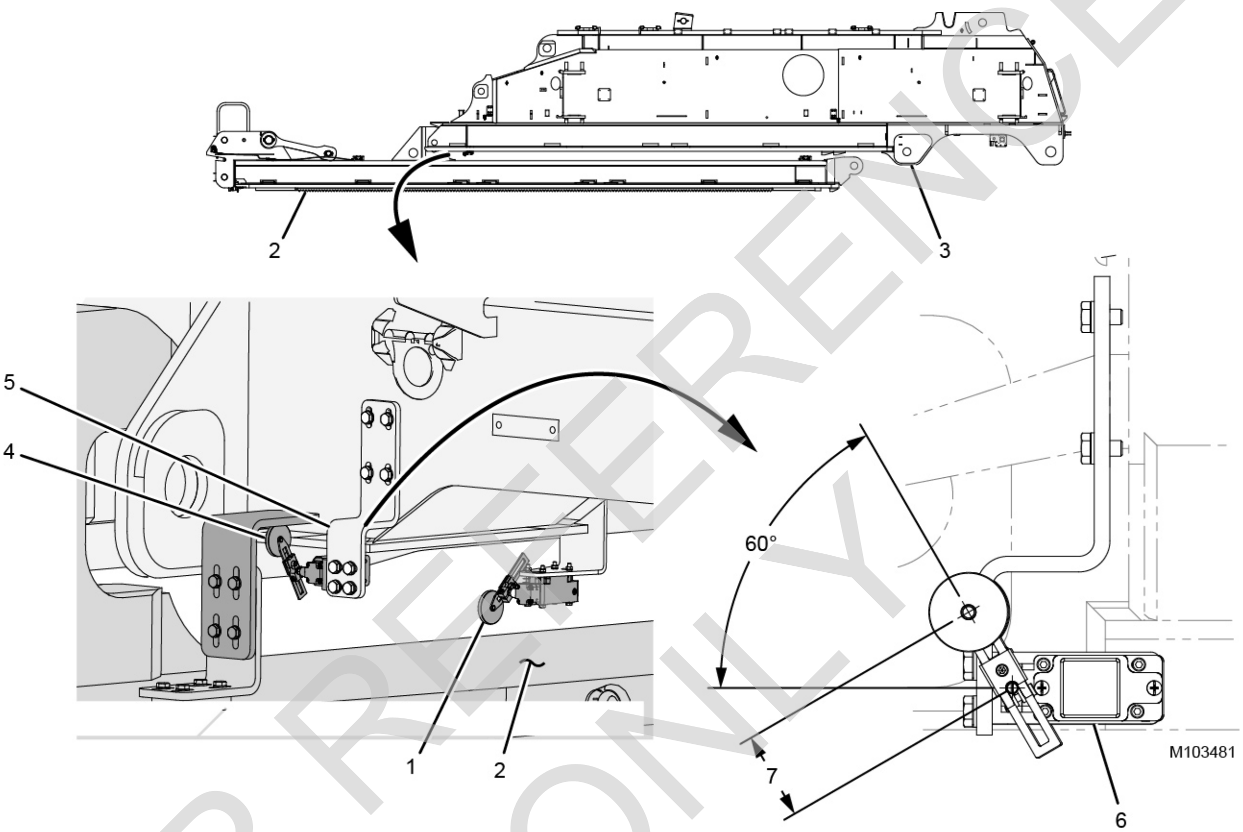
VPC-MAX On Hook Limit Switch Adjustment

The VPC-MAX on hook limit switches require adjustment.

On Hook Switch Adjustment

See Figure 10-53 for the following.

1. Set the adjustable limit switch arm to 56 mm (2 in).
2. Set the switch to trip when the beam hook is 10 mm (13/32 in) away from contacting the pin on the rear of the rotating bed.
3. The free state of the adjustable arm (4) is 60°, and the tripped state of the arm is 34°.



Item	Description
1	Beam Up Limit Switch
2	VPC-MAX Beam
3	Rotating Bed
4	On Hook Limit Switch Adjustable Arm
5	Switch Mount Bracket
6	On Hook Limit Switch
7	56 mm

FIGURE 10-53

FOR REFERENCE ONLY

ACTIVE FIXED MAST STOP SYSTEM

General

This part of Section 10 provides the electrical and hydraulic control of the active fixed mast stop (AFMS) system.

Additional component information for this system can be found in the following sections of the Service Manual:

- Section 2: Hydraulics
- Section 3: Electrical

See Figure 10-54 for an illustration of the active fixed mast stop.

See Figure 10-60 for the hydraulic schematic of the AFMS system circuit.

See Figure 10-61 for the electrical schematic of the AFMS system circuit.

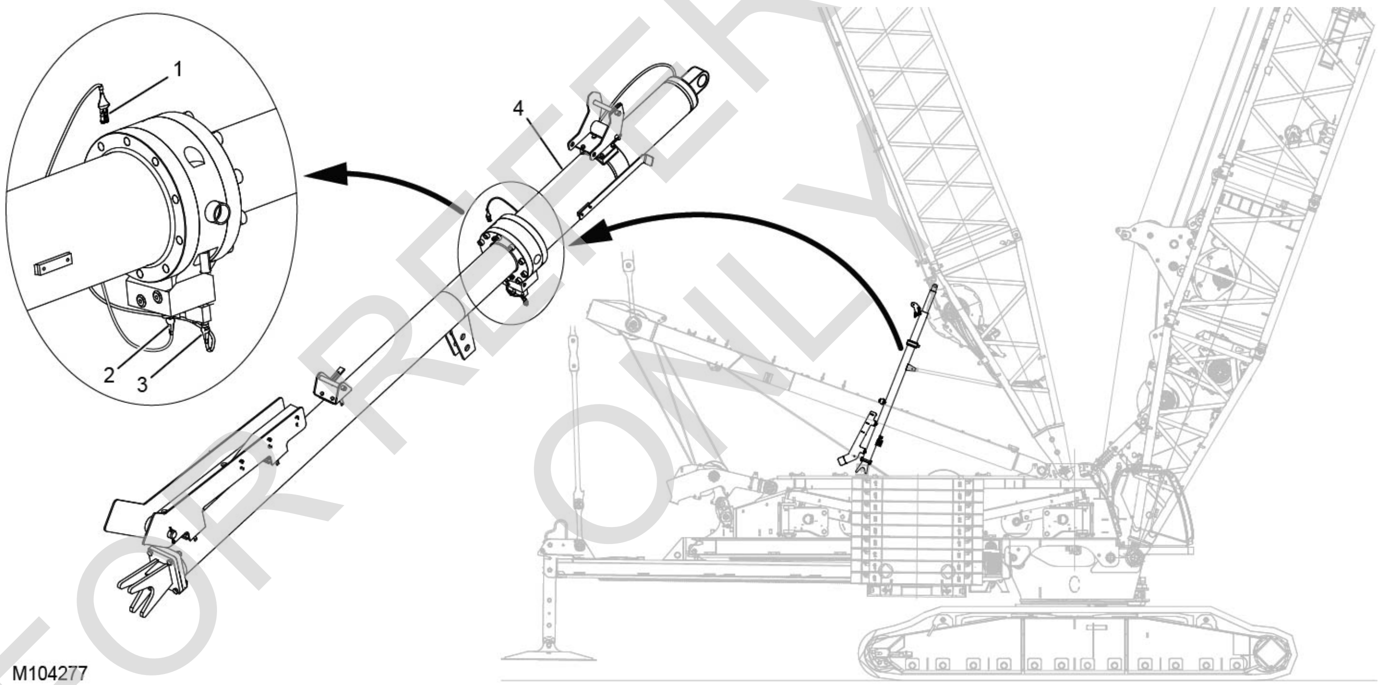
The AFMS system consists of two fixed mast stops, each containing an integral hydraulic cylinder. The AFMS system controls the pressure within the mast stop cylinders over the operational range of the cylinder as well as adapts to current crane conditions.

Each mast stop cylinder contains the following internal components:

- Hydraulic accumulator
- Pressure relief valve with bypass check valve
- Rupture disc

Each mast stop also uses the following (see Figure 10-54):

- Mast cylinder pressure transducer (1)
- Mast cylinder pressure-reducing solenoid valve (2)
- Mast cylinder directional control solenoid valve (3)
- Direct acting relief valve



Item	Description
1	Mast Cylinder Pressure Transducer
2	Mast Cylinder Pressure-Reducing Solenoid Valve
3	Mast Cylinder Directional Control Solenoid Valve
4	Mast Stop with Integral Hydraulic Cylinder

FIGURE 10-54

FOR REFERENCE ONLY

Active Fixed Mast Stop Operation

Hydraulic Supply

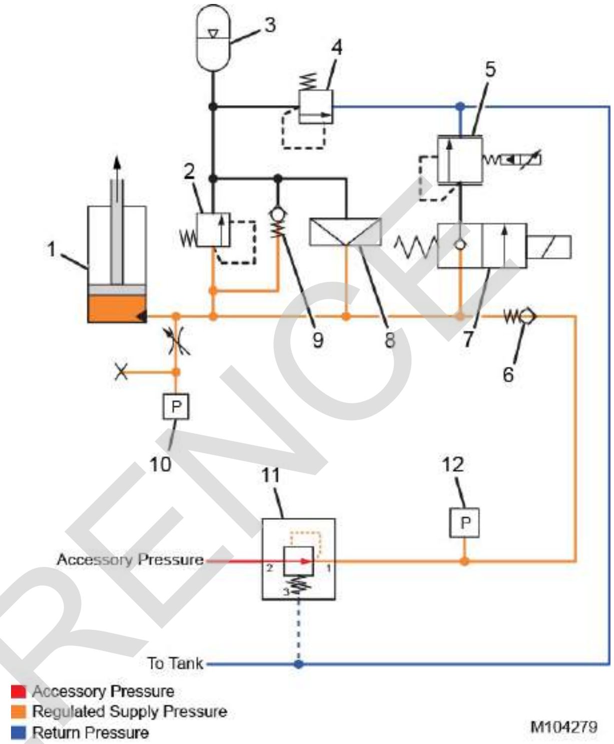
See Figure 10-55 for the following.

The hydraulic supply for the active fixed mast stop (AFMS) system is provided by the accessory pump. The mast cylinder system pressure-reducing valve (11) decreases the accessory pump pressure to the cylinder operating pressure of 31 bar (450 psi).

Normal Operation—Cylinder Extension

See Figure 10-55 for the following.

When the compressive load decreases on the mast stop cylinders, the pressure in the bore (piston) side of the cylinder decreases. When hydraulic pressure in the bore side of the cylinder decreases below the regulated supply pressure, the check valve (6) opens and allows hydraulic fluid to flow into the bore side until the pressure in the cylinder and the regulated supply pressure equalize. When this happens, the check valve closes.



Cylinder Extension

Item	Description
1	Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi])
3	Integrated Cylinder Accumulator
4	Relief Valve (set at 16,6 bar [240 psi])
5	Mast Cylinder Pressure-Reducing Solenoid Valve
6	Check Valve
7	Mast Cylinder Directional Control Solenoid Valve
8	Rupture Disc
9	Bypass Check Valve
10	Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer

FIGURE 10-55

FOR REFERENCE ONLY

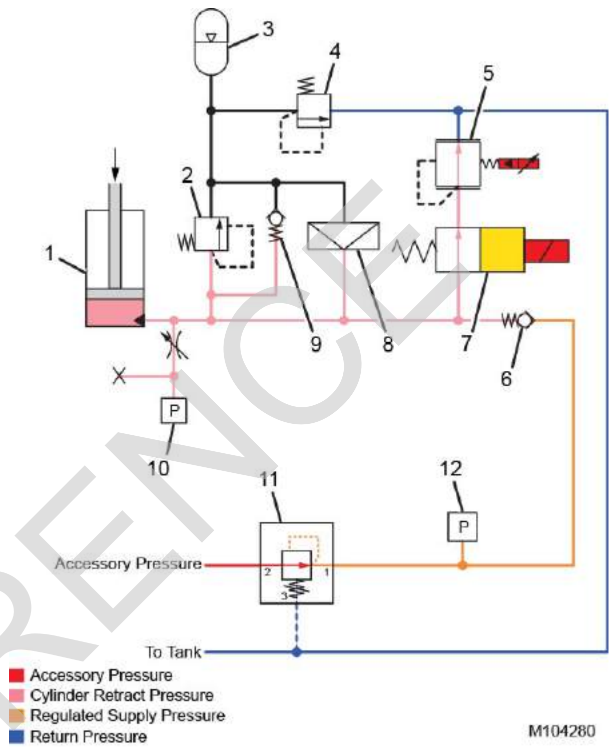
Normal Operation—Cylinder Retraction

See Figure 10-56 for the following.

When the load on the mast stop cylinder increases during cylinder retraction, the pressure on the bore side of the cylinder increases. The mast cylinder pressure transducer (10), located on each cylinder, detects this pressure and provides a feedback signal to the IOLC30 control module.

At this point, the cylinder pressure is higher than the system regulated supply pressure. This causes the check valve (6) to close, preventing hydraulic fluid from flowing back into the system supply circuit. The IOLC33 control module then sends a 24 VDC output voltage to the mast cylinder directional control solenoid valve (7), energizing the solenoid. The solenoid valve shifts position, allowing hydraulic fluid to flow to the mast cylinder pressure-reducing solenoid valve (5). At the same time, the IOLC30 control module sends a pulse width modulation (PWM) signal to this solenoid, modulating the solenoid valve to allow the high pressure oil to flow back to the hydraulic tank. This reduces the pressure in the cylinder bore until the target pressure is obtained.

NOTE: When the mast cylinder pressure-reducing solenoid valve is de-energized, the valve acts as a relief valve when the pressure becomes equal to or more than 241 bar (3500 psi). The relief setting provided by this valve is higher than the maximum operating pressure provided by the relief valve (2).



Cylinder Retraction

Item	Description
1	Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi])
3	Integrated Cylinder Accumulator
4	Relief Valve (set at 16,6 bar [240 psi])
5	Mast Cylinder Pressure-Reducing Solenoid Valve
6	Check Valve
7	Mast Cylinder Directional Control Solenoid Valve
8	Rupture Disc
9	Bypass Check Valve
10	Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer

FIGURE 10-56

FOR REFERENCE ONLY

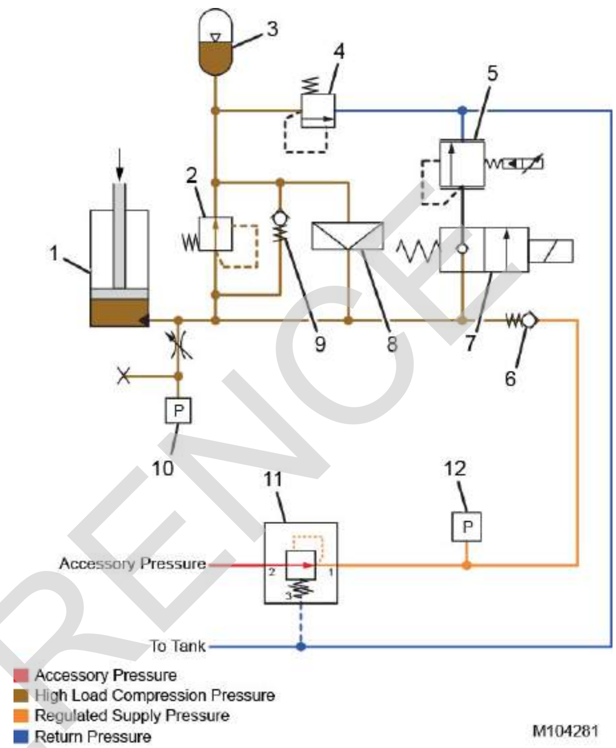
High Load Operation—Compression

See Figure 10-57 for the following.

When the active fixed mast stop (AFMS) system needs a higher load capability from the mast stop cylinder, the mast cylinder directional control solenoid valve (7) and the mast cylinder pressure-reducing solenoid valve (5) are de-energized. The higher cylinder pressure causes the check valve (6) to close, isolating the cylinder side of the circuit.

As the cylinder is compressed from the load and when the pressure reaches 221 bar (3200 psi), the relief valve (2) opens, allowing the hydraulic fluid to flow from the cylinder bore to the integrated cylinder accumulator (3), charging the accumulator.

A small portion of the hydraulic fluid stored in the accumulator flows through the relief valve (4) and back to the tank.



High Load Compression

Item	Description
1	Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi])
3	Integrated Cylinder Accumulator
4	Relief Valve (set at 16,6 bar [240 psi])
5	Mast Cylinder Pressure-Reducing Solenoid Valve
6	Check Valve
7	Mast Cylinder Directional Control Solenoid Valve
8	Rupture Disc
9	Bypass Check Valve
10	Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer

FIGURE 10-57

FOR REFERENCE ONLY

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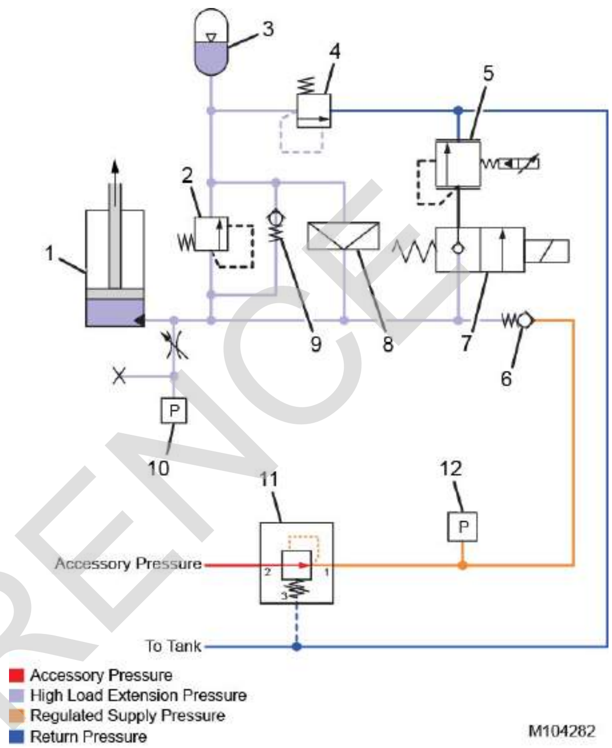
High Load Operation—Extension

See Figure 10-58 for the following.

After a high load event and when the mast stop cylinder starts to extend, a lower pressure is created in the cylinder bore versus the stored accumulator pressure. The higher pressure at the accumulator causes the bypass check valve (9) to open, allowing the hydraulic fluid stored in the accumulator to reenter the cylinder bore. Hydraulic fluid from the system supply circuit also flows to the cylinder bore via the check valve (6).

Once the system pressure has stabilized, the excess oil in the accumulator will bleed off through the relief valve (4) and return to the tank.



High Load Extension

Item	Description
1	Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi])
3	Integrated Cylinder Accumulator
4	Relief Valve (set at 16,6 bar [240 psi])
5	Mast Cylinder Pressure-Reducing Solenoid Valve
6	Check Valve
7	Mast Cylinder Directional Control Solenoid Valve
8	Rupture Disc
9	Bypass Check Valve
10	Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer

FIGURE 10-58

FOR REFERENCE ONLY

Loss of Load Operation

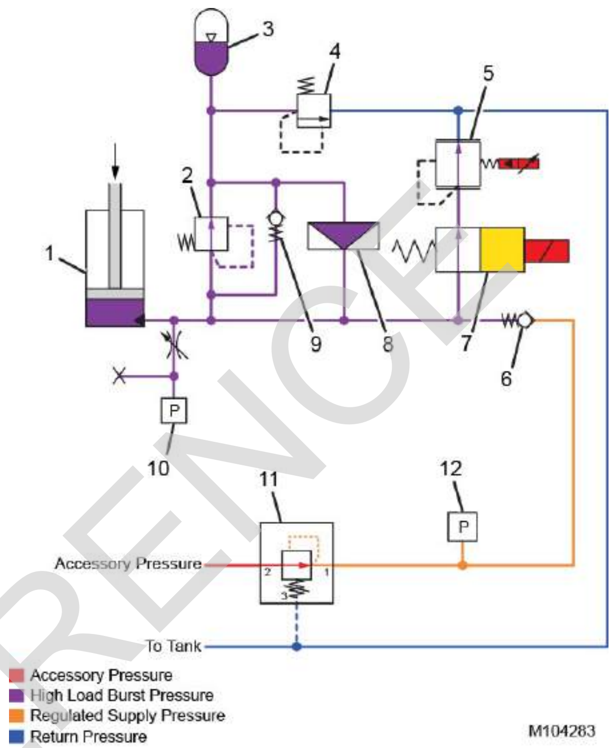
See Figure 10-59 for the following.

During normal cylinder retraction, the mast cylinder pressure-reducing solenoid valve (5) regulates the cylinder bore pressure. But during a load loss situation, the mast stop cylinders rapidly compress, causing a pressure spike. When the maximum hydraulic flow through the reducing valve is reached, the reducing valve will act as an orifice, causing the cylinder bore pressure to increase beyond the reducing valve setting.

When the pressure in the cylinder bore reaches 221 bar (3200 psi), the relief valve (2) opens, sending hydraulic fluid to the integrated cylinder accumulator (3), charging the accumulator.

If the cylinder bore pressure reaches 310 bar (4500 psi), the pressure differential across the relief valve will cause the rupture disc (8) to burst, allowing an additional flow path from the cylinder bore to the accumulator.

NOTE: Whenever a rupture disc bursts, it must be replaced and the whole cylinder fully inspected, including the seals and rod, prior to the cylinder being put back into service.



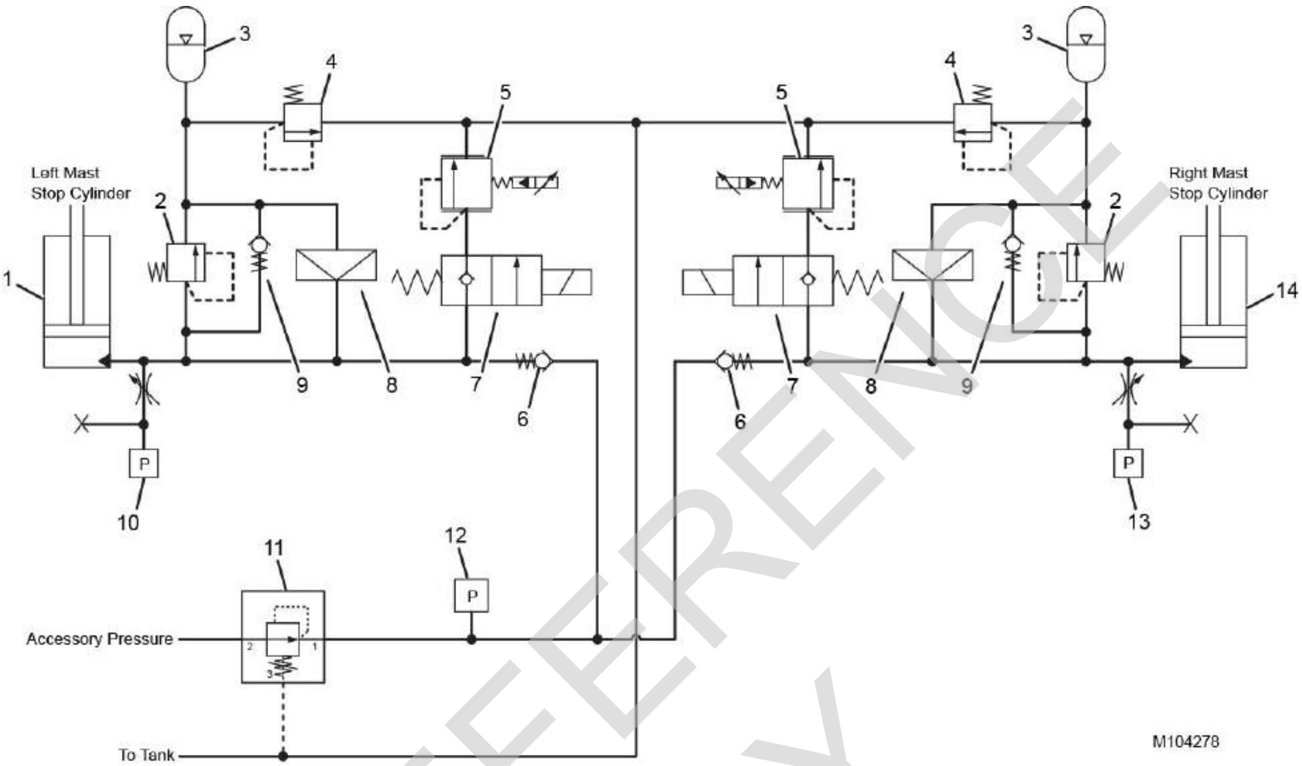
Loss of Load
(rupture disc shown burst)

Item	Description
1	Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi])
3	Integrated Cylinder Accumulator
4	Relief Valve (set at 16,6 bar [240 psi])
5	Mast Cylinder Pressure-Reducing Solenoid Valve
6	Check Valve
7	Mast Cylinder Directional Control Solenoid Valve
8	Rupture Disc
9	Bypass Check Valve
10	Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer

FIGURE 10-59

FOR REFERENCE ONLY

Active Fixed Mast Stop Hydraulic Schematic

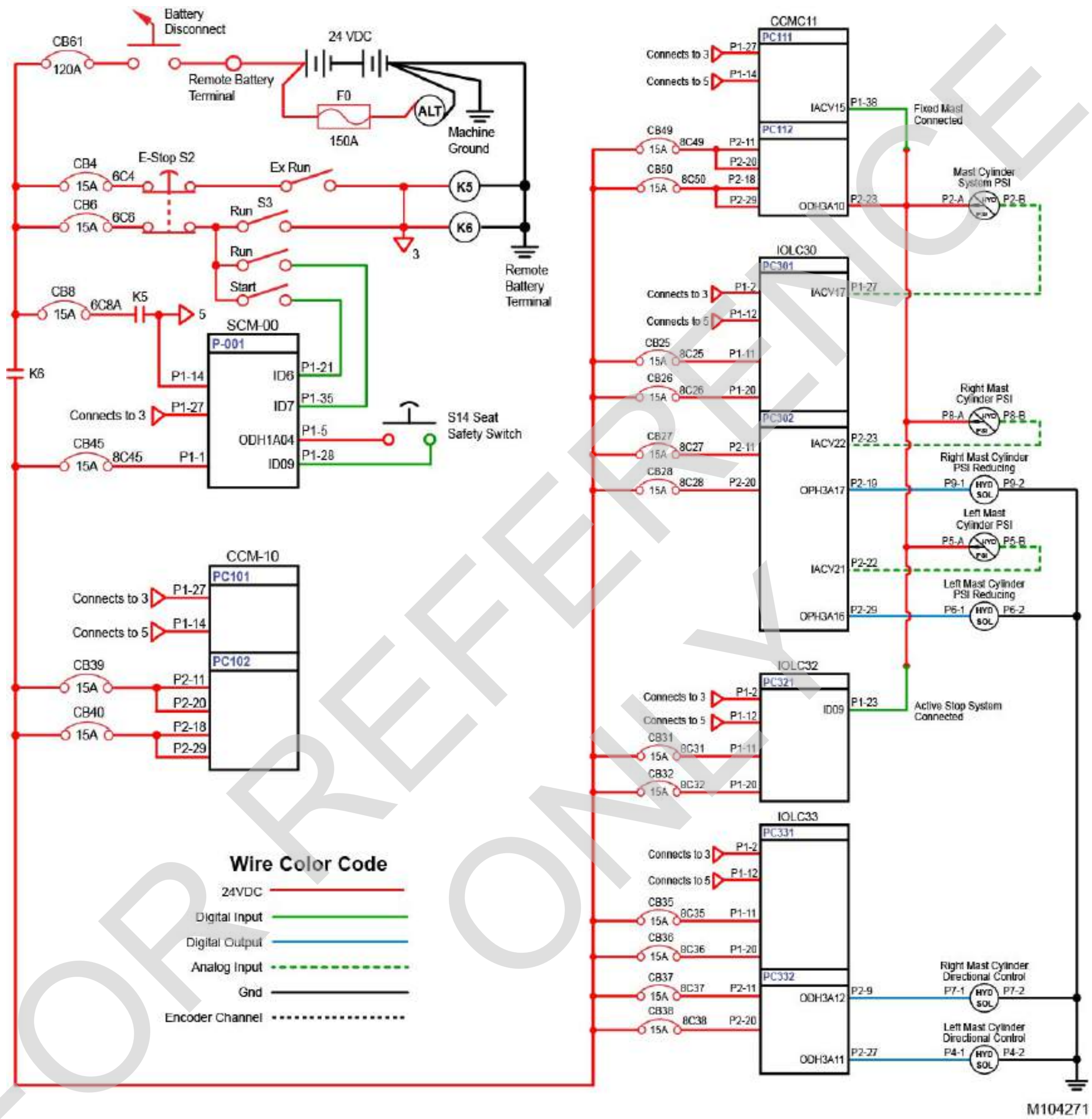


Item	Description
1	Left Mast Stop Cylinder
2	Relief Valve (set at 221 bar [3200 psi]) (qty 2)
3	Integrated Cylinder Accumulator (qty 2)
4	Relief Valve (set at 16,6 bar [240 psi]) (qty 2)
5	Mast Cylinder Pressure-Reducing Solenoid Valve (qty 2)
6	Check Valve (qty 2)
7	Mast Cylinder Directional Control Solenoid Valve (qty 2)
8	Rupture Disc (qty 2)
9	Bypass Check Valve (qty 2)
10	Left Mast Cylinder Pressure Transducer
11	Mast Cylinder System Pressure-Reducing Valve (set at 31 bar [450 psi])
12	Mast Cylinder System Pressure Transducer
13	Rignt Mast Cylinder Pressure Transducer
14	Right Mast Stop Cylinder

FIGURE 10-60

FOR REFERENCE ONLY

Active Fixed Mast Stop Electrical Schematic



FOR REFERENCE ONLY

FIGURE 10-61

ALPHABETICAL INDEX

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